

A proposed scheme for evaluating plant macrofossil preservation in some archaeological deposits

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Summary

A scheme for the objective assessment of plant macrofossil preservation in archaeological deposits is proposed. It may be of value both in studies relating preservation to the depositional environment and also in routine assessment work. Comments and criticisms are invited.

Introduction

In this paper a scheme for evaluating the preservation of *uncharred* plant macrofossils in archaeological deposits will be presented. It is explicitly intended for use with archaeological deposits, such as the fills of pits, wells and ditches, rather than natural or semi-natural sediments. It cannot be stressed too strongly that the suggestions made here are preliminary, and are intended to stimulate discussion and further work in this area.

The state of preservation of plant macrofossils is extremely variable even in a single feature. Commonly, investigators report macrofossil assemblages as 'well' or 'poorly' preserved but rarely is such evaluation supported by any description of objective criteria. Some observations on preservation states, processes of decay and replacement have been published: Körber-Grohne (1964) has described progressive degradation of *Juncus* seed testas and grass fruit pericarps by the loss of cell layers; wood decay in archaeological contexts has been described and illustrated by Schweingruber (1982, 191-206); and Green (1979) has discussed phosphatic replacement of macrofossils, common in contexts such as latrine pit fills with high levels of biogenic phosphate.

Moreover, it is widely appreciated that some categories of macrofossils appear to be very susceptible to degradation and rarely preserve, whilst others are extremely durable. In our experience, *Allium* leaf epidermis and *Avena* pericarp, for example, seem to survive only in

deposits of very low redox potential where mineralisation of organic compounds is slow. [The term 'mineralisation' is used here in a strict microbiological sense; see further below.] At the other extreme, some categories of macrofossils (e.g. *Lemna* seeds) remain recognisable even in incompletely or intermittently waterlogged clastic sediments. A few types (e.g. seeds of *Sambucus nigra*) may even survive for long periods in deposits which are devoid of any other kinds of macrofossil, where oxygen has probably not been limiting to decomposition.

Nevertheless, there is, at present, no generally accepted scheme for describing macrofossil preservation, comparable to that devised by Cushing (1967) for pollen. This is understandable, for macroscopic plant remains differ very widely in gross structure, cellular structure, their degree of lignification, silicification and calcification and in their content of polyphenolic compounds, (such as tannins), and other modifiers (Swift *et al.* 1979, 148). As a result, distinct elements of various taxa survive differentially and objective assessment of preservation is difficult.

The need for a method of evaluation has arisen from a research programme, initiated by the writers, to investigate the relationship between the physico-chemical characteristics of archaeological deposits and the states of preservation of plant micro- and macrofossils. The scheme proposed may, however, have more immediate applicability in archaeobotanical practice. Nowadays, archaeobotanists are often involved in the assessment of the potential for

analysis of plant macrofossil assemblages, following the procedures laid down in *The Management of Archaeological Projects* (Andrews 1991). One factor influencing the decision on whether to proceed with analysis is the preservation of the material, though obviously many other factors would be taken into account, particularly the interpretative value of the assemblage. Poor preservation and/or fragmentation need not necessarily preclude full analysis if the investigator feels the material contains useful archaeological information. However, as a first step, assessment of preservation should be as objective as possible, to avoid idiosyncratic bias on the part of individual workers. A scheme of the type proposed here may help to ensure objectivity.

Ideally, all elements of an assemblage should be considered in evaluation, but in practice this may not be possible. To evaluate preservation of all categories of macrofossil (e.g. leaves, buds, stems, wood, rhizomes, roots, fruits, seeds) for all taxa present in a sample would clearly be excessively time-consuming and would negate the aim of producing a rapidly and easily-used scheme.

Other problems are related to taphonomy:

(a) It is possible that at least some macrofossils found in archaeological features are secondarily derived. They might have been subjected to some degree of decomposition in their initial place of deposition, and there is little hope of differentiating this secondary component from the primary assemblage.

(b) Comparing preservation between, for example, a latrine pit fill and a wet ditch fill presents problems given that the assemblages from such different context-types would have come from different sources and may show few resemblances in species composition. The former may consist largely of dietary residues from human faeces, whilst the latter may be composed mainly of seeds from the local aquatic and weed vegetation. Absence of a particular taxon or plant element may indicate lack of preservation or, alternatively, that it was never present. For these reasons, the scheme proposed here is mainly confined to a restricted range of plant elements and families which the authors have frequently encountered in a wide variety of archaeological deposits; but also included are some categories of material which are more specific to particular context-types.

The items selected for assessment may be open to debate, and the authors would welcome

comment and criticism of the scheme. Furthermore, it is hoped that workers in related sub-disciplines of environmental archaeology might develop similar approaches.

