A variation of this article was first published in *Chronology & Catastrophism Review* (the Journal of the Society for Interdisciplinary Studies) in 2012 (www.sis-group.org.uk/review.htm). It constitutes the bulk of Chapter 4 in *Science and Religion: Reconciling the Conflicts* by David M. Barker which was published in 2013.

# TREE-RING DATING AND BIBLE CHRONOLOGY

*When the experts went about dating the recently discovered Dead Sea Scrolls,*
*the specialists in each field . . . all came up with different answers,*
*sometimes many centuries apart.*
—Hugh Nibley, 1964

Scientists use many techniques to estimate ages. Several are briefly discussed in this chapter along with indications as to their strengths and weaknesses. They include tree-ring dating, helium dating, crustal rebound, ice core, waterfall recession, and radiometric dating of rocks. Since these techniques provide much of the information in conflict with Bible chronology, it is helpful to understand some of the basics.

Willard Libby, the inventor of the Carbon-14 dating method (discussed in chapter 3), wrote about some of the conflicts between various scientific dating techniques:

> In both archeology and geology it has been held that several sequences of radiocarbon dates do not allow enough time for specific series of events. . . . In geology, some . . . criticisms of the radiocarbon dates are based upon inferences concerning the behavior of a presently nonexistent ice sheet. There is no way of proving or disproving assumptions concerning the speed of advance or retreat of the ice. . . . Similarly in archeology, opinions concerning time . . . are based largely upon assumptions concerning the rate of change in cultural processes.[1]

Thus Libby's radiocarbon system was challenged by what he recognized as techniques based on inferences and assumptions.

## Tree-Ring Dating (Dendrochronology)

Tree-ring dating seems to be a straightforward means of age estimation. For years we've been taught that trees grow "annual rings." Although trees in tropical regions generally do not produce growth rings,[2] in other parts of the world, they typically do. These can be counted to estimate ages.

A crucial question is: do all tree-rings correspond to annual growth periods? The answer is no. Ring growth is not directly tied to annual cycles. It is affected by temperature, water availability, insect infestation, competition from nearby plants, light intensity, and other factors.[3] N. T. Mirov indicated that "The term 'annual ring' is not accurate; it originated in the northern countries where the periods of summer growth and winter rest are well defined, but . . .

[1] Libby. *Radiocarbon Dating*, 2nd Ed. 1955, p. 148.
[2] Speer. *Fundamentals of Tree-ring Research*. 2010, p. 253.
[3] Ababneh. "Growth Patterns of Bristlecone Pine." PhD Diss. University of Arizona, 2006, p. 11.

formation of rings does not always coincide with the calendar year." Furthermore, he found that "in semi-arid parts of the world, such as the southwestern United States, where precipitation during the growing season is in the form of occasional violent cloudbursts, several rings may be formed in pines during one year."[4]

Growth in one tree may be different than trees nearby, and even in different parts of the same tree. Some rings are labeled "false rings," "frost rings," "locally absent" or "missing rings." Or, less often: "partial," "multiple," "intra-annual," or "sub-annual" rings.

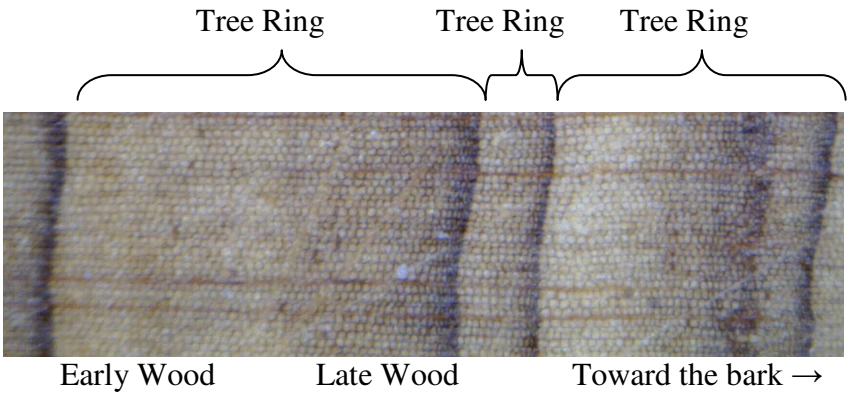


Figure 4.1. A microscopic image (~2mm) of a cross-section of a fairly typical tree-ring growth pattern. Wood sample provided by Gordon Thomas, photo by the author.

