A Dendrochronological Analysis
of the

Allen House
Shrewsbury, Monmouth County, New Jersey

Edward R. Cook
William J. Callahan, Jr.
October, 2005

Introduction

This is the final report on the dendrochronological analysis of the Allen House, located at the corner of Broad & Sycamore Streets, Shrewsbury, Monmouth County, New Jersey. In an effort to confirm the construction history of this house, architectural historian Penelope Watson of Watson & Henry Associates, 12 N. Pearl Street, Bridgeton, NJ 08302, tele: (856) 451-1779, requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of its structural timbers. Together with Ms. Watson and Ms. Cristina Radu, Callahan visited the house on 8 July, 2005, and collected wood core samples for the dendrochronological analysis of the timbers. Of the 11 samples acquired and analyzed, 8 were oak (Quercus sp.) and 3 were pine (Pinus sp.). Every effort was made on site to locate bark or waney edges on the sampled timbers in order to ascertain an absolute cutting date, or dates, of the trees used in the construction.

Dendrochronological Analysis

Dendrochronology is the science of analyzing and dating annual growth rings in trees. Its first significant application was in the dating of ancient Indian pueblos of the southwestern United States (Douglass 1921, 1929). Andrew E. Douglass is considered the "father" of dendrochronology, and his numerous early publications concentrated on the application of tree-ring data to archaeological dating. Douglass established the connection between annual ring width variability and annual climate variability, which allows for the precise dating of wood material (Douglass 1909, 1920, 1928; Stokes and Smiley 1968; Fritts 1976; Cook and Kariukstis 1990). The dendrochronological methods first developed by Douglass have evolved and been employed throughout North America, Europe, and much of the temperate forest zones of the globe (Edwards 1982; Holmes 1983; Stahle and Wolfman 1985; Cook and Callahan 1992, Krusic and Cook 2001). In Europe, where the dendrochronological dating of buildings and artifacts has long been a routine professional support activity, the success of tree-ring dating in historical contexts is noteworthy (Baillie 1982; Eckstein 1978; Bartholin 1979; Eckstein 1984).

The wood samples collected from the Allen House were processed in the Tree-Ring Laboratory by Dr. Edward Cook, following well-established dendrochronological methods. The samples were carefully glued onto grooved mounts and sanded to a high polish to reveal the annual tree rings clearly. The rings widths were measured under a microscope to a precision of ±0.001 mm. The cross-dating of the obtained measurements utilized the COFECHA computer program (Holmes 1983), which employs a sliding correlation to identify probable cross-dates between tree-ring series. In all cases, the robust non-parametric Spearman rank correlation coefficient was used for determining cross-dating. Experience has shown that for trees growing in the northeastern United States, this method of cross-dating is superior to the traditional skeleton plot technique (Stokes and Smiley 1968). It is also very similar to the highly successful CROS program employed by, for instance, Irish dendrochronologists to cross-date European tree-ring series (Baillie 1982).

COFECHA is used to first establish internal, or relative, cross-dating amongst the individual timbers from the site. This step is critically important because it locks in the relative positions of the timbers to each other, and indicates whether or not the dates of those specimens with outer bark rings are consistent. Subsequently, the internally cross-dated series are each compared with independently established tree-ring master chronologies compiled from living trees and dated historical tree-ring material. All of the "master chronologies" are based on completely independent tree-ring samples.

In the Allen House study, a regional composite master dating chronology from living trees and historical structures in the New Jersey region was referenced primarily. All dating results were verified finally by comparison with independent dating masters from surrounding areas in New York, New Jersey, Massachusetts and central Pennsylvania. In each case, the dating as reported here was verified as correct.

Results and Conclusions

The results of the dendrochronological dating of the Allen House timbers are summarized in **Table 1** and **Figure 1**. A total of 8 oak and 3 pine samples were analyzed in the laboratory, with 4 of the 8 oak samples providing firm dendrochronological dates. None of the pine samples was successfully dated. To achieve these datings required attention during analysis to the previously recorded structural context of the samples (see **Table 1**). The contextual association of samples from within the house, the redundancy of the indicated relative cross-datings, and the eventual existence of sapwood and bark/waney edges demonstrating cutting year, provide the essential constraints necessary for establishing cross-dating both within a site and with absolute chronological masters.

