2470

Ancient Monuments Laboratory
Report 55/92

SOME NOTES ON SAMPLING AND SIEVING FOR ANIMAL BONES

Sebastian Payne

Ancient Monuments Laboratory Report 55/92

SOME NOTES ON SAMPLING AND SIEVING FOR ANIMAL BONES

Sebastian Payne

Summary

This note offers general guidelines to excavators on planning sieving and sampling strategies for animal bones. It includes advice on choice of contexts, mesh size, and sample size, practical advice on procedures, and an appendix on quantitative problems involved in relating data from sieved samples to data from trench-recovered assemblages.

The importance of consultation with specialists before and during excavation is stressed; these notes are an adjunct to and not a substitute for proper consultation with a zoo-archaeologist.

Author's address :-

Sebastian Payne

Ancient Monuments Laboratory
English Heritage
23 Savile Row
London
W1X 2HE

English Heritage
Ancient Monuments Laboratory
Environmental Studies Branch
Advisory note

Some notes on sampling and sieving for animal bones

Sebastian Payne

1. Introduction: the reasons for wet-sieving

However carefully they work, excavators recovering finds by hand while they dig ('trench-recovery') usually miss many smaller bones, bone fragments and isolated teeth. As a result, most trench-recovered bone assemblages are considerably biassed: smaller animals are under-represented, as are smaller parts of the skeleton and the bones of younger animals. The standard of trench-recovery is also very variable, depending among other things on the eyesight and motivation of the excavators, on the speed of excavation, on lighting in the trench, and on the colour and texture of the deposit that is being excavated.

Bone recovery can be improved by dry-sieving, but in most conditions the standard of recovery by dry-sieving is again very variable; dry-sieving is often impossible for clayey deposits.

The primary reason for wet-sieving is that it is a means of providing a known and consistent standard of recovery of samples of bones and bone fragments. When, as in most rescue situations, it is possible only to sieve a small proportion of the excavated earth, wet-sieving has two main purposes:

a. to provide well-recovered samples of the bones of larger animals in order to assess the degree and effect of recovery bias in the trench-recovered assemblages.

b. to provide samples of the bones of small animals that are almost entirely missed by normal trench-recovery, such as rodents, smaller birds and smaller fish.

These notes are written as general guidance for excavators, but are no substitute for consultation with specialists before and during excavation. Choice of contexts for sampling, sample size, sieving method and mesh size should all be discussed with a zoo-archaeologist (and other specialists) during the planning of an excavation, and will need to be reviewed during excavation in the light of what is found.

2. Choice of contexts for sampling

The main aim is to produce a matrix of bone samples from the excavated contexts at a site in order to be able to characterise bone assemblages from different periods, areas and context types, and make valid comparisons, especially in relation to the specific aims of the excavation project. Contexts should therefore be chosen to give a full range of period, area and context type. As there may well be considerable variation between different contexts, a range of contexts of the same type and phase should, when possible, be sampled rather than relying on a single context of any particular type.

As sieving is usually time-consuming, it is important to concentrate resources on sieving worthwhile contexts. Contexts that are usually not worth sampling are those which are thought likely to be seriously contaminated (whether by later or by residual material), likely to be badly preserved, likely to be of mixed or uncertain origin, or unlikely to be reasonably closely dateable.

Unusually rich deposits - whether of larger bones (e.g. butchery dumps) or of smaller bones (e.g. owl pellet deposits) are likely to need special treatment; stop excavating and consult a zoo-archaeologist as soon as possible, and, if not, aim to sieve the whole deposit with a mesh of appropriate size. Whole skeletons and concentrations of articulated groups of bones are likely to need special treatment; again a zoo-archaeologist should be consulted.

3. Choice of mesh size

The smaller the mesh, the less that will be missed - but the longer sieving and sorting takes. As a rough rule of thumb, halving mesh size is likely to increase processing time by a factor of between 4 and 8. Sorting material produced by meshes smaller then 2 mm is particularly slow because of the need to sort under a microscope and slow handling of small and often fragile specimens.

With an 8 mm mesh, nearly all bones from animals as large as a cow or a horse will be recovered, as will most bones from animals the size of sheep or pigs, though some smaller parts of the skeleton (e.g. incisor teeth) will still fall through the mesh. A good range of bones from animals the size of cats and dogs, larger birds (e.g. chicken) and larger fishes (e.g. cod) will be recovered, but many smaller bones will be lost. A 4 mm mesh is needed to give reasonable recovery of bones of animals of the size of squirrels, pigeons or trout; a 2 mm mesh is needed for reasonable recovery of mouse, vole, sparrow or herring bones; and a mesh as small as 0.5 mm is needed to make sure that all rodent teeth are recovered.

