TREE-RING ANALYSIS OF BOXWOODS (*BUXUS SEMPERVIRENS* L.) FROM THOMAS JEFFERSON'S POPLAR FOREST

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submitted to

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Introduction

This research was initiated as part of an overall project that concerns the restoration of Thomas Jefferson's Poplar Forest to the original conditions as they likely existed at the time of the plantation's initial construction *ca*. 1809-1812. Subsequent ownership after Jefferson's death in 1826 has caused modifications to the original building and landscape. Our contribution to this restoration concerns the circle of boxwoods (*Buxus sempervirens* L.) that surround the carriage circle at the front of the drive leading to the front steps of the house (see Figure 1). In addition, considerable interest was expressed in possibly analyzing the tulip poplars (*Liriodendron tulipifera* L.) that dominate the Poplar Forest landscape. Unfortunately, our few collected samples of poplars were in an advanced state of decay and no further analysis is possible with these few samples. A previous analysis, however, of the ages of the living tulip poplars as derived from freshly cut stumps indicated that they were indeed Jeffersonian or pre-Jeffersonian in age.

Objective

Our objective was to determine the likely ages of these boxwoods by conducting a thorough sampling from the carriage circle. Two possible outcomes can be expected. First, the ages of the shrubs may be consistent with their having been planted at the time of the initial construction It would be recommended that these boxwoods be preserved. Second, the ages of the shrubs may not be consistent with their having been planted by Jefferson and his laborers. The fate of the boxwoods would then be up to the present management of the Poplar Forest.

Methods

Close examination of the boxwoods indicated that many had dead stems, and we targeted these stems, first by using a hand saw, and then by using a chain saw later in the day. We obtained 22 complete, usable cross sections from 10 boxwoods (see Table 1). Additional sections sampled were too rotten (*e.g.*, BXR021Dr1) or too decayed (*e.g.*, BXL009A) for additional analyses, but fortunately, such samples were few in number. To supplement the information from these cross sections, we also collected nine increment cores using a 4.3 mm diameter, 40 cm length Haglof increment borer. All samples were appropriately labeled and numbered, and all relevant information about each boxwood (*i.e.*, location, crown condition, diameter, *etc.*) was recorded on a standard specimen form as used by the Laboratory of Tree-Ring Science at the University of

Tennessee. Furthermore, we assessed whether the stem we sampled was a 2nd or 3rd generation progeny of the original planting, an analysis made possible because boxwoods sprout from their base when a central stem loses its ability to fix carbon in amounts necessary to continue propagation of the plant. Digital photographs were taken of the sampling process, as well (see Figures 2 and 3).

In the laboratory, all core samples were mounted and glued to wooden core mounts and allowed to dry for 24 hours. All sections were first cut with a band saw to provide a flat surface that would facilitate dating of the tree rings. All surfaces were then sanded with a Makita 4" X 24" belt sander, first using a 120 grit sandpaper belt, then a 150 grit and 240 grit, and eventually progressing to a 320 grit belt. This sequence provided a blemish-free surface on our samples that enhanced ring definition, a necessary prerequisite for successful tree-ring analysis and interpretation under standard 10X magnification. All rings were then counted and aged for each sample, and all information recorded in a spreadsheet (see Table 1).

Results

Growth zones rather than tree rings

The growth pattern of these shrubs indicated what appeared to be "growth zones" rather than true tree rings, a common physiological property of shrubs growing in temperate geographic zones (see *e.g.* Schweingruber 1992 and 1996). We found the rings to be ill-defined, exhibiting boundaries between the latewood growth (the darker band of wood) of the previous year and the earlywood growth of the following year (the lighter band) that were not very prominent (see Figures 4 and 5). A necessary prerequisite for tree-ring dating is that the rings be well-defined. Because of the lack of definition between latewood and earlywood, we could not be sure we had successfully identified each and every ring.

