Introduction to Crossdating

1444 fire scar

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5/19/2014
Dendroecology Pre-session

Tree-ring crossdating: An annually precise paleo dating method

Other paleo dating methods:

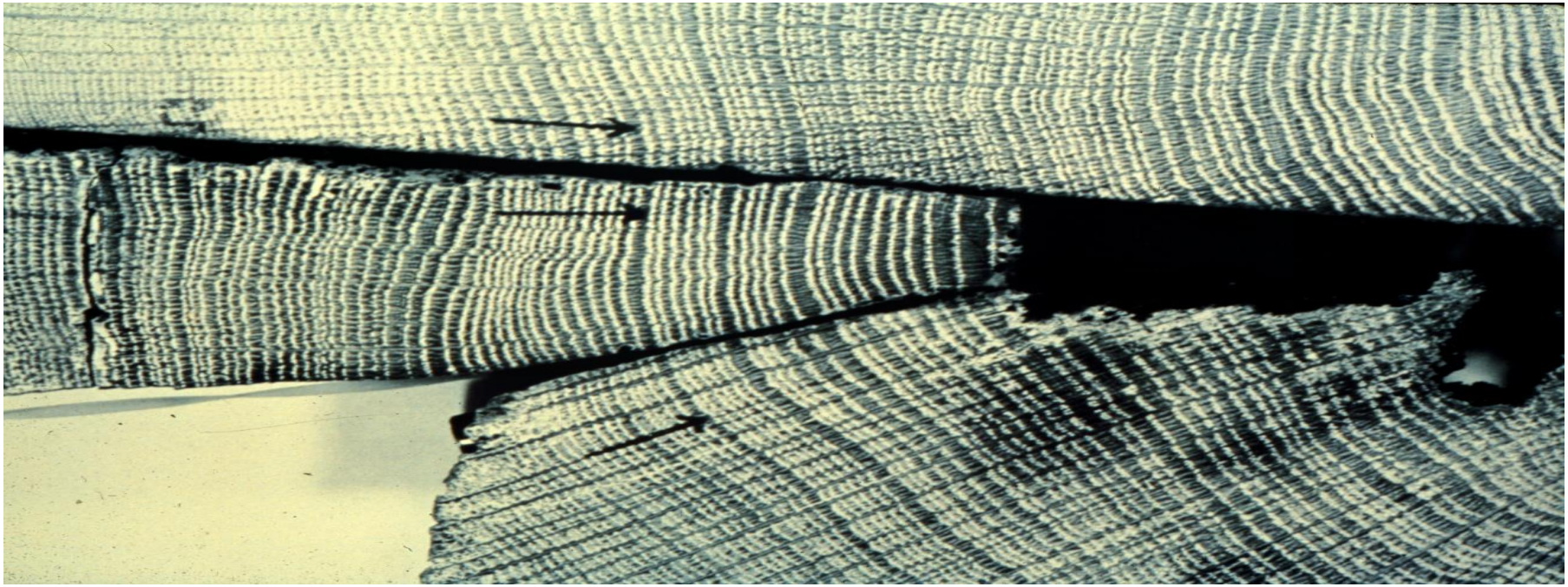
- Relative

  Stratigraphic – older layers buried beneath younger layers (geologic context), but can't assign accurate age

- Radiometric - based on radioactive decay

  Radiocarbon ^{14}C – can provide dates for ~ last 50,000 years, but has error of decades to centuries. *Calibrated with tree-rings due to atmospheric variations of $^{14}C/^{12}C$ geographically and through time.*

Shared pattern of ring growth makes crossdating possible

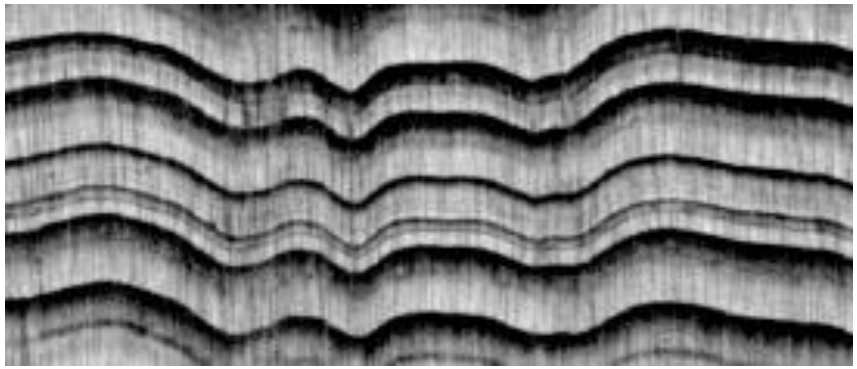


Baillie, 1982

- *Quercus* (oak) timbers from locations in Ireland up to 200 km apart. Note similarity of patterns - marked year is AD 1580

Definition: "Crossdating is the recognition of the same ring pattern in different trees, so that the actual growth date of any one ring of the pattern is the same in the different trees and one may carry a chronology across from tree to tree."
A.E. Douglass (1941) – Journal of Forestry

- Revolves around pattern recognition
- Three basic techniques:
  1. Graphical techniques (skeleton plot)
  2. Statistical techniques
  3. Memorization techniques



Example of matching ring-width patterns

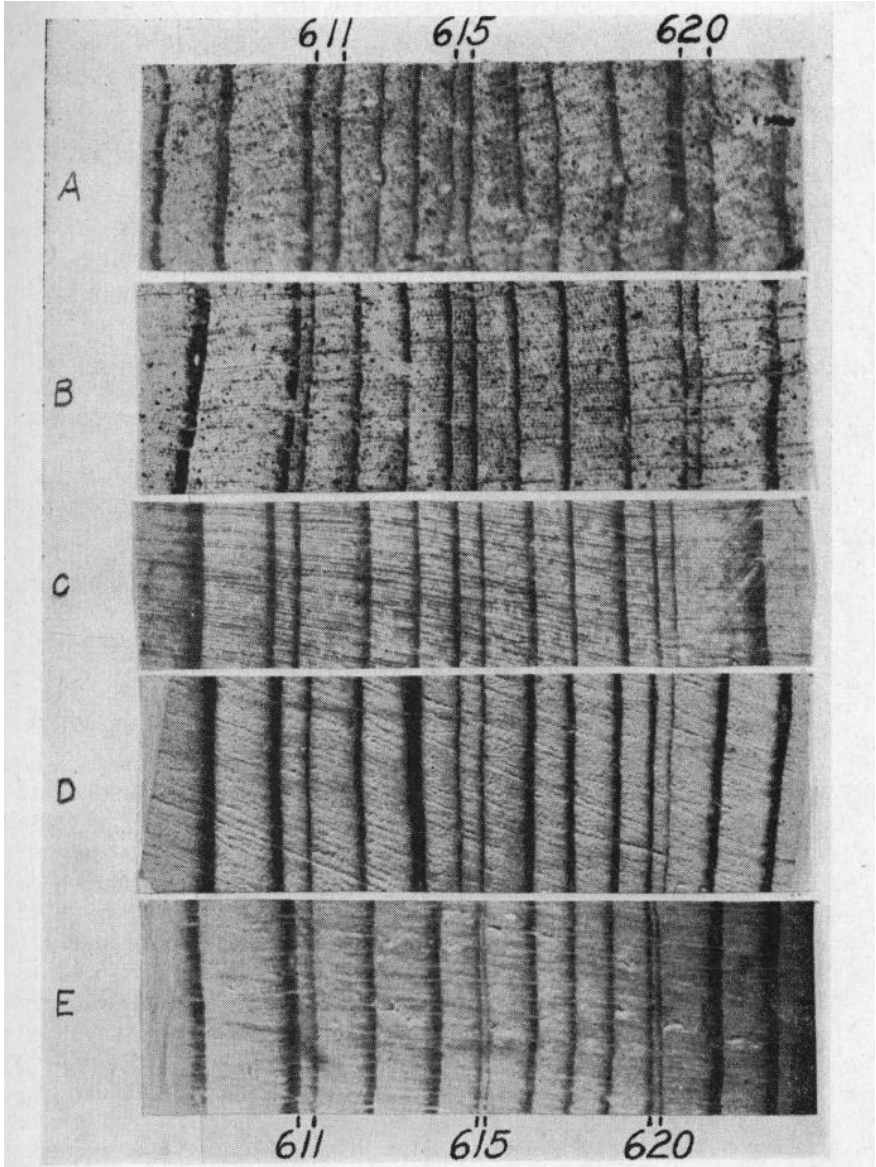
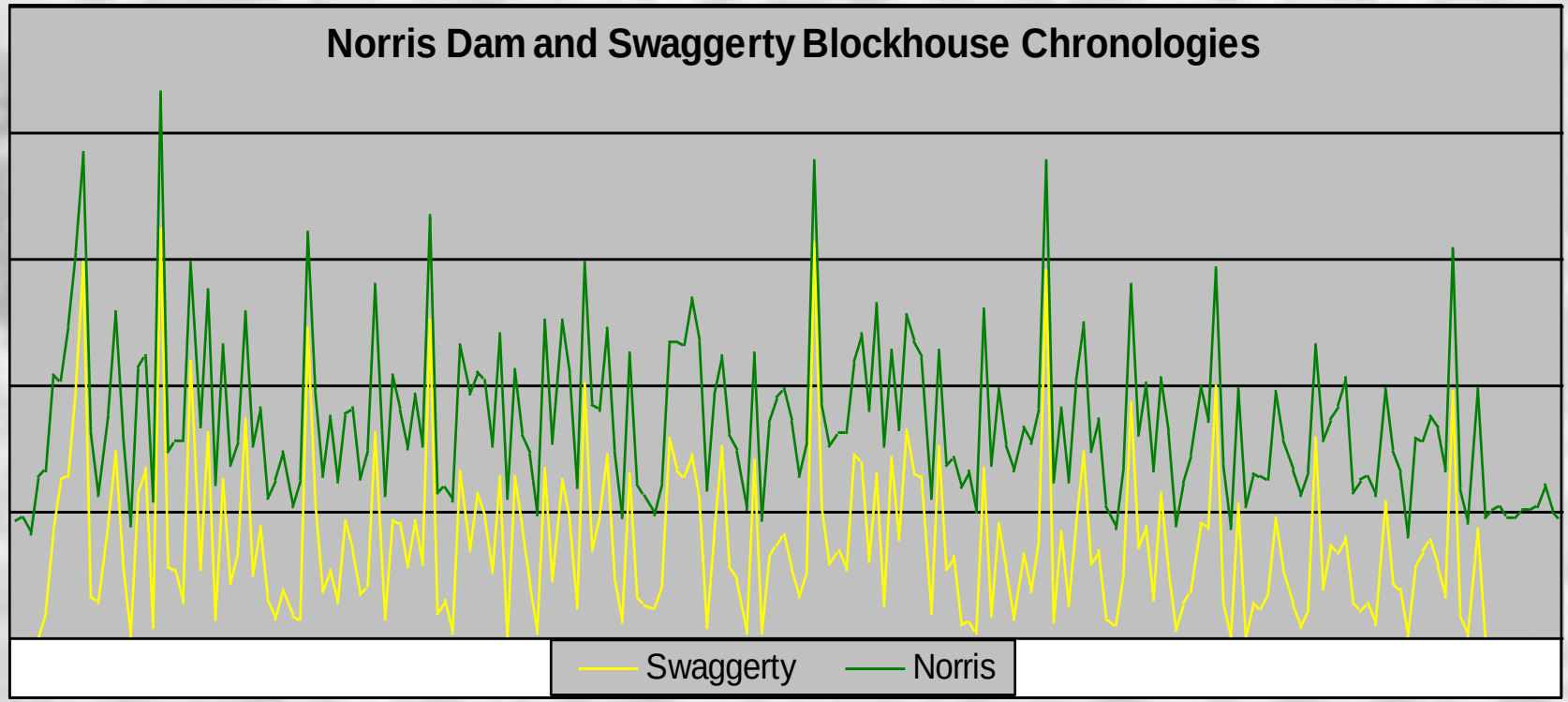


