The principles, successes, and difficulties of tree-ring dating historic structures

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The basis for tree-ring dating

Dendrochronology is based on the climatic variability recorded in annual tree-rings, unique to the represented period and geographic region. However, ring growth in each particular tree records climatic variation but is also influenced by non-climatic parameters, such as age, competition, and immediate landscape. The average of ring-width sequences from multiple trees mutes the "noise" unique to each tree, and emphasizes the "common signal" that is recorded each year in the tree rings at any site, and from sites within a specific climate region. In general, a tree-ring data set must contain a significant percentage of the common signal to successfully and accurately match its growth patterns to those of established, calendar-dated, reference chronologies made of forest and historic building chronologies of the same species. To obtain the significant percentage of a common signal, multiple samples need to be collected, measured, successfully crossdated, and averaged together. Single samples generally cannot be tree-ring dated, but there are always possible exceptions and cases where an attempt is worth the effort, as discussed below.

An additional problem in tree-ring dating is when a sample contains less than 50 rings, and even when ring count is less than ~80. These are more difficult to accurately place in time due to the shortness of their ring-width sequences. Short growth patterns often match patterns in a longer sequence or chronology at two or more places in time and so cannot be accurately crossdated. With increasingly longer sequences, the probability of accurate tree-ring dates also increase, and with sequences of over ~80 years, the date is considered accurate. Thus a sufficient number of rings in a sample, preferably over 80, is another important principle in tree-ring dating.

Finally, it is important to use the same species in crossdating. The growth response of different species to the same climate parameters can be different, or they respond to different climate parameters. For example, the growth patterns in an eastern hemlock site chronology needs to be compared to a reference chronology of eastern hemlocks to successfully date the chronology.

The single sample conundrum

While the requirements may seem relatively simple and easy to accomplish, dating historic buildings almost always has conundrums. Generally we attempt to collect samples from 10 or more beams, posts and other structural timbers in the building, and loose timbers that have been replaced. In most buildings, however, multiple species are represented, and/or there is not enough access to structural timbers to collect more than ~five samples. For multiple samples of the same species, a chronology is built and used in an attempt to date the building. The tree rings of a single sample of a different species is measured and an attempt is made to date that sequence, but with the understanding that the date is only tentative. The one-sample tree-ring sequence is first compared to reference chronologies of the same species if available, and to chronologies of different species, including the chronology from the same structure as deemed necessary. If the match of growth patterns in the one-sample sequence to a chronology is outstanding, then tentative dates are assigned, but will remain tentative until supported by comparing them to additional chronologies. If samples of the same species are found in sites around New York State after this collection, future comparisons and analyses will be used to confirm or refute the tentative felling year.

For crossdating single samples, the procedure used at the Cornell Tree-Ring Laboratory is to look for a placement with very high visual similarity between the single sample and a suitable reference chronology, and which is supported by statistical value of t-scores > 5.0, trend coefficients of over 65% of the years of overlap, with at least 75 years of overlap, and assign a "tentative date" for that sample. Again, if there is more than one possible placement with similar test values, the sample cannot be dendrochronologically dated. Exceptions in the tentative category are only when there is extremely good visual similarity (e.g. trees from the same forest) and statistical support (t-scores of >7, and trend coefficients of >70%). Single samples in all collections are well-documented and their data archived for use in comparison with future collections and reference chronologies.

Suggested References:

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