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The development of an Early Historic tree-ring chronology for Scotland

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ABSTRACT

This paper summarizes recent dendrochronological work on wood assemblages of Early Historic date. A tree-ring chronology covering the period AD 250–752 has been constructed using assemblages from the Northumbrian settlement at Whithorn, Dumfries & Galloway, and the crannog at Buiston, Ayrshire. Tree-ring evidence for a period of social instability in the later sixth century AD is considered as is the significance of the ninth-century AD 'gap' in tree-ring coverage which is emerging. The reasons for the failure to date any of the smaller assemblages are discussed.

INTRODUCTION

In the early 1970s M G L Baillie, as part of the long chronology-building programme being undertaken at Queen's University, Belfast, gathered all tree-ring samples available from Scotland at the time and was able to construct a chronology for south and central Scotland extending as far back as AD 946 (Baillie 1977). The lack of samples from 10th-century and earlier contexts meant that the chronology could not be extended any further back and the situation remained as such for nearly two decades. Excavations of Early Historic sites such as Dundurn (Alcock *et al* 1989) and Loch Glashan (Scott 1960) occasionally produced small numbers of waterlogged timbers, potentially useful for tree-ring analysis but, in the absence of any local master chronology covering the period, these odd timbers could not be dated.

The situation changed with the excavations at the monastic settlement at Whithorn (Hill 1997) and the crannog at Buiston, Ayrshire (Crone 1999), both of which produced sizeable assemblages of waterlogged wood. The creation of two robust, local chronologies for these sites enhanced the chances of dating smaller Scottish assemblages and a grant from the Hunter Trust enabled all the 'loose ends' from the earlier excavations to be assembled for analysis. This included samples which had already been measured but not dated and samples which had been stored for future analysis.

RESULTS

The results are presented below by site. The chronologies from Whithorn and Buiston have been published in detail within the excavation reports (Crone 1997; Crone 1999) but, for the purposes of this paper, they are summarized briefly below.

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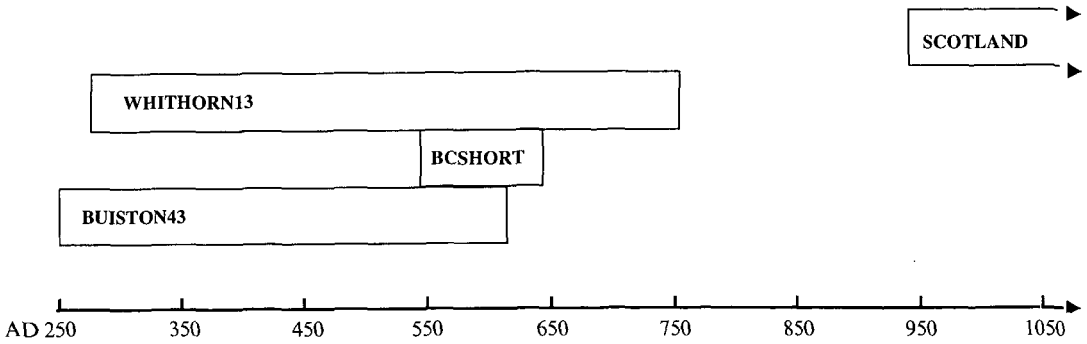


ILLUS 1 The chronological relationships between BUISTON43, BCSHORT, WHITHORN13 and SCOTLAND

WHITHORN, DUMFRIES & GALLOWAY (NGR: NX 444 403)

Excavations at Whithorn have revealed a sequence of deposits dating from the sixth century to the present day, the earlier phases of which record the development of the Christian community first established there by St Nynia (Hill 1997). The southern sector of the excavated area lies at the foot of the hill on which the medieval priory still stands and was poorly drained until the 13th century (*ibid*, 7), thus ensuring the preservation of organic materials, including structural timbers. Of 19 structural timbers sampled for dendrochronological analysis, 13 were averaged together to form a master chronology, WHITHORN13, 475 years in length (Crone 1997). Significant and consistent matches were found between this master and several Irish and English chronologies (Table 1) dating WHITHORN13 to AD 278–752 (illus 1).