Using a microscope, clues are found. Figure 4.1, shows a very small portion of three distinct growth rings. Note: a tree-ring consists of thin-walled cells (lighter in color, called "earlywood"), and thicker-walled cells (darker colored called "latewood"). But, according to a textbook on tree-ring research by James H. Speer (2010): "A tree may produce micro rings that are only two cells wide, with one cell of earlywood and one cell of latewood."[5]

Some rings are barely distinct, even under high magnification. Figure 4.2 shows a microscopic image of a wood cross-section (believed to be of a bristlecone pine) with some exceptionally narrow rings.

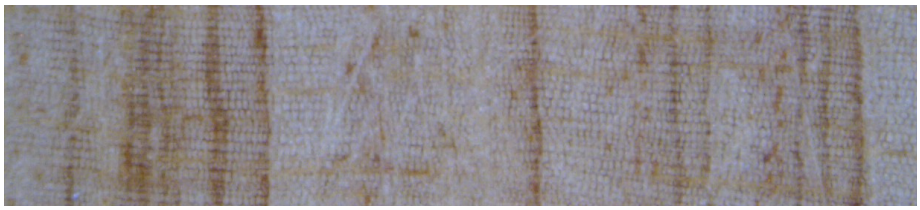

Figure 4.2. A micro-photo showing ~2mm of a cross-section with some indistinct and very narrow rings only a few cells wide. Which represent annual growth periods, and which do not? Photo by the author.

Tree-ring dating techniques may be divided into three main categories: (1) tree-stump or cross-section ring-counts, (2) living-tree age estimates, and (3) cross-dating (a technique used to

[4] Mirov. *The Genus Pinus.* 1967, pp. 354, 413.
[5] Speer. *Fundamentals of Tree-ring Research*. 2010, p. 47.

try to identify matching ring patterns in two or more wood samples). Although there is little conflict between Bible chronology and tree-stump ring-counting, some age estimates of living trees and cross-dating provide more contradictory results.

**Tree-Stump or Cross-Section Ring-Counts**

If it is known when a tree ceased growing, and a cross-section is intact, the ring-count is used to estimate how long the tree lived. Some fantastic claims of Giant Sequoia ring-counts appear to be spurious. Nathan Stephenson of the U.S. Geological Survey wrote: "Early claims of up to 11,000 rings counted on stump tops cannot be taken seriously."[6]

The tree slabs with the highest actual ring-counts appear to be:

| | |
|---|---|
| 3,290 | Giant sequoia CBR26[7] |
| 3,622 | Fitzroya (Chili)[8] |
| 4,862 | Bristlecone pine WPN-114 called "Prometheus" |

All of the cross-section ring-counts I have learned of are well within the range of Bible chronology except for one. It is the bristlecone pine WPN-114 known as "Prometheus." It is commonly cited as having lived about 5,000 years. Prometheus was cut down in 1964 and is said to have been the oldest living thing on Earth at that time. A count made by the Laboratory of Tree-Ring Research at the University of Arizona yielded 4,862 rings.[9] This count did not include the oldest rings—at the heart of the tree—since they had weathered away. If that tree grew one, and only one, ring in each of 4,862+ years, and if the Flood really occurred in about 2344 BC as listed in many Bible chronologies, then it was at least 554 years old when the Flood took place.[10]

If Noah's flood was as widespread and devastating as the scriptures suggest, could a tree have survived it? That is a possibility, especially a resilient tree like the bristlecone. Bristlecones grow in high, arid, mountainous regions of the western U.S., just below the timberline. Their growing season is short, and "Bristlecone, [is] loaded with pitch and tight-grown."[11] Rather than Prometheus having survived the Flood, to those who take the flood account literally, another explanation seems more likely. As mentioned earlier, Mirov noted that due to peculiar conditions in the southwestern region of the U.S.—where bristlecone pines grow—more than one ring may be formed in a year.

