The Tree-Ring Dating of Old Hall Plas Pengwern FFESTINIOG, MERIONETH

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Summary

Plas Pengwern is a large, roughly H-plan stone-built house with a central hall set between wings, one medieval in origin. Twelve samples from the cross-range were sampled these gave a range of felling dates, spring 1478, winter 1478/9, and spring 1479. A sample from the south purlin dated to spring 1493 south this was a replacement inserted sometime after 1493.

No date could be found for any of the samples taken from the Hall-range. So the Hall-range remains undated. One sample from the kitchen was found to date and gave a felling date of after 1483.

Keywords

Dendrochronology
Standing Building

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THE TREE-RING DATING OF THE

Description of building

MERIONETH, FFESTINIOG, Plas Pengwern (Pengwern Old Hall) (SH 6993 4304)
Plas Pengwern is a large, roughly H-plan stone-built house with a central hall set between wings, one medieval in origin. Recent repairs to the upper wing have revealed that it retains a largely complete and partly smoke-blackened medieval roof of four bays with tenoned ridge and purlins and three tiers of cusped windbraces. The interpretation of the range is in progress, but it appears to have been an elaborate timber-framed cross-wing to a rebuilt hall. Tree-ring dating has given a precise felling-date for the trusses of the medieval wing as well as a complex series of dates for various phases of rebuilding and repair. Plan in Smith, *Houses of the Welsh Countryside*, fig. 146a, with additional survey notes in NMRW.

Objectives of dating

The objective of the project was to date as many building phase as possible and so aid in the understand the development of this building complex.

Commissioners

Dating commissioned by Gwilym Jones/Peter Crew for the Snowdonia National Park..

Assessment

The building was assessed and sampled during a period when the building was being extensively repaired which allowed access to large areas of the roof which otherwise would have been inaccessible. The main objective was to date the primary construction timbers from each building phase. The rafters on the front wing were either unsuitable for analysis, having less than fifty annual rings or had all been replaced. A number of tie-beams, cross-beams, and purlins were assessed as being suitable for sampling. From the hall range a tiebeam and a number of principal rafters were found to be suitable for sampling and analysis. The far wing had had extensive repairs and no samples were taken from this range. From the kitchen range a number of floor joists were assessed as being suitable for sampling.

Methodology

The samples were taken using a 16mm hollow auger powered by an electric drill. The samples were sanded on a linisher using 60 to 1000 grit abrasive paper. These were then measured to an accuracy of 0.01mm using a travelling stage attached to a microcomputer based measuring system (Reynolds pers comm 1998).

The samples were compared with each other using dendrochronological techniques as outlined in English Heritage (1998). This involved both visual comparisons using semi-logarithmic graphs as well as statistical cross-correlations using a computer. This utilised cross-correlation algorithms (Baillie and Pilcher 1973) which have been implemented using computer software written for Windows in Visual Basic by M R Allwright and P A Parker. In comparing two individual samples, a *t*-value of 3.5 or higher is usually indicative of a good match, whilst *t*-values of 10 and above often suggest that samples have originated from the same parent tree. All individual samples showing a match with consistently high correlation during cross-matching are averaged together to form a mean site master. On comparing this site master with dated reference chronologies, *t*-values of 5 and above are normally expected. A conclusive match should also exhibit the highest matches with reference chronologies of local origin as well as with well-replicated regional chronologies. Matching positions suggested by computer are confirmed by satisfactory visual matching.

