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The Fox Hotel 1 and 1A Market Place Chipping Norton Oxfordshire

Tree-ring Analysis and Radiocarbon Wiggle-matching of Oak Timbers

Martin Bridge, Cathy Tyers, Alex Bayliss, Michael Dee, and Sanne Palstra

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Front Cover: The Fox Hotel. Photograph Martin Bridge.

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1 AND 1A MARKET PLACE
CHIPPING NORTON
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SUMMARY
Tree-ring analysis was undertaken on the ring-width series from fourteen of the fifteen timbers sampled from The Fox Hotel and the neighbouring building to the east, 1 and 1A Market Place. Cross-matching allowed three site master chronologies to be formed, two from the Fox Hotel, and one from 1 and 1A Market Place, which contained three, two, and three timbers respectively. Neither Fox Hotel chronologies could be dated by dendrochronology. The moulded beams in 1 and 1A Market Place, however, were converted from trees most likely felled in the second quarter of the fifteenth century AD.

Radiocarbon dating was undertaken on eight single-ring samples from cnfox05, the longest tree-ring series in the undated site sequence cnfox542m. Wiggle-matching of these results, taking account of the missing sapwood rings on the samples, indicates that the three cross-matched coeval timbers from the roof of the Fox Hotel were felled in the last quarter of the sixteenth century AD.

CONTRIBUTORS
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INTRODUCTION

The *Early Fabric in Historic Towns: Voluntary Group Projects*, funded by Historic England, have been developed in the recognition and acknowledgement of the excellent work being undertaken by local vernacular groups in the study of local architectural trends and fabrics. The intention of these projects is to encourage this type of study through the provision of support and facilitate training of more people in building analysis and recording. The local projects were coordinated by Rebecca Lane (Historic England South West Region: Architectural Investigation).

Early Fabric in Chipping Norton Project

Whilst Chipping Norton features in a study on historic towns in Oxfordshire (Rodwell 1975), and some buildings have been recorded and published in detail (eg Simons and Phimester 2005), no systematic research had been undertaken on the buildings of the town before this project.

The project examined vernacular historic buildings in the centre of Chipping Norton, aiming to improve understanding of the morphology and development of the historic town plan and to understand this within the framework of economic and social change. It aimed to identify early plan forms and to understand the dates of the introduction of vernacular architectural details (eg in materials, carpentry, fenestration, and decorative features), thus mapping the survival of early (pre-1900) fabric and revealing the architectural evolution of the town's buildings.

Initially, 21 properties were identified that were thought to be key to understanding the town's architectural development for a programme of comprehensive investigation. Nineteen of these properties were assessed for their suitability for dendrochronology, and 12 that contained oak timbers potentially suitable for analysis were sampled and analysed. Oak timbers from seven of these buildings could be dated by ring-width dendrochronology, whilst radiocarbon wiggle-matching has been undertaken for further sites where the ring-width dendrochronology had produced undated site master chronologies.

The results of the project are presented by Rosen and Cliffe (2017). The reports produced on the historic buildings recorded as part of this project by the Chipping Norton Buildings Record/Oxfordshire Buildings Record will be deposited in the Oxfordshire Historic Environment Record. The primary archive of the dendrochronological analysis, and the radiocarbon dating undertaken, is reported in the Historic England Research Report Series.

The Fox Hotel and 1/1A Market Place

The properties lie in the south-east corner of the Market Place, at the junction of two roads in the town, West Street and Market Place (Fig 1). The Fox Hotel is listed at Grade II (LEN 1368128) as a seventeenth-century L-shaped building, extended eastwards to incorporate two bays of a former early Baroque town house. No 1/1A Market Place lies further east (Figs 2 and 3). As early buildings in the town, they were a natural candidate for dendrochronological investigation as part of the *Early*

Fabric in Historic Towns: Chipping Norton project. It was hoped that any results might give additional evidence on the development of this building complex, especially as the current property divisions probably do not reflect the original ones.

On typological grounds Truss 1 in 1A Market Place and Truss A in the Fox Hotel are a matched pair (Fig 3). Both trusses have similar joints, housing ridge purlins at their apex using a slip tenon (ie a tenon captured with mortices between butted principals). A similar apex to the tie-beam truss in 1 Spring Street, Chipping Norton has been dated by ring-width dendrochronology to AD 1444–77 (Bridge and Tyers 2020a) but is generally a feature only found in cruck trusses.

The longer Market Place facade of the Fox Hotel is of two storeys with an attic. Being a functioning hotel, access was slightly limited, with most sampling being carried out in the attic areas in October 2015. The two original trusses (A and C; Fig 2) were of interest because they varied in form, but had similarities to other trusses in other buildings in this project. Truss A also has similarities to 8 Market Street (Bridge and Tyers 2020b), and Truss C has similar cranked feet to timbers found in The Chequers which has been dated by dendrochronology to AD 1444–76 (Bridge and Tyers 2020c).

The ground floor of 1 Market Place is a shop and the moulded beams there were sampled in 2021. The flat above (1A) was also accessed at a different time, in January 2016, allowing further sampling of Truss A, part of the same roof as over the Fox Hotel. A moulded beam to the east of this truss was also sampled in this flat.

RING-WIDTH DENDROCHRONOLOGY

Methodology

Fieldwork for the present study was thus carried out in October 2015, January 2016, and in 2021, following an initial assessment of the potential for dating a few weeks beforehand, and consultation with those involved in the project. In the initial assessment, accessible oak (*Quercus* sp.) timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. Those timbers judged to be potentially useful were cored using a 16mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a process of qualified statistical comparison by computer, supported by visual checks. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-values in the range of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values, however, do not preclude same-tree derivation.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring (ie if it has only the spring vessels or earlywood formed, or the latewood or summer growth) a precise felling date and season can be given.

If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The method used has been developed by Miles (2005) and has been implemented using OxCal v4.4 (Bronk Ramsey 2009; Miles 2006). Following the methodology described by Millard (2002), Bayesian statistical models are used to provide individual sapwood estimates for each timber using the variables of the number of heartwood rings present, the mean ring-width of those heartwood rings, the heartwood/sapwood boundary dated, and the number of any surviving sapwood rings (including those that can only be counted, not measured, or those lost on sampling). Miles (2005) suggests several such models, of which the one that applies to the timbers in this case is that for ‘post-Roman England and Wales’. This model is based on data from timbers throughout this area, although there is a bias towards data from Shropshire, Somerset, Hampshire, Oxfordshire, and Kent. This model is clearly appropriate geographically for historic timbers from buildings in Chipping Norton, as well as being compatible with the growth characteristics of this assemblage.

