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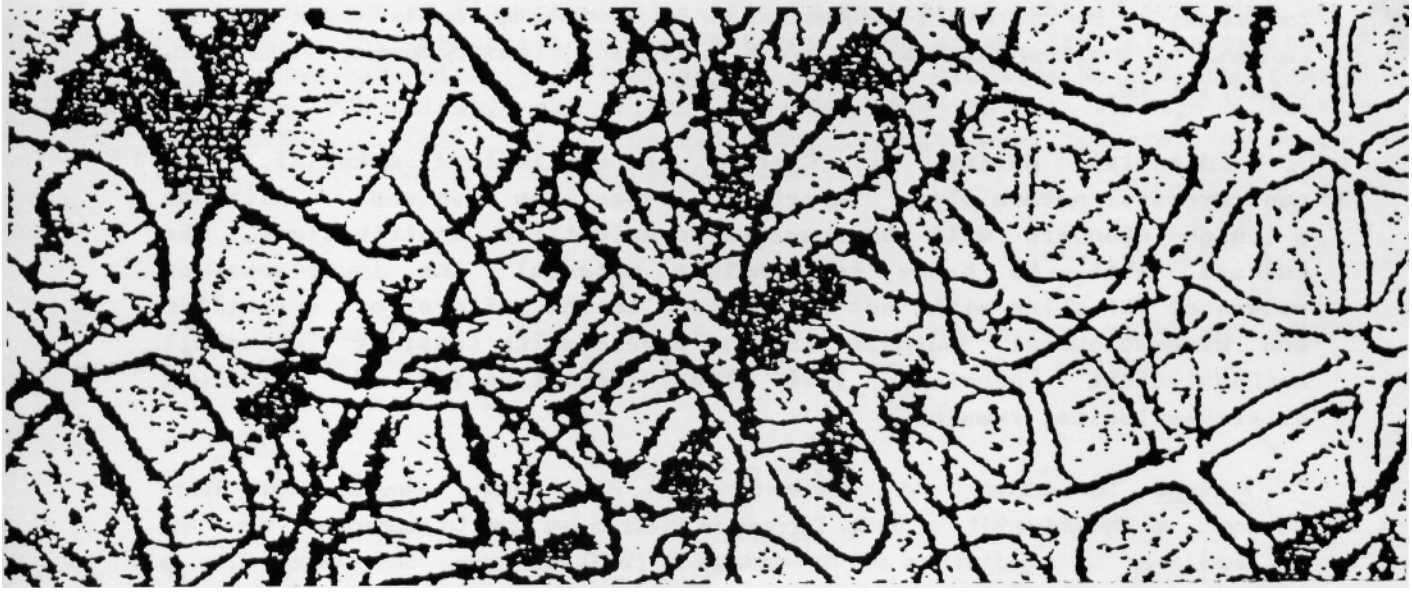

The Bulletin of the Association for Environmental Archaeology

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

The Newsletter of the Association, produced four times a year carries news about conferences and the business of the Association. It is edited by Vanessa Straker and Bruce Levitan, to whom copy should be sent c/o B. M. Levitan, University Museum, Parks Road, Oxford, 0X1 3PU.

Editorial policy for Circaea is to include material of a controversial nature where important issues are involved. Although a high standard will b6 required in scientific contributions, the Editors mill be happy to consider material the importance or relevance of which might not be apparent to the editors of scientific and archaeological journals, such as papers which consider in detail methodological problems like the identification of difficult bioarchaeological remains.

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

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EDITORIAL

This edition of Circaea is delayed by over a year, for which the Editors apologise profoundly (especially to the authors whose articles appear here). The principal reason for the hold-up has been simply that all three Editors have had too much to do in their regular employment, which has taken up evenings and weekends that would normally have been available for editing and producing Circaea.

There has been an additional complication, in that the daisy-wheel printer used for originating final copy broke down (as, indeed did all three editors) . The oft-invoked perceptive reader will notice that this editorial and some other parts of this issue have been produced on a different printer with a somewhat different typeface.

Both parts of Volume 7, it is hoped and intended, will be produced soon, using new technology and hardware, and are likely to have a new appearance. However, the instructions for authors given in this issue will continue to apply. We have some material for Volume 8, so part 1 at least should appear in 1990, the year in which Volume 8 will be due. Please continue to provide copy - we hope that publication time will be shorter in future. Authors wishing to supply copy on disk, something which our aching fingers would certainly appreciate, should note that we will be using Wordstar 5 running through MSDos on an IBM AT-compatible microcomputer with 5.25 inch drive. Transfer can also be effected from Amstrad PCW disks, and files can be sent to us through Janet (BIOL6@UK.AC.YORK). If you do send copy through Janet, please drop us a line to say that you have done so, however.

Erratum

Circaea Vol. 6, no. 1, p. 74, 10th line from bottom: 'n = 14' not 'n = 4'. We apologise to Marijke van der Veen for this error.

MISCELLANY

S. J. G. Hall and J. Glutton-Brock (1989). Two hundred years of British farm livestock. British Museum (Natural History). 272 pp., £19.50.

A coffee table book for archaeozoologists? Yes, and at coffee table prices. The BM(NH) is not cheap, but this is a very nice volume full of highly instructive pictures, for example of the Old English pig, pre-Far Eastern influence. If Great-Aunt Agatha's book-token won't quite run to it, nor one's institutional book budget, nag your public library. It won't hurt the general public to know a bit more about our agricultural past either.

Barbara Noddle

Front cover: Derived from a photomicrograph of remains of a keratinous sponge from Roman Tanner Row, York. Original photograph: Philippa Tomlinson.

Science-Based Archaeology in Wales

(Some notes on a Conference held at the University of Wales, College of Cardiff (UWCC) on December 16th 1988.)

This conference took place under the chairmanship of Professor Keith Branigan, and in the part-time presence of a Minister of State of the Welsh Office. The first scientific address came from Dr. Mark Pollard, the SERC representative in Cardiff, who put in an eloquent plea for another contract worker to be placed in the University by CADW (Welsh for English Heritage), specialising in geophysical survey and/or metallurgy. He was not in favour of freelance workers and, as he put it, cottage industry. Dr Quintin Dresser (of UWCC strongly supported by CADW) gave an account of radiocarbon dating; he operates the Cardiff laboratory. David Watkinson, who holds a CADW contract in UWCC dealing with conservation, gave an account of the teaching of this subject at Cardiff and his activities as a whole. Metallurgy was discussed in more detail by Peter Crew (Snowdonia National Park) who wished to educate field archaeologists to take more interest in the subject and to make a more rational collection of slag samples. Carl Hever gave an account of the latest one-man geo-surveying implements and begged for their wider use. He also showed a photograph of Professor Atkinson's prototype instrument dating from the days BC (in Wales that means Before CADW).

Biology then took over. Dr John Evans gave an account of mollusc work, both marine and terrestrial. Uniquely, he did not put in a plea for more money. Lunch then intervened. The recent merger has done nothing for the catering departments of either University College Cardiff or University of Wales Institute of Science and Technology. We were offered some lukewarm structures looking remarkably like one of Bone Jones' favourite topics of study, although they perhaps tasted better. Martin Bell (St David's University College, Lampeter) then described in his usual lucid manner the study of plant remains in Wales. Apparently some neolithic muesli has been discovered in Aberystwyth. As the nearest full-time professional archaeozoologist is situated at Oxford, I was called upon to speak on the study of non-human bones in Wales. As an amateur, not to mention a cottage industry, I felt free to ignore my brief and requested that animal bones be taken seriously as part of the agricultural if not industrial scene, and not just as the remains of the Sunday dinner of one of the more fortunate members of society. Since a request for a full-time archaeozoologist would be unrealistic in a place with such extensive acid soils as there are in Wales, I recommended that the subject should be in the charge of someone familiar with local conditions and previous work. That would seem to be one of the numerous tasks of Astrid Caseldine (Lampeter), who has recently been appointed by CADW to consolidate biological studies. I also suggested that an archive of all Welsh site reports, published or otherwise, and any data available on animal husbandry of the past, should be assembled, translating from the Welsh where necessary.

Dr Clifford Price then gave an account of the Ancient Monuments Laboratory, using their favourite pie diagrams to illustrate the proportions of various activities and finance. He implied that more money was in fact being spent than the diagrams indicated. It would appear that AML staff cannot be accepted into the Scientific Civil Service for political reasons, and that they cannot receive additional finance from development funds for bureaucratic ones. Bill Britnell, Director of the Clwyd-Powys Archaeological Trust, then gave what he termed a consumer's viewpoint. He suggested in-service training for excavators in order that they should know what and how many samples to take in a given situation. This viewpoint was endorsed from the floor. The final speaker was Richard Avent of CADW. He complained that CADW was expected to fund everything out of very little and got blamed for everything regardless. He than added that the Welsh Office had actually produced some more money. Unfortunately someone asked how much, and it transpired that a £5000 cut in funds had been graciously restored. There must be a Welsh word for this. It was certainly of no assistance to the hard-pressed museum conservators, of whom there are currently 2.5 for the whole Principality.

The highly successful organisation and pleasant atmosphere of the conference were in no small part due to the enthusiasm and energy of its organiser Kate Hunter, (Conservation, UWCC). However, to be serious, the situation for environmental archaeology in Wales is far from splendid. Development money is not going to do much for us, except perhaps in limited parts of Glamorgan and Gwent. One bright spark, however: conservators have increased by about *27%;* the Newport Museum has just appointed its own, as I was informed afterwards.

We have an environmental problem of potentially immense proportions, a second Severn Bridge having been sanctioned and the Severn littoral on the Welsh bank is absolutely stiff with well-preserved artefacts. How on earth, or perhaps in this context on mud, are we going to cope?

Barbara Noddle

Displacement of bone waste by seagulls

The dispersal of bone remains by other animals has been discussed, but I am not aware of any record of the following. This comes from an unpublished note 01 mine dated 1974 and found in the notes of the lectures on animal remains which I used to give to the Edinburgh archaeological students. During my 25 years in Edinburgh I never lost an opportunity to visit any of the islands in the Firth of Forth, boat trips being organised by the Edinburgh Natural History Society.

During visits to the uninhabited islands of Fidra and especially Craigleith, which lies one mile off North Berwick, I found them littered with beef and sheepmeat bones. There were examples of cow and sheep ribs, sheep scapula, tibia, and sections of femur from Scottish gigot chops - all recognisable joints suggesting human occupation. Yet the bones had been brought by the seagulls nesting on these islands, no doubt from a refuse tip on the shore, and carried whilst they still had some meat attached. These domestic animal remains were associated with wild bird and fish bones from prey caught by the gulls, so reinforcing the impression of human food remains actually accumulated on this site. It is useful to be aware of what is possible when faced with the interpretation of unusual or unexpected assemblages.

Another facet of interpretation was indicated by seagull bones: many of these were broken, and some of the breaks were so clean that they appeared like saw-cuts. Finally the name 'Fidra' means 'feather island' and dates from the time when Norse settlers used to 'farm' eider duck to collect the down from their nests.

N. L. Ryder

Archaeozoology in East Germany

Last summer I made a British Council Scientific Exchange visit to DDR to study sheep husbandry and in particular to gain information on fine-woolled Merino sheep. I also visited archaeozoologists in Berlin (Dr. H.-H. Müller and colleagues) and in Halle, scoured art galleries in Berlin and Leipzig for paintings of past livestock, and visited Erfurt Zoo, which is famous for keeping unimproved breeds of farm animal. Germany has a long tradition of interest in domestic animals. The first agricultural department of any German university was started in Halle in 1863 by Prof. Julius Kuhn (1825-191D) who began research on domestication and the development of different breeds that was to end only with the First World War.

Prof. Kuhn kept examples of the wild ancestors of livestock in yards at the University within the city and was the first to research the domestication process by cross-breeding, for example, domestic horses and pigs with wild forms of those animals. The results of his research were preserved as the skins and skeletons of the many experimental animals, many of which were mounted to give stuffed examples of how they appeared in life. We are fortunate that this collection survived two World Wars and the recent efforts of the university authorities to get rid of the old bones. For the latter we must thank archaeozoologist Dr M. Teichert who for 30 years has fought to establish a proper museum for this material, a visit to which formed a highlight of my trip.

I was particularly interested in the sheep and goats, which included the Bharal (Pseudovis nayaur), as well as the Argali and Urial wild sheep. There were crosses of the Argali with the Merino which had retained a short tail, but acquired a white woolly fleece. This contrasts with my own crosses of the Mouflon with the Merino, which although having more underwool, retained outer coat hairs. There were also examples of crosses of Angora goats with 'ordinary' goats, a cross that is common today in upgrading the latter for mohair production. An excellent booklet produced by the museum has photos taken about 1911 showing wild horses obtained in 1901, the range of cattle breeds kept, and Prof. S. von Nathusius who was director of this research centre from 1910 to 1914.

Other impressive museums were the Archaeology Museum in Halle - where I saw a replica of the famous Jordansmuhle horned ram from the Silesian TRB in Poland (mentioned on pp. 72 and 78B of my Sheep and Man) and judged the corded decoration not to be a fleece - and the Ethnography Museum in Leipzig, which specialises in Soviet Eurasia, an area not well known in the West.

In addition to East Berlin zoo, I visited the zoo at Erfurt, where I was honoured that the Director, Prof. Altman, had put on a special demonstration of sheep and goats for me, collected from different parts of the zoo and put into pens for the occasion. I was interested to see for the first time the bezoar wild goat of Iran and Turkey, which was the main ancestor of domestic goats, as well as the markhor of Afghanistan. This has corkscrew horns, whereas the bezoar has large horns with a sabre curve. There were short-haired black goats from Syria and long-haired Asiatic goats from Tadjikistan.

The only African breed was the Damara of Angola, which had surprisingly long hair and much underwool for an animal living in a hot climate. The Bulganan, a Balkan type with corkscrew horns and a thick coat, brought us back to Europe. The native goat of the region, the Thüringer Wald or Land Goat, was of particular interest at Erfurt. This had a short, tan coat with black extremities, and the herd had just produced the first white kid in eighteen generations. Other European goats on show were the white Swedish Jamtland and the Swiss Walisser (Valais) breed, which has the same black foreparts as the Bagot in Britain.

The most exotic sheep being kept was the Mongolian, a hairy black-headed breed with a short fat tail. Prof. Altman had shown that this type of tail can be produced by crossing a breed with a long fat tail with a fat-rumped breed. An example of a fat-rumped breed on show was the polled and lop-eared Hissar of Soviet Central Asia, which has a brown hairy fleece. From Africa there were polled ewes of the Cameroon Dwarf breed with the hair coat that sheep had in the past before a fleece was developed.

There was the hairy Racka (pronounced Ratska) breed of Hungary, with corkscrew horns, and the remainder were native breeds of Germany, which I shall describe elsewhere.

