Native Tree-ring Chronologies from some Scottish Medieval Burghs

By ANNE CRONE

VERY little site-oriented dendrochronology has been undertaken in Scotland, possibly because of the absence of a locally based dendrochronological facility until recently. However, timbers found during the excavations of several medieval burghs in the late 1970s and 1980s were saved for future analysis and had been stored in museums around the country. During a project to locate suitable samples for a Scottish tree-ring database the potential of these assemblages was recognised.[1] *Although relatively small assemblages, their analysis has expanded and strengthened the tree-ring database within Scotland, thus facilitating future work. Evidence for synchronous development in the early burghs in the late 12th century and the nature of the woodland resource at times during the medieval period is presented. An 'event horizon' in the early 10th century, signalled by the birthdates of many of the dated timbers, has been recognised and possible causes are discussed. The projects reported on here were all funded by Historic Scotland.*

Until recently, the only medieval chronologies for Scotland were those used to build the SCOTLAND chronology which covers the period from A.D. 946 to the present day.[2] As well as very old living oaks from Cadzow and Lockwood, this master chronology includes structural material from Glasgow Cathedral, Caerlaverock Castle, Dumfriesshire, Lincluden College, Dumfries and the towerhouse at Castle of Park, Dumfriesshire, thus providing good coverage for south and central Scotland. An independent chronology using timbers retrieved from the excavations in the High Street, Perth, was also constructed and cross-matched with SCOTLAND, extending the scope of the chronology further north.[3]

As a result of more recent work, coverage is beginning to extend into the north and east of the country with native Scottish chronologies from Stirling

[1] B. A. Crone and C. M. Mills, A Tree-Ring Database for Scotland progress report: November 1992 (unpubl. report for Society of Antiquaries of Scotland); B. A. Crone and C. M. Mills, A Tree-Ring Database for Scotland progress report: November 1993 (unpubl. report for Society of Antiquaries of Scotland); B. A. Crone and C. M. Mills, A Tree-Ring Database for Scotland progress report: November 1994 (unpubl. report for Society of Antiquaries of Scotland).

[2] M. G. L. Baillie, 'An oak chronology for south central Scotland', *Tree-Ring Bull.* 37 (1977), 33–44.

[3] Ibid.; M. G. L. Baillie, 'The dendrochronology', in N. Bogdan, *Perth High Street excavations 1975–78* (forthcoming, Edinburgh).

Castle, Spynie Palace, Darnaway Castle and St Andrews.[4] Analysis of other assemblages is also beginning to indicate the extent to which imported timber was used in Scotland. Swedish/Danish timber was used in Stirling Castle, Midhope Castle, Midlothian, and the Old Students' Union, St Andrews, while timber used in Queen Mary's House, St Andrews, appears to have come from further east in the Baltic.[5] In the case of a barrel from the Gallowgate, Aberdeen, the tree-ring sequence correlated so strongly with northern Polish chronologies as to make the identification of a source in that country irrefutable.[6] The increasing number of chronologies also facilitates the sourcing of native material and thereby the movement of timber within Scotland. For instance, very high correlations between the chronology from the Chapel Royal, Stirling Castle and those from Darnaway Castle and Spynie Palace, both in Moray, suggest that timber from that part of north-eastern Scotland may have been used at Stirling.[7]

With the exception of Perth High Street and St Andrews, all the work described above has been done on high-status, non-urban sites. Material suitable for dendrochronological analysis has survived from excavations in Inverness, Aberdeen, Glasgow and Elgin.[8] Additional material was also available from Perth High Street to examine the earliest phases on the site. Analysis of these urban assemblages would, therefore, redress that imbalance and provide an opportunity to address some of the issues identified recently as a high priority in the research agenda for the Scottish medieval burghs, namely the provision of a chronological framework and evidence for trade.[9]

INVERNESS

THE ASSEMBLAGE

Samples of seven oak (*Quercus* sp.) timbers from Castle Street, Inverness were recovered during the excavation of the site in 1979.[10] Five were radially split planks, several of which were tapered to a blunt end which was compressed as though from insertion into a hard matrix. These were identified as the *in situ* stave walling, Context 200, in Phase 2, dated to the late 13th century/early 14th century on pottery evidence. I901 was one of a series of stakes, Context 405, used to retain a

[4] B. A. Crone and R. Fawcett, 'Dendrochronology, documents and the timber trade; new evidence for the building history of Stirling Castle, Scotland', *Medieval Archaeol.*, XLII (1998), 68–87; C. M. Mills, 'Dendrochronology of timbers from Spynie Palace', in J. Lewis, *Excavations at the Episcopal Palace of Spynie, Moray* (forthcoming, Edinburgh); G. Stell and M. Baillie, 'The Great Hall and roof of Darnaway Castle, Moray, 162–86, in W. D. H. Sellar, (ed.), *Moray: province and people* (Edinburgh, 1993); C. M. Mills, 'Dendrochronology of oak timbers from historic buildings in St Andrews, Fife', *Tayside Fife Archaeol. J.* (forthcoming).

[5] Crone and Fawcett, op. cit. in note 4; C. M. Mills and B. A. Crone, 'Tree-ring evidence for the historic timber trade and woodland exploitation in Scotland', 46–55 in V. Stravinskienė and R. Juknys (eds.), *Dendrochronology and Environmental Trends* (Kaunus, 1998); M. G. L. Baillie, *A Slice through Time* (London, 1995), 132.

