David M. Lawrence
MATX 603
Institutional History

ANDREW E. DOUGLASS, THE UNIVERSITY OF ARIZONA AND THE LABORATORY OF TREE-RING RESEARCH

To understand the Laboratory of Tree-Ring Research's role in establishing the science of dendrochronology,[1] tree-ring dating, one has to understand its founder, Andrew Ellicott Douglass.

Douglass, the founder of the discipline, was not the first scholar to take note of the patterns of annual growth rings in trees. Scholars had noticed the patterns for centuries. Douglass was not the first to realize such patterns might prove useful to determine the age of a tree or of a structure made of wood. The English inventor Charles Babbage, father of the "difference engine" or modern computer, suggested that tree rings might be used for that purpose in 1838 (261-263), nearly 100 years before Douglass not only surmised the possibility of dating structures with tree rings, but developed the fundamental dating procedures in use by virtually all dendrochronologists (tree-ring scientists) today.

Douglass began his career as an astronomer—and he was a pioneering astronomer at a pivotal time in that discipline, working for the Harvard Observatory, establishing observatories in the western United States and in South America, and making many key observations of celestial phenomena at a time when photography was enhancing scientists' ability to record what they observed (Webb 7-13). At Harvard, Douglas began working with Percival Lowell, and—while on assignment for Lowell he was asked to find a site for an observatory in Arizona. He found the

[1] It is not clear who coined the term dendrochronology. The first mention of the term may be in an unpublished 1930 manuscript by Emil W. Haury entitled "A Sequence of Decorated Redware from Silver Creek Drainage, Arizona" (Stephen E. Nash *pers. comm.*)

site for and supervised the construction of the Lowell Observatory in Flagstaff. Douglass broke with Lowell over the latter's enthusiastic promotion of the fantasy of civilizations on Mars, and as a result found himself unemployed in July 1901 (Webb 37-49).

Douglass, a respected member of the Flagstaff community, was elected in 1902 to a position as Coconino County probate judge. He also accepted a teaching position at Northern Arizona Normal School, now Northern Arizona University (Webb 49-53). His work as an educator led to him securing a position at the University of Arizona in Tucson in 1906 (Webb 54-77, 86-90). He briefly served as the university's president (1910-11); dean of the College of Letters, Arts, and Sciences (1915-18); and argued for, designed, and supervised the building of the University of Arizona's Steward Observatory (1907-1923), then served as its director or director emeritus until 1958 (Anonymous 3).

His hiatus from astronomy from 1901 to 1907 was productive for the birth of dendrochronology, however. Ever the keen observer in his travels through the landscape in northern Arizona and southern Utah, Douglass in 1901 noticed the relationships among elevation, precipitation, and tree growth. Aware of research linking solar cycles—such as sunspot cycles—to climate, and ultimately tree growth, and he reasoned that study of the annual growth rings of trees would allow scientists to reconstruct past patterns in solar activity. Douglass began collecting tree-ring samples from the yards of T.A. Riordan's Arizona Lumber & Timber Company in January 1904, making his first measurements of tree-ring widths on a log in one of the yards. He obtained cross sections and began using a razor bad to shave the rough-cut surface in an effort to better see the ring-width patterns. (Webb 102-104). This method of surface preparation is still commonly practiced today (Pilcher 41, Speer 92-93).

While studying the wood from Riordan's yards, he noticed a similar pattern of wide and narrow rings in the outer radii of some of the logs near the bark. He examined the stump of a tree that had been cut years earlier in Flagstaff, and noticed a similar pattern. He determined that the tree had been cut down in 1894—a fact verified by the owner of the property (Webb 104-105). In that moment, modern dendrochronology—based on a procedure called crossdating in which characteristic growth patterns or other features in the annual rings of trees are matched to ensure dating accuracy—was born. Douglass began experimenting with ways to compare tree-ring patterns to climate, too, and published the first paper of his dendrochronological career, "Weather Cycles in the Growth of Trees," in the journal *Monthly Weather Review* in 1909.