Once a ring sequence has been dated chronologically, the date of felling needs to be interpreted. When the sapwood is complete on a sample, the determination of a felling date is relatively straight-forward. Each growth ring is comprised of one or more rows of open spring vessels, or early wood, followed by a band of dense summer growth or late-wood. During the winter months the tree remains dormant. If both the spring and summer growth are present and complete, then the tree would have been felled during the winter period. If only the spring vessels are present beneath the bark, then the tree can be said to have died or been felled during the spring period. If only a few vessels are present, then it is possible to further refine the time of felling to *early spring*. If some dense wood or summer growth is present, then a *summer or autumn* felling period can be determined. However, as it is not known how wide the summer growth band should be for that particular tree, it cannot be stated conclusively whether the tree was felled in early or late summer, or if indeed it was felled at some point in the winter. For instance, a severe May frost can suddenly halt their growth, which would produce a very narrow ring with little or no summer wood (Baillie 1982, plate 2c). Therefore, a certain degree of caution should be used in interpreting felling seasons between summer and autumn, or even winter seasons in some instances. Only apparently complete rings indicating felling during the winter months are measured, samples exhibiting spring or summer growth would give a felling date during the year following the last measured ring.

If the outer most rings are missing but the heartwood-sapwood boundary survives, then the number of missing sapwood rings can be estimated using an empirically derived sapwood estimate. The sapwood estimate used in this report is 11 to 41 rings, the 95% confidence range calculated by Miles (1997a) for Shropshire and the Welsh borders. Samples only having heartwood but without any indication of heartwood/sapwood transition are given a *terminus post quem* or felled after date which is calculated by adding a minimum of 11 years to the last ring present on the sample.

It should be remembered that dendrochronology can only date when the tree died, not the date of construction for a building or artefact. The interpretation of a felling date relies on having a good number of precise felling dates rather than just one or two. Nevertheless, it was common practice to build timber-framed structures with green or unseasoned timber and construction usually took place within twelve months of felling (Miles 1997a).

Sampling strategy

Following a preliminary assessment, twenty-seven samples were taken from oak (*Quercus* spp.) timbers having been identified as from the primary construction of the phases being studied. Details of the samples and their locations can be seen in Table 1 and Figs ***.

The sample were either taken using a 16mm hollow auger or sections of timber were cut from any timbers that had been removed from the building for replacement with new wood.

From the cross-wing eight cores were taken from *in situ* timbers and ten sections were taken from timber that had been removed from the roof during the repairs. From the hall-range four timbers were sampled using the 16mm augur and four timbers that had been removed from the building had 1" section removed from their ends. From the kitchen range only two timbers were suitable for sampling, these were from the floor joists, from these 1" sections were cut from their ends.

Of the twenty-seven samples taken, fourteen had complete sapwood, allowing precise date to be allocated to any dating samples. Nine had the heartwood/sapwood boundary present and would allow date ranges to be given to any dating sample. The remaining samples had only heartwood surviving, so only a *tpq* could be assigned to the sample.

Cross-matching and site chronology

Of the twenty-seven samples taken from the cross-wing, the hall-range and the kitchen, only thirteen were found to match together. These include from the cross-wing samples ***pgwff1*, *pgwff2*, *pgwff3*, *pgwff4*, *pgwff5*, *pgwff11*, *pgwff12*, *pgwffp6*, *pgwffp7*, *pgwffp8*, *pgwffm4***, and ***pgwffm6***. These were combined with ***pgwffk1*** from the kitchen range at the positions given in Table 2 to form the site master ***PENGWERN*** table 3. This 169-year chronology is well replicated.

Absolute dating

This new site master was then compared with over 1200 dated reference chronologies from the British Isles and was found to date strongly, spanning the years AD 1353-1521 (Table 4).

Undated samples

The fourteen undated samples were also compared with the site master, as well as individually with the dated reference chronologies, but failed to date consistently. This is primarily due to their having too few growth rings and some having distorted ring patterns.

Interpretation and discussion

Twelve samples from the cross-range dated, of these four retained complete sapwood giving felling dates of spring 1478 for the crossbeam Truss3, winter 1478/9 for the tiebeam of Truss 4, and spring 1479 for the tiebeam of Truss 3. The fourth gave a felling date of spring 1493 for the south purlin clearly showing that this is a replacement inserted sometime after 1493. All the other dated samples from this section of the building are consistent these dates. It has been shown that it is very common for timbers from one building to be felled over a few years (Miles 1997a).

