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Discovery, Innovation and Science in the Historic Environment

Research Report Series no. 78-2017

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NGR: NY 398 560 – Castle Street, Carlisle

NGR: TL 752 120 – Great Holts Farm, Boreham



ISSN 2059-4453 (Online)

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SUMMARY
Only two finds of sweet chestnut (*Castanea sativa*) nuts have been reported from any archaeological or environmental investigation for the pre-medieval period in Great Britain: from Castle Street, Carlisle, Cumbria (one nut pericarp fragment, in 1983); and from Great Holts Farm, Boreham, Essex (pericarp fragments from *circa* five nuts, in 1995). Castle Street, Carlisle was presumed Roman period and Great Holts Farm was contextually dated to the 3rd century AD, but the nut fragments were not comprehensively examined or dated. A new research study during 2014–2017 into the origins of sweet chestnut in Great Britain recovered the original specimens from their museum archives for re-examination. Direct radiocarbon analysis has confirmed that the Great Holts Farm nuts are of the Roman period (early–mid 3rd century AD); however, the Castle Street nut has been dated as 'modern'. Analysis of the genetic composition of the nut pericarps was attempted, but aDNA analysis was unsuccessful. The sweet chestnuts at Great Holts Farm were found together with other exotic (Mediterranean) foods, seeming to indicate that these nuts were imported rather than grown in Great Britain and appearing to be the remains of a single feast event. The Great Holts Farm specimens are now the sole evidence for sweet chestnut nuts being found in Great Britain for the whole of the historic period up to the medieval.

CONTRIBUTORS
Robin Allaby – University of Warwick
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ACKNOWLEDGMENTS
We thank Gill Campbell (Historic England) and Zoe Hazell (Historic England) for their guidance and contributions.

We thank Denise Druce (Oxford Archaeology North), Jacqui Huntley (Historic England), Anne-Marie Knowles (Tullie House Museum & Art Gallery), Michael R McCarthy, Tim Padley, Sue Stallibrass (Historic England) and Marijke van der Veen (School of Archaeology & Ancient History, University of Leicester) for locating the Castle Street, Carlisle specimen, granting permission to assess it and providing information about the excavation and specimens.

We thank Mark Germany (Archaeology South-East, UCL), Alison Locker, Peter Murphy and Alan West (Norwich Castle Museum) for locating the Great Holts Farm specimens, granting permission to assess them and providing information about them.

We thank Oliver Smith (University of Copenhagen) for his work on the aDNA analysis at Warwick University; and Andres Teira Brion (Universidade de Santiago de Compostela-USC, Spain) for collaborating with the aDNA analysis and providing

sweet chestnut nut reference material from the Roman saltworks excavations at O Areal, Vigo, Spain.

We thank Josefa Fernandez Lopez (Centro de Investigacion Forestal de Lourizan, Galicia, Spain) for assessing the photographs of the sweet chestnut nut fragments for their varietal characteristics.

ARCHIVE LOCATION
1. Tullie House Museum & Art Gallery, Carlisle
2. Murphy Collection, Norwich Castle Museum, Norwich

DATE OF RESEARCH
2014–2017

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# 1. INTRODUCTION

A doctoral research project to investigate the historical origins of sweet chestnut *Castanea sativa* (Mill.) in Britain commenced in 2013, with the objectives to:

1. assess the genetic composition of veteran sweet chestnut trees and ancient sweet chestnut woodland across Great Britain, to ascertain their genotypic origin(s) in Europe;
2. re-assess the historic archive of records and specimens of alleged sweet chestnut finds in Great Britain;
3. initiate a new palaeoenvironmental investigation of a target site for early presence of sweet chestnut in west Gloucestershire, to determine a date for sweet chestnut's earliest occurrence there; and
4. initiate new dendrochronological analyses of ancient sweet chestnut timbers, to determine the dendrochronological potential of sweet chestnut and to enable dating of specific trees and artefacts.

During work on Objective 2, two records were found of alleged sweet chestnut nut remains that had been recovered from Roman period archaeological investigations: at Castle Street, Carlisle, excavated in 1983; and at Great Holts Farm, Boreham, Essex, excavated in 1995. (See Map 1 for locations). It was decided to attempt to re-examine these finds to verify their identification and dating.

The two sets of nut specimens were subsequently found in their respective museum archives (in Carlisle and in Norwich) and made available for examination in 2015.

This Report describes the specimens and their original archaeological discovery, then presents the results of new recording and analyses, in particular:

- the specific and accurate reporting of the original finds and their contexts;
- the visual assessment of nut features enabled by high definition photography and microscopic examination;
- the attempt to extract ancient DNA (aDNA) from the nut pericarps to characterise their genotypic and geographical origins; and
- direct radiocarbon dating of the specimens to determine their age.

Appendix 1 presents the research programme timeline.


*Fig 1: Site locations for the two archaeological finds of sweet chestnut nut fragments in Great Britain: Castle Street, Carlisle; and Great Holts Farm, Boreham, Essex*

## 2. GREAT HOLTS FARM SPECIMENS

### 2.1 Initial excavation

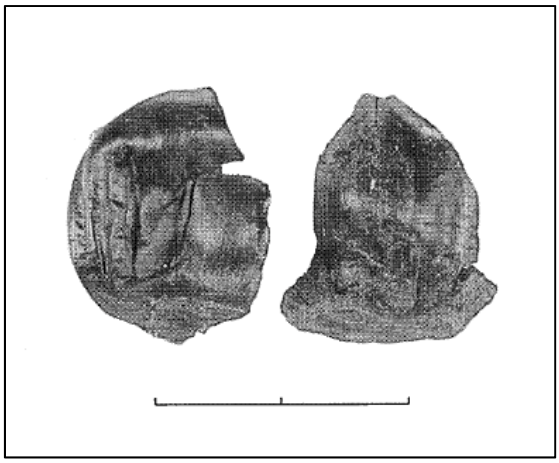
The archaeological excavations between 1992 and 1995 at Great Holts Farm near Boreham in Essex (Map 1) are described in Germany (2003). In 1995 the final phase of work on the site was the excavation of a well fill (site feature number 567). Well 567 is fully described in Germany (2003, 6, 20, 33–4, 40–1, figs 26 and 33): the well occurs within a portico structure of Building 416, which was constructed in the late 3rd/4th century AD apparently around the pre-existing well. The well was

