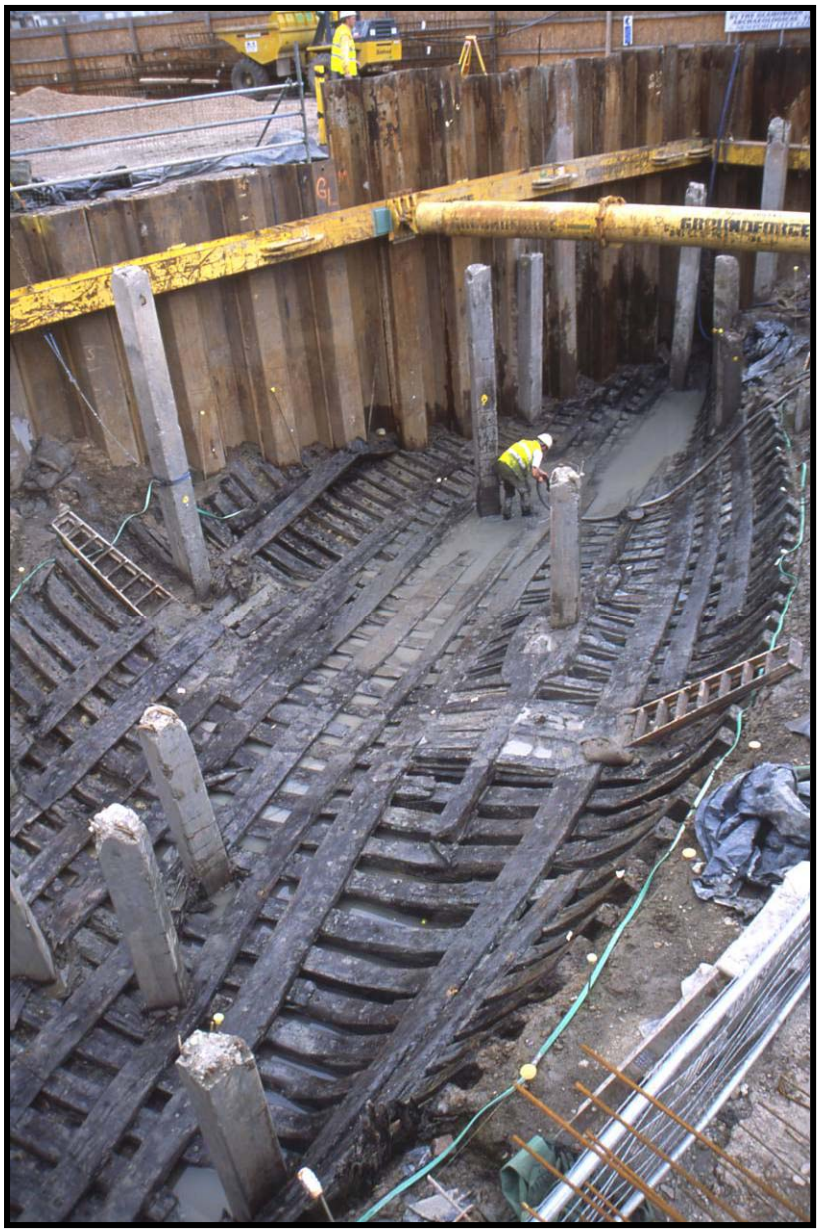
Newport Medieval Ship Project
Specialist Report:
Tree-ring analysis



Site number: GGAT 467
Site location: NGR: ST 31286 88169 Kingsway, Newport, South Wales, UK.

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The Newport Ship Project

Introduction

In 2002, during the construction of the Riverfront Theatre, on the banks of the River Usk in Newport, South Wales, an archaeological find of great significance was unearthed. In the summer of that year, while undertaking the excavations for the theatre's orchestra pit, the well-preserved remains of a 15th century clinker built merchant vessel were discovered.

The site, which was surrounded by a cofferdam, was being monitored by the Glamorgan Gwent Archaeological Trust at the time of discovery. The ship lay in what is locally known as a pill or small inlet, with its stern closest to the river and its bow facing into the inlet. The timbers were covered in thick alluvial mud, which created an ideal anaerobic environment for successful preservation. Seventeen strakes of planking remained on the port side and thirty-five on the starboard side of the ship. The vessel was approximately 30m in length.

A silver French coin was found purposely inserted into the keel of the vessel, dating the ship to after May 1447. Dendrochronological research has shown the hull planking to be from the Basque country and after 1449 in date.

After a much publicised 'Save Our Ship' campaign, it was decided that the ship would not be recorded and discarded but excavated with the aim to conserve. The riders, stringers, braces, mast step, frames and overlapping clinker planks and keel were dismantled one by one and lifted. Almost 2000 ship components as well as hundreds of artefacts were excavated.

This report summarises the tree-ring analysis that has taken place during the Newport Medieval Ship excavation and post-excavation research phase.

Tree-ring analysis of the Newport Medieval Ship

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Introduction

This study synthesises a decade of intermittent study of timbers found during the excavation and recovery of the Newport Medieval Ship and associated structures during a major building development on the west bank of the river Usk in south-east Wales in 2002. The national grid reference for the ship, using the centre of the mast step is (331283,188164 or ST3128388164).

To understand the strategies and methods employed particularly with regard to sampling for dendrochronology, a brief summary of the context of the excavations and the author's role will be helpful. The author first visited the site on 22nd June 2002 and was contracted by Glamorgan-Gwent Archaeological Trust (GGAT) to act as a consultant and timber specialist during the watching brief on 26th June 2002. Following recognition of the presence of at least part of a clinker built boat or ship on 29th June, limited extensions to the excavations of approximately a week at a time were provided to allow investigation of the location, extent and importance of the ship remains and associated archaeology. On July 19th, a five week extension was agreed to allow recording and possible selective recovery of the ship to be completed. On August 23rd a joint announcement by Newport City Council and the Welsh Assembly Government committed to a program of dismantling the ship and recovering it for further study, conservation and eventual display. Following completion of lifting of the ship within the confines of the sheet pile cofferdam on the 9th November 2002, Glamorgan-Gwent Archaeological Trust undertook a separate contract to carry out limited excavations beneath the ship, focussed on a timber structure underneath the ship's starboard side. During this excavation, undertaken between 18th November and 11th December, the author continued to advise on wood recording, sampling and recovery. Excavation of bow timbers extending beyond the confines of the original sheet coffer dam was undertaken by Oxford Archaeology in the spring of 2003. The author visited the site during this period but no samples were taken from timbers as all were recovered for post-excavation recording and conservation.

Methodology

Sampling strategy

The nature of the ship project developed and changed from a chance discovery in need of 'spot' dating to a major rescue excavation with some timbers requiring sampling before being discarded to a substantive post-excavation program of analysis of the recovered ship remains destined for conservation and eventual display. During the early stages of excavation, timbers (such as those from drain context 111) were assessed for dendrochronological dating potential by the author, sampled and these samples analysed soon after being taken in the hoping of informing decisions on excavation strategy. Soon after recognition of the ship and uncovering of part of the port side, samples were taken from a small selection of both framing timbers and hull planks. These samples were analysed soon after being taken but could not be cross-matched against available British and other European chronologies. As excavation progressed, exposing and removing timbers from within the ship, further samples were taken from any suitable timbers and analysed. The first 'spot date' from a possible rough out timber - a partially worked length of oak with much surviving bark edge found lying over the mast step of the ship (g1069) provided the first absolute dating of the site with a bark edge date of the winter of AD1467/8. Further dates for timbers in the vicinity of the ship

(such as the large knee 1629 found attached to a composite beam dated to the winter of AD 1465/6) confirmed the fifteenth-century date of the site complementing artefact discoveries such as coinage/jettons from Portugal (Besley 2013).

Once the formal announcement was made on funding to recover the ship for conservation and display, and a plan developed to dismantle the remainder of the ship into its constituent timbers (the ceiling timbers had already been removed but retained), it became clear that documentation of timbers would need to be completed prior to any further sampling for tree-ring dating. The ship was duly dismantled between August and November without additional samples being recovered.

Targeted excavation underneath the starboard side of the ship, and along the centreline exposed timber structures 1004 (a 'cradle' of oak and elm trunks)and 1003 (a collection of oak boards providing a 'walkway' through the starboard side of the ship). Not all the timbers from these structures were recovered in their entirety, and samples taken from some of these timbers on site produced bark edge dates defining the time after which the ship must have been deposited.

Documentation of recovered ship timbers first focused on recording of the outer hull planks. Recording had included making as assessment of ring counts and sapwood presence. Once these characteristics had been entered into the timber database, it was possible to prioritise timber selection for dendrochronological analysis on the basis of these criteria encouraging production of the longest ring-width sequences, optimising the chance to date these against external reference chronologies. Timbers with some sapwood were prioritised as, normally, a dated sequence with some sapwood allows the production of a felling date range where the period during which the timber's parent tree was cut down can be estimated. Timbers were also selected on spatial criteria, with samples being taken from numerous different strakes, including as many as possible from strake S14. The intention here was to see if any working patterns, such as numerous timbers from the same parent tree being found in the same location on the hull, could be discerned. The total number of samples measured was intended to be sufficient to build a well-replicated mean sequence to maximise the opportunity for dating against external reference chronologies (which had not proved possible with the data from only a few planks early during excavations). Approximately thirteen percent of the recovered outer hull planks of the Newport Ship were sampled for dendrochronological analysis (Table 2 and Figure 2).

A similar process of selective sampling of framing timbers was undertaken using ring counts and the presence of bark edge as indicators of timbers with good potential for cross-matching and the provision of precise felling dates to the year or season. In some cases, full cross-section slices were taken but in other instances a wedge shaped sample was taken through sapwood and the outer heartwood rings and a separate, overlapping core taken through the heartwood. Approximately fifteen percent of framing timbers (floors, futtocks and fillers) were sampled.

Few of the sawn inner hull timbers (predominantly ceiling planks and stringers) had sufficient rings to merit sampling although one ceiling plank, six bilge boards and one chock were sampled. similarly, two of the four riders in the bow were also sampled.

All tingles (radial boards fastened to the outboard face of the outer hull) with sufficient rings were sampled in the hope of providing dating and provenance for these apparent repairs.

Notes on sample numbering/coding

During the early stages of excavation undertaken by GGAT, timbers were usually assigned a wood record number (timber number series starting at 1001, given prefix 'g' in this report), assessed for suitability for tree-ring dating and selectively sampled by the author (sample series starting at 001). Timbers were often discarded after recording and do not therefore appear in later post-excavation records. During the excavation and recording of timbers and other wooden artefacts found lying within the ship, this approach continued with many timbers being recorded on wood record sheets, sampled if suitable for dating purposes and then discarded. Increasingly however, timbers were retained and held in the very limited storage space available on site having been assigned a wood record number. Some of these timbers were sampled at this stage in the hope of providing dating evidence to inform decisions on the future of the site. Once the excavations shifted from a very much rescue oriented approach with a commitment to the recovery of the ship for future study, timbers were lifted having been recorded *in situ* and transported to offsite storage. Smaller fragments of wood did however continue to be assessed on site, recorded, sampled and discarded. Those timbers which were recovered to temporary storage in custom built tanks in a redundant warehouse on the Corus steelworks site (including those excavated from the bow area by Oxford Archaeology) were subsequently relabelled with pre-numbered tags normally used as eartags for livestock prior to being moved to dedicated recording facilities established on the Maesglas Industrial Estate in Newport. During this renumbering process, a database was established to provide a concordance between original GGAT or OA numbers and the new 'cowtag' numbers. During the post excavation recording of individual timbers, any timbers selectively sampled for tree-ring dating by hand sawing a slice or wedge sample had new cowtags attached to these samples so they could be re-attached to their parent timbers after conservation. In many cases, the sampling of a large timber for dendrochronology would result in three pieces: the section of timber with the original cowtag attached (termed the parent), the slice sample (with new cowtag attached) and a third section of the timber (termed the orphan also with new cowtag attached).

In this report samples are normally coded in one of the following ways:

Where the sample came from a group of small, unnumbered wood fragments from the same context collected by excavators for assessment by the wood specialist, the sample was coded gUL1 with 'g' indicating part of the GGAT excavations, followed by 'UL' indicating derivation from an unnumbered fragment, followed by a unique number. This approach has been used on only five samples

Where the sample came from a timber which was assigned a GGAT wood number, sampled on site and subsequently discarded without post-excavation renumbering (cowtagging) then the sample code comprises prefix 'g' followed by the GGAT wood number. Any site sample number given to this is indicated in the description. Where the sampled timber formed part of the articulated remains of the ship, this number is preceded by a ship timber function code (see archive notes on timber function codes).

Where the sample came from a timber which was retained for post-excavation recording, then the sample code will normally comprise a function code followed by the cowtag number assigned to the sample. Further information is included in the description for each timber.

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage guidance documents (EH 1998). The samples were cleaned using razor blades so that the ring sequence could be clearly discerned and measured. The complete sequence of growth rings in each sample was measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). Cross-correlation algorithms (Baillie, Pilcher 1973, Munro 1984) are employed to search for positions where the ring sequences are highly correlated against each other. The ring sequences were also tested against a range of reference chronologies from Britain and Northern Europe. The *t*-values reported below are derived from the original CROS algorithm (Baillie, Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high t-values at the same relative or absolute position must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions. Correlated positions were checked visually using computerised ring-width plots.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 1998) and similar sapwood estimates for the species *Quercus faginea* growing in the Iberian peninsula are not as yet available. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

Details of samples taken for ring-width analysis are given in Tables 1-4. These are presented by context or, if derived from the articulated remains of the ship itself, grouped by structural element. These groupings are followed in the text sections below providing an outline of the dating results secured.

