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Integration of cereal cultivation and animal husbandry in the British Neolithic: the evidence of charred plant remains from timber buildings at Lismore Fields

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Introduction

The importance of cereal cultivation in the British Neolithic and its role in relation to the collection of wild plant foods and animal husbandry have long been the subject of archaeological debate. Some, like Tony himself (e.g. Legge 1989), have argued that cereals made a significant contribution to the Neolithic diet (e.g. Jones 2000; Monk 2000; Rowley-Conwy 2000; Jones and Rowley-Conwy 2007) and others that their contribution was limited (e.g. Entwistle and Grant 1989; Whittle 2003) and their role largely symbolic or ceremonial (e.g. Thomas 1993; Richmond 1999). In this context, the Lismore Fields timber buildings and the timber hall at Balbridie (Fairweather and Ralston 1993), with their rich charred plant assemblages, have been cited as evidence for the role of cereal cultivation in the British Neolithic (e.g. Thomas 1996; 1999; 2003; Cooney 1997; Richmond 1999; Dineley and Dineley 2000; Jones 2000; Monk 2000; Rowley-Conwy 2000; Jones and Rowley-Conwy 2007; Bishop et al. 2009), but with no general agreement on the interpretation of this evidence. The present contribution addresses this long-running debate in the light of the archaeobotanical remains from Lismore Fields.

The charred plant remains from Buildings I and II at Lismore Fields

The post-hole ground-plans of at least two Early Neolithic buildings were uncovered during excavations at Lismore Fields, Buxton, by D. Garton in 1985-7. ‘Building I’ almost certainly comprises two separate buildings, each similar in size to Building II, but the relationship between these two structures is unclear, and it is uncertain whether or not they were contemporary (Garton 1991; in press). About half of the features (post-holes, pits and slots) associated with Building I and nearly all of the features associated with Building II were processed for charred plant remains. In the case of post-holes, the post-packing, post-pipe and upper fill were sampled and processed separately, where they could be distinguished (for a detailed account of sampling and recovery methods, and tables of botanical identifications, see Jones in press).

Buildings IE and IW

Charred cereal remains were recovered from all but two of the features sampled in ‘Building I’ and, in some fills, these were at relatively high densities (up to c.350 cereal items per litre of deposit). The greatest concentrations of cereal remains were in the upper fills or post-pipes, supporting the view that the buildings were destroyed or cleared by fire (Garton in press), with charred plant remains falling into the post-pipes when the posts were removed, and collecting in the depressions at the top of the post-holes, but only rarely filtering into the post-packings. It is likely, therefore, that most of the charred remains date to the time of the buildings' demise.

Emmer wheat (Triticum dicoccum) was by far the most commonly occurring cereal (represented by both grain and chaff), though small numbers of grains more characteristic of free threshing wheat – bread wheat (T. aestivum) or rivet wheat (T. turgidum) – were found in a few samples. It is likely that the few grains resembling free threshing wheat were nothing more that contaminants of the emmer crop. Glume wheat chaff is usually represented on archaeological sites by the robust bases of glumes (with or without attached rachis internodes), whereas free threshing wheat chaff is usually represented only by fragments of rachis (the flimsy glumes having burnt away). No free threshing rachis remains were found to confirm the presence of free threshing wheat, though these tend to be removed with the straw at an early stage of processing, often away from settlement, while the glume bases of emmer are often removed at a later stage, usually in a domestic context (Hillman 1981; 1984; Jones 1984).

There was considerable variation in the proportions of grain and glume bases in samples from different features but remarkable consistency in these proportions in different fills (post-packing, post-pipe and upper fill) within the same post-hole. The relative proportions of wheat grain and chaff are plotted, for those features with more than 50 cereal items, as pie charts on a plan of the buildings (Fig. 1). Several of these relatively rich samples are from post-holes along the boundary between the eastern and western buildings (Buildings IE and IW). Grain predominated in two of these post-holes, on the eastern side of the boundary between the two buildings, and also in four post-holes and one pit in Building IE. Chaff (glume bases) predominated in two post-holes, on the western side of the boundary, and in two post-holes in Building IW. One post-hole, marking the E-W boundary on the south side of the buildings, contained substantial quantities of glume bases as well as grains.