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[6] Stephenson. "Estimated Ages of Giant Sequoias." *Madrono,* Vol. 47, no. 1, 2000, p. 65.
[7] Ibid., p. 64.
[8] Speer. *Fundamentals of Tree-ring Research*. 2010, p. 275.
[9] Cohen. *A Garden of Bristlecones*. 1998, p, 67.
[10] 1,964 + 2,344 = 4,308. 4,862 – 4,308 = 554 years.
[11] Hall. "Staying Alive." http://www.sfgate.com/cgi-bin/article.cgi?f=/c/c/1998/08/23/SC721. *San Francisco Chronicle*, 23 Aug. 1998.

Figure 4.3. Partially-living Bristlecone Pines. At the left, a Rocky Mountain Bristlecone showing strip bark growth.[12] At the right, one in Cedar Breaks National Monument, Utah.[13]

Ancient bristlecones are famous for their unusual "strip bark" growth patterns. Parts of many of the trees are dead and relatively small strips of cambium just under the remaining bark, sustains live portions of the branches. The trees shown in figure 4.3 are examples.

Warm temperature is often thought of as the main factor initiating ring growth. However, in her PhD Dissertation dealing with the Prometheus tree, Teresa Halupnik, after comparing the ring widths of Prometheus with climatic records, noted: "the ring widths were wider during the cooler period, and narrower during the warmer period." She concluded: "water stress during the warm period and abundant water availability during the cool period were the likely causes of the variable ring widths."[14] Might water stress also have been the cause of some sub-annual rings?

Experiments were performed by Walter E. Lammerts on bristlecone seedlings he had planted. He found that withholding water from a select group of them in his greenhouse for a period of three weeks in August caused that group to form an extra ring that year.[15] Thus—if Prometheus reacted similarly—water-stress would have been the means of it growing at least some sub-annual rings.

Of particular interest is that the bristlecones with the largest numbers of rings generally grow in rocky areas where the soil is poor and moisture is scarce during some parts of the

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[12] Photo courtesy of the U.S. Forest Service: http://www.fs.fed.us/rm/highelevationwhitepines/About/photo-tour/strip-bark.htm.
[13] Photo courtesy of the National park Service: http://www.nps.gov/cebr/upload/bristlecone.pdf.
[14] Halupnik. "Analysis of Tracheid Length Vs Age in Prometheus." PhD Dissertation UTA, 2008, pp. 5, 3.
[15] Lammerts. "Are Bristle-cone Trees Really so Old?" *Creation Research Quarterly* 20(2). 1983, p. 108.

summer. Ronald M. Lanner observed that Prometheus "grew in a relatively moist region but was located on a ridge of permeable rocky material that held very little water."[16]

"One season's growth increment may be composed of two or more flushes of growth, each of which may strongly resemble an annual ring" according to C. W. Ferguson. However, he went on to state that "such multiple growth rings are extremely rare in bristlecone pine."[17] This seems an odd conclusion since he also mentioned "in some instances, 5 percent or more of the annual rings may be missing along a given radius" in bristlecones.[18] Were there really that many years in which no annual ring grew, or did sub-annual rings grow in some parts of trees but not in others?

Waldo S. Glock et al. documented numerous instances of multiple rings having grown in various species within specific years. Some of the rings were incomplete (only extending part way around the center). The examples they cited were from areas subject to stress from large fluctuations in water availability, but in a warmer region that the habitat of the bristlecones. They wrote about the controversy over whether or not rings are strictly annual, discussing how either position "is an assumption unless supported by adequate evidence."[19] Describing the gist of each position: One may assume that growth always (1) "begins in the spring and goes to completion" or, that it "can slow down and cease completely within a single season . . . [and] can begin anew." (2) Annual rings are always signaled "by a sharply defined outer surface" or sometimes not. (3) The "growth factors present . . . in the spring can also be present later during the general growing season," or they cannot. (4) Either all of the rings that formed more frequently than annually "are diffuse, never sharp" or there are exceptions. (5) "The maximum number of sharply bounded growth layers in a tree [either] reveals the true number of years involved," or it doesn't. If it doesn't, the ring-count "exaggerates" the "true number of years involved."[20]

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[16] Lanner. *The Bristlecone Book*. 2007, p. 92.
[17] Ferguson. "A 7104-Year Chronology for Bristlecone." *Tree-Ring Bulletin.* Vol. 29, no 3-4, 1969, p. 6.
[18] Ibid., p. 7.
[19] Glock, Studhalter, and Agerter. "Multiplicity of Growth Layers." *Smithsonian Miscellaneous Collections,* Vol. 140, no. 1. June 17, 1960, p. 123.
[20] Ibid., pp. 123-124.