Context 111: Timber Drain

During the watching stage of the development, a timber drain comprising angled sides made from oak planks with a cover of flatly laid planks over oak stretchers was encountered. The structure was recorded *in situ*, and samples taken from two timbers (g1004 and g1005) from this structure. Both samples contained marginal ring numbers (<50) but their ring sequences cross-matched against each other with a *t*-value of 5.18 with good visual matching. A combined ring-width sequence could not be dated against British and other European chronologies. A fragment of reused boat/ship plank (gUL1) was sampled and has subsequently been cross-matched against the Newport Ship T37 site master (*t*=8.48) based largely on articulated outer hull planks. The parent tree for this plank was felled after AD 1388 (with no sapwood estimate applied).

Context 113: Framing timbers and rough-outs

A single sample from framing rough-out g1031 produced a 149-year ring-width sequence. This has not dated against British or other European chronologies.

Timbers lying within the Ship

Context 121

This context of alluvium with numerous wood fragments was removed relatively rapidly during early stages in the excavation. Three samples were taken from timber fragments g1078, g1083 and g1084. A possible hull plank fragment found near the stern, g1083, produced a 209-year ring-width sequence which could not be cross-matched against other timbers from the site but has been dated against British chronologies to AD 1200-AD 1408 with an inferred felling date of after AD 1418 (Tables

Table 1 and Table 6). The ring-width sequence from timber g1084 cross-matched with that from g1081 with a high *t*-value of 10.73 (Table 5) and close visual matching suggesting they derived from the same parent tree. A combined ring-width sequence cross-matched against series from timber g1086 from Context 130, and the fourth rider from the ship (R4, Table 4). Through dating of the mean of these cross-matched sequences against British chronologies (Table 6), the felling date of the parent tree from which timbers g1081 and g1084 derived is the spring of AD 1469.

Context 128

This context, lying below context 121 over a large area of the interior of the ship contained numerous wood fragments. Five radial pieces of oak were sampled and analysed. One of these,

g1084, came from the same parent tree as g1081 with a felling date of spring AD 1469 for this common parent tree.

Context 129

Within a dense deposit of stone in the stern of the vessel, two stave fragments Stave_2902 and Stave?_2904 were sampled but their ring-width sequences could not be cross-matched against each other or other ring width sequences from the site, or dated British and other European chronologies.

Context 130

This alluvium occupied much of the inter-frame spaces within the hull of the ship and also overlay some of the inner hull (mast step/keelson, ceiling planks and stringers). Numerous disarticulated timbers lying within the ship were recovered from this context. Eight timbers were sampled of which three have been dated.

Sample gUL4 which came from an unnumbered radial fragment has been cross-matched against the NewportT37 site master (*t*=4.88), with higher correlations against individual hull plank series included in this master including a particularly high *t*-value against P9.3_2325 (*t*=9.71). The parent tree for this plank was felled after AD 1398 (with no sapwood estimate applied).

An oak rough out found lying over the mast step, g1069, provided the first absolute medieval dating evidence for the ship site. This dated against a range of British site masters, with bark edge and a complete final ring indicating felling of its parent tree in the winter of AD 1467/8 (Table 6).

A radial fragment g1086 cross-matched against series from timbers g1081 and g1084 combined and the fourth rider from the ship (R4, Table 4). Through dating of the mean of these cross-matched sequences against British chronologies (Table 6), the felling date of the parent tree from which timber g1086 derived is after AD 1445.

Context 134

This timber group, possibly remains of an area of decking or a partition include a single ledge/stanchion with sufficient rings for analysis. A 84-year ring-width sequence was produced, but this has not dated against British or other European chronologies.

Context 147

Only one timber from the deck elements (possible hatch covers) encountered within the ship was sampled for dendrochronology. A single board (DE_2943) produced a 59-year ring-width sequence which could not be dated against British and other European chronologies.

Knees

Three knees found lying within the ship were sampled. Knee_1629 was found attached to a complex beam (context 135), lying approximately amidships. None of the beam timbers had sufficient rings to merit sampling but a combination of increment cores and wedge samples were taken from the knee during the excavations. A single ring-width series derived from these multiple samples was dated against British site masters with a felling date for the parent tree of the winter of AD 1465/6.

Knee_2798, a sample taken from knee 1638 (g1120) had also been attached to a complex beam and was found in the forward part of the ship. The ring-width sequence from this knee has not been dated.

A third, smaller knee (1614 g1222) found on the starboard side lying over frames F35-8 was sampled (Knee-2975) after completion of post-excavation recording. The ring-width series cross-matched against that of Knee_1629, and an oak block (Block_734) found inserted over the keel of the ship at F10 with high *t*-values (Table 5). The mean of these three timbers (Knees_F10) has dated against a wide range of British masters (Table 6) providing a felling date for the parent tree of the winter of AD 1461/2.

Context 1003

A group of boards laid flat provided a walkway (context 1003) into the side of the ship where access had been cut through the hull on the starboard side between F26 and F29 from strake S27 upwards (and cut through part of the underlying 'cradle' structure). A sample from one of these boards (Walkway_1487) matched with high *t*-values against timbers from the underlying cradle (Context 1004). A combined mean of these sequences (SubShipT5) cross-matches against numerous British master sequences (Table 6). The parent tree for Walkway_1487 is thereby dated to the winter of AD 1467/8.

Timbers lying below the Ship

Sampled timbers from directly below the ship should only be considered as pre-dating arrival/deposition of the ship following careful consideration of their disposition. A number of timbers could have fallen between the outside of the hull on the starboard side and the edge of the inlet onto which structure 1004 was laid. The majority of samples described below are however from timbers forming this cradle like structure onto which the ship settled and was then heeled over (or collapsed) onto its starboard side.

Context 1004

Underneath the ship at frame stations F49 and F54 two oak boles with roughly cut ends lay close to the centreline of the ship. The forward most of these, g579, lay with the keel settled close to its southern end. A sample cross-matched against other timbers from structure 1004 under the starboard side of the ship and it parent tree's felling date derived at spring AD1468.

Three of the sloping struts forming the part of structure 1004 onto which the starboard side of the ship had settled produced ring-width sequences which correlated with g579 and also with the Walkway_1487 timber from structure 1003(Table 5). Dating of the mean sequence against a range of British site masters (Table 6) produced felling dates for the parent trees of Strut_2972 (winter of AD 1467/8), Strut_2947 (winter of AD 1467/8), and Strut_g563 (AD 1467?).

Articulated Ship Hull

Keel

Lifting of the beech keel in six sections made access to the ring-width data straightforward with a being sample taken from the after end of the second section from the bow along with samples of the attached oak garboards. The 97-year sequence should be seen as an underestimate or the parent tree's age at felling as, although both pit and bark edge were present, the sample came from

relatively high in the tree, at least 14m above ground level. The ring-width sequence could not be dated against site sequences, the very limited historical data for beech in Britain or a wide range of oak chronologies.

Outer Hull Planks

A total of 373 individual outer hull planks were recovered as 711 fragments, from which 50 tree-ring samples were taken (Table 2, Figure 2). Samples were first taken soon after the ship's discovery with a group of plank samples being collected from the first area where the articulated hull remains were observed on the port side. Although these early samples produced viable ring-width series which matched against each other, no significant correlations could be found with European oak chronologies for many years after the ship's discovery. During post-excavation documentation of the ship, samples were normally taken as hand sawn slices after completion of recording and then cleaned with a razor blade along one cut edge to reveal the full ring sequence. The samples were also employed to assist in characterisation of the condition of the timbers as part of the conservation assessment (Panter unpubl), before being included in conservation tanks alongside their parent planks.

Same trees

Samples taken from heavily disturbed bow hull planks were used to confirm the correct equation of bow timbers with the less disturbed main part of the hull. Hence fifth and tenth port strake correlations were identified (P5.1_2920 and P5.1_2922 (*t* = 19.09), and P10.1_2928 and P10.1_2930 (*t* = 30.25)) and single raw ring-width series P5.1 and P10.1 calculated for subsequent cross-matching between individual timbers.

During cross-matching, high correlations and very close visual matches were observed between the ring width series from three pairs of planks (P1.5 and S3.3 (t = 12.31), P13.1 and S15.8 (*t* = 13.87); P13.3 and S21.1 (*t* = 14.97)) and a group of three planks (P11.2, P15.1, and S8.3), and a group of three planks and a filler from frame station F39 (P2.4, P5.5 and P6.4 and F39_2511_Filler) suggesting that these were derived from the same parent trees (Table 7). Again, single ring-width series were calculated for each of these groups.

Correlated Hull Plank Sequences

The five combined sequences mentioned above, and the ring-width sequences from a further 31 hull planks, another filler (F30_2985_Filler) and a bilge board (2988) were correlated with one another (as shown in Table 8). During correlation of these sequences, two subgroups of sequences with higher correlations were noted. The largest group (Group1planks - shaded green on the correlations table) comprised 29 sequences derived from 36 individual hull planks and two fillers. A smaller group (Group2planks - shaded red on the correlations table) comprised five individual plank sequences. A further three plank sequences were not assigned to either group but correlated with a sufficient number of sequences to warrant inclusion in the overall mean of 37 ring-width sequences named NewportT37.

During the development of this Newport Ship mean, derived largely from outer hull planks, the dating of this increasingly well-replicated site master remained problematic. Initial attempts to correlate sequences against established British and other European chronologies and site masters had proved unsuccessful. Appeals to dendrochronological colleagues for assistance led to the

developing Newport Ship site master to be compared with a wide range of ring-width data from across most of north-west Europe. In 2006, the author started correspondence and data exchange with Josué Susperreguii, a dendrochronologist working for the Arkeolan Foundation based in Irun, Gipuzkoa . Collaboration continued as work proceeded both on the Newport Ship post-excavation and in Basque Country, where Arkeolan continued to improve the time depth, geographical extent and replication of their regional oak ring-width chronologies. In2012, more intensive data exchange, and a visit to Arkeolan's laboratory allowed for confirmation of significant correlation between the NewportT37 mean and a chronology developed from the hinterland of the Basque coast (Arab4). Full publication of the collaboration of the author of this report with Josué Susperreguii will be published elsewhere (Nayling and Susperreguii forthcoming). Correlations between the Newport Ship master NewportT37, means of its subgroups and individual timber sequences on the one hand, and the Arab4 chronology from the Basque Country, and some of the site masters used in its construction are given in Table 9. These correlations support dating of the Newport T37 mean to the date range AD1277 to AD 1449 inclusive. They also suggest that the oak trees exploited to provide hull planks (and other timbers such as filler pieces and bilge boards) employed in the original construction were growing in the upland interior of the Basque coast of northern Spain.

Tingles

Tingles, patches of wood fastened to the outboard face of the hull, usually as a repair, were found over a wide area of the surviving hull. These can be divided into those with rebates on their inboard face to accommodate nail heads protruding from the outboard face of the hull (of which three were sampled for tree-ring analysis), and tingles without rebates where the outer face of the hull had been cut flat removing remnants of the heads of fasteners before the tingle was fastened. The latter type could be thought more likely to be a later repair. Seven tingles of this latter type were sampled for tree-ring analysis (Table 3).

The three tingles without rebates cross-matched against each other with high correlations and close visual matches indicating that the timbers were derived from the same parent tree (Table 10 and Figure 5). A combined raw ring-width sequence for this parent tree, TingleReb, could not be dated against British or other European chronologies.

The sequences from five of the unrebated tingles correlated with high *t*-values (Table 10) and close-visual matches (Figure 5). Two or three of these timbers could have derived from a common parent tree. A mean of these five correlated timbers, 5_Tingles, cross-matched against a wide range of British chronologies (including Castle of Park, Scotland) and one Irish chronology. Assuming a British origin, a sapwood estimate of 10-46 sapwood rings was applied to this group. Combining the felling date ranges from two of these where partial sapwood survived, assuming these represent a single repair event, suggests that the parent trees were felled between AD 1459 and AD 1483 (Figure 1).

Framing Timbers

A total of 211 uniquely coded framing timbers (floors and futtocks) were recovered from the ship. Thirty-two samples were taken from 31 distinct framing timbers plus one sample from an uncoded frame timber fragment (gUL5) (Table 4) . Samples were sometimes taken as a combination of a wedge sample of sapwood and outermost heartwood and an increment core of heartwood with the

ring sequences from the two subsamples overlapping. Two samples were taken from futtock F33.2 and their sequences combined.

Correlations between the framing timbers was limited in contrast to the outer hull planks. Significant, replicated correlations and acceptable visual matching could be found within a group of seven framing timbers (Table 11, Figure 8, Figure 9), from which a seven timber, 105-year mean FramingT7 was calculated. It has so far proved impossible to date these sequences, or their mean against external, previously dated site masters or chronologies, including those presently constructed at Arkeolan. The fact that five of the seven ring width sequences all end in the same relative year of 105 with possible or definite bark edge supports the correlation of this grouping.

Fillers

Six samples derive from fillers, timbers fastened over the inboard face of framing timbers before attachment of ceiling planks (Table 4). Two of these fillers (F30_2985_Filler and F39_2511_Filler) cross-matched against the outer hull planks and form part of the site master NewportT37 (Table 8). One of these fillers, F39_2511_Filler, was derived from the same parent tree as three port-side hull planks (P2.4, P5.5 and P6.4) (Table 7a). The remaining sequences from fillers could not be cross-matched against other site timbers or against British or other European chronologies.

Stringers

No stringers were sampled.

Ceiling Planks

It is a reflection of widespread use of tangential sawing as the main method of production of the boards employed as ceiling planks, that only two ceiling planks were sampled for tree-ring analysis (Table 4). One of these sequences could not be cross-matched against other site timbers or against British or other European chronologies. The other (CS1.5_2933) correlated against three bilge boards and through dating of the combined mean (see below) is dated to AD 1343 - AD 1424. No sapwood is applied to this sequence as, at present, there is insufficient data to provide suitable estimates.