N. L. Ryder

O'Connor, T. P. (1989). Bones from the General Accident Site. The Archaeology of York 15(2) (London: Council for British Archaeology). 75pp, 4 pi. Price: £10.00

The report describes and discusses the hand-collected bones from deposits at 24-30 Tanner Row ('General Accident site'), dating from the Roman to the medieval period. Bones recovered by sieving 154 soil samples from Tanner Row and 19 samples from 5 Rougier Street were also studied. The sites are located south-west of the River Ouse in York. They are situated within the area of the Roman colonia, close to the presumed location of the Roman bridge. A fine, but rather mysterious dessert is served at the end of the report by Andrew Jones, who discusses over 5000 bones of Clupeidae-(herring and sprat) found at an excavation in the cemetery of ther church of St Mary Bishophill Junior, not far from the other sites.

The "nearly 20,000 hand-collected bones from the 'General Accident site' can be dated to 11 periods, from the mid 2nd to the early 13th centuries. The bulk of the material derives from two main periods: the late 2nd to early 3rd centuries and the 12th to 13th centuries AD. So far, only little research has been carried out on Roman bone from York, so this corpus of material offered the opportunity for a good characterisation of Roman livestock and husbandry practices, both from hand-collected and sieved remains. The medieval material allowed comparison with results from Skeldergate (Archaeology of York 15(1)).

The thorough study by Terry O'Connor can best be described by complimenting the completeness of the research and the way in which the material is presented. In his introduction, the purpose of the study, the documentation, and details of final storage of the archiveare included. After a short introduction to the archaeology, the paragraph on materials and methods clearly indicates the procedures followed. There can be no misunderstanding, when judging the results and tables presented later on, about the way the material was studied and recorded. Towards the end of the study, the results are reconsidered in the paragraph 'Assessment of the Methodology'.

I fully agree with the author's remarks that 1-2mm residues do not add much to the information obtained by studying the remains larger than 2mm. In the case of very 'bone-rich' archaeological sites 'it is not necessary to sieve through twenty tonnes of sediment to recover a single specimen of, for example, great-crested grebe (Podiceps cristatus L.)' when one wonders about 'the place of this species in the Roman economy or natural history' (p. 122, last line). Instead, it is better to concentrate on studying bones from other, contemporaneous, sites within York or other comparable places, in order to get a more valid overall picture for the period.

It is a pity that O'Connor's table 18 (presenting the hand-collected specimens) does not contain percentages for each of the major taxa. I always like to get acquainted with bone data for a newly-published site in this way; this time *I* had to put new batteries in my calculator first.

A few other short remarks, before discussing the main results: the way of presenting the absolute and relative frequencies in tables 19 and 20 seems very useful and deserves to be followed as standard in other publications. In my opinion, the abundant cattle remains (horn-cores and metapodia) should have been studied for sex discrimination. Scattergrams 11-13 clearly indicate the presence of cow, bull and steer. I fully agree, however, that the possible mix of different races within the cattle population present some danger when doing this. But sex discrimination could have presented, for instance, a better explanation for the large animals from period 7 (fig. 13). It seems logical to explain these animals as males, indicating not primarily a shift towards larger animals but instead possible different breeding or slaughtering procedures (i.e. more male animals in the population). Because of lack of time, it was not possible for me to put the measurements for horn-cores and metapodia (available on the microfiche accompanying the report) into my computer. I hope to do so in the near future.

Before discussing the more general results, it should be taken into consideration that, although the amount of bone from the General Accident site was moderately large, it only represents a tiny part of Roman York, with certainly many different activity-, production-, or consumption aspects.

The main conclusions of the study, regarding the Roman period, are closely linked to the period of the founding of the colonia. During periof 5 (late 2nd-early 3rd century) there is strong evidence for the deposition of highly selected bone assemblages, the contents of which imply that certain meat products (and specifically marrow extraction?) were being handled on a commercial rather than a domestic scale. Smashed-up cattle limb bones and 'boned-out' scapulae have also been recorded from other Roman sites in north-west Europe, and thus clearly indicate a wide spread throughout the Empire. The explanation for the absence of so many of the epiphysis fragments may be that they were transported elsewhere for the manufacture of soup or broth. The Roman people living or working at the General Accident site were, perhaps, specialists in chopping up cattle diaphyses for purposes about which one can only speculate.

I don't agree with Terry's remark on p. 117 (third line) that the concentration of 'Celtic Shorhorn' cattle horncores has to be considered as a change in marketing practice. I rather interpret this in the light of the previous remark on the size of the excavation inside the very large colonia. It should be considered as a 'coincidental' occurrence, indicating that someone collected the horncores and did something with them or, better, with the horn itself.

The founding of the colonia can probably also be seen in the shift from wild goose to mallard and, almost certainly, in the luxury of abundant mice (Mus musculus domesticus) and black rats (Rattus rattus).

Particularly interesting is the story of the garden dormouse (*Eliomys* quercinus). Only last year the first example of this species was found in the Netherlands, near the *castellum* of Valkenburg. The presence of the species in the Netherlands was explained by us as importation during the transportation of some kind of nutriment (?grain). After reading O'Connor's report, a possible new item on the Roman menu may have to be considered as an alternative explanation, although the garden dormouse is a lot smaller than its edible relative (Glis) and, besides that, the numbers of bones are quite small.

The medieval bones also indicate evidence of industrial activity. Accumulations of cattle and goat horncores indicate a horn industry. The site itself gave evidence that it was used mainly for rubbish disposal, so the bones may indicate the usual domestic dump.

There are many more very digestible chunks in the report, as well as tasty desserts. I conclude with one of Terry's 'recommendations' (p. 123, third line): each animal bone requires 'different procedures for obtaining and examining the data' as long as they are well explained and 'directed towards simplicity of application and interpretation, both for practical and theoretical reasons'.

Gerard Uzereef, Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort, the Netherlands

Circaea volume 6 number 2, 1990 (for 1988), pages 91-96

The application of present-day cereal processing studies to charred archaeobotanical remains

Glynis Jones *

Data from a botanical study of present-day cereal processing in Greece are presented. The most appropriate ways of using these data as the basis for identifying the effects of cereal processing in archaeological material are then discussed.

Introduction

Contemporary low-technology farmers offer a rare opportunity to collect quantitative information on crop composition from a range of directly observable processing activities. The main purpose of this paper is t" make available some of the data from a study of present-day cereal processing on the Greek island of Amorgos. In addition, some suggestions are made about the most appropriate ways of using these data for comparison with archaeological material.

Data collection

The cereals cultivated on Amorgos were all free-threshing, and included wheat (both bread wheat, Triticum aestivum L. and macaroni wheat, T. durum Desf.) and barley (six-row hulled barley, Hordeum vulgare L.). These were often grown together, in varying proportions, as a maslin crop. Samples were collected from winnowing by-products (carried aside by the breeze), coarse-sieve by-products (retained by a sieve which allowed the grain to pass through it), fine-sieve by-products (passing through a sieve which retained the grain) and cleaned products (sieved grain). Ninety-nine samples were taken altogether and sub-samples sorted to give, where possible, a minimum of approximately 300 weed seeds per sample (Jones 1984).

Before quantifying the data, it was necessary to consider which items to count. One possibility was to count all fragments of grains and chaff, and to use these in the calculations of percentages. This could cause problems, however, especially when applied to archaeological material, as the degree of fragmentation may vary between sites and between different contexts within a site. This problem is similar to that experienced by bone analysts using the 'fragments method' of quantification (Uerpmann 1973). One way of standardising bone counts is to count diagnostic zones on each bone (Watson 1979).

* Dr Glynis Jones, Department of Archaeology and Prehistory, University of Sheffield, Sheffield 310 2TM, U.K.

Applying a similar technique to charred cereal remains, one could count only the embryo ends of grains (G. C. Hillman pers. comm.), the glume bases (of glume wheats), or the tops of rachis internodes (for free-threshing cereals), and the nodes of straw. These are the parts of the cereal plant most likely to survive in an identifiable state in charred archaeological assemblages. It should be emphasised, however, that this is not intended as a method for estimating absolute grain quantity, numbers of ears, or numbers of plants represented, but simply as a method of standardising counting to permit reliable comparisons. This method was applied to the samples collected on Amorgos.

Results and discussion

The number of items from each sample is given in Table 6. The wheat and barley figures are given separately, but the figures for bread wheat and macaroni wheat are combined as it was not always possible to distinguish the grain from these two species. As all the barley was six-row (three grains per rachis node) and the wheats had an average of approximately three grains per spikelet (and so per rachis node), and as the two cereals were processed in exactly the same way (see Jones 1984 and Halstead and Jones in press, for more detail of the processing sequence), it is not unreasonable to calculate the relative proportions of grains, rachis internodes and weed seeds for both genera together.

Glume wheats (e.g. emmer, T. dicoccum Schtibl., and spelt, T. spelta L.) were not grown on Amorgos and require a different processing sequence to free-threshing cereals (Hillman 1981; 1984): the glumes and rachises of free-threshing cereals are removed at an earlier stage in the processing sequence than those of glume wheats (but the glume bases of free-threshing cereals are rarely preserved archaeologically). Sometimes, however, glume wheats and free-threshing cereals have been treated together in calculations of the relative proportions of grain, chaff and weed seed. While this is a very convenient way of expressing the composition of samples and lends itself easily to visual presentation in the form of a 'triangular diagram', it can be misleading when both free-threshing cereals and glume wheats are involved. For example, as rachis internodes of free-threshing cereals (e.g. barley) tend to occur less frequently on archaeological sites than the glume bases of glume wheats (e.g. emmer; Green 1981), there is a danger that the relative proportions of grain and 'chaff' will, instead, reflect the relative proportions of the two types of cereal (Jones 1987).

Unfortunately, in mixed samples, it is not possible to calculate the relative proportions of grain, chaff and weeds seeds for glume wheats and free-threshing cereals separately, as it is impossible to determine which weed seeds were associated with which crop species. Perhaps the best way to overcome this problem is to adopt a multivariate approach (cf. Jones 1984; 1987). Rather than trying to reduce the variation in sample composition to summary percentages from which a triangular diagram can be constructed, the ratio of grain to chaff can be calculated separately for each crop species. The ratio of total grain (or chaff) to weed seed can then be calculated independently, as can the ratios of straw to grain (or chaff), and the percentages of different weed types. Arguably, this is the only satisfactory way of dealing with a mixture of glume wheats and free-threshing cereals. However, at sites with only one type of cereal, it may be possible to make some use of simpler summary statistics.

By comparing the percentages in Table 6, one can get an idea of the proportions which characterised each type of (by-)product on Amorgos. So, the winnowing by-products had about *50%* or more rachis internodes and, with five exceptions, more weed seed than grain. The coarse-sieve by-products had more than 30% rachis internodes, with varying proportions of grain and weed seed, while the fine-sieve by-products had more than 50% weed seed and very few rachis internodes. Cleaned (sieved) products had more than 80% (and usually more than 95%) grain with a very low proportion of rachis internodes.

When comparing these figures with data from archaeological samples, it should be borne in mind that the thoroughness of winnowing and sieving may vary, depending on the strength of the breeze, whether the crop is intended for animal or human consumption, and so on. Even more significantly, the quantity of weed harvested with the crop may vary greatly. Moreover, the ratio of grain to rachis internodes will not always approximate to 3:1 as it did for the material collected on Amorgos. Finally, caution is necessary as some of these components (e.g. grain) are more likely to be preserved by charring than others (e.g. rachis internodes; Boardman and Jones forthcoming). Nevertheless, these figures provide some guide to what might be expected for each type of (by-)product. The percentages can also be used to construct triangular diagrams (cf. van der Veen 1985), which can be used in visual comparison with archaeological samples of free-threshing cereals only (Fig. 14). More information could be included in the percentages by adding numbers of straw nodes. Above all, where possible, the types of weed seeds (classified according to their size, aerodynamic properties, etc. - cf. Jones 1984; 1987) should be used as a check on conclusions based on relative quantities of weed, chaff and grain.

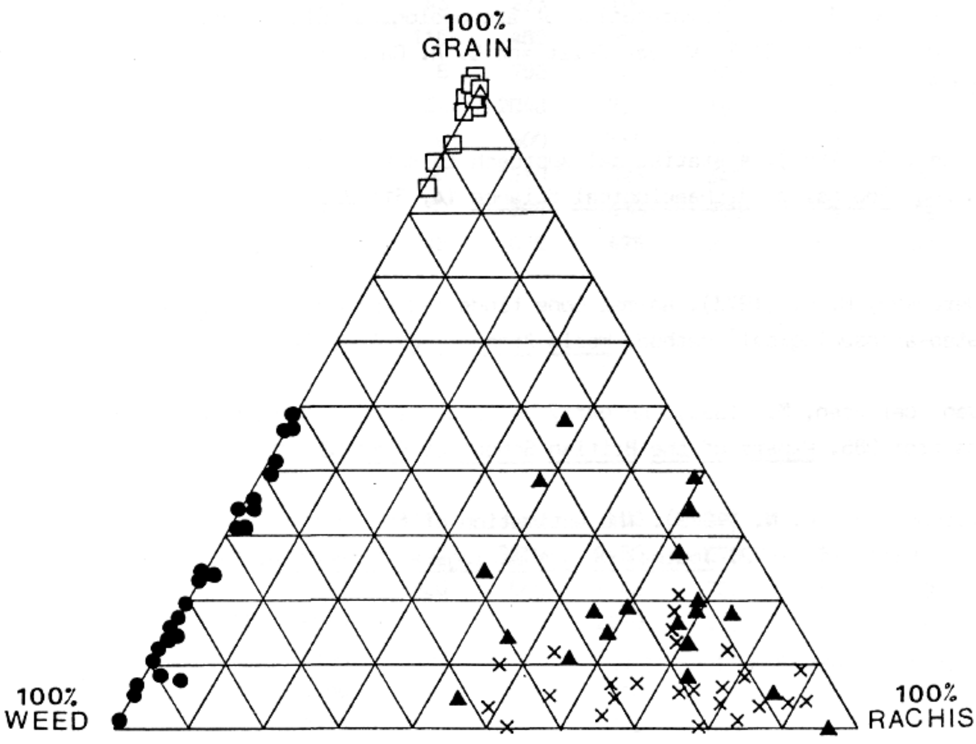

Figure 14. Diagram showing the relative proportion of grains, rachis internodes, and weed seeds in crop processing products and by-products for free-threshing cereals. Key: cross - winnowing by-products; circle - fine-sieve by-products; triangle - coarse-sieve by-products; square - cleaned products.

Acknowledgments

I am grateful to Josie Murray and Marijke van der Veen for pointing out the need for this paper, and to Paul Halstead for comments on an earlier draft.

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Table 6 (opposite and p. 96). Composition of free-threshing wheat and barley samples from Amorgos. Key: GRAIN = number of embryo ends; RACHIS = number of internode tops; STRAW NODES = number of cereal straw nodes; WEED SEED = number of weed seeds. Percentages calculated for total GRAIN+RACHIS+WEED SEED.