"c. 6m deep and was probably dug in the second quarter of the 3rd century and backfilled in the later 3rd century" (Murphy *et al* 2000). The well is described in Germany (2003, 20) as falling within 'Phase II.1 Mid-Roman' (*c.* AD 120/25 to *c.* AD 250/60) of the site history: its construction was dated by Darrah (Germany 2003, 188–9) to *c.* AD 220 on the basis of dendrochronological analysis of some of the oak boards used in the well's construction. Although Darrah attempted to refine the dendrochronological date of the well's construction by estimating wood removed from the well timbers during conversion from tree to board, it appears – based on the reported dendrochronology results (Germany 2003, 20) – that the most reliable date for the well's construction is a *terminus post quem* of AD 188. From the base of this well a 1.8m vertical section of organic material was excavated by mechanical digger in sections and then reconstructed on the ground: this contained the lining boards of the well and organic and silt infill material. The bottom 1.5m of this fill was waterlogged (Germany 2003, 20). This infill was analysed by Peter Murphy and others for macrofossils (Murphy 1997; Murphy *et al* 2000). The base of the infill (Context 6463 in Germany 2003, 40–1 and fig 33) was described as a dark brown organic mud that was found to be rich in botanical remains and fish and animal bones, with a discrete deposit (Context 6465) of compacted grass and cereal stems. "The origin of the material in the well is quite clear. It seems that when the well went out of use, flooring materials from within the farmhouse were dumped straight into it, along with other domestic debris" (Germany 2003, 211). The sweepings from the floor included strewn hay, straw and bracken that, together with the food remains, were deliberately dumped in the well (Murphy *et al* 2000, 44; Germany 2003, 211). This basal deposit 6463 contained a few fragments of sweet chestnut nut pericarps, walnuts, hazelnuts, olive stones, grape pips, stone pine nuts, cherry stones, sloe, bullace and apple pips. "The olive was the only fruit which was definitely imported but several others, although they can grow in Great Britain, were originally Mediterranean plants... whether these 'exotic' crops... were locally produced or represent imports is difficult to establish" (Murphy *et al* 2000, 45). "The fish bone assemblages ...comprised... scad (which is a valued food source in the Mediterranean) and Spanish mackerel... The cattle bones, which were inordinately large, were possibly derived from imported livestock" (Germany 2003, 40–1). The 'Spanish mackerel' here is *Scomber colias* , now commonly known as the Atlantic chub mackerel, see fishbase.org (Alison Locker pers comm). Murphy *et al* (2000) considered that this food evidence pointed to an affluent lifestyle with access to imported foods. Murphy (pers comm) opined that these food remains might be from a single feast event.

Sample No. 968 (a 15 litre bulk sample from Context 6463) produced remains from "c.5" nuts of *Castanea sativa* (Germany 2003, 213, table 74 and plate XII) – see Figure 2 below. Murphy (in Germany 2003, 209) described the *Castanea sativa* finds as "fragments of pericarp, fibrous on their interior surfaces and glossy externally, some showing basal attachment scars and stylar projections at the apex.... Nut lengths are estimated as *c.* 21mm".

Context 6463 was dated from a small assemblage of pottery in the well fill as "Late 3rd c. +" (Germany 2003, 41). The well fill was probably first deposited in the mid–late 3rd century AD (Context 6463), with subsequent deposits in the early 4th century (Context 6459), and was finally sealed by the upper deposit (6066) in the

late 4th century (Germany 2003, 41). Germany (2003, 22) states "a large quantity of household material, including food residues and straw from floors, was deposited in the bottom part of the well in the early 4th century" – this presumably refers to Context 6459 and not to Context 6463 beneath it.



[scale: 0–2cm]

*Fig 2: The original published photographs of chestnut 'nuts' from the excavation reports (Murphy et al 2000, plate 8b; Germany 2003, plate XII). Reproduced with permission of Peter Murphy (scanned format – the original photographs could not be located).*

The palynological assessment of all the waterlogged sediments excavated at Great Holts Farm did not produce any evidence of *Castanea sativa* (Wiltshire, in Germany 2003, 214–5).

## 2.2 Recovery from archives

The chestnut pericarp specimens were recovered from the Murphy Collection in Norwich Museum by Peter Murphy and Alan West, who gave consent for the specimens to be removed from the Archive for potential aDNA analysis at Warwick University: it was agreed that a small percentage of the fragments could be destroyed in the analysis.

The specimens were not examined at the Museum when they were collected by RJ. They were retained in their original packaging (plastic wallet – Fig 3) in a plastic box and taken by hand to Warwick University.


*Fig 3: photograph of the original packet [here, with the main fragments removed] of the Great Holts Farm specimens as recovered from Norwich Castle Museum archives © Rob Jarman*

The accession number within the Murphy Collection is NWHCM: 2013.123.

### 2.3 aDNA analysis

The aDNA analysis was undertaken during 2016 by Oliver Smith at Warwick University. Ancient DNA was extracted in a dedicated ancient DNA laboratory in which no other DNA work is carried out, to minimize the chances of cross contamination with modern sources. DNA extraction was performed using a 2% CTAB buffer approach following previous established protocols (Palmer *et al* 2012). The samples were incubated for 5 days before chloroform extraction, followed by purification through Qiagen columns.

Extracted DNA was then sequenced through a shotgun approach using the Illumina MiSeq next generation sequencing platform, which typically generates around 60 million DNA reads per run. Sample preparation requires the production of 'libraries' for sequencing, during which artificial DNA linker fragments are ligated to the extracted template DNA; all DNA is amplified through a polymerase chain reaction process. Library production is then assessed through gel electrophoresis.

In the case of the Great Holts Farm sample, the library build process was unsuccessful, owing to insufficient quantities of DNA being extracted. In this sample no DNA was observed to be amplified during the library process that was of a size consistent with artificial DNA linkers and template insert. (By contrast, the Castle Street, Carlisle sample did give acceptable libraries, *infra*).

These results lead to the conclusion that there is no detectable endogenous DNA in the analysed sweet chestnut pericarp samples from Great Holts Farm.

## 2.4 Description and photographic recording of the sweet chestnut fragments.

### *2.4.1 Description*

The pericarp fragments are thin, papery, black and very wrinkled. Some are still relatively flat, so that exterior and interior surfaces of the pericarp are evident. In these specimens, the inner surface is rough, as if the original texture was downy, but not hairy. The outer surface is smooth, with definite ribs, with sheen, like an oily iridescence.

The original identification report (Murphy 1997) did not specify the number of fragments, but Germany (2003, table 74) states that the fragments represented '*c.* 5' nuts. The collection as returned from Warwick University had 21 discrete fragments (and a small number of tiny particles/dust) in the storage box. Thirteen separate fragments were sufficiently large and distinctive to be photographed.

### *2.4.2 Photographic record*

The nut pericarp fragments were photographed by James Davies (Historic England, Swindon). Studio photographs were taken with a Nikon D810 camera with Nikkor 105 macro lens. Images were shot as RAW files and processed in Photoshop to produce 8-bit TIFF files. Specimens were displayed against black acrylic sheet and lit with Profoto lighting.