Eccentric growth rather than concentric growth

Another problem we encountered was the eccentric growth patterns exhibited by the shrubs. In some boxwoods, the growth pattern was concentric, *i.e.* the “rings” formed nearly complete circles or ellipses around the periphery of the sample (see Figure 4). Occasionally, a boxwood would exhibit eccentric growth behavior, *i.e.* the “rings” would be very erratic, with some rings pinching out against a previous growth area (see Figure 5). For tree-ring dating to be successful, concentric growth must be exhibited by the shrubs. We therefore had little hope of successfully dating some of our samples because of this erratic growth behavior.

Enhanced latewood or microrings?

Another vexing problem related to the latewood exhibited by the boxwoods. In some species of trees, latewood growth may be enhanced due to certain environmental processes, *e.g.* wildfires or insect attacks. We found latewood growth on these boxwoods to be problematic because some bands of latewood would appear “normal” while others appeared to be enlarged. These enlarged bands could not be differentiated from what could have been narrow rings. Such rings with enhanced latewood were ubiquitous in our samples.

Aging the boxwoods

Despite these problems, we felt some information could be gained from these boxwoods by conducting a simple count of these growth zones, on the condition that (1) each growth zone was annual in nature, (2) we could identify all growth zones, and (3) the enhanced latewood encountered was a true band of latewood and not a narrow ring. We marked each growth zone lightly with pencil, and tallied the number of growth zones for all samples on which the wood could be clearly seen through the microscope. We emphasize that this simple ring counting exercise does not constitute a strict dendrochronological analysis, and we provide this information in the hope it may still prove useful to the management of the Poplar Forest plantation.

We found that the boxwoods, despite their small diameter, could reach a great age (if our counts are truly reflective of age). The oldest stem sampled was 95 years old (BXR001, the first boxwood on the right as one enters the circle), while BXR017 (located to the left of the circle) was 94 years old. We point out that we easily determined that both these boxwoods were likely 2nd generation stems, as the first generation stem (*i.e.* the original planting) had long since died and left a central hole in the middle of the boxwood stem cluster. Most stems (*e.g.* BXL005 and

BXL018) were between 60-75 years in age or older, while only a few (*e.g.* BXR003) were younger. The average maximum age of ten samples (Table 1) was 73 years.

Discussion

If we use the maximum ages for the samples (94 and 95 years) as indicative of the ages this species can reach growing in this location, and combined with the fact these were second generation stems, we can then interpolate a possible age of 190 years for the two oldest boxwood clusters. This would place the planting year at 1811 (2001 - 190 years), which would be entirely consistent with these shrubs having been planted during the initial construction phase of the plantation. However, this determination is contingent on the original stem also having reached an age of 95 years, and this can not be determined. If, however, the original stem had reached an average age of 73 years, then the possible planting could have been around 1833 (2001 - 95 years - 73 years) or as young as 1864 (2001 - 95 years - 42 years, with 42 being the youngest dead stem we sampled).

Some stems, however, could be third generation, which would then make the ages of these boxwoods older. For example, the youngest dead stem we sampled was 42 years old (BXL009), but this stem could be a third generation stem. If the previous two generation stems reached the average age of 73 years, this would suggest this stem was planted around 1813 (2001 - 73 years - 73 years - 42 years). However, these is no evidence supporting the ages of these previous two generations. It is also possible the previous stems could have been younger, causing a planting date several decades later.

We were dismayed when we saw the physiological properties of the growth zones in this shrub, and we knew immediately that a precise, crossdated dendrochronological analysis would not be possible. Nonetheless, we feel some information could be gained from simple ring counts of these samples, and we are hopeful our interpretations, albeit their being preliminary, may be of some use to the management of the Poplar Forest landscape. In summary, we simply can not provide an exact planting date for these boxwood stems. Our findings indicate they could have been planted over a wide range of years, possibly as early as 1811, but possibly as late as the 1860s.