The complete data set on which this table is based is available at the time of publication by electronic mail via the Archaeological Information Exchange established by Sebastian Rahtz at the Department of Electronics and Computer Science, University of Southampton. Electronic mail messages to INFOSUK.AC.SOTON.CM with the subject line **aie-amorgos** will be mailed back with the data (leave the message blank). A key to the data is mailed back if the subject line is **aie-amorgos-key.**

	WHEAT GRAIN	WHEAT RACHIS	BARLEY GRAIN	BARLEY RACHIS	STRAW NODES	WEED SEED	% GRAIN	% RACHIS	% WEED
winnowing	36	156	222	980	280	743	12	53	35
by-products	0	1220	20	420	4300	327	1	83	16
	16	744	108	840	460	735	5	65	30
	108	1266	8	70	377	388	6	73	21
	82	786	4	34	95	388	7	63	30
	76	1798	88	1570	525	167	4	91	5
	40	306	8	200	165	357	5	56	39
	60	322	108	206	310	104	21	66	13
	6	508	0	228	110	669	0	52	47
	50	152	136	1800	725	255	8	82	11
	112	1692	175	1160	240	96	9	88	3
	42	462	124	256	280	170	16	68	16
	8	310	4	126	125	225	2	65	33
	42	498	40	282	280	301	7	67	26
	8	103	22	370	90	464	3	49	48
	24	1920	60	332	550	317	3	85	12
	40	568	44	474	450	263	6	75	19
	20	116	45	223	190	298	9	48	42
	10	192	116	460	260	158	13	70	17
	4	924	6	780	280	464	0	78	21
	8	112	92	2040	750	160	4	89	7
	34	786	150	400	460	167	12	77	11
	12	420	60	1210	325	341	4	80	17
	40	914	60	500	430	270	6	79	15
	84	444	245	820	475	271	18	68	15
coarse-sieve	375	625	4125	3050	100	1388	47	38	15
by-products	875	4560	800	2210	2450 -	679	18	74	7
	364	572	820	660	1240	722	38	39	23
	136	8064	0	800	2270	273	1	96	3
	8120	14650	100	180	1220	1199	34	61	5
	616	4180	192	2920	2640	1786	8	73	18
	552	2336	360	992	1640	556	19	69	12
	108	1306	276	660	743	1190	11	56	34
	79	860	31	280	286	1356	4	44	52
	440	1410	1700	8500	2650	2457	15	68	17
	568	1184	696	2800	1690	1383	19	60	21
	1100	3732	372	1320	1410	815	20	69	11
	412	1270	260	900	530	1025	17	56	27
	9800	14300	1400	2450	2250	530	39	59	2
	286	1230	140	144	371	1180	14	46	40
	172	310	264	348	450	660	25	38	38
	30	2360	350	3450	4080	564	6	86	8
	300	1068	92	464	814	687	15	59	26
	2	2	430	2400	1080	555	13	71	16
	796	1708	304	888	788	406	27	63	10

fine-sieve	29	0	115	0	0	590	20	0	80
by-products	15	16	16	2	0	321	8	5	87
	32	0	27	0	0	330	15	0	85
	179	0	3	0	0	209	47	0	53
	98	4	2	0	0	503	16	1	83
	96	0	56	0	0	296	34	0	66
	270	1	59	0	0	374	47	0	53
	27	0	5	0	0	426	7	0	93
	34	0	5	0	0	601	6	0	94
	34	0	220	1	0	263	49	0	51
	36	0	43	0	0	529	13	0	87
	96	11	78	2	0	369	31	2	66
	150	15	53	2	0	375	34	3	63
	99	0	49	0	0	290	34	0	66
	18	0	51	0	0	537	11	0	89
	253	6	58	0	0	339	47	1	52
	54	0	17	0	0	328	18	0	82
	3	0	16	4	0	1076	2	0	98
	82	1	27	0	0	359	23	0	77
	103	0	1	0	0	332	24	0	76
	82	7	64	2	0	308	32	2	67
	35	0	29	2	1	346	16	0	84
	22	10	110	0	0	412	24	2	74
	169	3	72	0	0	354	40	1	59
	20	0	65	2	0	151	36	1	63
	15	5	17	3	2	315	9	2	89
	126	5	111	0	0	339	41	1	58
cleaned	1400	0	18600	55	7	304	98	0	1
products	63500	18	58800	18	7	462	100	0	0
	6800	1	23700	20	4	377	99	0	1
	99990	10	4110	1	2	384	100	0	0
	70450	65	6530	23	3	405	99	0	1
	22870	40	78120	60	3	240	100	0	0
	9070	1	15200	5	0	436	98	0	2
	25730	24	39370	13	2	367	99	0	1
	11580	13	3880	6	0	582	96	0	4
	66	8	35650	50	13	279	99	0	1
	1 0420~	25	15660	4	16	343	99	0	1
	9300	65	19700	2	20	669	98	0	2
	17370	90	12090	11	32	478	98	0	2
	770	4	2480	1	3	422	88	0	11
	4250	0	8370	2	0	336	97	0	3
	65600	68	46500	15	5	303	100	0	0
	19300	46	1 5500	4	15	399	99	0	1
	288	29	4340	10	19	412	91	1	8
	32200	32	30700	7	25	513	99	0	1
	15440	3	470	0	4	704	96	0	4
	14860	28	24030	7	12	276	99	0	1
	1530	25	1230	22	12	485	84	1	15
	2120	65	25420	68	38	384	98	0	1
	65140	8	52300	4	8	375	100	0	0
	995	4	49910	32	1	321	99	0	1
	10420	23	26970	27	2	331	99	0	1
	18140	34	21700	30	7	412	99	0	1

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Transverse cell patterns of wheat and rye bran and their variation over the surface of a single grain

Tim Holden *

Although archaeological specimens of certain cereal species can readily be distinguished on the basis of the cellular characteristics of the testa (seed coat) and adherent fruit wall (pericarp), there are a number of problems associated with the separation of rye (Secale) and wheat (Triticum). This paper examines one feature of the transverse cells of the pericarp - cell size - and records how this feature varies over the surface of single grains of both wheat and rye. Both the variability of cell size over the surface of individual grains and the considerable degree of overlap between the cell sizes of the two taxa are highlighted. Some implications of this with regard to the identification of highly fragmented ancient cereal remains are then discussed.

Introduction

The accurate identification of ancient cereal grains has long been considered to be an essential preliminary to our understanding of past subsistence, crop evolution and dispersal and the origins of agriculture in the Old World, where the state of preservation allows, different species of cereals can often be distinguished on the basis of the gross morphology of their caryopses. Often, however, the less-than-perfect preservation of archaeological cereal remains - either by charring or as a result of waterlogging - makes the application of the commonly-used criteria, such as the size and shape of the grains, difficult. In such circumstances it has been suggested that cellular characteristics of the bran (the term being used here to include both pericarp and testa tissues) of certain cereals can be used as an aid to their identification.

Some genera of cereals can easily be distinguished from other cultivated species by microscopic examination of their bran layers. For example, it is a simple matter to distinguish between the three commonly-occurring groups - barleys, oats and rye/wheats -in all but the poorest states of preservation. It can, however, prove more problematical to distinguish cereals where less well-defined anatomical differences occur. Species of Triticum (wheat) and Secale (rye), for example, are especially difficult to tell apart on the basis of their anatomy. Both of these cereals have a testa that is characterised by two layers of thin-walled cells which are orientated in relation to each other such that they show a chequerboard pattern in surface view. The pericarp, too, is very similar, being composed of five distinct layers (Winton and Winton 1932, 193 and 257: see Fig. 15) of which the so-called transverse cell layer would seem to be the most promising for

* Tim Holden, Department of Human Environment, Institute of Archaeology, University College London, 31-4 Gordon Square, London UIC1H OPY, U.K.

diagnostic purposes. Over much of the grain's surface this layer is composed of regular rows of transversely elongated cells^ occasional pairs of smaller cells (half cells) being incorporated into this regular arrangement without disrupting the order of the rows.

With the identification of archaeological cereals in mind, Körber-Grohne and Piening (1980) and Körber-Grohne (1981), published two innovative papers which outlined a series of microscopic criteria that showed promise for distinguishing some of the more problematic cereals. Having looked at cellular characteristics of the transverse cell layer of a number of modern species, they added to the work of previous plant anatomists (see for example Gassner (1973) and Winton and Winton (1932)) and drew up a series of characteristics that could be used to distinguish ancient grains of certain cereals. These characteristics included features such as number of cell layers, presence of end wall thickening, cellular dimensions and the patterns that the cells make over the caryopsis surface. They should be generally usable both with charred material, where the overlying longitudinal cell layer has become detached, and with waterlogged remains, where the transverse cell layer remains intact. (For a comprehensive up-to-date review of many of these features see Dickson (1987).)

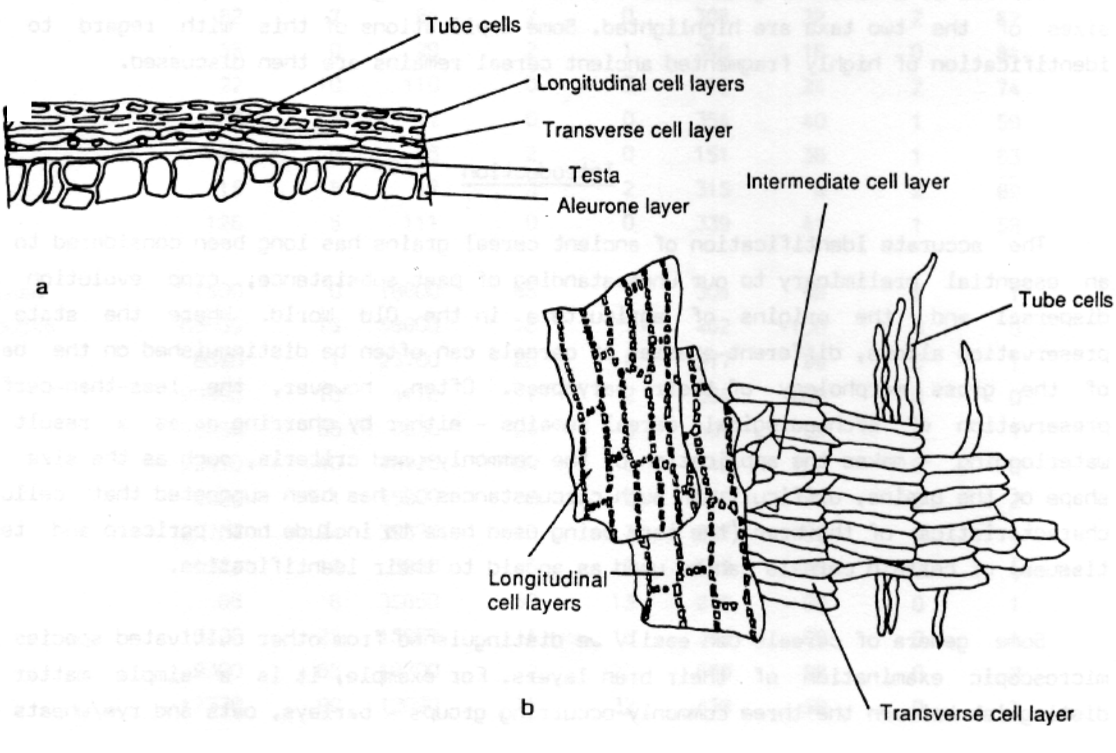

Figure 15. Diagram showing the cellular arrangement in (a) section, (b) surface view, of the pericarp of Triticum aestivum (after Winton and Winton 1932, 95). The general pattern is similar to that of both T. spelta and Secale cereale.

The study by Körber-Grohne and Piening made full use of both transmitted light and scanning electron microscopy. In each case they chose an area on the caryopsis surface that seemed to offer the maximum stability of cellular characteristics, this being on the 'flanks' of the grain. They put forward a good case for the applicability of this technique to poorly-preserved charred archaeological grains while still emphasising that a study of a large sample of modern and ancient material from a range of localities and ecotypes would be required if the microstructure of grains is to be used for diagnostic purposes. Colledge (1988) stresses this last point and provides data based upon the study of a substantial number of different modern species and populations which show that the stability of many of the above-mentioned characteristics is in fact, not as great as was originally hoped.

During recent work on the gut contents of the Lindow Man bog body (Holden 1986) it became evident that substantial quantities of cereal bran were present. This had been preserved by waterlogging. The characteristic chequerboard arrangement of cells indicated that it was the testa of either wheat or rye. Only in relatively few cases did the remains of transverse cells adherent to the testa survive in any quantity. Since all of the fragments of bran were very small, it was impossible to estimate from which part of the grain the fragments originated. Clearly then, if any of the above criteria were to be used for the identification of such fragmentary material it would be necessary to know how they vary, not only between species and between different populations of the same species but also over the surface of individual grains.

Methods

As a start to this work, an attempt at simplifying the problem was proposed. This was done by taking a single grain and a single characteristic and recording how the size (length and breadth) of the cells of the transverse cell layer varied over the surface of one grain of Triticum spelta L. (spelt wheat, supplied by Butser Iron Age farm). The grain was subjected to a crude fibre preparation (see appendix) and then mounted on standard microscope slides using a temporary mountant. Under a transmitted light microscope, a number of different fields of view were selected from various parts of the grain and for each field, the length and breadth of thirty cells were recorded. The resultant data are presented in graphical form with both the lengths and breadths of the thirty cells being shown next to each other along the x-axis of each histogram (Fig. 16). 'Half cells' have been omitted from the histograms since they were considered to confuse the general picture; however, the number of these seen in each microscopic field has been incorporated into Table 7. Information regarding the average lengths and breadths of the cells in each histogram and the standard deviations are also included in this table.

Having completed thirteen fields for T. spelta, an exactly similar procedure was carried out for a single grain of Secale cereale L. (supplied by Gordon Hillman Ref. no. G.C.H. 3355g.) and, although time constraints and fragmentation of the grain during preparation did not allow an equivalent number of fields to be recorded, they have still been included here for discussion (Fig. 17). It must be recognised, however, that any conclusions drawn from them will not be as secure as those drawn from the spelt wheat.