The thirteen largest fragments were photographed (see Table 1 and Fig 3). Five of these were selected for detailed photographic recording of their obverse and reverse faces to highlight specific morphometric features (see Figs 4–8).

After recording, each fragment was packaged individually into a labelled, sealed plastic sample bag: all of which were then placed together back into the original site archive box.

In all the photographs below, the scale is marked in millimetre divisions.

*Table 1: Great Holts Farm specimens and their photograph reference numbers*

| Specimen number | Face | Photograph number/s (HE archive) |
|---|---|---|
| 1 | Obverse<br>Reverse | DP195961c; DP195960<br>DP195965 |
| 2 | Obverse<br>Reverse | DP195961a; DP195960<br>DP195962a; DP195963 |
| 3 | Obverse | DP195960 |
| 4 | Obverse<br>Reverse | DP195957<br>DP195956 |
| 5 | Obverse<br>Reverse | DP195959<br>DP195958 |
| 6 | Obverse<br>Reverse | DP195961b<br>DP195964 |
| 7 | Obverse | DP195960 |

| Specimen number | Face | Photograph number/s (HE archive) |
|---|---|---|
| 8 | Obverse | DP195960 |
| 9 | Obverse | DP195960 |
| 10 | Obverse | DP195960 |
| 11 | Obverse | DP195960 |
| 12 | Obverse | DP195960 |
| 13 | Obverse | DP195960 |
| Packet 14 | 8 separate small fragments, not photographed, not assessed for features | |


*Fig 3: Image showing the thirteen Great Holts Farm sweet chestnut nut pericarp fragments selected for photography (DP195960), with individual specimens numbered.*

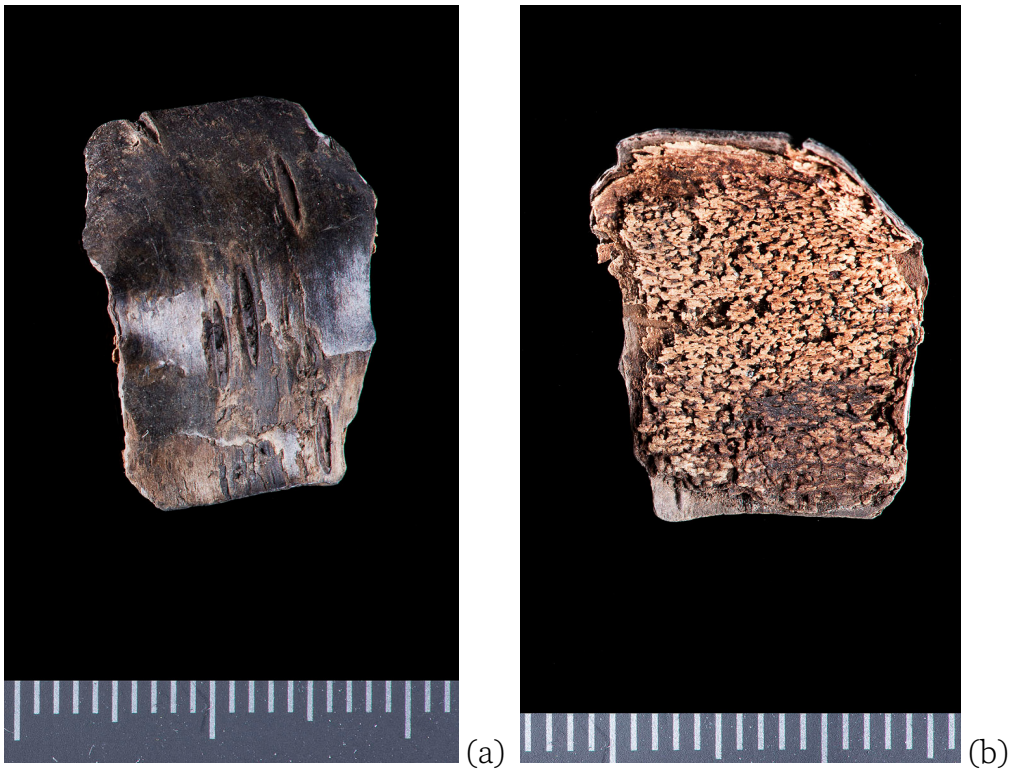



*Fig 4: Images of Specimen 1 (Fig 3-1) showing (a) Obverse face (exterior), and (b) Reverse face (interior).*

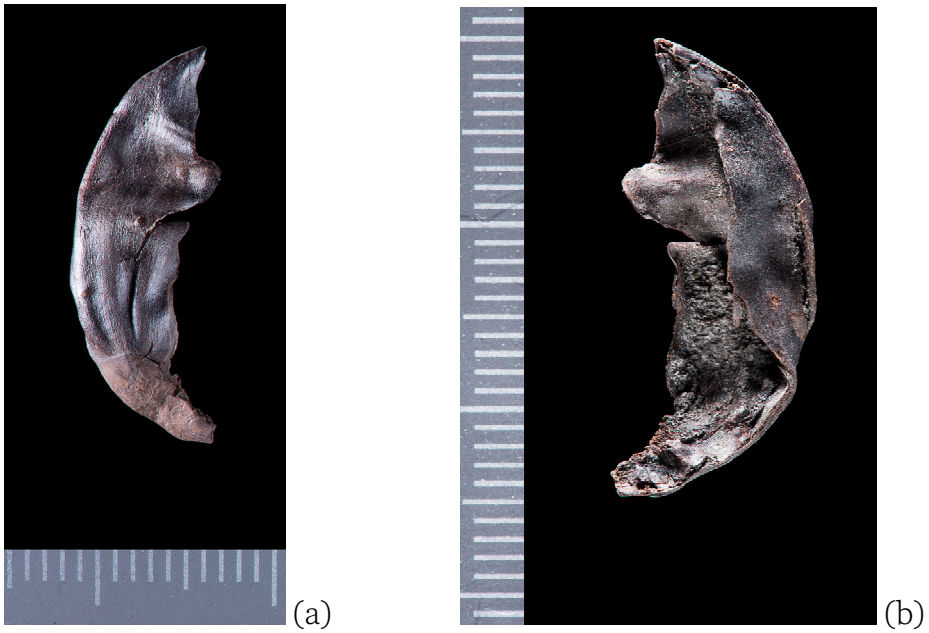



*Fig 5: Images of Specimen 2 (Fig 3-2) showing (a) obverse face and (b) reverse face (specimen compressed, so the interior face of the pericarp is mostly obscured by the exterior face). Basal scar visible on lower part of specimen (a).*

(a)

(b)

*Fig 6: Images of Specimen 4 (Fig 3-4) showing (a) obverse face (exterior) and (b) reverse face (interior). Basal scar 'fringe' visible on upper part of (a).*

(a)

(b)