Figure 4.4. The Prometheus stump. The heart of the tree is missing, but appears to have been to the right of the remaining stump. Photo by James R Bouldin.[21]

Figure 4.5. The Prometheus slab at the Ely Convention Center (photo inverted).[22] It is about 82" x 12" x 3". The left end includes some bark, and the heart of the tree (where the oldest rings grew) was apparently near the top right of this slab.[23]

I had the privilege of going to Great Basin National Park in April 2011 to take some micro-photos of the Prometheus slab at the visitor's center there. See Figures 4.6, 4.7, and 4.8.[24]

[21] Courtesy of J. R. Bouldin and http://en.wikipedia.org/wiki/File:Prometheus_tree1.jpg.
[22] Photo courtesy of Meg Rhodes, White Pine County Tourism and Recreation Board.
[23] Cohen. *A Garden of Bristlecones*. 1998, p, 64.
[24] More of the photos can be seen at www.davidmckaybarker.com.

Figure 4.6. The Prometheus slab at the Great Basin National Park (GBNP) visitor's center. It is about 54" long and 3" thick. (Photo by Kelly Carroll, GBNP.)

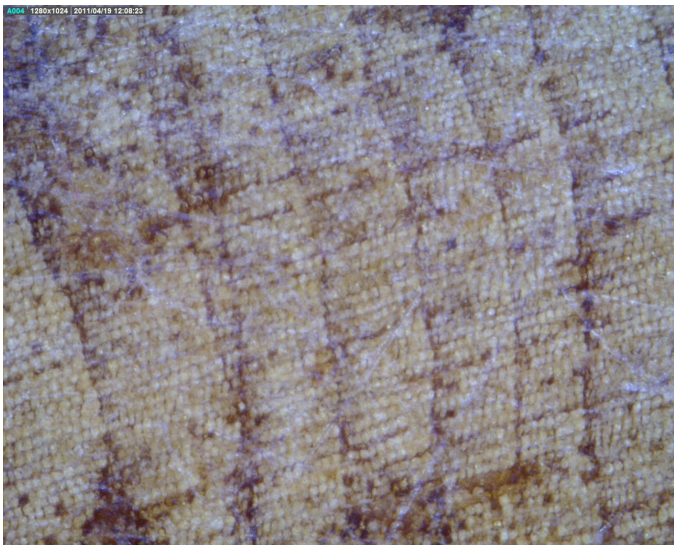
Figure 4.7. Image of a ~2mm section of the Prometheus slab at GBNP showing an unusual ring wedging out and back in. (2nd from the left). Photo by the author.

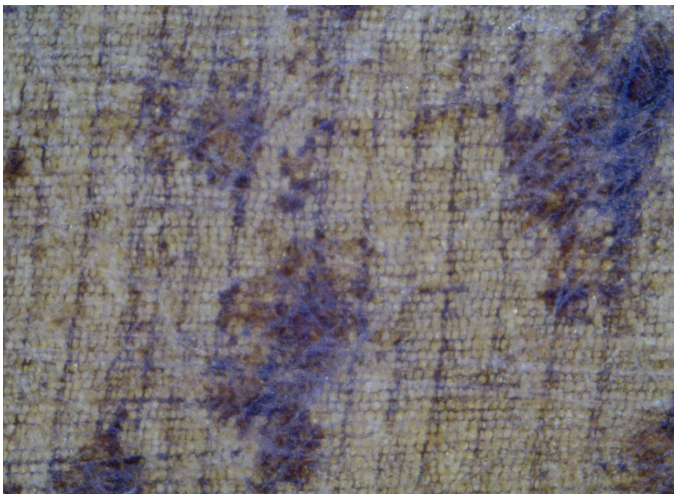

Figure 4.8. Image of a ~2mm section of the Prometheus slab at GBNP showing unusually narrow rings. Which were annual, and which were not? Photo by the author.

From examining the Prometheus slab and photographing numerous micro-images, I learned that discerning which of its rings were annual and which were not is difficult if not impossible. None of the "rings" on the GBNP slab make a complete circuit around a center—either due to strip bark growth, or portions having weathered away. Donald Currey described that in Prometheus, "die-back had left 92 percent of the circumference devoid of bark."[25]

At least one tree may have survived the Flood. However, to those who accept a literal reading of the biblical account, it seems more likely that the contradicting ring-counts don't accurately represent the actual age of the particular tree(s) in question. If Prometheus grew a sub-annual ring an average of once every eight years, the difference between the common dating of that tree and typical Bible chronologies is resolved.

