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# CONTAMINATION OF ARCHAEOLOGICAL DEPOSITS BY MACROSCOPIC BIOLOGICAL MATERIAL (CHIEFLY SEEDS) OF MODERN ORIGIN (WITH PARTICULAR REFERENCE TO THE USE OF FLOTATION MACHINES).

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It is now recognised by flotation machine users that a large proportion of the seeds recovered are often of modern origin. For example, a "Cambridge"-type flotation machine[1] was in continuous use on the fairly well drained gravel site of Bedfont in 1972.[2] Many uncharred weed seeds were obtained, although it seemed extremely unlikely that they had been preserved since the Iron Age in the non-waterlogged conditions on site. The fact that most of the seeds were of modern origin was confirmed by subsequent germination of about 20% of the total during storage.

This degree of contamination has been observed on other sites, and would seem to be of widespread occurrence. When a flotation machine is in use the recovery of all seeds is greatly increased and any contaminant (even if present in fairly small quantities per unit deposit) is more noticeable.

A number of possible sources for this contamination may be suggested:-

1. "Dirty" excavation and careless collection of samples.
2. Aerial contamination (seeds blowing onto the sample while it is exposed to the atmosphere).
3. Cross-contamination (from a more recent deposit) in the flotation machine.
4. Contamination of the archaeological deposit before excavation.

The first three are self-explanatory. They can be very important sources of contamination since a few grams of topsoil may contain surprisingly large quantities of modern seeds, and there are many wind-borne seeds at certain times of the year. However, with care it should be possible to greatly reduce contamination from these sources.

A short experiment was carried out by P Murphy using the M3 flotation machine[3]. A sample was processed in the usual way, then a test run was carried out without the addition of a new sample. The amount of material obtained from this run represents that which would have acted as a contaminant had a second sample been processed. Eight samples were tested in this way. The weight of the flot.obtained from the test run expressed as a percentage of the original flot. varied from 0.15% to 2.02% (mean 0.87%). This would seem to demonstrate that cross-contamination in the flotation machine may be slight, even if the machine is not cleaned between every sample. Obviously, this will vary with the machine and other conditions.

At Bedfont, stringent measures were taken to eliminate contamination from the first three sources, but significant quantities of modern seeds were still obtained. It was therefore apparent that the foutth source of contamination was an important factor. There are a number of ways in which modern top-soil and/or seeds can penetrate into buried archaeological levels:-

1. Ploughing can incorporate modern seeds lying on the surface of the soil into the plough soil. This would only be of significance on very shallow sites where the plough has disturbed archaeological levels.

2. Root holes and drying cracks (particularly in clayey soils) may penetrate into archaeological levels. They would often be expected to fill up with soil from the surface layers.

3. Earthworms are active on most archaeologiaal sites. They would seem to be the single most important factor in the introduction of contamination. Other burrowing animals (eg ants and moles) may be locally important, but would not be expected to have the widespread effect of earthworms.

The importance of earthworms in the introduction of modern seeds to earlier levels was clearly demonstrated at Bedfont by the observation in sections of earthworm burrows running through archaeological features, displaying a mass of small seedlings along their entire length.

The activities of earthworms were described in great detail by Darwin,[4] and have subsequently been discussed in relation to archaeology,[5,6]. Worms may be found in large numbers in most conditions except in very acid, peaty, waterlogged, or sandy soils. Although they are most active in the top 20cm of the soil they will burrow to much greater depths, particularly if it is dry or cold. They burrow partly by forcing the soil apart and partly by ingestion of the earth. Food is also obtained by the passing of soil through the body. Ingested earth is either voided into empty spaces in the soil or cast onto the sufface. Burrows usually have a thin lining of dark coloured earth to facilitate movement.

The main source of contamination is therefore topsoil which is swallowed and voided into the soil lower down or else used to line the burrows. The maximum dimension of material that can passed unharmed through the gut of the earthworm is about 2mm.[7] Therefore, contamination from this source would be restricted to the smaller weed seeds, etc.

Earthworms burrows are often observed in archaeological sections as dark lines running through deeper, paler, layers. Darwin considered that this was due to the dark linings forming a solid band after collapse of the burrows. However, in non-friable soils where collapse of burrows would be fairly slow, it might be suggested that washing in of topsoil from above could occur. This would explain why many of these "dark streaks" are the full thickness of an uncollapsed burrow (the dark line formed by a collapsed lining should be much narrower). An alternative explanation suggested by Hensen[4] was that earthworms used old burrows to cast into, but Darwin did not agree with this. Washed-in material could theoretically contain seeds of any size, but it may be that only finer material is deposited. This could be determined by experiment.

It is not unusual to find earthworms at depths of 2 metres or more. In extreme environmental conditions they will burrow deeply and curl up in a spherical aestivation chamber which they usually line with small stones 2.0-5.0 mm in diameter. As many of the large seeds (eg cereal grains) are in this size range, this is another means by which modern seeds might be incorporated into earlier deposits. It is already known that earthworms will use seeds as well as stones to line the aestivation chamber. Darwin[4] recorded the use of flax seed husks, oat grain (with husk) and pear seed for this purpose.