Where neither any sapwood nor the heartwood/sapwood boundary survives, the sapwood model may be applied in the same way, although in this case the resultant posterior distributions provides a *terminus post quem* for the felling date of the timber rather than an estimate of the felling date itself.

The individual probability distributions for the felling date of each timber, but not the *termini post quos* calculated for any timbers lacking their heartwood/sapwood boundaries, may then be combined to produce a highest probability density estimate for the combined felling date of a group of associated timbers. The Acomb statistic shows whether the dates of the timbers agree with the interpretation of a single felling episode: an acceptable threshold is reached when it is equal to or greater than An (a value based on the number of timbers in the group). The A statistic shows how closely an individual felling date agrees with this interpretation (most values in a model should be equal to or greater than 60).

Highest Posterior Density intervals derived from the posterior distributions produced by the sapwood models are cited *in italics* to indicate that they derive from statistical modelling. They have been rounded outwards to the nearest year.

It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

Results

Details of the samples taken are given in Table 1. The approximate positions of timbers sampled are shown in Figures 2 and 3.

Timbers from the Fox Hotel were sampled in October 2015 and were from the roof area, with the exception of the first sample, which was taken from a beam in the bar area of the ground floor, and the last sample, a lintel in the first-floor west-end room. The truss shown as Truss B (Figs 2–4) was found to be of elm (*Ulmus* sp.), thought to be a replacement truss, and this was not sampled. Access to Truss A was in a restricted cupboard area (Fig 5).

Access to No 1A Market Place, the top-floor flat in the adjacent property with a baroque facade, became available in January 2016. This allowed access to a truss thought to be a continuation of the roof of the hotel (Truss A), as well as a moulded ceiling beam in the present kitchen area (Fig 6), below the truss located to the east of the eastern external gable (Rosen and Cliffe 2017). Further samples were taken from moulded beams on the ground floor of this property when access became available in April 2021.

All samples were measured, the ring-width measurements are provided in the Appendix. All but the very short ring series obtained from cnfox11 were compared to each other, cnfox11 being too short for reliable dating. This process identified consistent cross-matching between samples cnfox05, cnfox04, and cnfox02 (Table 2a; Fig 7) from Truss A, and potential cross-matching between cnfox10 and cnfox08 (t = 6.1 with 77 years overlap) from Truss C (Fig 8). It should be noted however that cnfox10 had extremely narrow rings in places, and the data in the appendix for this sample cannot be guaranteed to be accurate but is the best current determination of the ring series. The ring-width series of these two groups were combined to form two working site master chronologies, cnfox542m and cnfox108m. These were compared against an extensive range of reference chronologies for oak, but no satisfactory cross-matching was obtained. Many of the Fox Hotel samples, including those mentioned above, exhibited sudden growth declines (Figs 7 and 8) that are unlikely to have resulted from external weather conditions, but rather, management or pathological events, and as such, a lack of dating for these samples is not surprising.

Only 32 rings were obtained from the sample (cnfoxX01) from the principal rafter in No 1A Market Place, and this did not cross-match with the other timbers from Truss A and could not be dated. Two samples were taken from the moulded ceiling beam on the first floor (Figs 2, 3, and 6) in order to capture the longest possible ring-width series. The samples, cnfoxX02a and cnfoxX02b, cross-matched (t=8.6 with 29 years overlap) and were combined to form a single 115-year long series, cnfoxX02. This matched with the ring series from the two ground-floor moulded ceiling beams in 1 Market Place (Table 2b), and a 128-year site chronology, cnfoxXt3, was formed. This was subsequently dated to the period AD 1292–1419. The strongest matches for this site chronology are shown in Table 3. It should be noted that, without the match with 8 Market Place, Chipping Norton, this evidence would not have been considered strong enough for dating certainty, and wiggle-matching may have been employed to corroborate this result. This was not done, however, because of the cross-matching with the site master chronology from 8 Market Place.

RADIOCARBON DATING

Following the failure of the dendrochronology to provide calendar dating for the felling of the timbers in the Fox Hotel, the longest tree-ring sequence (cnfox05) from undated site sequence cnfox542m (Fig 7) was selected for radiocarbon dating and wiggle-matching.

Radiocarbon dating is based on the radioactive decay of ^{14}C, which trees absorb from the atmosphere during photosynthesis and store in their growth-rings. The radiocarbon from each year is stored in a separate annual ring. Once a ring has formed, no more ^{14}C is added to it, and so the proportion of ^{14}C versus other carbon isotopes reduces in the ring through time as the radiocarbon decays. Radiocarbon ages, like those in Table 4, measure the proportion of ^{14}C in a sample and are expressed in radiocarbon years BP (before present, 'present' being a constant, conventional date of AD 1950).

Seven radiocarbon measurements have been obtained from single annual tree-rings from timber cnfox05 (Table 4; Fig 10). Dissection was undertaken by Alison Arnold and Robert Howard at the Nottingham Tree-Ring Dating Laboratory. Prior to sub-sampling, the core was checked against the tree-ring width data. Then each annual growth ring was split from the rest of the tree-ring sample using a chisel or scalpel blade. Each radiocarbon sample consisted of a complete annual growth ring, including both earlywood and latewood. Each annual ring was then weighed and placed in a labelled bag. Rings not selected for radiocarbon dating as part of this study have been archived by Historic England.

Radiocarbon dating was undertaken by the Centre for Isotope Research, University of Groningen (GrM-), the Netherlands in 2020–1. Each ring was converted to α-cellulose using an intensified aqueous pretreatment (Dee *et al* 2020) and combusted in an elemental analyser (IsotopeCube NCS), coupled to an Isotope Ratio Mass Spectrometer (Isoprime 100). The resultant CO_2 was graphitised by hydrogen reduction in the presence of an iron catalyst (Wijma *et al* 1996; Aerts-Bijma *et al* 1997). The graphite was then pressed into aluminium cathodes and dated by Accelerator Mass Spectrometry (AMS) (Synal *et al* 2007; Salehpour *et al* 2016).

Data reduction was undertaken as described by Wacker *et al* (2010), and the facility maintains a continual programme of quality assurance procedures (Aerts-Bijma *et al* 2021), in addition to participation in international inter-comparison exercises (Scott *et al* 2017; Wacker *et al* 2020). These tests demonstrate the reproducibility and accuracy of these measurements.