Plate VII.—Study in crossdating. Display of JCD signatures from different localities.

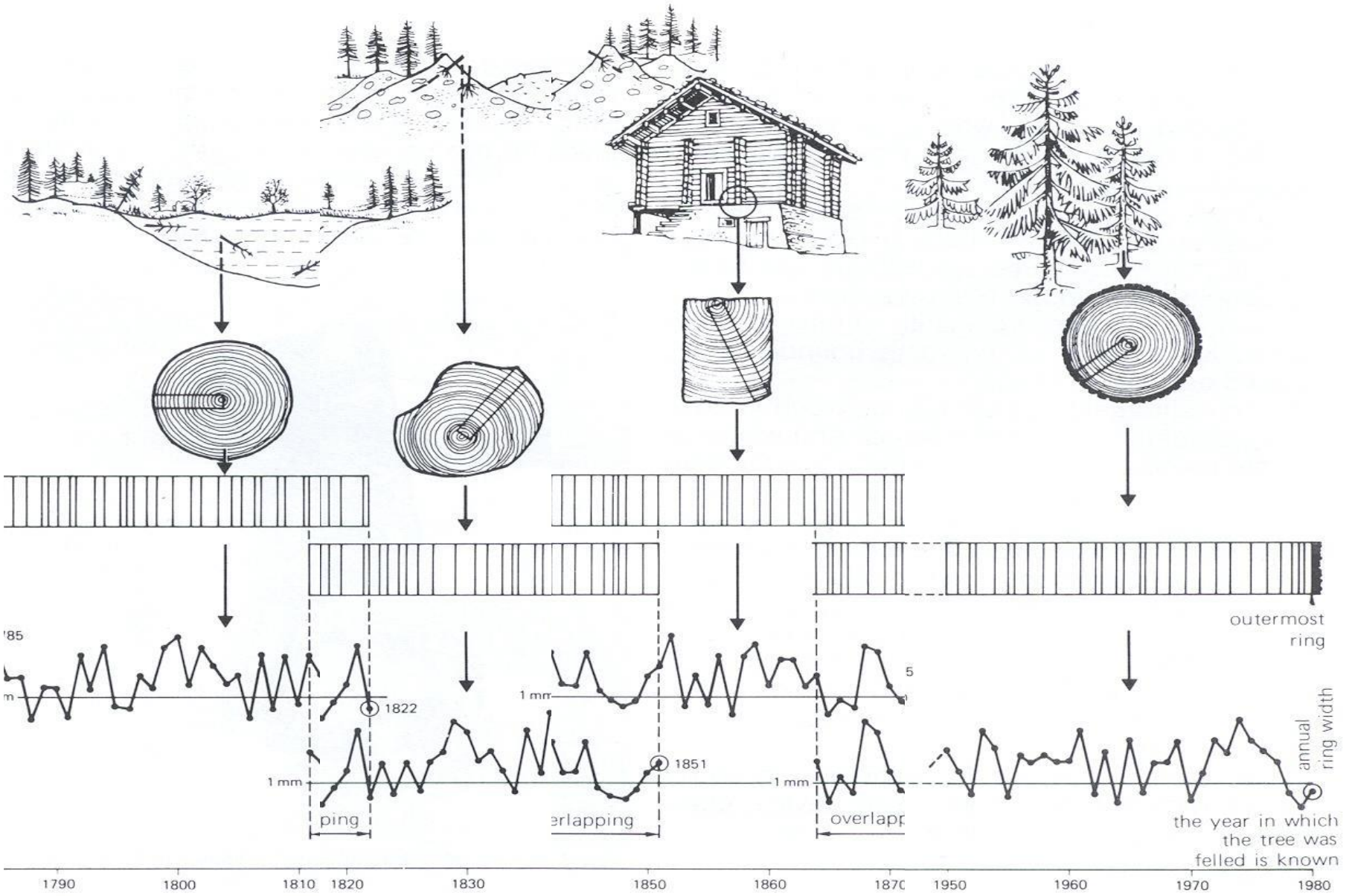
Crossdating

Two techniques:

- **Skeleton plots (common in the U.S.)**
- **Alignment plots (common in Europe)**