Although eight samples were taken from the Hall-range, no date could be found for any of these samples so this section of the building has to remain undated.

Only one sample from the kitchen range was found to date and gave a felling date of after 1483.

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References

Baillie, M G L, 1982 *Tree-Ring Dating and Archaeology*, London

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

Baillie, M G L, and Pilcher, J R, 1982 unpubl *A Master tree-ring chronology for England*, unpubl computer file *ENGLAND*, Queens Univ, Belfast

Hillam, J, and Groves, C, 1994 *Compilation of master chronologies from the North*, unpubl computer file *NORTH*, Sheffield Dendrochronology Laboratory

English Heritage, 1998 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates*, London

Laxton, R R, and Litton, C D, 1988 *An East Midlands Master Tree-Ring Chronology and its use for dating Vernacular Buildings,* Univ Nottingham, Dept of Classical and Archaeol Studies, Monograph Ser, **3**

Leggett, P A, 1980 The use of tree-ring analysis in the absolute dating of historical sites and their use in the interpretation of past climatic trends, PhD Thesis CNAA (Liverpool Polytechnic)

Miles, D H, 1997a The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, **28**, 40-56

Miles, D H, 1997b *Working compilation of 58 reference chronologies centred around Wales by various researchers*, unpubl computer file *WALES97*, Oxford Dendrochronology Laboratory

Miles, D H, and Haddon-Reece, D, 1993 List 54 - Tree-ring dates, *Vernacular Architect*, **24**, 54-60

Miles, D H, and Haddon-Reece, D, 1995 List 64 - Tree-ring dates, *Vernacular Architect*, **26**, 60-74

Miles, D H, and Haddon-Reece, D 1996 List 72 - Tree-ring dates, *Vernacular Architect*, **27**, 97-102

Miles, D H, and Worthington, M J, 1999 Tree-ring dates, *Vernacular Architect* **30**, 98-113

Miles, D H, and Worthington, M J, 2000 Tree-ring dates, *Vernacular Architect* **31**, 90-113

Miles, D H, and Worthington, M J, 2002 Tree-ring dates, *Vernacular Architect* **33**, 81-102

Tyers, I, 1996 *The tree-ring analysis of six secular buildings from the city of Hereford*, Anc Mon Lab Rep, **17/96**

Tyers I, 1999 Dendrochronological *analysis of timbers from Apethorn Fold Farmhouse, Hyde, Tameside,* Anc Mon Lab Rep, **59/1999**

Tyers, I, 2000 *Dendrochronological analysis of timbers from Apple Tree Cottage, Elstead, Surrey*, ARCUS Rep, **561**

Tyers, I, 2000 *Tree-ring analysis of oak timbers from Arches Cottages, Sawley, Lancashire,* Anc Mon Lab Rep, **21/2000**