The results are conventional radiocarbon ages, corrected for fractionation using $\delta^{13}C$ values measured by Accelerator Mass Spectrometry (Stuiver and Polach 1977; Table 4). The $\delta^{13}C$ values presented in Table 4 were measured by Isotope Ratio Mass Spectrometry, and more accurately reflect the natural isotopic composition of the sampled wood.

WIGGLE-MATCHING

Radiocarbon ages are not the same as calendar dates because the concentration of ^{14}C in the atmosphere has fluctuated over time. A radiocarbon measurement has thus to be calibrated against an independent scale to arrive at the corresponding calendar date. That independent scale is the IntCal20 calibration curve (Reimer *et al* 2020). For the period covered by this study, this is constructed from radiocarbon measurements on tree-ring samples dated absolutely by dendrochronology. The probability distributions of the calibrated radiocarbon dates from the Fox Hotel, derived from the probability method (Stuiver and Reimer 1993), are shown in outline in Figure 11.

Wiggle-matching is the process of matching a series of calibrated radiocarbon dates which are separated by a known number of years to the shape of the radiocarbon calibration curve. At its simplest, this can be done visually, although statistical methods are usually employed. Floating tree-ring sequences are particularly suited to this approach as the calendar age separation of tree-rings submitted for dating is known precisely by counting the rings in the timber. A review of the method is presented by Galimberti *et al* (2004).

The approach to wiggle-matching adopted here employs Bayesian chronological modelling to combine the relative dating information provided by the tree-ring analysis with the calibrated radiocarbon dates (Christen and Litton 1995). It has been implemented using the program OxCal v4.4 (http://c14.arch.ox.ac.uk/oxcal.html; Bronk Ramsey *et al* 2001; Bronk Ramsey 2009). The modelled dates are shown in black in Figure 11 and quoted in italics in the text. The Acomb statistic shows how closely the assemblage of calibrated radiocarbon dates as a whole agrees with the relative dating provided by the tree-ring analysis that has been incorporated in the model; an acceptable threshold is reached when it is equal to or greater than An (a value based on the number of dates in the model). The A statistic shows how closely an individual calibrated radiocarbon date agrees with its position in the sequence (most values in a model should be equal to or greater than 60).

Figure 11 illustrates the chronological model for cnfox05. This model incorporates the gaps between each dated annual ring known from tree-ring counting (eg that the carbon in ring 3 of the measured tree-ring series (GrM-24156) was laid down eight years before the carbon in ring 11 of the series (GrM-24848); Fig 10). It also incorporates the radiocarbon measurements from cnfox05 (Table 4) calibrated using the internationally agreed radiocarbon calibration data for the northern hemisphere, IntCal20 (Reimer *et al* 2020).

The model has good overall agreement (Acomb: 164.9, An: 26.7, n: 7), and all the dates on the single rings have good individual agreement (A > 60) with their positions in the sequence. It suggests that the final surviving ring of cnfox05 formed in *cal AD 1558–1575 (95% probability; cnfox05 h/s*; Fig 11), probably in *cal AD 1562–1571 (68% probability).*

ESTIMATING FELLING DATES

None of the samples included in either of the dated site master chronologies, cnfoxXt3 and cnfox542m, has complete sapwood (Table 1), but two samples from cnfoxXt3 and all three samples from cnfox542m retain their heartwood/sapwood transitions. In addition, timber cnfox02, retained 15 sapwood rings.

The felling dates of these five timbers can thus be estimated using the sapwood model described above (Millard 2002; Miles 2005). For cnfoxX02 and cnfoxX03 we use the date of the heartwood/sapwood boundaries for these timbers suggested by dendrochronology, and for cnfox02, cnfox04, and cnfox05 we calculate the estimated date of the heartwood/sapwood transition in each timber using its known position in the wiggle-match sequence (that for cnfox04 is the ring dated by *GrM-24165*; Fig 11). The probability distributions of these estimated felling dates are shown in outline in Figure 12. The same sapwood model has been applied to cnfoxX04 although, as this sample did not retain its heartwood/sapwood transition, the resultant date estimate provides a *terminus post quem* for the felling of this timber (shown in grey in Figure 12). The Highest Posterior Density intervals for these distributions are given in Table 1.

The combined felling date for the timbers in cnfoxXt3 has been calculated using samples cnfoxX02 and cnfoxX03. This model has good agreement (Acomb: 111.2, An: 50.0, n: 2) and suggests that these timbers were felled in *AD 1422–44 (95% probability; cnfoxXt3 felling*; Fig 12). The *terminus post quem* for the felling of cnfoxX04 is clearly compatible with this timber being part of this felling event.

The model for the combined felling date for the timbers in cnfox542m also has good agreement (Acomb: 86.1, An: 40.8, n: 3) and suggests that these timbers were felled in *cal AD 1573–90 (95% probability; cnfox542m felling*; Fig 12). This estimate takes into account the uncertainties from both the radiocarbon wiggle-matching and the sapwood estimation.

DISCUSSION

The interpretation of the results in terms of the development of the building poses some interesting questions.

The three moulded beams in 1/1A Market Place (likely felling date range *AD 1422–44* at 95% probability) were found to match very well with the site chronology from 8 Market Street, Chipping Norton (Bridge and Tyers 2020b), which has a likely felling date range of AD 1424–56. The two site chronologies show unusual periods of narrow rings which coincide (Fig 13) and the high *t*-value (9.3) between the two site chronologies suggests that the two buildings were potentially obtaining their timber from the same woodland, and may be exactly contemporary.

The matched pair of trusses, Truss 1 in 1A Market Place and Truss A in the Fox Hotel (in the eastern section with the baroque façade) show many similarities in form with fifteenth-century trusses in other parts of the town (notably those in 8 Market Street, as noted above), but the radiocarbon wiggle-matching demonstrates that the timbers in these trusses were probably felled in the later part of the sixteenth-century. Rosen and Cliffe (2017) record that Anthony Toft inherited that part of the property that is now shared between 1/1A and the Fox Hotel on the death of his father in AD 1585, which falls within the narrow estimated date range provided by the wiggle-matching for the felling of these timbers (*cal AD 1573–90 at 95% probability*), so one could speculate that some alterations were made by him. The similarity in form of these trusses to those elsewhere in the town with similar dates to those found for the moulded beams is not readily explicable, however, unless like-for-like replacement trusses were made in the latter decades of the sixteenth century.