In addition to wheat, small quantities (<10 g) of hazelnut shell (Corylus avellana) were found in most features and a substantial quantity in a pit in Building IE. Occasional seeds of crab apple (Malus sylvestris) were found in a few features, and a large quantity of flax seeds (Linum usitatissimum) in one posthole. Only one grain of barley (Hordeum sp.) was found, in the upper fill of a posthole.

Building II

Charred plant material was recovered from all but two of the features sampled in Building II, but in much smaller quantities than in Building I. The relative paucity of charred plant material may be due to the loss of upper fills in many of the post-holes (Garton in press), or it may reflect a genuine absence. Cereals were particularly rare in Building II compared with Building I, wheat grains occurring in only two post-holes, and glume bases in low numbers (<10) in about a third of the post-holes. Flax seeds, hazelnut shell and crab apple seeds were found at frequencies similar to those in Building I, and included one whole crab apple.

The interpretation of the charred plant remains

The samples of relatively pure grain in Building IE apparently represent remnants from the storage of fully processed emmer, and in these respects resemble the grain found in the Balbridie timber hall, though the Lismore grain was found in smaller quantities and comprises predominantly one species whereas, at Balbridie, barley grain made up a significant proportion (c.18%) of the total grain. Because the glumes that enclose the threshed grain are somewhat less likely to survive burning than the grains (Boardman and Jones 1990), it is also possible that the emmer in Building IE was originally stored as whole spikelets, the glumes having largely burnt away. The samples in which glume bases predominate, in Building IW, clearly represent by-products from the dehusking of emmer, as it is unlikely that glume bases would survive charring conditions that destroyed grain (Boardman and Jones 1990). Chaff remains are relatively uncommon at British Neolithic sites (Moffett et al. 1989; Jones and Rowley-Conwy 2007; Stevens 2007; Bishop et al. 2009) so these chaff-rich deposits provide the best evidence to date for emmer processing by-products in the British Neolithic. Processing by-products have also been found at other sites (Jones and Rowley-Conwy 2007), however, a notable example being the barley rachis remains found at Late Neolithic Scord of Brouster in Scotland (Milles 1986).

The different crop processing (by-)products represented in Buildings IE and IW may reflect a difference in the function of these two structures, with storage of grain in Building IE, and dehusking activity or chaff storage in Building IW. A different function for the two buildings is also suggested by phosphate analyses: the highest phosphate values are mostly from features in Building IW while those in Building IE tend to be lower (Buck et al. in press). It is tempting to suggest that the association of chaff-rich samples with high phosphate values, and grain-rich samples with lower phosphate values, indicates that animals were kept in Building IW, at least some of the time, whereas Building IE was for human use, regardless of whether or not the two structures were contemporary. Some support for this comes from a few fragments of probable animal dung found in one of the chaff-rich post-holes on the western side of the boundary between the two buildings.

Stable Isotope Analysis

Emmer wheat grains from five grain-rich features in Building I were submitted for carbon and nitrogen stable isotope analysis (four samples from Building IE and one from the posthole on the boundary between the buildings with approximately equal quantities of grain and glume bases), as part of a broader isotopic study of crops from Neolithic sites across Europe (Bogaard et al. 2013). All five samples gave very similar results (Table 1). These are plotted (Fig. 2) in comparison with carbon and nitrogen isotope 'thresholds' for levels of watering and manuring respectively, derived from modern experimental and farm studies of cereals grown under known conditions of watering and manuring (Fraser et. al. 2011; Wallace et al. 2013). For the inference of crop water status, $\Delta^{13}C$ (which takes into account changes in the isotopic ratio, $\partial^{13}C$, of atmospheric CO_2 through time) is plotted; for the inference of manuring rates, the isotopic ratio $\partial^{15}N$ has been adjusted for the effect of charring by subtracting 0.31‰ (following Nitsch et al. 2015) before plotting in relation to modern isotopic thresholds.