Evaluating preservation

The simplest way to ensure comparability of evaluation between samples seems to be to use a standard recording sheet, an example of which is attached. Six categories of macrofossils are considered, with an arbitrary 'score' for various states of fragmentation and preservation. This permits assessment both of comminution by the soil fauna and microbial degradation. Macrofossils of taxa which are likely to have been exposed to comminuting agents other than soil animals have been omitted from the scheme. These macrofossils include fruits and seeds of segetal species which may have been fragmented during grain milling or chewing by humans.

Clearly if a category is absent, the 'score' is 0. By totalling 'scores' for each section, a measure of the state of preservation of the assemblage would be obtained, based on objective, albeit selected, criteria. In a final section an assessment of the degree of replacement may be made. A few notes on the material considered may be helpful.

1. *Seeds/fruits*: The taxa selected for consideration here are almost all exceedingly common in archaeological deposits. The features selected for consideration are mostly self-explanatory.

The frequency of *Sambucus nigra* seeds is here taken as a measure of overall preservation state for the assemblage: very degraded assemblages may consist of *S. nigra* but little else. Of course, there will be occasional assemblages in which *S. nigra* originally formed the predominant component; an example comes from Brandon, Suffolk, where lenses of almost pure *S. nigra* seeds in peat were thought to be related to dyeing (Murphy, unpublished); but such exceptional assemblages should be readily distinguishable.

2. *Mosses*: Moss identifications from archaeological sites were reviewed by Seaward and Williams (1976); more recently remains of mosses have been widely reported from urban deposits (eg Stevenson 1986). Replacement (see below) has apparently not been reported. In section 2 assessment of fragmentation and survival of gametophyte leaves may be made.

3. *Buds/bud-scales*: An identification key is provided by Tomlinson (1985). Buds occur widely in waterlogged deposits, and occasionally are replaced. Again, in this section fragmentation through degradation of the axillary tissue may be estimated, as well as the degree of survival of bud-scale margins.

4. *Deciduous leaves*: Although sclerophyllous leaves (e.g. *Ilex*, *Calluna*, *Buxus*, *Pteridium*) tend to survive preferentially, deciduous leaves, particularly those with a high tannin content (e.g. *Quercus*), are found in waterlogged deposits. An assessment of fragmentation may be entered in section a. Unsurprisingly, the more lignified vascular and fibrous tissue of the leaves survives better than the epidermis and parenchymatous mesophyll tissue.

5. *Wood/twigs*: Degradation of wood in archaeological deposits is fully discussed by Schweingruber (1982). Just two characteristics are considered here. The first—the state of preservation of scalariform vessel perforation plates of common taxa such as *Corylus* and *Alnus*—gives an indication of the initial stages of degradation of fine structures. The second—gross deformation of wood structure with the development of radial fissures and sinuous medullary rays—measures later stages of decay.

6. *'Epidermal' tissues*: In this section some of the more commonly encountered 'epidermal' tissues are considered (see, for example, Greig 1988). Of these, *Allium* leaf epidermis seems to be the most readily degraded, *Triticum* and *Secale* fruit pericarp the least.

7. *Pseudomorphic replacement*: In this section an estimate of the degree of replacement of seeds by calcium phosphate (or, less frequently, other compounds) may be made. [The term 'mineralisation' has been used to describe this form of preservation (Green 1979) but 'replacement' will be used here to avoid confusion with the microbiological usage of 'mineralisation', as mentioned above, meaning release of inorganic ions by microbial activity from organic compounds]. Other characteristics include the presence/absence of faecal concretions (often including cereal pericarp fragments, scraps of *Agrostemma githago* testa, fly puparia and eggs of intestinal parasitic worms) and the presence/absence of sub-spherical, often hollow, 'globules' (see note by Carruthers, 1989). Stem fragments and wood may also be replaced.

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References

- Andrews, G. (1991). *The management of archaeological projects*. London: Historic Buildings and Monuments Commission.
- Carruthers, W. (1989). Mystery Object No. 2 - Animal, Vegetable or Mineral? *Circaea* 6, 20.
- Cushing, E. J. (1967). Evidence for differential pollen preservation in late Quaternary deposits in Minnesota. *Review of Palaeobotany and Palynology* 4, 87-109.
- Green, F. J. (1979). Phosphatic mineralisation of seeds from archaeological sites. *Journal of Archaeological Science* 6, 279- 84.
- Greig, J. (1988). The medieval plant remains from rock-cut pits at Watergate Street, Chester. *Ancient Monuments Laboratory Report* 57/88.
- Körber-Grohne, U. (1964). Bestimmungsschlüssel für subfossile *Juncus*-Samen und Gramineen-Früchte. *Probleme der Küstenforschung im Südlichen Nordseegebiet* 7 (ed. W. Haarnagel). Hildesheim: August Lax.
- Schweingruber, F. H. (1982). *Microscopic wood anatomy*. (2nd edn.) Teufen: F. Flück-Wirth.
- Seaward, M. R. D. and Williams, D. (1976). An interpretation of mosses found in recent archaeological excavations. *Journal of Archaeological Science* 3, 179- 82.
- Stevenson, R. (1986). Bryophytes from an archaeological site in Suffolk. *Journal of Bryology* 14, 182-4.
- Swift, M. J., Heal, O. W. and Anderson, J. M. (1979). *Decomposition in terrestrial ecosystems, Studies in Ecology* 5. Oxford/London: Blackwell Scientific Publications.
- Tomlinson, P. (1985). An aid to the identification of fossil buds, bud-scales and catkin-bracts of British trees and shrubs. *Circaea* 3 , 45-130.