*Fig 7: Images of Specimen 5 (Fig 3-5) showing (a) obverse face (exterior) and (b) reverse face (exterior). The fragment is tightly folded, obscuring the interior: if unfolded, almost half of the original surface area of the pericarp could be present.*

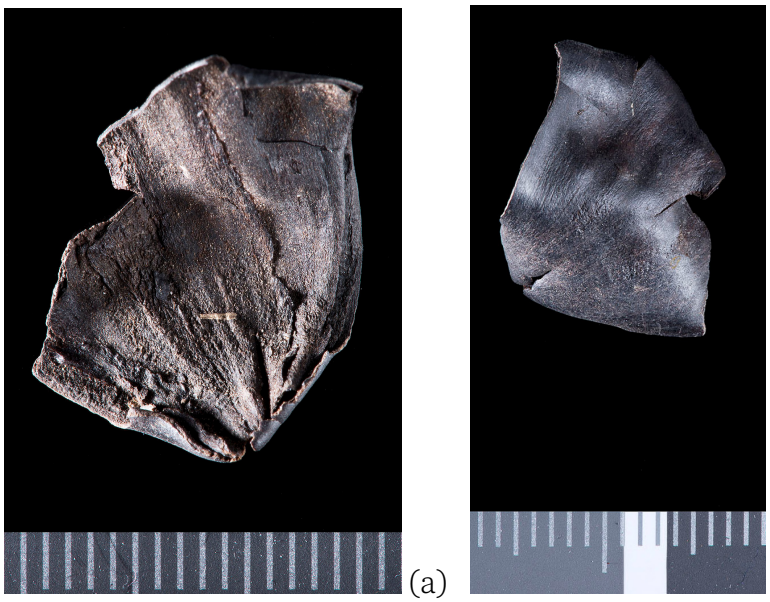

(a) (b)

*Fig 8: Images of Specimen 6 (Fig 3-6) showing (a) obverse face (exterior) and (b) reverse face (interior).*

### *2.4.3 Discussion*

The two nut pericarp specimens illustrated photographically in the three publications covering the nut finds (Fig 2) do not seem to be directly recognizable within the fragments that exist now. The basal scars that Murphy described can still be observed in two of the specimens (2 and 4), but there is no visible evidence of the 'stylar projections' (that is, the remnants of the style, part of the female flower, that persist at the apex of the formed nut shell) that were recorded. Presumably this is the result of fragmentation and erosion of fragile features during the 20 years since the specimens were first described. The good state of preservation reflects the care with which the specimens must have been originally excavated and cleaned for examination, as the surface features and hairs of the pericarp are crisp and intact.

## 2.5 Radiocarbon dating

### *2.5.1 Sampling*

The original dating for the sweet chestnut pericarp finds was indirectly from the pottery fragments found in Context 6463 (Germany 2003, 41), so it was decided to use direct radiocarbon dating to gain a more precise date for the specimens.

Consent was given by the Murphy Collection at Norwich Castle Museum, Norwich (Peter Murphy and Alan West) for destructive sampling of a minimal proportion of the specimens.

Three fragments were selected by R Jarman and P Marshall for radiocarbon dating, on the basis that they appeared to have derived originally from three separate nuts, thereby ensuring that the same nut was only dated once.

- Specimen 1 – mass 233mg: 92mg was separated from the specimen and submitted for radiocarbon dating, returning the remaining material to the archive packet;

- Specimen 5 – mass 134mg: 89mg was cut from the piece, vertically along the fold line, and submitted for radiocarbon dating, returning the remaining material to the archive packet;

- Specimen 12 – mass 48mg: the whole piece was submitted for radiocarbon dating, leaving no remaining material.

### *2.5.2 Radiocarbon dating methods*

Three samples from three discrete nut pericarps were dated (Table 2).
The sample dated at Scottish Universities Environmental Research Centre (SUERC) was pretreated and measured by Accelerator Mass Spectrometry (AMS) following the methods outlined in Dunbar *et al* (2010).

The single sample measured at the Oxford Radiocarbon Accelerator Unit (ORAU) was pretreated and combusted as described in Brock *et al* (2010), graphitised (Dee and Bronk Ramsey 2000) and dated by AMS (Bronk Ramsey *et al* 2004).
At the $^{14}$CHRONO Centre, The Queen's University, Belfast, the sample was dated using methods described by Reimer *et al* (2015). The nut pericarp was pretreated using an acid wash and graphitised using hydrogen reduction (Vogel *et al* 1984).

### *2.5.3 Radiocarbon results*

The three measurements are statistically consistent at 95% confidence ($T'=1.2$; $T'(5\%)=6.0$; $\nu=2$; Ward and Wilson 1978) and could therefore be of the same actual age. However, given there is no *a priori* evidence that they are the same actual age, they have been combined in the chronological model (see below) using the OxCal function `Combine`.

The chronological modelling was undertaken using the program OxCal v4.2 (Bronk Ramsey 2009; Bronk Ramsey and Lee 2013) and the atmospheric calibration curve for the northern hemisphere published by Reimer *et al* (2013). The algorithms used are defined exactly by the brackets and OxCal CQL2 keywords on the left-hand side of the technical graph which defines the model (http://c14.arch.ox.ac.uk/).

The model (Fig 9) incorporates the tree-ring dates derived from the well timbers (Germany 2003, 20), which provide *termini post quos* for the well's construction, as their sequences only contained oak heartwood; the model also incorporates the three dates obtained from the sweet chestnut nut pericarps from Context 6463 of the well fill (Germany 2003, 40).

The model displays good overall agreement (Amodel:106) between the radiocarbon dates for the nut pericarps and those for the prior archaeological evidence, such that the timbers used for the well lining boards are earlier in date than the deposits in the well fill. The model estimates that the *Castanea sativa* nuts deposited in context

6463 date to *cal AD 185–195* (*1% probability*; *Castanea sativa*;*[6463]*; Fig 9) or *cal AD 210–260* (*73% probability)* or *cal AD 280–325* (*21% probability*), probably *cal AD 220–255* (*62% probability*) or *cal AD 305–315* (*6% probability*).