Most of the timbers had been heavily trimmed, thus removing many of the outer growth-rings. Consequently, the calendrical date for the outermost year-ring of most of the samples provided, at best, a *terminus post quem* for the felling of the tree. The bulk of the dated timbers came from two of the many sub-rectangular, wicker-framed buildings found at the foot of the hill (Hill 1997, 138). The youngest of the five dated timbers from Building 24 provided a *terminus post quem* of AD 706 which, when allowance is made for the missing tree-rings trimmed off the timber, indicates that the building was probably constructed in the first half of the eighth century (*ibid*, 130). Some sapwood, the distinctive band of living tissue found just under the bark on oak, had survived on one sample and it was, therefore, possible to calculate that the tree had been felled sometime between AD 756 and 801. This, in turn, indicates that the structure from which the timber came, Building 17, was probably built some time in the second half of the eighth century (*ibid*, 130).

BUISTON, AYSHIRE (NGR: NS 416 433)

Excavation of the crannog at Buiston in 1989–90 revealed multiple timber palisades encircling a settlement which consisted, at any one time, of a single timber roundhouse (Crone 1999). The lacustrine muds which encased the crannog had ensured preservation of the organic component in all but the uppermost layers and some 303 structural oak timbers were sampled for tree-ring analysis. A site master chronology, BUISTON43, 366 years in length and incorporating 43 samples, was constructed which was dated to AD 250–615 against the Whithorn chronology (illus 2) and against a suite of northern Irish and English chronologies (Table 1). For statistical reasons only sequences longer than 70 years were included in this site master chronology (for

TABLE 1

Correlations between the Scottish Early Historic chronologies and other master chronologies.
The figures quoted are t-values, a statistic which describes the degree of correlation between two chronologies (Baillie & Pilcher 1973). The higher the t-value, the greater the agreement between the two chronologies.

MASTER	WHITHORN13	BUISTON43	BCSHORT	SCOTEH
TEEORRY Northern Irish (Baillie, unpubl data)	10.97	7.04	4.8	10.71
CARLISLE-SAX Carlisle, Northumbria (Baillie, unpubl data)	5.99	5.26	4.94	7.54
BRITIM British & Irish Master (Baillie & Pilcher, unpubl data)	8.28	4.99	5.1	8.5
NTHMILLSM Northern Irish Mills (Baillie, unpubl data)	7.21	6.12	4.75	8.78
WHITHORN13	–	7.79	4.15	–
BUISTON43	–	–	4.81	–

fuller discussion see Crone 1999). A separate chronology was constructed using the shorter sequences which comprised the bulk of the assemblage. BCSHORT, 101 years in length and incorporating 45 samples, was dated to AD 540–640 (Table 1).

The bark or sub-bark surface was still present on 43% of the oak timbers making it possible to date to the year phases of construction, collapse and repair on the crannog. In AD 594 the crannog was levelled and resurfaced with large oak baulks and a palisade of oak stakes was erected around it. In AD 608 a palisaded walkway was built as a defensive perimeter around the crannog but the stake palisade continued in use and was repaired in AD 613. In AD 614 work began on felling timbers for a new ring-beam palisade and in AD 620 work on this palisade was completed. In AD 630 a small stake palisade was erected just outside the circuit of the ring-beam palisade. Small repairs were made to these two palisades in the middle of the seventh century.

IONA, ARGYLL (NGR: NR 915 924)

During excavation of the waterlogged infill of the vallum ditch on Iona in 1979 large quantities of wood were retrieved, consisting primarily of structural and artefactual debris (Barber 1981). The wood was preserved within peat deposits which had developed in the ditch between 1365 ± 55 BP (GU–1243) and 1260 ± 55 BP (GU–1245). Unfortunately, many of the larger structural timbers set aside for conservation have been lost, but samples were taken from five of the more fragmentary timbers and stored for future analysis (Table 2). Belts of compressed rings made one sample unmeasurable and only one sample produced a long ring-pattern. However, samples Io001 and Io002 matched each other ($t = 4.11$; the t-value is the degree of correspondence statistically expressed) and a sub-master, 215 years long, was constructed. Samples Io003 and Io004 also matched each other ($t = 4.2$) and a sub-master, 90 years long, was constructed. The two site sub-master chronologies did not cross-match with each other.