Chocks

A single chock or brace, BRP2_1752, has been analysed. Its ring sequence correlates against the framing mean FramingT7 with a *t* -value of 5.44 with its final ring dating to relative year 105 with surviving bark edge (Table 4, Table 11, Figure 8 and Figure 9).

Bilge Boards

Ring-width sequences were measured from six bilge boards and three (BB_2987, BB_2988 and BB_2989) found to correlate well with each other and with the ceiling plank CS1.5_2933. The resultant calculated mean (CS1_5_BB) correlates significantly with site master NewportT37 and many of its constituent individual ring-width sequences, and also with the Arab4 chronology and some of its constituent site masters (Table 12 and Table 13). None of the samples had partial sapwood or definite heartwood sapwood boundaries so no felling date ranges could be applied even if a suitable sapwood estimate was available. Date ranges for the dated bilge boards are given in Table 4.

Riders

Two of the four riders found in the bow of the ship were sampled (Table 4). The sample from the after most rider (R4_2973) cross-matched against disarticulated timbers found within the ship (g1081, g1084 and g1086) from which mean R4_1080s was calculated and dated against British site masters (Table 5 and Table 6). Partial sapwood survived allowing for estimation of the felling range of the parent tree as AD 1461-90.

F10 Block

During excavation of the ship, an unusual feature was encountered where a flooring timber would normally have been located running across the keel at frame station 10. The framing timber(s) appear to have been cut away at the centreline and a roughly cut block of wood was found tightly wedged into this space with smaller pieces of wood directly over the keel. The ring width sequence from this apparent (late?) insertion correlated highly against two knees found disarticulated (one partially) within the ship (Table 5c). The mean of these sequences dates against a range of British site masters (Table 6, Knees-F10block), indicating the parent tree of this timber was felled in the winter of AD 1465/6 (the same as Knee-1629). Although the correlation between Knee_1629 and the block at F10 is just $t< 10$, there is a close visual match between the ring patterns suggestive of a same tree origin for these two timbers (Figure 11). Given the same felling date and very similar ring patterns, use of parts of the same parent tree for a large (standing?) knee with associated beam timbers (context 135), and a rather enigmatic insertion over the keel at F10, could represent different aspects of a single phase of activity.

Discussion

Dendrochronology has played a key role at different stages in the Newport Medieval Ship project. It provided the first absolute dating of the site to the medieval period, thereby stressing the significance of the ship. The timely provision of dating information played its part in securing a future for the ship against a background of impending development and potential destruction. Subsequent correlation of well-replicated means predominantly from outer hull planks point to an Iberian origin for the ship. Dating of knees and riders, alterations and repairs to the later fifteenth century (including precise felling dates of AD 1465/6) against British chronologies imply episodes of repair and refit, some of which may have been in process when the ship was salvaged and abandoned. These correlations could also be taken to imply long running association between the ship and British waters pointing to the 'sphere of operations' within which the ship sailed and traded.

Original construction of the ship presumably started after AD 1449 - the date of the latest surviving ring on one of the absolutely dated hull planks. This dating has been achieved through correlation against a number of recently constructed site means from buildings in the hinterland of the northern Spanish Basque coast where the oak species *Quercus faginea* (indistinguishable on wood anatomy from a number of other deciduous oak species such as *Quercus petrea and Quercus robur*)predominates. At the present time, there are insufficient data to provide appropriate sapwood estimates for this species in this location. Until such data is collected, felling date ranges for the absolutely dated oak hull planks with heartwood/sapwood boundaries or partial sapwood cannot be calculated. This makes the collection and analysis of such data, preferably from living trees with similar age structures a research priority from a Newport Ship perspective.

The development of historical dendrochronology in the Basque area of Spain has been critical to understanding the origins of the Newport Ship. Export of timber from this area to another shipbuilding location, whilst possible, seems an unlikely interpretation of the data. Again, more research (particularly documentary) is needed to clarify the historical evidence for timber supply for shipbuilding in the region during the fifteenth century, as has been done for the sixteenth century with regard to the Red Bay wrecks (Grenier, Stevens & Bernier 2007). Nearly all the hull plank samples cross-matched to form a well-replicated site mean but other timbers appear to have been hewn from similarly sourced timber given correlations with bilge boards, fillers and one ceiling plank. The source location is however not well-defined and further development of site and regional chronologies in the region will be needed if confident dendroprovenancing is to be achieved.

The framing timbers analysed proved far more difficult to correlate with only seven tree-ring sequences along with that from one of the mast step braces cross-matching against each other. Ring sequences from 'compass' timber (i.e. timber with branching allowing selection to provide grown curved timbers) are inherently less likely to cross-match with the trees' morphology becoming a significant variable in ring width obscuring common climatic response. It is possible that active management of the parent trees could further impact on growth patterns. The absolute dating of framing sequences may yet prove possible - it is feasible that these trees were growing in an area from which we do not have contemporary chronologies stressing again the importance of improving temporal and spatial coverage for oak chronologies in Basque territory.

Dating of oak struts from structure 1004, onto which the starboard side of the ship settled, to AD 1467 and in one case the spring of AD 1468 provide a precise date for the ship's likely final arrival in Newport. This has inevitably encouraged a degree of historical particularism leading to possible association with activities of Warwick 'the Kingmaker' during his control of the Lordship of Newport ((Trett 2005).

Tables

Table 1. Samples and results of analysis: Newport Ship: Timbers excluding articulated hull remains

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range	Felling date
c1073	c1073 g1338 poss displaced ceiling	Radial	242 x 22	79	-	3.06	Undated	-
g1094	sample 42 g1094	Radial	95 x 31	83	-	1.13	Undated	-
g1147	g1147. Fragment F30 starboard. Sample 43	Radial	67 x 14	88	29	0.77	Undated	-
g1209	sample 50 no cont w1209 loose plank	Tangential	150 x 27	68	-	1.93	Undated	-
gUL2	Site 467 unlabelled fragment 2	Half		57	3	2.33	Undated	-
Beam								
Beam?_1607	c1607 g1288 possible beam fragment. Increment core	Whole	400 x 240	192	+?HS	1.37	Undated	-
Context 111								
g1004	g1004 from drain. Cont 111. Cross-matches against g1005	Quarter	100 x 92	46	22+Bw	1.98	Relative 4-49	-
g1005	g1005 from drain. Cont 111. Cross-matches against g1004	Tangential	305 x 90	48	13+B	2.06	Relative 1-48	-
gUL1	Reused boat? plank from upper drain. Cont 111 22/6/02. Cross-matches against plank mean from ship	Radial	130 x 25	84	-	1.47	AD1305-AD1388	-
Context 113								
g1031	Frame roughout g1031. Discarded on site	Half	220 x 108	149	7+8s	1.14	Undated	-
Context 120								
g1050	Possible bilge board fragment between frames	Tangen	222 x 26	66	-	2.45	Undated	-

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range	Felling date
	34 and 35 on port side.	tial						
Context 121								
g1078	g1078 hacked fragment with possible chamfer. Cont 121/8? near the stern. Discarded on site	Quarter	110 x 80	101	-	1.22	Undated	-
g1083	g1083 possible hull plank fragment with hood end? Cont 121/8? near stern. Discarded on site	Radial	85 x 30	209	-	0.65	AD1200-AD1408	after AD1418
g1084	g1084 tapering radial fragment. Cont 121/8? near stern. Discarded on site. Same tree as g1081	Radial	85 x 20	133	24	0.71	AD1334-AD1466	AD1466-88
Context 128								
g1081	g1081 radial fragment. Cont 128 just aft and starboard of amidships. Discarded on site. Same tree as g1084	Radial	68 x 13	81	29++ ½Bs	0.79	AD1388-AD1468	AD1469 spring
g1202	g1202 radial fragment cF32 starboard. Cont 128. Discarded on site	Radial	175 x 33	78	28++ ½Bs	0.93	Undated	-
g1203	g1203 radial fragment. cont 128? cF40 starboard. Discarded on site	Radial	100 x 10	82	-	1.19	Undated	-
g1204	g1204 radial fragment. cont 128? cF40 starboard. Discarded on site	Radial	67 x 8	103	-	0.63	Undated	-
g1206	g1206 radial fragment. cont 128? cF40 starboard. Whole piece formed sample	Radial	115 x 65	82	+?HS	1.35	Undated	-
Context 129								
Stave_2902	Stave_2902 g 1076. Cont 129	Radial	100 x 19	58	-	1.72	Undated	-
Stave?_2904	Stave?_2904 g1077. Cont 129	Radial	108 x 19	77	+HS	1.15	Undated	-
Context 130								
g1070	g1070 radial plank. Cont 130. Plank at F58-9 starboard. Plan 27. Discarded on site	Radial	285 x 28	108	-	2.53	Undated	-
g1069	g1069 roughout overlying mast step. Cont 130.	Whole	245 x 200	58	19+B	2.64	AD1410-AD1467	AD1467

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range	Felling date
	First medieval date measured 13/7/2002				w			winter
g1071	g1071 plank fragment. Cont 130. Discarded on site	Tangential	150 x 25	54	-	2.53	Undated	-
g1072	g1072 possible wedge. Cont 130. Discarded on site	Radial	65 x 40	72	37++ ½Bs	0.82	Undated	-
g1073	g1073 dismantled framing timber fragment. Cont 130. Discarded on site	Quarter	180 x 140	102	+?HS	1.61	Undated	-
g1086	g1086 triangular radial fragment possibly part of a framing timber? Cont 130	Radial	82 x 42	91	-	0.86	AD1345-AD1435	after AD1445
gUL3	Unnumbered unworked fragment under timber group context 134. Cont 130	Radial	97 x 12	60	-	1.57	Undated	-
gUL4	Unnumbered fragment. Cont 130	Radial	97 x 28	74	-	1.28	AD1325-AD1398	-
Context 134								
g1054	g1054 ledge/stanchion. Cont 134	Whole	111 x 83	84	23+Bw	0.86	Undated	-
Context 147								
DE_2943	Sample c2943 from board c1249, part of deck element 147	Radial	155 x 22	59	3	2.64	Undated	-
Knees								
Knee_1629	Knee c1629 g1061. Increment cores and wedge samples taken on site	?		147	23+Bw	1.79	AD1319-AD1465	AD1465 winter
Knee_2975	Knee c1614 g1222 4 rad raw	Whole	190 x 185	132	28+Bw	1.18	AD1330-AD1461	AD1461 winter
Knee_2978	Knee c1638 g1120. Unable to link wedge sample of sapwood	Half	280 x 250	75	+?HS	2.83	Undated	-
Knee_2975	Knee c1614 g1222 4 rad raw	Whole	190 x 185	132	28+Bw	1.18	AD1330-AD1461	AD1461 winter
Knee_2978	Knee c1638 g1120. Unable to link wedge sample	Half	280 x 250	75	+?HS	2.83	Undated	-

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range	Felling date
	of sapwood							
Context 1004								
Strut_2965	Beam reused as strut c1539 g511. Chamfer and redundant peg holes	Quarter	175 x 105	55	-	3.3	Undated	-
Shore_2871	c1416 g577 Port side shoring timber?	Quarter	210 x 165	58	10	3.39	Undated	-
Strut_2966	Strut c1659 g566	Whole		98	28+Bs	2.27	Undated	-
Strut_2972	Strut c1662 g514	Whole		115	17+Bw	1.4	AD1353-AD1467	AD1467 winter
Strut_2977	Strut c1677 g512	Whole	210 x 195	48	15+B	2.2	Unmeasured	-
Strut_2947	Strut c1658 c 2947 g519	Whole	335 x 175	114	19+Bw	1.57	AD1354-AD1467	AD1467 winter
Strut_g563	Strut g563	Whole	365 x 360	120	21+?B	1.62	AD1348-AD1467	AD1467?
Strut_g579	Strut g579	Whole		123	18++½Bs	1.44	AD1345-AD1467	AD1468 spring

+HS = heartwood/sapwood boundary, +?HS = possible heartwood/sapwood boundary, +B = bark edge, +Bw= bark edge winter, ++1/2 Bs =plus incomplete last ring, spring felled

Table 2. Samples and results of analysis: Newport Ship Timbers outer hull planks

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
P1.2_1753	1753 ggat2419 P1.2 at aft end of 2/6 keel	Radial	195 x 41	76	-	2.52	AD1351-AD1426
P1.5_1755	P1.5 at forward end of 5/6 keel. Same parent tree as S3.3	Radial	205 x 42	121	-	1.7	AD1305-AD1425
P2.4_2339	Same parent tree as F39_2511_Filler P5.5 and P6.4	Radial	202 x 36	104	-	1.9	AD1317-AD1420
P3.6_2309	Plank 387 P3.6 sample 2309	Radial	198 x 32	99	-	1.96	AD1331-AD1429
P4.4_2341	P4.4 timber 401 sample 2341	Radial	240 x 32	124	-	1.71	AD1308-AD1431
P5.1_2920	P5.1 sample 2920 parent 1745	Radial	115 x 26	60	-	1.68	AD1355-AD1414
P5.1_2922	P5.1 sample 2922 parent 199	Radial	205 x 30	90	-	2.19	AD1323-AD1412
P5.5_2343	Same parent tree as F39_2511_Filler P2.4 and P6.4	Radial	220 x 32	96	6	2.29	AD1351-AD1446
P6.1_2918	P6.1 sample 2918 parent 616	Radial	185 x 24	94	-	1.98	AD1337-AD1430
P6.4_2345	Same parent tree as F39_2511_Filler P2.4 and P5.5	Radial	220 x 31	140	6	1.56	AD1305-AD1444
P7.1_2925	P7.1 sample 2925 parent 774	Radial	175 x 26	74	-	2.32	AD1340-AD1413