*Table 2: Great Holts Farm, Boreham, Essex radiocarbon results*

| Laboratory number | Sample reference | Material (identified by) | $\delta^{13}C$ (‰) | Radiocarbon Age (BP) |
|---|---|---|---|---|
| OxA-36295 | Context B6463:12 | *Castanea sativa* nut pericarp (P Murphy, University of East Anglia) | −28.8±0.2 | 1815±29 |
| SUERC-74813 | Context B6463:1 | *Castanea sativa* nut pericarp (P Murphy, University of East Anglia) | −27.7±0.2 | 1771±29 |
| UBA-35147 | Context B6463:5 | *Castanea sativa* nut pericarp (P Murphy, University of East Anglia) | −26.1±0.22 | 1785±28 |

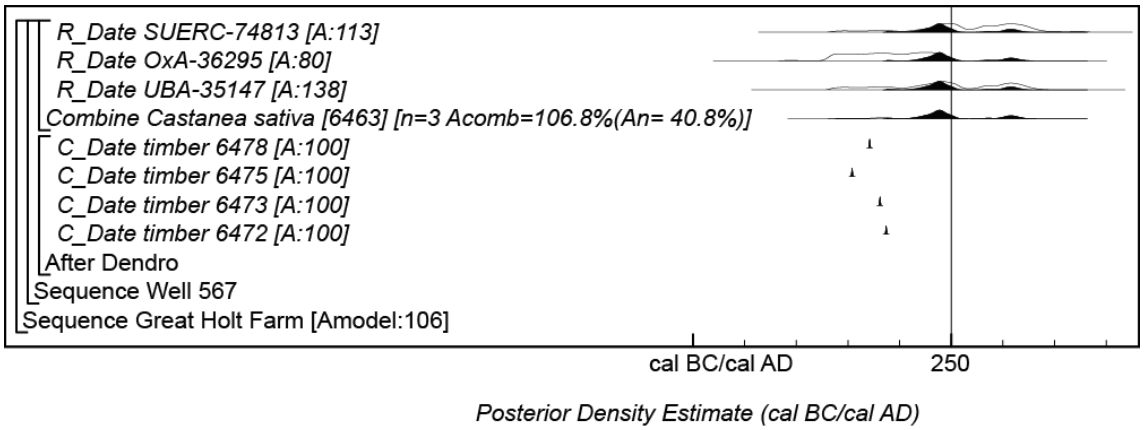



*Fig 9: Probability distributions of dates from Great Holts Farm, well 567. Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates, two distributions have been plotted: one in outline, which is the simple radiocarbon calibration, and a solid one, based on the chronological model used. The large square brackets down the left-hand side along with the OxCal keywords define the overall model exactly.*

## 3. CASTLE STREET, CARLISLE SPECIMEN

### 3.1 Initial excavation

The Castle Street, Carlisle excavations (see Map 1 for location) were undertaken in 1981–2, managed by Mike McCarthy of the Carlisle Archaeological Unit. The

excavations are reported in McCarthy (1991a) in the form of an overall excavation report, supported by separate Fascicule reports. Fascicule 1 (McCarthy 1991b) covers the finds and analyses of plant remains.

In 1983, Marijke van der Veen of the Biological Laboratory, Dept of Archaeology, University of Durham reported on an environmental small finds collection from the Castle Street excavations, which was published as AML Report No. 4010 (Van der Veen 1983). This report described 'the identifications of a series of items sent to the laboratory, mainly concerning items handpicked during the excavation'. 'SF No. E31', reported from 'Context B555', was identified as '*Castanea sativa*, sweet chestnut, fragment'. No other finds were reported as from B555. Van der Veen transferred this information to Goodwin and Huntley at Durham, who contributed the section (Goodwin and Huntley 1991) on waterlogged plant remains in Fascicule 1(McCarthy 1991b). However, there is no mention in the relevant site publications (McCarthy 1991a; McCarthy 1991b) of the sweet chestnut nut find, of 'SF E31', of 'Context B555', or of Van der Veen's 1983 report. There is a reference in Fascicule 1 (McCarthy 1991b, 37) to 'Sample 31: Context 649' within Period 6B, with a description of plant and insect remains, including hazelnut fragments, but no reference to a sweet chestnut nut fragment. This 'Sample 31' does not appear to be the same as 'SF E31' that Van der Veen (1983) described. Fascicule 1 (McCarthy 1991b, 39–41) does refer to Context numbers close to 555, all within Periods 8A and 8B. In Period 8A there is Building 542, which has beams 542 & 544 that surround a surface and layer 550 and 552. A child inhumation outside this building is 556. So 555 might be associated with this part and phase of the site, but physical proximity is not necessarily the basis for sequential numbering of contexts in archaeological recording. It would appear that Goodwin and Huntley ignored, missed or rejected the sweet chestnut find described by Van der Veen.

However, Hall and Huntley (2007, 77–8) cite the Castle Street sweet chestnut find reported by Van der Veen (1983) in their review of macrofossil plant remains from archaeological deposits in Northern England: ' ...the plant remains from Castle Street offer evidence of the housing and feeding of animals just outside the fort at various times during the Roman period, with only sparse evidence for any other activity and only traces of exotic taxa likely to have been imported for human consumption. To these can be added a tantalizing record of sweet chestnut, *Castanea sativa*, presumably remains of a nut (listed together with hazel nutshell "spot finds"), and presumably of Roman date, from the early stages of excavation at this site'. Hall and Huntley (2007) presumed that the find was of a nut fragment and that it was of Roman date.

Van der Veen has subsequently confirmed (pers comm 2015) that *C. sativa* was definitely identified and that the single fragment was of a 'nut pericarp'. The re-examination of the archived specimen has verified the identification. However, Van der Veen did not make any comment on the antiquity of the specimen nor on its reported context 'B555'.

Tim Padley (Tullie House Museum) offered in June 2017 to search for the original Castle Street 1981–2 excavation field notes in the Tullie House Museum archives, in order to retrieve any possible information for the alleged 'Context 555' and the

sweet chestnut find. This search has not been possible within the time available (report still awaited at going to press).

### 3.2 Recovery from archives


*Fig 10: Photograph of the original packet for the Castle Street, Carlisle sweet chestnut nut fragment as recovered from the archives, with original annotations © Rob Jarman*

The nut pericarp fragment was located (following extensive enquiries by RJ and Historic England staff) by Denise Druce (Oxford Archaeology North) whilst working on the Castle Street, Carlisle archives. Consent was granted by the custodians of the fragment (Tullie House Museum & Art Gallery Trust, Carlisle) for the fragment to be submitted for potential aDNA analysis by Prof. Robin Allaby at Warwick University (along with the Great Holts Farm nut fragments *supra).*

### 3.3 aDNA analysis

The fragment was sent by Denise Druce directly to Robin Allaby: the nature and condition of the fragment at that point was unknown.

The aDNA analysis was undertaken during 2016 by Oliver Smith at Warwick University along with the Great Holts Farm specimens – see section 3.3 *supra* for methods used.

The Castle Street sample provided acceptable libraries for sequencing, unlike the Great Holts Farm sample.

In total 0.5 million DNA reads were obtained from the Illumina MiSeq sequencing of the Castle Street libraries, which is considerably less than the capacity of the MiSeq. This indicates a general lack of DNA from the sample, including microbial DNA, in this context.

Initial analysis indicated that 5.2% of reads could be aligned with the *Castanea mollissima* genome (used as a proxy for *C. sativa*). However, this does not equate to 5.2% of reads assigned as *Castanea,* since it is likely that conserved DNA regions will align with a wide range of taxa.