**Estimating the Ages of Living Trees**

More frequent conflicts appear when comparing age-estimates of living-trees with Bible chronology. In order to avoid causing serious damage to ancient living trees, bore-holes are made and pencil-sized core samples extracted. The rings are counted and then used along with data on the size and shape of the tree to estimate its age.

The age of a tree called "Methuselah" was listed as 4,789 years in 1957 (thus, it was supposed to have been a seedling about 2832 BC). It was claimed that this was verified by cross-dating.[26] Later, Tom Harlan dated the tree's innermost ring at 2800 BC.[27]

Figure 4.9. Photos of the tree called "General Sherman," a giant sequoia believed to be the largest tree in the world (by volume). At its base, it measures 102.6 feet in circumference.[28] The photo on the left (showing a man leaning against the trunk) was

[25] Cohen. *A Garden of Bristlecones*. 1998, p. 64.
[26] Bailey. "Pinus Longaeva." http://www.conifers.org/pi/Pinus_longaeva.php.
[27] Lanner. *The Bristlecone Book*. 2007, p. 87.
[28] http://en.wikipedia.org/wiki/General_Sherman_(tree).

taken in 1909.[29] The one at the right was taken in 2009 from a more distant vantage point.[30]

Age estimates for the tree called "General Sherman" range from about 2,000 to 6,000 years. Although the 6,000-year estimate seems contradictory to the dating of the Flood, it is not accurate according to Nathan Stephenson who studied the techniques used to estimate that age. The more reliable estimation method yielded the 2,150-years.[31]

If trees were perfectly symmetrical, age estimates would be less cumbersome and more accurate. Since they are not, trying to discern the age of ancient living trees is somewhat speculative.

Other extraordinary claims have been made for the ages of living trees. For instance, scientists in Sweden say they've found "the world's oldest known living tree."

Its root system has been growing for 9,550 years. . . .

> The spruce's stems or trunks have a lifespan of around 600 years, "but as soon as a stem dies, a new one emerges from the same root stock."[32]

If the root stock is really as resilient as suggested, perhaps it truly is one of the few survivors of the Flood. However, the age was not estimated from ring-counts, but by radiocarbon dating.[33] Those familiar with the information in the preceding chapter can recognize that such an estimate is far from certain.

The apparent conflict between living-tree age-estimates and Bible chronology may thus be due to (1) errors in estimates, (2) the tree having survived the Flood, (3) multiple rings grown in some years, or (4) confusion in Bible chronology. The most likely explanation of the differences seems to be errors in the estimations.

**Cross-Dating**

When wood samples from trees with overlapping lifespans are found, if portions of their ring patterns are distinct enough to be recognizable matches, longer ages can be derived. Although it sounds quite simple, those who have compared the rings of wood samples have learned that cross-dating is no easy task.

Many trees are particularly difficult to cross-date. Some ring patterns are so uniform as to make cross-dating infeasible. Other trees have patterns that seem to match in parts but not in others. In figure 4.10, different segments of the same slab of wood are shown. Some sections are easily recognizable matches while others are not.

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[29] Courtesy of USGS http://libraryphoto.cr.usgs.gov/cgi-bin/search.cgi?search_mode=noPunct&free_form=general+sherman&free_form=&free_form=&free_form.
[30] "General Sherman." Courtesy of Famartin at http://en.wikipedia.org/wiki/File:General_Sherman_Tree_wide.jpg.
[31] Stephenson. "Estimated Ages of Giant Sequoias." *Madrono,* Vol. 47, no. 1, 2000, p. 61.
[32] Owen. "Oldest Living Tree Found in Sweden." *National Geographic News,* April 14, 2008, p. 1. http://news.nationalgeographic.com/news/2008/04/080414-oldest-tree.html.
[33] Ibid.

M. A. Stokes and T. L. Smiley described: "One complication which sometimes arises in the process of cross-dating is the absence of an annual ring at the location in the tree where the sample was taken."[34] Was their assumption of absent annual rings correct, or, as seems more likely, did an extra ring form in a particular year in at least a part of a tree?