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TABLES

Table 1: Details of the samples taken from the Fox Hotel, and 1A Market Place, Chipping Norton

Sample number	Timber and location	Total number of rings	Mean ring width (mm)	Relative date span	Sapwood	Mean sensitivity	*Felling date (95% probability)*
The Fox Hotel							
cnfox01	North ceiling beam in 'Snug' back lounge	104	0.97	-	9 (+2NM)	0.22	
cnfox02	South principal rafter, Truss A	46	2.93	25–70^{542m}	10 (+5NM)	0.29	*cal AD 1563–89*
cnfox03	Collar, Truss A	47	2.68	-	h/s	0.36	
cnfox04	North principal rafter, Truss A	32	2.42	39–70^{542m}	h/s	0.34	*cal AD 1569–99*
cnfox05	Upper purlin to east of Truss A	72§	1.75	1–72^{542m}	h/s	0.28	*cal AD 1573–1607*
cnfox06	North purlin in east bay, behind dormer	32	3.55	-	h/s	0.20	
cnfox07	South purlin in east bay	56	2.75	-	h/s	0.31	
cnfox08	North principal rafter, Truss C	89	1.39	1–89^{108m}	?h/s	0.21	
cnfox09i	Lower north purlin, west bay	39	1.62	-	-	0.22	
cnfox09ii	*Ditto*	33	1.65	-	13?C	0.19	
cnfox10	South principal rafter, Truss C	93	1.37	13-105^{108m}	14¼C	0.26	
cnfox11	Lintel to 'window' in west end room (Room 2)	17	4.78	-	h/s	0.16	
1 and 1A Market Place				Dates spanning			
cnfoxX01	North principal rafter, Truss A	32	3.67	-	h/s	0.19	
cnfoxX02a	Moulded ceiling beam on first floor	103	1.40	-	h/s	0.25	
cnfoxX02b	*ditto* (inner rings)	41	1.81	-	-	0.25	
cnfoxX02	Mean of X02a and X02b	115	1.51	AD 1292–1406	h/s	0.25	*AD 1416–47*
cnfoxX03	West ground-floor moulded ceiling beam	115	1.07	AD 1305–1419	8	0.25	*AD 1422–55*
cnfoxX04	East ground-floor moulded ceiling beam	75	1.13	AD 1337–1411	-	0.20	*after AD 1422–54*

Key: NM = not measured; h/s = heartwood-sapwood boundary; C = complete sapwood; ¼C = complete sapwood, felled during the following spring; ^{542m} = relative years within site master chronology cnfox542m; ^{108m} = relative years within site master chronology cnfox108m. § Measurements obtained by Robert Howard in preparation for radiocarbon analysis are used here. Felling dates for single timbers are Highest Posterior Density intervals derived from the statistical modelling described in the text and illustrates in Figures 11 and 12. Combined felling dates for cnfox542m and cnfoxXt3 are described in the text and illustrated in Figure 12.

Table 2a: Cross-matching between samples in the site master cnfox542m

	t-value (overlap in years)	
Sample no	cnfox04	cnfox05
cnfox02	5.9 (32)	7.3 (46)
cnfox04		3.5 (32)

Table 2b: Cross-matching between samples in the site master cnfoxXt3

	t-value (overlap in years)	
Sample no	cnfoxX03	cnfoxX04
cnfoxX02	3.8 (102)	5.4 (70)
cnfoxX03		3.0 (75)

Table 3: Dating evidence for sample cnfoxXt3, AD 1292–1419

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	t-value
Oxfordshire	8 Market Street, Chipping Norton	Bridge and Tyers 2020b	CN8MKTt5	1315–1420	105	9.3
Shropshire	The Peach Tree, Shrewsbury	Miles and Worthington 2000	PEACH1	1277–1407	116	5.2
Norfolk	St Mary's Church, Feltwell	Howard and Arnold 2009	FTWASQ01	1303–1494	117	5.0
West Midlands	Upper Spon Street, Coventry	Miles and Worthington 1999	UPPRSPON	1327–1454	93	4.8
Hampshire	Parsonage Farm, Overton	Miles *et al* 2005	OVERTON7	1326–1545	94	4.7
Oxfordshire	Wysdom House, Burford	Bridge and Miles 2011	BURFRD9	1318–1376	59	4.7
Oxfordshire	82-84 High Street, Burford	Miles *et al* 2006	BURFRD4	1307–1472	113	4.7
Devon	Church of St Nectan, Hartland	Arnold and Howard 2013	NECBSQ01	1203–1452	128	4.6
Kent	Church House, Edenbridge	Howard *et al* 2000	EDBASQ12	1250–1374	83	4.6
Oxfordshire	162 The Hill, Burford	Miles *et al* 2006	BURFRD6	1336–1458	84	4.5

Table 4: Radiocarbon measurements and stable isotope measurements from The Fox Hotel, Chipping Norton

Laboratory Number	Sample	Radiocarbon Age (BP)	$\delta^{13}C_{IRMS}$ (‰)
GrM-24156	cnfox05, ring 3 (*Quercus* sp. heartwood)	346±11	−24.34±0.15
GrM-24848	cnfox05, ring 11 (*Quercus* sp. heartwood)	359±15	−24.68±0.15
GrM-24160	cnfox05, ring 24 (*Quercus* sp. heartwood)	348±15	−24.89±0.15
GrM-24161	cnfox05, ring 38 (*Quercus* sp. heartwood)	292±15	−25.13±0.15
GrM-24162	cnfox05, ring 51 (*Quercus* sp. heartwood)	308±16	−24.95±0.15
GrM-24163	cnfox05, ring 61 (*Quercus* sp. heartwood)	316±15	−25.49±0.15
GrM-24165	cnfox05, ring 70 (*Quercus* sp. heartwood)	324±15	−25.55±0.15