The carbon isotopic results indicate that the emmer was reasonably well-watered, which is to be expected for cereals grown in a temperate climate. The nitrogen isotopic values are consistent with medium to high levels of manuring, similar to those obtained for wheat samples from two Neolithic sites in Greece and Bulgaria (Koufovouno and Slatina), for which significant rates of manure application have been inferred, and somewhat higher than three emmer wheat samples from the Stepleton Neolithic causewayed enclosure at Hambledon Hill, Dorset (Fig. 2; Jones and Legge 2008; Bogaard et al. 2013). This result is consistent with a degree of integration between crop cultivation and animal husbandry at Lismore Fields.

Discussion

The presence of relatively large quantities of emmer wheat in Building I should occasion no surprise as the most likely circumstance in which cereals would be preserved in quantity is when a building containing cereals is burnt down, or cleared by fire after it has gone out of use, preserving the charred remnants of activities, including storage, carried out within the building (Jones 2000; Jones and Rowley-Conwy 2007). Whether cleaned grain or processing by-products are found in such burnt buildings will depend on the function of the building, and Buildings IE and IW seem to have served different purposes, both involving the (by-)products of cereal processing. Relatively few cereal remains were found in Building II, which may not have been burnt or may have been used for a different purpose. There is nothing to suggest that the storage of emmer wheat grain in Building IE, whether as whole spikelets or free grain, was in itself unusual; storage is a normal aspect of the use of a staple, but seasonal, resource.

The emmer processing by-products in Building IW are interesting, first because the absence of cereal processing has been cited as evidence that Neolithic timber buildings in Britain were not associated with domestic activities, and may have had a primarily symbolic or ceremonial significance, housing a special type of food – cereal grain (e.g. Thomas 1996; 1999; Richmond 1999). The presence at Lismore Fields of a burnt building in which cereal processing took place, or where the by-products of this processing were kept, detracts from the argument for a special status of cereal grain. On the basis of the evidence presented here, it is possible to suggest a rather different interpretation. If indeed the co-occurrence of chaff-rich deposits and high phosphate levels (along with a few fragments of probable animal dung) indicates that animals were stalled in Building IW, and fed on cereal processing by-products, this may suggest the overwintering of livestock indoors. This in turn would have provided the opportunity for the accumulation of animal dung that could then be spread on cereal cultivation plots, which would account for the 'manuring' signature observed in the nitrogen isotope values for the grain stored in Building IE.

It is uncertain whether Buildings IE and IW were in use at the same time (Garton 1991; in press) but, whether or not they were exactly contemporary, the activities represented in the two buildings may represent different aspects of an agricultural cycle operating during this period of the site's occupation. The close integration of crop cultivation and livestock management implied by this interpretation of the evidence would constitute a highly sustainable mixed farming system, similar to that argued for other parts of Europe in the Neolithic and Bronze Age (e.g. Halstead 1981; 1989; 1996; Rowley-Conwy 1981; Bogaard 2004; 2005; Bogaard et al. 2013). For Neolithic crop cultivation in Britain, it has been argued that 'it is questionable whether stands of crops would have been maintained in the same location for long, rather than being opportunistically seeded in available clearings', especially given the lack of evidence for legume crops which could have been grown in rotation with cereals (Thomas 1999; 2003). The integration of livestock husbandry with cereal cultivation suggested here for Lismore Fields provides an alternative means of maintaining soil fertility in fixed cultivation plots, and implies a type of livestock management rather different to the mobile pastoralism, largely divorced from limited or sporadic cultivation of cereals, envisaged by some for the British Neolithic (e.g. Thomas 1999; 2007; Stevens and Fuller 2012). As such, the Lismore Fields cereal remains may provide the first concrete evidence for integrated mixed farming in the British Neolithic.

