TREE-RING ANALYSIS OF A BRANCH FROM THE ANKERWYKE YEW

SUMMARY

A section taken from a branch lying next to the Ankerwyke yew, (*Taxus baccata* L.) has been measured to contain 317 rings. The branch probably started growing before 1673. However, reference chronologies only precisely confirm the ring sequence between 1747 and 1989. The branch fell or was felled in the winter of 1989/90. The start of a *c*.50 year period of reduced growth coincides with historical evidence of damage suggesting that a portion of the tree broke away in the winter storms of 1886/7 or 1890/91. The branch provides a tree-ring sequence longer than has previously been recovered by coring the trunks of large girthed hollow yew trees, highlighting this methods potential to refine the age estimate of historic yew trees.

INTRODUCTION

English yew (*Taxus baccata* L.) is generally acknowledged as the British tree capable of longest life. Many of the largest specimens are found in the churchyards of England and Wales and could well be over 1,000 years old, but supporting dendrochronological evidence is currently scant. The hollowing characteristic of yew trees over about 4.6m girth (Mitchell 1972) making their dating difficult by totally empirical means.

The Ankerwyke yew (NRG: TQ 004 727) grows in the rich floodplain of the Thames near Wraysbury, Buckinghamshire. The site is liable to flooding, and once thought to be an island. The general area is loam with a gravel subsoil. The tree lies just north of the ruins of the Ankerwyke Priory, which was probably founded after 1160, by Gilbert de Muntfichet, Lord of Wraysbury, during the reign of Henry II. However, it has been suggested that the priory was built on the site of an earlier hermitage. The tree is within sight of Runnymede, where King John sealed the Magna Carta in 1215. Henry VIII is also said to have met Anne Boleyn under the tree in the 1530s.

A large branch has been lying next to the Ankerwyke yew since before 1995 (Robert Bevan-Jones per comm.). The branch was recognised to present an opportunity to gain tree-ring information without the need for core sampling the live tree itself. The aim was to establish whether tree-ring analysis could be successfully applied to the branch to establish its age and identify the patterns of growth.

METHODOLOGY

The measuring of sections, as opposed to core sampling is preferable to reduce potential difficulties caused by narrow rings and lobate growth, which can lead to missing rings in yew (Moir 1999). The tree-ring sequences were revealed by the use of a belt sander, using progressively finer grits, to a 600 abrasive grit finish, which produces a result normally suitable for measuring. Further preparation if required being performed by hand. The tree-rings were measured under a x20 stereo microscope to an accuracy of 0.01mm using a microcomputer based travelling stage. Statistical cross-correlation algorithms were employed to search for the positions where tree-ring sequences correlated. The search produces "*t*-values", and the higher this value then the more certain the correlation. Those *t*-values in excess of 3.5 are taken to be significant and indicative of acceptably matching positions, this value happening by chance about once in every 1000 mismatches (Baillie 1982). Visual comparisons of sequences are also employed to support or reject possible cross-matches between tree-ring sequences and serve as a means of identifying measuring errors. Tree-ring analysis and graphics were achieved via a dendrochronological programme suite (Tyers 1999).

RESULTS

The Ankerwyke yew has a very bulbous trunk, and its girth increases from 8.55m at a height of 0.5m to 9.53m at a height of 1m. Strip bark developed through partial cambial dieback was observed on parts the tree that appeared to correspond to where larger branches had been removed. The branch lying next to the tree was measured to have a girth of 1.42m. The centre of the branch had started to rot. Nevertheless, a full section of the branch was sawn from one end. The section was measured along two slightly different radii and the sequences named RUAK01A and RUAK01B (**Photo 1**). These sequences were found to cross-match with a *t*-value of 10.27, and were combined to form a 317-year mean sequence called RUAK01 spanning 1673 to 1989.