By now Douglass's scientific career was focused on developing the science of dendrochronology in addition to astronomy. His next major breakthrough in tree-ring science came in 1911, when he found out that trees in Prescott, Ariz., had similar growth patterns to those in Flagstaff. Given that Prescott was about 70 miles southwest of Flagstaff, the finding suggested that annual tree growth responded to regional environmental—climatic—patterns. As he took advantage of this larger number of specimens, he noted that unusual features, such as unusually narrow annual rings, could serve as markers to aid in recognizing tree-ring patterns and, ultimately, to accurately date specimens. "Apparently, if a sufficient number of comparisons be made, and if the trees thus compared be distributed over widely different localities, the yearly identification of rings may be made with almost perfect certainty," Douglass wrote in 1914 (108). Such dating was important—even for trees whose cutting dates were known—because trees in variable environments may put on multiple growth bands or "rings" (false rings) in a year, or a ring may be missing along some radii (missing or locally absent rings; Fritts 20-21).

In the same publication, Douglas discussed methods of converting series of ring-width measurements into standardized indices that could be statistically compared with measurements of weather and climate phenomena (109-112). His initial focus was on finding a relationship between ring width and precipitation (112-115) and then, ultimately solar activity (117-121).

Douglass's observations and insights lay the foundation for the rapid development of the discipline, in particular its methods. Before long, he realized that narrow rings—relative to their neighbors—were better markers to use in helping to establish accurate dates. "For some unknown reason, rings of diminished size seem to carry more individuality than enlarged rings, and so they are usually picked out for cross-comparison. In nearly every decade some are thus distinguished, and in each century there are usually 3 to 4 conspicuously small rings which give very important aid," he wrote in a 1919 Carnegie Institution of Washington publication (55-56).

Once a tree-ring sample was dated, it was marked in a standard way to speed comparison with other samples, "The identification mark is a pin-prick or very small hole placed on the last ring of each decade. The middle year of each century has 2 pin-pricks and the centuries are marked with 3; the 1,000-year mark is 4. Marks found in error are 'erased' by a scratch through them," he wrote (55). This method is still used by tree-ring laboratories around the world (Speer 97). In the case of photographic or x-ray images, the images themselves are marked in this manner.

For a time, Douglass worked primarily on trees of known cutting date. He used his memory—he had a phenomenal recall of tree-ring patterns (Peter M. Brown, *pers. comm.*)—or a tabular list of characteristic years. In 1914, however, anthropologist Clark Wissler asked him for help in dating Native American sites in the Southwest. The cutting date of the beams, charcoal and other wood debris from sites such as those in Chaco Canyon or Mesa Verde were not known, however, and Douglass found himself training a cadre of collaborators to identify, obtain, preserve and analyze these samples. An easier method of tracking and comparing tree-ring patterns was needed. Thus, sometime in the 1920s the skeleton plot was born.

A skeleton plot is drawn on a thin strip of graph paper, with years marked along the long axis. Rings noticeably shorter than their neighbors are marked with lines, the length of the line inversely proportional to the width of the ring—the smaller the ring, the longer the line. Other characteristic features can be marked on the skeleton plot as well. Aside from making it easier to compare individual tree-ring series, skeleton plots made it easier to compare individual series to master chronologies within a region or compare chronologies from other regions. Douglass wrote in 1935 that skeleton plots were commonly used by 1927 (3-4), but his writing and that of others re vague about its specific origins. Nevertheless, it is certain that he had a hand, if not the hand, in developing them (Henri D. Grissino-Mayer, *pers. comm.*).[2] This technique, too, is still widely used today (Speer 13-14).

Douglass's collaboration with the anthropological community—backed by the American Museum of Natural History, National Geographic Society, and other institutions—contributed to explosive growth in the study of Southwestern anthropology by helping sort out dates of many pre-Columbian dwellings spanning nearly 2,000 years. The key break came in 1929 with the discovery of a fragment of charcoal at the Whipple Ruin site near Showlow, Ariz. The sample, now immortalized with the identification number, HH-39, helped Douglass join two chronologies: an absolutely dated chronology dating from the 1920s to the mid-thirteenth century and a nearly 600 year-old floating chronology (Haury 13-14). The discovery and dating of HH-39 enabled Douglass to extend the absolute dating of pre-Columbian sites in the Southwest to the

[2] The question prompted an interesting discussion on the International Tree-Ring Data Bank Forum in which Steven E. Nash, who wrote a history of the contributions of dendrochronological research to North American archaeology, confessed that even he was not sure who specifically invented the technique.

middle of the first millennium.[3] Douglass's publication of his Southwestern master chronology in the December 1929 issue of *National Geographic Magazine* permanently raised the prominence of this new branch of science. By 1936, Douglass had extended the master chronology well into the first century CE (Nash 90).

