

It all started with this article from NYTimes.com
<http://www.nytimes.com/2002/11/12/science/life/12CONV.html>

A Writer Leaves History Behind to Celebrate Trees

(A Conversation With Tom Pakenham)

November 12, 2002

By CLAUDIA DREIFUS

Excerpts:

Q. The dating of trees seems a rather inexact science, is it not?

A. You'd think there'd be plenty of papers written about the age of trees and that people would draw interesting diagrams showing how you would extrapolate from the existing rings across the void and get various dates. But there's a deafening silence from scientists about tree age.

Q. Is it a myth that you can tell a tree's age by its rings?

A. If there is a void in the middle of the tree, there will be no rings there to count. You can only make estimates. And some trees don't have rings, the baobabs, for instance. Many old trees are extremely hollow.

To the Editor, New York Times

I was rather horrified by the inaccurate statements about tree-ring dating that you allowed to slip into print in the interview with Thomas Pakenham today. Tree-ring science is an exact science -- none of the data obtained from tree rings would be useful if the dates were inaccurate. Dendrochronologists don't say much these days about how old trees are because they are interested in more important questions -- such as "What can the tree rings tell us about our planet's past?"

You at The New York Times should know something about tree rings. A check on Lexis-Nexis shows that since 1980 you have run more than 100 stories in which the words "tree rings" appear in full text. Some of the stories are irrelevant. But most are not, such as the July 13, 2002, story in which you misspell the name of Neil Pederson at Lamont-Doherty Earth Observatory, or the March 26, 2002, story about a medieval climate warming detected in tree-ring data. I do not remember tree-ring dating being labeled an "inexact" science in stories like that.

Did Walter Sullivan, who wrote a story about tree rings and drought on September 2, 1980, ever question the "exact" nature of tree-ring dating? He didn't seem to question it on June 7, 1994, when he wrote a story about ash from Santorini and said that the ash cloud may have "persisted long enough to stunt the growth of oak trees in Irish bogs and of bristlecone pines in the White Mountains of California, producing tightly packed tree rings." You really do have to know when those rings were laid down before you can associate them with a specific volcanic eruption.

I tell you what. I am a member of the National Association of Science Writers as well as a working dendrochronologist and occasionally paid-up member of the Tree-Ring Society. If you feel the need for a refresher course on tree-ring dating, I'll be more than happy to try to introduce you to knowledgeable practitioners in your neighborhood, such as Neil Pederson (not Peterson) at Lamont-Doherty Earth Observatory. (It's actually a local phone call for youse guys.)

Sincerely,
Dave Lawrence

To the Editor, New York Times

Further to the message below, I want to assure you that not everyone agrees with the representations by David Lawrence. As a tree physiologist who has devoted his career to understanding how trees make wood, I have made sufficient observations on tree rings and cambial growth to know that dendrochronology is not at all an exact science. Indeed, its activities include subjective interpretations of what does and what does not constitute an annual ring, statistical manipulation of data to fulfill subjective expectations, and discarding of perfectly good data sets when they contradict other data sets that have already been accepted. Such massaging of data cannot by any stretch of the imagination be considered science; it merely demonstrates a total lack of rigor attending so-called dendrochronology "research".

I would add that it is the exceptionally rare dendrochronologist who has ever shown any inclination to understand the fundamental biology of wood formation, either as regulated intrinsically or influenced by extrinsic factors. The science of tree physiology will readily admit that our understanding of how trees make wood remains at quite a rudimentary state (despite several centuries of research). On the other hand, there are many hundreds, if not thousands, of publications by dendrochronologists implicitly claiming that they do understand the biology of wood formation, as they have used their data to imagine when past regimes of water, temperature, pollutants, CO₂, soil nutrients, and so forth existed. Note that all of the counts and measurements on tree rings in the world cannot substantiate anything unequivocally; they are merely observations. It would be a major step forward if dendrochronology could embrace the scientific method.

sincerely,
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And the fun begins

I find myself agreeing with Rod's statement: "*The science of tree physiology will readily admit that our understanding of how trees make wood remains at quite a rudimentary state (despite several centuries of research).*"...and for the most part can't argue with: "*...it is the exceptionally rare dendrochronologist who has ever shown any inclination to understand the fundamental biology of wood formation, either as regulated intrinsically or influenced by extrinsic factors.*"

However, and this is a big HOWEVER, I am firmly convinced that the scientific community knows enough about the formation of annual growth rings to apply the dendrochronological method. In fact, dendrochronology is an important tool in the study of tree physiology!