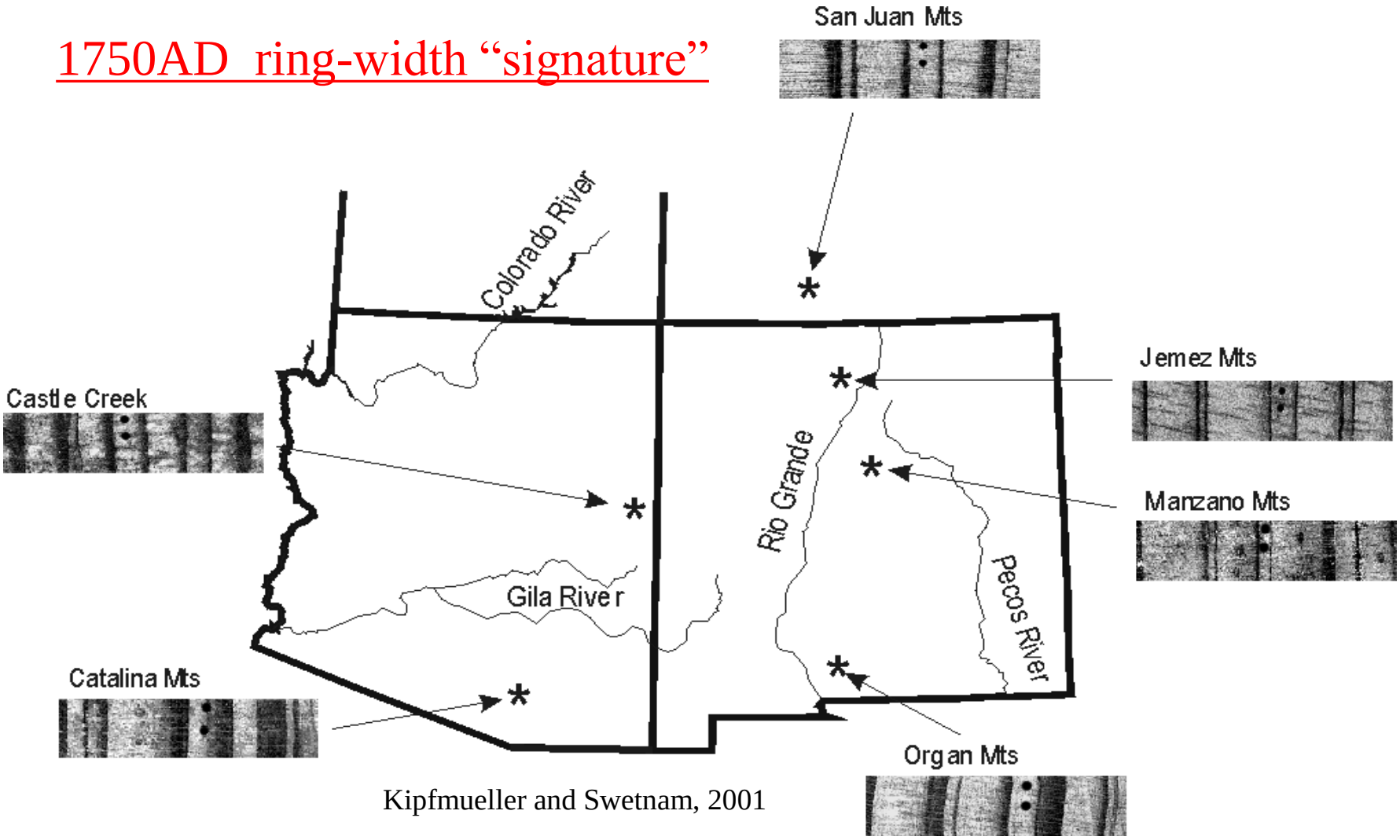
Crossdating can be used to extend a chronology back in time by overlapping older and older samples and matching growth patterns



How is cross-dating between different trees (and even between species) possible?

1. Tree (ring) growth cannot proceed faster than is allowed by the most limiting factor to the physiological processes of ring formation.
2. If trees have the same limiting factor, the pattern of year to year variation in ring properties will reflect the variation in the limiting factor. Hence they will show similar growth patterns.
3. For example: tree rings from dry regions often reflect variations in moisture availability, and those from cold regions reflect growth season temperature

1750AD ring-width "signature"

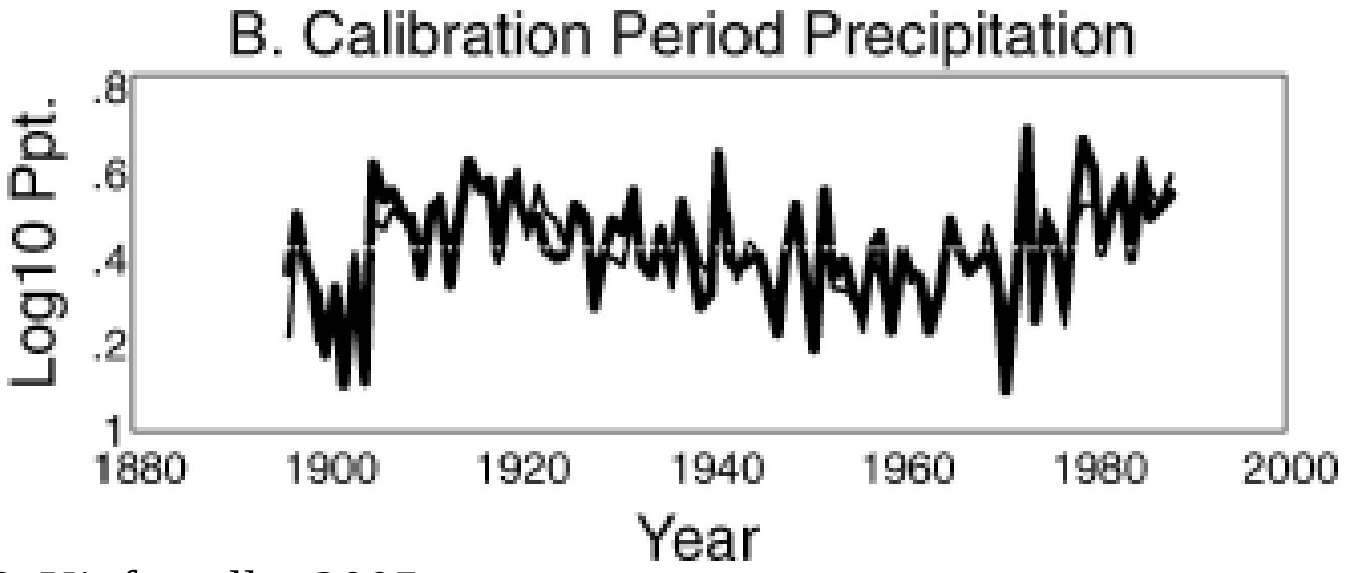


Kipfmueller and Swetnam, 2001

1747 **wide** - 1748, 1750, 1752 **small**

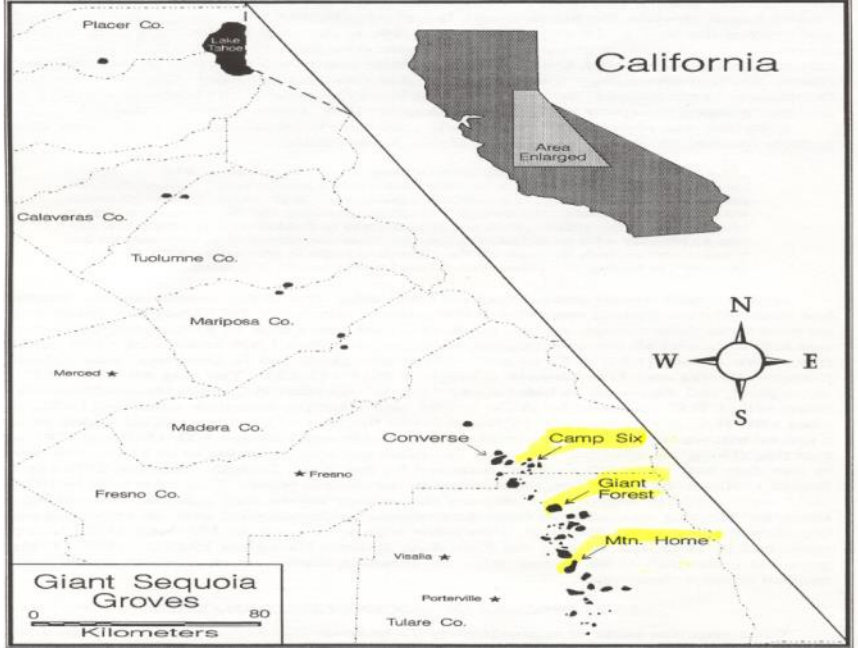
Why is this ring pattern replicated throughout the SW?

Limiting factor for tree (ring) growth in these semi-arid montane forests is predominantly **winter precipitation** and …
Winter storms are geographically widespread throughout the SW:
http://www.ncdc.noaa.gov/special-reports/2005-winter-storms.html



$r^2 = 0.74$

Salzer & Kipfmueller 2005



A low value on the graph below indicates small rings on average in that year, a high value, big rings