Discussion

From the data recorded for just one spelt wheat caryopsis, it is clear that there is considerable variation in cellular dimensions in the transverse cell layer over the grain's surface. This manifests itself in a number of ways:

(a) the regular cell patterns (uniform rows of cells) that are common over most of the grain break down in places, this being especially noticeable near the embryo end. In this region the variation in size of adjacent cells can be considerable;

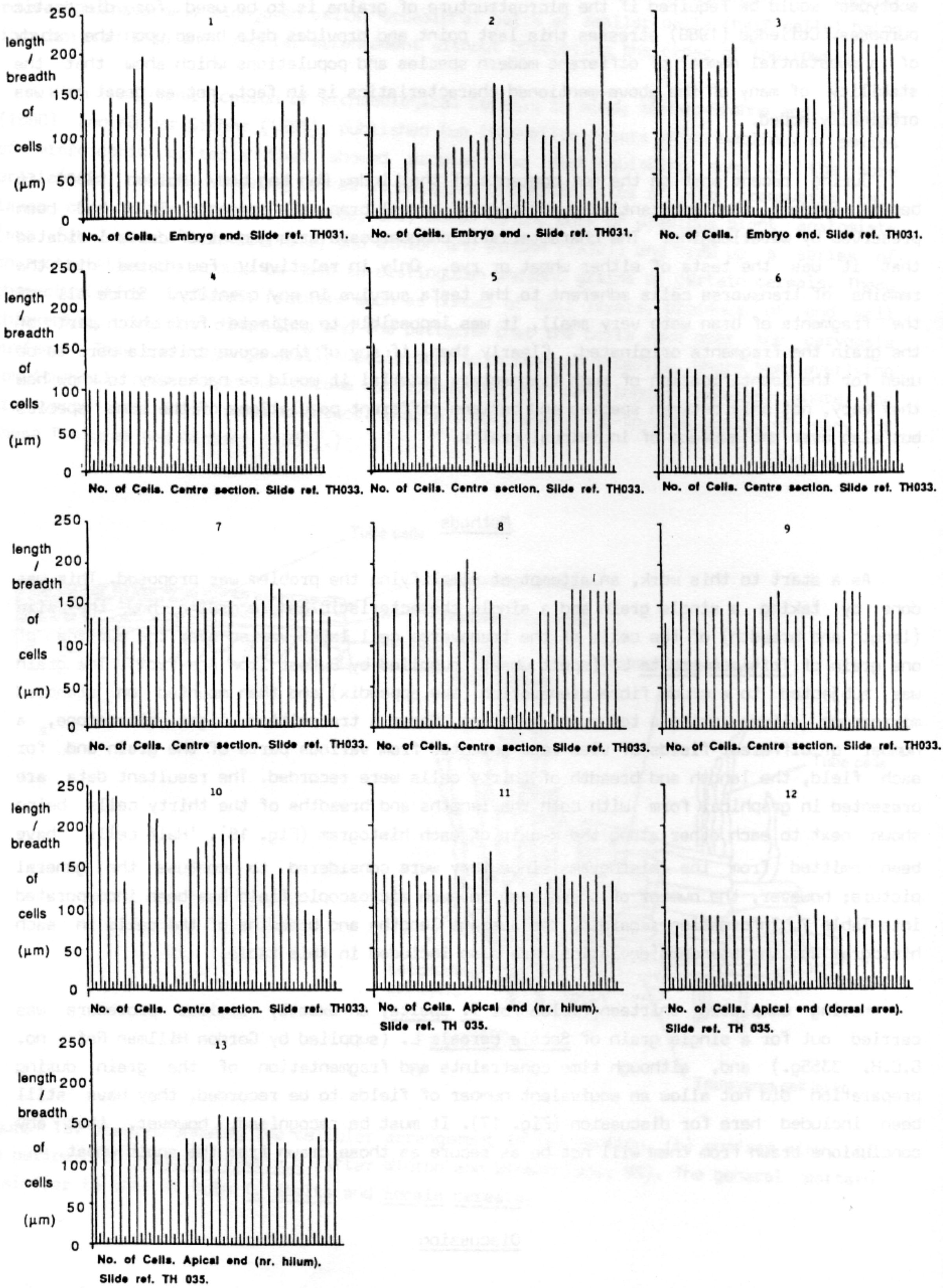

Figure 16. Histograms showing the length and breadth of individual cells in the transferse cell layer at thirteen sites on a single grain of Triticum spelta.

(b) the regular pattern is also disrupted by groups of smaller cells which occur from time to time over the whole of the grain;

(c) even where the rows are seen to be regular, the length of the constituent cells from different parts of the grain surface, or even from adjacent rows, can be substantially different in size. (For example, the cells in spelt histogram 4 from the central section of the grain are uniform and consistently 100 urn in length, whereas those shown in histogram 5 of the same grain are again uniform but this time are all closer to 150 urn long).

In a situation where the archaeological samples of cereal bran have been milled and it is no longer possible to demonstrate from which part of the grain the fragments arose, the cells could vary from approximately 80 urn to 150 urn in length while still maintaining their regular rows. Even though the cells in rye are apparently, on average, more uniform and generally shorter than those of spelt, the degree of overlap is considerable and any identification of small samples made upon metrical calculations alone would be fraught with problems.

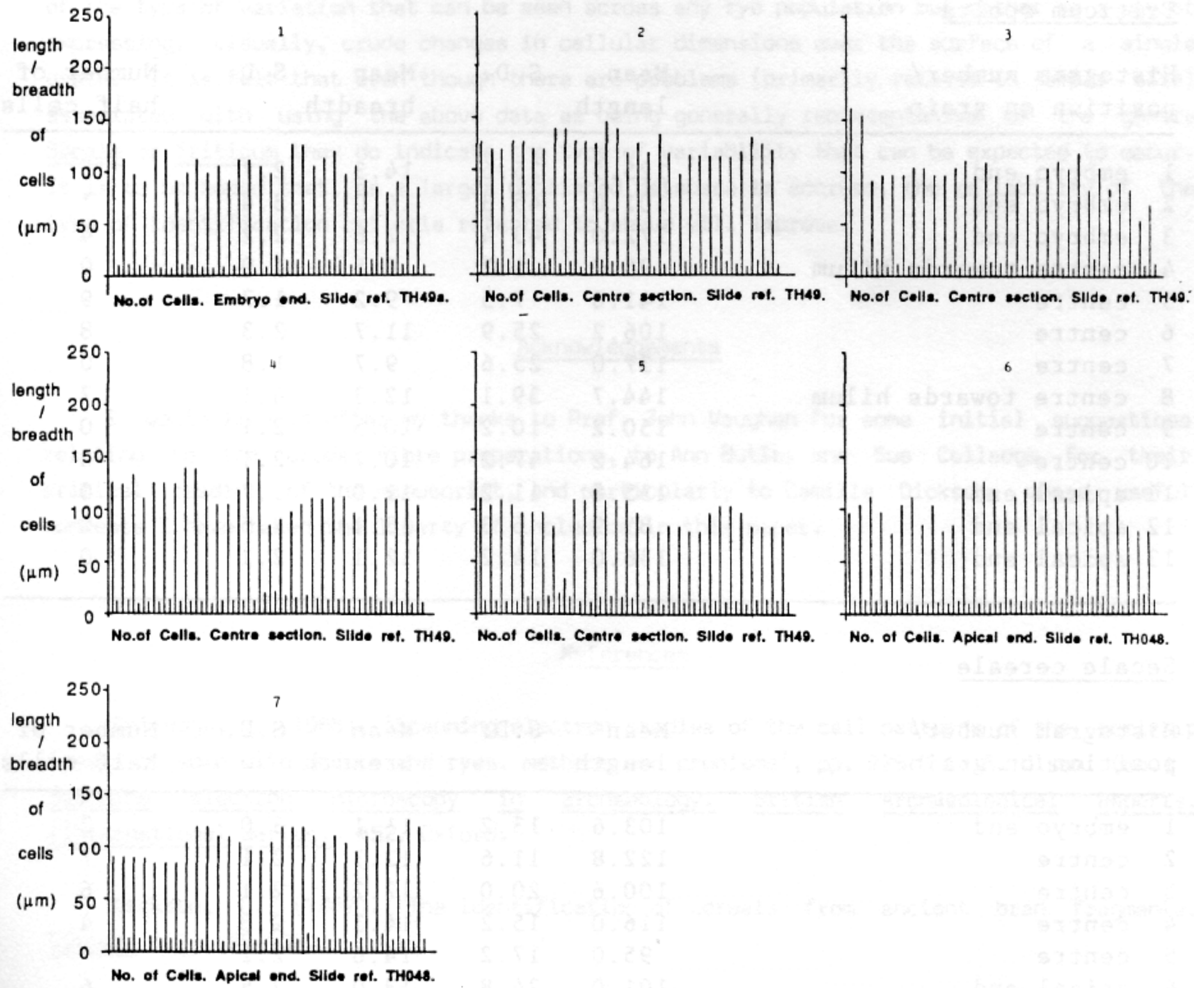

Figure 17. Histograms showing the length and breadth of individual cells in the transverse cell layer at seven sites on a single grain of Secale cereale.

Conclusions

The study of cellular characteristics of bran fragments from certain cereals would seem to offer a good potential for distinguishing taxa which, even when in a good state of preservation, are difficult to identify. It has already been pointed out by Körber-Grohne and Piening (198Q) that, in order to evaluate fully the potential of these criteria so that they can be made more generally applicable, a wide-ranging series of studies is needed, looking at the stability of these characteristics both between species and within members of the same species from different habitats. Colledge (1988) has made a start to this essential work and has clearly illustrated the dangers of using these characteristics without a full understanding of their variability.

Where the archaeological remains are fragmentary, it is essential that we also have an understanding of how these characteristics vary over the surface of a single cereal grain. This study has taken only one of these characteristics (cell size) and shown that it does indeed vary considerably in relation to its position on the surface of the grain.

Triticum spelta

Histogram number/ position on grain		Mean length	S.D.	Mean breadth	S.D.	Number of half cells
1	embryo end	125.5	25.6	14.3	2.7	5
2	embryo end	101.0	45.3	14.0	3.4	*
3	embryo end	172.0	43.4	12.8	2.2	4
4	centre towards hilum	95.7	4.2	9.5	1.9	0
5.	centre	141.6	7.5	9.2	1.7	9
6	centre	106.2	25.9	11.7	2.3	8
7	centre	137.0	25.6	9.7	1.8	0
8	centre towards hilum	144.7	39.1	12.3	4.1	7
9	centre	150.2	10.2	10.5	2.1	0
10	centre	164.2	47.2	10.7	2.1	0
11	apical end	135.8	11.2	11.0	1.7	0
12	apical end	85.9	6.3	13.1	2.5	0
13	apical end	136.0	14.2	12.1	2.1	0

Secale cereale

Histogram number/ position on grain		Mean length	S.D.	Mean breadth	S D.	Number of half cells
1	embryo end	103.6	13.2	11.1	3.0	2
2	centre	122.8	11.6	12.3	2.1	7
3	centre	100.6	20.0	12.2	2.1	6
4	centre	116.0	15.2	14.3	2.8	4
5	centre	95.0	17.2	14.6	2.1	*
6	apical end	101.0	24.8	13.0	2.5	6
7	apical end	105.6	12.1	13.5	1.7	2

Table 7. Mean lengths and breadths and corresponding standard deviations (S.D.) of cells represented in Figs. 16 and 17. * - call patterns too disorganised to show half cells.

It seems likely that other cellular characteristics will also vary in the same way. Clearly then, this work. serves to reiterate the words of previous writers who have indicated that this problem of cellular variation is one that must be further investigated in order to assess the reliability of these identification criteria.

Some additional comments

In addition to the above observations, Mrs Camilla Dickson (Department of Botany, University of Glasgow) has pointed out that she has recorded cell patterns of *Triticum compactum* Host, that resemble both *T. spelta* L. and *Secale cereale* L. and she also remarks on the confusion that could be caused by the presence of *Triticale* (possibly a natural hybrid between *Triticum* and Secale). These are both good points, and I feel that it is worth making a note of them. Mrs Dickson also comments that my histograms for rye do not show up features that she has observed - notably the groups of short cells that are frequently oval or rounded and which occur at certain points over the surface of grain. It is accepted that this could be an artifact of the low number of fields recorded for the rye grain; however, these histograms were not envisaged as being perfect representations of the type of variation that can be seen across any rye population but rather as a way of expressing, visually, crude changes in cellular dimensions over the surface of a single grain. It is felt that even though there are problems (primarily related to sample size) associated with using the above data as being generally representative of the genera *Secale* or *Triticum* they do indicate the type of variability that can be expected to occur. It is to be hoped that, as a larger published database is accrued, the reliability of the type of identification criteria referred to above will improve.

Acknowledgements

I would like to offer my thanks to Prof. John Vaughan for some initial suggestions relating to the crude fibre preparations, to Ann Butler and Sue Colledge for their critical reading of the manuscript, and particularly to Camilla Dickson, whose useful comments I have taken the liberty of including in this paper.

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Appendix; Preparation of_ the grains

The grains were cut into three pieces at right-angles to their long axis: (a) the apical end, (b) the central section and (c) the embryo end. Each of these fragments was crushed in a pestle and mortar before being subjected to a crude fibre preparation (as used by Department of Food and Nutritional Sciences, Kings College (Kensington Campus), London). The crushed fragments were first soaked for approximately 2 hours in petroleum ether, then placed in a solution of 5% sulphuric acid, heated to boiling point, then simmered for 2-3 minutes. They were then transferred to a beaker of water to rinse off the acid, before being placed in a solution of 10% sodium hydroxide which was also brought to the boil prior to being simmered for 2-3 minutes. Finally, they were removed, and rinsed several times in water as before. It was then possible to scrape away any residual starch from the inner bran surfaces and to separate some of the cell layers for mounting on standard microscope slides.

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Sesame (*Sesamum indicum* L.) pollen in 14th century cesspits from 's-Hertogenbosch

H. wan Haaster *

The identification of pollen of sesame, *Sesamum indicum* L. from 14th century cesspits in 's-Hertogenbosch, the Netherlands, is recorded and discussed.

In 1984 excavations were carried out in the grounds of the 18th century cemetery of the St Jan church in 's-Hertogenbosch. Below the level of the cemetery, remains of successive houses and yards from the 13th and 14th century were revealed. Among the features excavated were several cess- and rubbish pits. At the request of the town archaeologist, samples from the pits were analysed by the author for botanical and zoological remains (publication of the complete results is in preparation).

The pollen analysis appeared to be very important in proving the former use of foodplants of which the parts used are not easily preserved. One of the most interesting finds was the pollen of the sesame plant, *Sesamum indicum* L. Up till now, three pollen grains have been encountered in two cesspits from a 14th century context, though no macrofossil remains have been found.

S. indicum is an annual herb belonging to the family Pedaliaceae. Pollen -grains of this family are usually 5-13-colpate and oblate-subprolate. The size (35 x 40 urn) and the aperture number of the pollen grains from the cesspits (Fig. 18) suggest that they are *S. indicum* pollen. Other *Sesamum* species have fewer colpi and are usually much bigger. *S. indicum* is 9-11-colpate and oblate. The exine is about 3 urn thick at the centre of the mesocolpia, the nexine distinctly thicker than the sexine and lens-shaped between the colpi. The sexine consists of pila that are densely but irregularly arranged. The outline in polar view is more or less circular or slightly polygonal and the equatorial view is elliptical (Erdtmann 1952; Raj 1961; Alvarado 1983).

Sesame is a native of hot, dry, tropical parts of Africa. From there its cultivation spread quickly via Egypt and the Middle East to almost all tropical and subtropical parts of the world. The first record of it as a cultivated plant dates from about 1600 BC in Mesopotamia. Sesame is cultivated for its seeds, which can be used as a flavouring or for the extraction of oil (they contain up to 55% oil). Together with olive oil, that of sesame is amongst the oldest edible oils (Brouk 1975; Zeven and Zhukovsky 1975).