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
P7.8_2348	P7.8 timber 165 sample 2348	Radial	201 x 29	108	-	1.84	AD1302-AD1409
P8.6_2329	P8_6 170 sample 2329	Radial	230 x 32	127	+?HS	1.78	AD1292-AD1418
P9.3_2325	P9_3 375 sample 2324	Radial	210 x 31	133	8	1.56	AD1311-AD1443
P10.1_2928	P10.1 sample 2930 parent 169	Radial	172 x 28	85	1	2.01	AD1354-AD1438
P10.1poss_2930	P10.1 sample 2930 parent 846	Radial	165 x 29	80	+HS	1.99	AD1359-AD1438
P10.2_2324	P10_2 605 sample 2324	Radial	185 x 26	84	2	2.04	AD1342-AD1425
P11.2_2319	P11.2 sample 2319. Same parent tree as P15.1 and S8.3	Radial	200 x 18	123	-	1.63	AD1293-AD1415
P11.5_2321	P11_5 196 sample 2321	Radial	251 x 21	151	18	1.61	AD1293-AD1443
P12.4_2303	Plank 221 P12_4 sample 2303	Radial	227 x 28	158	+?HS	1.42	AD1282-AD1439
P13.1_771	P13_1 771 g1043 sample 6. Sampled on site. Same parent tree as S15.8	Radial	205 x 21	122	6	1.58	AD1308-AD1429
P13.3_2295	Plank 604 P13_3 sample 2295. Same parent tree as S21.1	Radial	242 x 33	144	7	1.65	AD1292-AD1435
P14.1_g1042b	P14.1 g1042 sample 07B. Sampled on site	Radial	0 x 0	79	-	2.45	AD1338-AD1416
P14.2_g1042a	P14_2 sampled during excavation 2396 ggat1042 Sample 07	Radial	0 x 0	117	-	1.79	AD1313-AD1429
P15.1_g1041	P15_1 g1041 sample 8. Sampled on site. Same parent tree as P11.2 and S8.3	Radial	163 x 25	77	-	1.96	AD1306-AD1382

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
P15.3_2358	P15.3 timber 627 sample 2358	Radial	237 x 27	138	2	1.66	1309-1446
P15.4_2852	P15_4 cow 2852 ggat1045 sample 11B	Radial	172 x 28	95	-	1.79	1-95
P16.1_2360	P16.1 timber 627 sample 2360	Radial	210 x 31	89	-	2.34	AD1335-AD1423
P16.3_g1045A	P16_3 2842 g1045 sample 11a	Radial	245 x 35	91	-	2.31	AD1345-AD1435
S1.3_1754	sample 1754 g2269 S1.3 at aft end of 2/6 keel	Radial	178 x 34	82	-	2.04	AD1358-AD1439
S1.7_1751	sample 1751 ggat2351 S1.7b at for end of 6/6 keel	Radial	216 x 32	92	-	2.25	AD1325-AD1416
S3.3_2307	Same parent tree as P1.5	Radial	215 x 34	139	-	1.49	AD1285-AD1423
S6.1_1696	sample 1696 ggat2242 S6.1 slice	Radial	203 x 28	110	11	1.84	AD1340-AD1449
S8.3_2291	Same parent tree as P11.2 and P15.1	Radial	220 x 28	140	7	1.54	AD1302-AD1441
S11.5_2305	Plank 501 S11.5 sample 2305	Radial	242 x 38	168	-	1.46	AD1277-AD1444
S13.4_1748	511 S13.4 sample 1748	Radial	160 x 30	72	4	2.18	AD1366-AD1437
S13.6_1729	474 S13.6 sample 1729	Radial	230 x 33	128	+?HS	1.79	AD1291-AD1418
S14.3_1723	S14_3 1723	Radial	220 x 33	115	+?HS	1.82	AD1318-AD1432
S14.4_1727	466 S14_4 sample 1727	Radial	245 x 33	89	1	2.72	AD1345-AD1433

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
S14.5_1725	419 S14_5 sample 1725	Radial	247 x 31	118	6	2.08	AD1321-AD1438
S14.6_1721	S14_6A 1721	Radial	280 x 34	145	3	1.57	AD1286-AD1430
S14.7_1719	S14_7 1719	Radial	223 x 34	102	4	2.04	AD1340-AD1441
S15.8_2301	Same parent tree as P13.1	Radial	215 x 26	124	-	1.69	AD1291-AD1414
S21.1_2317	Plank 251 S21.1 sample 2317. Same parent tree as P13.3	Radial	203 x 23	133	-	1.5	AD1294-AD1426
S24.1_2315	Plank 546 S24.1 sample 2315	Radial	270 x 23	127	+?HS	1.61	AD1296-AD1422
S26.4_2297	Plank 130 S26_4 sample 2297	Radial	195 x 30	125	8	1.52	AD1296-AD1420
S27.4A_2293	Plank 136 S27_4A sample 2293	Radial	205 x 25	134	17	1.5	AD1312-AD1445

+HS = heartwood/sapwood boundary, +?HS = possible heartwood/sapwood boundary

Table 3. Samples and results of analysis: Newport Ship : Hull Timbers: Tingles

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range	Felling date
Tingles no rebates								
162_T_P10	Tingle 162 P10 OB no rebates	Radial	185 x 30	101	-	1.74	AD1300-AD1400	after AD1410
1774_T_P10	Tingle 180 1774 OB P10.4/5 no rebates	Radial	168 x 26	126	+?HS	1.31	AD1315-AD1440	AD1450-86?
1776_T_S24	Tingle 248 1776 OB no rebates S24_4/5	Radial	150 x 25	65	-	2.32	1330-1394	after 11404
2274_T_S3	Tingle 245 S3 OB no rebates sample 2274	Radial	201 x 24	65	-	3.1	Undated	
2276_T_S28	Sample 2276 from Tingle 422 S28 OB no rebates	Radial	176 x 29	131	11	1.23	AD1318-AD1448	AD1448-83
2278_T_S23	Tingle 272 S23 OB no rebates sample 2278	Radial	167 x 24	134	5	1.24	AD1321-AD1454	AD1459-95
2281_T_S26	Tingle 131 S26 OB no rebates sample 2281	Radial	148 x 26	117	-	1.22	AD1326-AD1442	after AD1452
Tingles rebates								
1744_T_P12	209 OB tingle P12.4/5 sample 1744 F31-F33/34	Radial	70 x 24	106+40h	-	1.33	Relative 8-113	
2286_T_S31	Tingle 344 S31_2B/3 OB rebates sample 2286	Radial	170 x 25	160	-	1.07	Relative 1-160	
2287_T_P9	Tingle 208 P9_4/5 OB rebates sample 2287	Radial	174 x 25	117	-	1.35	Relative 10-126	

+HS? = possible heartwood/sapwood boundary

Table 4. Samples and results of analysis: Newport Ship : Hull Timbers excluding outer hull

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
Bilge Boards							
BB_2987	Bilge board c1576 g1799	Radial	135 x 25	75	-	1.71	AD1330-AD1404
BB_2988	Bilge board c2111 g1640	?	175 x 25	88	-	1.74	AD1331-AD1418
BB_2989	Bilge board c2250 g1262	Tangential	260 x 30	73	+?HS	1.72	AD1334-AD1406
BB_2990	Bilge board c1955 g1618	Tangential	119 x 25	50	17+	1.05	
BB_2992	Bilge board c1016 g1697	Radial	210 x 30	77	-	2.69	
BB_2993	Bilge board c2231 g1874	Radial	120 x 25	76	-	1.5	
Ceiling							
CS1.3_2927	Sample of c1316	Tangential	175 x 32	65	1	1.88	
CS1.5_2933	Sample c1104	Tangential	260 x 34	82	-	1.57	AD1343-AD1424
Chocks							
BRP2_1752	c1587 g1727. Cross-matches against framing mean FramingT7	Whole	215 x 180	95	16+?B	1.46	Relative 11-105
F10block							
Block_734	c734 g2035 block at F10	Half	235 x 150	124	28+Bw	1.3	AD1342-AD1465. Felling date AD1465 winter
Fillers							
F23_1701 Filler	c789 g1997 filler over F23.0	Radial	183 x 27	109	18	1.65	
F30_2985 Filler	Filler F30.0 sample of c1191 g1879. Correlates with hull planks in Plank Group1 within Newport T37	Radial	250 x 25	151	-	1.65	AD1277-AD1427

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
F36_2986 Filler	Filler F36 c1070 g1864	Tangential	185 x 32	59	36+?B	1.36	
F39_2511 Filler	c1093 g1867 filler for F39 stbd. Same parent tree as planks P2.4, P5.5 and P6.4	Radial	165 x 34	89	-	1.84	AD1347-AD1435
F39_2991 Filler	Filler F39 c1065 g1861	Tangential	150 x 26	66	-	1.75	1-66
F41_2513 Filler	CT1082 parent g1844	Tangential	230 x 75	97	21+?B	1.27	1-97
Framing Timbers							
F10.1_2835		Whole	190 x 120	54	9+?B	2.2	
F10.2_2863		Half	220 x 150	45	12	2.76	
F12.0_2914	Forms part of mean Framing_T7	Half	230 x 155	92	25	2.03	Relative 6-97
F14.2_2912	Forms part of mean Framing_T7	Half	205 x 120	99	11+?B	1.62	Relative 7-105
F17.0_2874		Half	225 x 173	76	12	2.01	
F18.0_2894		Whole	320 x 220	75	12	2.83	
F18.2_2908		Half	210 x 125	67	23+?B	1.29	
F19.1_2847	F19_1 2847 frame g1049 sample 15. Sample taken on site	Whole	185 x 150	91	10++½Bs	1.68	
F22.4_2869		Half	210 x 120	69	9	2.58	
F23.4_2833		Quarter	205 x 105	80	15	2.51	Relative 23-102
F24.0_2837	Much wedging of rings	Whole	280 x 240	93	12	2.11	
F27.0_2519		Whole	280 x 280	73	13+?B	2.31	
F28.0_1134	c1134 ggat1988 F28.0 2nd core and wedge			77	11+Bw	2.18	
F29.2_2883	Forms part of mean Framing_T7	Whole	220 x 135	105	20+?B	1.63	Relative 1-105
F30.4_2867		Whole	235 x 135	62	7+?B	2.29	
F32.0_2844		Whole	270 x 245	117	16+?B	1.36	

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
F33.1_861	c861 ggat1048 sample 14. Sample taken on site	Half	230 x 120	40h+48	8	2.11	
F33.2_2286_2906	Futtock F33_2 2286 and 2906 combined			118	28	1.1	
F35.0_2390	c2390 g1911 F35.0 wedge and core samples. Unable to combine data			26	14++½Bs	2.24	
F35.3_2840	Forms part of mean Framing_T7	Whole	163 x 90	99	12+Bw	1.16	Relative 7-105
F37.0_2892		Whole	265 x 230	99	18+?B	1.8	
F37.1_2853	Futtock F37_1 g1047 sample 013. Sample taken on site	Half	255 x 155	91	13++½Bs	1.98	
F40.2_2848	Forms part of mean Framing_T7	Whole	230 x 160	105	13+Bw	1.26	Relative 1-105
F41.0_2850		Half	240 x 235	58	13+Bw	2.96	
F41.1_2854	F41_1 sample 2854 frame 1046 S12	Whole	195 x 145	82	10++½Bs	1.75	
F44.0_2860		Half	210 x 200	52	11	4.31	
F45.0_2855	Forms part of mean Framing_T7	Half	225 x 165	88	25+?B	1.15	Relative 18-105
F45.2_2872		Half	235 x 135	53	-	2.54	
F48.0_2831		Quarter	295 x 255	96	21+?B	2.48	
F50.1_2888		Half	200 x 130	85	8	1.77	
F53.0_2910		Whole	220 x 220	157	16+?B	1.43	
gUL5	unnumbered fragment of framing timber	Radial	85 x 55	65	-	1.22	
Keel							
Keel_2540	Keel 2540 sample from aft end of 2 of 6. NB Wood species beech (*Fagus sylvatica*)	Whole	230 x 221	94	+B	1.77	
Riders							
R2_2974	Rider R2 g 1658 c1419	Quarter	190 x 130	111	4	0.79	
R4_2973	Rider R4 g 1659 c1613	Quarter	260 x 160	249	17	1.15	AD1213-AD1461. Felling date range

Sample Code	Description	Conversion	Dimensions (mm)	Total Rings	Sapwood	ARW (mm)	Date range
							AD1461-90

+HS = heartwood/sapwood boundary, +?HS = possible heartwood/sapwood boundary. Bw = Winter felled bark edge. Bs = Summer felled bark edge.?B = possible Bark edge. HS = heartwood/sapwood boundary

Table 5. Correlations (CROS73 *t*-values) between samples from disarticulated timbers and Rider R4 and inserted block at F10 Block_734

a) Context 111

Filenames	g1005
g1004	5.18

b) Context 121/8

Filenames	g1081
g1084	10.73

c) Knees and block at F10

Filenames	Knee_1629	Knee_2975
Block 734	9.17	8.29
Knee_1629	*	9.14

d) Contexts 1003 and 1004

Filenames	Strut_2947	Strut_g563	Strut_g579	Strut_2972
Walkway_1487	7.65	4.38	5.79	11.42
Strut_2947	*	4.04	4.51	7.99
Strut_g563	*	*	3.63	4.62
Strut_g579	*	*	*	6.17

e) Rider R4_2973 and timbers g1081_4 and g1086

Filenames	g1086	R4_2973
g1081_4	5.53	5.28
g1086	*	4.82

Table 6. Correlations (CROS73 *t*-values) between site means and individually dated samples and selected British regional chronologies and site means