The strength of the cross-dating of the oak samples is indicated by the Spearman rank correlations in the seventh column ("CORREL") of **Table 1**. These statistical correlations, produced by the COFECHA program, indicate how well each sample cross-dates with the mean of the others in the group. These individual correlations vary slightly in statistical strength, but all are in the range that is expected for correctly cross-dated timbers from buildings in the eastern United States. Of the 4 samples that cross-dated well between themselves, and also dated well against the local oak historical dating master (see **Table 1**, column 6), none had absolutely verifiable bark edge at the time of sampling, although all exhibited strong evidence of the presence of sapwood, i.e., those anatomically specialized wood cells in active trees that comprise one or more of the outermost growth rings. In the absence of verifiable bark edges on oak samples, the presence of sapwood indicates that the outermost extant rings must lie close to the lost wane edge. The number of absent tree rings, unfortunately, is never precisely determinable, yet in most cases should not exceed 10 to 15 years.

From the datings that were achieved, there emerged no certain evidence of an intrinsic construction period that produced the Allen House. The dated samples, all of oak from the cellar, do suggest a possible construction phase sometime shortly after the end of the year 1702. The presence of sapwood rings on the dated materials indicates that some construction took place thereafter, very likely within two decades (i.e. <1720). However, in the absence of collaborating dates from the remainder of the structure, it must be emphasized that this cellar construction may not be representative of the Allen House in its present configuration: the cellar timbers may have been reused, they may have belonged to an earlier structure that was demolished or reconfigured, the cellar unit may have existed independent of the present building, etc..

Of the remaining samples: the three attic oak timbers produced a floating chronology 55 years long that gave an indication of a cross-date, but with so few rings and a weak t-correlation with the master chronologies this result is statistically unsustainable and therefore is ignored. The three coniferous samples (Pinus sp.) also remain undated. Although the physical integrity of the cores was good and a floating chronology 115 years long was established, this did not produce any cross-date with local masters or more southerly pine master chronologies. The fireplace lintel was sufficiently long (100 rings) to produce statistically reliable results, but it did not cross-date, and it was subsequently determined that this piece was most certainly a relatively modern replacement.

Table 1. Dendrochronological dating results for all samples taken from the Allen House, Shrewsbury, Monmouth County, New Jersey. For WANEY, +BE means the bark edge was present and thought to be recovered at the time of sampling; -BE means that the bark edge was not recovered; +SP means that sapwood was present on the sample. All correlations are Spearman rank correlations of each series against the mean of all others of the same species. If the outermost recovered +BE ring is completely formed, it is indicated as "comp", meaning that the tree was felled in the dormant season following that last year of growth.

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
AHSMNJ01	Oak	Attic crawl space, brace, 1st from east wall	-BE +SP?	51	No Date	-.--
AHSMNJ02	Oak	Attic crawl space, brace, 1st from west wall	+BE? +SP	54	No Date	-.--
AHSMNJ03	Oak	Attic crawl space, brace, 2nd from west wall	-BE +SP	42	No Date	-.--
AHSMNJ04	Pine	Attic crawl space, post, 3rd from west wall	-BE	71	No Date	-.--
AHSMNJ05	Pine	Attic crawl space, sill, east side over brick wall between two house sections	-BE	110	No Date	-.--
AHSMNJ06	Pine	Attic crawl space, plate, over knee wall, west side	-BE	65	No Date	-.--
AHSMNJ07	Oak	Kitchen, lintel over fireplace	-BE +SP	100	No Date	-.--
AHSMNJ08	Oak	Cellar, sill over west wall	-BE +SP	115	1578 1692	0.46
AHSMNJ09	Oak	Cellar, joist, 4th from east wall	-BE +SP	119	1584 1702	0.48
AHSMNJ10	Oak	Cellar, joist, 7th from east wall	-BE +SP	92	1593 1684	0.59
AHSMNJ11	Oak	Cellar, joist, 1st from east wall	+BE? +SP?	95	1598 1692	0.37

