BIRMINGHAM ARCHAEO-ENVIRONMENTAL

BAE

Ayscoughfee Hall Gardens, Spalding: a palaeoenvironmental evaluation of deposits encountered during archaeological excavations

Dr T. Hill, Dr B. Gearey MIFA and Dr I. Tyers

NAU-1751-08

Ayscoughfee Hall Gardens, Spalding: a palaeoenvironmental evaluation of deposits encountered during archaeological excavations

By

Dr Tom Hill, Dr Ben Gearey MIFA and Dr Ian Tyers

July 2008

Summary

A phase of archaeological investigations was undertaken within the grounds of Ayscoughfee Halls, Spalding. Birmingham Archaeo-Environmental was subcontracted to evaluate the site for its palaeoenvironmental potential. It was hoped that palynological assessments of the former gardens could determine the types of plants and flowers grown during the 18th and 19th centuries. However, as high levels of bioturbation had affected the upper deposits present in all the archaeological trenches, it was not possible to distinguish between the modern topsoil and that of the former garden plots. Further excavations revealed a series of possible pits dissected by medieval and post medieval culverts. Organic remains were found to be present in these pits that are deemed suitable for palaeoenvironmental assessment. It is recommended that pollen and charred/waterlogged plant macrofossil assessments are undertaken on these features. Tree ring analyses of 6 yew trees from within the grounds indicated that a number of the trees may date back to the initial landscaping undertaken by Johnson in 1732. In addition, three window sample cores were extracted from the well located to the east of the Hall. The majority of the sediments encountered were however believed to be fluvial in nature and would have derived from the River Welland. As a consequence, no further work is deemed necessary on the well deposits.

KEYWORDS: Ayscoughfee Halls, Spalding, Lincolnshire, River Welland

Contact address for authors:

Birmingham Archaeo-Environmental
Institute of Archaeology and Antiquity
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Prepared for:

NAU Archaeology
Scandic House
85 Mountergate
Norwich
NR1 1PY

Ayscoughfee Hall Gardens, Spalding: a palaeoenvironmental evaluation of deposits encountered during archaeological excavations

1. INTRODUCTION

A desk-based assessment of Ayscoughfee Hall, Spalding, Lincolnshire (TF 2490 2236), was undertaken by NAU Archaeology on behalf of South Holland District Council (Penn, 2008). The work revealed that a number of garden plots were established within the grounds by the 1730s with historical records providing some insight into the types of plants grown. In addition, the desk based assessment identified a medieval well, which was subsequently uncovered during ground investigations.

Birmingham Archaeo-Environmental (BA-E) was subcontracted to undertake a palaeoenvironmental evaluation of the Ayscoughfee Hall gardens. The primary objective of this was to assess whether relict soils (palaeosols) were preserved within the gardens that date to the 18th and 19th centuries. If such buried soils were encountered within the trench excavations, it was hoped that pollen assessments would establish the type of plants being grown in the gardens. An assessment of the medieval well deposits was also required to establish if any deposits of palaeoenvironmental potential were preserved. Window sampling was to be undertaken within the well to evaluate the well sediments for palaeoenvironmental potential. In addition, an assessment of age of the *Taxus baccata* (yew) trees present within the grounds was required using dendrochronology.

This report provides a summary of the works undertaken to date at Ayscoughfee Halls, and includes recommendations for further work based on the palaeoenvironmental potential of the site.

2. METHODS

2.1 Site Visit

An initial visit to Ayscoughfee Halls was undertaken on the 19th February 2008 to coincide with start of the archaeological excavations taking place. A total of 10 trial trenches were excavated by NAU, the locations of which are provided in Figure 1. The deposits within each trench were visually assessed in an attempt to identify palaeosols that might predate the existing gardens. If suitable deposits were encountered, appropriate sampling was required to assess their palaeoenvironmental potential.

Additional site visits were undertaken over the period of archaeological excavation. Where deposits considered to be of palaeoenvironmental potential were encountered, appropriate sampling was undertaken. Monolith tins and bulk samples were taken and returned to the laboratory at Birmingham Archaeo-Environmental, University of Birmingham, for further assessment.

2.2 Window Sampling of the Well

A well was encountered within Trench 1. Once abandoned, such water sources may become infilled with organic material. Due to the deep nature of the well feature, combined with the presence of standing water within the well, a windowless sampling terrier rig was hired by NAU to take cores from the cores. Although the location of the well restricted access conditions, combined with its relatively narrow width (*c*. 1.50 m), a total of three cores were successfully sampled in close proximity to one another: WS1, WS2 and WS3.

2.3 Dendrochronology
A site visit was also undertaken by Dr Ian Tyers in February 2008 to assess the suitability of the yew trees for dendrochronological consideration. The full dendrochronological report can be found in Appendix I for reference. A summary of the methodology is provided below.

A total of six trees were selected for sampling from within the grounds of the gardens. Care was taken to avoid sampling trees showing signs of disease or deemed too small for analysis. The sampling location on the chosen trees also avoided former branches and areas where bark patterns suggested unusual growth. A single sample was taken from each tree using a 30-40cm standard forest increment corer (5mm diameter). Samples were then air dried and assessed for their dendrochronological potential.

3. PRELIMINARY RESULTS OF FIELDWORK

3.1 Garden Evaluation
During the initial site visit, no evidence for buried soil horizons was encountered within the trenches. Trenches 5, 7, 8, 9, and 10 had been fully excavated by this point (Figure 1), and although considerable spatial stratigraphic variation was evident, the uppermost sediments within the trenches were typified by light brown fine sands and silts with occasional gravels. There was also some iron staining as well as occasional organic mottling within the deposits. The sands and silts were commonly found to overlie grey-brown silts and clays which were interpreted as natural floodplain deposits of the River Welland (Figure 2).