DUNDURN, PERTHSHIRE (NGR: NN 708 232)

Excavations at this Early Historic fortification revealed the unexpected preservation of waterlogged material which had built up behind the citadel defences (Alcock *et al* 1989). A number of radially split oak planks were retrieved, two of which were submitted to Queen's University for tree-ring analysis (Table 2). Although the samples had sufficiently long sequences they could not be correlated with each other nor could they be individually dated against any of the master chronologies available at the time. However, the 'wiggle-matching' of high-precision

radiocarbon dates obtained from one of the timbers dated the earliest Phase 1 stockade to 608 ± 15–30 cal AD (*ibid*, 201).

LOCH GLASHAN, ARGYLL (NGR: NR 915 924)

The crannog at Loch Glashan was excavated in 1960 (Scott 1960; RCAHMS 1988, 206) and all objects retrieved during the excavations have been stored since then in the Kelvingrove Museum, Glasgow. Despite the recorded evidence for plentiful timber (Campbell 1991, illus 170), very little was sampled and only two of those timbers stored at the Kelvingrove Museum were found to be suitable for dendrochronological analysis (Crone unpubl: a). They were retrieved from the sub-structure of the crannog. The presence of E-ware pottery and a 'Pictish' penannular brooch indicates activity on or around the crannog sometime between the late sixth century and the eighth/ninth centuries (Scott 1960). The two samples varied hugely in size (Table 2) and did not correlate with each other.

CASTLE LOCH, DUMFRIES & GALLOWAY (NGR: NY 086 813)

This crannog at Castle Loch, Lochmaben, has never been excavated, but in the early 1970s a small number of timbers was extracted and samples sent to Queen's University (Wilson 1982). Only two samples yielded sufficiently long ring-patterns and they could not be dated. There is no other dating evidence for this crannog, but the morphology of the planks, with shaped tips and tenons on their 'upper' ends, is so similar to a group of planks inserted into the final palisade at Buiston and dendro-dated to AD 630 (Crone 1999), as to suggest a comparable Early Historic date.

One of the original samples was made available for re-measurement and a roundwood stake from the crannog which had been donated to the Dumfries Museum was also located. A sample could not be removed from the stake, as it forms part of the museum display, so a silicon rubber cast of the ring-pattern was obtained instead. The upper end of the stake, which had already been sawn across when it was removed from the crannog, was very finely sanded and the dust blown out of the pores of the ring-pattern. Two layers of liquid silicon rubber were then brushed over the surface with a sheet of muslin sandwiched between them to give the cast some rigidity. The cast picked up the ring-pattern in relief and it was consequently very easy to measure the sequence. None of the samples from the crannog yielded long ring-patterns (Table 2) and they did not correlate with each other.

INTER-SITE CROSS-MATCHING

Robust site master chronologies could not be constructed for any of the sites other than Buiston and Whithorn. WHITHORN13, BUISTON43 and BCSHORT were subsequently combined to form a master chronology, SCOTEH (Scottish Early Historic), covering the period AD 250–752 (Table 1 & illus 1). The individual sequences from each site were then compared against those from the other sites, with SCOTEH and the site master chronologies from Buiston and Whithorn, and with a suite of master chronologies from Ireland and England. There were no significant cross-correlations and so the individual sequences must remain undated.

TABLE 2
Dendrochronological samples from Early Historic sites in Scotland

Sample	Conv. code†	Cross-section (mm)	Description	No of Rings	Sap	Bark	Other labels
Iona							
001	D1	187 × 20	large plank	182	?	/	
002	D1	93 × 38	small plank	85	/	/	
003	D1	71 × 15	plank frag with hole	58	2	/	
004	D1	83 × 11	thin plank	68	/	/	
005	A1	110 diam	worked roundwood	–	yes	?	
Loch Glashan							
001	A1	435 × 230	unworked section	321	/	/	Kelvingrove Museum
002	A1	85 diam	branch fragment	62	yes	yes	Small Find 218
Castle Loch							
001	?	/		95	/	/	QUB 2626
002	B1	182 × 52	plank	58	/	/	
003	A	60 diam	roundwood	63	/	/	DUMFM 1954:45
Dundurn							
001	?	/		146	/	/	QUB 3166
002	?	/		125	/	/	QUB 5125*