During small-scale sampling it is possible to reduce contamination by avoiding obvious earthworm burrows but this is impossible with large scale sampling, so it is clear that a certain amount of unavoidable modern contamination will be present in most flotation samples. The problem is therefore to establish methods of distinguishing ancient material from modern. The following suggestions might be considered:-

1. Radiocarbon dating of seeds

On occasions where there are sufficient seeds for a radiocarbon date, it might be assumed that this could clearly establish their age. However, it is quite likely that many deposits will contain a mixture of ancient and modern seeds, in which case any date would be meaningless.

2. Concentrations of seeds

In the light of the above discussion it might be expected that the degree of contamination should diminish somewhat with depth (as earthworm activity declines), reaching zero only at great depths where there are no earthworms. A concentration of modern seeds might conceivably occur in the pea-grit zone (ie where there is build up of aestivation chambers at a barrier to further earthworm penetration). Apart from this, there is no reason to suppose that a concentration of seeds should build up at a particular level. Therefore, any layer with high seed concentrations sandwiched between layers with very few seeds might reasonably be supposed to consist largely of genuine ancient seeds. However, there may be occasional exceptions to this. One notable example at Winklebury is being studied in the Ancient Monuments Laboratory.

3. Species present

Where the species identified are quite different to those available from the modern vegetation, there may be grounds for assuming them to be ancient. However, care must be taken, for example the modern vegetation might have changed recently.

4. Preservation

This is the most widely used means of distinguishing modern from ancient seeds. In waterlogged conditions uncharred seeds may be preserved relatively unchanged, but there is not much danger of modern contamination because there is usually little earthworm activity. In most other soil conditions it is unlikely that uncharred material will be preserved for any length of time. It is therefore a simple matter to reject all uncharred seeds as modern in origin and to consider only the charred material as genuine. Undoubtably, this selection greatly reduces the amount of modern contamination which must be considered. However, before all of the remainder is assumed to be ancient, it is necessary to ensure that there is no possible modern source of charred seeds. Before this possibility is disregarded, a number of points should be considered:-

a. Experiments have been carried out in Canada[3] to determine the amount of barley (Hordeum vulgare L) that falls to the ground during harvesting by the windrower-combine method. This was found to vary from 1.5 to 5.1 bushels per acre. The variation was influenced by crop maturity and weather conditions. Although different crops and harvesting techniques would produce different figures it is obvious that fairly large quantities of modern seeds may be present on the soil surface after harvesting.

b. Burning of fields as a means of straw disposal is a standard practice. Stubble burning is a long standing habit, but since the reduction in demand for straw as animal bedding and the introduction of combine harvesters which do not remove it from the fields, straw burning has become very widespread, (an estimated 36.6% of total straw production being burnt each year). The acreage burnt varies from area to area, but is more than 50% of the acreage under cereals in eastern England and more than 30% in many other areas.[9]

c. Casual observation of fields after burning suggests that some of the straw becomes charred. Theoretically, cereal grain laying on the surface of the soil might also become carbonised.

d. Charred cereal grains of modern origin might become incorporated into deeper levels by the processes outlined above.

It could be argued that the postulated sequence of events is unlikely to contribute significantly to the number of cereal grains recovered from archaeological levels. This is possibly true for sites containing large quantities of carbonised grain. However, many sites produce very little grain. For example, at Bedfont 1000 buckets of processed soil yielded about twenty cereal grains (from six samples). In these circumstances a very small modern component could be highly significant.

5. Size and morphology of cereal grains

It may be possible to recognise modern grains of some species by slight morphological differences when compared to their ancient counterparts. The best criterion which might be used to distinguish the two is size. However, this is not completely reliable as some ancient grains may be surprisingly large.[10]

SUMMARY AND SUGGESTIONS

It is apparent that on many sites there may be large scale modern contamination. Some of this may be eliminated by care and cleanliness in sample collection, storage, and processing, but some (chiefly that caused by earthworms) is unavoidable. A suitable record might be kept of earthworm activity on each excavated site.

It should be useful to record the modern vegetation originally covering an archaeological site so that the species likely to contribute contaminants are known. The seeds present in the modern soil and their distribution with depth might be studied on each site.

On well-drained sites modern contamination may be rejected by only accepting charred seeds as genuine. However, there is a theoretical source of modern charred grain in areas where straw burning is, or has been, carried out. It should be possible to establish by field tests whether this is likely to be a significant source of contaminants or not. In any case, it would obviously be of value to collect data on recent land use practices in the vicinity of an excavated site. This question should be investigated before all charred grain recovered in flotation machines is automatically assumed to be contemporary with the deposit in which it was found.

## REFERENCES


1. Jarman, H N, Legge A J, Charles J A, Retrieval of Plant Remains from Archaeologica Sites by Froth Flotation, (in Papers in Economic Prehistory, 1972, (Ed) E S Higgs)

2. Keepax, C A 1972, Report on Environmental Investigations (in Excavations at Bedfont 1971-2, Alexander, J, Farrant N)

3. Personal communication

4. Darwin C, 1881, The Formation of Vegetable Mould through the Action of Worms. Murray: London

5. Cornwall I W, 1958, Soils for the Archaeologist. Phoenix House: London

6. Atkinson R J C, 1957, Worms and Weathering. (Antiquity 31 219-233)

7. Evans J G, 1972, Land Snails in Archaeology. Seminar Press: London

8. Dodds M E, 1974, Grain losses in the Field when Windrowing and Combining Barley (Canadian Agricultural Engineering 16 (1) 6-9)

9. NFU Working Party on Straw Disposal:- Report on the Use and Disposal of Straw 1973

10. Arthur J R B, (Personal communication)