Oxford Dendrochronology Laboratory
Report 2016/29

PRELIMINARY DENDROCHRONOLOGICAL INVESTIGATIONS AT THE RED LION HOTEL, HIGH STREET COLCHESTER, ESSEX (TL 9968 2521)

Summary

A number of areas within this building were looked at and some areas were sampled – namely the front west corner, the rear west range and parts of the east range. One area with large timbers which was not sampled on this occasion was the bar area at first floor on the east range (for hotel operational reasons). Many of the timbers had rather short sequences and matching between timbers was poor. Two timbers from the front range (thought to be the third phase of construction) did however date, two corner posts of the front west room. One timber was felled in **winter 1475/76**, and a second with detached sapwood was probably felled at the same time, or within a very few years of this date. A post from the 'southern hall' in the rear of the west range matched a corner post at the rear of the east range. These were subsequently dated and have a very similar felling date, the 'southern hall' timber having a last measured ring of **1475**, and although this looked like the final ring on the timber itself, this was uncertain on the core. The implication of this is that the west range and front range are contemporaneous, but further samples are needed to confirm this.

Author: Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

September 2016

Preliminary Dendrochronological Investigations at the Red Lion Hotel, High Street, Colchester, Essex (TL 9968 2521)

BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies. These include chronologies made by colleagues in other countries, most notably areas such as modern Poland, which have proved to be the source of many boards used in the construction of doors and chests, and for oil paintings before the widespread use of canvas.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

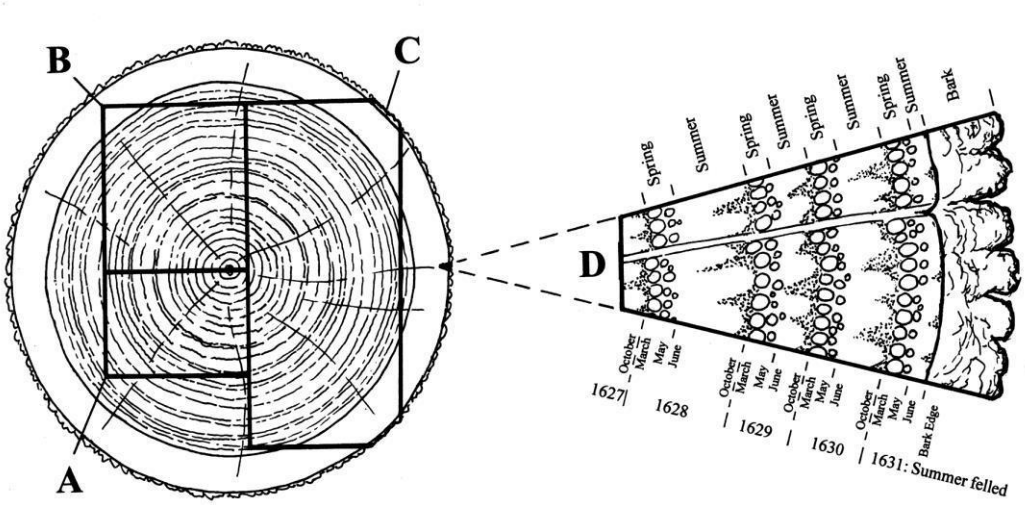
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value in oak studies. Higher values are usually found with matching pine sequences. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 9 – 41 (Miles 1997).



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997, 42)

The Red Lion Hotel (Notes from Dave Stenning 1994)

The building is complex and is well-described in Stenning 1994, which should be read in association with this report. In brief however, the first phase of what exists on the site today is the 'southern hall' which has a long axis approximately north-south. This has a crown-post roof with thin, flat braces. The main posts do not have jowls. RCHME considered this range to be later than the range to the north of it (unsampled as yet), but DFS argues that it is probably earlier. The frontage range has jowless posts and tension ('Colchester') bracing pegged to studs rather than principal posts. The elaborate front facing the road appears to have been built as shops at ground floor level.