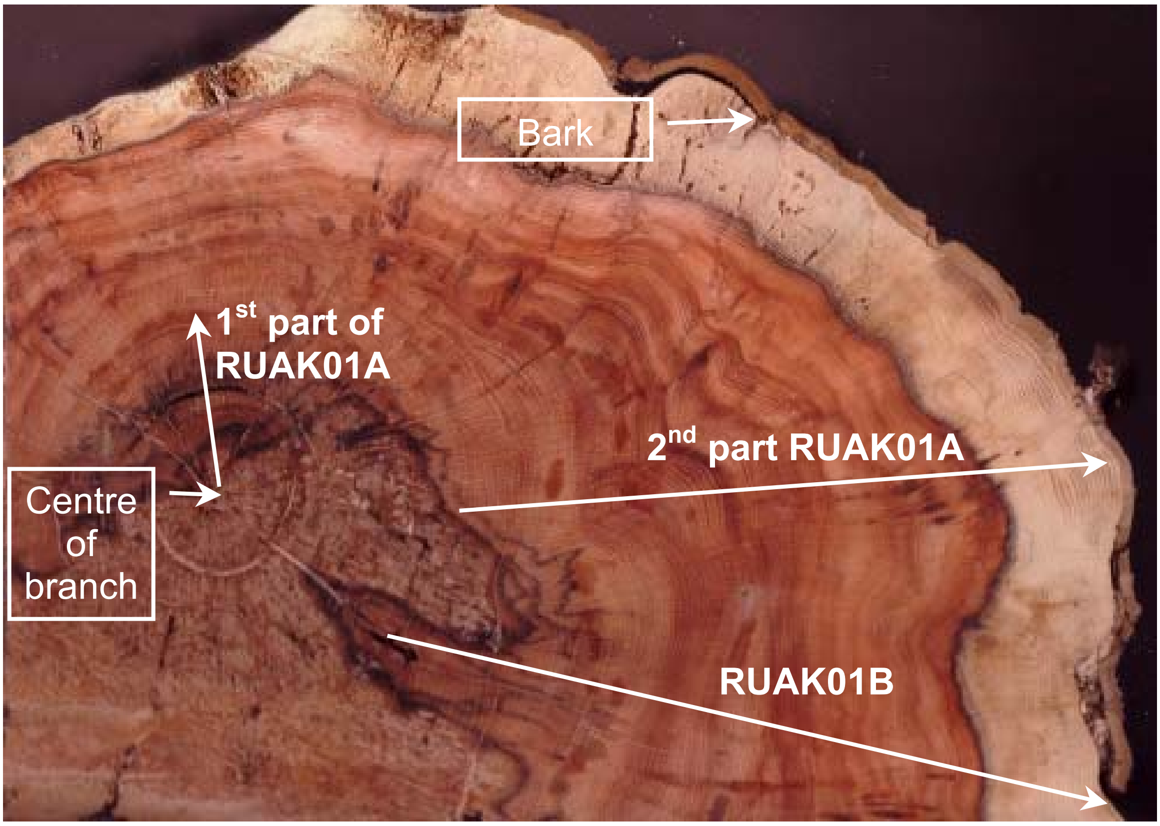

Photo 1: Tree-rings revealed through the sanding of section RUAK01 (arrows indicate approximate routes of the measured sequences)

A number of yew chronologies have previously been established within 50 km (30 miles) of the Ankerwyke yew, and high cross-matching values against these reference chronologies over the periods of overlap (**Table 1**) provide good evidence for the annual resolution of the sequence.

Table 1: Cross-matching of sequences RUAK01 and RUAK1-ED against independent yew reference chronologies.

			RUAK01		RUAK1-ED		
File	Start Date	End Date	*t*-value	Overlap (yr.)	*t*-value	Overlap (yr.)	Reference chronology
HPYEW92	AD1690	AD1992	5.47	300	8.04	243	HAMPTON COURT PALACE - G.LONDON (Moir 1999)
HVYEW00	AD1789	AD2000	-	201	4.52	201	HVYEW00 - COULSDON - G.LONDON (North 2000)
KESTON1	AD1831	AD1993	5.29	159	5.34	159	KESTON1- KENT {Author, unpublished)
UKYEW10	AD1690	AD2003	4.93	300	8.00	243	UK YEW MEAN (Author, unpublished}
CAPELYEW	AD1865	AD2002	4.94	125	5.00	125	CHURCHYARD - CAPEL - SURREY (Moir 2003b)
DUXFDYEW	AD1849	AD2003	6.31	141	6.38	141	DUNSFOLD YEW - SURREY (Moir 2004c)
GUPY1	AD1795	AD2003	5.33	195	5.40	195	PEWLEY - GUILDFORD - SURREY (Moir 2004b)
NOPK05	AD1824	AD1987	5.47	164	5.54	164	NORBURY PARK - MICKLEHAM - SURREY (Moir 2004d)
THOR-YEW	AD1879	AD2002	5.34	111	5.40	111	THORLEY - HERTFORDSHIRE (Moir 2003a)

NOTE: All the yew chronologies listed are components of the UKYEW10 mean chronology.

However, few of the current yew reference chronologies extend sufficiently into the past to cross-match against the earliest part of the RUAK01 sequence. Only the Hampton Court chronology (a component of the UKYEW10 mean chronology) extends back beyond 1789. While the Hampton Court reference chronology is reasonably well replicated after 1710, the trees were planted around 1700, and their early growth was variable and contained narrow rings.