[6] B. A. Crone, 'The wood including dendrochronological analysis of the barrel staves', in A. S. Cameron and J. A. Stones (eds.), *Aberdeen: an in-depth view of the city's past* (Soc. Antiq. Scot. Monogr. Ser., Edinburgh, forthcoming).

[7] Crone and Fawcett, op. cit. in note 4.

[8] J. Wordsworth, 'Excavation of the settlement at 13–21 Castle Street, Inverness, 1979', *Proc. Soc. Antiq. Scot.*, 112 (1982), 322–1; A. S. Cameron and J. A. Stones (eds.), *Aberdeen: an in-depth view of the city's past* (Edinburgh, forthcoming); W. Lindsay, 'Elgin', *Discovery & Excavation Scotland* (1977), 24.

[9] G. Barclay (ed.), *State-funded 'Rescue' Archaeology in Scotland* (Edinburgh, 1997).

[10] Wordsworth, op. cit. in note 8, table 1.

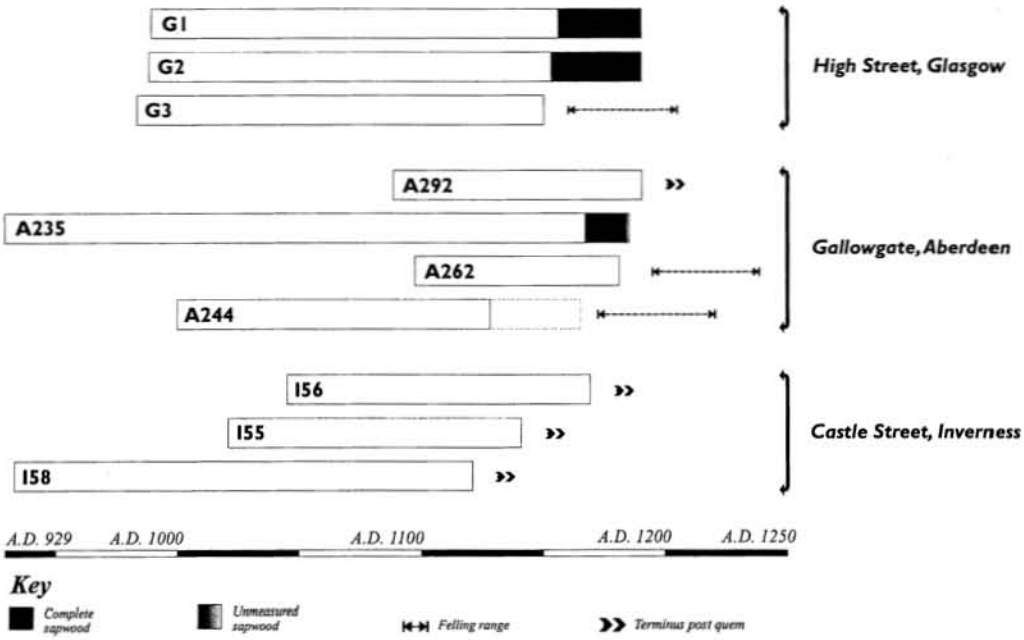

FIG. 1

Chronological relationships within and between site chronologies from Aberdeen, Glasgow and Inverness.

sill-beam and I905 was a post, Context 407, lying at the end of the same sill-beam. These timbers both came from Phase 4, thought to be early to mid-14th century.

RESULTS

Apart from one broken fragment (I54), all the timbers had long, sensitive ring-patterns but none had retained any sapwood and had probably lost some heartwood rings as a result of their shaping. Three of the planks, I55, 56 and 58, correlated well together and individually against the SCOTLAND master so they were combined to form a site master, INVMAS, 237 years in length (Fig. 1). Correlations with a suite of master chronologies from Scotland, England and Northern Ireland date the chronology to A.D. 933–1169 (Table 2). The addition of the minimum sapwood allowance of 10 years to the outermost heartwood ring of each sequence provides *termini post quem* of A.D. 1151, 1179 and 1131 but the timbers could have been felled some considerable time after these dates (Table 1). Unfortunately, it is not possible to be more specific than this given that we cannot estimate how many heartwood rings were trimmed off during the shaping of the plank. The other four timbers could not be cross-matched or dated.

ABERDEEN

THE ASSEMBLAGE

Five oak timbers retrieved during excavations at 45–75 Gallowgate, Aberdeen, in 1985–6 were suitable for dendrochronological analysis (Table 1). Although