In general, the light brown sands and silts found to overlie the natural deposits were highly homogenous and showed little variation in sedimentary content. There was therefore no evidence to suggest that palaeosols from the historic gardens dating back to the 18th century had been preserved. In some trenches, the unit was less than 0.20 m thick before natural deposits were encountered (Trench 9: Figure 3).

A subsequent visit to the site was made upon completion of Trenches 2, 3 and 4 (Figure 1). Very similar deposits were encountered within these trenches, with grey-brown sands and silts. However, a concentration of archaeological finds and associated deposits of palaeoenvironmental potential were encountered. A summary of context descriptions and environmental samples taken is provided in Table 1.

In Trench 2, a possible post-medieval furnace and associated brick-lined pit was identified. Deposits were present above and below the furnace grate, and were deemed suitable for evaluation. It was proposed that the charcoal remains may provide an insight into the function of the furnace. Samples were subsequently taken from the fill from above the grate (Context 98, sample 1) and from the 'waste' beneath the grate (Context 99, sample 2). Both samples were relatively similar in nature, and were dominated by fragments of brick and charcoal. There were also occasional fragments of metal, glass, small bone and some organic remains.

Trench 3 was found to contain an east-west trending culvert capped with horizontally layered bricks (Culvert 122). The feature was suggested to date to the 18th century or earlier. Proximal to the culvert, in the east-facing trench face, a thin organic-rich silt horizon with possible charcoal fragments was located within the grey-brown sands and silts (Figure 4). It is unclear how other deposits (Contexts 108, 109, 110, 137) relate to a pit fill or natural processes of sediment accumulation. A small *c*. 0.50m deep pit feature [226] within the trench immediately east of the organic horizon was found to relatively rich in organic remains. Samples were subsequently taken from the culvert fill (samples 3, 4 and 6), the trench face (samples 5 and 7) and associated pit (sample 9) for consideration for palaeoenvironmental assessment.

Excavations in Trench 4 revealed further deposits possibly suitable for palaeoenvironmental assessments. The trench was dominated by two major brick-lined culverts believed to post-date the culvert in Trench 3. The culverts trended *c*. east-west and north-south and although not exposed within the trench the culverts are believed to intersect with one another. At the southern end of the trench, a possible pit feature was identified which was dissected by, and hence predates, the culverts (pit [256]; Figures 5 and 6). Pottery within the pit fill suggest that the feature dates to the medieval period. Monolith and bulk samples were taken from the pit fill, whilst a sample from the culvert fill was also taken (samples 10, 11 and 12 respectively).

3.2 Window Sample Borehole Evaluation

Trench 1 revealed a well capped by a large sheet of stone. Initial inspections suggested that the base of the well was located at *c*. 4.0 m depth. Using a windowless sampling terrier rig, coring commenced from *c*. 4.0 m and continued until natural deposits were encountered. The three window sample boreholes were extracted, terminating at a depth of between *c*. 7.0 - 8.0 m. The stratigraphy of each borehole is provided in Appendix II, whilst photographs of the boreholes are provided in Figures 7-9.

A full 4.0 m sequence was sampled from WS1 (Figure 7). In WS2, sampling failed between 7.0 - 8.0 m depth (Figure 8), whilst in WS3, sampling also failed between 4.0 - 5.0 m depth (Figure 9). Consequently, only 3.0 m length sequences were obtained for WS2 and WS3. All three boreholes were however found to contain very similar stratigraphy. Each borehole was typified by light grey-brown to orange-brown fine sands with varying silt content. The upper *c*. 0.30 m of WS1 and WS2 contained some organic material, but this was very well humified and sand remained the dominant component.

3.3 Dendrochronology

The full dendrochronological report is provided in Appendix I and only a summary is provided here. The coring and subsequent tree-ring analysis revealed that many of the yew trees within the grounds of Ayscoughfee Halls have experienced repeated periods of diminished and disturbed growth, which is interpreted as a result of pruning regimes. The tree-ring analysis has identified with trees with minimum ages varying between 160 and 240 years. Although interpretational difficulties exist which are likely to be a consequence of extensive pruning, estimated ring numbers have identified at least 4 yew trees (Trees 1, 2, 4 and 5) are *c*. 270-280 years old (age estimates at breast height; see Appendix I). In contrast, Trees 3 and 6 appear to be younger, dating to the late 18th century and mid-19th century respectively.

4. CONCLUSIONS

4.1 Garden Evaluation

The majority of the sediments encountered within the trenches around the grounds of Ayscoughfee Hall were found to be relatively shallow and homogenous in nature. This suggests deposits relating to the 18th and 19th century garden plots are poorly preserved. Due to the relatively shallow sediments identified in Trenches 5, 9 and 10, the influence of modern bioturbation would have substantially reworked any soils that had developed during the garden's history. This, in turn, would have reworked and destroyed any pollen deposited from plants growing *in situ*. As a consequence, there is no potential for establishing past planting regimes relating to the garden plots through palynology.