FIGURES

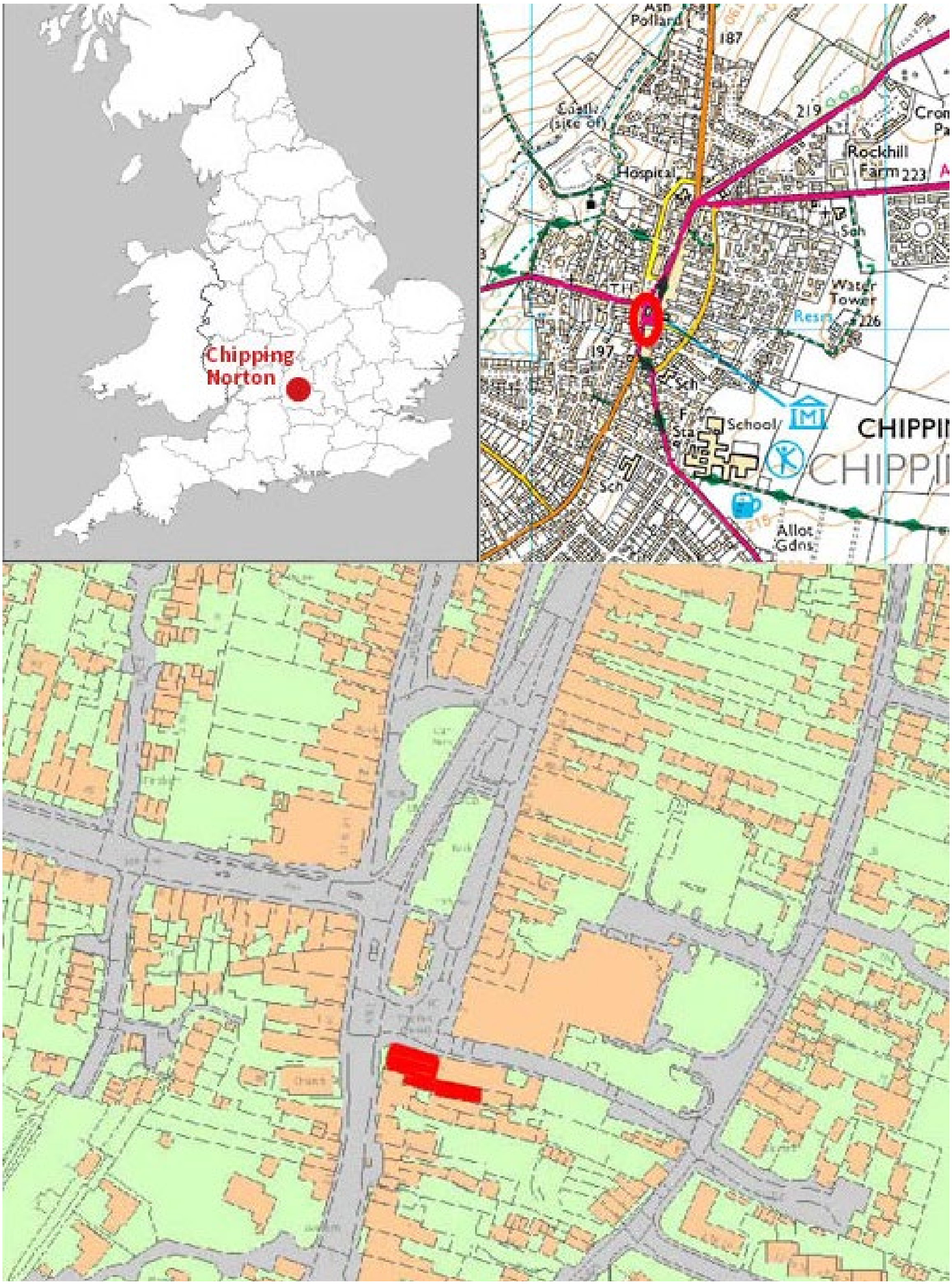


Figure 1: Maps to show the location of The Fox Hotel, 1 and 1A Market Place in Chipping Norton, marked in red. Scale: top right 1:15000; bottom 1:1654. © Crown Copyright and database right 2022. All rights reserved. Ordnance Survey Licence number 100024900.

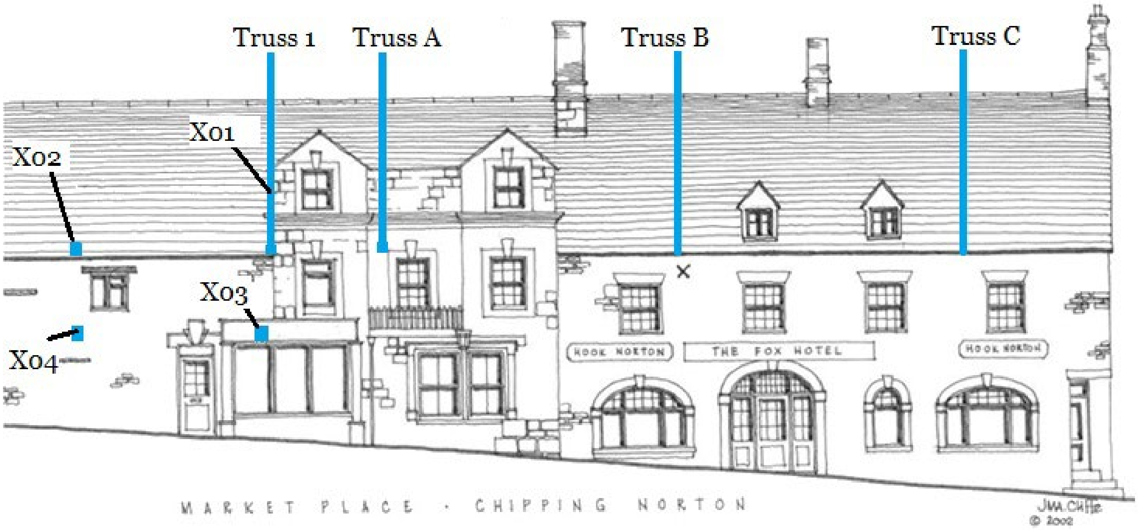


Figure 2: The north elevation of the Fox Hotel and buildings to the east (left). showing the approximate positions of the trusses and beams investigated in this study (adapted from an original drawing by Jan Cliffe (OBR))