A subsequent BLAST analysis attributed DNA reads to the most likely taxa by searching through the GenBank database. This analysis confirmed the low content of bacterial DNA, with only 11% of reads being attributable to Procarya. However, the reads previously aligned with the *Castanea* genome were shown not to be uniquely attributable to *Castanea,* but were DNA elements of low complexity (simple sequences such as ATATAT et seq. that could turn up in any genome). Unfortunately, no DNA reads could be attributed specifically to *Castanea*. These results lead to the conclusion that there is no detectable endogenous DNA in the sweet chestnut sample from Castle Street, Carlisle.

## 3.4 Description and photographic recording of the sweet chestnut fragments

### *3.4.1 Description*

On unpacking the Castle Street fragment returned from Warwick University it was noted that there were in fact two separate pieces of pericarp: however, there was no obvious fracture of a single piece into two. It is unclear at what point after Van der Veen's record of a 'fragment' on 27 July 1983 that there became two fragments.

The two pericarp fragments are robust, thick skinned and a light brown in colour on the outer surface. It does not appear that they have been smoked or heated: there is no iridescent sheen on the outer surface. The interior of the pericarp is prominently hairy, with dense long hairs, unlike the Great Holts Farm specimens, which were downy. The outer surface is heavily ribbed. Both specimens appear to be flattened/folded, with the hairy inner surface sandwiched between the outer faces and obscured.

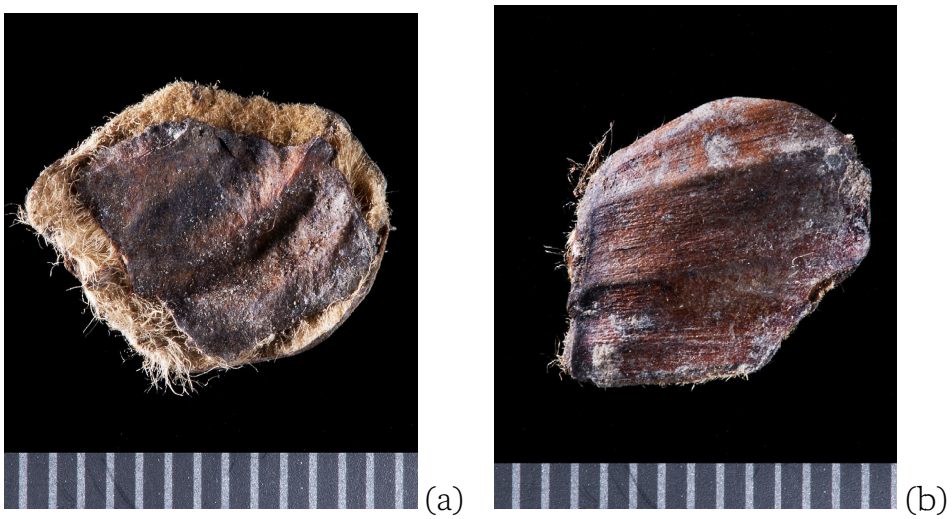
### *3.4.2 Photographic record*

The nut pericarp fragments were photographed by James Davies (Historic England, Swindon), using the method described in section 2.4.2.

Detailed photographic recording of the obverse and reverse faces of the two fragments highlighted specific morphometric features (see Table 3 and Figs 11 and 12).
After recording, each fragment was packaged individually into a labelled, sealed plastic sample bag: the bagged samples were placed back into the original site packet (Fig 10).

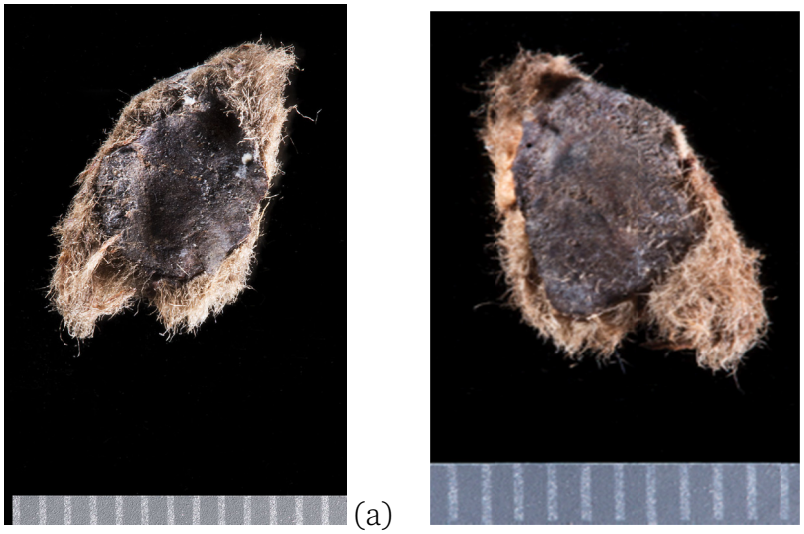
*Table 3: Castle Street, Carlisle specimens and their photograph reference numbers*

| Specimen number | Face (where relevant) | Photograph number/s (HE archive) |
|---|---|---|
| 1 | Obverse<br>Reverse | DP195969<br>DP195968 |
| 2 | Obverse<br>Obverse<br>Reverse | DP195967 (not illustrated in Fig 12 *infra*)<br>DP219760<br>DP219761 |



(a) (b)

*Fig 11: Images of Specimen 1 showing (a) obverse face (exterior) (b) reverse face (exterior), both depicting the outer face of the pericarp, the specimen being a folded piece of pericarp enclosing the hairy inner surface.*



(a) (b)

*Fig 12: Images of Specimen 2 showing (a) obverse face (exterior) (b) reverse face (exterior), both depicting the outer face of the pericarp, the specimen being a folded piece of pericarp enclosing the hairy inner surface.*

## 3.5 Radiocarbon dating

### *3.5.1 Sampling*

Following the photographic recording, and considering that there were two fragments available, it was decided to attempt radiocarbon dating on one of the pieces. Consent was given by Tullie House Museum & Art Gallery Trust (Anne-Marie Knowles) for destructive sampling to gain a more precise growing date for the nut, necessitated by the absence of a proper account of the alleged Context 555 in the published excavation reports.

- Specimen 1 - mass 35mg: the whole piece was selected for radiocarbon assessment, as the minimum size suitable for radiocarbon assessment;
- Specimen 2 - mass 41mg: this was retained intact for return to the archives.

It is possible that both specimens derive from the same nut, since Van der Veen (1983) had described only a single fragment. Specimen 2 is now the sole surviving remnant of the original Castle Street find.

### *3.5.2 Radiocarbon dating methods*

The single sample measured at the Oxford Radiocarbon Accelerator Unit (ORAU) was pretreated and combusted as described in Brock *et al* (2010), graphitised (Dee and Bronk Ramsey 2000) and dated by AMS (Bronk Ramsey *et al* 2004).