The earliest 74 years of sequence RUAK01 contains a number of exceptionally narrow rings (**Figure 1**), and it was thought possible that this section contains missing rings. Due to the difficulty in comparing the earliest part of the Ankerwyke sequence with certainty, a slightly shorter sequence RUAK1-ED was edited, which is 243-years long and dated to span AD 1747 to AD 1989. The annual resolution of the sequence RUAK1-ED could be confirmed, and this sequences is therefore suitable for use in subsequent dating and as a reference chronology.

INTERPRETATION AND DISCUSSION

Under the microscope, bark occurs just after the full development of the outermost ring in AD 1989, establishing that the branch fell or was felled in the winter of AD 1989/90. The durability and high resistance to decay often attributed to the outer wood of yew is demonstrated by the branch being suitable for dendrochronological analysis, despite having been exposed to the elements for 15 years.

Sequences RUAK01 and UKYEW10 are plotted together in **Figure 1** to reveal the abnormalities between the sequences, and also to visually confirm their cross-matching. The branch has a mean growth rate of 0.73mm/yr. A histogram of mean decadal growth rate (**Figure 2**) identifies that with the exception of the 1720's the narrowest decade of growth occurs in the 1890's. The period of low growth begins in 1887 when the narrowest ring for *c*. 120 years of the tree's growth occurs. A succession of extremely narrow rings in 1887, 1890/91 and 1893 coincide respectively with a severe drought (Brooks 1950), a long winter (Brooks 1950) and a drought (Moss and Simons 1992). An image of the Ankerwyke yew by Strutt in (1822), shows the tree in good form, while Lowe in (1897) recorded the base as "a good deal broken away". *The Illustrated London News* for January 8th, 1887 records snowdrifts and the effects of a recent winter storm, which damaged trees in Kensington Gardens. While, March 9-13th 1891 saw strong easterly winds flatten over half a million trees, and 3.5m snowdrifts were recorded at Dulwich (Eden 1995).

Together the evidence appears consistent with a portion of the Ankerwyke yew breaking away probably in the winter of 1886/7 or of 1890/91. Thereafter the branch demonstrates a much-reduced growth rate (0.49 mm/yr), until a sustained recovery from 1935. Between 1935 and 1989 a steady increase in radial growth rate indicates that the branch had largely recovered from the damage probably inflicted on the tree around *c*. 1890.

Core samples of the trunks of large hollow yew trees over 5m girth have previously been taken to refine their age estimates, however this method has not been known to recover more than *c.* 190 rings (**Table 2**). The recovery of 317 rings from the Ankerwyke yew branch is therefore unexpected, but demonstrates a possible method of obtaining long tree-ring sequences from yew, which could be especially useful because branches occasionally become available through tree surgery and windfall.
Unfortunately without additional core sampling of the trunk of the Ankerwyke yew it is not possible to apply the growth rate information obtained from the branch to the trunk. Furthermore, additional sampling of other yew trees which were observed in the near vicinity would be required to identify changes in growth rate which might be the result of changing of site factors.

Table 2: Maximum tree-rings sequences recovered from yew trees in the UK.

Dendrochronological analysis	**Girth (m)**	**Location / Sample**	**Rings recovered**	**Growth rate of sequence (mm/yr)**
Thorley, Hertfordshire (Moir 2003a)	5.18	Trunk / core	125	1.30
Capel, Surrey (Moir 2003b)	5.20	Trunk / core	189	2.57
Dunsfold, Surrey (Moir 2004c)	7.64	Trunk / core	95	1.74
Happy Valley, G. London (North 2000)	3.23	Trunk / core	212	1.61
Hampton Court, Surrey (Moir 1999)	2.23	Trunk / section	303	0.95
West Horsley, Surrey (Moir 2004a)	2.80	Trunk / section	312	1.50
Ankerwyke, Surrey (Moir 2005)	8.55	Branch / section	317	0.73

CONCLUSIONS

The section from the branch of the Ankerwyke yew contains 317 rings, demonstrating that the branch started growing before AD 1673. It is possible that the earliest part of the section contains some missing rings, but a sequence from 1747 to 1989 is dated with annual resolution. Bark identifies that the branch fell or was felled in the winter of 1989/90. A portion of the Ankerwyke yew is also thought to have broke away in the winter storms of 1886/7 or 1890/91, resulting in reduced growth until *c*.1935.

Although a full climatic analysis was beyond the scope of this study, the strong match between the Ankerwyke yew branch and the Hampton Court chronology suggests that the yews at both sites responded similarly to climate. Some of the narrowest rings of the branch appear to coincide with drought and severe winters consistent with the results of climate analysis that was undertaken on yew at Hampton Court (Moir 1999).