* Drs H. van Haaster, Instituut voor Prae- en Protohistorie, Department of Archaeobotany, Singel 453, 1012 UP Amsterdam, the Netherlands.

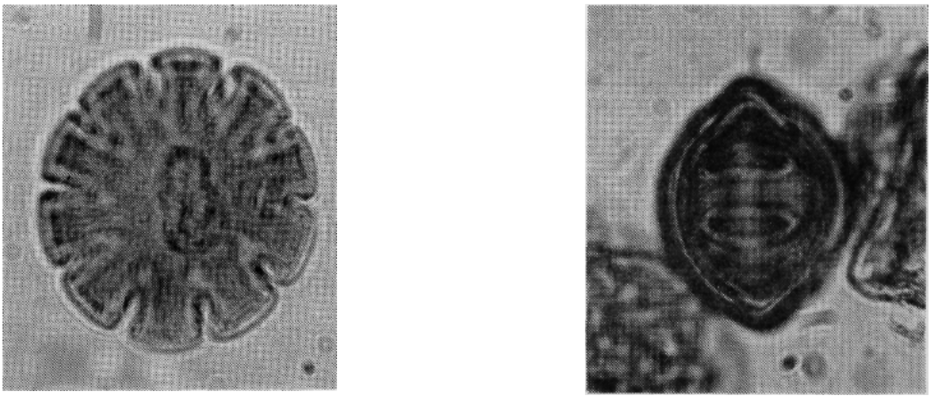

Figure 18. Pollen of Sesamum indicum from 14th century 's-Hertogenbosch. Size - 35 x 40 urn.

Although the use and cultivation of sesame was known to the Romans (Pliny, Natural History XVIII), there is no evidence that they introduced it to Europe. According to Kaufmann (quoted by Fischer 1929), it was brought to Europe by the Crusaders (11-13th centuries), together with pistachio, lemon, apricot, watermelon and St John's bread (carob). So far, I know of no other archaeobotanical records for this plant.

The presence of sesame pollen in the above-mentioned cesspits is undoubtedly an indication of the use of sesame seeds or oil by the former users of the pits. The pollen probably adhered to the seeds or was present in the oil, because it seems highly improbable that the plant was grown locally.

Acknowledgments

I would like to thank Dr U. Punt, Laboratorium voor Palaeobotanie en Palynologie, University of Utrecht, for his help with the identification of the pollen.

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A tale of two innominates

Barbara West *

Summary

Two new measurements on innominate bones were tested on a variety of mammals, using specimens of known age and sex. The potential value of these measurements in determining sexual dimorphism in archaeological material is discussed.

One winter's day (a long time ago), while examining two cattle innominates from a Saxon site in London, I was struck by the difference in pubis lengths, and attributed this to sexual dimorphism, because of similar characteristics in humans. Although the fact that the pubis is relatively longer in human females than in males is well known to human osteologists, this principle had not, to my knowledge, been applied to other animals (an opinion later revised). Two simple measurements were then devised to illustrate this sexual dimorphism (Fig. 19), and it was decided to test the idea on animals of known age and sex in distinct populations.

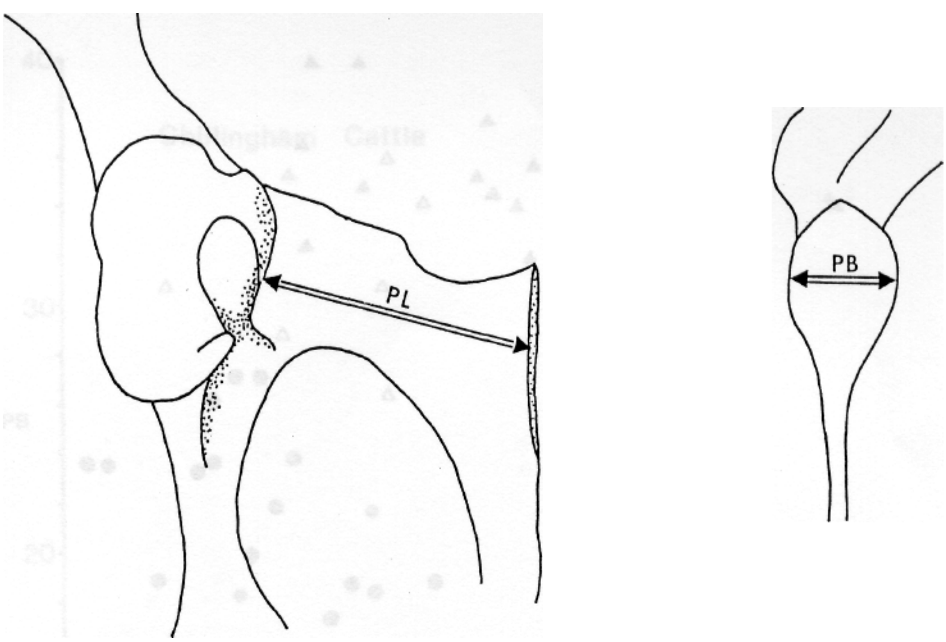


Figure 19. Diagram of measurements: PB - breadth of pubic symphysis; PL - pubic length.

* Barbara West, Greater London Environmental Archaeology Section, Museum of London, London Wall, London EC2Y 5IMH, U.K.

Dr Juliet Clutton-Brock (British Museum of Natural History) generously allowed me to measure the collection of Soay sheep in her care in advance of her own publication on the material (Clutton-Brock et al. in press), in addition to the BMNH collection of dogs (Dennis-Bryan and Clutton-Brock 1988), Chillingham cattle, and African and Indian elephants. James Rackham (Museum of London) kindly offered to measure his private osteological collection of Border goats currently housed in Lincolnshire (Bullock and Rackham 1982) and Sebastian Payne (Ancient Monuments Laboratory, English Heritage) permitted me to measure his Cambridge collection of Turkish wild boar skeletons (Bull and Payne 1982; Payne and Bull in press).

The discussions engendered by this idea were both lively and fruitful. For instance, Juliet Clutton-Brock pointed out that, if extra room was needed in the female pelvis to accommodate offspring, the pubis was the logical place for bone expansion. Also, one of her conversations with Dr Andrew Kitchener (Royal Museum of Scotland) inspired me to try this method on elephants. Dr Kitchener subsequently sent me his measurements for the Indian elephants in the collections of his museum and the Anatomy Department of Edinburgh University. Sebastian Payne disclosed that he has tested a method for determining sexual dimorphism in sheep, using measurements for the midpoint of the pubis, which will be very useful for fragmentary material (Holmes, Legge and Payne in prep.). He also predicted that these measurements would not work for pigs or dogs, since they are multiparous animals, in which extra pelvic accommodation for large-headed offspring is not required.

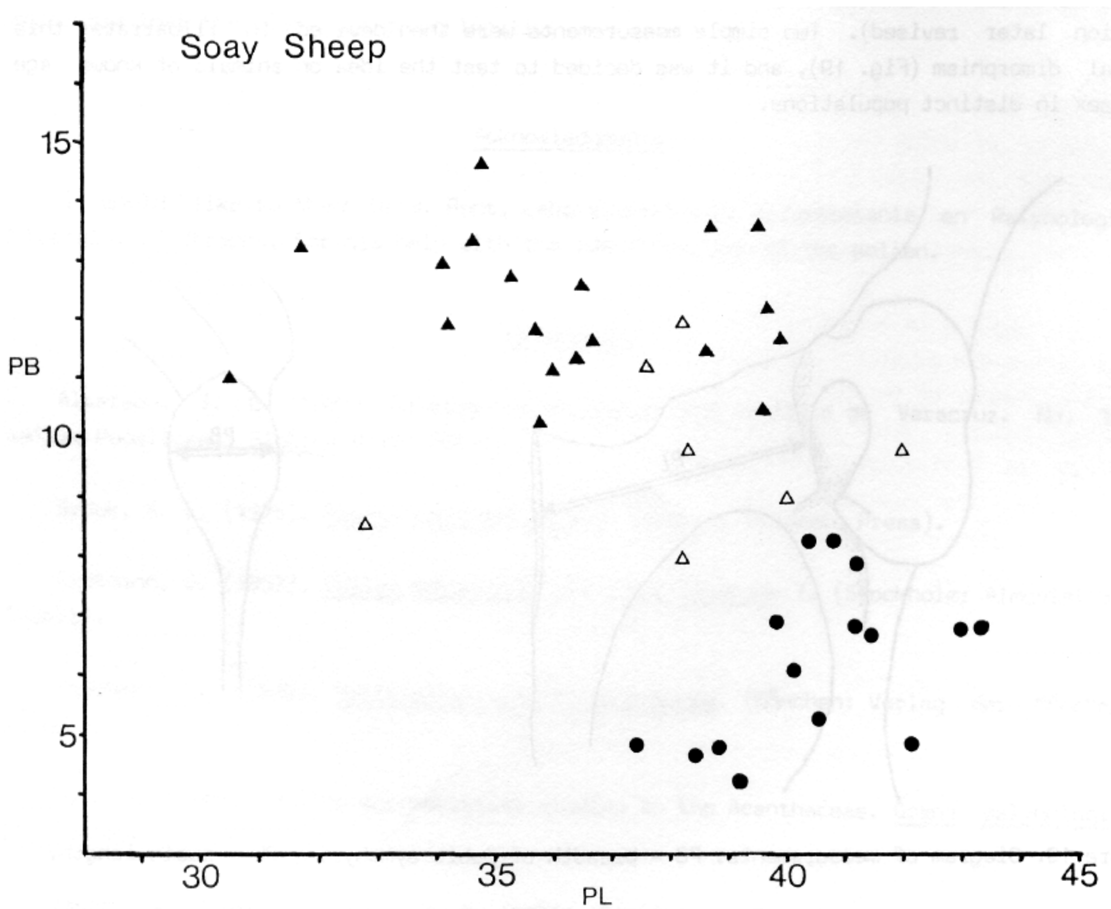


Figure 20. Pubic lengths plotted against pubic breadth, using innominates of Soay sheep from the British Museum (Natural History) collection. Symbols as in Fig. 21.

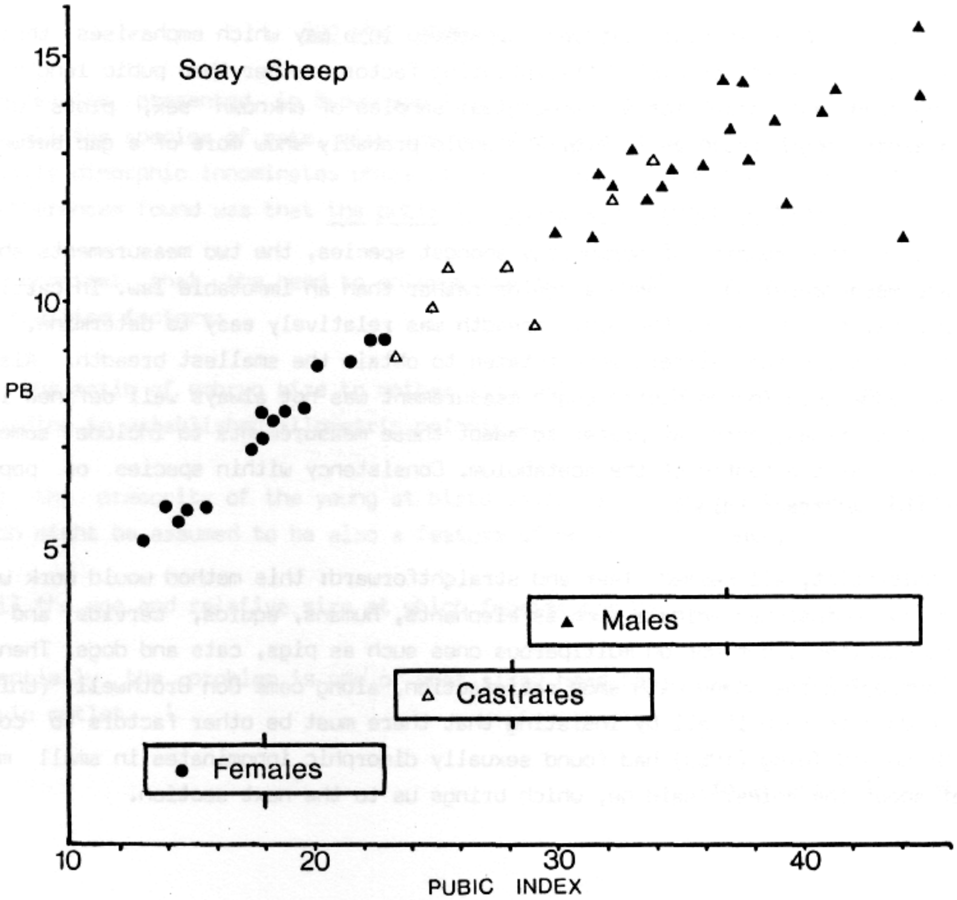


Figure 21. Pubic index ((PB x 100)/PL) plotted against pubic breadth of BMNH Soay sheep innominates.

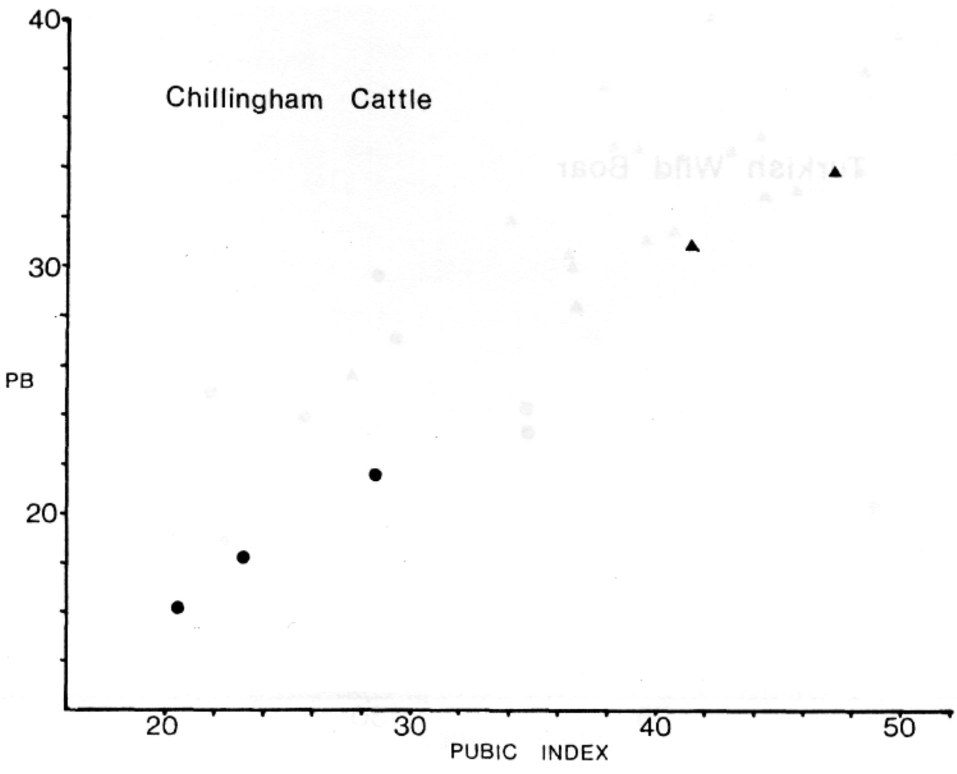


Figure 22. Pubic index ((PB x 100)/PL) plotted against pubic breadth, using innominates from the Chillingham cattle collection at the BMNH. Symbols as in Fig. 21.

