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Monitoring recent pollen preservation changes at Star Carr: a comment on Albert et al. (2016)

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ABSTRACT

The early Mesolithic site at Star Carr, North Yorkshire, is famous for the exceptional preservation of a wide range of organic materials in the waterlogged deposits at the edge of a former lake. Recent concerns over the effects of oxidation and acidification of the deposits on their artefactual and environmental archives prompted Albert et al. [Albert, B. et al., 2016. Degradation of the wetland sediment archive at Star Carr: an assessment of current palynological preservation. *J. Archaeol. Sci. Rep.* 6, 488–495] to compare the current state of pollen preservation with that in sequences analysed in the 1990s, demonstrating significant levels of deterioration. However, the methods of analysis adopted in their study are not in all respects comparable to those used previously, with implications for interpretation of the character and extent of deterioration. This paper compares the methods used in the two studies, examining which differences between the pollen sequences provide good indicators of deterioration, and which may be ascribed instead to methodological differences or variability of lake-edge vegetation.

1. Introduction

Star Carr, in the Vale of Pickering, North Yorkshire, is one of the best known early Mesolithic sites in Europe, notable for the exceptional preservation of a wide range of organic materials – both artefactual and 'natural' – in the waterlogged deposits at the edge of a former lake (J.G.D. Clark, 1954; Mellars and Dark, 1998). Recent concerns over the effects of ongoing drying and acidification on organic remains surviving in situ have prompted a new phase of excavation and sedimentological analyses (Milner, 2007; Milner et al., 2011; Conneller et al., 2012; Milner et al., 2015), including pollen analysis of a new sequence of deposits (Albert et al., 2016) close to the site of pollen sequences analysed by the present writer in the 1990s (Dark, 1998a). Albert et al. (2016) use these earlier sequences as 'a benchmark for comparison' with their new pollen diagram, concluding that 'The pollen archive in organic sediments at the Star Carr site is now badly damaged'.

While not disputing Albert et al.'s conclusion that the pollen archive at Star Carr has deteriorated in recent years, aspects of their comparison are problematic due to differences in methodology between their study and mine. This has implications for interpretation of both the extent and character of deterioration that has occurred. As future monitoring of the site may include production of further pollen sequences for comparison with these studies, it is important to appreciate in which respects the pollen data of Albert et al. and myself are, and are not, comparable, and for the implications of these issues to be considered.

2. Background: previous pollen analyses from Star Carr

Pollen analysis has been a key tool in the history of research at Star Carr (Walker and Godwin, 1954; Cloutman and Smith, 1988; Dark, 1998a, 1998b, 1998c), but the focus here is the lake-edge sequences published in the 1998 *Star Carr in Context* monograph (Mellars and Dark, 1998), as these form the basis for Albert et al.'s comparison.

In brief, in 1989/1992, three sequences for high resolution multiproxy palaeoecological analysis (M1, M2 and M3) were sampled from a trench (VP85A/Trench A) 20 m east of Clark's original excavations, spanning the transition from dry land to the former open waters of the lake. Also in 1992, a core was sampled from undisturbed deposits immediately adjacent to the south-west corner of Clark's Cutting II (the 'Clark site sequence' of the 1998 monograph, referred to as CLK hereafter). These sequences confirmed earlier findings that the main (first) occupation was at a time when the lake-edge was fringed with reedswamp and sedges, but also provided the first evidence for human impact on the local vegetation, including repeated burning of the reeds (Dark, 1998a, 1998b, 1998c).

Key points to emerge very clearly from these analyses, and which have a direct bearing on interpretation of Albert et al.'s results, are the extent to which the wetland vegetation varied along the lake-edge, with distance from former open water, and over time (Dark, 1998b, pp. 147–8). Furthermore, pollen preservation deteriorated with distance from the edge of former open water, and moving up through each sequence: preservation was excellent in the lower half of M1 (the highest resolution sequence) and CLK - in deposits containing artefacts - but declined markedly further up the profile in deposits analysed

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to allow identification of the *Corylus avellana* (hazel) rise (which provides a key marker horizon for correlating pollen sequences in the area). For M2 and M3, closer to the former edge of dry land, preservation was less good, a key indicator of which was that a higher proportion of fern spores had to be classed as Pteropsida (monolete) indeterminable due to loss of their distinctive surface ornamentation, and (in M3) an increased proportion of the pollen assemblages being unidentifiable due to corrosion.

3. Albert et al.'s SC24 pollen sequence

3.1. Location

Albert et al.'s pollen sequence was sampled in 2010 from the southern end of a new trench (SC24) abutting the eastern edge of Clark's 1951 excavation area (Milner et al., 2011). Their sample location was 'selected to correspond closely to the altitude and position within the lake-edge peats of the Dark (1998a) profile' (Albert et al., 2016, p. 490). It isn't specified which of my four lake-edge profiles this refers to, but it appears to be M1, from the southern/lakeward end of VP85A/Trench A, as they note that I 'recognised five major pollen zones' (Albert et al., 2016, p. 491): only M1 contained five zones, M2, M3 and CLK all having four. The SC24 sampling point lay 20 m west of VP85A/Trench A (M1, M2, M3), and 10 m east of CLK, approximately on the 23.25 m subsurface contour (as illustrated in Boreham et al., 2011, Fig. 1). This places its base at a slightly higher topographic position than CLK, which is closer to the 23.00 m contour, and at a height roughly equivalent to the midpoint between M1 and M2. Thus CLK, M1 and M2 all provide possible points of comparison with the SC24 sequence, but none is in an identical position with respect to the former edge of open water. Bearing in mind the strong link between sample height/distance from the former lake edge and pollen preservation, it would be expected that pollen preservation would be a little worse than in CLK and M1 but better than in M2.