Future core sampling of the main trunk of the Ankerwyke yew is recommended to enable the long tree-ring sequence obtained from the branch to be correlated with the radial growth of the trunk, and thereby considerably refine the age estimate for this historically significant tree. Additional sampling should also identify the effect(s) that loss of the large branch in 1989 had on the tree.

ACKNOWLEDGEMENTS

I would like to thank the National Trust for granting permission to take a section of the branch, and Colin Bayes (the site warden), for his help during sampling. I am grateful to Robert Bevan-Jones for commissioning this analysis, and to The Conservation Foundation for funding.

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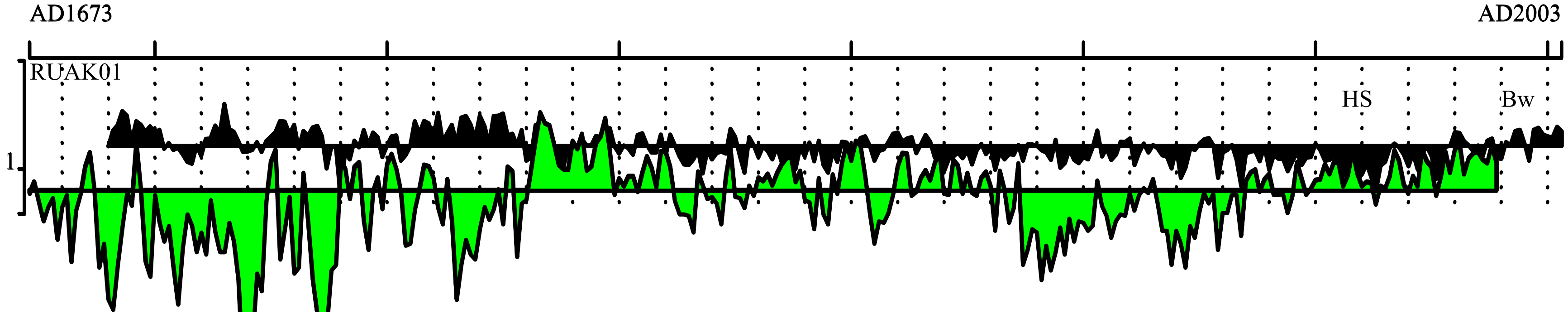
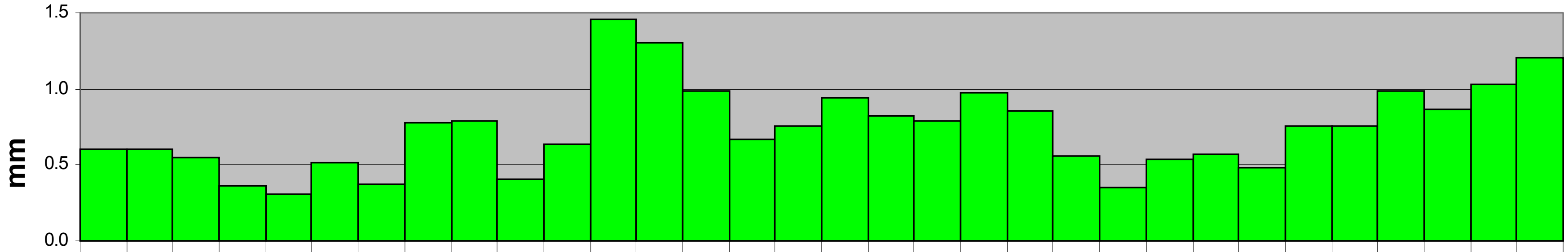
Tree-ring analysis of a branch from the Ankerwyke Yew

Figure 1: Plots of the tree-ring sequences UKYEW10 (top) and RUAK01 (bottom).



Note: The ring width (mm) is plotted on a (y axis) logarithmic scale, using common axis for both samples. Two rings of less than 0.06 mm are lost off the bottom of this plot. HS = heartwood/sapwood boundary, Bw = winter bark.

Figure 2: Mean decadal radial growth



	1671	1681	1691	1701	1711	1721	1731	1741	1751	1761	1771	1781	1791	1801	1811	1821
RUAK01	0.60	0.60	0.55	0.36	0.30	0.51	0.37	0.78	0.79	0.41	0.63	1.46	1.30	0.98	0.67	0.75

	1831	1841	1851	1861	1871	1881	1891	1901	1911	1921	1931	1941	1951	1961	1971	1981
RUAK01	0.94	0.82	0.79	0.97	0.85	0.56	0.36	0.54	0.57	0.48	0.76	0.75	0.98	0.86	1.03	1.21

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