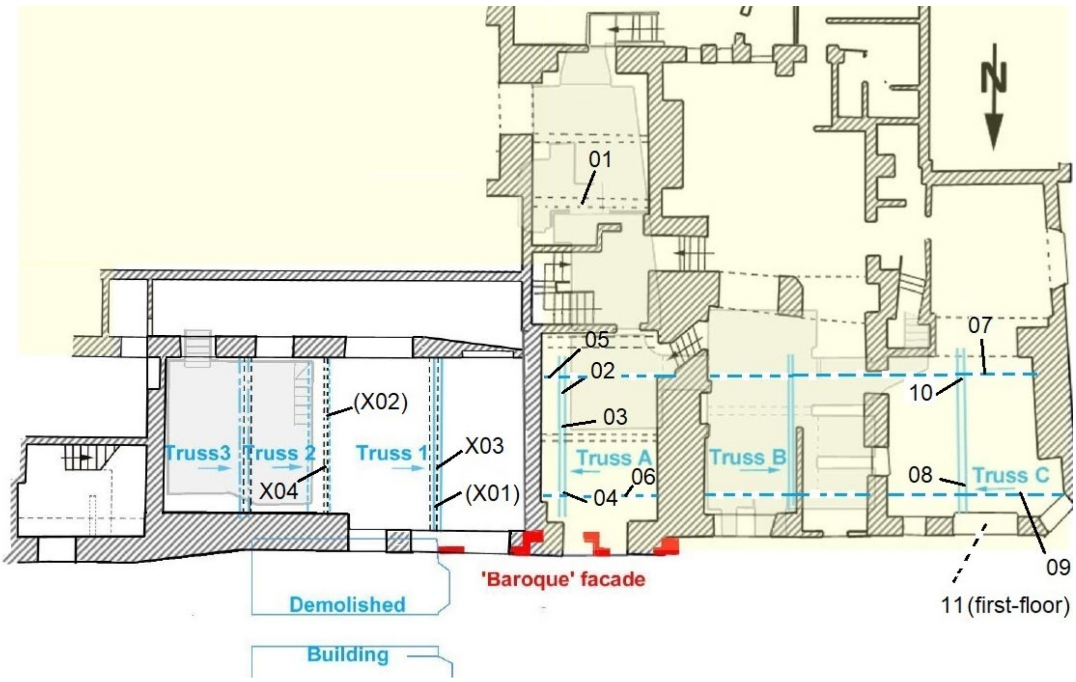


Figure 3: Plan of the Fox Hotel and No 1/1A Market Place ground floor, with superimposed timbers from other floors, showing the approximate locations of samples taken for dendrochronology. Those in 1/1A are distinguished by floor, with first-floor samples in parentheses (adapted from a drawing by Jan Cliffe, annotated by Paul Clark)

Figure 4: View of Truss B, the elm replacement truss, which was not sampled for dendrochronology (photograph Martin Bridge)

Figure 5: View of Truss A from the west, now in a cupboard area in the Fox Hotel with restricted access (photograph Martin Bridge)


Figure 6: View of the cavetto and ogee moulded beam in 1A Market Place (photograph Martin Bridge)

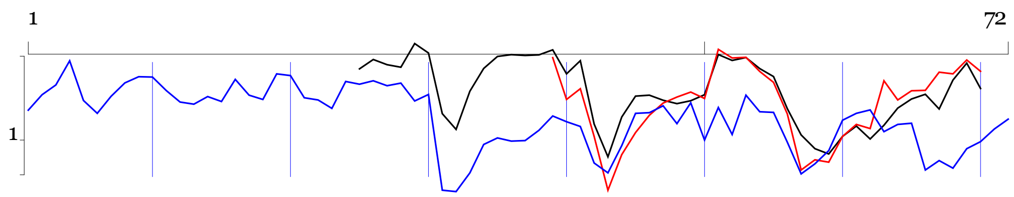


Figure 7: Plots of the ring series of samples cnfox02 (black), cnfox04 (red), and cnfox05 (blue), which form site master cnfox542m, showing their similarity in growth. The x-axis is years, and the y-axis is ring-width (mm) on a logarithmic scale

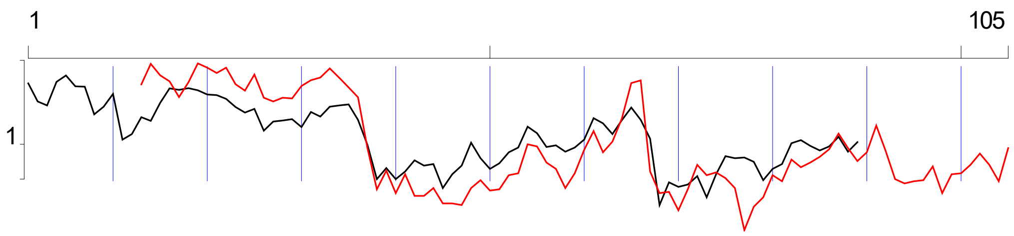


Figure 8: Plots of the ring series of samples cnfox08 (black), and cnfox10 (red), which form site master cnfox108m, showing their similarity in growth. The x-axis is years, and the y-axis is ring-width (mm) on a logarithmic scale

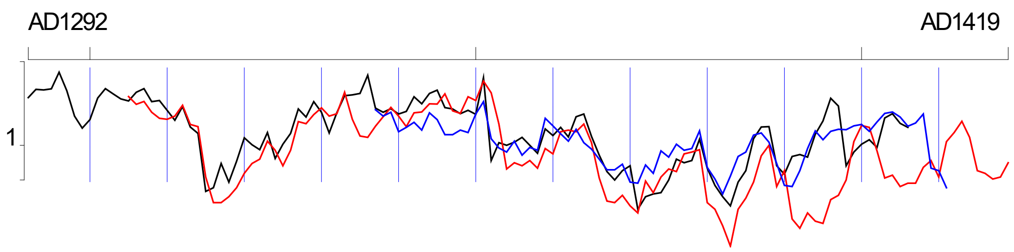


Figure 9: Plots of the ring series of samples cnfoxX02 (black), cnfoxX03 (red), and cnfocX04 (blue) which form site master cnfoxXt3, showing their similarity in growth. The x-axis is years, and the y-axis is ring-width (mm) on a logarithmic scale

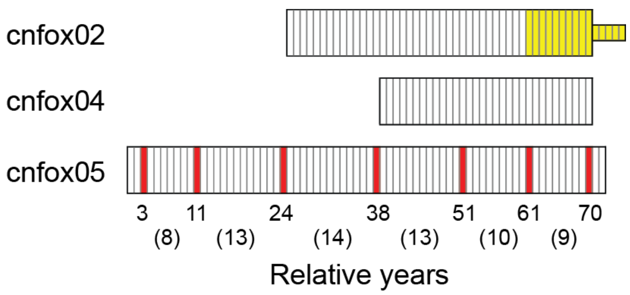


Figure 10: Schematic illustration of timbers from site master sequence cnfox542m, showing the relative positions of the single-ring sub-samples from timber cnfox05 submitted for radiocarbon dating and the gaps between these samples (white: heartwood rings; yellow: sapwood rings)