The results shown in Figs 20-5 were presented in a way which emphasises that pubic breadth appears to be the crucial differentiating factor, rather than pubic length. James Rackham pointed out that, for archaeological samples of unknown sex, plots of pubic breadth against length (such as in Fig. 20) would probably show more of a gap between the sexes.

Because of the vagaries of morphology amongst species, the two measurements shown in Fig. 19 are meant merely as a general guide rather than an immutable law. In cattle, pigs and elephants, for instance, the pubic breadth was relatively easy to determine, whereas in sheep and goats the calipers were rotated to obtain the smallest breadth. Also, the acetabulum edge used in the pubic length measurement was not always well defined in some species. Other researchers may prefer to adapt these measurements to include some other points, such as the centre of the acetabulum. Consistency within species or population groups is the important thing.

At this point, all seemed clear and straightforward: this method would work well on all normally uniparous animals such as elephants, humans, equids, cervids and bovids (including caprines), but not on multiparous ones such as pigs, cats and dogs. Then, just as I was surveying the scene with smug satisfaction, along came Don Brothwell (University College London) to ruin it all by insisting that there must be other factors to consider, because Brown and Twigg (1969) had found sexually dimorphic innominates in small mammals. 'And what about the voles?' said he, which brings us to the next section.

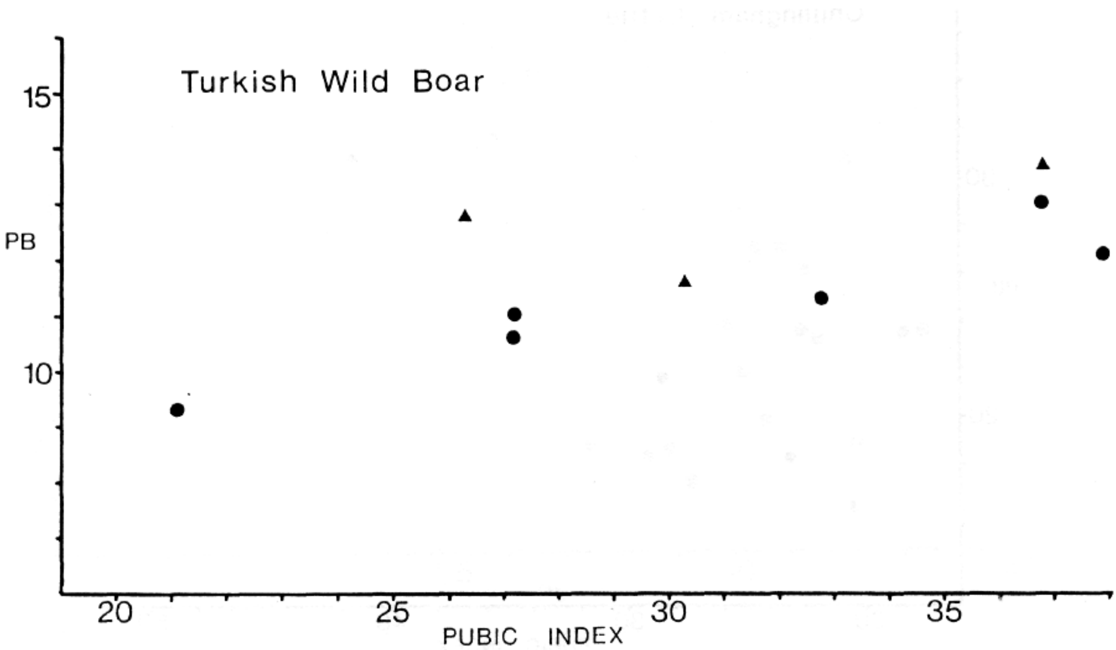


Figure 23. Pubic index ((PB x 100)/PL) plotted against pubic breadth, using innominates of Turkish wild boar from Sebastian Payne's collection. Symbols as in Fig. 21.

The results presented in Brown and Twigg[1]s paper are indeed intriguing in that, although all the species of rats, mice and voles studied were multiparous, some species had sexually dimorphic innominates while others did not. In addition, one of the primary sexual differences found was that the pubis is longer and thinner in females;

> 'We consider that the need to enlarge the pelvic outlet may be related to three interrelated factors:
>
> (i) the ratio of embryo size to mother size which will be higher in smaller species according to established allometric principles;
>
> (ii) the precocity of the young at birth which is a feature of desert rodents and which might be assumed to be also a feature of Holarctic rodents;
>
> (iii) the age and relative size at which females can become parous.
>
> Essentially the problem is one of what sized head has to pass through what sized pelvic outlet...'

(Brown and Twigg 1969, 129)

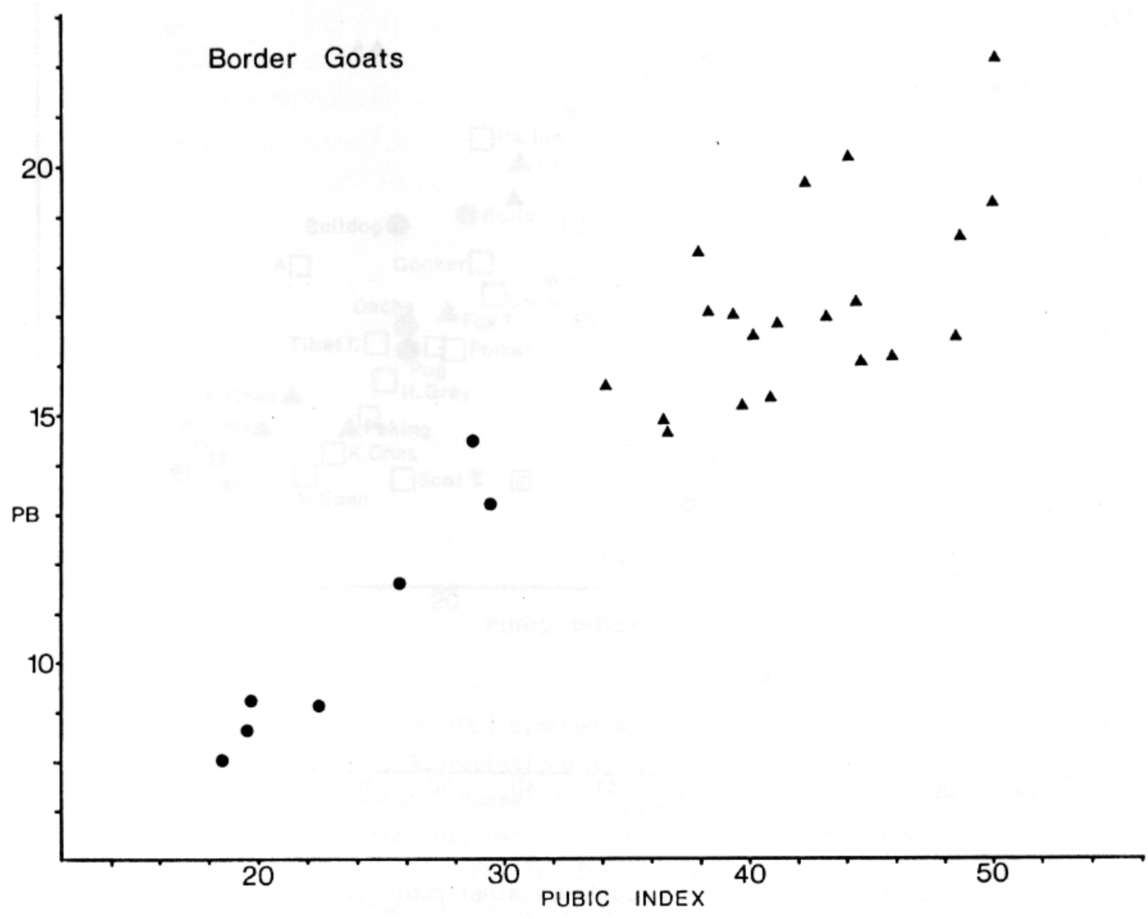
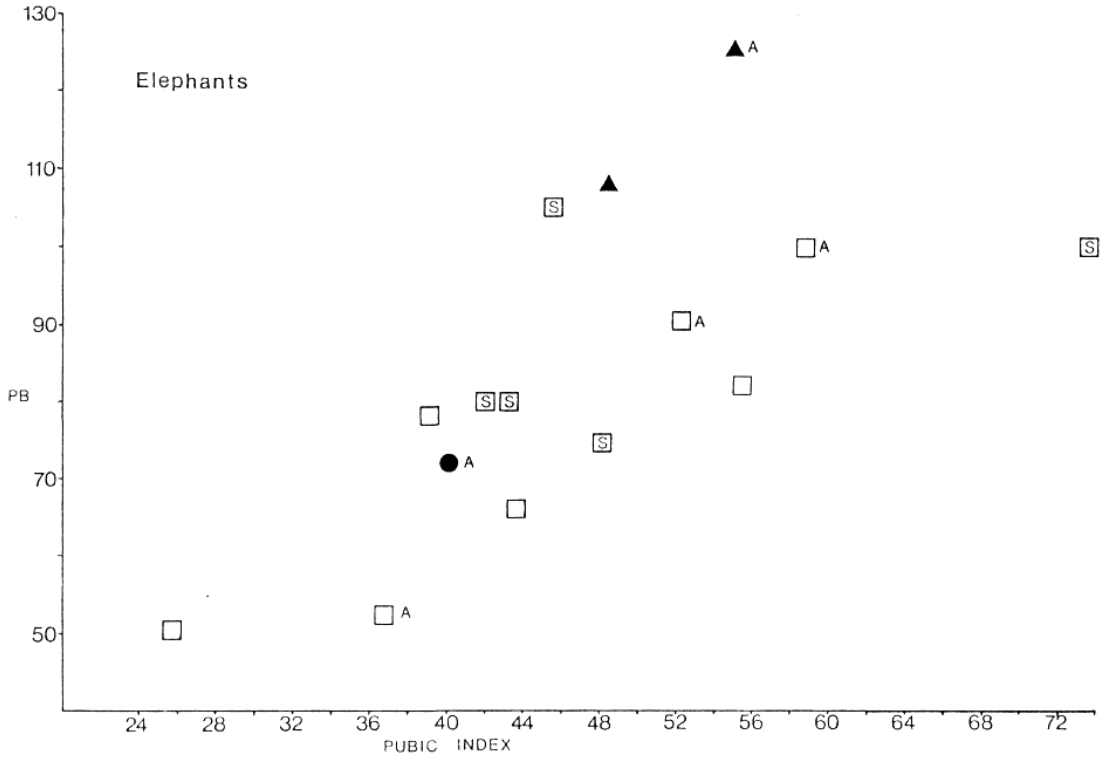


Figure 24. Pubic index ((PB x 100)/PI_) plotted against pubic breadth, using innominates of Border goats from James Rackham's collection. Symbols as in Fig. 21.

Amongst the mice, they found that the differentiation in female innominates was much more striking in the very small harvest mouse (Micromys minutus) than in the larger species (which supports the first factor quoted above). The second and third factors are supported by the following: although rats (Rattus spp.) and water voles (Arvicola terrestris) are similar in size, the latter exhibit marked pelvic sexual dimorphism while rats do not. Also, extreme sexual dimorphism exists in the innominates of the small voles Clethrionomys glareolus and Microtus agrestis. Brown and Twigg propose that all the voles have retained an adaptation to the rigorous conditions, short summers and reduced breeding season of northern climates during the later Pleistocene, by becoming parous at an early age and producing fewer young at a more advanced state of development.

In considering how these principles might be applied to other mammals, *I* thought that sexual dimorphism in the pubis would be more pronounced in small dogs than in large ones, for example, and decided to test this by measuring the BMNH collection mentioned previously. The results shown in Fig. 26 are interesting, in that the very large dogs such as Great Dane and Mastiffs do indeed show little sexual dimorphism, but a marked separation is found in large Bloodhounds, as well as small Bulldogs and Dachshunds. Amongst the smallest breeds, such as King Charles' Spaniels, the dimorphism was not as clear as expected, whilst the large Salukis were most annoying in showing a complete reversal of expected trends. Commenting on Fig. 26, Dr Clutton-Brock noted that Bulldogs are specially bred to have large heads and she agreed with Dr Kim Bryan's comment that dog



breeders in this century have drastically manipulated the characteristics of each breed.

Figure 25. Pubic index ((PB x 100)/PL) plotted against pubic breadth, using innominates of African (marked 'A') and Indian elephants from the BMIMH collection. Those marked 'S' are from the collections of the Royal Museum of Scotland and Edinburgh University. Symbols as in Fig. 26.