Finally, we would like to emphasize that the wooden structures and beams at the Poplar Forest are of considerable scientific interest for reconstructing past climate. If some of these beams date from the Jefferson period, as indeed they should, then it may be possible to extract climatic information for several hundred years, perhaps back to the pre-Columbian period if these beams of wood are as old as they appear. Little information is known about past climate trends in the interior portions of the upland Southeast. Most paleoclimatic information on century time scales for this region has come from baldcypress trees growing in more coastal locations (see *e.g.* Stahle and Cleaveland 1992 and Stahle *et al*. 1998). Few long-term tree-ring records have been developed for interior locations of this portion of Virginia, and none in the Southeast have extended back to the pre-Columbian period. We suggest that future efforts be placed in a systematic sampling of old wood beams that may be found at Poplar Forest for the purpose of reconstructing past climate for interior portions of Virginia.

References

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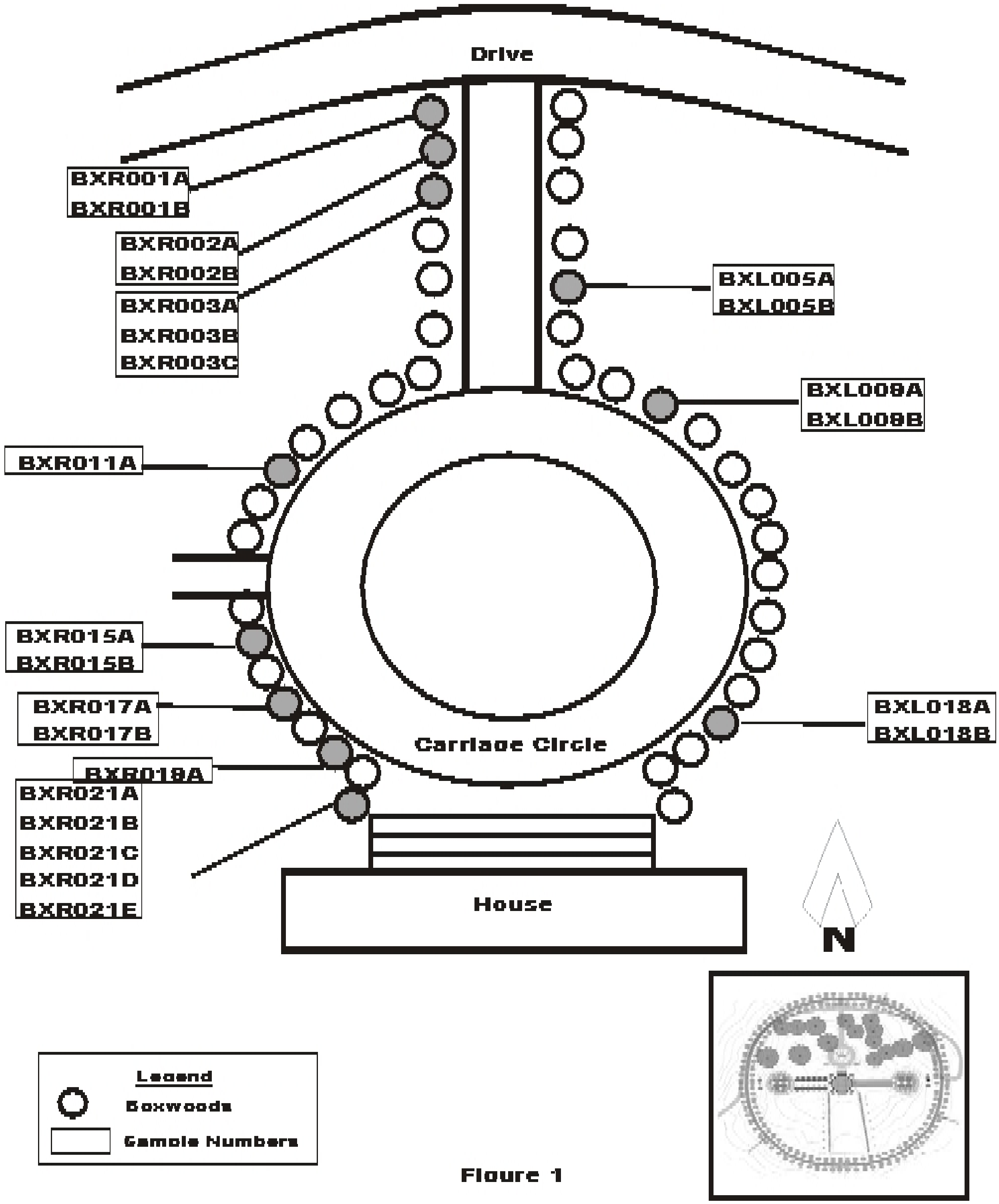