We could take an example from particle physics. Physicists still don't have the elusive unifying theory, they still don't know the fine details of what composes matter and energy. That hasn't stopped the application of nuclear energy.

Heck, ask a physicist what electricity is? Forget the simple idea of 'a flow of electrons through a conductor' we all learned in Physics 101. Try to get a really comprehensive answer. Yet, where would any of us be with out the practical application of electricity?

Dendrochronology works! There are exceptions to the method where it won't work. These are readily acknowledged. We can all benefit from learning more about xylogenesis and cambial physiology, but will that knowledge fundamentally alter the methodology of cross-dating? Or will it improve our interpretation of the information contained in carefully cross-dated tree-ring time-series?

Having taught the 'Botanical Basis of Dendrochronology' for several years, I am confident in the botanical foundation of cross-dating and dendrochronology. Some interpretation of growth ring timeseries published in the literature may push the limits of our physiological understanding. Again, Rod's point that more research in cambial physiology and xylogenesis can never be understated! We'll all benefit from that approach.

Keep in mind, to say all published research in any field is completely accurate is in itself inaccurate. Liberty has been taken with methods and interpretation of data in all fields of research. It's not bad to question methodology, data, and interpretation. What we need to keep in mind is to "not dispose of the baby with the bathwater."

That said, and returning to the NY Science Times article, the funny thing is carefully reading the original article. It's just bad editing or reporting. Either Pakenham didn't address or understand the question or the reporter mixed-up what Pakenham said. Gee, that's never happened in press before, has it! Pakenham says "...people would draw interesting diagrams showing how you would extrapolate from the existing rings across the void and get various dates." The key word here is 'void'. He's talking about hollow trees! We all agree with that. One can only estimate the age of a hollow tree and given the unknown rate of growth, it is near impossible to extrapolate the age from the remaining rings in the outer layer of wood which is decay free. The next QA again is a mismatched question and response. Pakenham's answer is with regard to hollow trees not whether one can use tree rings to age a tree.

Who know's what was discussed in that interview and what actually made it to press. Who know what Pakenham might know or believe about tree rings and dendrochronology? At this point, Pakenham might be wondering what was published vs. what he said in the interview.

Frank

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Frank W. Telewski, Associate Professor and Curator
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Email "Conversation" between Rod Savidge (Tree Physiologist) and Hal Fritts (Dendrochronologist)

Format: Savidge's: *initial letter*

Fritts': response

Dear Hal,

The nature of genuine scientific endeavour is to discover and explain the truth about nature, no matter how that knowledge impacts the preconceptions of mankind.

No dispute here.

Over the last century, dendrochronology has set itself up for criticism by persistently shying away from, rather than confronting, the key issues.

That is how you allow yourself to see us. Rod, this is a generalization that would irritate any scientist in any discipline. You consider it a fact but it is the myth that you insist on calling your and everyone else's reality. Please allow your self to consider that you may have some limitations of experience here. You sit at your lofty seat of "God" and make these pronouncements.

I give you credit, Hal, for long ago identifying many of the shortcomings of dendrochronological investigation;

Yes, Ron I accepted the criticism at face value but when I got down to doing the nitty gritty of dendrochronological work, I realized how false and biased these criticisms were. They were made by people that had created their own reality which they believed in as you do. Most of them had personal motives to say such things. Glock was fired from the Tree-Ring Lab and was really getting even.

however, the world is nevertheless entitled to ask what has been done to solve the problems identified decades ago? In my view, almost nothing has been done; the same problems remain today,

You perceive them to be present today because you refuse to recognize the checks and balances used by dendrochronologist to assure that false rings and missing rings are located and identified. They are not located by their anatomical nature as you might think they should be but by a procedure of replication and further replication until there is sufficiently small uncertainty to call it true. This particular point is a statistical point that I realize you cannot appreciate or accept. All science is based on likelihood and probability. That is why it is so important that things be replicated by other scientists. But you can't replicate our experiment because you really do not understand what procedure and checks we use.

and the field of dendrochronology continues to walk the easy road, but now promulgating itself as an exact science. That is not the way of real science at all.