TABLE 1
DENDROCHRONOLOGICAL SAMPLES FROM FIVE MEDIEVAL SCOTTISH BURGHS

S.No.	No. of rings	Sap-wood	Bark-edge	Date (A.D.)	Felling date/ range	
CASTLE STREET, INVERNESS						
I36	122+	–	–	undated		
I54	56	–	–	undated		
I55	121	–	–	1021–1141	*tpq* 1151	
I56	125	–	–	1045–1169	*tpq* 1179	
I58	189	–	–	933–1121	*tpq* 1131	
I901	89	–	–	undated		
I905	42	–	–	undated		
GALLOWGATE, ABERDEEN						
A235	255	16	*	929–1183	1184–5	*within 1–2 rings of sub-bark surface
A244	166+	h/s?	–	1000–1128	1175–1220	only first 129 rings used in analysis
A262	85	h/s?*	–	1097–1181	1194–1239	*within 2–3 rings of h/s boundary
A292	105	–	–	1087–1191	*tpq* 1201	
A375	53	h/s?	–	undated		
HIGH STREET, GLASGOW						
G1	202	34	SB	989–1190	1191	spring-felled
G2	203	37	SB	988–1190	1191	spring-felled
G3	168	h/s	–	983–1150	1160–1205	
HIGH STREET, PERTH						
11181	57	–	–	undated		
7685	117	22	B	undated		
7686	55	–	–	undated		
10029	113	–	–	undated		
11592	41	–	–	undated		
5195	154	–	–	undated		
ELGIN WELL						
T2	355	31	SB	947–1301	1301	
T5	354	26		944–1297	1297–1326	TREE 1 (felled after A.D. 1297)
T13b	337	13		950–1286	1286–1328	
T13a	235	12		1050–1286	1284–1327	
T3	268	–		982–1249		
T15	314	44		981–1294	1294–1305	TREE 2 (felled after A.D. 1294)
T10	253	25		1015–1267	1267–1297	
T11	262	44		1025–1287	1287–1298	TREE 3 (felled after A.D. 1287)
T22	245	26		1029–1273	1273–1302	
T21	257	–		1000–1256		TREE 4 (felled after A.D. 1256)
T20	279	–		953–1231		
T23	245	–		956–1200	*tpq* 1210	
T27	189	–		961–1149	*tpq* 1159	
T28	186	–		952–1137	*tpq* 1147	
T29	160	–		967–1126	*tpq* 1136	
T25	235	–		886–1120	*tpq* 1130	

KEY: B = bark-edge; SB = sub-bark surface; h/s = heartwood/sapwood; *tpq* = *terminus post quem*.

TABLE 2
CORRELATIONS BETWEEN THE BURGH CHRONOLOGIES AND OTHER NATIVE SCOTTISH CHRONOLOGIES

	ELGINX15 @A.D. 1301	GLASGHST @A.D. 1190	GALGATE @A.D. 1191	INVMAS @A.D. 1169
SCOTLAND A.D. 946–1975	5.20	6.3	3.16	8.72
PERTH HIGH ST A.D. 949–1204	3.36	3.79	–	3.03
CHAPEL ROYAL, STIRLING CASTLE A.D. 1055–1406	5.52	–	5.25	–
DARNAWAY CASTLE A.D. 969–1387	10.23	–	3.67	–
SPYNIE PALACE A.D. 1074–1236	4.91	–	4.01	–
ST JOHN'S HOUSE, ST ANDREWS A.D. 1072–1248	6.25	–	6.26	–
HIGH STREET, ELGIN A.D. 886–1301	/	–	5.14	4.40
HIGH STREET, GLASGOW A.D. 983–1190		/	3.63	3.01
GALLOWGATE, ABERDEEN A.D. 929–1191			/	3.11
CASTLE STREET, INVERNESS A.D. 933–1169				/
CARLISLE MEDIEVAL A.D. 893–1600	5.92	3.52	3.73	5.05
CARLISLE LANES A.D. 917–1193	4.18	4.36	3.23	6.43
WASDALE A.D. 995–1214	3.88	4.59	3.24	4.80

clearly structural the timbers were no longer *in situ* when excavated but were found as redeposited material within well-stratified contexts.[11] Timbers A262, A292 and A375 were part of a deep midden deposit dated by pottery to between A.D. 1250–1350 (Phase 2a). Timber A244 was found lying on a yard surface and A235 was found in a pit, both features dated to between 1350–75 (Phase 2b).

RESULTS

The five timbers selected for dendrochronological analysis were very variable in terms of length and quality of sequence (Table 1), unsurprising perhaps given

[11] Cameron and Stones, op. cit. in note 8.

that they represent redeposited material and may have come from a variety of sources. The timbers from Phase 2a were trimmed roundwood logs with relatively short ring-patterns, in contrast to those from Phase 2b which had exceptionally long ring-patterns. The dated Phase 2a timbers correlated better with each other than with the Phase 2b timbers, suggesting a similar source distinct from that of the latter. Four of the sequences were combined to form a master, GALGATE, 263 years in length. Correlations with a suite of master chronologies from Scotland, England and Northern Ireland date the chronology to A.D. 929–1191 (Table 2). At least two felling phases can be clearly discerned (Fig. 1). Although the sub-bark surface was present on A235 it was desiccated so that the outermost one or two rings were indistinct and could not be measured. The calendrical date of the outermost measured ring is A.D. 1183 so the parent tree was felled in either A.D. 1184 or A.D. 1185. Although the sapwood had decayed off A262 the heartwood/sapwood boundary was present but was also desiccated so that two or three rings could not be measured. The calendrical date of the outermost measured ring was A.D. 1181. In the British Isles an estimate of 10–55 years is used to allow for any missing sapwood so, after the addition of three missing heartwood rings and the sapwood allowance the parent tree was probably felled sometime between A.D. 1194–1239.[12] Given that this was a young tree with only 85–8 heartwood rings it is more likely to have had a small number of sapwood rings and, therefore, to have been felled earlier rather than later within that range, perhaps in the last decade of the 12th century/first decade of the 13th century. A292, after the addition of the minimum sapwood allowance of 10 years to the outermost heartwood ring, could not have been felled before the first decade of the 12th century (Table 1).

GLASGOW

THE ASSEMBLAGE

During excavations in 1988 at the Bishop's Castle site on the High Street, Glasgow three large oak timbers were retrieved from the fill of a ditch and were thought to represent deliberate backfilling sometime in the first half of the 15th century.