Figure 1. Plan of Poplar Forest, showing boxwoods sampled and where cores and sections were taken (cartographic design by David F. Mann).

Figure 2. David Mann obtaining a small cross section from a dead stem with a hand saw.

Figure 3. Coring boxwoods was very problematic due to the tight clustering of the stems, and because the wood was very dense.

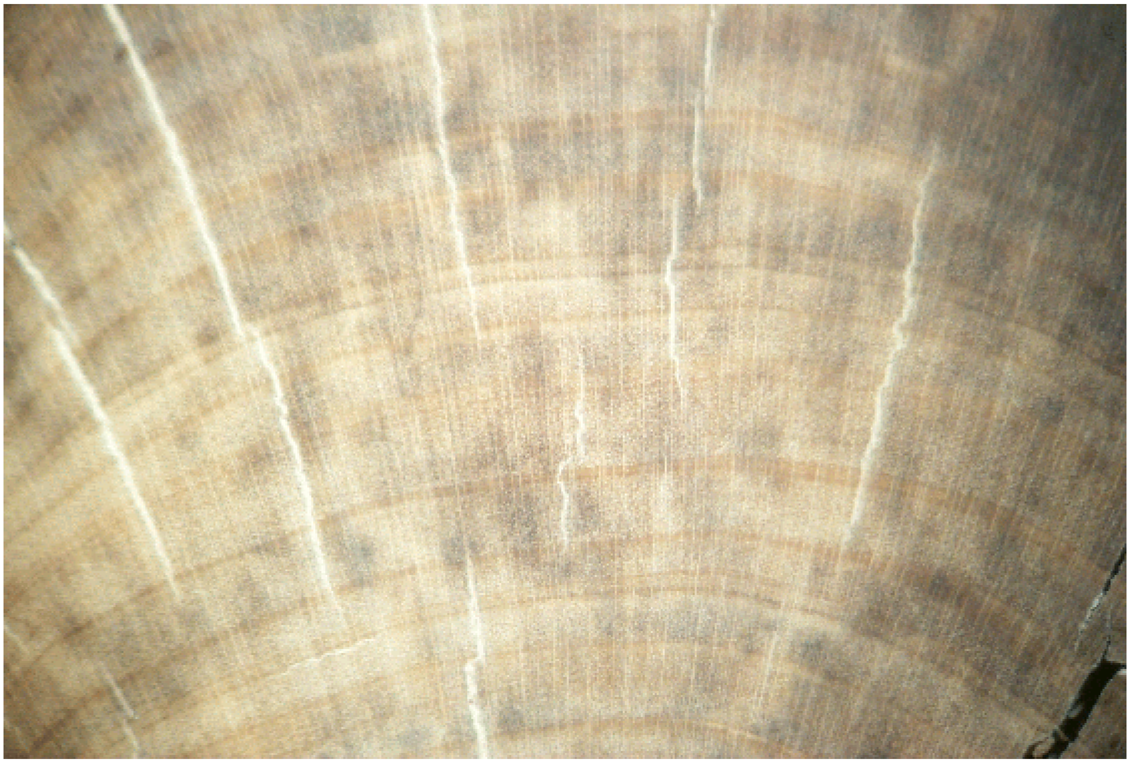

Figure 4. Image of boxwood sample BXR003A, showing even, concentric ring growth.