	-	-	5Tingles	g1069	g1083	Knees_F10 block	R4_1080s	Subship T5
	start	dates	AD1300	AD1410	AD1200	AD1319	AD1213	AD1345
	dates	end	AD1454	AD1467	AD1408	AD1465	AD1468	AD1467
Bedstone Manor Farm Salop (Miles, Haddon-Reece & Moran 1995)	AD1341	AD1560	6.04	5.19	-	5.36	-	5.09
Clunbury Church nr Ludlow Shropshire (Tyers 2000)	AD1239	AD1494	7.33	3.1	-	3.05	4.41	4.48
(Tyers 1996)Hereford Cathedral Barn Late (Tyers 1996)	AD1359	AD1491	4.71	3.98	-	6.06	3.27	8.25
Pound Farm, Herefordshire (Nayling 2002)	AD1316	AD1441	5.26	3.32	-	3.16	5.59	4.75
White House, Vowchurch, Herefordshire (Nayling 1999)	AD1364	AD1602	8.16	5.84	-	5.53	3.51	7.01
66/68 Westgate St Gloucester Gloucs (Tyers, Wilson 2000)	AD1209	AD1518	4.54	-	5.24	7.99	5.23	5.21
New Inn House Kingswood Gloucs (Arnold, Howard & Litton 2004)	AD1191	AD1519	3.87	4.89	5.36	6.73	3.12	4.92
Broomham Kings Nympton Devon	AD1370	AD1464	-	7.45	-	-	-	4.47
Archdeacons House Exeter Devon (Howard, Laxton & Litton 1999)	AD1186	AD1404	7.14	\	7.32	3.27	-	4.39
Bowhill House, Exeter Devon (Hillam 1991)	AD1292	AD1468	5.79	3.2	-	5.3	3.49	6.6
Exeter Cathedral Devon (Mills 1988)	AD1137	AD1332	-	\	5.43	\	-	\
Dublin (Baillie 1977)	AD1357	AD1556	7.68	4.5	-	3.05	3.54	4.62
Scotland Castle of Park (Tyers pers comm)	AD1350	AD1551	10.35	3.12	-	-	3.27	5.52

Table 7. Correlations (CROS73 *t*-values) between highly correlated ship timber samples (hull planks and one filler) interpreted as derived from the same parent tree

a) NPGr1Tr1 Newport Ship Hull Planks Group 1 Tree1

Filenames	P2.4_2339	P5.5_2343	P6.4_2345
F39_2511_Filler	11.23	15.21	11.97
P2.4_2339	*	11.87	14.05
P5.5_2343	*	*	10.2

b) P11.2_15.1_S8.3

Filenames	P15.1_g1041	S8.3_2291
P11.2_2319	11.56	10.38
P15.1_g1041	*	12.93

c) P1.5_S3.3

Filenames	S3.3_2307
P1.5_1755	12.31

d) P13.1_S15.8

Filenames	S15.8_2301
P13.1_771	13.87

e) P13.3_S21.1

	S21.1_2317
P13.3_2295	14.97

Table 8. Correlations (CROS73 *t*-values) between synchronised samples from outer hull planks, one filler and one bilge board forming site mean NewportShipT37 :

Filenames	NPG1 Tr1	P1.2_ 1753	P1.5_ S3.3	P3.6_ 2309	P4.4_ 2341	P5 .1	P7.1_ 2925	P7.8_ 2348	P8.6_ 2329	P9.3_ 2325	P1 0.1	P10.2_ 2324	P11.2_15. 1_S8.3	P11.5_ 2321	P12.4_ 2303	P13.1_ S15.8	P14.2_g 1042a	P16.3_g1 045A	S1.3_1 754	S1.7_1 751	S6.1_1 696	S11.5_ 2305	S14.3_ 1723	S14.6_ 1721	S14.7_ 1719	S24.1_ 2315	S26.4_ 2297	S27.4A_ 2293	P14.1_g1 042B	P16.1_ 2360	S13.4_ 1748	S14.4_ 1727	S14.5_ 1725	P6.1_ 2918	P13.3_ S21.1	S13.6_ 1729
F30_2985 _Filler	6.93	3.77	-	4.84	5.71	-	3.8	3.14	-	3.13	-	-	5.5	7.84	3.76	4.15	5.16	4.74	3.2	-	3.07	9.8	3.06	3.94	-	5.16	7.47	4.02	-	4.05	-	3.27	-	4.05	4.28	3.93
NPG1Tr1	*	5.25	6.51	6.76	4.46	5.37	4.91	3.37	3.62	3.41	5.34	6.48	5.68	8.38	6.33	6.96	3.63	4.22	10.41	5.2	6.91	6.61	6.65	7.65	3.37	5.52	6.6	8.52	-	3.14	-	3.8	3.71	-	3.45	3.23
P1.2_1753	*	*	4.44	7.45	-	3.29	3.17	3.83	-	-	3.64	4.24	-	5.59	4.53	3.31	3.97	3.32	-	-	3.22	4.7	-	3.08	3.82	-	5.46	5.91	-	3.33	-	4.56	-	-	-	-
P1.5_S3.3	*	*	*	4.57	-	-	-	-	-	4.53	6.83	3.54	-	5.33	7.84	4.44	-	-	4.08	4.04	3.36	3.09	4.21	6.76	-	4.3	3.77	5.85	-	4.31	-	4.08	4.98	-	-	-
P3.6_2309	*	*	*	*	3.37	3.28	4.11	4.11	-	-	4.93	3.18	4.22	6.54	6.26	4.77	4.12	5.85	-	3.56	3.37	4.71	3.77	4.44	5.59	4.52	6.32	5.72	3.37	3.34	3.56	3.84	3.56	4.54	-	-
P4.4_2341	*	*	*	*	*	-	-	5.1	5.58	4.4	-	-	7.29	4.71	-	-	7.26	4.21	3.6	3.37	-	5.79	-	4.32	4.72	3.84	7.3	3.46	3.48	3.97	-	4.73	3.1	8.96	5.34	3.03
P5.1	*	*	*	*	*	*	3.89	-	-	-	3.91	-	-	3.69	3.03	3.72	-	-	3.65	3.27	-	3.9	3.96	-	3.7	3.11	5.25	3.85	-	-	-	-	-	-	-	4.58
P7.1_2925	*	*	*	*	*	*	*	-	-	-	4.19	3.72	-	3.87	-	-	-	4.12	-	3.77	4.27	5.17	3.54	3.62	3.72	3.53	4.14	4.88	-	-	-	-	-	-	-	-
P7.8_2348	*	*	*	*	*	*	*	*	6.27	3.13	-	-	5.16	4.57	-	4.03	3.8	-	-	3.18	-	4.09	-	-	4.24	-	5.2	-	-	3.29	-	3.67	-	3.6	4.01	4.1
P8.6_2329	*	*	*	*	*	*	*	*	*	-	-	-	9.38	-	-	-	4.77	-	-	-	-	3.01	-	3.47	-	-	4.04	-	3.02	-	-	-	-	3.02	-	-
P9.3_2325	*	*	*	*	*	*	*	*	*	*	3.06	-	4.88	4.23	3.86	-	-	-	3.58	-	-	4.14	-	-	-	4.28	4.58	-	-	5.25	-	3.69	4.39	-	3.5	3.34
P10.1	*	*	*	*	*	*	*	*	*	*	*	3.6	-	4.16	6.68	3.86	-	3.38	4.48	4.75	-	3.73	6.33	4.25	4.28	-	-	3.87	-	-	3.89	5.75	4.55	-	-	-
P10.2_2324	*	*	*	*	*	*	*	*	*	*	*	*	-	3.1	-	3.51	-	-	-	5.46	5.36	3.31	4	3.99	3.34	-	3.25	5.25	-	-	-	-	3.02	-	-	-
P11.2_15. 1_S8.3	*	*	*	*	*	*	*	*	*	*	*	*	*	4.65	-	-	5.84	3.29	3.21	-	-	5.02	-	3.08	3.29	3.04	6.81	4.18	3.78	3.73	3.43	5.22	3.68	5.15	4.64	-
P11.5_2321	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5.86	4.45	4.14	5.98	4.86	-	4.2	8.92	3.18	4.21	3.36	4.94	9.78	5.7	-	4.3	-	4.33	4.24	3.43	4.6	-
P12.4_2303	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.36	-	-	4.59	-	-	4.75	-	-	3.81	4.54	4.63	3.51	-	3.66	-	4.24	4.07	-	-	-
P13.1_S15 .8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	3.53	4.46	-	4.61	4.87	4.16	-	3.19	4.91	4.8	-	-	-	-	-	-	-	4.06
P14.2_g1042a	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.02	-	-	-	5.43	-	3.48	-	3.56	6.2	3.72	3.03	-	-	4.16	-	5.3	-	-
P16.3_g1045A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	3.33	-	5.94	3.1	-	6.61	3.23	4.95	3.79	-	-	-	-	-	3.49	3.12	-
S1.3_1754	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.55	4.57	4.68	4.26	4.13	-	-	3.5	4.9	-	-	-	4.49	-	-	-	-
S1.7_1751	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8.15	3.27	-	3.98	3.15	-	4.18	4.47	-	-	-	3.37	-	-	-	-
S6.1_1696	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.6	3.06	5.57	-	-	3.24	6.71	-	-	-	-	-	-	-	-
S11.5_2305	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	4.63	4.25	6.19	8.51	5.14	-	4.18	-	4.74	3.49	-	4.58	4.02
S14.3_1723	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.61	-	-	-	4.35	-	-	-	-	-	-	-	-
S14.6_1721	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	4.75	4.16	8.18	-	-	-	3.22	3.05	-	-	3.42
S14.7_1719	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	4.5	4.1	-	-	-	3.55	-	4.18	-	-
S24.1_2315	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.72	-	-	3.5	-	-	3.27	-	-	3.33
S26.4_2297	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.35	-	4.51	-	3.61	4.5	4.47	3.16	5.64
S27.4A_2293	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	3.01	3.34	5.07	3.35	-	-	-
P14.1_g1042B	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4.43	5.79	6.18	7.64	4.03	-	-
P16.1_2360	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.19	9.46	6.74	3.88	-	-
S13.4_1748	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5.98	7.96	-	-	-
S14.4_1727	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5.67	3.62	-	-
S14.5_1725	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.57	-	-
P6.1_2918	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.09	-
P13.3_S21 .1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.93
S13.6_1729	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

	Group1planks plus two fillers		Group2planks		ungrouped planks		Bilge Board 2988

Table 9. Correlations between mean NewportT37 and its components, and regional chronology Arab4 and selected site masters used in its construction. All Arkeolan data Josué Susperreguii pers comm

Filenames	-	-	Arab4	arab2	arab6sites	czbmea	ipbmea	CasaL	Jaur	ldi2568Petritea	Saga	ldi2477Arret	ldi3643Gort	a4subccm
-	start	dates	AD1277	AD1277	AD1284	AD1336	AD1341	AD1339	AD1307	AD1335	AD1284	AD1299	AD1335	AD1277
-	dates	end	AD1819	AD1819	AD1468	AD1489	AD1591	AD1468	AD1439	AD1438	AD1464	AD1444	AD1447	AD1689
NewpT37	AD1277	AD1449	5.74	5.58	5.98	4.73	4.04	4.43	6.44	6.32	-	4.38	7.86	5.13
NPG1T29	AD1277	AD1449	6.01	5.86	6.14	5.28	3.64	4.53	6.62	6.04	-	4.84	8.46	5.6
F30_2985_Filler	AD1277	AD1427	-	-	-	-	-	-	-	3.76	-	3.03	-	3.14
NPG1Tr1	AD1305	AD1446	8.64	8.63	8.24	5.21	4.19	4.9	6.38	4.62	4.31	5.78	6.56	6.13
P1.2_1753	AD1351	AD1426	5.75	5.61	4.34	4.93	3.94	3.38	3.35	4.61	-	3.93	4.79	6.03
P1.5_S3.3	AD1285	AD1425	6.45	6.56	7.47	-	-	5.57	6.22	4.94	5.09	4.06	4.56	3.65
P3.6_2309	AD1331	AD1429	6.11	6.02	5.56	3.31	4.35	3.13	4.93	4.44	-	5.29	4.98	5.36
P4.4_2341	AD1308	AD1431	3.25	3.04	-	3.23	-	-	-	3.27	-	-	-	-
P5.1	AD1323	AD1414	3.47	3.7	-	-	-	-	-	3.28	-	3.8	3.15	3.57
P7.1_2925	AD1340	AD1413	5.99	5.94	4.54	3.13	-	-	3.09	5.01	-	4.81	4.12	5.56
P7.8_2348	AD1302	AD1409	3	-	-	-	-	-	3.47	3.91	-	-	3.39	-
P8.6_2329	AD1292	AD1418	-	-	-	-	4.11	-	-	-	-	-	3.11	-
P9.3_2325	AD1311	AD1443	4.13	4.12	3.82	-	-	-	3.42	-	-	-	-	3.51
P10.1	AD1354	AD1438	6.51	6.73	6.64	-	-	3.9	4.76	4.45	3.32	5.41	7.41	4.76
P10.2_2324	AD1342	AD1425	5.63	5.55	5.09	4.57	3.18	3.87	5.19	3.84	-	3.19	4	4.96
P11.2_15.1_S8.3	AD1293	AD1441	-	-	-	3.71	4.06	-	-	-	-	-	3.61	-
P11.5_2321	AD1293	AD1443	4.62	4.5	4.23	-	-	-	4.59	5.24	-	3.32	5.53	4.12
P12.4_2303	AD1282	AD1439	6.09	6	5.95	-	4.58	4.39	5.51	4.94	3.2	5.1	4.37	5.55
P13.1_S15.8	AD1291	AD1429	-	-	-	-	-	4.23	4.41	-	-	-	3.15	4.32
P14.2_g1042a	AD1313	AD1429	-	-	-	3.11	3.13	-	-	-	-	-	-	-
P16.3_g1045A	AD1345	AD1435	3.85	3.68	-	4.28	-	-	3.34	3.55	-	-	4.93	4.13
S1.3_1754	AD1358	AD1439	4.08	4.27	4.19	3.06	-	3.61	4.17	3.31	-	4.02	4.8	3.63
S1.7_1751	AD1325	AD1416	5.45	5.61	5.1	3.43	-	5.32	5.2	4.09	-	-	5	5.52
S6.1_1696	AD1340	AD1449	4.66	4.75	5	-	-	4.46	4.34	-	3.24	3.68	3.27	4.11
S11.5_2305	AD1277	AD1444	3.62	3.28	4.04	4.74	-	3.1	3.5	4.37	-	3.43	5.8	3.57
S14.3_1723	AD1318	AD1432	5.48	5.86	5.24	-	-	-	3.66	-	4.6	4.51	4.94	4.08
S14.6_1721	AD1286	AD1430	3.96	3.93	4.9	3.23	-	3.92	4.31	-	3.54	3.05	3.38	-
S14.7_1719	AD1340	AD1441	3.82	3.68	3.2	-	-	-	3.28	-	-	-	3.79	3.86
S24.1_2315	AD1296	AD1422	3.44	3.38	3.51	-	-	-	4.1	3.68	-	4.61	-	3.06
S26.4_2297	AD1296	AD1420	3.54	3.32	3.22	5.81	5.04	3.04	3.53	5.74	-	-	3.97	3.42
S27.4A_2293	AD1312	AD1445	7.26	7.11	6.65	5.95	3.11	4.76	3.97	3.72	4.1	3.77	4.92	5.83
NPGr2T5	AD1321	AD1438	4.24	4.16	4.67	-	4.11	3.2	-	5.35	-	-	4.32	-
P14.1_g1042B	AD1338	AD1416	-	-	3.01	-	-	3.19	-	-	-	-	-	-
P16.1_2360	AD1335	AD1423	-	-	-	-	-	3.06	-	3.38	-	-	-	-
S13.4_1748	AD1366	AD1437	-	-	-	-	3.43	-	-	4.72	-	-	3.35	-
S14.4_1727	AD1345	AD1433	3.25	3.1	3.31	-	3.41	3.35	-	4.26	-	-	4.2	-
S14.5_1725	AD1321	AD1438	3.5	3.42	3.66	-	4.03	-	-	4.49	-	-	-	-
P6.1_2918	AD1337	AD1430	-	-	-	-	-	-	-	-	-	-	-	-
P13.3_S21.1	AD1292	AD1435	-	-	-	-	-	-	3.37	-	-	-	-	-
S13.6_1729	AD1291	AD1418	-	-	-	-	-	-	-	-	-	-	-	-