Hughes and Brown, 1992

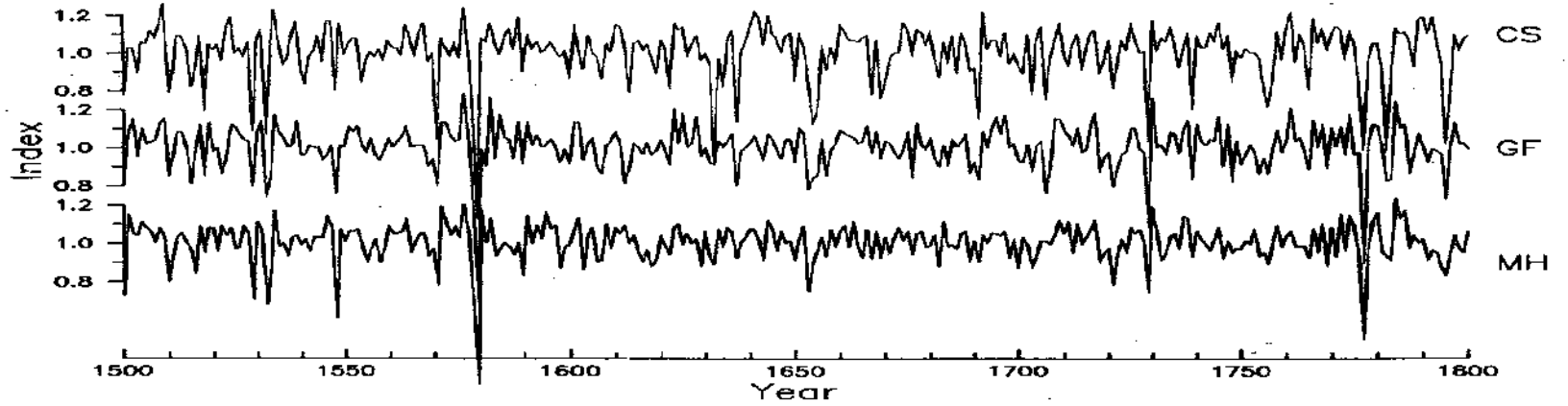
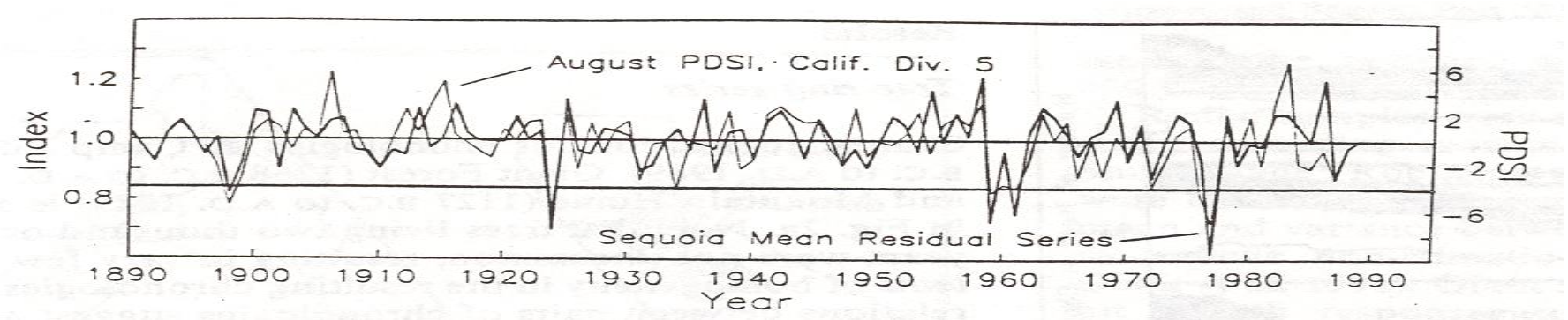


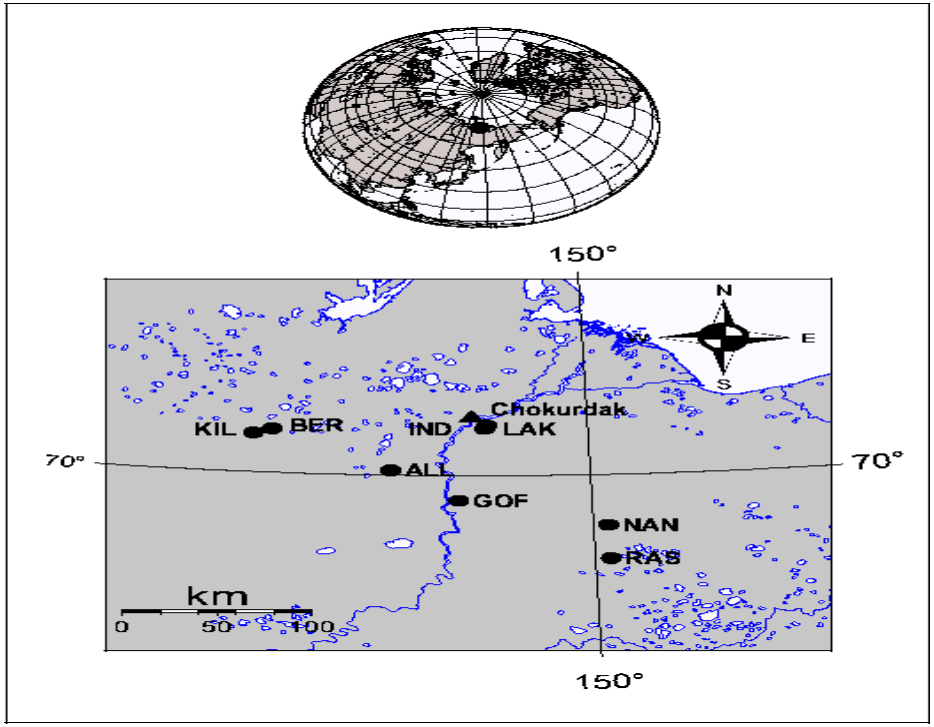
Figure 3. Ring-width indices for Camp Six (CS), Giant Forest (GF), and Mountain Home (MH) from A.D. 1500 to 1800.

Why do sequoias have synchronous small or missing rings?

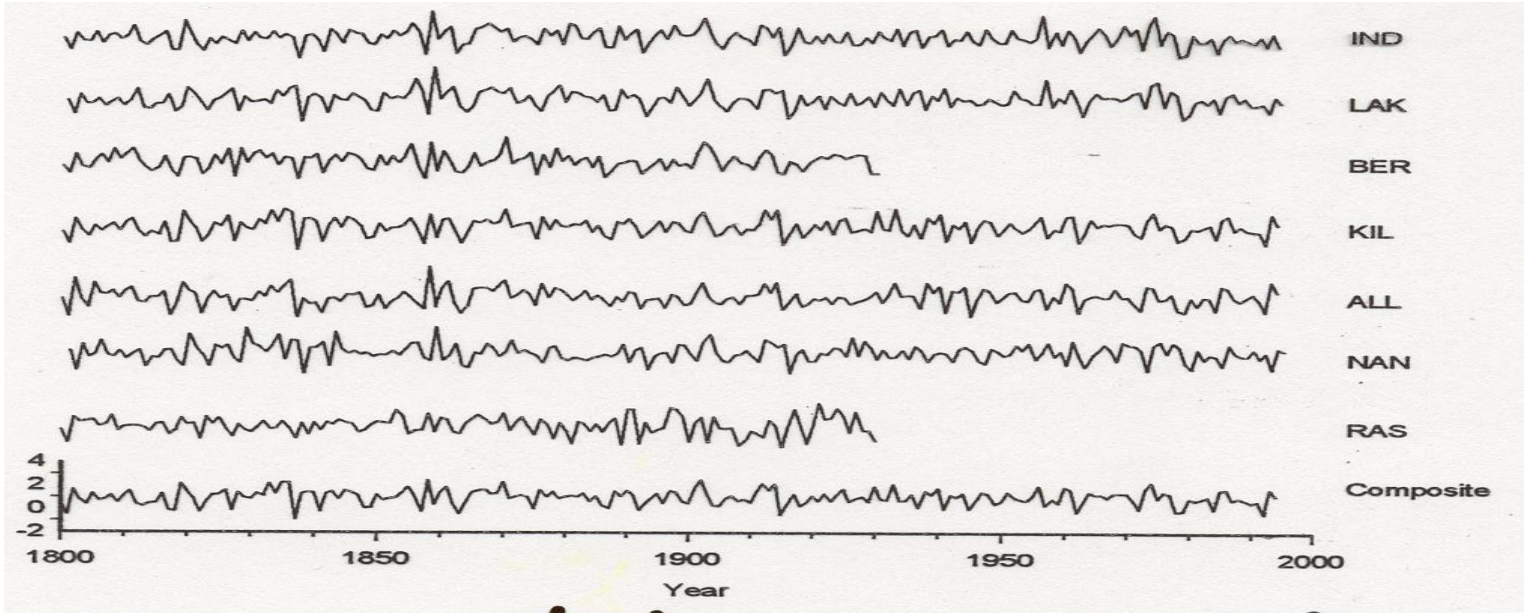


Hughes et al., 1990

Most of the time the tree rings are not much affected, but, sometimes, the soil gets dry enough to limit growth throughout the region.