However, the pit features identified in Trenches 3 and 4 were found to contain deposits of greater palaeoenvironmental potential. Although silt rich, the relative abundance of organic remains within the pits warrants further investigation. Although archaeological evidence is somewhat sparse, initial interpretations suggest that these pits may be medieval in age. If this is the case, whilst the original aims of the palaeoenvironmental assessment at Ayscoughfee Halls focussed on the form and function of the 18th century gardens, analysis of the possible medieval deposits may provide an insight into the landscape conditions that prevailed prior to the establishment of the Hall and associated surroundings.

4.2 Window Sample Borehole Evaluation

The deposits encountered within the medieval well were found to be dominated by fine sands with little variation in stratigraphy. A thin organic-rich sand unit was however encountered in the upper *c*. 0.30m of the sedimentary sequence. It is concluded therefore that the majority of the sediments encountered within the boreholes were naturally-derived. The relatively fine and well sorted nature of the sands suggests that the deposits would have developed through fluvial processes, and may relate to a relict channel or floodplain of the River Welland. The well would have been cut into these natural deposits due to the high permeability of the sands. Taking into account the low gradient and surface elevation of the site, the local water table would have been the source for the well's water supply. The overall absence organic deposits or man-made waste within the well raises a number of hypotheses regarding the well's use. It may be that the well was in use for a very short period of time, which would have prevented the accumulation of deposits within the well. Alternatively, the well may have been enclosed, covered or even regularly cleaned, to ensure it provided suitable water for the Hall, which also would explain the lack of debris overlying the natural sands. The latter may be regarded as the more likely explanation.

4.3 Dendrochronology

The results of the tree-ring analysis have shown that of the 6 trees sampled, 4 are suggested to have an age of between 270 and 280 years (with a margin of error ±20-30yrs). Although there are interpretational difficulties, some inferences can be made. These age estimates would indicate the presence of trees that may have been part of the Johnson planting scheme of *c*. AD1732. In addition, the two remaining yew trees, although dated to the later 18th century and early 19th century, could also be as old as the others but may have experienced extensive pruning. Alternatively, they may have been planted at a later date to replace dead or poorly growing trees. These interpretations are based on limited information relating to the planting schemes used and it is also unclear whether transplanted trees were ever used.

The tree ring analysis also revealed exhibited improved growth over the recent period dating back to AD1955. Several of the sampled trees are growing faster now than they have for most of the previous 200-250 years. The increased recent growth suggests the sampled trees are in quite robust health and his could be interpreted as a reflection of a change in management regime within the grounds of Ayscoughfee Halls.

5. RECOMMENDATIONS FOR FURTHER ANALYSIS

The ongoing palaeoenvironmental investigation at Ayscoughfee Halls has revealed contrasting results to date. Whilst it was hoped that buried soil horizons that could provide information regarding the historical garden plots, such features were absent. Deposits of palaeoenvironmental potential relating to the 18th century onwards seem to be somewhat restricted. As a consequence, palynological investigations are not recommended.

Excavations within Trenches 3, 4 and 6 revealed deeper stratigraphic sequences, some of which may predate the construction of Ayscoughfee Hall. The deposits sampled as part of the palaeoenvironmental assessment may provide information relating to human activity and landscape conditions during the medieval period. A suite of palaeoenvironmental assessments are thus recommended on selected samples. A summary of these recommendations is provided in Table 1:

- Pollen assessments on the organic-rich deposit encountered in pit [139] (context 110; Trench 3) and [256] (context 254; Trench 4). Samples should be taken from the top, middle and bottom of each organic-rich horizon (6 samples in total).

- Waterlogged plant macrofossil assessments should also be undertaken on a number of bulk samples from Trenches 3 and 4. Such assessments will evaluate whether identifiable plant remains are preserved, and determine the potential for palaeoenvironmental reconstruction. Assessments should therefore be undertaken on the following features:

  - Bulk samples from contexts 110 and 254 taken from pits [139] and [256] respectively. In addition, pit [226] fill (227) from Trench 3 should be assessed. Assessments should also be undertaken on the bulk samples extracted from the brick culverts encountered within Trenches 3 and 4 (6 samples in total).

- Radiocarbon dating of key stratigraphic units should also be considered. If the archaeological evidence does not produce a secure chronology from pits [139], [256] and [226], bulk samples of the organic-rich fills should be submitted for AMS radiocarbon dating.

- The monolith tin extracted from culvert 122 should be considered for soil micromorphology analyses. A thin section and bulk would be extracted from the monolith, from which more detailed information regarding the nature of sediment accumulation may be derived.

In order to establish the use of the furnace encountered in Trench 2, it is proposed that the material sampled from above and below the furnace grate is assessed for charred remains, with specific attention to the charcoal fragments (2 samples in total). This may provide an insight into what was being burnt within the furnace.

The well boreholes are composed almost entirely of natural river sands. Although there is a small organic-rich sand horizon at the top of WS1 and WS2 which may provide some material suitable for palaeoenvironmental assessment, the high level of humification of organic remains suggests identifiable plant material may not have survived. Consequently, no further palaeoenvironmental assessments are recommended on the well deposits.

The dendrochronological assessment undertaken as part of the initial survey has revealed interesting results relating to the development of the yew trees within the grounds of Ayscoughfee Halls. A number of the trees have been confidently associated with the initial planting of yews within the gardens by Johnson in AD1730. However, due to the apparent propensity of yews to halt ring development when stressed, the species on the whole has poor potential for dendrochronological studies. No further tree-ring assessments are therefore recommended.