RESULTS

The three timbers were all large, radially split oak planks, two of which had retained the full complement of sapwood rings to the sub-bark surface (Table 1). The sapwood had broken off the third sample leaving the heartwood/sapwood boundary as the external surface. They all yielded long, sensitive ring-patterns. Two of the samples, G1 and G2, correlated so strongly together ($t = 17.14$) as to indicate that the planks had been cleft from the same tree. The ring-pattern of the third sample was compressed in places but displayed the same overall growth trends as the other two samples and was, therefore included in the site master

[12] J. Hillam, R. A. Morgan and I. Tyers, 'Sapwood estimates and the dating of short ring sequences', 165–85 in R. G. W. Ward (ed.), *Applications of Tree-Ring Studies: Current Research in Dendrochronology and Related Subjects* (BAR Int. Ser., 333, Oxford, 1987).

chronology, GLASGHST, 208 years in length (Fig. 1). Correlations with a suite of master chronologies from Scotland, England and Northern Ireland date the chronology to A.D. 983–1190 (Table 2). The large springwood pores of the succeeding year were just beginning to develop on the sub-bark surface on Samples G1 and G2 so the parent tree was felled in the spring of A.D. 1191. Without the sapwood no more than a felling range can be provided for G3. However, the felling range does straddle A.D. 1191 and, although the sapwood has been lost from G3, the heartwood/sapwood boundary lies at roughly the same point as on G1 and G2, so it is possible that they were all felled at the same time.

PERTH

THE ASSEMBLAGE

Dendrochronological dates had already been obtained for the Perth High Street site from Phases IIa onwards, indicating building activity from A.D. 1150/1 to the early 13th century.[13] However, the ceramic evidence suggests that there was activity prior to the mid-12th century date and it is thought that a pre-burghal settlement existed there.[14] Timbers from the earlier, pre-IIa phases were, therefore, sought for further dendrochronological analysis. A further six of the structural oak timbers were sampled but only three had suitably long ring-patterns (Table 1). With the exception of 7685, which retained a fragment of the bark edge, none of the other samples retained sapwood but it was hoped that their analysis might produce a clustering of end-dates indicating building phases. The staves of a barrel re-used as a well-lining in one of the earliest phases on the site were also analysed. Although the sapwood had been trimmed off making it impossible to allocate an exact felling date for the timber, a date for the outermost rings would provide a *terminus post quem* which would thereby provide a valuable bracket for early activity on the site.

RESULTS

The structural timbers

None of the sequences from the structural timbers matched each other, nor did they match M. G. L. Baillie's PERTH master or any of its components. They were then run against all existing Scottish medieval chronologies and the northern English medieval chronologies but no consistent position of match could be found.

It is somewhat surprising that none of the structural timbers could be dated. Some had sufficiently long ring-patterns and the presence of a local chronology should have made dating relatively straightforward. There are a number of possible reasons for the failure to date the sequences. Firstly, it is possible that different sources of timber were being used in Perth. The material examined included young, very fast-grown roundwood like A7686, as well as very slow-grown timber

[13] Baillie, op. cit. in note 3.
[14] Derek Hall, pers. comm.; R. M. Spearman, 'Early Scottish towns: their origins and economy', 96–110 in S. T. Driscoll and M. R. Nieke (eds.), *Power and Politics in Early Medieval Britain and Ireland* (Edinburgh, 1988).

like A5195 which was only 90 mm along the measured radius yet had 154 rings. Internal agreement between many of the sequences used in the PERTH High Street master is not strong, again suggesting that the timber had come from a variety of disparate sources. Furthermore, the PERTH High Street master is not well replicated in the early decades of the chronology; only two trees cover the first 60 years.[15] If the structural timbers are much earlier than the mid-12th-century date for Phase II then the failure to date may lie in the absence of well-replicated chronologies covering the early periods.

The barrel staves

All the stave sequences produced very good visual and statistical correlations with each other and a chronology, BARRELX8, 158 years in length, was constructed. The chronology was then run firstly against the PERTH High Street chronology and the sequences from the structural elements described above. No correlations could be found and so it was also run against all Scottish chronologies, and medieval chronologies from England, Ireland, the Baltic region and other parts of the Continent; again, no consistent position of match was found.

The high degree of correlation between the barrel staves suggests that all the timber used was coming from the same source and possibly even the same tree. It may be this that has hindered successful cross-dating in that we may be attempting to match one tree, rather than a well-replicated site chronology, against the master chronologies. It is also possible that, as with the structural timbers, the barrel may date to an earlier period for which there are currently no well-replicated, local chronologies available.

ELGIN

THE ASSEMBLAGE

The well at Nicholson Garage, 213–19 High Street, Elgin, was excavated in 1977.[16] The timber lining consisted of four corner posts, four horizontal braces and 22 planks, all of oak.

The corner posts were either half- or quarter-logs which had been trimmed square, thus removing all the sapwood and an unknown number of heartwood rings. Similarly, the braces had been heavily converted. The planks were all radially cleft. Sapwood had been preserved on eight of them and in one instance the sub-bark surface was present. Six of the planks displayed drilled holes, suggesting re-use. In all, sixteen samples were taken, from all four corner posts, eleven of the planks and one brace (Table 1). For stratigraphical reasons the excavator believed that the well could not have been dug before the early 15th century.

[15] Baillie, op. cit. in note 3.
[16] Lindsay, op. cit. in note 8.