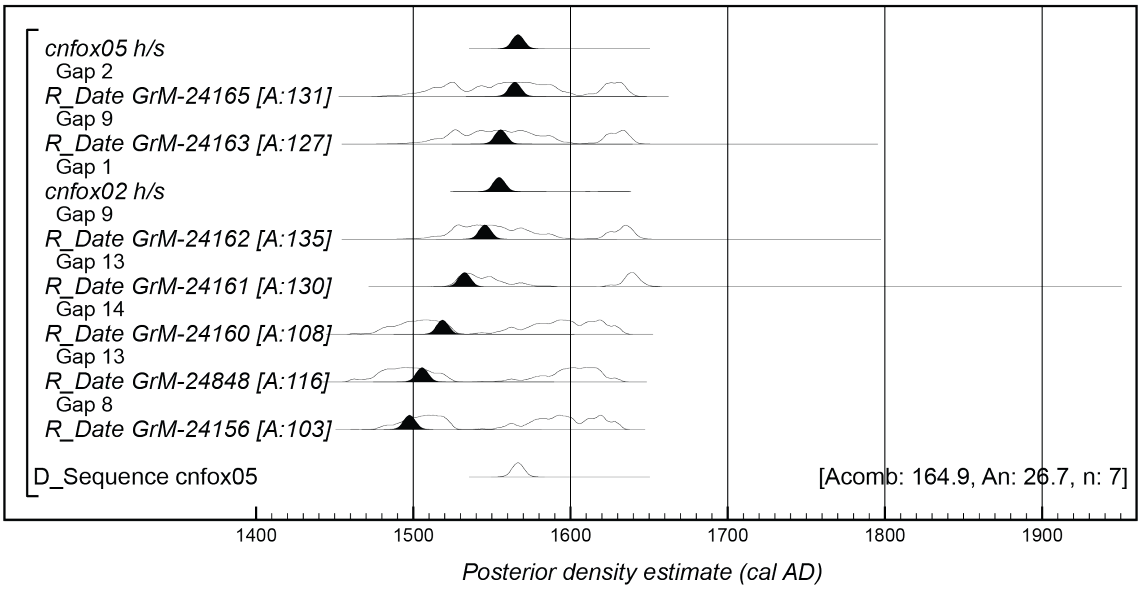


Figure 11: Probability distributions of dates from timber cnfox05, the upper purlin to the east of Truss A in the Fox Hotel. Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates two distributions have been plotted: one in outline, which is the simple radiocarbon calibration, and a solid one, based on the wiggle-match sequence. Distributions other than those relating to particular samples correspond to aspects of the model. For example, the distribution 'cnfox05 h/s' is the estimated date when the heartwood/sapwood boundary ring of timber cnfox05 formed. The large square brackets down the left-hand side along with the OxCal keywords define the overall model exactly

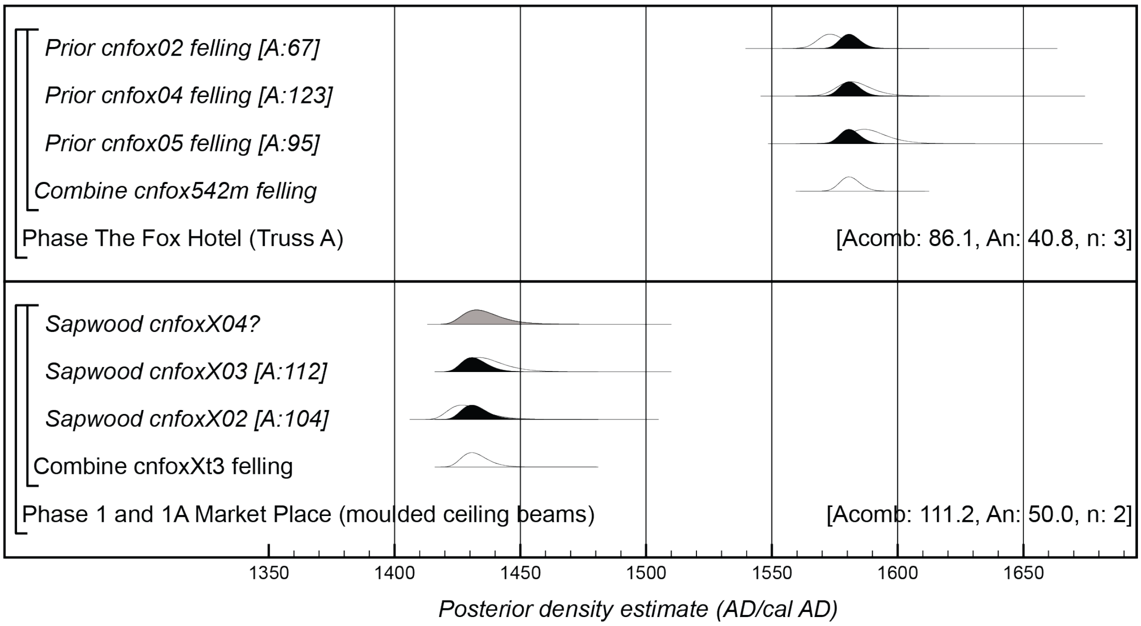


Figure 12: Probability distributions of (a) felling dates for timbers from 1 and 1A Market Place and the Fox Hotel (outline), (b) terminus post quem for the felling of cnfoxX04 (grey), and (c) combined felling dates for the timbers in cnfoxXt3 and cnfox542m (black). The format is as Figure 11.