6. ARCHIVE

All monolith and bulk samples from Trenches 2, 3 and 4 discussed within this report will be stored at the Birmingham Archaeo-Environmental laboratory at the University of Bimringham, Edgbaston, Birmingham. All window sample boreholes extracted from the well will also be stored until the archaeological excavation is complete, after which consultation with NAU will take place regarding long-term storage (if deemed necessary). Tree-ring cores are presently retained by Ian Tyers.

ACKNOWLEDGEMENTS

The authors would like to thank Andy Hutcheson, Russell Trimble and Helen Stocks (NAU Archaeology) for their assistance during the initial palaeoenvironmental consultations, on-site visits and subsequent report production.

REFERENCES

Penn, K. (2008). *An Archaeological Desk-based Survey of Ayscoughfee Hall Gardens, Spalding, Lincolnshire*. NAU Archaeology Report No. 1618.

Sample No.	Context(s)	Description	**Recommendations**
1 - Bulk	98	Rubble from above furnace grate	**Charred remains**
2 - Bulk	99	Waste from beneath furnace grate	**Charred remains**
3 - Bulk	212	silt within culvert 122	**Waterlogged remains (2L)**
4 - Monolith	212	silt within culvert 122	**Soil micromorphology**
5 - Monolith	108, 109, 110, 137	Possible fill sequence of pit [139]	**Pollen assessment x 3**
6 - Small Bulk	212	Fill of culvert 122	**Waterlogged remains (100%)**
7 - Small Bulk	109	Organic-rich unit from within possible pit [139]	**Waterlogged remains (100%)**
8 - Small Bulk	227	Peaty layer from within pit [226]	**Waterlogged remains (100%)**
10 - Monolith	253, 254, 255	Pit [256] fill sequence	**Pollen assessment x 3**
11 - Bulk	254	Possible pit [256] fill	**Waterlogged remains (2L)**
12 - Bulk	267	Silt within culvert 207	**Waterlogged remains (2L)**

Table 1: Summary of environmental samples taken from Ayscoughfee Halls, Lincs. Table included proposed recommendations for further sanalysis on selected samples

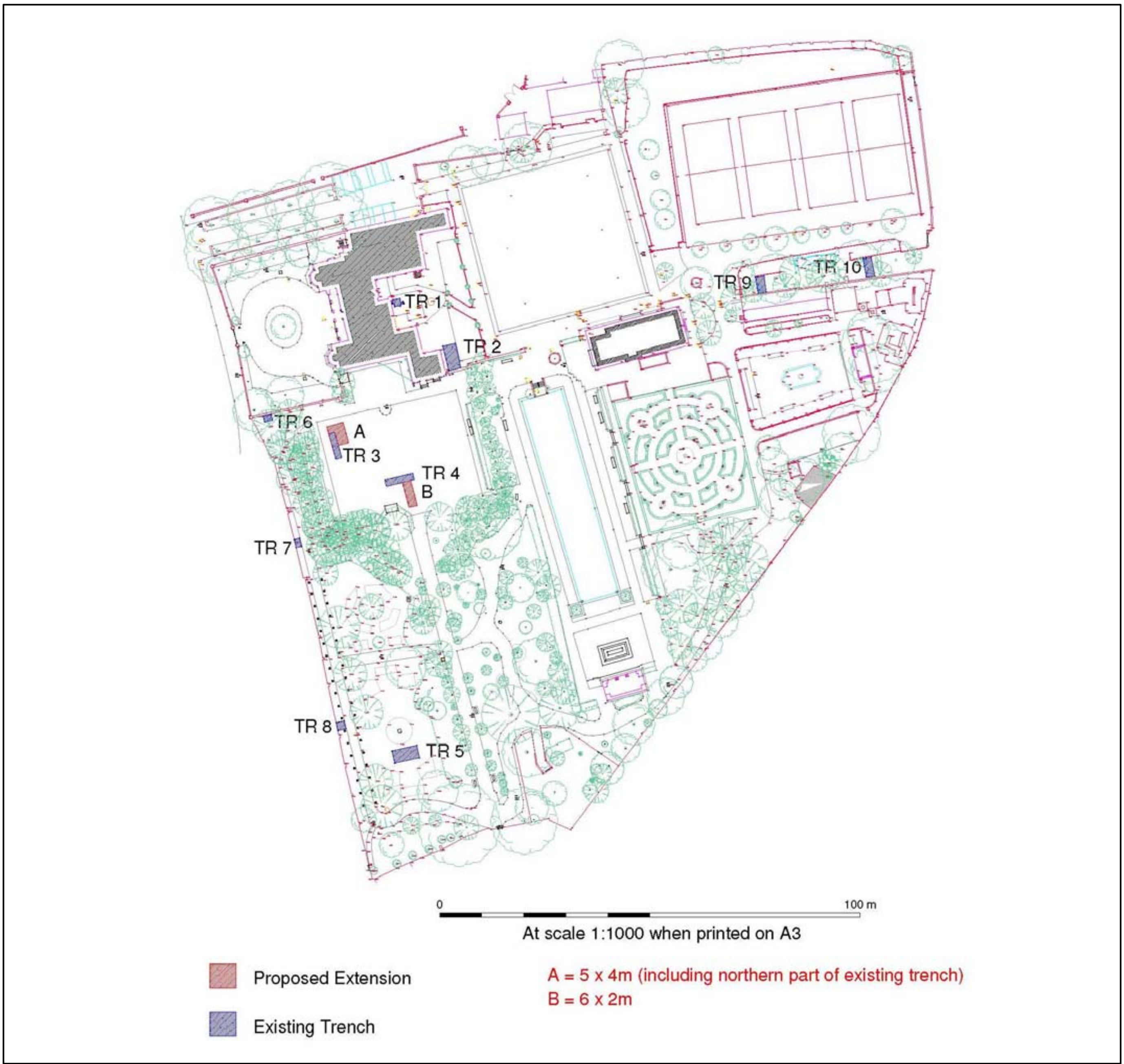

Figure 1: location of archaeological trenches excavated within the grounds of Ayscoughfee Halls during the palaeoenvironmental evaluation. The plan was adapted from the original site plan provided by NAU Archaeology.