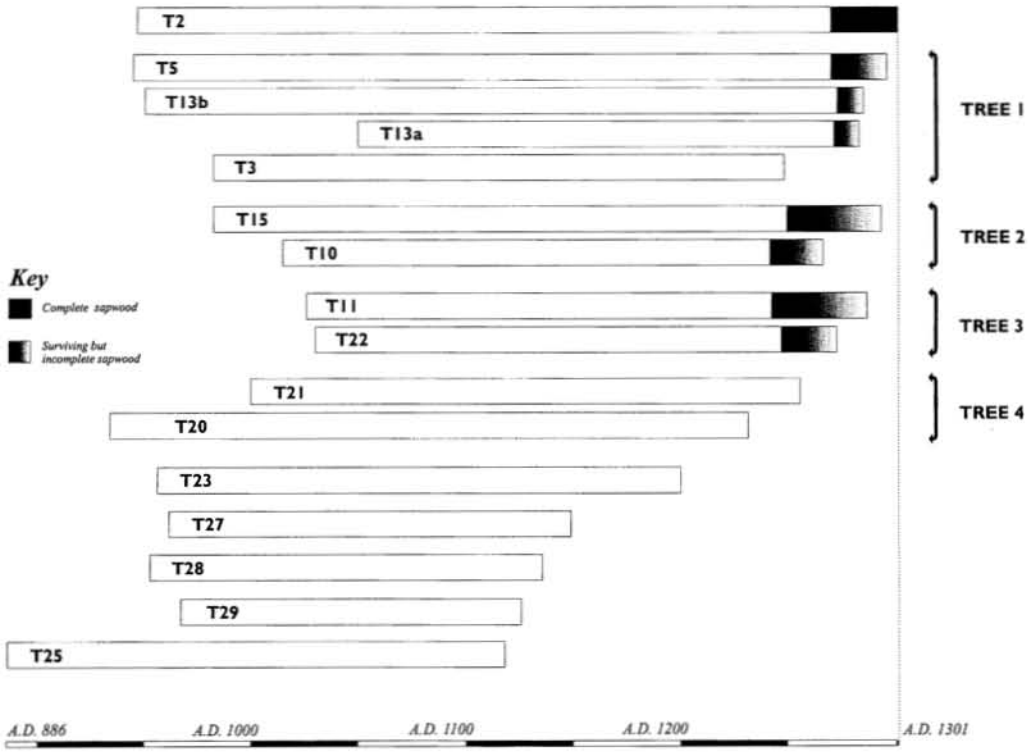

FIG. 2

Chronological relationships of the dated timbers from the Elgin well.

RESULTS

All the samples produced long, clear tree-ring sequences (Table 1). The sixteen sequences were cross-matched against each other and many of the correlations were so high as to indicate an origin in the same tree. T3, T5, T13a and T13b were clearly cleft from the same tree (Fig. 2) and were averaged together to produce a sub-master, TREE 1. Similarly, pairs of sequences, T10/T15 (t = 9.5), T11/T22 (t = 15.1) and T20/T21 (t = 12.3) were averaged together to form sub-masters, TREE 2, TREE 3 and TREE 4 respectively. A site master, ELGINX15, 416 years in length and incorporating all but one of the timbers, was constructed. T29 produced weaker correlations against the master and components and, therefore, although dated, was not included in the final site master chronology.

ELGINX15 was cross-matched against all existing native Scottish chronologies (Table 2) producing consistently high correlations for the years A.D. 886–1301. The calendar dates of the individual sequences are given in table 1 and their chronological relationships are shown in figure 2. One of the planks, T2, retained the full sapwood complement to the sub-bark surface, thereby providing an exact felling date of A.D. 1301. As many of the other dated timbers retain a large proportion of their sapwood it is possible to calculate the span of years within

which they were probably felled. The felling ranges listed in table 1 have been calculated using the British Isles sapwood allowance. It is clear that some of the planks converted from the same tree have lost more sapwood rings than others so the outermost sapwood ring for the tree-group is quoted here. TREE 1 was felled after A.D. 1297 and probably before A.D. 1328; TREE 2 was felled after A.D. 1294 and probably before A.D. 1305; and TREE 3 was felled after A.D. 1287 and probably before A.D. 1302. The absence of any sapwood on Tree 4 means that all that can be said is that it was felled after A.D. 1266. The felling ranges of the trees straddle A.D. 1301 so they could all have been felled at the same time as T2. However, given the evidence for re-use seen on the timbers it remains possible that they were felled at different times, albeit only a few years apart.

Neither the corner posts (T23, T27, T28 and T29) nor the brace (T25) retained any sapwood and it is, therefore, impossible to determine a felling range. The excavator has suggested that the corner posts were adapted from some earlier construction which might explain the significantly earlier end-dates. However, it remains a possibility that substantial numbers of the heartwood rings have been trimmed off, particularly given the short length of at least three of the sequences (T27, T28 and T29) in comparison to the assemblage as a whole, and that all the timbers in the well were felled at the same time.