Table 1: Summary of tree-ring dating

PENGERN, WALES 11 - 41

Sample number & type		Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges (AD)
Cross-wing										
pgwff1a	c	Tiebeam T3	1379-1458	1458		80	1.73	1.07	0.220	
pgwff1b	c	Tiebeam T3	1389-1478	1457	21 1/4C	90	1.56	0.58	0.232	
****pgwff1***		Mean of 1a +1b	1379-1478	1457	21 1/4C	100	1.74	0.95	0.221	Spring AD 1479
pgwff2a	c	Front post T3	1409-1469	1464?	5	64	1.74	0.82	0.349	
pgwff2b	c	Front post T3	1385-1452			68	1.51	0.66	0.283	
****pgwff2***		mean of pgwff1a +b	1385-1469	1464?	5	85	1.74	0.79	0.298	AD 1475-1505
pgwff3a	c	Tiebeam T4	1370-1478	1457	21C	109	1.81	0.78	0.206	
pgwff3b	c	Tiebeam T4	1359-1449	h/w		91	1.79	0.55	0.233	
****pgwff3***		Mean of pgwff3a +3b	1359-1478	1457	21C	120	1.75	0.60	0.213	Winter AD 1478/9
pgwff4	c	South purlin T4-5	1437-1492	1473	19 1/4C	56	1.96	0.60	0.241	Spring AD 1493?
****pgwff5***	c	South post T2	1388-1460	1458	2	73	1.88	1.05	0.271	AD 1469 - 1499
****pgwffP6***	c	South upper purlin T1-2	1375-1458			84	1.10	0.59	0.266	After 1469
****pgwffP7***	c	South lower purlin T1-2	1353-1416		h/w only	64	1.65	0.89	0.221	After 1427
****pgwffP8***	c	South lower purlin T2-4	1382-1458	1452	6	77	1.49	0.75	0.286	AD 1463 - 93
Ground Floor										
pgwff11a1		Crossbeam T3	1365-1395	h/w		31	1.	0.94	0.24	
pgwff11a2		Crossbeam T3	1398-1477	1447	30 1/4C	80	1.	0.94	0.24	Spring AD 1478
pgwff11b		Crossbeam T3	1378-1467	1450	17	90	1.65	0.87	0.209	
****pgwff11***	c	Mean of pgwff11a1 +11a2+ 11b	1365-1477			113	1.59	0.78	0.226	Spring AD 1478
****pgwff12***	c	Crossbeam T4	1402-1506	1506		105	1.30	0.50	0.308	AD 1517 - 1547
pgwff13	c	Lintel								Unmeasured
Hall Range Roof										
pgwff21a1		Tiebeam north end	-			49	1.51	1.00	0.321	
pgwff21a2		Tiebeam north end	-		16C	32	1.05	0.39	0.295	
pgwff21b		Tiebeam north end	-		16C	32	1.10	0.39	0.288	

pgwff21	c	Mean of pgwff21a1+b			16C	32	1.08	0.38	0.289	
pgwff22	c	Principal rafter W side N truss			23	85	1.54	0.72	0.272	
pgwff23	c	Principal rafter E side Mid truss			24C	79	1.74	0.85	0.262	
pgwff24a	c	Principal rafter W side Mid Truss	-			62	1.80	0.70	0.171	
pgwff24b	c	Principal rafter W side Mid Truss	-		22C	76	1.56	0.62	0.234	
pgwff24		Mean of pgwff24a+b			22C	84	1.67	0.71	0.208	
Kitchen Range										
**pgwffk1*	s	Floor joist ex-situ	1397-1472			76	2.03	0.68	0.277	After 1483
pgwffk2	s	Floor joist ex-situ			22C	76	1.73	1.39	0.388	
Ex-situ timbers from Cross-wing										
pgwffm1a	s	Stud		h/w only		39	1.03	0.79	0.278	
pgwffm2a	s	Rafter				60	1.30	0.50	0.298	
pgwffm2b	s	Rafter				60	1.36	0.64	0.254	
pgwffm2	s	Mean of pgwffm2a + b	-			60	1.42	0.61	0.279	
pgwffm3	s	Purlin	-		17C	82	1.45	0.73	0.265	
pgwffm4a	s	Rafter	1363-1440		h/w only	78	0.95	0.62	0.299	
pgwffm4b	s	Rafter	1407-1465	1447	18	59	0.74	0.29	0.270	
**pgwffm4*		Mean of pgwffm4a + b	1363-1465	1447		103	0.91	0.55	0.284	AD 1465-1488
pgwffm5	s	rafter	-		28 1/4C	74	1.13	0.43	0.280	
**pgwffm6*	s	Purlin repair to cross-wing	1386-1521	1515	6	136	1.66	0.89	0.305	AD 1526-1556
Ex-situ timbers from Hall Range										
pgwffn1	s	Hall rafter ex-situ	-		1	45	1.29	0.58	0.223	
pgwffn2	s	Purlin	-		21 1/4C	64	1.28	0.32	0.191	
pgwffn3	s	Purlin	-		21 1/4C	82	1.44	0.73	0.270	
pgwffn4	s	Purlin	-		17 1/4C	94	1.56	1.17	0.266	
*** = *PENGWERN* Site Master**			**1353-1521**			**169**	**1.62**	**0.63**	**0.218**	