Figure 2: Photograph of Trench 7, showing thin topsoil underlain by light grey silts and clays believed to be floodplain deposits of the River Welland.

Figure 3: Photograph of Trench 9, identifying the shallow topsoil encountered overlying the natural deposits. The potential for palaeosol preservation was shown to be low.

Figure 4: Photograph of the east-facing trench section of Trench 3, locating the brick culvert and thin organic-rich horizon present within the grey-brown sands and silts. A monolith tin was taken of the organic unit (approximate location shown), whilst bulk samples were also taken from the trench face and from within the culvert fill.

Figure 5: Photograph of Trench 4, identifying the two brick-lined culverts and possible pit feature cut by the construction of the culverts (see Figure 6).

Figure 6: Possible pit feature located in Trench 4. Organic-rich silts encountered towards the base of the pit fill. Monolith and bulk sampling subsequently undertaken for palaeoenvironmental consideration.

Figure 7: Photograph of WS1 extracted from the well in Trench 1.

Figure 8: Photograph of WS2 extracted from the well in Trench 1.

Figure 9: Photograph of WS2 extracted from the well in Trench 1.

APPENDIX I

TREE-RING ANALYSIS OF LIVING TREES: YEWS AT AYSCOUGHFEE HALL, SPALDING, LINCOLNSHIRE

By Dr Ian Tyers

Tree-ring analysis of living trees: Yews at Ayscoughfee Hall, Spalding, Lincolnshire

Summary
This report discusses investigations into the age structure of a group of yew trees (*Taxus baccata*) forming a series of hedge lines in Ayscoughfee Hall Gardens in Spalding (NGR TF 249 223, see Figure 1). Ayscoughfee Hall Gardens were originally laid out for Maurice Johnson *c*. 1730. Visual inspection showed the yew trees to be a mixture of straight stemmed, single trees, and multiple stemmed trees. There is a significant diversity of size, shape and apparent health, with a few standing dead, several with dead stems, and several with crown dieback. Throughout repeated former pruning had resulted in dead branches, holes, and distorted stems. The individual yews appeared to be a mixture of male and female specimens, and none appeared to be any of the named varieties used in many later planting schemes.

A total of 6 yew trees were sampled in order to estimate their ages. The estimated ages indicate at least 4 yew trees around 270 years old are present in the hedges. Assuming they were planted as fairly small stems, and were not transplanted as larger trees these estimates support the interpretation of the yew hedge in Ayscoughfee Hall Gardens as a feature derived from the period of Maurice Johnson.

Tree-ring dating
Counting tree-rings provides a method of ageing trees but does not provide a method for dating trees.

Dendrochronology attempts to provide absolute dates for the rings present in individual ancient timbers of unknown date. This is achieved by measuring very precisely the widths of each successive ring within a sample and comparing the pattern of narrow and wide rings with reference chronologies built up by previous work.

Standing trees provide the anchor for dendrochronological reference chronologies and a great deal of work was undertaken during the 1970's and 1980's creating a replicated spread of data from oaks within the British Isles (e.g. Pilcher & Baillie 1980). Modern data has been used worldwide for anchoring reference chronologies, for developing suitable methodologies to apply to sub-fossil, archaeological, standing building and art-historical assemblages, for examining climate change (e.g. Briffa *et al* 1986), and for ecological impact studies. This study provided an opportunity to examine yews that have been repeatedly pruned in order to investigate their potential as tree-ring data anchors.

Methodology

The yews were initially examined accompanied by Russell Trimble, from Norfolk Archaeology Unit, and Tom Hill & Ben Gearey from Birmingham University. This examination allowed us to discuss the scope and potential of the analysis being proposed. The coring was undertaken on 19th February 2008. A range of sizes of tree and varied locations within the yew hedge lines were selected (Figure 1). Trees showing any sign of disease were not selected, and the very smallest trees were also not selected. The sampling locations attempted to avoid former branches, areas where the bark pattern suggested there was twisted or unusual growth, and areas of active epi-cormic growth. A single sample was extracted from each selected tree using either a 30cm or 40cm standard foresters increment corer (a 5mm diameter Mattson type). The core was taken at 'breast height' (depending on the slope of the ground and the surface roots this would be approximately 1m up the trunk of the tree). The circumference of the stem at that height was recorded, and the location of the tree marked on a garden plan. The core was labelled and temporarily mounted in paper tubing. Six trees were selected for sampling (Table 1, Figure 1). The sampled trees were labelled Trees 1-6 inclusive.