Table 10. Correlations (CROS73 t-values) between synchronised samples from tingles forming means TingleReb and 5_Tingles

a)Three rebated tingles from a common parent tree, TingleReb

Filenames	2286_T_S31	2287_T_P9
1744_T_P12	13.12	13.4
2286_T_S31	*	16.78

b) 5_Tingles without rebates

Filenames	1774_T_P10	2276_T_S28	2278_T_S23	2281_T_S26
162_T_P10	14.96	3.85	7.53	3.63
1774_T_P10	*	10.36	13.12	7.11
2276_T_S28	*	*	8.57	5.84
2278_T_S23	*	*	*	7.08

Table 11. Correlations (CROS73 t-values) between samples from framing timbers forming the mean Framing_T7 and Brace sample BRP2_1752

	F14.2_2912	F23.4_2833	F29.2_2883	F35.3_2840	F40.2_2848	F45.0_2855
BRP2_1752	-	3.20	-	5.41	6.80	-
F12.0_2914	-	5.18	5.1	3.44	3.11	-
F14.2_2912	*	-	4.25	3.94	6.52	3.64
F23.4_2833	*	*	-	-	3.8	-
F29.2_2883	*	*	*	4.65	-	3.64
F35.3_2840	*	*	*	*	4.49	-
F40.2_2848	*	*	*	*	*	3.69

Table 12. Correlations (CROS73 t-values) between synchronised samples of ceiling and bilge boards used to calculate mean CS1_5_BB

Filenames	BB_2988	BB_2989	CS1.5_2933
BB_2987	9.57	3.24	5.07
BB_2988	*	4.04	5.16
BB_2989	*	*	6.33

Table 13. Correlations (CROS73 *t*-values) between site means for Newport Ship hull planking NewportT37 and some of its constituent timbers, and the Basque Arab4 chronology and some of its constituent site masters and the site mean CS1_5_BB dated to AD1330 to AD 1424 inclusive. All Basque data pers comm Josué Susperreguii.

Filenames	-	-	**CS1_5_BB**
	start	dates	AD1330
	dates	end	AD1424
NewpT37	AD1277	AD1449	5.98
NPG1T29	AD1277	AD1449	5.66
P1.5_S3.3	AD1285	AD1425	3.52
P10.1	AD1354	AD1438	4.48
P10.2_2324	AD1342	AD1425	3.57
P11.5_2321	AD1293	AD1443	3.49
P13.1_S15.8	AD1291	AD1429	4.02
P16.3_g1045A	AD1345	AD1435	3.19
P3.6_2309	AD1331	AD1429	4.63
P5.1	AD1323	AD1414	3.97
S11.5_2305	AD1277	AD1444	3.27
S14.3_1723	AD1318	AD1432	4.68
S14.6_1721	AD1286	AD1430	3.41
S26.4_2297	AD1296	AD1420	3.38
S27.4A_2293	AD1312	AD1445	4.24
NPG2T5	AD1321	AD1438	3.34
S14.5_1725	AD1321	AD1438	3.14
Arab4mean	AD1277	AD1819	5.91
a4subccM	AD1277	AD1689	4.75
CasaL	AD1339	AD1468	4.19
Jaur	AD1307	AD1439	5.7
ldi2568Petritea	AD1335	AD1438	3.18
ldi2477Arret	AD1299	AD1444	4.33
ldi3643Gort	AD1335	AD1447	5.14

Figures

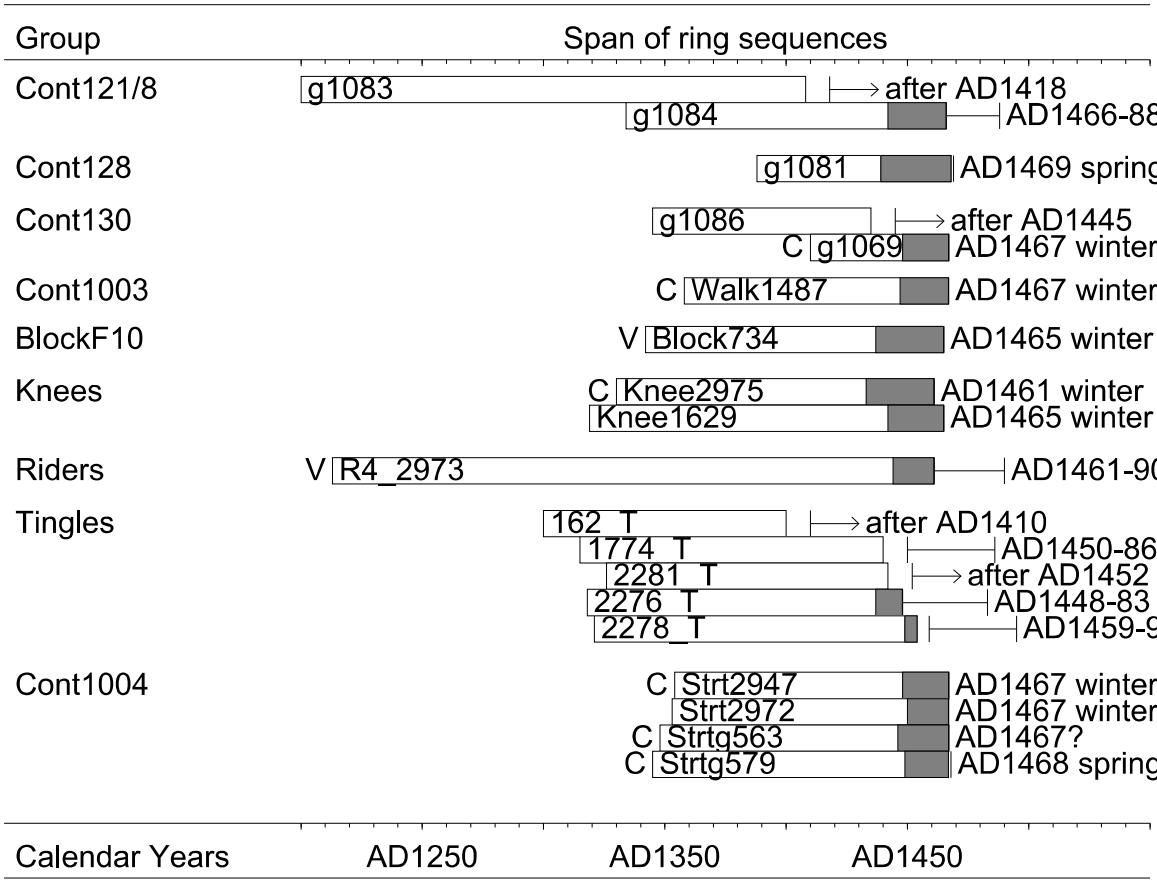

Figure 1. Bar diagrams of timbers dated against British site masters grouped by context or structural element

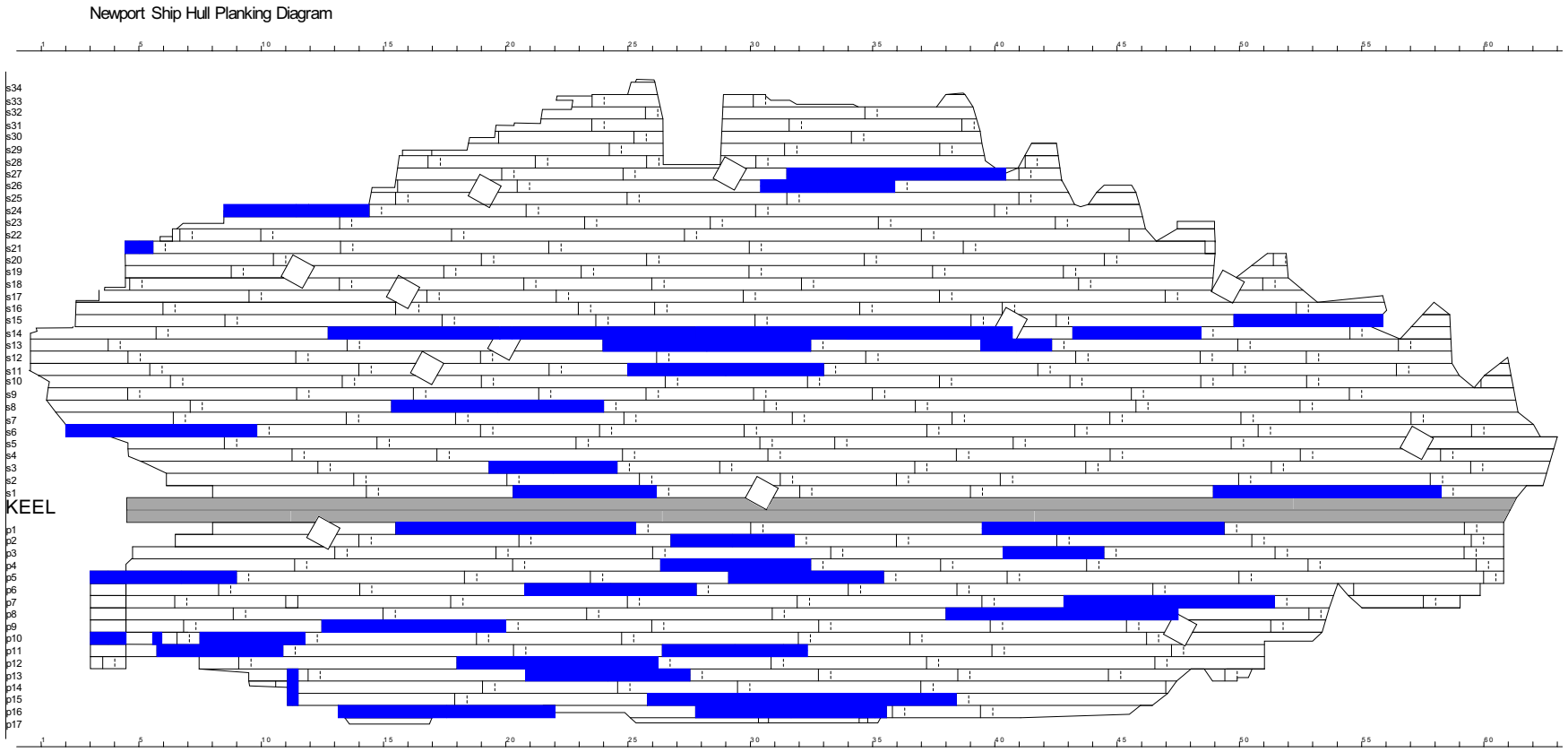

Figure 2. Diagrammatic representation of the outer hull planks indicating those sampled for dendrochronology