Choice of mesh size usually has to be determined by balancing time against loss, while taking into account the questions that are being asked and knowledge of what bones are likely to be present in the sample. In practice it often makes sense to use more than one mesh size - a coarse mesh, perhaps 4 mm or 8 mm, to sieve large volumes of earth to produce control samples of bones of the larger animals, and smaller volumes with a finer mesh, perhaps 2 mm or 1 mm, to produce samples of bones of smaller animals and to provide some check on what is being missed by the coarser mesh.

4. Choice of sample size

It is important that the samples of earth that are sieved are large enough to produce useful quantities of bones; few things are more dispiriting to excavator and zoo-archaeologist alike than the waste of time involved in sieving and examining large numbers of samples so small that most have only produced a few uninformative scraps of bone. As a rough guide, in most circumstances sample volumes probably need to be increased until most coarse mesh samples are producing at least 50-100 g of bone and most fine mesh samples are producing at least 5-10 g, which is likely to require samples of at least 10 buckets (100 litres) for coarse mesh sieving and of at least 1 bucket (10 litres) for finer mesh sieving.

The temptation to sieve only rich samples should be avoided - it cannot be assumed that these are typical; larger samples will be needed if contexts are poor (though there is clearly a point beyond which yield is too low to be acceptable).

5. Procedures

5a. Quantitative caution: 'whole-earth' samples and context volumes

One of the most important purposes of wet-sieving is to provide a good basis for quantitative statements about animal bone assemblages, e.g. the relative abundance of rabbit and cow bones, or of sheep jaws and sheep phalanges, for valid comparison and archaeological interpretation.

When the whole of a context is wet-sieved with the same mesh, there is no problem - all the bone from the context, whether recovered in the trench or by wet-sieving, can be treated as a single analytical unit. If, however, only part of the context is sieved, or if part is sieved with a coarse mesh and part with a finer mesh, there can be problems in relating trench-recovered and wet-sieved data (see Appendix 1).

The easiest way to achieve what is necessary is to make sure that the earth that is taken for samples for sieving is 'whole earth', from which no bones or other finds have been removed during excavation. Another way is to record the volume of the whole context as well as the volume of the sample or samples taken for sieving; in practice, however, this is not easy to do reliably.

5b. Sieving

The aim is to produce a clean 'residue' of pieces of bone, stone, pottery and anything else retained by the mesh, allowing rapid and reliable sorting. Before sieving, the volume (or weight: either can be used, but please don't switch from one to the other) of each sample of earth should be recorded in order that bone concentrations can be calculated and compared.

If earth is hard to sieve (usually when there is too much clay), it may help to soak samples in water for 1-3 days before sieving. If there are still problems, try experiments and take advice; techniques that may help include agitating with a limited quantity of water ('slurrying'), drying followed by rapid wetting, ultrasonic disaggregation, and treatment with chemicals such as hydrogen peroxide.

5c. Sorting

The aim should be to sort systematically through the cleaned 'residue' for all bones and bone fragments, not just to pick the residue over and pick out the most obvious specimens.

Sorting is best done when a residue is almost dry: when the particles are no longer wet enough to stick together, but are still damp enough for colours to be more intense than when dry. Residues should be dried slowly, otherwise fragile bones may split: direct sunlight, fans, heaters and ovens should all be avoided. Sorting becomes more difficult once a residue is completely dry, and cannot be done properly unless it is clean. It is usually a mistake to store unsorted residue for long periods as it becomes more difficult to sort (and may need to be rewashed), and large sorting back-logs are inevitably depressing.

Sorting is usually best done with a brush, on a surface whose colour contrasts well with the residue (white is a bit bright; grey, pale blue and pale green are all preferable), in good light (strong daylight is best, but not direct sunlight).

It is important that sorting is properly supervised by someone who knows what different kinds of bones (e.g. sesamoids, vole teeth etc.) look like. Sorted residues should regularly be checked by another sorter and/or by the supervisor to make sure that too much is not being missed (start by checking all of a new sorter's residues until an acceptable standard is reached, then check one in every ten or twenty at random); some sorted residues should be kept for final checking by the bone specialist, and possibly for permanent storage as part of the site archive. Sorting should not become a penance, an activity for the incompetent, or something to be raced through on wet days or in the evening.

It is often helpful to separate a residue into different size fractions before sorting, as it is easier to sort residue of fairly uniform size. If this is done, it is important either that the different fractions are all sorted at the same time and never allowed to get separated, or that care is taken in labelling different fractions.