The cores were air dried for a few weeks in their tubes and then extracted and mounted, in the original horizontal plane of the parent tree, on lengths of softwood batten. The ring sequences in the cores were revealed by sanding a clean surface along their entire lengths using increasingly fine sanding discs from 120 grit down to 400 grit. After preparation standard dendrochronological methods (see e.g. English Heritage 1998) were applied to the samples. The complete sequence of identifiable growth rings in each core was measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The cores included numerous sequences of very disturbed patterns of growth. Remarkably one sample (#3) included several discontinuous rings. Such anatomical features are extremely uncommon in 'standard' trees and this feature probably indicates that this tree, at least, has responded to its historical pruning disturbance by growing in a variety of aberrant or unusual ways. Every core was complete to the bark-edge and thus the last ring is of known date (that is the 2007 growing season). It had originally been intended to attempt to identify if it was possible to treat the sample assemblage as if it were a group of archaeological samples of unknown date and relationship. The known presence of missing or discontinuous rings, and the suspected presence of many more such events in the areas of disturbed growth meant that this was no longer a feasible approach.

A modified methodology therefore treated each measured ring sequence as representing the minimum number of rings present in the samples, with the assumption that there were likely to be missing rings within certain parts of each sequence. If areas of synchronicity could be identified between individual sample sequences these were likely to represent true annual growth sequences, whilst areas of unsynchronised growth were likely to represent either areas of missing rings, or periods where external disturbing factors were likely to have affected individual trees differently. To aid this process ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between them.

A number of interpretational issues need to be commented on before discussing the results. The relationship between total tree age (or cambial age) and the age obtained by counting rings in cores is complex.

Firstly, ring counts only identify the true tree age where a species of tree rarely or never misses out growing seasons. Oak and other large hardwood trees are well behaved in this respect, but some of the smaller hardwoods like willow, alder, and hawthorn have proven unreliable. Softwoods such as pine, and yews are normally well behaved, however the cores from Ayscoughfee indicate that pruned yews may be intrinsically unsuitable for dendrochronological studies.

Next, the true tree age can only be precisely identified by obtaining a core or section of the tree at ground level. This is only achievable when timber is being felled and the stumps can be sampled and counted. Sampling above ground level will inevitably miss however many years it took the tree to grow to the sampling height. A metre or so in height (what foresters call 'breast height', abbreviated *bh* below) is the only really practical height to sample a tree with standard increment corers. Under normal circumstances it might be expected that yew trees take a few years or a few decades to reach this height, depending on size at transplantation, and the pruning regime implemented.

Finally, trees are never truly cylindrical. The central rings are as a result rarely in the geometric centre, by selecting for coring only the roundest and straightest trees makes it more likely that the sampled trees are reasonably symmetrical. Since coring direction is judged by eye, whilst standing close to the tree, and usually standing on ground that has been disturbed by tree roots, the corer will very rarely pass through the pith of the tree. There are a number of methods by which the likely numbers of rings missed from the middles of the trees can be calculated. These methods provide estimates for the total tree age at the sampled height. Since these calculations assume symmetrical stems and consistent growth rates, neither of which are necessarily reasonable assumptions, these calculations may provide either over- or under-estimates of the true ages of the trees.

In Table 1 below the estimation of tree age at coring height is based on the following calculations:

2 of the samples (#3, & #6), whilst not including the pith, did have rings exhibiting marked curvature at the inner end of the core, for these the length of the radius missing was determined by use of simple geometry, the growth rate of the innermost decade of the core was calculated from the measured sequence and the number of missing rings estimated by calculating missing radius divided by the inner decades average growth rate (Table 1). These are estimates, but given the short missing sections there was no significant potential for error here.

The remaining 4 samples were taken through to a void or other problems within the stem that were invisible from the outside. The cores extracted were incomplete, and there was no useful curvature on them with which to identify the approximate distance to pith. The tree-age at sampling height was determined in these cases by calculating the radius of the tree, from its girth, allowing for the non-circular nature of the bark surfaces, multiplying the inner growth rate by the missing radius and adding this to the measured number of rings (Table 1). These are estimates, and given the disturbed nature of the tree-ring sequences there was probably a significant potential for error here. Note the actual ring counts obtained do provide an absolute minimum age for the material.

Results & Discussion

The numbers of measured rings, growth rates, sizes and estimated ages of the sampled Ayscoughfee Hall Gardens yew trees are provided in Table 1.

The coring has revealed that many of the Ayscoughfee Hall Gardens yew trees have suffered repeated periods of diminished and disturbed growth, likely to have been caused by pruning regimes. The direct tree-ring analysis of the cores has with certainty identified trees with minimum ages varying between 160 and 240 years of age. Estimates of the total tree ages from incomplete and nearly complete cores have been made. There are a variety of interpretational difficulties with material that has been extensively pruned, and which hence exhibits a variety of aberrant growth characteristics. However calculations of estimated ring numbers have identified the likely presence of at least 4 yew trees that are candidates for being original to the Johnson planting scheme of *c*. 1732. Two others both in the main avenue appear to be later, one from the later 18th century (#3) and another from the mid-19th century (#6). In both cases the root stocks may be as old as the others but they may have been pruned very low, alternatively they may have replaced dead or poorly growing trees, or be naturally grown seedlings. Since it is not known if the original or later planting schemes used transplanted yew trees of any significant size and age, it is worth noting that if they did this would invalidate these interpretations.

It is notable that the majority of the cored trees have exhibited much improved growth over the recent period stretching back to *c*. 1955. At present several of the sampled trees are growing faster now than they have for most of their previous 200-250 years of growth. The analysis of the cores also reveals that this section of the tree-ring sequences are more synchronised than previously. Whether this change is co-incident with a known change in management regime in the gardens or the retirement or employment of a specific gardener would be of some interest. The increased recent growth suggests the sampled trees are in quite robust health. The sampling selectivity means this statement is not necessarily indicative of the general wellbeing of the Ayscoughfee Hall Gardens yew trees. A younger tree identified in the hedge line (#6) appears to have been relatively undisturbed throughout its life when compared with the other sampled trees.