Recognition of the importance of Douglass's work helped inspire the institutionalization of the new discipline of dendrochronology. Douglass chaired the first tree-ring conference in 1934 (Glock 4). Shortly afterward, he helped establish the first journal devoted to tree-ring dating, the *Tree-Ring Bulletin* (now *Tree-Ring Research*), and wrote the editorial introducing the first issue of the journal in July 1934 (2-3). In the pages of the journal, Douglass expounded on what Glock referred to as the "Douglass method" (4), which codifies the basic techniques of the discipline. After three decades as a professor of physics and astronomy at the University of Arizona, the university gave him a new title in 1936—Professor of Dendrochronology (Anonymous 3).

On December 4, 1937, the university's Board of Regents voted to establish a permanent tree-ring research laboratory. In an anonymous account in the January 1938 issue of the *Tree-Ring Bulletin*, the board is quoted as saying the laboratory's mission would be "for the purpose of caring for the collections, equipment, property and activities connected with tree-ring work which has been carried on during the past 30 years and for the further purpose of recognizing the priority of the University of Arizona in pioneering this most important field of study." Douglass served as director of the Laboratory of Tree-Ring Research from its founding in 1938 until 1958, and director emeritus of the lab until his death in 1962 (Anonymous 3). The opening paragraph of his obituary in the *Tree-Ring Bulletin* summed up his contribution to the field, "It cannot be said that he created tree-ring research, but it can be truly stated that he pioneered, developed, and stimulated the study and application of tree-ring data," (Anonymous 3).

[3] Actually, the two chronologies overlapped, but the length of the overlap period was too short to be reliably dated.

BIBLIOGRAPHY

Anonymous. “Tree-Ring Laboratory.” *Tree-Ring Bulletin* 4 (1938): 2.

—. “Andrew Ellicott Douglass: 1867-1962.” *Tree-Ring Bulletin* 24 (1962): 2-10.

Babbage, Charles. *The Ninth Bridgewater Treatise*, 2nd Ed. London: John Murray, 1838. Print.

Douglass, A.E. “Weather Cycles in the Growth of Trees.” *Monthly Weather Review* 27 (1909): 225–237. Print.

—. “A method of estimating rainfall by the growth of trees.” *The Climatic Factor as Illustrated in Arid America.* Publication No. 192. Washington: Carnegie Institute of Washington, 1914. 101-121. Print.

—. *Climatic Cycles and Tree Growth: A Study of the Annual Rings of Trees in Relation to Climate and Solar Activity.* Publication No. 289. Washington: The Carnegie Institute of Washington, 1919. Print.

—. “The Secret of the Southwest Solved by Talkative Tree Rings.” *National Geographic Magazine* 56 (1929): 736-550.

—. “Editorial.” *Tree-Ring Bulletin* 1 (1934): 2-3.

—. “Accuracy in Dating – II. The Presentation of Evidence.” *Tree-Ring Bulletin* 1 (1935): 19-21. Print.

—. “The Central Pueblo Chronology.” *Tree-Ring Bulletin* 1 (1936): 29-34. Print.

Fritts, H.C. *Tree Rings and Climate.* London: Academic Press, 1976. Print.

Glock, Waldo S. “Report on the First Tree-Ring Conference.” *Tree-Ring Bulletin* 1 (1934): 4-6.

Haury, E.W. “HH-39: Recollections of a Dramatic Moment in Southwestern Archaeology.” *Tree-Ring Bulletin* 24 (1962): 11-14. Print.

Nash, Stephen Edward. *Time, Trees, and Prehistory: Tree-Ring Dating and the Development of North American Archaeology, 1914-1950.* Salt Lake City: University of Utah Press, 1999. Print.

Pilcher, J.R. "Sample Preparation, Cross-dating, and Measurement." *Methods of Dendrochronology: Applications in the Environmental Sciences.* Ed. E.R. Cook and L.A. Kairiukstis. Dordrecht: Kluwer Academic Publishers, 1990. 40-51. Print.

Speer, James H. *Fundamentals of Tree-Ring Research.* Tucson: University of Arizona Press, 2010. Print.

Webb, George Ernest. *Tree Rings and Telescopes: The Scientific Career of A.E. Douglass.* Tucson, Ariz: University of Arizona Press, 1983. Print.