Key: * = sample included in site-master; c = core; ⊚ = pith included in sample; ¼C,½C,C = bark edge present, partial or complete ring: ¼C = spring (ring not measured), ½C = summer/autumn (ring not measured), or C = winter felling (ring measured); H/S bdry = heartwood/sapwood boundary - last heartwood ring date Hw only = heartwood only; std devn = standard deviation; mean sens = mean sensitivity, Sapwood estimate used 9 -41 sapwood rings

Table 2: Matrix of *t*-values and overlaps for components of ***PENGWERN***

	PGWff1 1379-1478	PGWff11 1365-1477	PGWff2 1385-1469	PGWff3 1359-1478	PGWFF12 1402-1506	PGWFF4 1437-1492	PGWFF5 1388-1460	PGWFFM6 1386-1521	PGWFFP6 1375-1458	PGWFFP7 1353-1416	PGWFFP8 1382-1458	PGWM4 1363-1465
pgwffk1 1397-1472	4.65 76	4.21 76	3.37 73	5.2 76	5.74 71	3.66 36	3.92 64	5.63 76	1.43 62	1.23 20	1.92 62	2.39 69
pgwff1 1379-1478		5.2 99	4.38 85	9.22 100	4.75 77	3.29 42	3.6 73	5.51 93	3.32 80	2.92 38	6.88 77	5.27 87
pgwff11 1365-1477			4.83 85	5.55 113	3.77 76	0.62 41	3.46 73	2.9 92	4.01 84	3.15 52	5.06 77	5.55 101
pgwff2 1385-1469				6.94 85	4.81 68	3.29 33	5 73	4.25 84	4.83 74	3.58 32	6.98 74	5.44 81
pgwff3 1359-1478					5.82 77	2.4 42	5.92 73	5.15 93	4.79 84	4.94 58	7.98 77	6.58 103
PGWFF12 1402-1506						4.53 56	4.73 59	6.68 105	2.68 57	0.43 15	4.81 57	5.81 64
PGWFF4 1437-1492							1.67 24	6.38 56	1.54 22	No Test	1.99 22	3.95 29
PGWFF5 1388-1460								2.4 73	4.8 71	1.74 29	5.03 71	4.81 73
PGWFFM6 1386-1521									1.58 73	0.64 31	2.92 73	2.95 80
PGWFFP6 1375-1458										6.25 42	4.77 77	5.05 84
PGWFFP7 1353-1416											4.51 35	4.32 54
PGWFFP8 1382-1458												7.74 77

Table 3: Ring-width data for site master curve ***PENGWERN*** AD 1353-1521, Plas Pengwern, (Pengwern Old Hall) FFESTINIOG, MERIONETH Wales - mean of samples ***pgwff1 + pgwff2 + pgwff3 + pqwff4 + pgwff5 + pgwff11 + ppwff12+ pgwffk1 + pgwffm4 + pgwffm6 + pgwffp6 + pgwffp7 +pgwffp8***
169 rings, starting date AD 1353

ring widths (0.01mm)