The lack of synchronicity within the tree-ring sequences suggests that these yews exhibit missing or aberrant rings. This prevents their use with standard dendrochronological techniques, whether this is typical of all yews, or only hedgerow managed yews is not known. Yews apparent propensity for missing rings when stressed suggests it has poor potential for dendrochronological studies.

Acknowledgements
The analysis was commissioned by Birmingham University, on behalf of Norfolk Archaeology Unit, NPS Group, itself working for South Holland District Council using Leader+ project funds. My thanks to Russell Trimble, from Norfolk

Archaeology Unit, the various staff, volunteers, press and visitors, who help make the sampling easier and Tom Hill & Ben Gearey from Birmingham University.

References

Briffa, K R, Wigley, T M L, Jones, P D, Pilcher, J R & Hughes, M K, 1986 *The reconstruction of past circulation patterns over Europe using tree-ring data, final report to the Commission of European Communities, contract no CL.111.UK(H)*, unpubl rep, **-**

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

Pilcher, J R & Baillie, M G L, 1980 Eight Modern Oak Chronologies from England and Scotland, *Tree Ring Bulletin*, **40**, 45-58

Figure 1. Plan of Ayscoughfee Hall Gardens showing the approximate location of the sampled yew trees, based on a plan of all the hedge line trees kindly supplied by Russell Trimble from NAU, Archaeology, NPS Group.

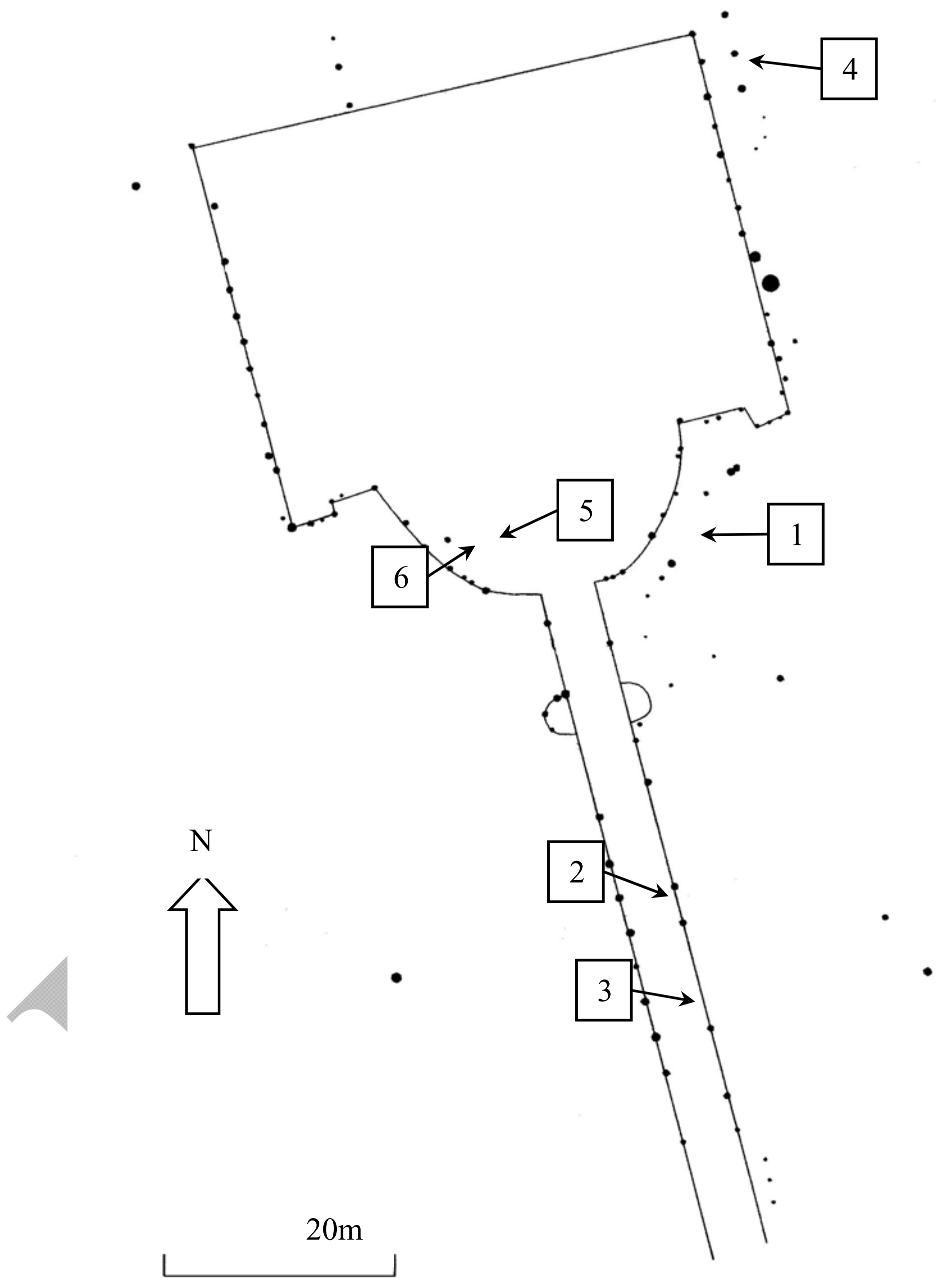

Table 1. List of yew samples from Ayscoughfee Hall gardens, Spalding

The right hand column indicates the actual or estimated ages of the sampled trees at the coring height. Planted yews take an unknown number of years to grow to the coring height.