3.2. Pollen preservation

The SC24 pollen sequence spans only the basal 40 cm of deposits, counting not being considered viable above this. Hazel pollen appears at the very top of the sequence, but not the hazel rise, suggesting, as Albert et al. note (p. 491), that pollen is no longer preserved (at least to a level considered countable by the authors) in the later deposits included in previous analyses. This suggests that preservation in the upper layers of peat has declined, although a note of caution is necessary as there is no definition of 'uncountable' (perception of which can vary considerably between different analysts) and the details of the pollen concentration data are not provided.

The situation for the lower deposits is more complex. While pollen counts were obtained for much of the pre-hazel rise sequence, SC24 contained three bands, up to 6.5 cm thick, where pollen was absent, or present at uncountably low levels. This was not a feature of the M1, M2 or CLK sequences, but fissures extending from the topsoil into the upper parts of the otherwise waterlogged deposits were noted in trench VP85A/Trench A in the 1980s, as well as a major sand-filled intrusion originating from the base of the sequence, ascribed to spring activity (Mellars et al., 1998, pp. 37, 39; Dark, 1998a, p. 133). The M2 sequence, from the large block sample removed from Trench A for laboratory excavation (Mellars, 1998), was close to part of this intrusion where it entered the block, but the white sand filling the intrusion made it simple to position M2 to avoid it. As Albert et al. note (p. 493), it seems likely that the bands in SC24 result from further drying and shrinkage of the peat since the 1980s, causing lateral cracking and oxidation to extend into the formerly waterlogged deposits.

For samples from which pollen counts were obtained, comparison with the previous sequences is not straightforward due to differences in methodology, detailed in Table 1 and discussed below.

Table 1
Key differences in methodology between Dark (1998c) and Albert et al. (2016).

	Dark, 1998c	Albert et al., 2016
Pollen preservation assessment	**Unidentifiable** pollen: recorded as corroded, degraded, crumpled, or broken, each grain being assigned to a single one of these categories arranged hierarchically (after Cushing, 1967). **Identifiable** pollen: state of preservation not recorded.	Sub-samples of 50 grains assessed for 'damage' (torn and/or folded) and 'deterioration' (removal of exine microsculpturing and appearance of holes). 'For damaged and deteriorated pollen, class 1 means well preserved, class 2 means degraded so that identification is difficult but still possible and class 3 means degraded so badly that grains cannot be securely identified.' (Fig. 4 legend)
Sum for pollen percentage calculations	**Main sum**: total pollen and spores, excluding obligate aquatics (i.e. fern spores included). **Fern spores**: included in main sum **Sum for unidentifiables**: main sum + sum unidentifiables	**Main sum**: total land pollen (TLP) (i.e. fern spores excluded). **Sum for fern spores**: TLP in pollen diagram (Fig. 3) but sometimes 'TLP + taxon' in text (p. 493) **Pollen condition assessment counts**: % of 50-grain sub-sample
Pollen concentration data	Grains/g dry weight	Grains/cm^3
Microscopic charcoal particle analysis	Area estimation by point counting (R.L. Clark, 1982), in relation to sample dry weight	Concentration (presumably in relation to volume but units missing)

3.3. Methods and results

The methodology adopted by Albert et al. differs in several respects from mine (Table 1), as would be expected to some extent given the contrasting objectives of the two studies. For my pollen counts, preservation in the deposits containing the worked timbers and most of the bone and antler artefacts was good, poor preservation only becoming significant when the pollen sampling was extended upwards to locate the hazel rise. Detailed assessment of the overall state of preservation of the pollen assemblages was not undertaken as it was not necessary to fulfil the objectives of seeking any effects of local human activity on the environment, and obtaining a detailed correlation between the environmental sequence and archaeological record. In my sequences the state of preservation was recorded only for pollen grains/spores so badly affected that they could not be identified (indeterminable), as a check on the reliability of the counts. It was not recorded for the whole assemblage, or a sample thereof, in the manner of Albert et al.'s specifically preservation-focused study. Albert et al.'s (p. 491) comparisons of the sequences appear not to take this into account, noting that

> '*Whereas Dark (1998c) recorded < 5% deteriorated grains, high levels of deterioration and damage are present throughout this new profile.*'

and

> '*In comparison to the original analyses of Dark (1998c), where only isolated crumpled/folded and deteriorated grains were noted, the present analyses produce a high encounter rate of moderately (Type 2) damaged and deteriorated grains.*'

While my analyses showed that pre-hazel rise samples from M1 (and also M2 and CLK) contained <5% indeterminable grains, I did not record the condition of pollen grains and fern spores that were identifiable. While the vast majority were, in fact, well preserved, it is not