Figure 5. Image of boxwood sample BXL005B, showing eccentric ring growth.

Table 1: Summary of tree-ring dating

Poplar Forest, Lynchburg Virginia, Carriage Circle Boxwoods

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Sample number	Timber and position	Collected by	Generation	comments	No of rings from pith	Total Specimen Length
BXL005Ar1	cross-section (rot)	HDGM, DFM, JS	2nd or 3rd	pith rotted	77	2.7mm
BXL005Ar2	cross-section (rot)	HDGM, DFM, JS	2nd or 3rd	pith rotted	32	
BXL005Br1	cross-section	HDGM, DFM, JS	2nd or 3rd	stem channel, two primary piths	0	3.7mm
BXL005Br2	cross-section	HDGM, DFM, JS	2nd or 3rd	stem channel, two primary piths	0	
BXL009Br1	core	HDGM, DFM, JS	2nd or 3rd	living stem	42	2.3mm
BXL018Ar1	cross-section	HDGM, DFM, JS	2nd	small stem channel	73	3.9mm
BXL018Ar2	cross-section	HDGM, DFM, JS	2nd	small stem channel	52	
BXL018Br1	core	HDGM, DFM, JS	living stem		66	4.1mm
BXR001Ar1	cross-section	HDGM, DFM, JS	2nd		95	3.4mm

BXR001Ar2		cross-section			HDGM, DFM, JS		2nd		88	
BXR001Br1		core			HDGM, DFM, JS		living stem		75	4.1mm
BXR002Ar1		cross-section (rot)			HDGM, DFM, JS		2nd or 3rd	pith rotted	67	3.9mm
BXR002Ar2		cross-section (rot)			HDGM, DFM, JS		2nd or 3rd	pith rotted	55	
BXR002Br1		core			HDGM, DFM, JS		living stem		64	2.0mm
BXR003Ar1		cross-section			HDGM, DFM, JS		2nd or 3rd		53	3.6mm
BXR003Ar2		cross-section			HDGM, DFM, JS		2nd or 3rd		47	
BXR003Br1		core			HDGM, DFM, JS		living stem		48	2.3mm
BXR015Ar1		core			HDGM, DFM, JS		living stem		49	2.7mm
BXR015Br1		cross-section			HDGM, DFM, JS		2nd or 3rd		70	3.4mm
BXR015Br2		cross-section			HDGM, DFM, JS		2nd or 3rd		65	
BXR017Ar1		core			HDGM, DFM, JS		living stem		43	2.2mm

BXR017Br1		cross-section			HDGM, DFM, JS		2nd	extensive cracking	94	5.6mm
BXR017Br2		cross-section			HDGM, DFM, JS		2nd	extensive cracking	80	
BXR021Ar1		core			HDGM, DFM, JS		living stem		61	1.7mm
BXR021Br1		core			HDGM, DFM, JS		living stem		60	3.0mm
BXR021Cr1		cross-section			HDGM, DFM, JS		2nd or 3rd	dead stem	67	6.0mm
BXR021Cr2		cross-section			HDGM, DFM, JS		2nd or 3rd	dead stem	77	
BXR021Dr1		cross-section (rot)			HDGM, DFM, JS		2nd or 3rd	pith rotted	72	6.9mm
BXR021Dr2		cross-section (rot)			HDGM, DFM, JS		2nd or 3rd	pith rotted	58	
BXR019Ar1		cross-section			HDGM, DFM, JS		2nd or 3rd	stem channel	79	3.8mm
BXR019Ar2		cross-section			HDGM, DFM, JS		2nd or 3rd	stem channel	46	
BXR021E		not used, extensive rot			HDGM, DFM, JS		2nd or 3rd	not sanded	0	
BXL009A		not used, extensive rot			HDGM, DFM, JS		2nd or 3rd	not sanded	0	
BXR011A		sample fractured			HDGM, DFM, JS		2nd or 3rd	not sanded	0	