Tree	Rings in core	Sap rings	Overall growth rate mm/year	Inner decade growth rate mm/year	Outer decade growth rate mm/year	Estimated Radius at *bh* (mm) [1]	Age Estimate at *bh*
1	168	13	0.63	0.35	1.27	185	~270
2	208	28	0.59	0.52	0.36	190	~280
3	235	13	0.67	1.50	1.86	210	=245
4	244	15	0.50	0.73	0.91	170	~270
5	169	20	0.53	0.73	0.18	160	~270
6	160	16	1.07	1.72	0.89	195	=165

[1] Assuming non-eccentric growth and 15mm bark.

Age Estimates at *bh* (breast height)

= ; the centre is nearly present on the core, a simple geometric calculation was necessary to estimate age at coring height

~ ; no curvature of the rings at the centre of these cores, an estimate of the number of missing rings is used to derive the age estimate. These estimates are probably reliable only to within a broad range of the actual value, if reasonably circular, and not too heavily disturbed by pruning these may be within 20-30 years of the true value.

APPENDIX I

WINDOW SAMPLE BOREHOLE STRATIGRAPHY

Troels-Smith (1955) classification scheme of sediments used for borehole assessment, a summary of which is provided below:

Degree of Darkness	
nig.4	black
nig.3	
nig.2	
nig.1	
nig.0	white

Degree of Stratification	
strf.4	well stratified
strf.3	
strf.2	
strf.1	
strf.0	no stratification

Degree of Elasticity	
elas.4	very elastic
elas.3	
elas.2	
elas.1	
elas.0	no elasticity

Degree of Dryness	
sicc.4	very dry
sicc.3	
sicc.2	
sicc.1	
sicc.0	water

	Sharpness of Upper Boundary
lim.4	< 0.5mm
lim.3	< 1.0 & > 0.5mm
lim.2	< 2.0 & > 1.0mm
lim.1	< 10.0 & > 2.0mm
lim.0	> 10.0mm

	Sh	*Substantia humosa*	Humous substance, homogeneous microscopic structure
I Turfa	*Tb*	*T. bryophytica*	Mosses +/- humous substance
	Tl	*T. lignosa*	Stumps, roots, intertwined rootlets, of ligneous plants
	Th	*T. herbacea*	Roots, intertwined rootlets, rhizomes of herbaceous plants
II Detritus	*Dl*	*D. lignosus*	Fragments of ligneous plants >2mm
	Dh	*D. herbosus*	Fragments of herbaceous plants >2mm
	Dg	*D. granosus*	Fragments of ligneous and herbaceous plants <2mm >0.1mm
III Limus	*Lf*	*L. ferrugineus*	Rust, non-hardened. Particles <0.1mm
IV Argilla	*As*	*A.steatodes*	Particles of clay
	Ag	*A. granosa*	Particles of silt
V Grana	*Ga*	*G. arenosa*	Mineral particles 0.6 to 0.2mm
	Gs	*G. saburralia*	Mineral particles 2.0 to 0.6mm
	Gg(min)	*G. glareosa minora*	Mineral particles 6.0 to 2.0mm
	Gg(maj)	*G. glareosa majora*	Mineral particles 20.0 to 6.0mm
	Ptm	*Particulae testae molloscorum*	Fragments of calcareous shells

The influence for sediment compaction experienced during window sampling has been accounted for within the visual stratigraphic assessment, which will explain any potential differences between the stratigraphic record described below and the core photographs (Figures 7-9). The well surface was measured at *c*. 4.00m below ground level (bgl). Consequently, all borehole records commence at 4.00m.

WS1

4.00-4.30m

Da	St	El	Dr	UB
2	0	0	2	-

Ga3, Ag1, Sh+, Ggmin+, Ggmaj+
Light grey-brown silty sand with occasional gravel and organic mottling

4.30-5.80m

Da	St	El	Dr	UB
2	0	0	2	0

Ga2, Ag2, As+, Lf+, Ggmin+
Light grey-brown silty sand with some iron mottling evident

5.80-6.70m

Da	St	El	Dr	UB
2	0	0	1	1

Ga3, Ag1, Lf+, As+
Light brown silty sand

6.70-8.00m

Da	St	El	Dr	UB
2+	0	0	1	1

Ga4, Ag+, As+, Lf+
Orange-brown sand

WS2

4.00-4.35m

Da	St	El	Dr	UB
2+	0	0	2	-

Ga3, Ag1, Sh+, Ggmin+, Ggmaj+
Medium grey-brown silty sand with occasional organic mottling

4.35-5.60m

Da	St	El	Dr	UB
2	0	0	2	1

Ga2, Ag2, As+, Ggmin+, Sh+
Light grey-brown silty sand

5.60-7.00m

Da	St	El	Dr	UB
2	0	0	2	1

Ga3, Ag1, As+, Lf+
Grey-brown to orange-brown silty sand

WS3

4.00-5.00m Unsuccessful sample extraction

5.00-6.60m

Da	St	El	Dr	UB
2	0	0	2	0

Ga3, Ag1, Sh+, As+
Grey-brown silty sand with occasional organic mottling

6.60-7.20m	Da	St	El	Dr	UB
	2	0	0	2	1
	Ga4, Ag+, Sh+				
	Grey-brown sand				
6.60-8.00m	Da	St	El	Dr	UB
	2+	0	0	1	1
	Ga4, Ag+, Lf+				
	Orange-brown sand				