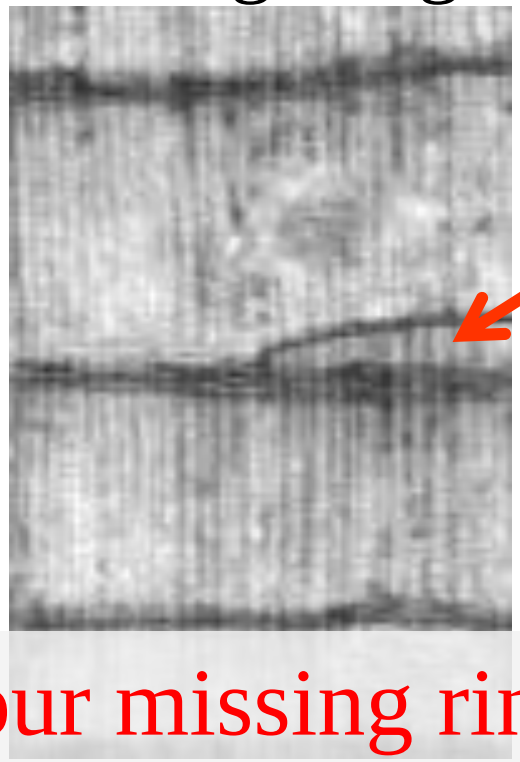


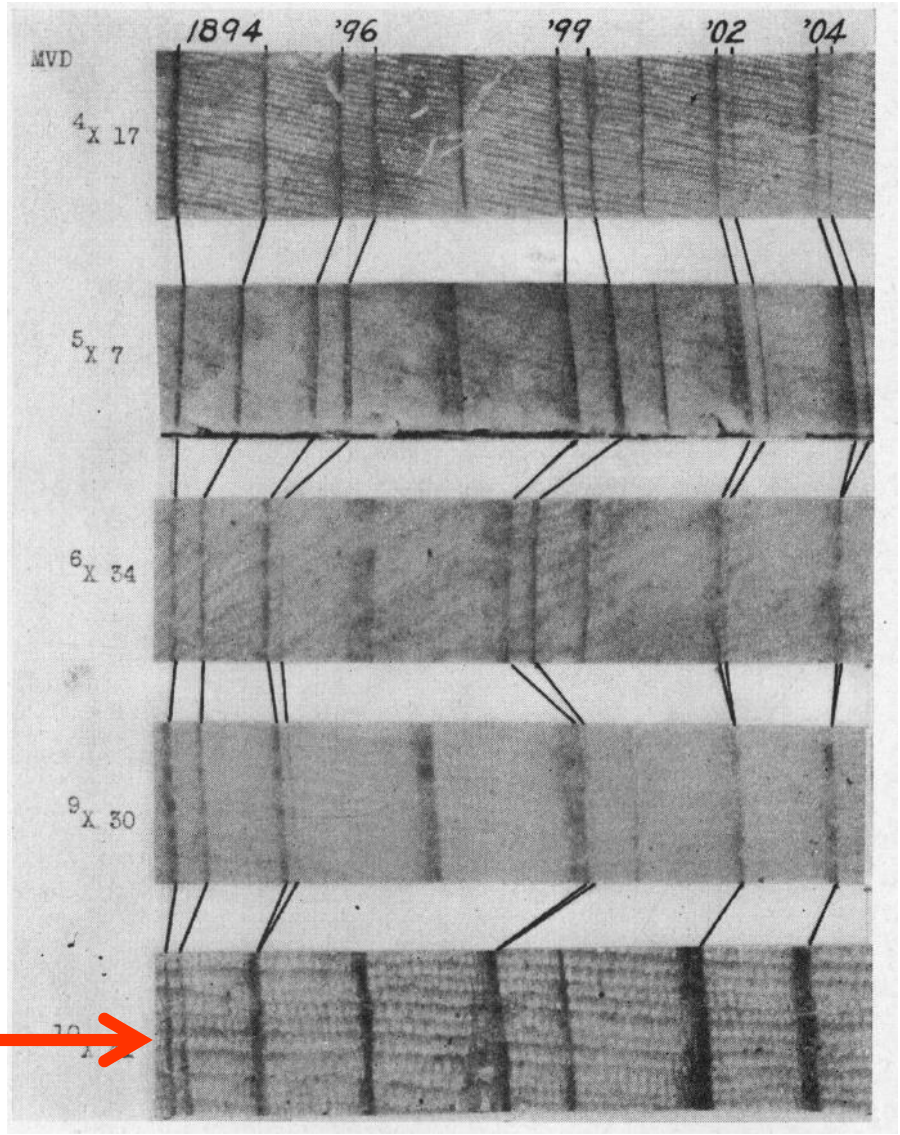
Larch trees at 70 degrees North also show strong cross-dating. Why?



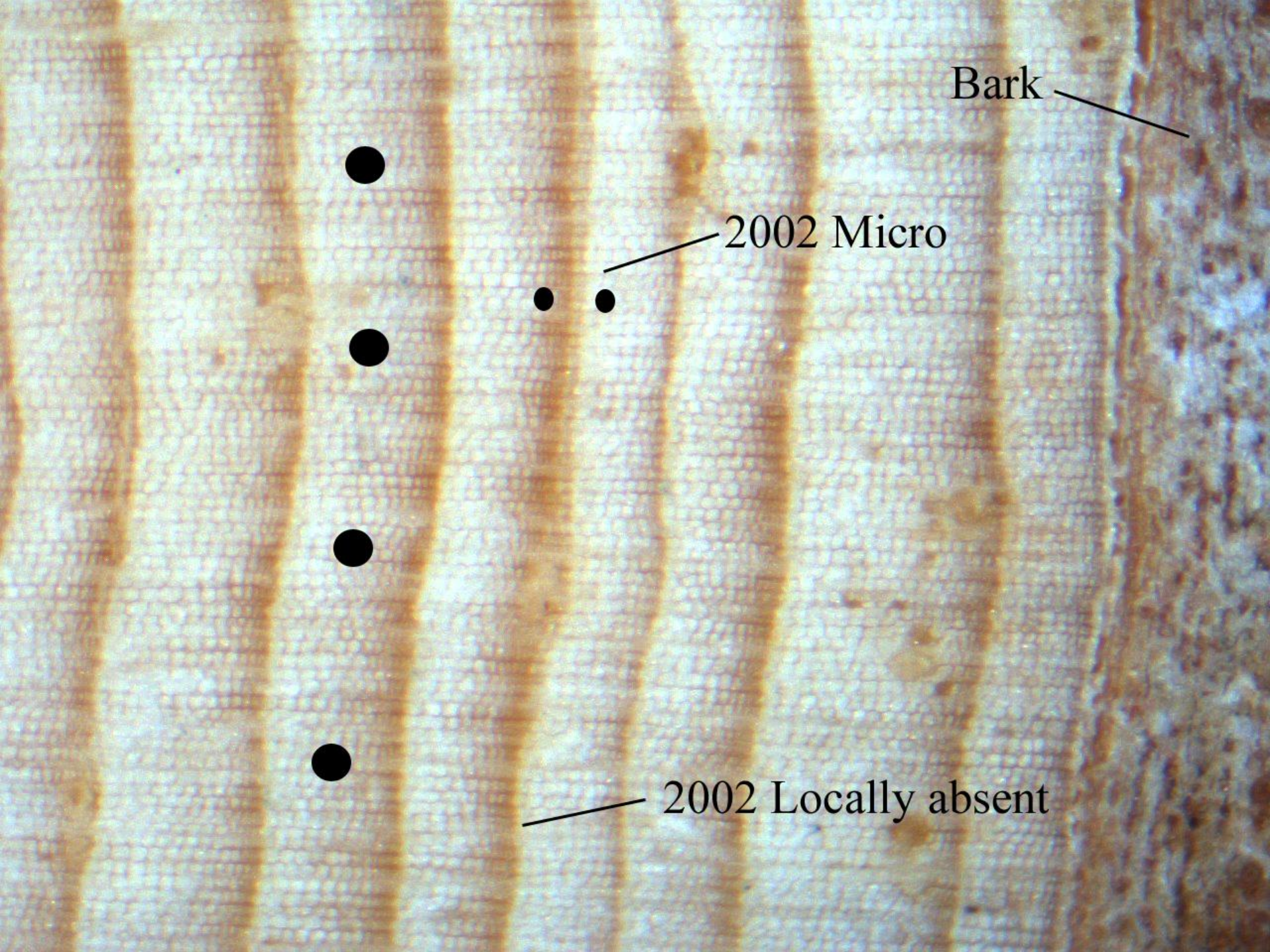
So you just count the rings, right?

Missing Rings



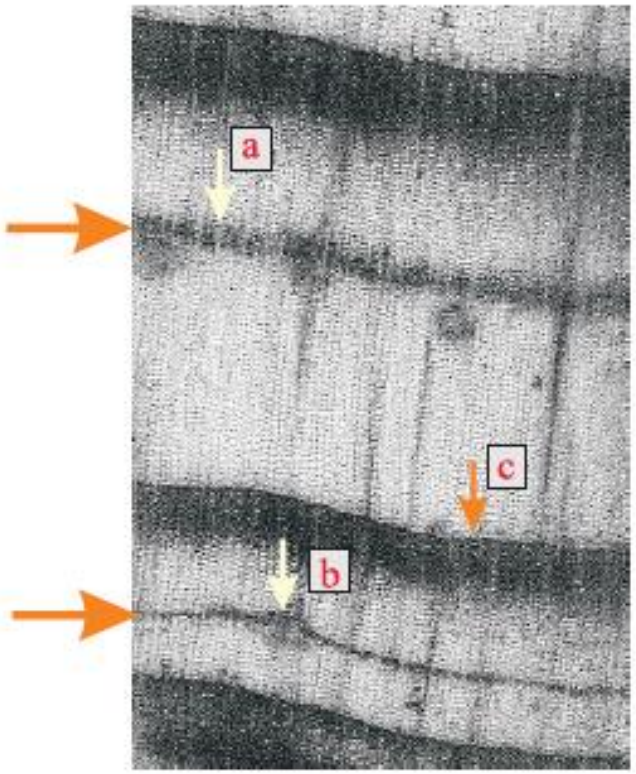


Four missing rings from 1893 – 1905!