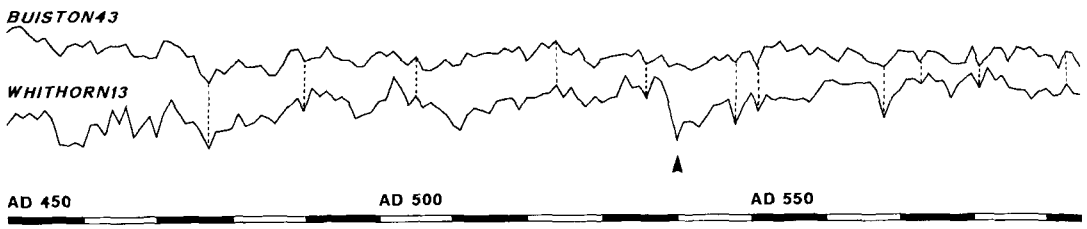
* 'wiggle-matched'
† For conversion codes see Crone & Barber 1981

DISCUSSION

When selecting oak timbers which might be suitable for tree-ring analysis two requirements are essential: long ring-patterns and/or large assemblages (Hillam *et al* 1987; Crone 1988). Both Buiston and Whithorn satisfied these requirements and, consequently, it was possible to construct three robust chronologies for these sites. The other assemblages investigated in this report contained insufficient samples with long ring-patterns and so the chances of successful dating were very much reduced. The failure to date the 321–year sequence from Loch Glashan remains a puzzle; despite being a single sequence it is of such a length that the statistical chances of finding a unique correlation should be high. It is possible that the timber is bog oak and, therefore, of considerable antiquity, pre-dating all other relevant sequences.

The failure to date any of the longer sequences against the dated master chronologies may also be as much a consequence of the biogeographic diversity of Scotland as of the size and quality of the assemblage. The dated sites of Buiston and Whithorn lie within the Central and Southern Lowlands zone which is characterized by relatively low rainfall and relatively large temperature ranges (Usher & Balharry 1996, 10). This is very similar to the climate of northern Ireland where, due to the efforts of the Palaeoecology Centre at Queen's University, there are a number of well-developed chronologies covering, *inter alia*, the Early Historic period. These chronologies provided the correlations which dated the Scottish chronologies (Table 1). In contrast, the climate of the Scottish west coast (Argyll and the Hebrides) is characterized by exceptionally high rainfall (almost double that of the Lowlands zone) and a relatively narrow temperature range (*ibid*, 21). This is further complicated by the diverse geology of the region and the complex soil associations arising from that diversity. Consequently, tree-growth within the west coast zone is likely to differ substantially from that of the Lowlands zone. Tree-ring coverage in Scotland is still very much a Lowlands phenomenon and is likely to remain so until sizeable assemblages of long-lived oaks are retrieved from a west coast source.

Diversity of timber resources can also make chronology construction and dating difficult, but this is a problem more commonly associated with urban sites (Hillam 1987, 145). However,



ILLUS 2 A section of the tree-ring chronologies from Buiston and Whithorn showing the quality of correlation between them. Note the narrow growth-rings around AD 540 on WHITHORN13 and their absence on BUISTON43

Iona was virtually treeless in the Early Historic period, probably as a result of clearance by the monks (Bohncke 1981, 347), and Adomnan records two occasions on which oak timbers required for building work were brought by sea to the island (Anderson & Anderson 1961, 453, 455). In one case he specifies the 'river Sale' which has been identified as the river Shiel in mainland Argyll (*ibid*, 454) but the timber could have come from any number of sources given the sphere of influence of the Columban community. This diversity of sources renders internal cross-matching difficult and may explain why it was not possible to cross-match the two site chronologies from Iona.