The date of the well

The excavator has argued that the well is unlikely, on stratigraphic grounds, to have been dug before the early 15th century, i.e. at least a century later than the felling date indicated by the dendrochronological analysis. If we assume, in the absence of evidence to the contrary (certainly, the excavator observed that there was no evidence to indicate that repair work had been carried out), that the well represents a single phase of construction, then the simplest interpretation of the results is that the well was constructed in A.D. 1301. However, there are redundant drilled holes on some of the planks and it was initially thought that two groups of planking had been used in the well, one of re-used material and the other freshly felled, with no signs of re-use. Analysis has demonstrated that this is not the case. TREE 3 is represented by two planks, T11 which has no evidence of re-use, and T22 which displays a single drilled hole, suggesting that, even where there are no redundant features, the planks may still have been re-used. Thus, even if we assume that all the trees were felled in A.D. 1301, they had clearly been used elsewhere before they were used in the well. The survival of so much sapwood on many of the planks has a bearing on their history. Sapwood, the outermost rings of the oak tree, is fragile and notoriously susceptible to insect attack, and it is usually assumed that it would not survive intact the processes of demolition and decay in aerobic conditions, i.e. in a standing building. As the evidence indicates that the planks have been used in an earlier structure it seems likely that this was also a similar waterlogged feature, possibly another well.

DISCUSSION

DATING THE SITES

In terms of site-specific information, previously unknown, earlier phases of building activity have been identified at both Glasgow and Aberdeen but, because the timbers were redeposited, this information cannot be related to specific structures. The sampled timbers were *in situ* in Inverness but, unfortunately, the trimming of the staves means that we cannot be more exact about the date other than to say that they were probably felled in the late 12th/early 13th century. This is somewhat earlier than the date ascribed to that phase by imported pottery typologies but it is not inconsistent with the overall stratigraphy of the site. The construction of the wall, vertical planking set directly into clay, is unique in medieval Scotland and the excavator suggested that it belonged to an earlier building tradition.[17] The early tree-ring dates support this conjecture.

The presence of redundant features, particularly a dowel hole sawn in half, on some of the planks means that the felling date of A.D. 1301 cannot be ascribed to the construction of the well found at 213–19 High Street, Elgin; instead the date provides a *terminus post quem* for its construction. The felling date pinpoints a phase of building activity, possibly the construction of a well elsewhere in the town, in A.D. 1301.

BUILDING ACTIVITY ON THE EARLY BURGHS

The assemblages from Aberdeen, Glasgow and Inverness are small and very much random samples in that they were not the result of systematic sampling at the time of excavation and represent what has survived after many years in storage. Furthermore, with the exception of the Inverness assemblage, the timbers were redeposited and could, therefore, have been felled at any point in time prior to their burial. It is all the more surprising, therefore, that their analysis has produced such remarkably consistent results. Despite coming from contexts apparently spanning the late 13th to 15th centuries the felling ranges of the dated timbers all fall within a short timespan straddling the late 12th/early 13th century (Fig. 1). Where there are exact felling dates these indicate activity in the late 12th century — in A.D. 1190/1 in Glasgow and A.D. 1184–5 in Aberdeen. Analysis of timbers from the Perth High Street excavations also pinpointed a felling phase in A.D. 1192/3.[18]

Thus, we have four Scottish burghs in which dendrochronological analysis indicates, on balance, a phase of building activity in the last decade or so of the 12th century. That this happened roughly contemporaneously across the country would suggest that it was a response to some common factor. The origin and early development of urban settlements in Scotland is still a subject of some debate and their study is reliant on archaeology to flesh out the burghal charters.[19] All the towns discussed here were given burgh status during the 12th century and were flourishing communities by the 14th century; what is not known in any detail is the

[17] Wordsworth, op. cit. in note 8, 380 and pers. comm.
[18] Baillie, op. cit. in note 3.
[19] Spearman, op. cit. in note 14.

early development of the settlements in response to their new legal status.[20] The late 12th century and 13th century were a boom period for the Scottish burghs and it is possible that, in the dendrochronological results, we have identified the first major phase of building activity resulting from the new-found prosperity of the burghs.

The sampling of these timbers did not recover evidence for activity prior to this date, despite the fact that, in the case of Glasgow and Aberdeen in particular, the redeposited timbers could, in theory, have come from any phase of the towns' early development. Glasgow was not granted burghal status until A.D. 1175–8 but there was certainly earlier building activity in the locality, i.e. at Glasgow Cathedral.[21] This absence of evidence for earlier settlement may, of course, be due to topographic and/or depositional factors. A. A. M. Duncan has argued that '. . . even in the earlier 12th century, they were already flourishing towns, even though they were not all burghs, for the growth which they show by the middle or third part of the century simply could not be the consequence of only fifty years, no matter how active the king in giving encouragement'.[22] The only dendrochronological evidence for early development comes from Perth, where Baillie has pinpointed a felling date of A.D. 1150/1, indicating building activity in the newly established burgh. The failure to date any of the structural timbers and the barrel from the earliest phases may simply be because, in Scotland we still have very few well-replicated chronologies covering the 10th and 11th centuries against which to compare them.

THE SOURCE OF THE TIMBER

The statistical correlations with other Scottish master chronologies and some of the northern English chronologies indicate that all the timber used in the burghs was native in origin (Table 2). They also show a strong distinction between chronologies from the North and East and those from the South and West. This distinction, between a south-western Scottish 'tree-ring region' and one centred on north-eastern Scotland was becoming apparent in earlier work and the results summarised here tend to confirm that north-eastern Scotland is, indeed, a distinctive climatic region in terms of tree-ring growth.[23] The exception to this emerging pattern is the chronology from Inverness which shows greatest agreement with the south-western SCOTLAND master and some of the northern English masters and poor correlation with other north-eastern chronologies.

It is possible that the Inverness timbers may have been brought up the Great Glen from a more southerly source. However, the early burghs would certainly have had access to sufficient local supplies for their building needs, probably guaranteed by Royal decree. In an act dated between A.D. 1189–95 William I

[20] M. Lynch, M. Spearman, and G. Stell, *The Scottish Medieval Town* (Edinburgh, 1988).