Bark
2002 Micro
2002 Locally absent

Other challenges for crossdating

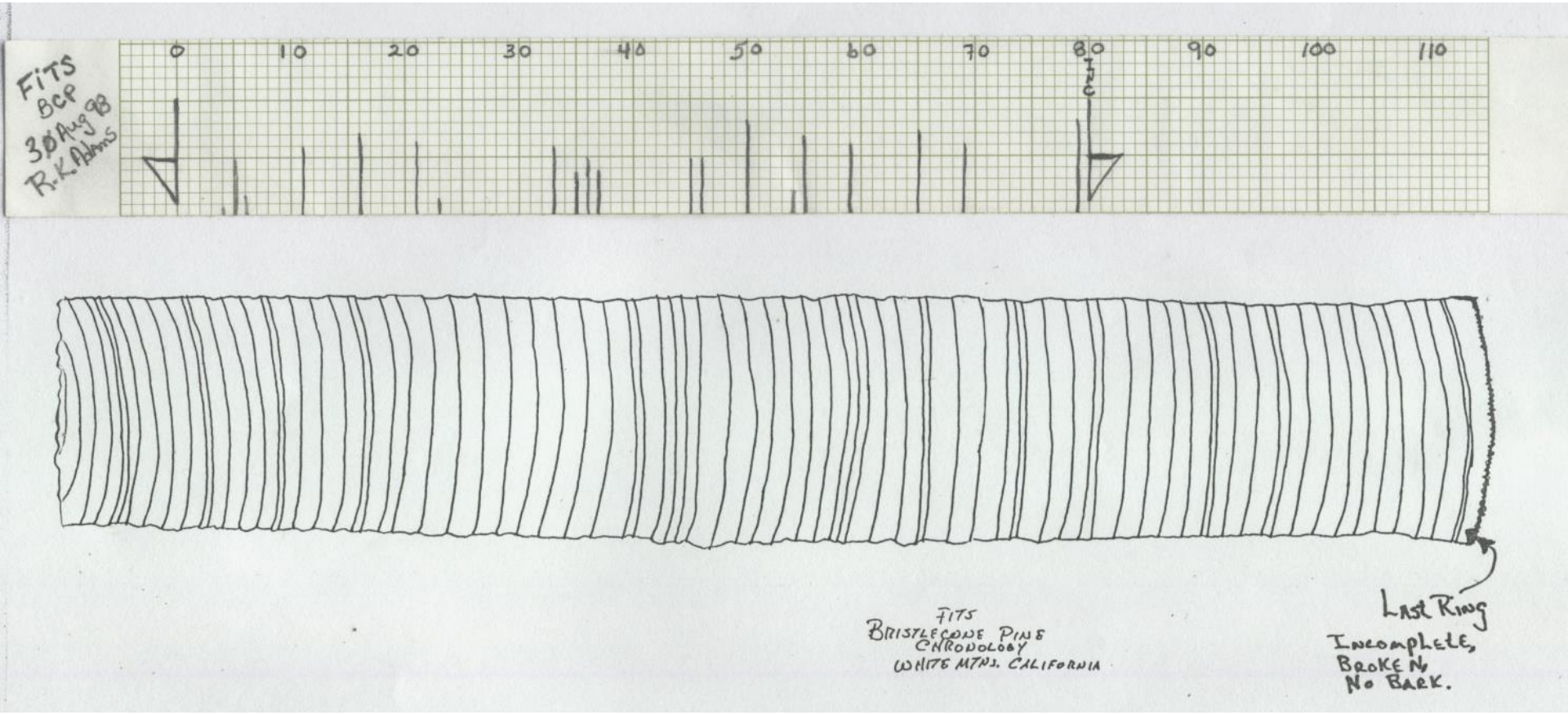
False rings



Juniper spp.

Skeleton plots

- Simple graphical representation of the ring width pattern in a sample (focusing on narrow rings)



Skeleton plots

- "This count of small rings then is turned into a skeleton plot….these deficient rings expressed in vertical lines from the base of a long paper strip, the length of line being greater for more deficiency and specially long or dotted for absences. These can easily be compared together for the satisfactory relative place of each specimen and a composite made that can be compared with a master chart if one has been made."

A.E. Douglass. 1946. PRECISION OF RING DATING IN TREE-RING CHRONOLOGIES. University of Arizona Laboratory of Tree-Ring Research Bulletin No. 3.

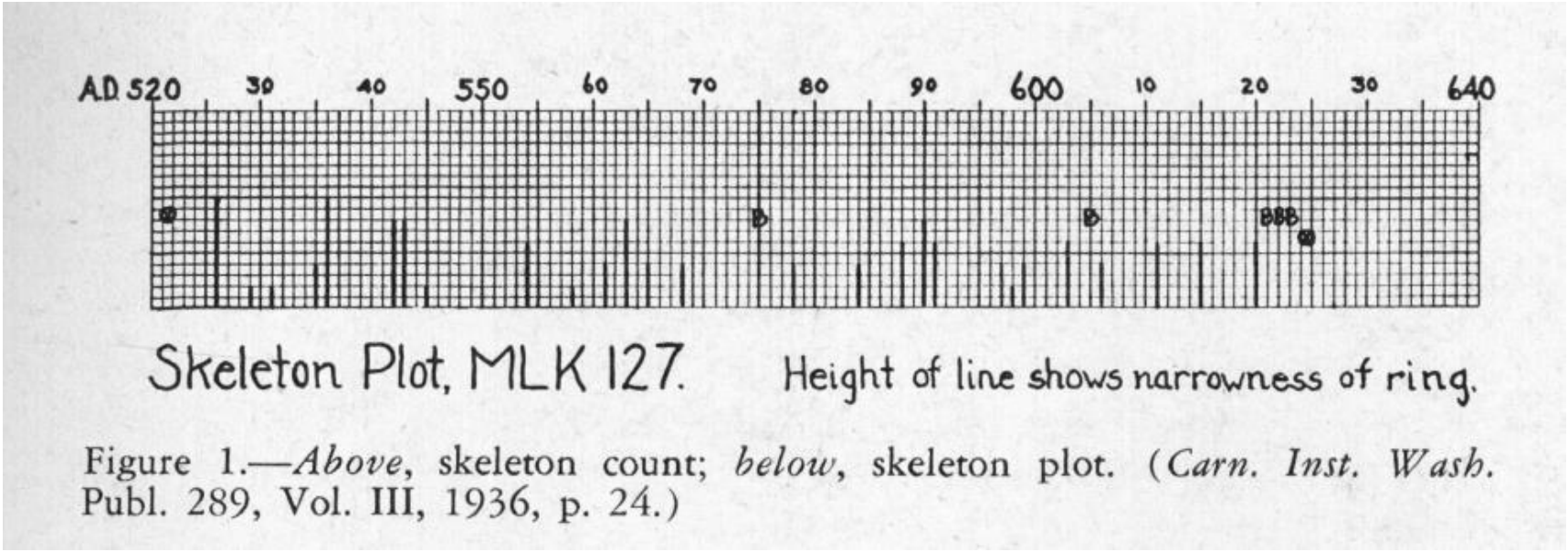
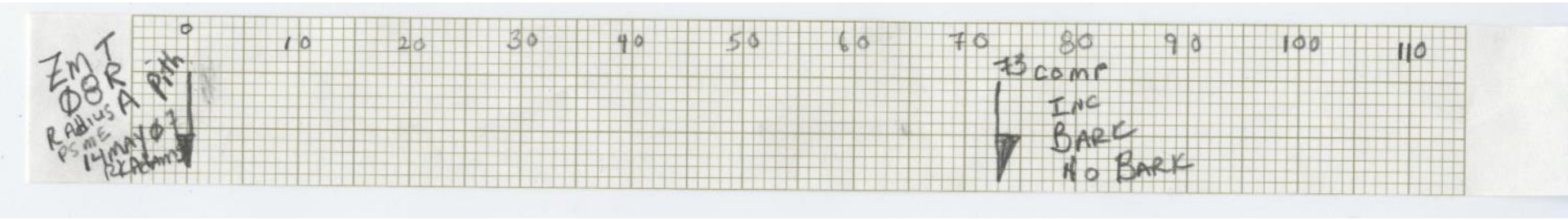


Figure 1.—*Above*, skeleton count; *below*, skeleton plot. (*Carn. Inst. Wash.* Publ. 289, Vol. III, 1936, p. 24.)