SAMPLING

Samples were taken in August 2016. The locations of the samples are described in Table 1, with some being illustrated in Fig 1. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **rInc**) and were polished with progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples are given in Table 1. Many of the samples yielded rather short sequences and cross-matching between them was limited, with many not dating independently against the reference material either. Two pairs of samples did cross-match (Table 2) – samples **02** and **05** (from different parts of the building) and samples **31** and **32**. Each pair was combined to form a new series, and these were each subsequently dated (Tables 3a and 3b).

Samples **31** and **32** were from two diagonally opposite corner posts of the first-floor front west room. One retained complete sapwood and was from a tree felled in winter 1475/76, the other had complete sapwood but this became detached on coring. Although it was thought that no rings were lost, the felling range is given as 1475-77 to take account of the possibility that there was some small loss. This date was a little earlier than stylistic evidence suggested, and this phase was thought to be later than the rear ranges.

Sample **05** from a rear corner post of the east range did not retain sapwood, but did exhibit the heartwood-sapwood boundary, giving a likely felling date range of 1468–1500. The post from truss 2 of the rear west range (the 'southern hall' as Stenning describes it) looked to have complete sapwood, but the core taken had an outer surface that appeared to cut across the depth of the outer ring, giving the possibility that it was not actually the outer ring of the tree. A short range of 1475-77 is therefore given for the felling date to take account of this possibility.

This suggests that both the rear 'southern hall' and the front range are contemporaneous, or at least part of a continuous building programme (see Fig 2). This was something of a surprise result, but really needs further samples to confirm it – and it would be useful to also sample in the area to the north of the southern hall, which contained large timbers that looked to have more rings than many of the others, but which were not sampled on this occasion as the bar area was in use for much of the day. It is strongly recommended that more samples are sought to confirm the findings to date.

ACKNOWLEDGEMENTS

This study was commissioned by Colchester Borough Council as part of a wider census of historic buildings, and I am grateful to Dr Jess Tipper, for making arrangements, and to Dave Stenning for sharing his great knowledge of the building. The staff of The Red Lion Hotel are thanked for their co-operation in allowing sampling to take place. I thank my fellow dendrochronologists for permission to use their data.