Figure 4.10. Photos of sections of the same slab of wood. Near the left end of the top two images are three narrow rings (marked by arrows) separated by wider rings. These are the same rings seen in different parts of the slab. Some of the patterns farther away from the center do not have the appearance of a match. Wood slab provided by Gordon Thomas, photos by David Barker.

[34] Stokes and Smiley. *An Introduction to Tree-Ring Dating*. 1968, p. 13.

The Belfast "long chronology" claims to span over 7,000 years by cross-dating 1,000 different timbers.[35] Other tree-ring schools claim counts as high as 8,200 years, and "the known occurrence of samples 9,000 years old (dated by radiocarbon only) lends hope that in time an absolute chronology may be available covering at least 10,000 years."[36] These claims do appear to be in conflict with Bible chronology. Note that the term "absolute chronology" is used in the same manner as "absolute date" to signify that the estimates are in years, and it should not be interpreted to mean absolutely certain.

> Alasdair Beal noted some of the difficulties encountered in cross dating:
> No one tree records the whole of history, so a master chronology must be built up by linking pieces of wood from different trees in sequence and then matching samples to be dated against this; this is not easy and it is made harder by the fact that although the growth of the various individual trees responds to a common climatic signal, there are considerable local variations. . . . It is part science, part art.[37]

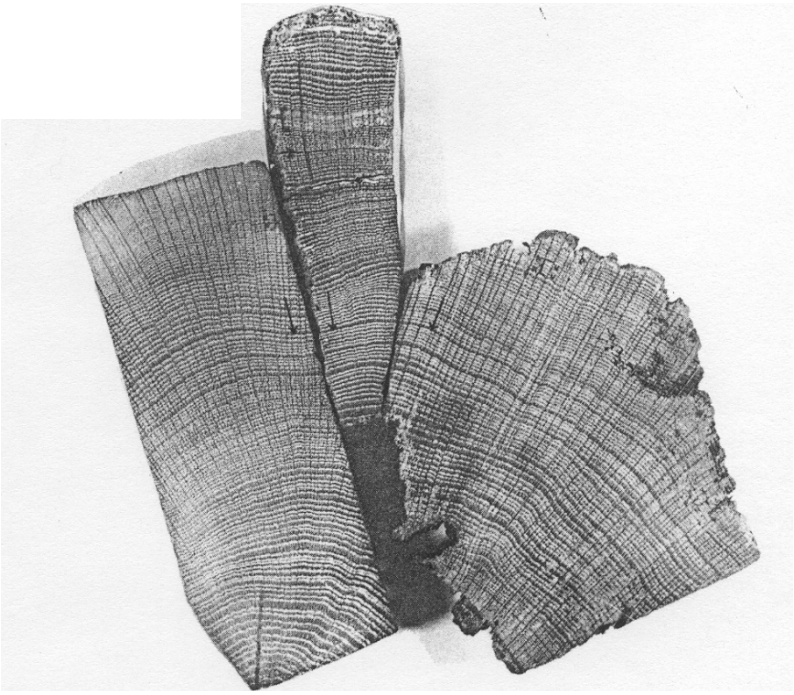

Figure 4.11. "A rare signature pattern in samples from Trinity College, Dublin. . . . The arrowed ring is the year AD 1580."[38]

Beal also noted inconsistencies in the ring patterns shown in Baillie's photo (figure 4.11):

> At first sight it looks very impressive. . . . However, look again with a little care: the rings on the left hand timber above the arrowed ring do not appear to match those on the centre

[35] Baillie and Pilcher. "Belfast 'Long Chronology.'" In *Applications of Tree-ring Studies.* 1987, p. 203.
[36] Baillie. *Tree-Ring Dating and Archaeology*. 1982, p. 37.
[37] Beal. "A Bit Creaky?" *C&C Review.* SIS, 1991, p. 39.
[38] Baillie. *Tree-Ring Dating and Archaeology*. 1982, frontispiece. Used with permission.