Of course, the evidence presented here applies only to Lismore Fields, and should not be extrapolated to other parts of Britain without supporting evidence in these areas, and it is beyond the scope of this paper to consider whether the relative rarity of Neolithic timber buildings in Britain (compared with Ireland and mainland Europe) is evidence for their absence or merely indicates that their survival is unusual (see Monk 2000 and Rowley-Conwy 2000 for discussion of these issues). Suffice it to say that rarity in itself should not be seen as a reason for discounting the evidence of archaeobotanical remains, as it would quite usual for food (and fodder) to be eaten rather than burnt, and it is unsurprising that charred plant remains are more often found in burnt buildings than at unburnt sites (cf. Thomas 2007). If the use of cereal by-products as fodder in the Neolithic were widespread, however, it would go some way towards explaining the rarity of chaff on most Neolithic sites. Campbell (2000) has suggested that the use of cereal by-products as fodder may explain the relative paucity of chaff at some Iron Age sites in the Danebury area and Upper Thames Valley, as chaff destined for fodder would be less likely to find its way onto household fires. Cereal chaff, like grain, would then be found in quantity only when a building in which it was stored or used was exposed to fire. This is not inconsistent with Stevens' suggestion (2007) that Neolithic cereals, including emmer wheat, were dehusked in bulk soon after harvest, and stored fully processed, as this would generate significant quantities of chaff that, along with straw, could provide a useful source of fodder.

The type of integrated mixed farming suggested for Lismore Fields does not imply extensive land clearance or field systems (cf. Richmond 1999; Thomas 2003) but rather, if anything, is more consistent with small-scale cultivation and animal husbandry, where cultivated plots are located near to settlements, facilitating the collection and application of manure (Jones 2005). This would be consistent with the pollen evidence for limited woodland clearance in the Early Neolithic (Richmond 1999). Stall-feeding of livestock also suggests the keeping of modest numbers of animals, which would arguably be inconsistent with mobile pastoralism (e.g. Halstead 1996). A further implication of a potentially widespread mixed farming economy relates to its inherent sustainability. On the basis of radiocarbon dates for cereal grains, it has recently been suggested (Stevens and Fuller 2012) that, after an initial flourishing of cereal cultivation following its introduction to Britain in the Early Neolithic (possibly accompanied by an increase in population), cereals were all but abandoned around 3650-3600 cal BC (with a corresponding decline in population) to re-emerge later in the Middle Bronze Age. The sudden decline in agricultural activity in the Late Neolithic is attributed to climatic deterioration. While it is reasonable to suppose that, faced with adversity, early farmers might have chosen to diversify and make more use of wild resources, it is unclear why they would, as suggested, have abandoned one element of a relatively stable mixed farming strategy to opt for a more specialised and riskier reliance on mobile pastoralism (Stevens and Fuller 2012). It is possible that the lack of cereal radiocarbon dates in the Late Neolithic and early Bronze Age owes more to the selection of material for dating than to any actual rise or fall in the cultivation of cereals.

Conclusions

The unusual preservation conditions provided by burnt timber structures at Lismore Fields have preserved evidence not only of grain storage but also of cereal processing. This in turn has allowed us to address research questions that can rarely be attempted for the British Neolithic due to a lack burnt buildings at other sites. On the basis of the combined evidence of the botanical composition of the cereal assemblage, stable isotope analysis of the grain, and soil phosphate analyses, it has been suggested that animals may have been stalled overwinter at Lismore Fields, fed on cereal processing by-products, and that their dung was used to manure cultivated cereal plots. Such a mixed farming regime represents a radical alternative to the widely accepted view that Early Neolithic communities merely incorporated cereals into their seasonal activities of wild plant collection and mobile pastoralism, though we concur with most other authors that different strategies may have been employed in different parts of the country and that wild resources may have acted as a buffer against crop failure.

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Table headings

Table 1. Stable isotope determinations.

Figure captions

Figure 1. Plan of Buildings IE and IW with pie charts representing the proportions of grains and glume bases in archaeobotanical samples with 50 or more cereal items. filled features = postholes; empty features = pits and slots. Pie-charts: black = grains; white = glume bases. [Base-plan of postholes, pits and slots redrawn following Garton 1991, Fig. 1.2]

Figure 2. Plot of $\Delta^{13}C$ and $\partial^{15}N$ values for emmer grain. Dashed vertical line represents the threshold for moderate and well-watered wheat (Wallace et al. 2013) and solid vertical lines represent the thresholds for low, medium and high manuring rates (Fraser et al. 2011), inferred from modern experiments and field studies. $\partial^{15}N$ values adjusted for charring by subtracting 0.31‰ (Nitsch et al. 2015). diamonds = Lismore Fields samples; triangles = Hambledon Hill samples.