358	338	320	325	306	325	240	216	298	208
238	209	176	199	235	196	252	217	203	208
212	176	166	095	131	181	290	256	245	224
264	262	291	248	188	211	199	182	137	110
104	118	135	171	185	189	157	191	168	214
260	228	233	221	175	181	197	173	100	130
133	086	109	099	175	182	103	192	168	177
212	186	118	096	081	106	113	137	158	184
170	177	140	116	124	111	085	076	104	133
172	145	135	088	103	109	131	104	102	143
141	108	095	120	118	117	118	179	186	153
200	136	144	210	251	236	153	100	123	117
162	204	255	238	160	157	114	096	115	056
116	167	215	196	243	138	118	189	134	092
068	104	184	252	160	174	120	089	118	170
173	201	134	172	048	066	084	083	113	097
119	119	103	134	116	163	136	093	118	

number of samples in master

1	1	1	1	1	1	2	2	2	2
3	3	4	4	4	4	4	4	4	4
4	4	5	5	5	5	6	6	6	7
7	7	8	9	9	10	10	10	10	10
10	10	10	10	11	11	11	11	11	12
12	12	12	12	12	12	12	12	12	12
12	12	12	12	11	11	11	11	11	11
11	11	11	11	11	11	11	11	11	11
11	11	11	11	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12
12	12	12	12	12	12	10	10	9	9
9	9	9	8	8	8	8	7	7	7
6	6	6	6	6	5	3	3	3	3
3	3	3	3	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2
2	2	2	2	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	

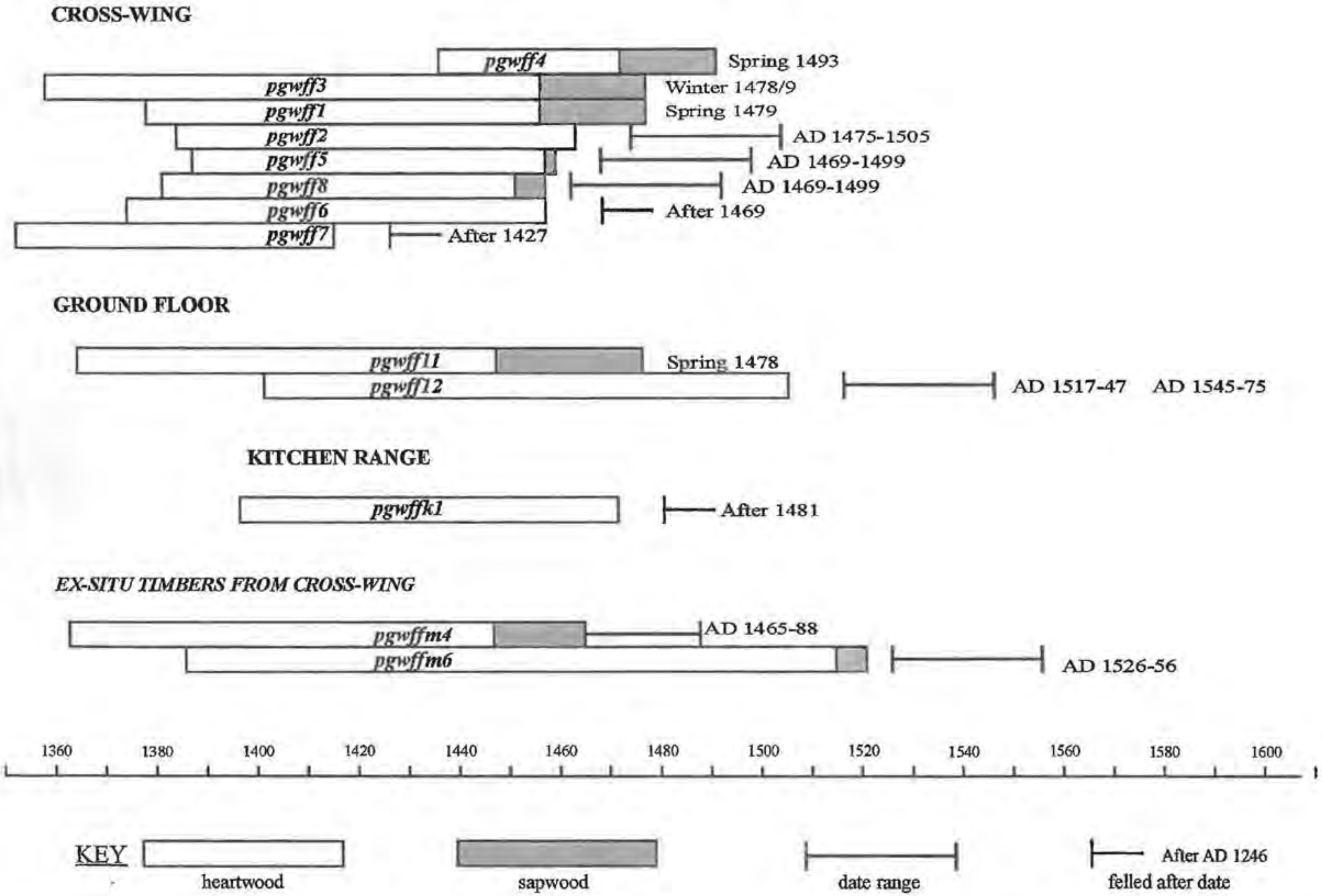
Table 4: Dating of ***PENGWERN*** against reference chronologies at AD 1521.