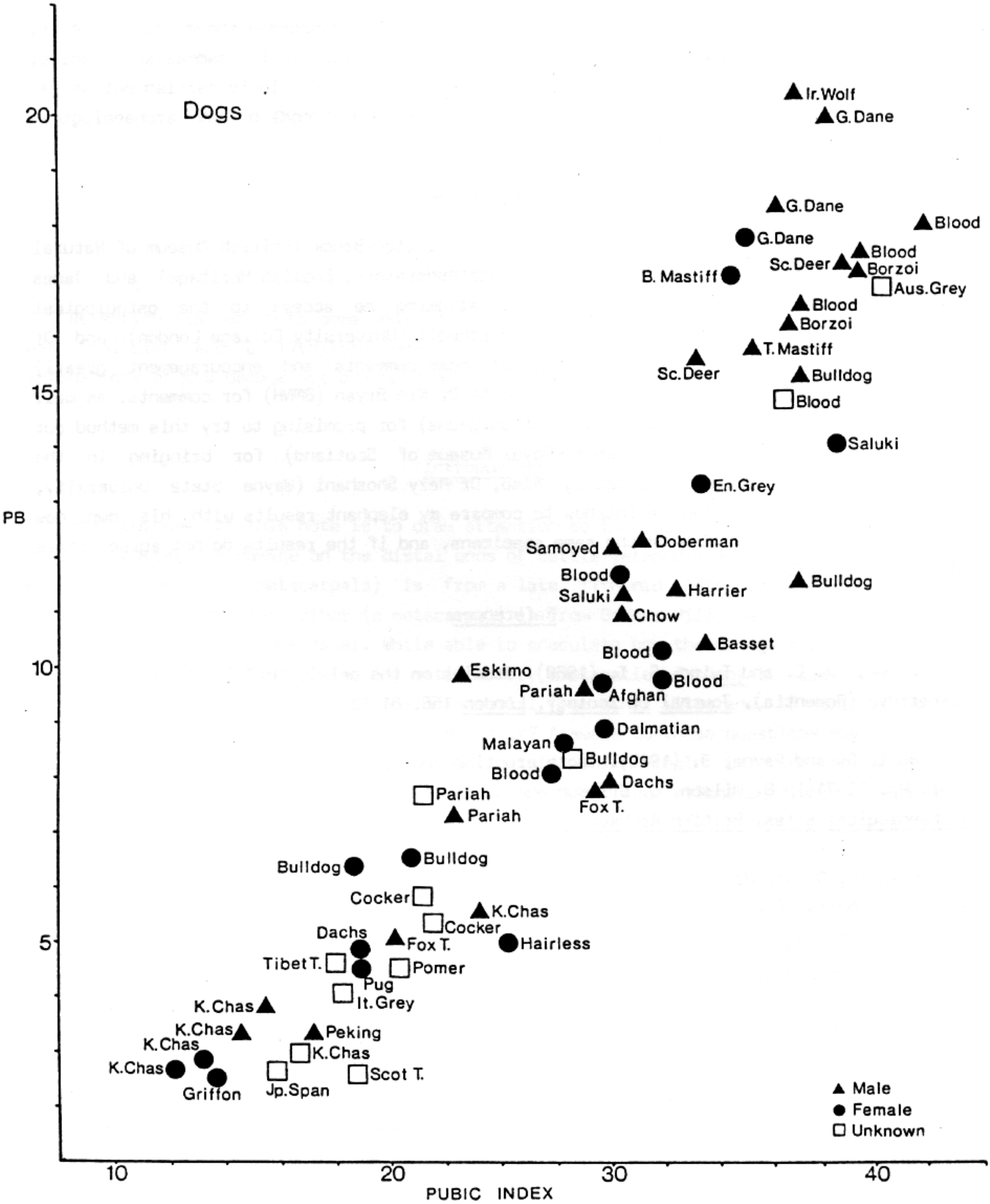


Figure 26. Pubic index ((PB x 100)/PI_) plotted against pubic breadth, using innominates of dogs from the BMNH collection. Abbreviations as follows: Afghan - Afghan Hound; Aus. Grey - Australian Greyhound; Basset - Basset Hound; B. Mastiff - Brindled Mastiff; Blood - Bloodhound; Cocker - Cocker Spaniel; Dachs - Dachshund; Doberman - Doberman Pinscher; En. Grey - English Greyhound; Fox T. - Fox Terrier; G. Dane - Great Dane; Griffon - Griffon Bruxellois; Hairless - African Hairless; Ir. Wolf - Irish Wolfhound; It. Grey - Italian Greyhound; Jp. Span - Japanese Spaniel; K. Chas - King Charles' Spaniel; Peking - Pekingese; Pomer - Pomeranian; Sc. Deer - Scottish Deerhound; Scot. T. - Scottish Terrier; T. Mastiff - Tibetan Mastiff.

A very brief conclusion

To conclude, then, I suggest that the interpretations discussed above for rodents, and previously for domesticated animals, are generally applicable to mammalian species, and that measurements of the length and breadth of the pubis should to carried out on as many species as possible in order to test this, using both modern and archaeological samples.

Acknowledgments

I would particularly like to thank Dr Juliet Glutton-Brock (British Museum of Natural History), Dr Sebastian Payne (Ancient Monuments Laboratory, English Heritage) and James Rackham (Museum of London) for generously allowing me access to the osteological collections in their care, as well as Don Brothwell (University College London) and Dr Terry O'Connor (University of York), all of whose comments and encouragement greatly improved the first draft. Thanks are also due to Dr Kim Bryan (BMNH) for comments, as well as to Dr Caroline Grigson (Royal College of Surgeons) for promising to try this method out on camels, and Dr Andrew Kitchener (Royal Museum of Scotland) for bringing in the elephants (indispensible to any paper). Also, Dr Hezy Shoshani (Wayne State University, Michigan) has warned that he intends to compare my elephant results with his own new method for sexing mandibles on the same specimens, and if the results do not agree there will be fisticuffs.

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Addendum; Simon Parfitt (Institute of Archaeology) has sent me a copy of a paper on sexual dimorphism in the pelvis of the squirrel monkey, in which ratios of pubis length to ischium length are used, as well as one of the measurements of the midpoint of the pubis also being tested by Sebastian Payne for sheep: Gingerich, P. D. 1971. The development of sexual dimorphism in the bony pelvis of the squirrel monkey. Anatomical Rec. **172,** 589-96.

Circaea volume 6 number 2, 1990 (for 1988), pages 115-118

Some peculiarly damaged cattle metapodials

Simon J. PI. Davis*

Summary

Attention is drawn to some unusual damage to cattle metapodials from a Roman site near Droitwich and a 17th/18th century site at Dorchester, England. Some possible explanations of the damage are advanced but no secure conclusion is reached.

Introduction

The purpose of this note is to draw attention to two recently observed cases of a peculiar pattern of damage on the distal ends of cattle metapodials. One case (eighteen metatarsals and two metacarpals) is from a late 17th/mid 18th century AD pit in Dorchester, Dorset. The other (a metacarpal) is from Dodder Hill, a Roman fort near Droitwich, Hereford and Worcester. While able to speculate how the damage might have been done, I am quite unable to find any satisfactory explanation for why it was done. Has anyone observed this kind of damage in material from other sites and, if so, in what contexts? How widespread in time and space was it? Answers to these questions may help to establish whether any meaningful pattern exists which could in turn provide an interpretation. I would be very grateful for comments and suggestions and look forward to hearing from colleagues.

Brief description of the sites and their animal bone assemblages

Dodder Hill, a Roman fort near Droitwich, was excavated in 1977 under the direction of D. Freezer. The site was occupied by part of the XIVth Legion for a very limited period, securely dated by pottery and coins to c. AD 55-66. The bones (Davis 1988) were found in two pits and a gully sealed by a cobbled surface. The amount of bone is small. The 232 recorded bones and teeth belong to cattle (61%), sheep/goat (32%, probably all sheep), pig (4%) and small quantities of hare, equid, canid, bird (probably chicken) and fish (probably salmon). The cattle remains are mostly foot bones (these include 28 distal metapodials) and teeth, which may therefore derive from butchery rather than household waste. Most of the cattle were probably female and most were adult when slaughtered. They were possibly retired dairy cows and, like other cattle from southern England in early Roman times, were small.

The 17th/18th century AD pit at Dorchester was excavated in 1982 by D. Batchelor from the rear yards of tenement occupations in Church Street. It contained unbutchered cattle foot bones (metapodials and phalanges; Davis 1987). A small number of other bones

* Simon Davis, Ancient Monuments Laboratory, English Heritage, 23 Savile Row, London W1X 2HE, U.K.

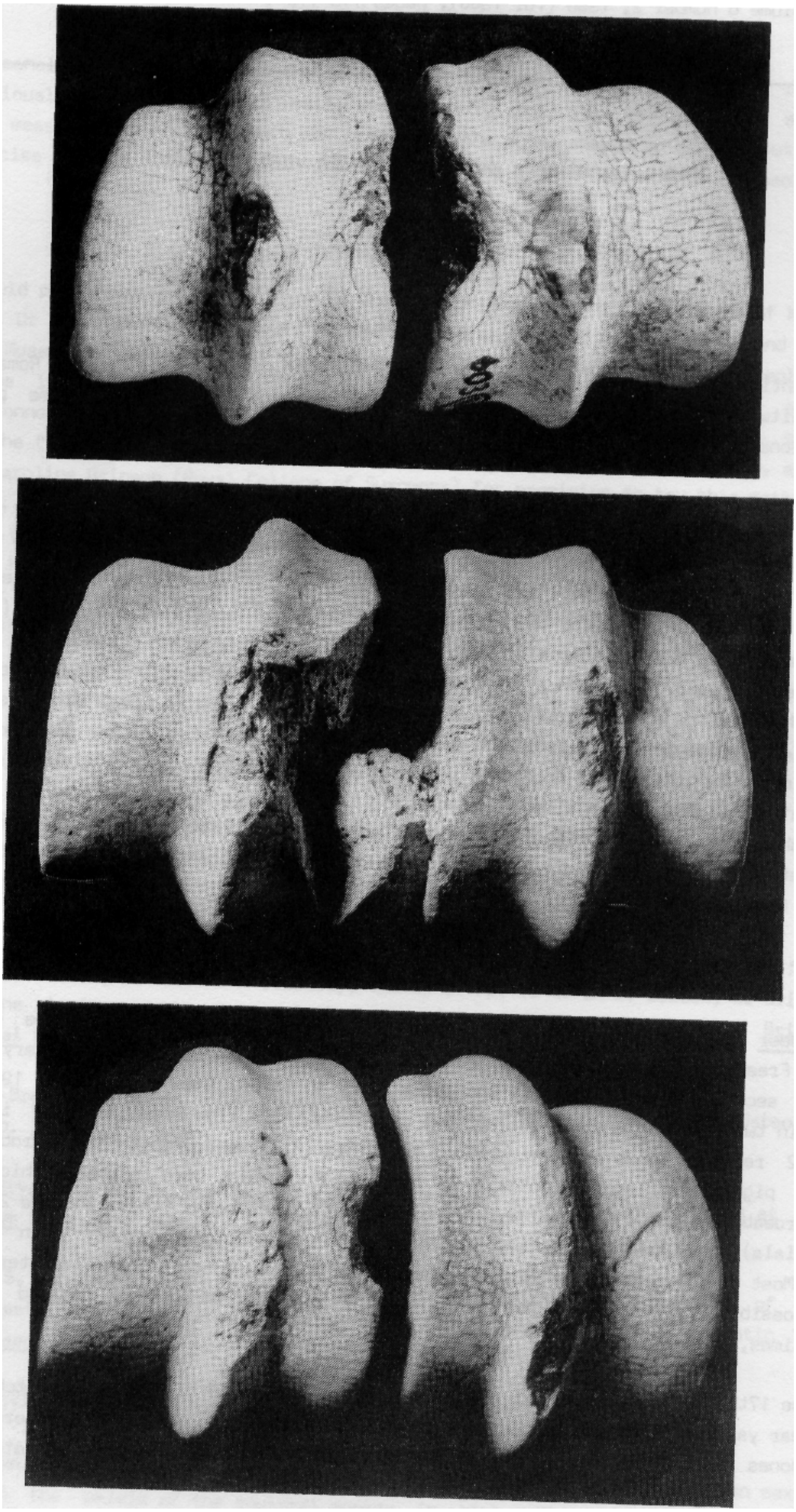

Figure 27. Distal view of the cattle metacarpal from Dodder Hill (above) and two cattle metatarsals from Dorchester (centre and below) to show the damage inflicted in antiquity on the condyles. The photographs are not all to the same scale.

belonging to cattle, sheep/goat, pig, cat and ?rabbit were also found in these contexts but their presence was probably incidental. The cattle foot bones belonged to some 20 large adult cows or oxen. Like O'Connor's (1984) sheep foot bones from York, this unusual collection of cattle foot bones from Dorchester may also be waste from hide processing (in this case a cow-hide tannery). The raw hides were presumably imported with foot bones attached to serve as handles.

The damage

Description of_ damage: Damage was observed on the distal articulations of two of the 39 metacarpals and 18 of the 39 metatarsals at Dorchester and one of the 12 metacarpals at Dodder Hill (examples are shown in Fig. 27). In most cases both condyles are damaged at their most distal region. There is damage to that part ('x' in Fig. 28) of each condyle adjacent to the inter-articular gap. Here, a wedge or several chips of bone appear to have been 'pressed' or flaked proximally (i.e. towards the proximal part of the metapodial) from each condyle, presumably after death. Some damage has also occurred to the most distal part" of each condylar verticillus ('y' in Fig. 28) from which a chip or several small flakes of bone had been removed. There is no damage to the top of the inter-articular gap ('z' in Fig. 28) as might have been caused by a sharp instrument inserted between the condyles.

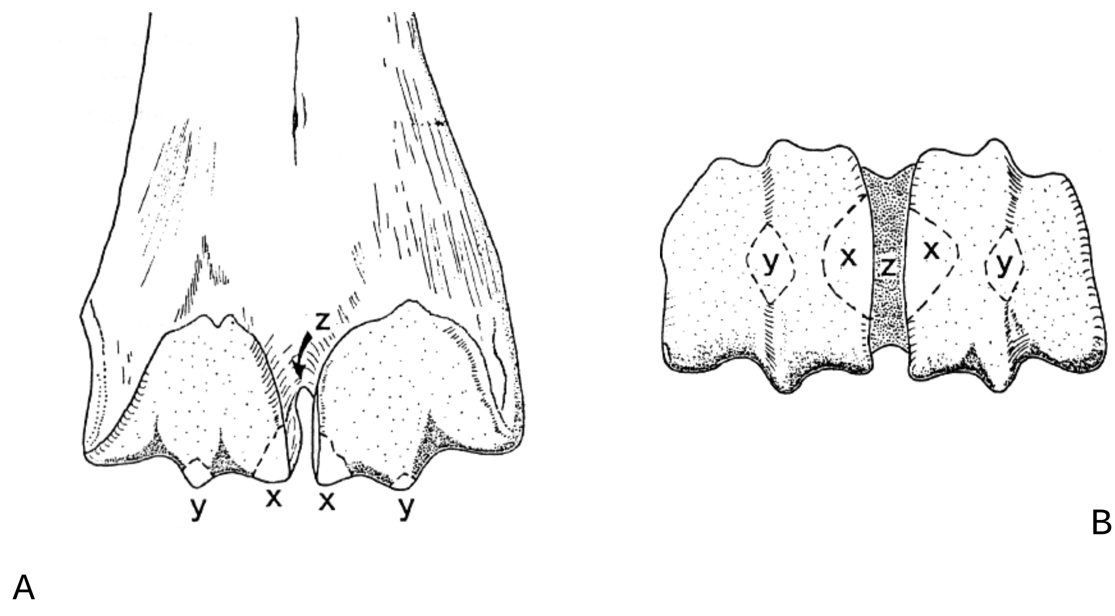

Figure 28. The distal end of a cattle metapodial (a) in anterior and (b) in distal view, to show where damage has occurred. Key: 'x' - damaged central part of the condyle adjacent to the inter-articular gap; 'y' - verticillus; 'z' - top of the inter-articular gap.

At Dorchester many of the cattle phalanges are also damaged. The edges of the proximal (i.e. metapodial) articulations of approximately half of the 76 first phalanges are slightly abraded and most of these same phalanges also have slightly damaged distal articulations (i.e. the phalanx 1-2 articulation). Of the 34 second phalanges, at least 13 have similar damage to their proximal and distal articulations and a small proportion of the 32 third phalanges show signs of slight damage too.