We have a lot more scientists that understand what we are doing than you can possibly imagine. You frankly are the exception, not the rule. This is the position you took at Davos and every other contact I have had with you. I have not seen any movement or genuine willingness to learn on your part. As long as you take such a high and mighty position, you will never be convinced because then you would have to admit you, not dendrochronologist have unrealistic views. It is this gap that has to be bridged and it is not dendrochronologist that will be able to bridge it.

Any grade school child can count and measure the widths of bands in wood and be led to believe that they are absolutely and inviolately "annual" rings.

A case in point, you actually believe that dendrochronologists are this stupid.

Taking it the next step, to admitting that, 'Well, some are and some aren't really annual rings, some are false rings', of course opens you up to the obvious question: 'How do you know which is which?' Thus, the "exactness" of dendrochronology begins to be doubted.

You and all others that take this high and mighty approach doubt it because you think dendrochronologists are just your grade school children out there counting and measuring widths of bands they "think" are annual rings. Ron, you are so far off on this point we can't possibly rebut it because what you see is NOT what we are doing and nothing we can say will persuade you because we are only children in your mind.

Taking it yet one more step, to admitting that, 'Well, it could be that some years the tree actually did not produce any wood at all, in which case there would be no annual ring', introduces a complex problem: 'Are

there missing rings and, if so, where are they, and how do I integrate plausible missing rings with false rings to correctly age this specimen?'

That is precisely the logic all dendrochronologist go through and there are true and tried procedures that we use that will pass any scientific test, if only one will truly look at what is being done.

As you well know, Hal, dendrochronology students were led to statistics to solve their problems. Statistics does not have a hotline to the truth, however.

Correct, it is not an answer to all things, but it along with knowledge of physiology and anatomy it has a very important place. I have always taken the position that the biological basis and statistics must be used together, not statistics alone. You saw from my PS that the debate about the importance continues to go on. I would say to my field that in the absence of a more balanced concern with the tree biology, and statistics we leave ourselves open to critics like you.

The most it can do is identify the best 'guess' from the limited data available and, even more problematic for interpretation, within underlying assumptions. It seems that some dendrochronologists have set themselves up as gurus; they just know the answers, although they cannot explain them nor support them other than by statistical inference.

This is again your perception of what you view as the reality. There are many many dendrochronologists who are very good at understanding physiology. Others, have a more shallow background. We are a population with many different viewpoints and I don't know any one who is not willing to listen to the others viewpoint and to learn from them. All understand the basic procedures and checks if they are true dendrochronologists. That does not mean that we don't have some in the field making bad decisions, but these are usually caught when these people try to publish in the field.

As you point out, there is a long history of unconvinced scientists like myself questioning the validity of dendrochronological methodology and deductions.

I would not call it a long history at all. There are people from the outside that question. Many of these become convinced when they truly consider and see what we do. I went through this process myself so I so have a little understanding of what is happening.

Disciples of dendrochronology may want to reflect a moment on how it could be that all of the various subdisciplines based upon the assumption of the "annual" ring have gained such momentum and influence in the face of such doubt and in the absence of the key ingredient needed to ensure that their foundation is solid.

Again, we are viewed by you as disciples following the word of the master. If this were really true, then we surely should reflect. But honestly, Ron, we also practice quite a lot of rigor, reflection, questioning etc.

What is that key ingredient? It is the desire to know the whole truth, even if in finding it there should emerge no further reason for the field of study to continue.

Ron, the logic here comes from your assumption that you understand the problem completely and nobody else is smart enough to do it.

I do not see that introspective critical capacity in the dendrochronology literature, rather I see the promulgation of dogma with statistical inference its crutch.

Perhaps some reading of the literature starting with basic works early in the century and following the development of ideas would provide you some perspective. We really cannot do that for you, although it might be a good thing to do.

I see a technology for estimating chronology, not a science. My impression is that disciples of dendrochronology would prefer to remain in darkness than permit any light to illuminate their weaknesses.

Ron, consider how you arrived at such a statement. It all comes from your assumption that we are children counting rings. We have much more valuable things to do than sit around counting rings and we do more valuable things too.

Hal, you wrote that "We can answer such criticism, but not until we investigate further how the tree responds to its environment and how the tree lays down layers of cells we call the tree ring."

Here you assume that one has to do all the physiology and all the anatomy before one can attempt using tree rings. What you miss, is that there are more circumstances that we cannot date than there are opportunities to data.