	Reference chronology	Spanning	Overlap	t-value
♣	LLANSHAY *(Miles and Haddon-Reece 1996)*	1319-1432	80	5.11
	BROOKGT *(Miles and Haddon-Reece 1993)*	1362-1611	160	5.14
	PLASMWR1 *(Miles and Haddon-Reece 1996)*	1428-1556	94	5.20
	TANHOUSE *(Miles and Worthington 1999)*	1338-1435	83	5.23
	CLIVEHS *(Miles and Worthington 2002)*	1385-1590	137	5.25
	SARUMBP6 *(Miles and Worthington 2000)*	1450-1569	72	5.28
	APETHORN *(Tyers 1999)*	1379-1512	134	5.41
	NORTH *(Hillam and Groves 1994)*	440-1742	169	5.63
	BEDSTONE *(Miles and Haddon-Reece 1995)*	1341-1560	169	5.61
	ELSTEAD *(Tyers 2000)*	1396-1591	126	5.60
	SAWLEY *(Tyers2000)*	1433-1506	74	5.60
	EASTMID *(Laxton and Litton 1988)*	882-1981	169	5.71
	ARDEN2 *(Miles and Worthington 2000)*	1371-1568	169	5.75
♣	**ENGLAND** *(Baillie and Pilcher 1982)*	404-1981	169	5.75
♣	nan8 *(Miles and Haddon-Reece 1996)*	1313-1524	169	5.81
♣	HEREFC *(Tyers 1996)*	1313-1640	169	5.84
	STUBLEY	1382-1490	109	5.96
♣	PENIARTH *(Miles and Haddon-Reece 1996)*	1385-1550	137	5.97
	CLAYTON *(Leggett 1980)*	1471-1580	51	6.46
	OLDWORD2	1415-1531	107	6.59
	WALES97 *(Miles 1997b)*	404-1981	169	6.51

♣ Component of WALES97

Chronologies shown in **bold** are composite chronologies

Figure 1: Bar diagram showing relative positions of dated samples



CROSS-WING
pgwff4
Spring 1493
pgwff3
Winter 1478/9
pgwff1
Spring 1479
pgwff2
AD 1475-1505
pgwff5
AD 1469-1499
pgwff8
AD 1469-1499
pgwff6
After 1469
pgwff7
After 1427
GROUND FLOOR
pgwff11
Spring 1478
pgwff12
AD 1517-47
AD 1545-75
KITCHEN RANGE
pgwffk1
After 1481
EX-SITU TIMBERS FROM CROSS-WING
pgwffm4
AD 1465-88
pgwffm6
AD 1526-56
1360
1380
1400
1420
1440
1460
1480
1500
1520
1540
1560
1580
1600
KEY
heartwood
sapwood
date range
After AD 1246
felled after date