To save time, it may sometimes be necessary to sort only part of the smaller fractions of a residue (e.g. one might opt to sort all the >2 mm fraction and only one quarter of the 1-2 mm fraction). If so, care should be taken to produce a representative sub-sample (e.g. by successive halving by the cone and opposing quadrant method, or with a sample-splitter), and the finds from the two fractions should be kept separate, and labelled appropriately, specifying the proportion of the smaller fraction that was sorted (e.g. '1-2 mm, 1/4 of sample').

5d. Storage

Bones should not be bagged and stored until they are properly dry - otherwise mould will attack them. As with drying residues, bones should be dried slowly to avoid any risk of damage. Small, fragile specimens should be protected by tubes, boxes (or gelatine capsules); if possible these should be stored in the same bag/container as the rest of the bone from the sample so that there is only one container of bone per sample. Do not overfill bags, tubes or boxes; and make sure that labels and ink are permanent.

5e. Records

The sieving record should provide at least the following information for each sample:

a. Context number/site reference: if sample numbers are used, give context number/site reference as well to guard against confusion and/or error.

b. Context information, as appropriate for the site: e.g. area/co-ordinates, context type, description, phase, period, etc.

c. Comments (if any): e.g. special reason for taking sample.

d. Size of sample: either volume or weight can be used, but please don't switch from one to the other.

e. Mesh size used (and sub-sample fraction when relevant).

f. Name of sorter.

g. Number of containers of bone: helpful to confirm that no container has been lost when no bone was found in a sample, and, if it is necessary to use more than one container for a sample (though this should be avoided if possible), to warn that more than one container should be found.

6. Co-ordination, supervision and feedback:

Thought should be given to the co-ordination of sampling for animal bones with any other sampling, especially sampling for plant remains. It is often possible and sensible to use the same samples as routine flotation samples for plant remains and as finer mesh samples for animal bones. The organisation of sampling and sieving is usually made simpler if one person takes overall responsibility.

Feedback is important in optimising choice of mesh and sample size, and varying them when necessary to take account of variation in the nature of the samples and their content; samples should be processed while excavation is taking place and specialists should be brought on site to look at what is being produced and provide feedback.

7. Useful reading

Levitan, B.M., 1982 Excavations at West Hill, Uley: 1979. The sieving and sampling programme. Western Archaeological Trust Occasional Papers 10.

O'Connor, T.P., 1988 Archaeological bone samples recovered by sieving: 46-54 Fishergate, York, as a case study. Ancient Monuments Laboratory Report 190/88.

Payne, S., 1975 Partial recovery and sample bias. Pp. 7-17 in: Clason, A.T. ed., Archaeozoological studies, Amsterdam: Elsevier.

8. Revision

These notes may be revised from time to time; feedback would be gratefully received. For feedback so far, thanks to: Justine Bayley, Simon Davis, Richard Hubbard, Andrew Jones, Bruce Levitan, Simon Mays, Bev Meddens, Lisa Moffet, Rosemary Payne, Clifford Price and Pat Stevens.

Appendix 1: Problems in combining trench-recovered data and data from sieved samples.

The problems involved in combining and comparing the data from trench-collected assemblages and sieved samples are illustrated by the example of a pit containing the remains of 10 sheep and 480 herrings, which provided similar quantities of meat. Counts are given below for three kinds of bone - sheep mandibles, sheep phalanges and herring vertebrae:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
Present in whole pit	**20**	**240**	**26,880**
Number per individual	2	24	av. 56
Number of individuals	10	10	480
Meat per individual (kg)	12		0.25
Meat (kg)	120		120

Trench-recovery: Experience of sieving trials suggests that trench-recovery misses relatively few sheep mandibles, most sheep phalanges and almost all herring vertebrae. This might produce the following assemblage from the pit, wrongly suggesting that little herring was eaten and that sheep phalanges were separated from the heads and disposed of differently:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
Trench-recovered	**20**	**6**	**1**
Number per individual	2	24	56
Number of individuals	10	1	1
Meat per individual (kg)	12		0.25
Meat (kg)	120		0.25
(Present in whole pit	**20**	**240**	**26,880)**

Sieving: If samples of earth are sieved to check what is being missed by trench-recovery, what is found by sieving depends on the mesh used, the size of the samples, and whether the samples are taken for sieving after bones have already been removed in the normal way in the trench ('dump earth') or whether earth is taken for sieving without anything being removed ('whole earth').

An 8 mm mesh would recover most sheep phalanges but no herring vertebrae. Random samples might produce the following results:

		Sheep mandibles	Sheep phalanges	Herring vertebrae
8 mm mesh				
Whole earth	**(1/4 pit)**	**5**	**50**	**0**
	(1/20 pit)	**1**	**10**	**0**
Dump earth	**(1/4 pit)**	**0**	**48**	**0**
	(1/20 pit)	**0**	**10**	**0**
(Present in whole pit		**20**	**240**	**26,880)**

Note that the 'dump earth' samples produce no sheep mandibles because nearly all of these would have been recovered in in the trench.