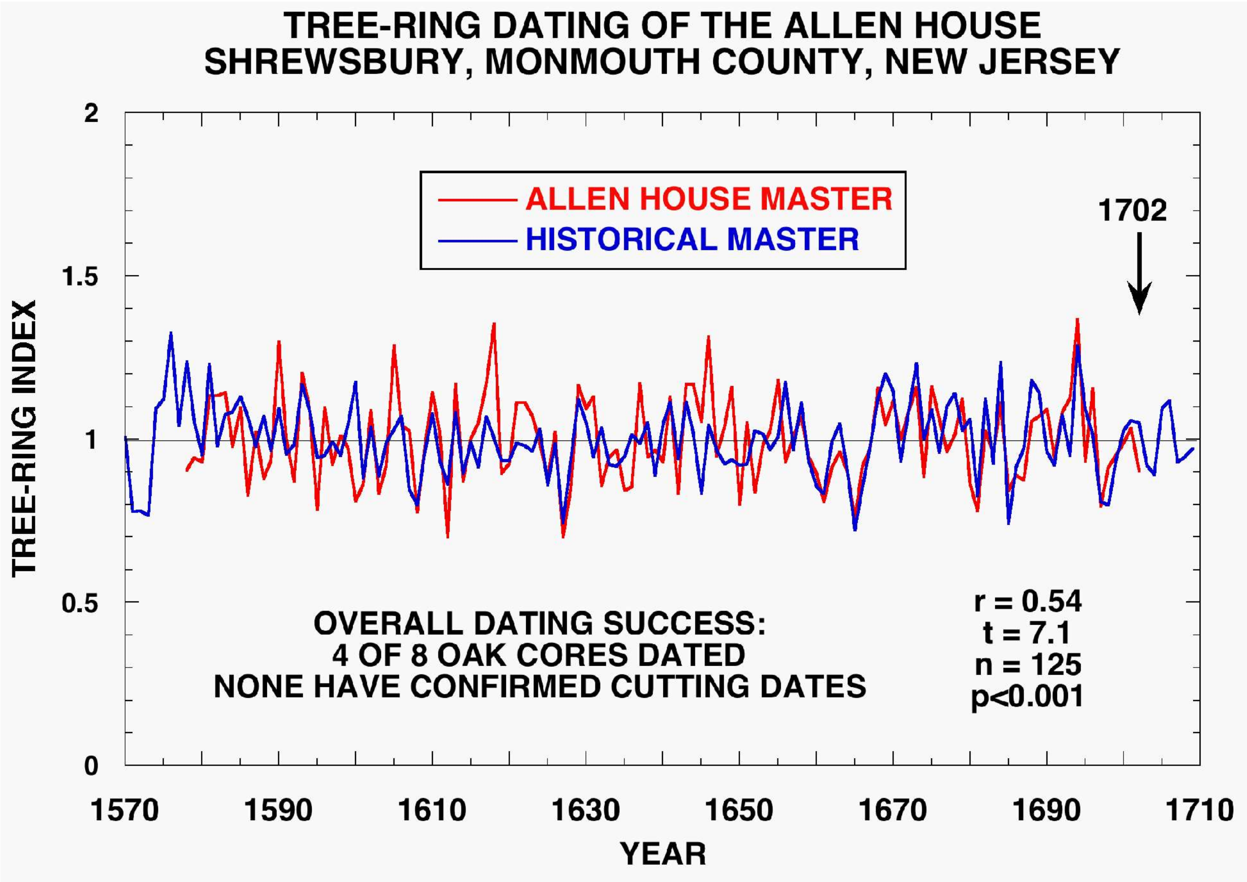

Figure 1. Comparison of the cross-dated oak master chronology compiled from the dated samples from the Allen House, with the best, previously developed local oak dating-master developed from living trees and historical samples from New Jersey. The Spearman rank correlation between the series (r=0.54) is highly significant (p<<0.001) with an overlap of 125 years and a t-statistic of 7.1.

The "r-factor" is the Spearman rank correlation coefficient, a measure of relative agreement between two groups of measurements or data. It can range from -1 (perfect opposite agreement) to +1 (perfect direct agreement). The "t-value" is Student's distribution test for determining the unique probability distribution for "r", i.e. the likelihood of its value occurring by chance alone. As a rule, a t=3.5 has a probability of about 1 in 1000, or 0.001, of being invalid. Higher "t" values indicate increasingly stronger statistical certitude.

The t-statistic (t=7.1) associated with the correlation between these two series (r=0.54) is highly significant (p<<0.001) for a 125-year overlap. For that reason, there can be no doubt that the dates presented here are very strongly valid, and that the statistical chance of the cross-dates being incorrect is much, much less than 1 in 1000.

Selected References

Baillie, M.G.L. 1982. *Tree-Ring Dating and Archaeology*. Croom Helm, London and Canberra. 274 pp.

Baillie, M.G.L. 1995. *A Slice Through Time: Dendrochronology and Precision Dating.*B.T. Batsford, Ltd., London

Bartholin, T.S. 1979. ”Provtagning för dendrokronologisk datering och vedanatomisk analys.” *Handbook i archeologiskt fältarbete, häfte 2.* 1-15 Riksantikvarieämbetets dokumentationsbyrå, Stockholm.

Cook, E.R. and Callahan, W.J. 1987. *Dendrochronological Dating of Fort Loudon in South-Central Pennsylvania*. Limited professional distribution.

Cook, E.R. and Callahan, W.J. 1992. *The Development of a Standard Tree-Ring Chronology for Dating Historical Structures in the Greater Philadelphia Region.* Limited professional distribution.