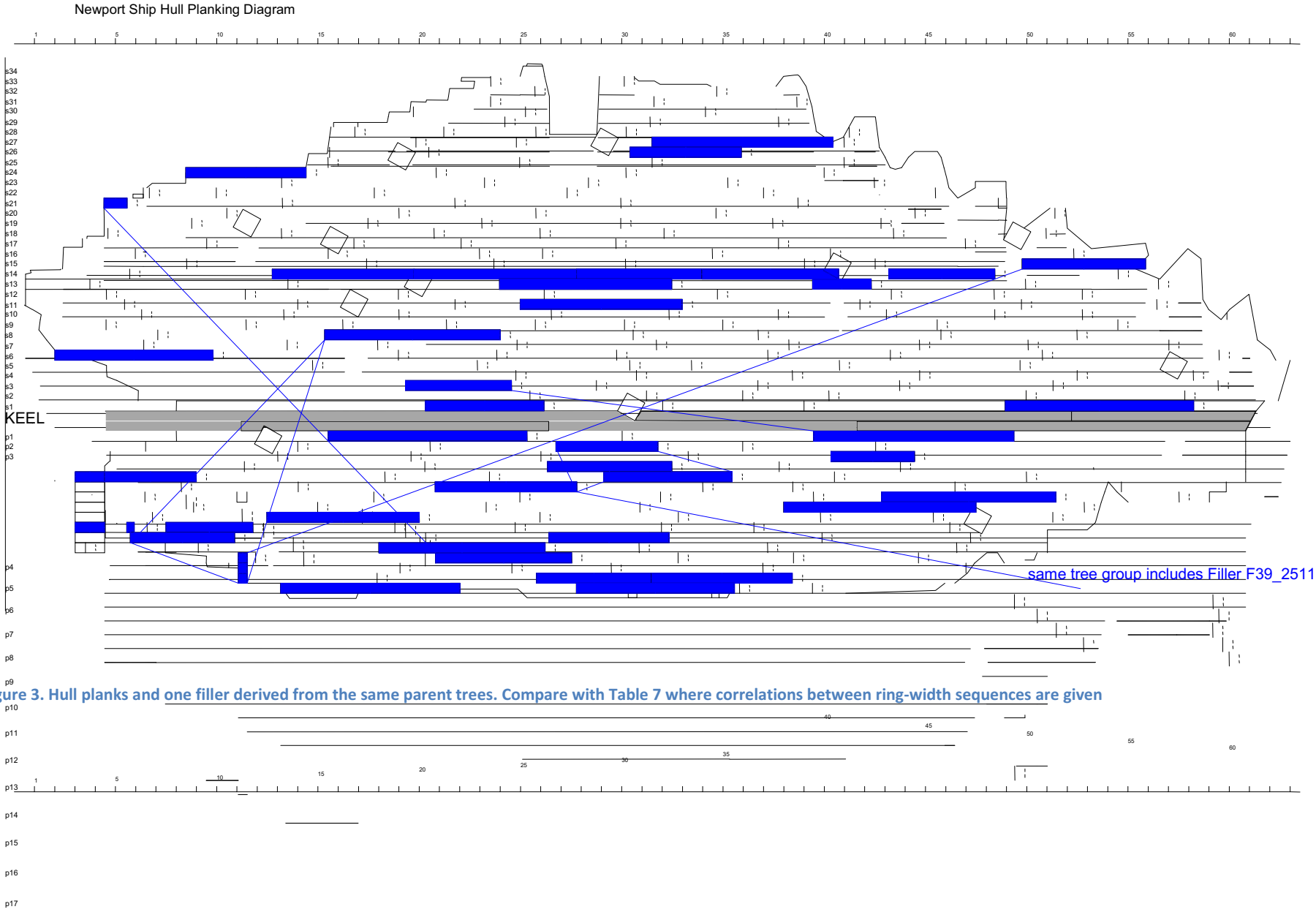

Figure 3. Hull planks and one filler derived from the same parent trees. Compare with Table 7 where correlations between ring-width sequences are given

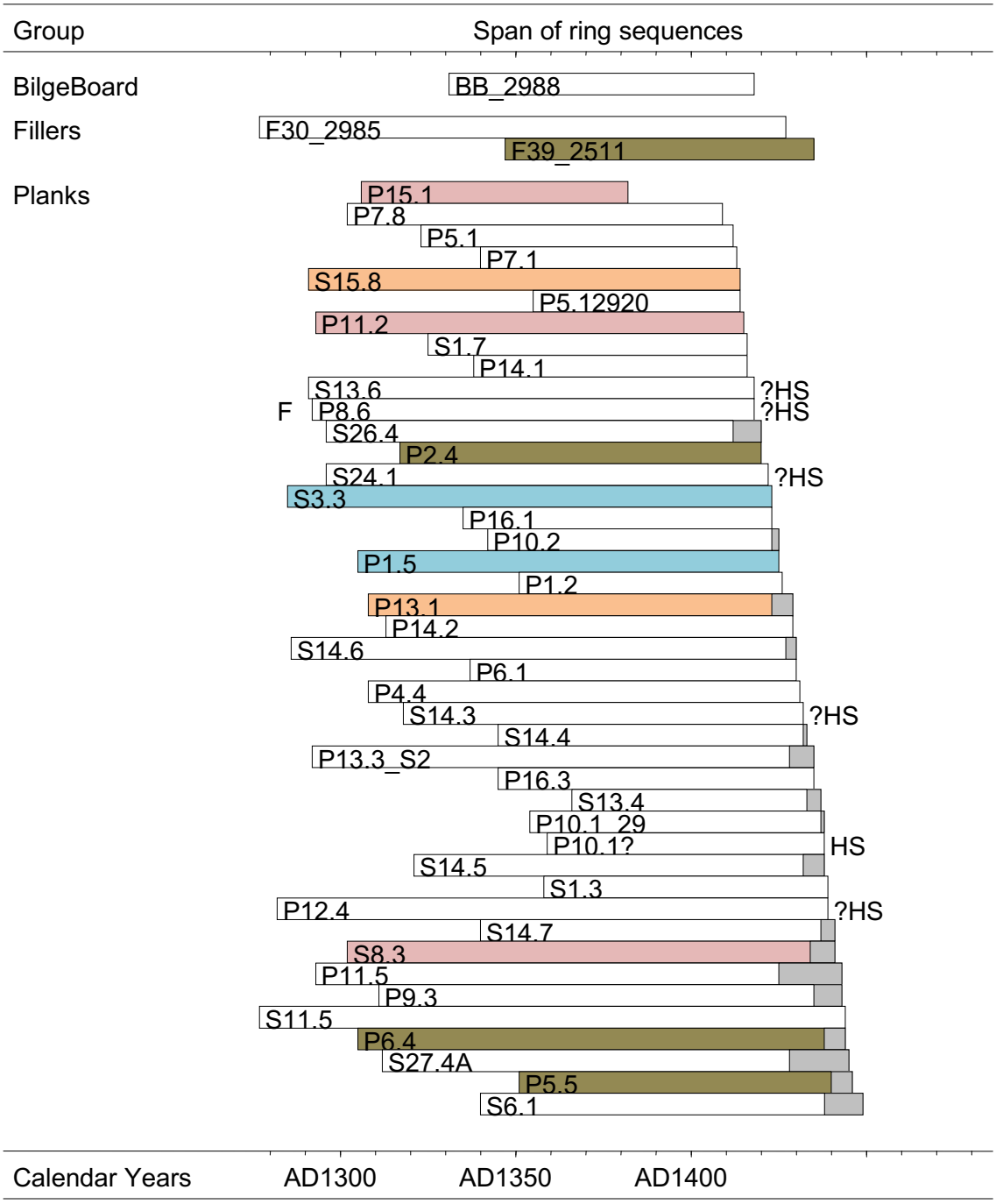

Figure 4. Newport Ship cross-matched timbers from outer hull planks, two fillers and one bilge board combined to form site master Newport T37. Sapwood is shaded and timbers from the same parent tree given the same fill colour. Absolute dates for the date range of each sequence is given in Table 2. Note no sapwood estimate has been applied and hence felling date ranges for timber with heartwood/sapwood boundary or partial sapwood are not given.

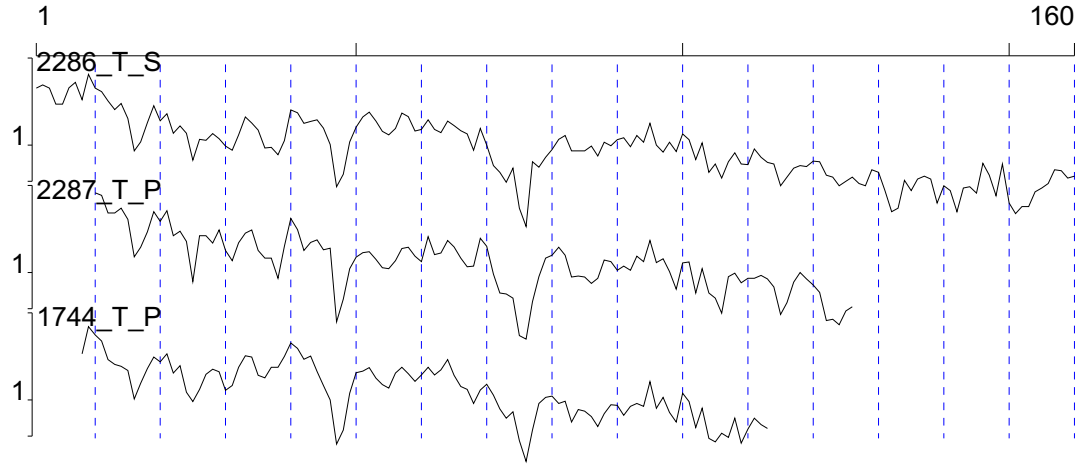

Figure 5. Ring-width plots of tingles with rebates derived from the same tree based on high correlations and close visual matches

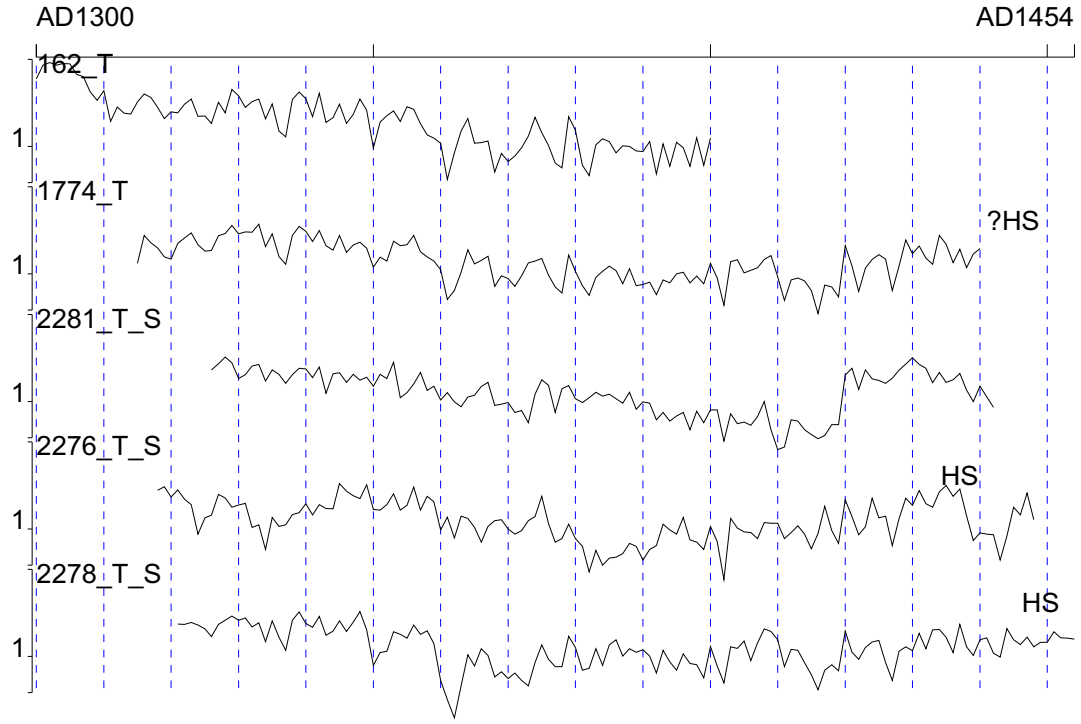

Figure 6. Ring-width plots of tingles without rebates. Compare with table of correlations