How was the damage inflicted?: The damage on the articular surfaces of the distal metapodials does not appear to have been caused by cutting or chopping phalanges from the rest of the foot. It is more likely to have been caused by inserting medially and laterally an instrument rather like a modern screwdriver into either side of the fetlock-joint, perhaps to dislocate phalanges from metapodial. In a similar way, damage to the phalanx 1-2 and phalanx 2-3 joints could have been caused by lateral or medial insertion of the same instrument to dislocate phalanges from one another.

Why?: One possible explanation for the peculiar pattern of damage is that these phalanges and metapodials were separated for bone-working at some later stage. However, the prevalence of damage to metatarsals rather than metacarpals in the material from Dorchester is difficult to explain. Another explanation for the pattern of damage at Dorchester links the bones with tanning. Tanning cattle hides was once a long process which required as many as 15 or more months. However, tannage may be accelerated by continual movement (Waterer 1956). Perhaps damage to the phalanges resulted from the movement of the skins held (or, as O'Connor has suggested to me, clamped) to some kind of machine via their foot bones.

Further finds of this sort of damage on bones from archaeological sites may help to provide an explanation.

Acknowledgments

I thank Miranda Armour-Chelu, Juliet Clutton-Brock, Peter King, Beverley Meddens, Terry O'Connor and Sebastian and Rosemary Payne for many useful discussions concerning this strange pattern of damage. Nicholas Balaam and Fachtna McAvoy kindly entrusted me with the Dorchester and Dodder Hill animal bone assemblages.

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Circaea volume 6 number 2, 1990 (for 1988), pages 119-120

Cleaning archaeological fish scales

Andrew Leak *

Summary

A method is described for the cleaning of fish scales from archaeological deposits prior to identification and estimation of age at death.

Introduction

On the surface of cycloid and ctenoid fish scales, the types most commonly found in archaeological deposits, are a series of striations, the circuli. The circuli in many cases form diagnostic patterns which may be used, to a lesser or greater extent, to derive data about the age, growth rate, and size of the fish (Casteel 1976; Bagenal 1974; 1978). It is the interpretation of the circuli which is described as 'reading' the scales, but most fish scales recovered from archaeological sites are difficult to read.

The scales often have a lot of particulate material, both organic and mineral, adhering to their surfaces. Typically archaeological scales are stained with organic substances, and iron salts. The combination of the various contaminants encountered in fish scales of archaeological origin, make it difficult to use transmitted or incident light microscopy to observe and measure their surface features. It is, therefore, necessary to clean archaeological scales before any work may be undertaken with them. Low-power microscopy has proved to be the most reliable method of initially assessing the potential of various scales for analysis. To use the microscope well, the scales in question should ideally be mounted between two glass slides. Mounting archaeological scales is not a completely trouble-free operation. The scales are often dry and brittle, and rarely flat. It is very easy to shatter and destroy archaeological material if it is not first softened (see below) before attempting to mount it.

Techniques investigated

Several techniques for cleaning scales were tried, the emphasis being on simplicity, speed, and the ability to clean a lot of material at once. Mechanical shakers are available in many laboratories, so cleaning was first attempted using one of these machines. Various test cleaning solutions were devised: 5% caustic soda (NaOH), dilute household bleach ('Domestos'), water, household soap, tetra-sodium pyrophosphate

* Andrew Leak, Environmental Archaeology Unit, Walled Garden, University of York, Heslington, York Y01 5DD, U.K.

($Na_4P_2O_7.10H_2O$) and diaminoethanetetra-acetic acid ($[CH_2N(CH_2.COOH).CH_2.CODNaJ_2.2H_2O$ - EDTA). About 9 ml of each of these solutions was placed in 10 ml vials which contained a few archaeological scales. The jars were attached to a Stuart flask shaker and the machine run for ten minutes, at the slow speed setting. On completion of this trial period, the scales were removed from their vials and washed thoroughly in water. The scales were then observed under a microscope and the success of the cleaning assessed by eye. Photographs were taken at each stage of the operation, so that independent evaluations could be made.

Most successful were the treatments which used tetra-sodium pyrophosphate and EDTA. Pyrophosphate was very good at removing particulate materials from the surface of the scales. EDTA very successfully removed organic stains from the scales. Subsequently, it was decided to combine the two most successful treatments to produce the best overall result, by removing the coarse particulates from the scales first with sodium pyrophosphate, then using EDTA to remove the stains.

The overall cleaning process that has been most successful is an operation which uses an Ultrasonic cleaning tank (the one used was manufactured by Kerry Ultrasonics Ltd). First the scales were separated and placed into a vial containing sodium pyrophosphate. The mixture was put onto an ultrasonic shaker and agitated for ten minutes. The scales were then removed from the vial and thoroughly washed in water, after which the scales were placed in another vial which contained EDTA and ultrasound-treated for a further five minutes. The scales were then thoroughly washed in water and placed between sheets of blotting paper to dry them. The scales were ready to mount between slides immediately, as they were both clean and softened.

Though the mechanically shaken system was fairly good, its results - when compared with those using the same cleansing agents, but in an ultrasonic tank - were distinctly inferior. A further advantage to the ultrasonic system is that it is often only necessary to clean the scales once in pyrophosphate in order for them to be usable for interpretative purposes.

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Circaea volume B number 2, 1990 (for 1988), pages 121-124

A note concerning a new way to build a 'seed' reference collection

Christian de Vartavan *

Summary

A brief review of methods of storing reference material of 'seeds' is given, with a description of a novel system that is readily transportable.

Introduction

Current systems for storing reference collections of 'seeds' (and. similarly-sized organisms such as molluscs) include the following, which we may term the 'Hillman' system, the 'Institute of Archaeology' system, the 'metal case' system, and the 'paper envelope[1] system:

The first of these, the 'Hillman' system, was used to build up the 'seed' reference collections in the Botany Department of University College, Cardiff and the British School in Ankara, Turkey. It consists of two ranks of glass tubes held at their bases in narrow wooden racks. The small racks are easy to handle and make the stored material easily visible. The disadvantages, however, are that all the racks had to be made specially for the purpose and were therefore expensive. They can only store a small number of species (maximum 20) at one time and, if dropped, all embedded tubes may separate from their rack.

The 'Institute of Archaeology' system uses square polystyrene racks in which 100 tubes (in rows 10 x 10) may be inserted. The advantages are that these racks are very cheap and can be bought ready-made (the price varies but Hillman (pers. comm.) has traced a very cheap supply in West Germany). Other advantages depend on tube size. If conventional 5 x 1 cm tubes are used, then protection is almost complete if the racks is dropped since the depth of the rack is about the same as the tube length; this also makes the racks easily storable, as the upper surface is even. The disadvantages also depend on the length; traditional 5 x 1 cm tubes make the stored material absolutely invisible, whereas longer tubes allow only that material stored in the outer rows to be seen when more than half of them are inserted. This becomes a major and tedious disadvantage when several related taxa need to be examined during identification or even when a particular taxon is sought.

The 'metal case' system involves laying the tubes flat in ranks (and sometimes in boxes) in the shallow metal drawers of office cabinets. This excellent system makes the stored material easily accessible and visible. Security is excellent since only the tubes being examined can be dropped unless a whole drawer is pulled out. It is, moreover, a

* Christian de Vartavan, Department of Human Environment, Institute of Archaeology, University College, 31-4 Gordon Square, London IC1H OPY, U.K.

system designed to be resistant to wear. It has one major disadvantage, however, since each drawer unit may be very expensive. A second disadvantage is that the drawers are rather heavy and difficult to carry around. This is a system better suited to large institutions with permanent facilities in mind than to the independent scientist.

The 'paper envelope' system, in which seeds and other plant parts are stored in small paper envelopes which are in turn stored in boxes, has the advantages of being cheap and quick to organise (labels, for example, may not be needed). Moreover, seeds purchased from nurseries or obtained from Botanic Gardens can be stored immediately as most come in labelled envelopes. The first disadvantage is that the envelopes are more susceptible to wear and tear as well as insect predation than other storage media. Security, moreover, is not satisfactory, as envelopes are left unsealed for easy access and the material may be scattered if one of the boxes is dropped. Another important disadvantage is that, once stored, the material is virtually invisible.

There are, of course, other systems than those described here (as, for example, the 'slide' system, where seeds are glued on a slide and further protected by a transparent cover which may or may not be glued onto the slide - a tedious, unsafe, expensive and generally awkward system since the seeds are fixed in position and cannot be turned, scraped or dissected).

The 'cork tile' system

I should like to describe a new system for those who do not wish to struggle with jungles of densely-packed glass tubes; this is the recipe:

Ingredients:

a number of glass tubes (for example 5.2 x 1 cm) with plastic lids;

a number of 30 x 30 cm cork tiles (these are readily available at 'DIY[1] stores;

a number of small labels, e.g. 'Ivy' brand 12 x 38 mm (Ref. No. P1238);

cardboard (1500 g m^{-2} seems best);

an LP record carrying-case, currently available at record shops - an optional component that may be very useful in some circumstances.

Tools:

a sharp 'Stanley knife' or single-sided razor-blade

a sharp-pointed instrument such as a pair of compasses

a pen with waterproof, permanent ink

Method:

The first stage is to design a cardboard 'template' that will save considerable time (see the white grid at the bottom of the photograph, Fig. 29). Therefore, cut a 7.5 x 30 cm strip of cardboard. If using 1 x 5.2 cm tubes, draw on it ten 1.2 x 5.3 cm rectangles spaced at 1.5 cm (the size of the rectangles should, of course, be related to the size of the tubes to be accommodated). Then cut the rectangles out to make the grid. This is then used as a template to draw rectangles on the cork tiles in a series of parallel rows (see photograph).

Next the rectangles are cut from the tile (applying pressure to the centre of the area to be removed after cutting along the edges of each rectangle).

The rectangles may then be filled with tubes containing reference material; the plastic lids of the tubes can be punctured using, for example, the point of a pair of compasses, to allow the contents to 'breathe'. Tubes should be labelled clearly and permanently with the name of the material and any reference number within the system or according to a published taxonomic list, using a paper label. The label is placed so that it can be read when the tile onto which the tubes have been placed is turned over (Fig. 29, below, right).

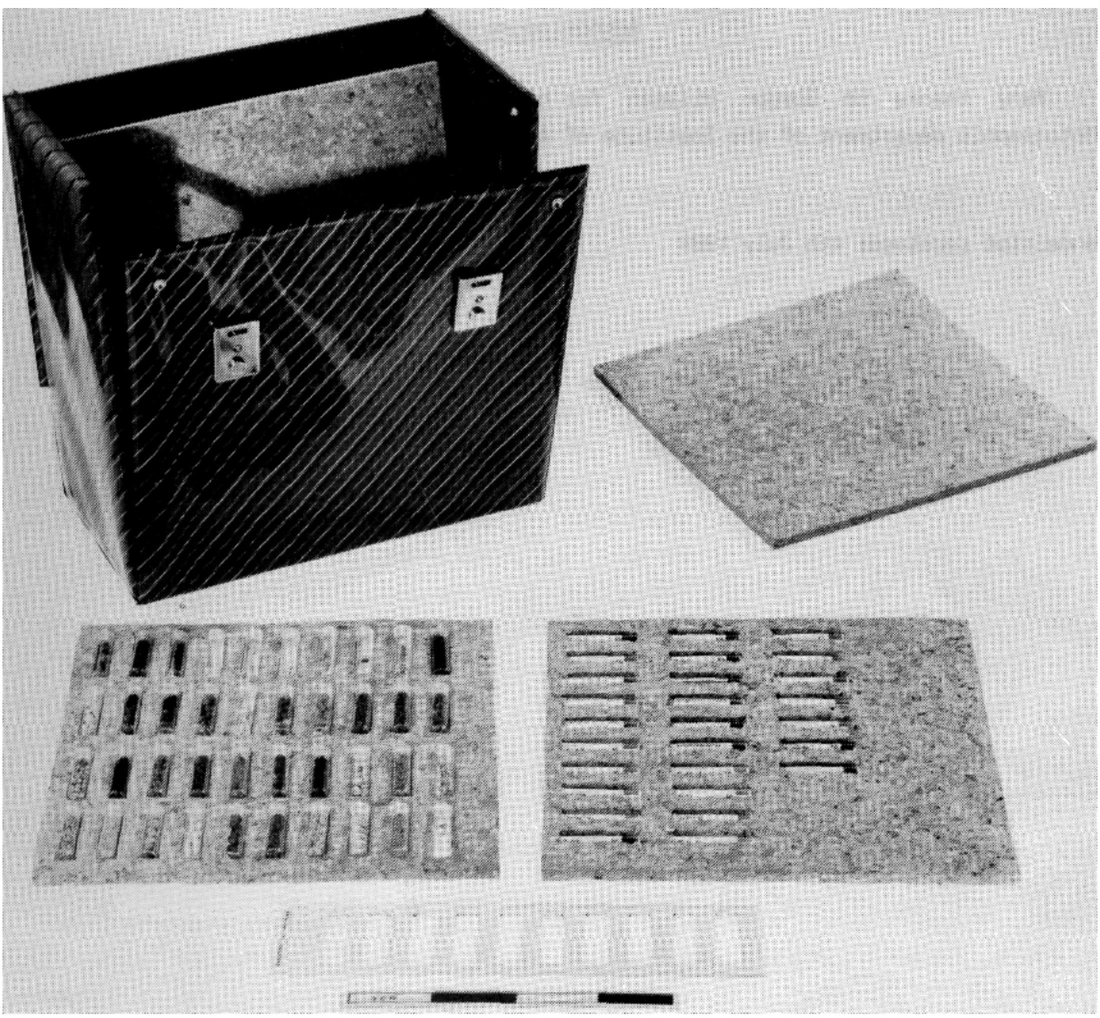

Figure 29. The cork tile system for storage of 'seeds'. Using this simple system, the contents of the tubes may be seen (below, left) as well as the labels (below, right). Tubes and tiles are stored in ready-made LP carrying-cases if travel is necessary.

Finally, capped tubes are placed in the rectangular spaces on the tile with the label facing downwards so that the contents of the tube are completely visible. The plastic cap, being slightly wider than the tube, should secure the tube in the cut space. The tile may then be labelled according to the material in the tubes it carries.

This process is continued for the whole collection; the LP carrying-case is ideal if material is to be transported.

The advantages of this system of building a reference collection are that it allows a clear and permanent visual display of all stored specimens (Fig. 29, below, left) as well as labels. The tiles are easy to store, whether piled on one another or, better, shelved like books. Thus 100 tiles may carry 4000 taxa and be stored on a couple of shelves of 2.5 m length. The tiles may be dropped without much danger to the stored material, whatever tube length is used; moreover, unlike polystyrene racks, cork tiles do not require chlorofluorocarbons (CFCs) in their manufacture, and the materials required to make the system are cheap and easily available. The main disadvantage of the system is the amount of work required in cutting rectangles in the tiles to hold the tubes.

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C I R C A E A

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