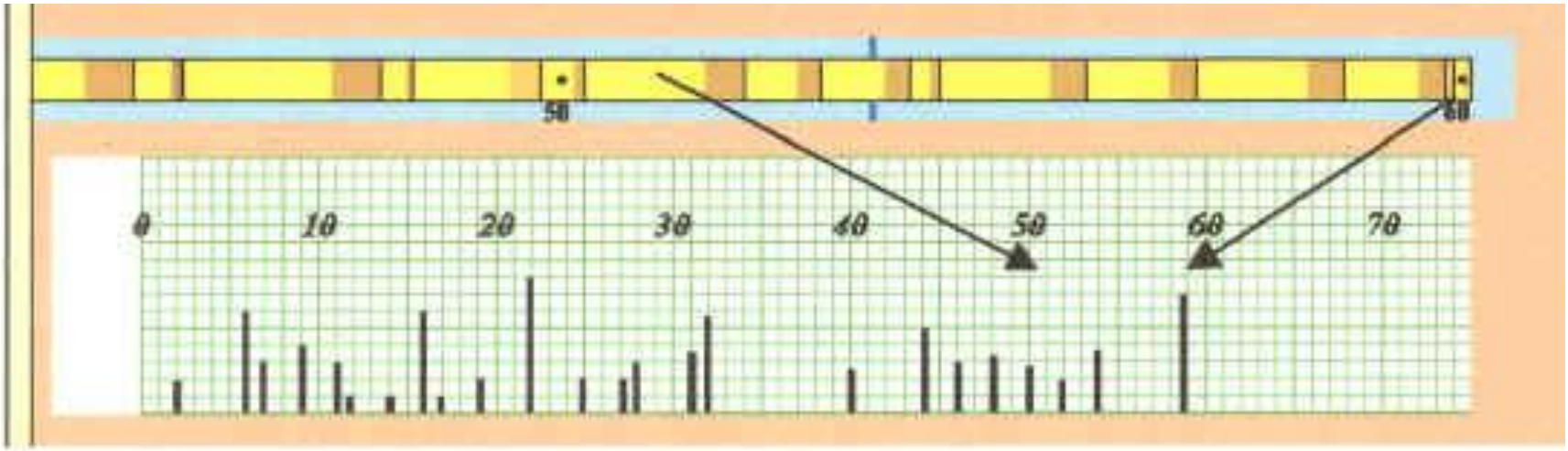
Skeleton plotting – uses

1. <u>Quick</u> way to find dates of wood at a site with an existing chronology
2. To develop a <u>master chronology</u> at a new site

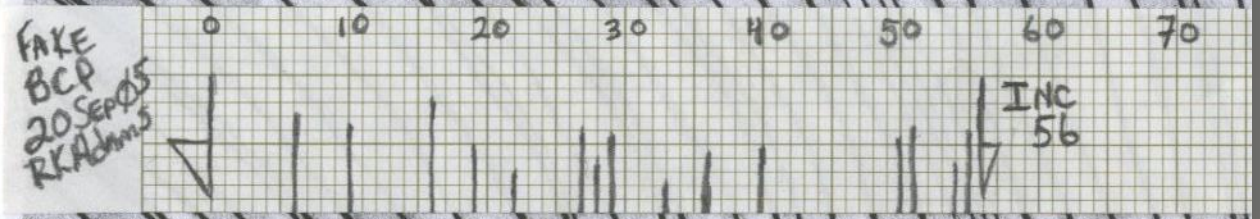


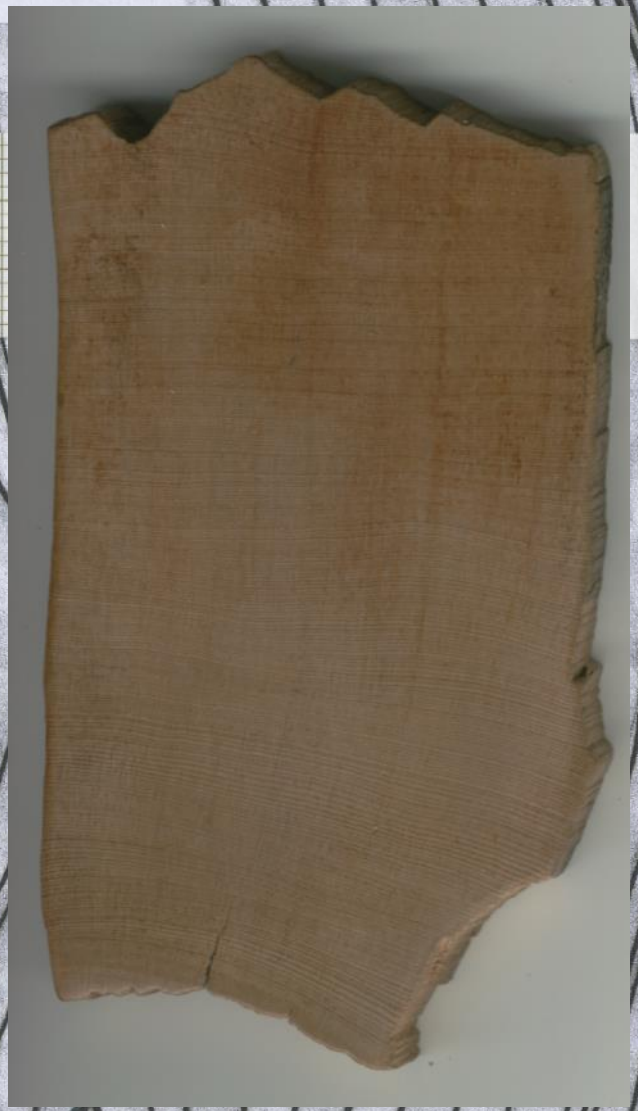
Skeleton plotting online tool developed by Dr. Paul Sheppard:

http://www.ltrr.arizona.edu/skeletonplot/introcrossdate.htm



Skeleton plotting exercise developed by Tom Harlan

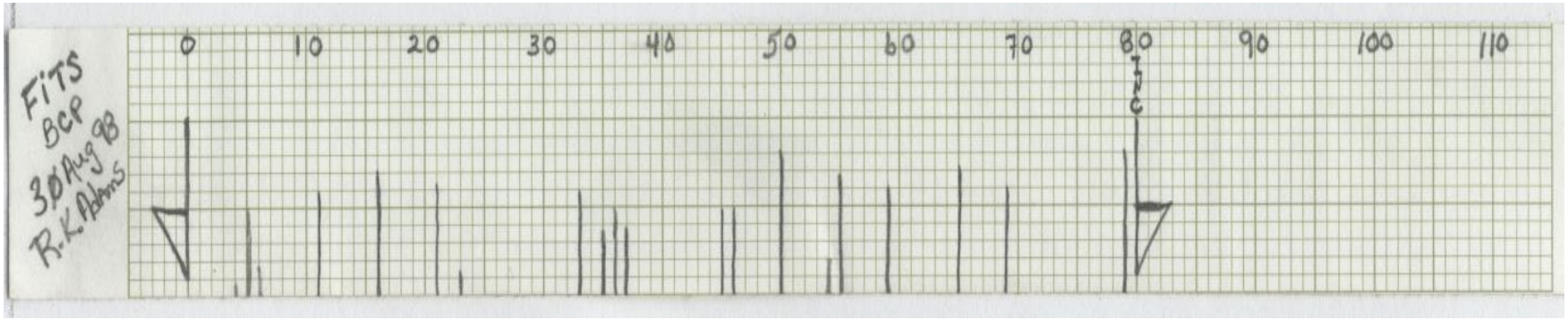




Now everyone gets to make their own skeleton plots

Skeleton plot required elements

- On the far Left side: name (“E.Q. Margolis”), date, sampleID, and radius (e.g., “A”)
- 5 spaces in: Inner ring “Flag” and inner ring descriptor (“pith” or “Inc.”). Flag filled if pith, open if Inc.
- “0”, “10”, “20”,…… every 10 squares on top of plot
- Final ring “Flag,” filled if complete, unfilled if incomplete.
- Final ring descriptor: (Inc., or Complete, Bark).
- Descriptors on special rings (e.g., Big [“B”],False [“Fls”], Frost[“Frst”], Injury [“Inj”], or Locally Absent [“LAb”])



Final Quote from A.E. Douglass

“The most efficient and at the same time the most convincing method of crossdating is by that of memory, which develops on examining scores of specimens of approximately the same age in which similar patterns are identified in the great majority of case.” (1941)