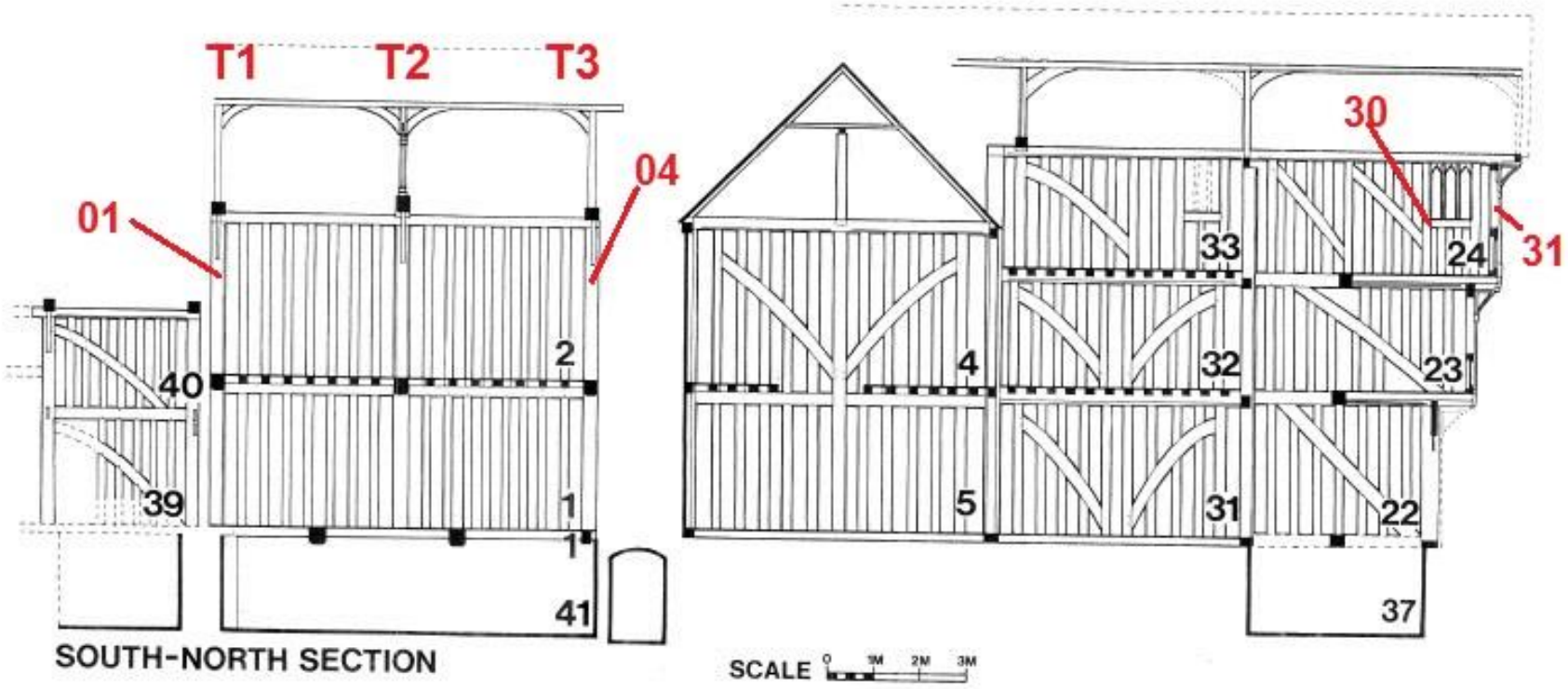


Figure 1: Cross-section of west and front ranges showing the west wall and some of the timbers sampled (adapted from original in Stenning 1994)

Table 1: Details of samples taken from the cellars, The Red Lion Hotel, Colchester.

Sample number	Timber and position	Date of series	H/S boundary date	Sapwood complement	No of rings	Mean width (mm)	Std devn (mm)	Mean sens	Felling date range
West range 'southern hall' at first floor level									
rlnc01	South-west corner post, truss 1	-	-	H/S	48	3.09	1.64	0.19	-
rlnc02	Post in west wall, truss 2	1413–1475	1458	17 nrC?	63	2.29	0.94	0.17	1475–77
rlnc03	Post in east wall, truss 2	-	-	2	41	3.74	1.08	0.17	-
rlnc04	North-west corner post, truss 3	-	-	19C	78	1.72	0.96	0.18	-
East range, first floor level									
rlnc05	South-west corner post at rear	1412–1459	1459	H/S	48	2.86	0.95	0.18	1468–1500
rlnc06	South-west corner to wider section	-	-	9	95	1.22	0.43	0.16	-
rlnc07	North-east corner post to 2nd room from south	-	-	?H/S	54	2.79	1.27	0.26	-
West range second floor level									
rlnc08	Front corner of rear range? outside Rm 7	-	-	22C	66	1.27	0.40	0.19	-
Front range facing High Street at first floor level									
rlnc30	West wall, inner window jamb	-	-	H/S	<40	NM	-	-	-
rlnc31	North-west corner post	1299–1475		13C	177	1.11	0.25	0.17	Winter 1475/76
rlnc32	South-east corner post to west room	1392–1458		H/S +17NM?C	67	1.82	0.44	0.21	1475–80
rlnc33	Central south post to mid-truss, west room	-	-	5	<40	NM	-	-	-
Site sequence **rlnc3132** (mean of **31** and **32**)		**1299–1475**			**177**	**1.23**	**0.34**	**0.18**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood present, felled the following winter; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured.

Table 2: Cross-matching between the dated samples
(*t*-values above 3.5 are significant)

	t-value		
Sample	**rlnc05**	**rlnc31**	**rlnc32**
rlnc02	6.2	4.0	2.6
rlnc05		4.2	3.9
rlnc31			6.3