Dendrochronologist, contrary to what you seem to think, have solid procedures to reject those many cases that cannot be

reliably cross-dated. You never allow us this possibility when you say that only I, a physiologists know what I am talking about. How can we answer this??? We never will be able to.

I agree with that, but you are quite mistaken in saying that "Physiologists outside dendrochronology have little inclination to do it for us as this message reveals." (Perhaps the "for us" part is partially correct; I prefer to do my research for a greater purpose than simply to please dendrochronologists!)

Making a contribution to science is not (should not be) a matter of being on the inside or outside of a group. Cambial physiologists are few in number, but I would suggest that those attempting such research -- whatever their affiliation or lack thereof -- have made and will continue for many years to make greater contributions to dendrochronology than anyone investigating tree rings.

Again we are those poor unenlightened children. I hope such statements make you feel good about yourself.

Let me issue a challenge to the community: Who will be the first to develop a procedure for producing a complete annual ring in a stem piece cultured in vitro? It remains to be done. By doing so, you will have set the stage for determining and differentiating among direct effects of environmental factors on the nature of the annual ring. Anyone seriously interested should contact me, and I will help you begin to become familiar with the literature.

Surely that is a good thing to do, but while you are going about doing that, we have wonderful opportunities to help people manage our earth more kindly and realistically. We think these kinds of questions are equally important, if not more important as we are likely to destroy our planet unless we learn quickly what the trees have to say about our past. Even though you disbelieve that we can read the earth's history from tree rings, we have our part to play in the scientific world. Yes we need to learn from people like you, but fortunately few scientists consider us as ignorant and out of communication with "true" science as you.

have a good day,

You know, Rod, I really have more important things to do in taking care of a person I care much about here at home. This is not a good day, as instead of doing that, I feel called upon to somehow challenge you to be a little more tolerant and understanding. To be quite frank, I feel it is not sinking in and that means I have failed. That makes me very sad, indeed.

Rod

*Regretfully,
Hal Fritts*

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Dear Rod and Hal,

Maybe I should just walk away from this and forget it. I'm not sure where all this is going, but I feel compelled to say something again. I also believe that the majority of subscribers to this list already know most of what I'm about to write, but here goes.

Hal is correct when he says many of these challenges have been made before to dendrochronology. He's taken on that challenge for over four decades. But when good science is challenged, it has to stand up to scientific facts. I believe Hal has successfully 'defended' dendrochronology in the past and continues to do so. Challenge isn't a bad thing, it keeps us all honest. The greater discipline of dendrochronology has nothing to hide or apologize for.

As scientists, let's review the facts:

1. Not all trees produce growth rings (annual or otherwise).
2. Many trees (species and individuals) do produce growth rings in response to changing seasonal environmental signals (daylength, temperature, water availability- this has been recorded, independently verified, and published in the scientific literature for decades).
3. Depending on the seasonal environmental changes, these rings can consistently represent annual growth increments. There are exceptions i.e. environments with two rainy seasons will produce two growth rings per year; trees which produce multiple growth-flushes resulting in numerous false growth rings; environments so dry, the cambium is rarely activated along much of the entire cambial surface on an annual basis. The formation of an annual growth increment or growth ring can and has been documented in numerous species using cambial marking, histological/anatomical time-course sampling of the developing cambium, the use of dendrographs in conjunction with anatomical analysis.
4. Of the trees that produce annual growth rings, some trees will not produce concentric (circular) stem cross sections. Some species of juniper and thuja fit this description, this does not include strip bark morphology.
5. Of the trees which produce more or less regular concentric annual growth rings, or in the case of a linear cambium (not circumferential) found in strip bark growth forms, only trees which exhibit a characteristic known as 'sensitivity' can be used in dendrochronological studies. Sensitivity is the variation in a character of a given annual growth ring. For the great majority of dendrochronological studies, sensitivity refers to variations in ring width, although other features, wood density, latewood width, etc can be used.
6. Sensitivity or year-to-year variations in annual ring width have been shown to be influenced by environmental conditions in numerous published physiological scientific studies.
7. The year-to-year variations in pattern of annual growth ring character must be consistent between radii within the same tree, and be consistent with other trees in the stand.