[21] A. Gibb, *Glasgow: The Making of a City* (London, 1983), 10; S. T. Driscoll, 'Highlights of the excavations at Glasgow Cathedral 1992–93', 25–34 in R. Fawcett (ed.), *Medieval Art and Architecture in the Diocese of Glasgow* (Brit. Archaeol. Assoc. Conf. Trans. XXIII, 1998).

[22] A. A. M. Duncan, *Scotland: The Making of the Kingdom* (Edinburgh, 1975), 470.

[23] C. M. Mills, B. A. Crone and F. Watson, 'Dendrochronology and documentary evidence in Scottish woodland history', *J. Human Palaeoecology*, 6 (forthcoming).

granted the Bishop of Moray and his successors the rights to gather timber and fuel from the King's forests around Elgin, Forres and Inverness but he specifically excluded the easements granted by his predecessors, David I and Malcolm I, to the burgesses of those three burghs, implying that the latter had had similar rights there.[24] Certainly the high correlation with the chronology from Darnaway Castle, which lies some 25 km to the west of Elgin, supports a local source for the timber from the well. In A.D. 1341 and again in A.D. 1362, grants of David II mention the forests of *Sanquhare*, *Tullouche* and *Drum* near the burgh of Forres and M. L. Anderson suggests that the burgesses of Forres and Elgin had rights of pasture and wood-bote in these forests.[25] It is perhaps in these forests that the well timbers were felled.

The analysis of the well-lining from Elgin provides some insights into the type of woodland and quality of timber available in these local woodlands in the early 14th century. T2, which was felled in A.D. 1301, was at least 355 years in length and if we add the 'lost' outer rings to those assumed to have been felled at around the same time, then TREE 1 was at least 358 years, TREE 2 was at least 321 years, TREE 3 was 276 years and TREE 4 was 319 years. Furthermore, the pith, the centre of the tree, was not present on any of the planks so at least some of the innermost rings, may be up to twenty, must have been trimmed off. These are very long-lived trees with narrow, slow-grown ring-patterns indicating an origin in dense, mature woodland. By any measure, this was high-quality timber, fine-grained and, therefore, easily split into the thin boards much prized as panelling in high status buildings. It is somewhat surprising, therefore, to find it cleft into thick, heavy planks and used as lining in such a lowly structure as a well; it implies that the burgesses of Elgin had a surfeit and/or easy access to good quality timber.

Timber began to be imported into Scotland from the Baltic in the later 13th century and it has been generally assumed that the impetus behind this trade was diminished supplies of local timber.[26] However, it is clear from assemblages such as Elgin and Darnaway that, in north-eastern Scotland at least, high-quality timber was still locally available at that time.[27]

THE 9TH-/10TH-CENTURY GAP

While the new chronologies discussed in this paper have expanded the geographical spread of tree-ring coverage in Scotland none of them have substantially pushed chronological coverage back in time (Figs. 1–2). The site chronology from Glasgow Cathedral which forms the earliest section of the SCOTLAND master starts in A.D. 946, Perth High Street begins in A.D. 949 and Darnaway in A.D. 969. Of the recently developed chronologies Aberdeen begins in A.D. 929, Inverness in A.D. 933 and Glasgow in A.D. 983, none of them extending back beyond the early to mid-10th century. This phenomenon is most forcibly demonstrated in the larger assemblage from Elgin. The surviving innermost rings

[24] G. W. S. Barrow, *Regesta Regum Scottorum, II: The Acts of William I 1165–1214* (Edinburgh, 1971), 356–7.
[25] M. L. Anderson, *A History of Scottish Forestry*, 1 (Edinburgh, 1967), 127.
[26] D. Ditchburn, 'Trade with northern Europe, 1297–1540', 161–79 in Lynch et al., op. cit. in note 20.
[27] Stell and Baillie, op. cit. in note 4.

on most of the Elgin trees lie around the mid-10th century (Fig. 2: it is clear from a comparison of planks cleft from the same tree that some have had substantial numbers of their inner rings trimmed off, i.e. T13a, T10 etc.). If an allowance is made for the 'lost' inner rings (see above) then their 'birth dates' lie in the early 10th century. Elgin has produced a single sequence which extends back beyond the early 10th century to A.D. 886 (Fig. 2 and Table 1) and Glasgow Cathedral also produced a single sequence that began in A.D. 896 but, because of a band of problematic rings, it was not included in the master chronology.[28] However, these sequences do not detract from the overall impression that the tree-ring chronologies are highlighting an 'event horizon' in the early to mid-10th century A.D.

This 'event horizon' is further emphasised by the gap emerging between the medieval chronologies beginning in the mid-10th century and the Early Historic chronology which ends in A.D. 752.[29] Although the Scottish evidence is currently based on only a few chronologies it mirrors similar gaps which emerged during the development of tree-ring chronologies in Ireland and northern Europe and which were difficult to bridge.[30] Baillie has called these gaps 'depletion/regeneration phases' and suggests that the apparent lack of woodland regeneration is due to sustained human pressure on agricultural resources.[31] Woodlands regenerate when pressure for building materials, fuel and agricultural land is reduced, i.e. when human settlement contracts. This is reflected in the tree-ring record by a proliferation of 'birth dates' and a synchronous absence of felling dates because building activity is reduced. We do not, as yet, have any tree-ring evidence for a reduction in building activity but the synchronicity of the 'birth dates' of many of the dated medieval tree-ring sequences suggests that in the early 10th century woodland throughout Scotland, from Glasgow to the Moray coast, is able to regenerate, thereby implying a contraction of human settlement.