An increasingly important side effect of the expansion of tree-ring coverage elsewhere in the world has been the realisation that the tree-ring record contains evidence of natural events of such a scale that they would almost certainly have had repercussions on the socio-economic conditions of the time (Baillie 1995). Baillie (*ibid*, 89) has listed the accumulating evidence from tree-ring studies, ice-core studies and contemporary documentation for a natural catastrophic event in AD 536 which affected the global climate for the following decade. There was a hemispheric response to this event in tree-ring patterns across Europe and America in the form of severely restricted growth (*ibid*, 95), while contemporary sources record climatic deterioration and the impact on the human population in terms of crop failure and subsequent famine, widespread death and plague. This period of restricted growth can be seen in the Whithorn chronology (illus 2) and suggests that south-west Scotland, at least, probably suffered to some degree from the repercussions of deteriorating climate. The writer has argued elsewhere (Crone 1999) that, as such conditions would have generated an atmosphere of uncertainty and fear, people may have started building settlements in more defensible locations such as lochs, hence the floruit in crannog-building in the late sixth/early seventh centuries evident from the tree-ring results in both northern Ireland and south-west Scotland (Crone 1993). Somewhat surprisingly, this tree-ring 'event' is not visible in the Buiston chronology (illus 2), although it can be seen in almost all the Irish chronologies for the period, in the Carlisle chronology and in many of the German chronologies (Baillie 1995, 94).

There is now a gap of nearly 200 years towards the end of the Early Historic period, between AD 752 and 946 (illus 1), which has still to be bridged in the Scottish Lowland chronology. This gap may be more apparent than real because, at present, we have so few chronologies in Scotland. However, none of the other medieval chronologies constructed more recently than the SCOTLAND master extends back beyond the middle of the 10th century either, and several start at about that time (summarized in Mills *et al* forthcoming). In this context, it is worth noting that, early in the development of the Irish and German tree-ring chronologies a gap centred around the ninth century also became apparent (Baillie 1995, fig 8.4). Baillie (1982, 213) has called these gaps 'depletion/regeneration phases' and suggests that they reflect intense agricultural activity during the ninth century which prevents regeneration of the oakwoods to

replace those depleted during the widespread building activity of the previous century. The implication is that, during the eighth and ninth centuries, the pressure of population on building and agricultural resources is high but begins to fall off in the 10th century, thus allowing the oakwoods in Ireland and Germany to begin regenerating.

If this scenario is applicable to Scotland then we may have trouble bridging the gap (although the failure to find timbers may be equally revealing, as Baillie's work has demonstrated) but we are still very much at an early stage in chronology development. In Ireland the eighth and ninth centuries were bridged by timbers from horizontal mills (Baillie 1982, 184–92) but, to date, the timber components of these structures have not been recovered in Scotland (ie O'Sullivan 1994; Batey 1995). Crannogs are an obvious source of timbers but, after the sixth/seventh-century floruit, do not appear to become 'fashionable' again until the later medieval period (Barber & Crone 1993, 531). Excavated evidence for the rural settlement of this period is still scant (Foster 1997) and unlikely to yield waterlogged deposits (ie Driscoll 1997), unless in exceptional circumstances. Such circumstances have occurred on a number of Norse settlement sites in the Northern Isles — for example, The Biggins, Papa Stour, Shetland (Crawford 1985, 142) and Tuquoy, Westray, Orkney (Owen 1993, 332) — but wood on these sites is more likely to have come from Scandinavia and would, therefore, be unsuitable for the construction of a native oak chronology. Oak timbers from a possible Viking portage at Tarbert, Kintyre, are more likely to be native but, like the other assemblages from Argyll described above, have not been successfully dated and may be bog oaks (Crone unpubl: b).

Waterlogged urban deposits are another potential source of timbers for this early period. Legally defined towns, ie burghs with charters, first appear in Scotland in the 12th century but it is likely that there were pre-burghal settlements before that date, particularly in towns like Perth (Spearman 1988). Limited urban excavation has meant that there is, as yet, little evidence for such pre-burghal development (*ibid*, 97) but the forthcoming dendrochronological analysis of timber assemblages from some of the older urban excavations may reveal early phases of building activity preserved in the reuse of timbers.

CONCLUSIONS

The successful analysis of the assemblages from Buiston and Whithorn has now added another building block to tree-ring coverage in Scotland but this attempt to tie up the 'loose ends' of earlier excavations has demonstrated that we still need much larger assemblages of timber from the varied zones throughout Scotland if we are to overcome the problems created by Scotland's complex biogeographical diversity. The construction of these Early Historic chronologies has also demonstrated that, as well as the provision of a more accurate dating framework for Scotland, additional information bearing on the socio-economic conditions of the times is chronicled in the tree-rings and is there to be reaped, as it has been elsewhere in Britain and Ireland.

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A copy of the archive report containing raw ring-width data and statistical correlations is lodged at AOC Archaeology.

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