> timber at all and the same is true of the rings below the bottom 'signature' ring. On the right hand timber, the rings above the arrowed ring don't look much like those on the central timber either. In this instance, the historical context of the samples appears to have been carefully checked and the match is probably genuine, but had this not been done who would have been able to say? If only tree-ring evidence had been available, an element of doubt would have been in order.
>
> The Belfast team rightly took great care cross checking the modern end of their chronology against historical and archaeological evidence—after all, if this went adrift the whole chronology would be useless. However, for earlier periods this is not possible and there are only the tree rings to go by. . . . It is a daunting task, faced with a vast collection of oaks recovered unstratified from bogs. Understandably, the researchers resorted to radiocarbon dating to give approximate dates to help them make progress . . . but in the process the independence of their dates from radiocarbon dates must have been compromised. The fact that they also used other tree-ring chronologies (English, German and Californian) to help as the work proceeded means that the chance of a truly independent check of the validity of their chronologies has also been lost.
>
> There is no doubt that a great deal of work has gone into the Belfast bog oak chronology and it may well be absolutely, precisely, correct but the above considerations suggest that a bit of caution is in order; it may not be the last word on the matter.[39]

Jesse Lasken pointed out that some of the data used to support the Irish and German oak cross-dates "actually contradicts them":

> This, in combination with other factors . . . suggests the need for an independent re-examination of the European oak dendrochronologies.
>
> Several studies . . . that were used to bridge the Irish chronology at c. 940 BC, have suggested that English and Irish oaks exhibit multiple (false) matches on a relatively frequent basis. . . .
>
> The theoretical basis for matching trees as far apart as Northern Ireland and Germany, particularly given the differences in the two climates and other factors, is non-existent.[40]

Due to the difficulties in matching ring patterns, dendrochronologists have devised methods to convert ring-widths to mathematical indexes. Baillie described one process:

> Visual comparison of ring width plots involves superimposing the two patterns under study and shifting their relative positions until such a time as significant agreement is obtained between them. In practice the observer looks at significant features in one pattern and attempts to duplicate them in the second. . . . However, visual matching is subjective and the ability of a trained observer to find sufficient similarities, in two long ring patterns, to establish a cross-correlation, is not a measurable quantity.[41]

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[39] Beal. "A Bit Creaky?" *C&C Review.* SIS, 1991, pp. 39-40.
[40] Lasken. "Should the European Oak be Re-examined?" *C&C Review.* SIS, 1991, p. 30.
[41] Baillie. "A Recently Developed Irish Tree-ring Chronology." *Tree-ring Bulletin,* 1973, p. 20.

**Statistical Analysis**

In regards to the statistical methods dendrochronologists use in cross-dating wood samples, Lasken made an astounding observation:

> Theoretically, a random distribution is 50%. . . .
>
> It was reported that for a 4700 year period the south German and Irish oak chronologies yield an agreement of 54%. . . .
>
> Thus, it is by no means certain that 54% is a truly significant result. . . .
>
> . . . The authors [Pilcher et al.] acknowledge, and they admit, it is not 'a rigorous statistical test.'"[42]

With computer programs designed specifically for tree-ring cross-dating now available, claims of high precision have been made. Some dendrochronologists are convinced that statistical analysis provides proof positive—especially when "computerized." My experience with computers has taught me that, once programmed correctly, computers can "crunch the numbers" accurately and almost instantly—even complex mathematical formulas and vast amounts of data that would take days to calculate by hand. However, the programs don't remove the need for data input, assumptions, and reasoning built into their models. Nor do they eliminate the necessity to interpret the results obtained.

A tree-ring expert, Dr. Henri Grissino-Mayer, describing one of the popular programs in use, indicated that it is "powerful in its diagnostics and functions, but its operation and the interpretation of its output remain complex." He also mentioned, "the program should not be used as a substitute for visual crossdating on the wood sample. The ultimate decision concerning whether or not a tree-ring series is dated must lie with the dendrochronologist based on both graphical and statistical techniques."[43] Still, the confidence dendrochronologists have in the results, are astonishing. He indicated that they use "correlation and autoregressive modeling techniques to ensure a sequence is dated to 99.99% accuracy."[44] Could this claim be overly optimistic? According to Edward R. Cook and Neil Pederson, in the statistical modeling used for cross-dating:

> significant uncertainty exists due to our incomplete . . . understanding of radial growth. . . . This biological uncertainty cascades into the realm of statistical uncertainty in ways that are difficult to quantify. . . . Therefore great care must be taken to apply the many well-developed and tested statistical methods of dendrochronology in ways that reduce the probability of making false inferences. This is especially true in the case of. . . . uncertainty that arises from the way in which trees as complex organisms can have properties expressed in their ring widths that are impossible to predict.[45]