The 8th–10th centuries A.D. is the period during which the disparate kingdoms north of the Forth/Clyde line emerge as a single state, Alba. There is a scarcity of documentary and other evidence for this period and so the processes and events whereby the new state emerged must remain, to a large extent, conjectural.[32] However, it seems reasonable to assume a measure of political instability and social dislocation. The disappearance at this time of the language of the indigenous Pictish population and its replacement by Gaelic, the language of the ascendant Dal Riata certainly implies some major social transformation, be it violent or otherwise.[33] An additional destabilising element, and one which probably contributed to the emergence of Alba, was the appearance of the Vikings who, throughout the 9th century and the first half of the 10th century, terrorised the Scottish littoral. Their raiding was concentrated along the northern and western periphery of Scotland during the first half of the 9th century but later, particularly in the 860s

[28] Baillie, op. cit. in note 2, 38.
[29] B. A. Crone, 'The development of an Early Historic tree-ring chronology for Scotland', *Proc. Soc. Antiq. Scot.* 128 (1998), 485–93.
[30] M. G. L. Baillie, *Tree-Ring Dating and Archaeology* (London, 1982), 211–22.
[31] Ibid., 213.
[32] E.g. P. Wormald, 'The emergence of the *Regnum Scottorum*: a Carolingian hegemony?', 131–60 in B. E. Crawford (ed.), *Scotland in Dark Age Britain* (St Andrews, 1996).
[33] Ibid., 133.

and the early 10th century, concerted attacks were made along the east coast, with major incursions, some quite sustained in duration, as far inland as Fortriu, the heartland of the new state.[34] Opinions differ as to the effect of these raids. Duncan describes them as sporadic and their impact obscure while Broun sees 'a picture of regular devastation'.[35] The presence of Norse power centres to the south in York and across the Irish Sea in Dublin certainly had a powerful effect on the political power-play of the Scottish kings and it is difficult not to assume that the raiding would have had a similarly destabilising influence on social and economic organisation.[36] Against this background the tree-ring evidence for a contraction of human settlement, possibly to safer, inland locations, does not seem out of place. It is perhaps notable that all the tree-ring evidence so far comes from either coastal sites, such as Inverness, Darnaway, Elgin and Aberdeen or sites on major navigable waterways, i.e. Glasgow and Perth.

The tree-ring data merit further investigation, particularly in conjunction with place-name and archaeological evidence. In particular, the tree-ring evidence may have implications for the study of Pictish land organisation and early Church estate management.

CONCLUSIONS

Analysis of these urban assemblages has produced results which are of interest to the archaeologist, historian and dendrochronologist alike. Tree-ring coverage in Scotland has been extended, emphasising the distinction between a south-western and north-eastern region. This has greatly increased our ability to determine the source of the timber and thus to contribute evidence for the timber trade within medieval Scotland. The existence of the new chronologies will also improve our chances of dating any new material that may be retrieved during future excavation or building restoration. Approximately synchronous building activity has been identified, adding to our knowledge of the early development of the Scottish burghs. The tree-ring evidence for a contraction of human settlement in the early 10th century provides a tantalising sidelight on a period about which very little is known.

Given the volume of information which has been provided by this retrospective analysis of mainly small, random samples, the benefits of a more comprehensive and rational sampling policy in future excavations are obvious, not least because of the insights they might provide into the origins and development of the early burghs.[37]

[34] B. E. Crawford, *Scandinavian Scotland* (Leicester, 1987), 50.

[35] Duncan, op. cit. in note 22, 93; D. Broun, 'The origin of Scottish identity in its European context', 21–31 in Crawford (ed.), op. cit. in note 32.

[36] Crawford, op. cit. in note 34, 60.

[37] More comprehensive accounts of the analyses are available as unpublished reports for Historic Scotland, i.e. B. A. Crone, Dendrochronological data from three Scottish medieval urban sites (unpubl. report for Historic Scotland); B. A. Crone, Dendrochronological analysis of waterlogged timbers from the well at 213–19, High St, Elgin (unpubl. report for Historic Scotland); B. A. Crone, Perth High Street; dendrochronological analysis of the barrel and miscellaneous structural timbers (unpubl. report for Historic Scotland). The archive reports containing the raw ring-width data are lodged with AOC Archaeology.

POSTSCRIPT

Since this paper was submitted new data have become available which have resulted in the successful dating of one sequence from Perth High Street. The new data consist of a single sequence from timbers found in association with the remains of a bridge over the River Kelvin near the Roman fort of Balmuildy.[38] The remains were originally thought to be Roman because of the proximity to the Roman fort but the timber, at least, proved to be medieval, the sequence dating to A.D. 1056–1331. Sample 5195 correlated well with the River Kelvin sequence, producing a t-value of 8.1 and dating it to A.D. 974–1127. As Sample 5195 is a squared stake from which the sapwood and some of the outer heartwood rings had been trimmed the date of A.D. 1127 provides only a *terminus post quem* for its use. This result does not, therefore, materially change the conclusions outlined above, but adds to the evidence for activity in Perth in the late 12th century.

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[38] P. M. Davidson, 'The bridge over the Kelvin at Summerston', 88–94 in S. N. Miller (ed.) *The Roman Occupation of South-Western Scotland* (Glasgow, 1952). Further information from David Brown, pers. comm.