The 'whole earth' samples give a reasonably good estimate for the ratio of sheep phalanges to mandibles (1:10 as compared with 1:12 originally in the pit), the slight shortfall of phalanges being accounted for by the small proportion of phalanges that fall through the 8 mm mesh; but the importance of herring is missed.

The 'dump earth' samples again miss the herring, but also give a misleading estimate for the ratio of sheep phalanges to mandibles (0:48 or 0:10) because of the mandibles removed in the trench. Adding the 'dump earth' data and the trench-recovered data gives ratios that depend on the proportion of the earth that was sieved and are misleading because of the phalanges that were present in the earth that was not sieved:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
Trench-recovered + dump earth (1/4 pit)	20	54	1
Trench-recovered + dump earth (1/20 pit)	20	16	1
(Present in whole pit	20	240	26,880)

To produce a reasonable estimate, it is necessary to know what proportion of the earth was sieved and to multiply the sieve sample data appropriately before adding them to the trench-recovered data:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
Trench-recovered + (dump earth (1/4) x 4)	20	196	1
Trench-recovered + (dump earth (1/20) x 20)	20	206	1
(Present in whole pit	20	240	26,880)

The proportion of sheep mandibles to phalanges is now similar to the 'whole earth' sample (about 1:10) and only slightly higher than the proportion originally present in the pit (1:12); but the importance of herring is of course still missed.

A 1 mm mesh would recover most of the herring vertebrae:

		Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh				
Whole earth:	**1/4 pit**	5	60	5,750
	1/20 pit	1	12	1,150
	1/200 pit	0	1	115
Dump earth:	**1/4 pit**	0	58	5,750
	1/20 pit	0	12	1,150
	1/200 pit	0	1	115
(Present in whole pit)		20	240	26,880

In this case, the largest whole earth sample gives a good estimate for the ratio of sheep mandibles to phalanges, and only a slight under-estimate of the importance of herring:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh			
Whole earth: 1/4 pit	**5**	**60**	**5,750**
Number per individual	2	24	av. 56
Number of individuals	3	3	103
Meat per individual (kg)	12		0.25
Meat (kg)	36		25.75

The smaller samples still give a reasonable basis for guessing at the importance of herring but too few sheep bones to give a good estimate for the ratio between phalanges and mandibles.

The 'dump earth' samples lack sheep mandibles as before, but recover large numbers of herring vertebrae. Adding 'dump earth' sample data to the trench-recovered sample data:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh			
Trench-recovered + dump earth (1/4 pit)	**20**	**64**	**5,751**
Trench-recovered + dump earth (1/20 pit)	**20**	**18**	**1,151**
Trench-recovered + dump earth (1/200 pit)	**20**	**7**	**116**
(Present in whole pit)	**20**	**240**	**26,880**

again gives misleading proportions on both counts, varying according to the proportion sieved:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh			
Trench-recovered + dump earth (1/4 pit)	**20**	**64**	**5,751**
Number per individual	2	24	av. 56
Number of individuals	10	3	103
Meat per individual (kg)	12		0.25
Meat (kg)	120		25.75

Corrected estimates, taking into account the proportion of the pit that was sieved:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh			
Trench-recovered + (dump earth (1/4) x 4)	**20**	**238**	**23,001**
Trench-recovered + (dump earth (1/20) x 20)	**20**	**246**	**23,001**
Trench-recovered + (dump earth (1/200) x 200)	**20**	**206**	**23,001**
(Present in whole pit)	**20**	**240**	**26,880**

give results much closer to the original pit contents:

	Sheep mandibles	Sheep phalanges	Herring vertebrae
1 mm mesh			
Trench-recovered + (dump earth (1/4) x 4)	**20**	**238**	**23,001**
Number per individual	2	24	av. 56
Number of individuals	10	10	411
Meat per individual (kg)	12		0.25
Meat (kg)	120		102.75

It should, however, be noted that the figures for sheep phalanges based on the smallest sample (1/200) are very vulnerable to chance variation: if, for instance, two had been found in the sample instead of one, the estimate would have been 406; if none had been found the estimate would have been 6!

Recommendations:

* **Use a small enough mesh to recover what you need to recover**

* **Sieve enough earth to produce a useful sample of bones**

* **Use 'whole earth' samples**

  or

  if 'dump earth' samples are used, record what proportion of the whole context was sieved and make sure that the bone recovered by sieving (from the sample) and by trech-recovery (from the whole context) are kept separate.

../sieving 10.92 (2)