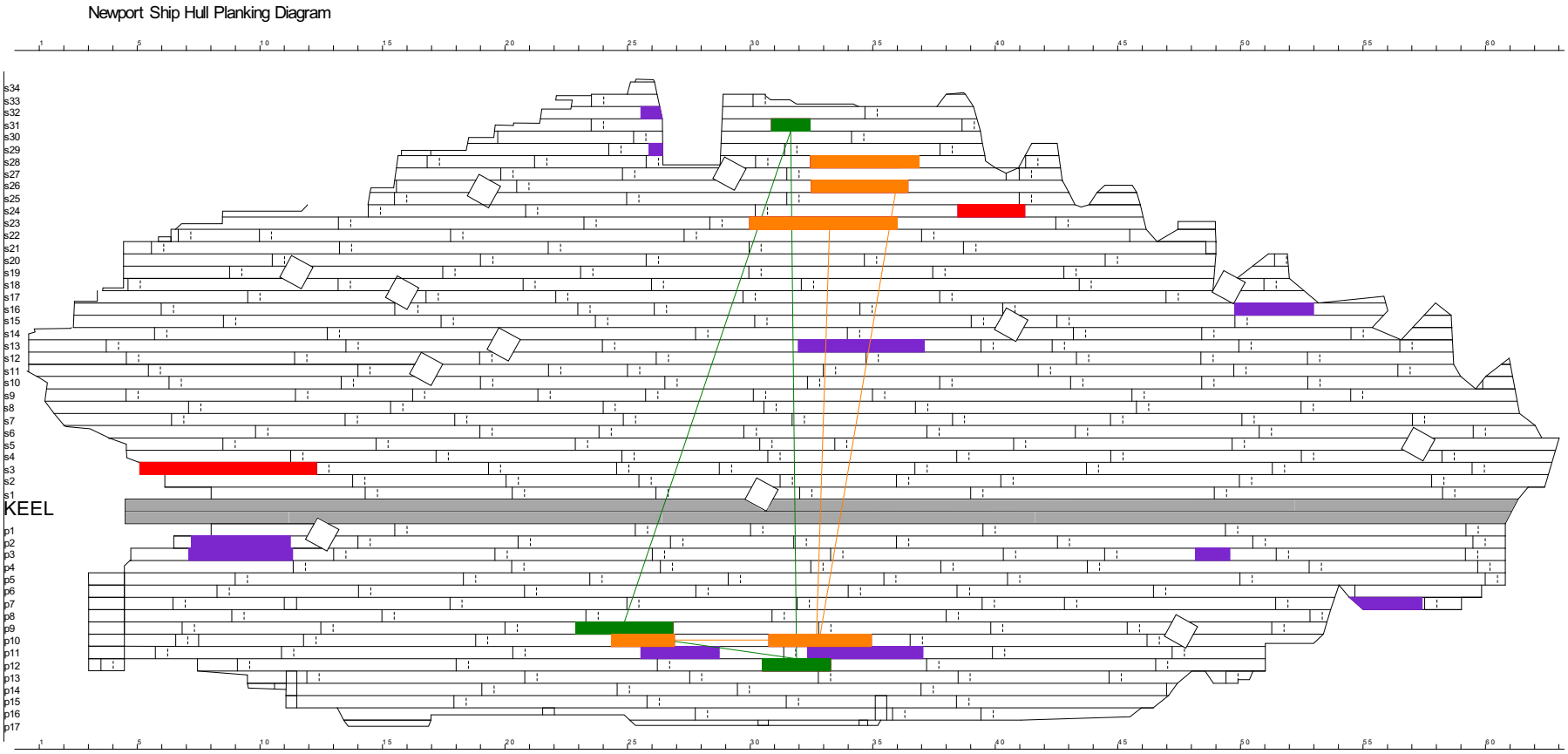

Figure 7. Tingles (repair patches) on outer hull. Green shading = rebated tingles from same parent tree, undated. Orange = Tingles no rebates absolutely dated against British masters. Red = sampled and undated tingles. Purple = unsampled tingles

Figure
8

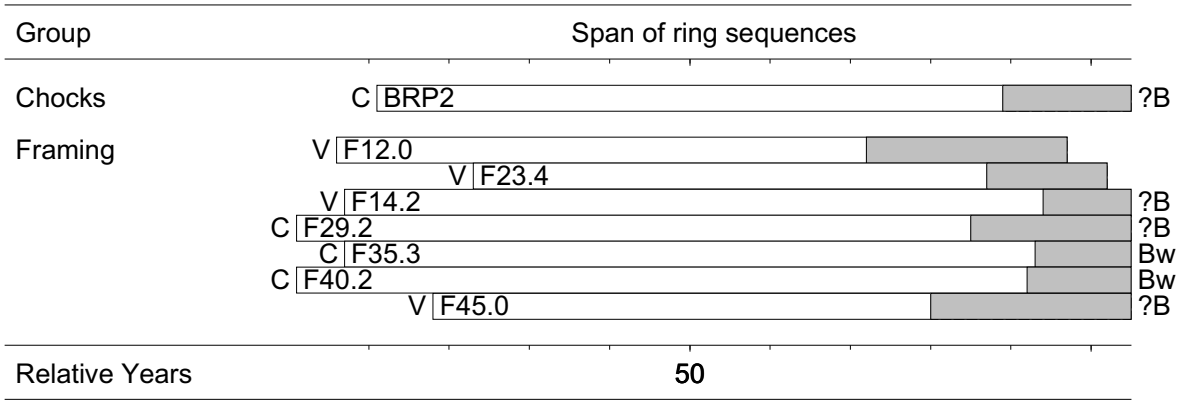

Figure 8. Bar diagram of relatively dated framing timber ring-width sequences forming 105-year mean FramingT7 and chock BRP2

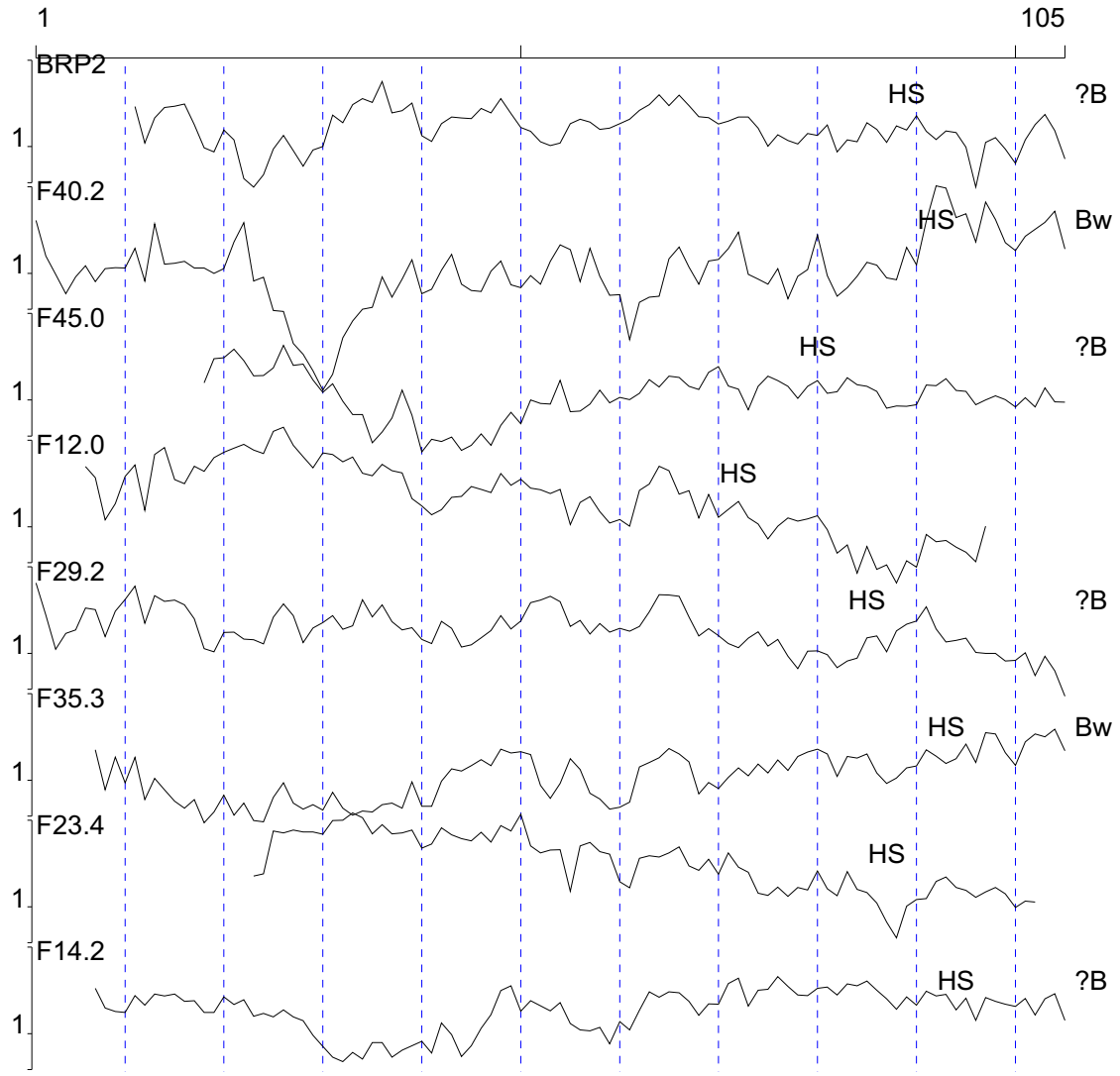

Figure 9. Ring-width plots for relatively dated framing timber ring-width sequences forming 105-year mean FramingT7 and BRP2

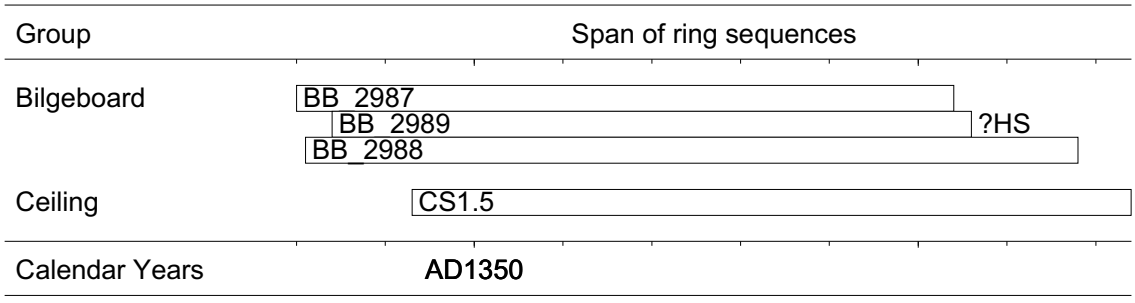

Figure 10. Bar diagram of dated ceiling and bilge board ring-width sequences forming 95-year mean CS1_5_BB dated to AD 1330 to AD 1424 inclusive

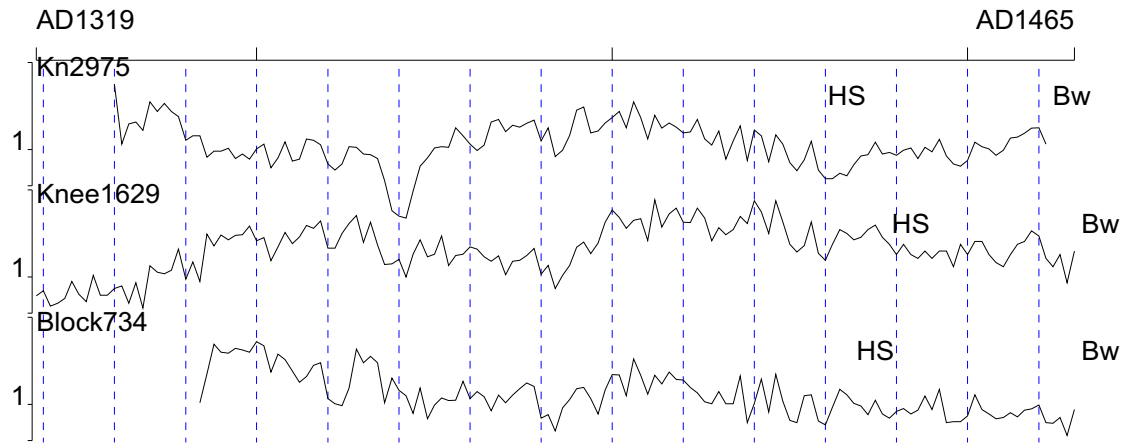

Figure 11. Ring-width plots for synchronised samples Knee_2975, Knee_1629 and Block_734 from F10. These were used to produce the mean Knees_F10block dated AD 1319 to AD 1465 inclusive. The ring-width patterns of Knee_1629 and Block_734 are very similar suggestive of common parent tree although correlation was *t*<10

Bibliography

Arnold, A.J., Howard, R.E. & Litton, C.D. 2004, *Tree-ring analysis of timbers from New Inn House, 7 Wotton Road, Kingswood, Gloucestershire,* English Heritage, Portsmouth.

Baillie, M.G.L. 1977, "Dublin Medieval Dendrochronology", *Tree Ring Bulletin,* vol. 37, pp. 13-20.

Baillie, M.G.L. & Pilcher, J.R. 1973, "A simple crossdating program for tree-ring research", *Tree Ring Bulletin,* vol. 33, pp. 7-14.

EH 1998, *Dendrochronology: guidelines on producing and interpreting dendrochronological dates,* , London.

Grenier, R., Stevens, W. & Bernier, M.A. 2007, *The underwater archaeology of Red Bay: Basque shipbuilding and whaling in the 16th century,* Parks Canada.

Hillam, J. 1991, *Tree-ring analysis of timbers from Bowhill House, Exeter, Devon*, Anc Mon Lab Rep.

Howard, R.E., Laxton, R.R. & Litton, C.D. 1999, *Tree-ring analysis of timbers from the Archdeacon of Exeter's House, Palace Gate, Exeter*, Anc Mon Lab Rep.

Miles, D., Haddon-Reece, D. & Moran, M. 1995, "Tree-ring dates for buildings: List 64", *Vernacular Architect,* vol. 26, pp. 60-74.

Mills, C.M. 1988, *Dendrochronology of Exeter and its application*, Sheffield University.

Munro, M.A.R. 1984, "An improved algorithm for crossdating tree-ring series", *Tree Ring Bulletin,* vol. 44, pp. 17-27.

Nayling, N. 1999, *Tree-ring analysis of timbers from the White House, Vowchurch, Herefordshire,* English Heritage, Ancient Monuments Laboratory.

Nayling, N. 2002, *Tree-ring analysis of timbers from Pound Farm, Kington, Herefordshire,* English Heritage, Centre for Archaeology.

Panter, I. unpubl, *A Condition Assessment and Conservation Strategy for the Newport Ship*.

Trett, B. 2005, "The Newport medieval ship: historical background", *Monmouthshire Antiquary,* vol. 21, no. 0, pp. 103-106.

Tyers, I. 2000, *Tree-ring analysis of oak timbers from the church of St Swithin, Clunbury, Shropshire*, Anc Mon Lab Rep.

Tyers, I. 1996, *Tree-ring analysis of six secular buildings from the City of Hereford*, Anc Mon Lab Rep.

Tyers, I. & Wilson, R. 2000, *Tree-ring analysis of oak timbers from 66 and 68 Westgate Street, Gloucester*, Anc Mon Lab Rep.

Tyers, I. 2004, *Dendro for windows programme guide 3rd edn*.