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Sample record sheets (preservation and replacement)

1. Seeds/fruits

- a. *Ranunculus sceleratus*
 >50% of achenes intact ... 2
 50-25% of achenes intact ... 1.5
 >75% of achenes split, sometimes degradation of central tissue ... 1
- b. Caryophyllaceae (isolated seeds)
 >50% of seed testas uniformly well-preserved ... 2
 50-25% with testas uniformly well-preserved ... 1.5
 >75% show degradation of tissue between tubercles, some fragmentation ... 1
- c. Chenopodiaceae (isolated seeds)
 >50% with intact testas ... 2
 50-25% with intact testas ... 1.5
 >75% with fragmented testas, though internal tissues may be intact ... 1
- d. *Rubus fruticosus*
 >50% of fruitstones with endocarp intact ... 2
 50-25% with endocarp intact ... 1.5
 >75% with endocarp degraded, only internal tissues survive ... 1
- e. *Urtica dioica*
 >50% of nutlets intact ... 2
 50-25% of nutlets intact ... 1.5
 >75% of nutlets split, some fragments becoming translucent...1
- f. *Sambucus nigra*
 <25% of assemblage ... 2
 25-50% of assemblage ... 1.5
 >50% of assemblage ... 1
- g. Polygonaceae
 >50% with perianths ... 2
 50-25% with perianths ... 1.5
 <25% with perianths ... 1
- h. Alismataceae
 >50% of achenes as intact carpels ... 2
 50-25% as intact carpels ... 1.5
 <25% as intact carpels, most specimens 'embryos' ... 1
- i. *Juncus* spp
 >50% with outer scalariform cell layers preserved ... 2
 50-25% with outer scalariform cell layers preserved ... 1.5
 <25% with outer scalariform cell layers preserved, mostly endosperm tissue visible ... 1
- k. Gramineae
 >50% of caryopses with pericarp cell pattern clear ... 2
 50-25% with cell pattern clear ... 1.5
 >75% with cells degraded or obscured by dark pigments ... 1

Total 'score' for seed/fruit preservation (maximum possible score = 20) _____

2. Mosses

- a. >75% of fragments >10 mm ... 2
 - 75-25% of fragments >10 mm ... 1.5
 - <25% of fragments >10 mm ... 1
- b. >75% of stem fragments with leaves ... 2
 - 75-25% of stem fragments with leaves ... 1.5
 - >25% of stem fragments devoid of leaves ... 1

3. Buds/bud-scales

- a. >50% of buds intact ... 2
 - 50-25% of buds intact ... 1.5
 - <25% of buds intact; bud-scales mostly isolated ... 1
- b. >50% of bud-scale margins preserved ... 2
 - 50-25% of scales with intact margins ... 1.5
 - <25% with intact margins ... 1

4. Deciduous leaves

- a. >50% of fragments > 10 mm ... 2
 - 50-25% of fragments >10 mm ... 1.5
 - <25% of fragments > 10 mm ... 1
- b. >50% of fragments with epidermis and mesophyll ... 2
 - 50-25% with epidermis and mesophyll ... 1.5
 - <25% with epidermis and mesophyll;
most fragments 'skeletons' of vascular tissue ... 1

5. Wood/twigs

- a. >50% of scalariform perforation plates with all bars intact ... 2
 - 50-25% with all bars intact ... 1.5
 - < 25% with all bars intact ... 1
- b. >50% of twigs with medullary rays undeformed; no radial fissures ... 2
 - 50-25% with undeformed rays, no fissures ... 1.5
 - <25% with undeformed rays, no fissures ... 1

6. 'Epidermal' tissues

- a. *Allium* leaf epidermis present ...1
- b. *Avena* pericarp present ... 1
- c. *Triticum/Secale* pericarp present ... 1
- d. Other epidermal tissues ... 1

Total 'score' for preservation of vegetative plant material, etc. (maximum possible 20) _____

7. Pseudomorphic replacement

- a. >50% of seeds replaced ... 2
 - 50-25% replaced ... 1.5
 - <25% replaced ... 1
- b. 'Faecal concretions' present ... 1
- c. Sub-spherical 'globules' present ... 1
- d. Replaced stems present ... 1
- e. Replaced wood present ... 1

Total score for replacement (maximum possible score 6) _____