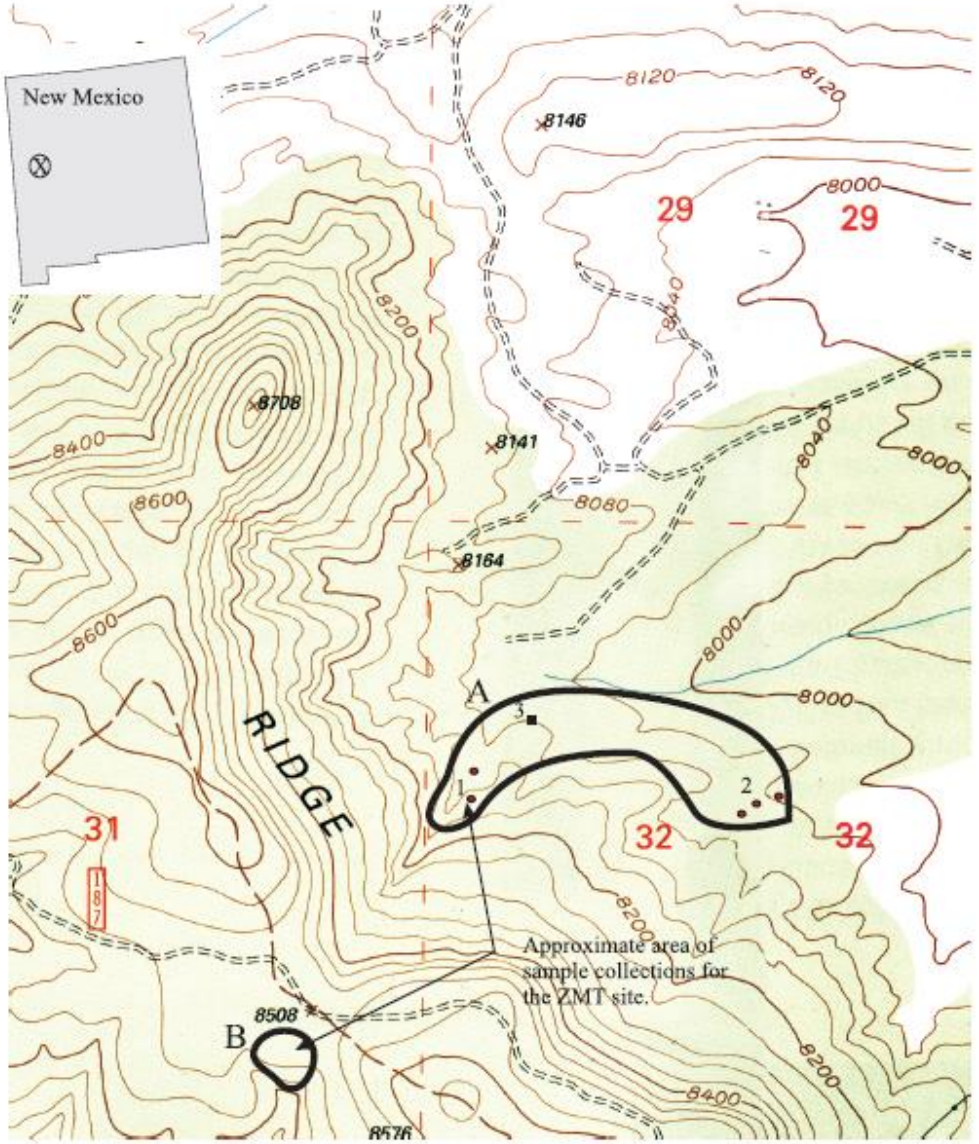
Final Final Quote from Rex Adams

“Surface, surface, surface”

Plotting & Dating Real Wood!

5/19/2014

- ZMT = Zuni Mtns
- All species collected from same area so they experienced the same climate and therefore should crossdate



Collection sites in the Zuni Mountains, Valle Largo and Paxton Springs USGS quads, T10N, R12W, S31/32. Collection made by Adams, Baisan, and Wright, July 1998. Fire scar samples, ponderosa pine, douglas-fir, Rocky Mountain juniper, and gambel oak collected in area A, pinon pine in area B. 1: fire scar samples ZMT 7, 30; 2: fire scar samples ZMT 1,2,35; Class samples collected between 1 and 3.

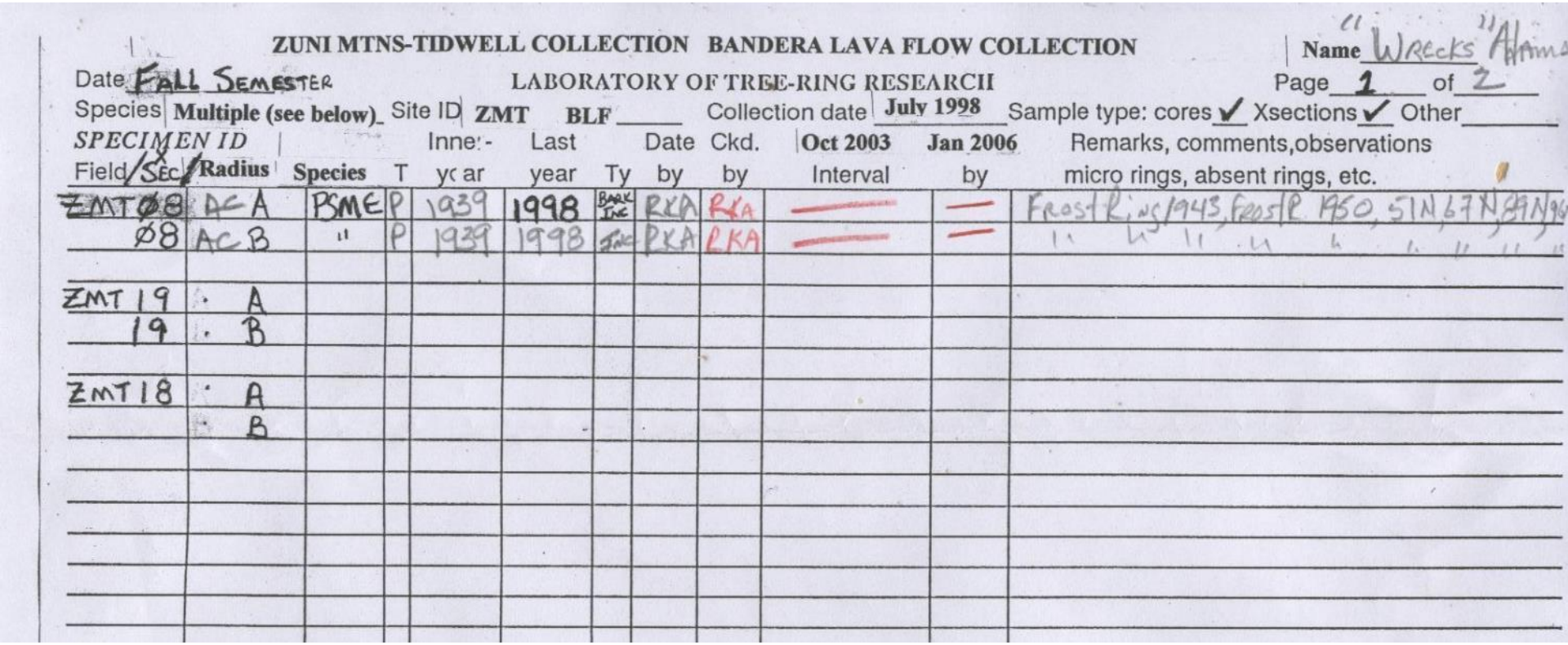
Plot 2 radii for each piece (A & B)

If it looks like a ring, then it's a ring

Skeleton plots

- Put at least one real calendar date on the finished skeleton plot
- This makes it easy to transfer the dates to the wood
- Ideally you mark the inner and outer ring dates (and maybe key small rings)

Data sheets



ZUNI MTNS-TIDWELL COLLECTION BANDERA LAVA FLOW COLLECTION

LABORATORY OF TREE-RING RESEARCH

Name "Wrecks" "Ahmm"

Date FALL SEMESTER

Page 1 of 2

Species Multiple (see below) Site ID ZMT BLF ____ Collection date July 1998 Sample type: cores ✓ Xsections ✓ Other ____

SPECIMEN ID Field/Sec/Radius	Species	T	Inner-most year	Last year	Ty	Date by	Ckd. by	Oct 2003 Interval	Jan 2006 by	Remarks, comments, observations micro rings, absent rings, etc.
ZMTØ8 AC A	PSME	P	1939	1998	BARK INC	RKA	RKA	—	—	Frost R. in 1943, Frost R. 1950, 51N, 67N, 89N, 96
Ø8 AC B	"	P	1939	1998	BARK INC	RKA	RKA	—	—	" " " " " " " " " "
ZMT 19 · A										
19 · B										
ZMT 18 · A										
· B										

Building a composite master chronology