Cook, E.R. and L. Kariukstis, eds. 1990. *Methods of Dendrochronology: Applications in the Environmental Sciences*. Kulwer, The Netherlands.

Douglass, A.E. 1909. Weather cycles in the growth of big trees. *Monthly Weather Review* 37(5): 225-237

Douglass, A.E. 1920. Evidence of climate effects in the annual rings of trees. *Ecology* 1(1):24-32

Douglass, A.E. 1928. Climate and trees. *Nature Magazine* 12:51-53

Douglass, A.E. 1921. Dating our prehistoric ruins: how growth rings in trees aid in the establishing the relative ages of the ruined pueblos of the southwest. *Natural History* 21(1):27-30

Douglass, A.E. 1929. The secret of the southwest solved by talkative tree-rings. *National Geographic Magazine* 56(6):736-770.

Eckstein, D. 1978. Dendrochronological dating of the medieval settlement of Haithabu (Hedeby). In: *Dendrochronology in Europe*, (J. Fletcher, ed.) British Archaeological Reports International Series 51: 267-274

Eckstein, D. 1984. *Dendrochronological Dating (Handbooks for Archaeologists, 2).* Strasbourg, European Science Foundation.

Eckstein, D. and Bauch, J. 1969. “Beitrag zur Rationisilerung eines dendrokronologischen Verfahrens und zur Analyse seiner Aussagesicherheit.” *Forstwissenschaftliches Centralblatt* 88, 230-250.

Edwards, M.R. 1982. Dating historic buildings in lower Maryland through dendrochronology. In: *Perspectives in Vernacular Architecture*. Vernacular Architecture Forum.

Fritts, H.C. 1976. *Tree Rings and Climate.* Academic Press, New York. 567 pp.

Holmes, R.L. 1983. Computer assisted quality control in tree-ring dating and measurement. *Tree-Ring Bulletin* 43:69-78

Stahle, D.W. and D. Wolfman. 1985. The potential for archaeological tree-ring dating in eastern North America. *Advances in Archaeological Method and Theory* 8: 279-302.

Stokes, M.A. and T.L. Smiley. 1968. *An Introduction to Tree-Ring Dating*. University of Chicago Press, Chicago 110 pp.

Edward Cook was born in Trenton, New Jersey, in 1948. He received his PhD. from the Tucson Tree-Ring Laboratory of the University of Arizona in 1985, and has worked as a dendrochronologist since 1973. Currently director of the Tree-Ring Laboratory at the Lamont-Doherty Earth Observatory of Columbia University, he has comprehensive expertise in designing and programming statistical systems for tree-ring studies, and is the author of many works dealing with the various scientific applications of the dendrochronological method.

William Callahan was born in West Chester, Pennsylvania, in 1952. After completing his military service he moved to Europe, receiving his MA from the University of Stockholm in 1979. He began working as a dendrochronologist in Sweden in 1980 at the Wood Anatomy Laboratory at the University of Lund, and returned to the United States in 1998. A former associate of Dr. Cook at the Tree-Ring Laboratory of Lamont-Doherty, he has extensive experience in using dendrochronology in dating archaeological artifacts and historic sites and structures.

Some regional historical dendrochronological projects completed by the authors:

Abraham Hasbrouck House, New Paltz, NY
Carpenter's Hall, Philadelphia, PA
Christ's Church, Philadelphia, PA
Conklin House, Huntington, NY
Customs House, Boston, MA
Daniel Pieter Winne House, Bethlehem, NY
Ephrata Cloisters, Lancaster County, PA
Fawcett House, Alexandria, VA
Gadsby's Tavern, Alexandria, VA
Gilmore Cabin, Montpelier, Montpelier Station, VA
Gracie Mansion (Mayor's Residence), New York, NY
Hanover Tavern, Hanover Courthouse, VA
Harriton House, Bryn Mawr, PA
Hollingsworth House, Elk Landing, MD
Independence Hall, Philadelphia, PA
John Browne House, Forest Hills, NY
Log Cabin, Fort Loudon, PA
Lower Swedish Log Cabin, Delaware County, PA
Morris Jumel House, Jamaica, NY
Old Swede's Church, Philadelphia, PA
Panel Paintings, National Gallery, Washington, DC
Pennock House & Barn, London Grove, PA
Powell House, Philadelphia, PA
Spangler Hall, Bentonville, VA
St. Peter's Church, Philadelphia, PA
Strawbridge Shrine, Westminster, MD
Thomas & John Marshall House, Markham, VA
Varnum's HQ, Valley Forge, PA
William Garrett House, Sugartown, PA
Yew Hill, Fauquier County, Virginia