Table 3a: Dating evidence for the site series **rlnc0502** **AD 1412–1475** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
Kent	Kent Master Chronology	(Laxton and Litton 1989)	**KENT88**	1158–1540	64	4.7
East Anglia	East Anglia Master Chronology	(Bridge 2003)	**ANGLIA03**	944–1789	64	3.4
Site Chronologies						
Suffolk	St Andrew's Church, Cotton	(Arnold and Howard 2012)	COTASQ01	1375–1461	50	6.5
Shropshire	St Winifred's Well, Woolston	(Haddon-Reece and Miles 1992)	WINIFRED	1301–1473	62	5.9
Suffolk	Panelling, Otley Hall	(Tyers 2000)	OTLEY_EN	1380–1555	64	5.6
Berkshire	6 Canon's Cloisters, Windsor Castle	(Miles and Bridge 2012)	WINDSOR6	1391–1479	64	4.9
West Sussex	Jarvis, Steyning	(Miles *et al* 2007)	JARVIS1	1384–1514	64	4.8
Kent	Archbishop's Palace, Charing	(Howard *et al* 1998)	CHARING1	1280–1481	64	4.4
Essex	Coggeshall Abbey	(Arnold and Howard 2015)	COGASQ02	1372–1567	64	4.3
Essex	Hill Hall, Theydon Mount	(Bridge 1999)	HILLHAL1	1425–1564	51	4.1

Table 3b: Dating evidence for the site series **rlnc3132** **AD 1299–1475** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
East Anglia	East Anglia Master Chronology	(Bridge 2003)	**ANGLIA03**	944–1789	177	8.8
London	London Master Chronology	(Tyers pers comm)	**LONDON**	413–1728	177	7.9
Southern England	Southern England Master	(Bridge 1988)	**SENGLAND**	1083–1589	177	7.1
Site Chronologies						
London	White Tower, Tower of London	(Miles 2007)	**WHTOWR5**	1260–1489	177	7.7
Kent	Walmer Castle, Deal	(Arnold and Howard 2014)	WLMCSQ01	1396–1523	80	7.5
Essex	Falconer's Hall, Good Easter	(Bridge 1996)	FALCONER	1324–1457	134	7.5
Hampshire	Tudor House, Southampton	(Miles *et al* 2009)	TUDORHS4	1289–1463	165	7.5
Essex	Stow's Farm, Tillingham	(Miles and Bridge 2014)	STOWSFM	1323–1471	149	7.3
Kent	Cobham Hall	(Arnold *et al* 2003)	COBHSQ01	1317–1662	159	6.9
Essex	Coggeshall Abbey	(Arnold and Howard 2015)	COGASQ02	1372–1567	104	6.8
Hampshire	Place House Cottage	(Miles and Worthington 1999)	PLACEHS	1311–1447	137	6.7

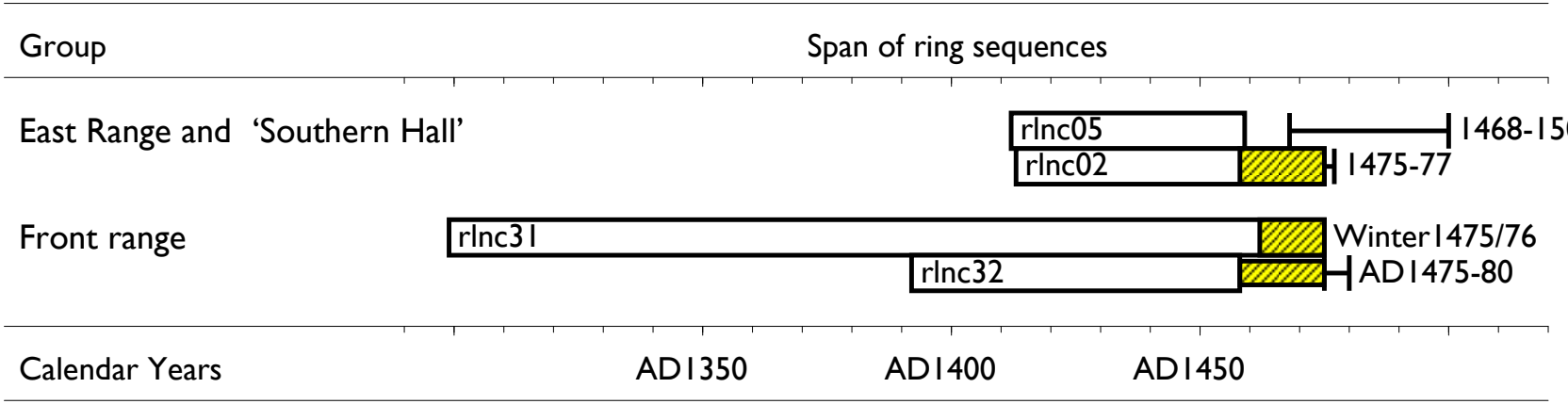


Figure 2: Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges.
White sections represent heartwood rings and yellow hatched sections represent sapwood, with narrow sections of bar representing unmeasured rings.