When we as scientists get to #7, then and only then does dendrochronology begin. The aging of a living tree, the dating of old buildings etc, doesn't require anything more than the matching of patterns in confirmed annual growth increments to assign actual calendar dates. This has been verified when samples of wood were cut at a known date. The tree is killed, the cambium ceases to be, the clock is stopped. When the properly replicated and verified cross-dated chronology is compared to the timber of known harvest date, the known date of harvest is verified against the constructed chronology.

We can't use trees which don't produce annual growth rings or trees which have no year-to-year variability (sensitivity) in annual growth rings which can't be verified to other radii within a tree and replicated in other trees growing independently in the stand. Or, for that fact, trees which produce too many locally absent growth rings or complex patterns of false rings.

The key words here are verified and replicated within and between trees!

If a sample is seriously deformed, like coring through a knot, or is severely suppressed with too many missing rings, then yes, these samples might be discarded. As long as the sample depth is sufficient, the loss of some samples does not invalidate or compromise the methodology. Oh, and where this all started, is the tree hollow? No growth rings. You can't use what you don't have. You can't date a hollow tree or distorted wood.

The careful replication, verification and cross-dating procedure will ultimately identify false and/or missing rings if they occur at a low enough frequency within a tree. If there are too many missing rings or too many false rings, then the analysis can't proceed. There have been many attempted dendrochronological studies which haven't gotten past the stage of attempted chronology development for these very reasons. Until a researcher picks up several cores or tree cross

sections, actually looks at the growth rings in the wood and begins to plot the patterns, that researcher won't have a clue as to what I am writing here. This ain't no kindergarten ring counting class!

The next step beyond the application of an accurately, verified and replicated tree ring chronology is the interpretation of the variations in ring characteristics. This is where the application of statistics becomes critically important. Statistical methodology, when properly applied to a properly designed experiment and or observational study, is a powerful tool. Admittedly, this is where my expertise begins to fade and I would rely on the expertise those scientists who have a clear understanding of the strengths and weaknesses of any mathematical procedure. I would work closely with them to verify if the statistical models and analyses conform to known physiological knowledge.

Climatic and environmental reconstructions are carefully constructed by first taking a period of known recorded environmental conditions and comparing it to the carefully verified and replicated cross-dated chronology.

This provides a level of confidence for making a correlative comparison for an extended period of time beyond the recorded environmental record.

What we now see is the application of cause and effect studies on growth ring formation to a correlation analysis for the reconstruction of past environmental conditions. Herein might lie a weakness because certain assumptions might be made in specific studies, especially when one is working with a tree species which has not been studied in terms of its phenology or physiology. But does obtaining a statistically significant correlation to an environmental signal from a carefully replicated, verified and cross- dated chronology mean it is all garbage when there is a pre-existing wealth of knowledge regarding general tree growth and development which in the very least implies this is how trees respond to their environment?

The ability to grow a tree ring in a culture tube will not refute nor ultimately vindicate dendrochronology. Producing cambial derivatives in culture to better understand the cellular workings of the vascular cambium is a noble effort which might shed light on xylogenesis. However, when dealing with the tree as an entire organism responding to the environment requires more than a vascular cambium. To attempt to reduce tree ring formation to a series of conditions within a culture tube just to prove or disprove dendrochronology would be a waste of time and money.

To understand how the cambium works, one needs to back away from the cambium from time to time and take a look at the whole organism, from root tips to shoot tips and everything in between, and then what is its position in the environment. Physiology, anatomy, morphology and ecology. No matter how much we reduce things, the science always has to come back to the whole tree to be meaningful or relevant.

We will continue to learn more about cambial physiology and tree ecophysiology. But all this information will not disprove or refute dendrochronology. It will fine tune the science and may lead to some minor to possible significant reinterpretation of the published data, depending on the subject of the study. But it will not prove that chronology development and interpretation is or was a waste of time and money.

Do we need more money invested in cambial research? Absolutely. Should funding for dendrochronological studies stop until we have a complete understanding of the physiology of the cambium, I sure hope not.

Rod, that's the best I can do. All I can suggest is if you are really interested in understanding dendrochronology, not just discarding it, maybe just try working through a cross-dating procedure on your own with some actual trees and then see what you think. The key thing here is that cross-dating appears to be a very simple procedure, and for the most part it is. But this is only true when all the criteria presented above work. Quite often, it can not be applied at all.

Thank all for providing me this opportunity,

Frank

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