### *3.5.3 Radiocarbon results*

The radiocarbon result is presented in Table 4: it has been calibrated with data from Hua *et al* (2013), using OxCal (v4.2) (Bronk Ramsey 2009). The date range given in Table 4 and the probability distribution of the calibrated date (Fig 13) have been calculated using the probability method (Stuiver and Reimer 1993).

The analysis concludes that the *Castanea sativa* nut is modern, probably contemporary with the period of the excavation.

*Table 4: Castle Street, Carlisle radiocarbon result*

| Laboratory number | Sample reference | Material (identified by) | $\delta^{13}C$ (‰) | Radiocarbon Age ($F^{14}C$) | Calibrated Date (95% probability) |
|---|---|---|---|---|---|
| OxA-36076 | Context B555:1 | *Castanea sativa* nut pericarp (M van der Veen, Durham University) | −26.7±0.2 | 1.27013±0.2 | 1959–1960 (9%) or 1962 (3%) or 1979–1982 (83%) |

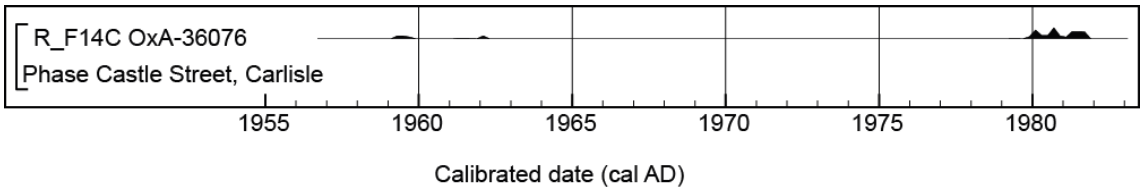



*Fig 13: Probability distribution of the date of the Castanea sativa nut from Castle Street, Carlisle. The distribution is the result of simple radiocarbon calibration (Stuiver and Reimer 1993).*

# 4. DISCUSSION

## 4.1 Re-evaluation of the original reports for the specimens

Great Holts Farm: the nut fragments were dated in the original excavation report to the late 3rd century AD, using pottery found in the basal well fill Context 6463. The well construction was originally dated by Darrah (Germany 2003, 188–9) to AD 220, although it appears from the reported dendrochronology results (Germany 2003, 20) that the most reliable date for the well's construction is a *terminus post quem* of AD 188. The chestnut specimens have now been definitively dated to *cal AD 210–260* (*73% probability)* or *cal AD 280–325* (*21% probability*), probably *cal AD 220–255* (*62% probability*) or *cal AD 305–315* (*6% probability*).

The sweet chestnut nuts from which the pericarp fragments derived would have been growing at most two years before their consumption, as sweet chestnut nuts are not durable for longer, so they could have derived from sweet chestnut trees grown in the region of the Roman farmhouse and consumed soon after harvest; or they could have been imported from elsewhere in Great Britain or continental Europe, having been harvested some months or a year before the consumption date. The nuts now appear to be earlier (early–mid 3rd century AD) than the pottery-based date (late 3rd century AD) that was originally estimated.

Castle Street, Carlisle: this record has been problematic to research – the official excavation reports (McCarthy 1991a; McCarthy 1991b) do not mention the sweet chestnut nut fragment, nor the context for the nut, as reported in the small finds analysis from the 1981–2 excavation (Van der Veen 1983). The first acknowledgment of Van der Veen's 1983 report and the sweet chestnut find is in Hall and Huntley (2007).

Searches for original site excavation field notes from 1981–2 were requested from Tullie House Museum in June 2017, but no information has been provided up to the time of publication of this report. It is unclear whether there might be any records that could elucidate the context or the circumstances of the sweet chestnut find at Castle Street.

The Castle Street sweet chestnut nut is now known from direct radiocarbon dating to be modern, probably contemporary with the period of the excavation. It is important to complete the account of this find with a record of the site context.

## 4.2 aDNA

The attempt to extract aDNA from the sweet chestnut nut pericarp fragments was unsuccessful for both the Castle Street and the Great Holts Farm specimens.

The extraction was also unsuccessful in a comparative study of a collection of sweet chestnut nut pericarp specimens that were provided to Warwick University by Andres Teira Brion from an archaeological excavation of the Roman saltworks at O Areal, Vigo, Spain (Teira Brion 2010). The samples from O Areal had been preserved in a phreatic level from an inland fossilised sand dune below sea level. They were waterlogged in marine water. The remains had been radiocarbon dated (1710±30 BP; Beta–302977; cal AD 240–410). As with the Great Holts Farm specimens, there was insufficient DNA extracted from the O Areal specimens to enable the library preparations.

From the three sites examined for aDNA, the Castle Street specimen provided the most DNA, but even this was insufficient to inform a *Castanea* specific aDNA assessment. It would seem probable that the relative youth of the Castle Street specimen contributed to this (excavated in 1981/2, it was therefore at least 34 years old at time of analysis in 2016; Fig 14). However, in the context of aDNA analysis, even material of this age did not provide sufficient preserved DNA.

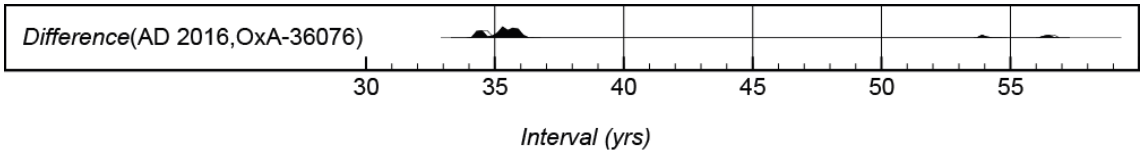



*Fig 14: Probability distribution for the number of years before aDNA analysis was undertaken on the Castle Street material*

It is possible that it is the sweet chestnut nut pericarp tissue that is problematic for DNA analysis, rather than the age of the material. Conventional DNA analysis of modern sweet chestnut plant material would normally sample leaves, buds or nut flesh, from fresh tissue, or temporarily desiccated material, or stored deep frozen material. Sweet chestnut nut pericarps are not the preferred tissue from which to extract DNA (C Mattioni pers com).

## 4.3 Photographic revelations

The photographs revealed a remarkable set of preserved sweet chestnut nut pericarps.

It is now clear from the radiocarbon dating that the Castle Street Carlisle specimens are modern and so would be expected to be relatively well preserved, compared with the Great Holts Farm specimens. This is evident when the photographs of the

two collections are considered: the exterior and interior surfaces of the Carlisle pericarp are very different from the Great Holts Farm pericarps.