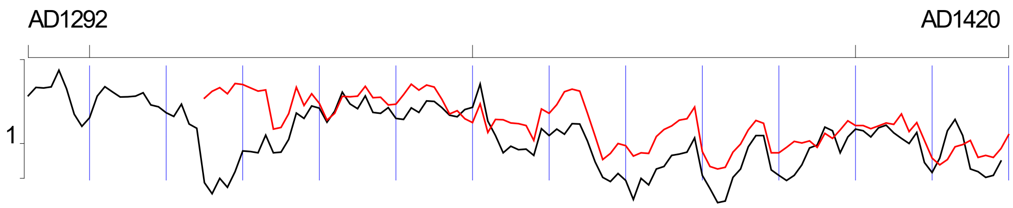


Figure 13: Plots of the site chronologies for the three matching timbers from 1/1A Market Place (cnfoxXt3; black) and the five matching timbers from 8 Market Street, Chipping Norton (cn8mktT5; red) showing their similarity in growth

APPENDIX

Ring width values (0.01mm) for the sequences measured

cnfox01

203	268	181	153	167	50	45	56	61	76
77	142	83	85	70	83	80	62	62	97
167	108	85	72	59	58	124	117	118	120
92	99	57	49	37	48	30	44	42	55
76	105	94	98	85	99	115	118	78	95
152	42	51	54	52	50	72	108	104	114
120	114	140	103	111	116	102	104	164	165
90	71	59	83	115	147	107	61	52	57
68	70	93	91	91	100	84	90	101	97
78	79	89	152	196	121	115	108	149	139
106	116	115	137						

cnfox02

380	453	411	392	611	512	164	122	250	383
480	496	489	494	543	346	443	135	73	154
228	232	211	198	209	234	497	445	470	382
329	180	110	85	77	107	130	102	132	182
216	236	179	308	423	263				

cnfox03

431	400	428	604	428	385	494	384	194	94
118	226	343	351	210	382	371	161	278	189
255	126	137	219	204	231	201	155	335	572
403	226	193	145	287	198	292	509	395	218
81	61	76	119	124	150	222			

cnfox04

469	214	262	107	39	76	115	159	200	224
246	218	548	466	472	362	295	163	57	69
66	107	134	124	304	212	252	254	357	346
449	363								

cnfox05

175	234	281	442	210	165	227	292	328	326
253	204	196	226	206	312	232	214	346	335
221	212	181	300	285	304	277	291	208	235
39	38	54	92	104	98	99	120	157	141
129	65	54	90	165	167	190	136	201	100
184	111	232	170	168	96	53	64	82	145
165	176	117	134	137	57	68	59	85	97
123	148								

cnfox06

189	269	275	202	137	235	256	316	251	329
237	285	343	387	327	342	304	319	297	385
424	463	510	637	446	337	313	290	541	557
653	496								

cnfox07

215	201	299	268	225	237	115	229	298	245
347	326	476	300	257	190	292	301	366	460
393	452	374	223	242	416	315	427	333	243
492	470	651	376	252	177	225	199	112	190
222	219	375	285	223	405	296	402	344	167
80	44	35	28	44	43				

cnfox08

313	223	207	322	363	296	294	175	202	257
109	121	166	155	217	285	277	286	275	254
251	234	201	181	194	129	153	156	160	138
183	168	202	207	211	158	99	52	64	52
60	74	67	69	44	57	67	103	77	63
70	86	94	139	123	95	98	87	94	109
163	148	121	157	199	158	111	32	49	45
47	55	37	57	80	77	78	72	51	63
69	102	108	97	89	96	115	87	104	

cnfox09i

174	140	125	82	75	98	95	91	141	83
129	116	149	141	321	277	271	217	214	334
267	294	227	215	171	174	125	173	169	109
96	94	74	75	84	85	170	237	190	

cnfox09ii

243	277	230	143	255	242	165	176	173	226
284	245	188	237	189	213	159	148	139	148
194	187	92	68	71	71	81	93	85	94
127	111	104							

cnfox10

307	451	364	325	242	319	455	420	380	420
308	273	369	239	223	239	236	298	332	349
414	348	290	241	93	43	61	40	57	38
38	44	33	33	32	44	51	42	43	56
58	100	96	71	63	44	58	90	128	86
105	162	315	331	60	40	41	29	43	68
56	59	53	44	20	31	37	56	50	75
65	71	79	91	122	93	73	86	142	88
52	48	50	51	66	40	57	58	68	84
68	50	93							

cnfox11

456	351	332	331	514	478	567	595	662	531
517	405	564	465	529	376	446			

cnfoxX01

376	487	332	261	271	268	232	259	279	333
287	536	415	289	253	299	329	314	458	475
309	372	465	344	414	458	447	543	435	367
459	374								

cnfoxX02a

239	218	279	308	242	272	210	157	204	143
131	49	45	65	59	93	142	118	101	121
71	96	113	173	160	216	177	122	194	254
258	265	373	201	186	199	180	189	249	218
265	282	203	198	181	193	179	356	75	105
100	106	116	100	86	136	120	140	117	171
180	118	83	61	52	62	68	30	38	40
41	52	77	72	75	112	65	47	38	32
50	62	113	141	142	68	58	81	84	80
123	158	242	209	68	88	102	111	96	167
181	151	140							

cnfxX02b

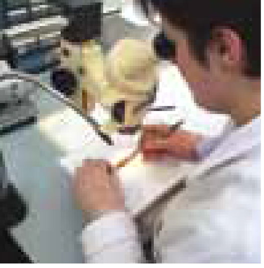
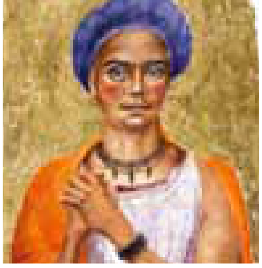
245	286	283	289	395	279	173	138	162	243
290	263	240	242	263	273	213	192	177	164
210	140	119	36	45	77	41	55	88	85
84	133	85	109	138	224	180	239	196	131
176									

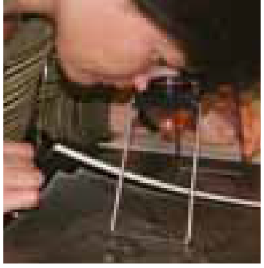
cnfoxX03

250	216	228	186	166	163	173	212	148	142
55	34	34	38	45	59	71	77	108	91
68	91	156	150	178	202	173	181	271	163
119	116	143	171	204	173	142	184	187	218
217	263	191	182	249	232	334	268	149	64
72	68	75	65	94	85	129	133	129	149
105	54	35	34	39	32	28	51	41	55
64	61	85	88	92	34	30	22	15	30
37	50	82	100	46	62	25	21	28	24
23	36	39	52	107	145	140	90	54	57
46	49	49	66	75	55	107	127	157	116
62	59	53	55	72					

cnfoxX04

195	173	186	129	140	154	133	184	162	122
122	133	127	180	227	113	95	88	108	83
96	91	166	144	124	108	135	105	93	77
63	63	70	50	49	69	59	90	80	102
91	94	131	66	53	40	56	81	88	121
126	106	71	47	46	62	94	131	111	130
135	134	144	148	130	155	182	187	170	143
152	180	65	62	45					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