Thus, the programs depend on subjective input, have built-in assumptions, modeling, subjective variable choices, and rest on the foundation of statistical probability theory. They rely

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[42] Lasken. "Should the European Oak be Re-examined?" *C&C Review.* SIS, 1991, p. 31.
[43] Grissino-Mayer. "Evaluating Crossdating Accuracy." *Tree-Ring Research.* Vol. 57(2), 2001, pp. 205-206.
[44] Henri D. Grissino-Mayer (personal communication).
[45] Cook and Pederson. "Uncertainty and Statistics in Dendrochronology." In *Dendroclimatology*. 2011, p. 77.

on measurements and data derived from observations of relative ring-width sizes, and the surmises derived there from. An independent audit of the long chronologies and the statistical techniques used in their formation, seems needed.

**Skeleton Plot**

One cross-dating method is intended to focus on unusually narrow ring patterns. It is known as the "skeleton-plot." Stokes and Smiley discussed the way it works and then acknowledged a critical weakness:

> In skeleton plotting the narrow rings are the ones primarily being compared. . . . The decision of narrowness is based on the comparison of each ring with its immediate neighbors. The narrower the ring, the longer the line is drawn. The narrowest rings are arbitrarily represented with a line 2 cm in height. . . .
>
> . . . Since these lines are not measured, these averages, like the individual plots, are a matter of judgment. . . .
>
> . . . Unfortunately, the actual practice is mastered by trial-and-error experience and cannot be adequately described.[46]

If a process is not precise enough to be "adequately described," independently verified, or sufficiently measurable, how can it be relied upon with confidence? They also acknowledge that even after this process of reducing the data to paper,

> while several of the patterns match, there are many individual rings which do not match from plot-to-plot. *This variation is typical*. It is logical to ask how many such unmatched rings can be accepted in what we call matched plots. Our answer would have to be that, *when most of the rings match*, the fit is considered correct. While this may sound like a very unscientific answer, the experienced dendrochronologists using these methods are able to duplicate each other.[47] (emphasis added)

The fact that experienced tree-ring experts can duplicate each other does not necessarily mean they are both right.

Another world-renowned dendrochronologist, M. G. L. Baillie, acknowledged an important weakness of tree-ring dating: "It is very easy to make the results . . . seem excessively tidy. This is usually the result of attempting to present the results in too logical a fashion. The fact of the matter is that dendrochronological research is not all that logical in itself, it is only logical with hindsight. . . . Here the 'art' of dendrochronology becomes apparent."[48]

James Speer also mentioned the skeleton plot method, and the "master chronology" derived by comparing a number of wood samples. "For a ring to be represented on the master

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[46] Stokes and Smiley. *An Introduction to Tree-Ring Dating*. 1968, pp. 47, 49.
[47] Ibid., p. 50.
[48] Baillie. *Tree-Ring Dating and Archaeology*. 1982, p. 23.

chronology it has to appear on 50% of the plots, and the length of the lines are averaged together (usually only counting the trees that represent that ring)."[49]

Speer also noted: "Dendrochronologists use the principle of uniformitarianism when we reconstruct past climate. . . . For this reconstruction to be possible, dendrochronologists have to assume that the processes affecting tree's response to these environmental factors have not changed. . . . This is a common assumption made in the natural sciences, but it has some drawbacks of which the researcher should be aware."[50]

Beal concluded his article critiquing tree-ring dating techniques with: "There is a great tendency amongst historians of all persuasions to treat tree-ring dates or radiocarbon dates as gospel when they suit but to reject them out of hand when they don't. This is not helped by the tendency of the scientists who do the measurements to claim far more certainty than is reasonable for their findings."[51]

The scholarly research—including mainstream dendrochronologists—shows that there is a significant amount of subjectivity and uncertainty associated with tree-ring cross-dating. Therefore, in my opinion, the fantastic claims of the contradictory long counts do not constitute a viable challenge to Bible chronology.

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[49] Speer. *Fundamentals of Tree-ring Research*. 2010, p. 14.
[50] Ibid., pp. 10-11.
[51] Beal. "A Bit Creaky?" *C&C Review*. SIS, 1991, p. 42.