The Great Holts Farm specimens had been waterlogged for nearly two thousand years, whereas it seems probable that the Castle Street specimen had only been in/on the ground for a relatively short time (a record of the actual context for this find has not yet been reported).

It is possible that the differences in the outer pericarps relate to whether the nuts had been smoked or heated before they were consumed. The Carlisle specimens appear matt, whereas the Great Holts Farm nuts have sheen on the pericarp exterior surfaces.

It had been hoped that the photographs would reveal the potential for morphometric analysis of the specimens to determine their original variety or varieties. Josefa Fernandez-Lopez (Galicia, Spain) was shown the photographs of the pericarp fragments, but declined to make any assessment of varietal form in that manner. See Fernandez-Lopez (2013) and Fernandez-Lopez *et al* (2014) for examples of a range of sweet chestnut nut varieties (with respect to Galicia, NW Spain) and their morphometric features. The O Areal specimens had previously been assessed visually for varietal characteristics, also unsuccessfully (A Teira Brion, pers comm).

## 4.4 Radiocarbon dating

### *4.4.1 Results*

The radiocarbon results confirm that the sweet chestnut nuts from Great Holts Farm are probably from the early to mid 3rd century AD. The specimen from Castle Street Carlisle is modern.

### *4.4.2 Discussion*

The radiocarbon results highlight the importance of direct radiocarbon dating of plant macrofossils and serve as an example of why it cannot be assumed that material is contemporary with its context. Pelling *et al* (2015) have recently emphasized the importance of examining the archaeobotanical record held in archives to identify contaminated material.

The Castle Street Carlisle specimen, albeit now classified as 'modern', should continue to be conserved in the museum archive, as it is a rare example of a recorded find of sweet chestnut nut evidence, from a known (subject to the original excavation context being determined) location and of known antiquity, that can be used as a reference point for future studies of environmental or archaeological finds of sweet chestnut nut remains. The original reported context of the find needs to be confirmed and described and the circumstances of the sweet chestnut find ascertained from the excavation field notes.

The radiocarbon dates for the Great Holts Farm specimens confirm their early–mid 3rd century AD Roman antiquity; but they cannot answer the question of whether the nuts are all from the same harvest year, or from several different harvest years. If the nuts were brought to the farmstead for a specific feast, as the contextual evidence perhaps indicates, then they would be presumed to be of the same age, as sweet chestnut nuts are not normally stored for much longer than one to two years after harvest. If the nuts were used on several different occasions, spread across several years, then they could be presumed to derive from several different growth years.

Answering this question is relevant to the wider consideration of whether sweet chestnut was regularly used as food during the Roman occupation of Great Britain: from the evidence at Great Holts Farm, it would seem that it was only very rarely used, on special occasions, together with other exotic, presumed imported, foods.

### 4.5 Archive storage and handling

The survival of the sweet chestnut nut pericarps at Great Holts Farm for nearly two thousand years and then their subsequent recovery and preservation is remarkable and evidently very unusual: these are the only finds of any sweet chestnut nut remains from anywhere in Great Britain for any period pre-medieval. The post-excavation survival of these pericarps is fortunate, presumably indicating appropriate transition from their original anaerobic waterlogged environment to the museum environment.

The Great Holts Farm specimens have undergone some changes in physical features since the time of their first assessment in 1995–7, notably the apparent loss of the stylar projections that were reported by Murphy in 1997. At what point between 1997 and 2017 these features were eroded is unknown.

Conditions for the further storage of these specimens in their home archives may need to be adjusted, given their evident rarity and significance.

### 4.6 Further research

Detailed analysis of the Great Holts Farm specimens to determine how the nuts might have been harvested, preserved, prepared for consumption and then disposed of could be instructive. The question of whether they had been smoked or roasted would be primary.

Analysis of other surviving food remains from Great Holts Farm Well 567, to date them and derive origins, is worth considering.

## 5. CONCLUSIONS

The Castle Street Carlisle record of a possible Roman period sweet chestnut find has been found to be modern contamination of the original excavation site. The inference by an archaeological review report that the find was Roman was, with

hindsight, a distraction. This example endorses the basic principle that organic/environmental material should be directly dated using appropriate methods and not indirectly dated using contextual or derived information: this is especially important for rare or unusual finds such as this.

The Great Holts Farm sweet chestnut nuts are confirmed as from the early–mid 3rd century AD and can now be defined as an unique find for the whole of the archaeological and palaeoenvironmental record in Great Britain up until the medieval period. Compilations of food evidence from Roman sites in Great Britain have not reported any other finds of sweet chestnut (Van der Veen *et al* 2007; Van der Veen *et al* 2008; Witcher 2013). Even at Silchester, where excavations of Roman period remains have been so productive of food items, sweet chestnut evidence is absent (Lodwick 2014; Lodwick 2016).

The context for the sweet chestnut nuts at Great Holts Farm indicates that they were probably a high status food, alongside other preserved 'exotic' foods that were presumed imported, notably olives and stone pine nuts, and possibly also fish products using scad and Spanish (Atlantic chub) mackerel. The sweet chestnut evidence from Well 567 and the absence of sweet chestnut from the wider excavation indicate that it was not typical in the diet of the Roman farmstead occupants.

The sweet chestnut nut pericarp specimens from Great Holts Farm are significant for understanding sweet chestnut's earliest origins in Great Britain. Statements are frequently found alleging that the Romans introduced sweet chestnut to Great Britain and, for example, that Roman legions used it as a staple food. Such conclusions cannot be drawn when there is at present no evidence that sweet chestnut grew and flowered in Great Britain and produced pollen and nuts, and only the Great Holts Farm evidence of any sweet chestnut nut consumption, for any period pre-medieval.

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# APPENDIX 1 TIMELINE FOR THE RESEARCH PROGRAMME

| | |
|---|---|
| October 2013 | Doctoral research commenced |
| July 2014 | Great Holts Farm and Castle Street, Carlisle nut finds identified as research targets for archived specimens |
| July 2015 | Great Holts Farm specimens recovered from Murphy Collection, Norwich Castle Museum. |
| Sept 2015 | Castle Street specimens recovered from archive and transferred by post to Robin Allaby at Warwick University |
| October 2015 | Great Holts Farm specimens transferred by hand to Robin Allaby at Warwick University |
| 2016 | aDNA analysis of Great Holts Farm and Castle Street specimens at Warwick University by Oliver Smith |
| February 2017 | Great Holts Farm and Castle Street specimens returned by Oliver Smith to RJ |
| April 2017 | Great Holts Farm and Castle Street specimens photographed at HE Swindon |
| May 2017 | Great Holts Farm and Castle Street specimens selected for radiocarbon dating |
| November 2017 | Great Holts Farm and Castle Street radiocarbon results received |
| December 2017/January 2018 | Specimens returned to Norwich Castle Museum / Tullie House Museum, Carlisle |

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ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)