REFERENCES

Arnold, A. J., Howard, R. E., Laxton, R. R. and Litton, C. D. (2003) *Tree-ring analysis of timbers from Cobham Hall, Cobham, Kent,* **Centre for Archaeology Rep**, 50/2003.

Arnold, A. and Howard, R. (2012) *Church of St Andrew Church Road Cotton Suffolk: Tree-ring analysis of timbers*, **EH Research Report Series**, 19-2012.

Arnold, A. J. and Howard, R. E. (2014) *Walmer Castle, Kingsdown Road, Deal, Kent: tree-ring analysis of oak and pine timbers*, **HE Res Rep Ser**, 40-2014.

Arnold, A. J. and Howard, R. E. (2015) *The Abbot's Lodging and Corridor, Coggeshall Abbey, Essex: tree-ring analysis of timbers*, **HE Res Rep Ser**, 27-2015.

Baillie, M.G.L. and Pilcher, J.R. (1973) *A simple cross-dating program for tree-ring research.* **Tree Ring Bulletin**, 33, 7-14.

Bridge, M. C. (1988) *The dendrochronological dating of buildings in southern England*, **Medieval Archaeology**, 32, 166-174.

Bridge, M. C. (1996) List 69 - Tree-ring dates, **Vernacular Architecture**, 27, 91-92.

Bridge, M. C. (1999) *Tree ring analysis of timbers from Hill Hall, Theydon Mount, Essex*, **Anc Mon Lab Rep**, 55/1999.

Bridge, M. C. (2003) Compilation of master chronologies from East Anglia, unpublished computer file ANGLIA03, University College London Dendrochronology Laboratory.

English Heritage (1998) *Guidelines on producing and interpreting dendrochronological dates,* **English Heritage, London.**

Haddon-Reece, D, and Miles, D H, 1992 List 43 - Tree-ring dates, **Vernacular Architecture**, 23, 48-51.

Howard, R., Laxton, R. R. and Litton, C. D. (1998) *Tree-ring analysis of timbers from the Archbishop's Palace, Charing, Kent*, **Anc Mon Lab Rep**, 45/98.

Laxton, R. R. and Litton, C. D. (1989) *Construction of a Kent master chronological sequence for oak, 1158–1540 AD*, **Medieval Archaeology**, 33, 90–98.

Miles, D. (1997) *The interpretation, presentation, and use of tree-ring dates*, **Vernacular Architecture**, 28, 40-56.

Miles, D. (2007) *The Tree-Ring dating of the White Tower, HM Tower of London (TOL99 and TOL100), London Borough of Tower Hamlets*, **EH Research Dept Rep Ser**, 35/2007.

Miles, D. H. and Worthington, M. J. (1999) Tree-ring dates, **Vernacular Architecture**, 30, 98-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2007) Tree-ring dates, **Vernacular Architecture**, 38, 120-139.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2009) Tree-ring dates, **Vernacular Architecture**, 40, 122-128.

Miles, D. H. and Bridge, M. C. (2012) Tree-ring dates, **Vernacular Architecture**, 43, 97-103.

Miles, D. H. and Bridge, M. C. (2014) Tree Ring Dating Lists, **Vernacular Architecture**, 45, 115-119.

Stenning , D.F. (1994) *The Red Lion, Colchester,* **Essex Archaeology and History,** 25, 134-159.

Tyers, I, (2000) *Tree-ring analysis of panelling from Otley Hall, Otley, Suffolk*, **ARCUS Rep**, 550.

Tyers, I. (2004) *Dendro for Windows Program Guide 3rd edn*, **ARCUS Report,** 500b**.**