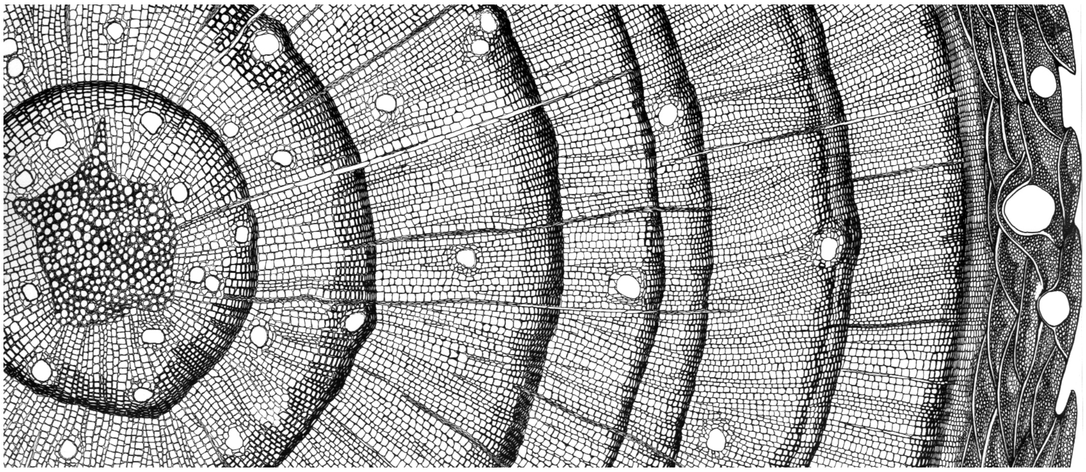
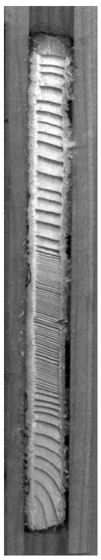
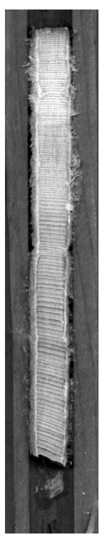
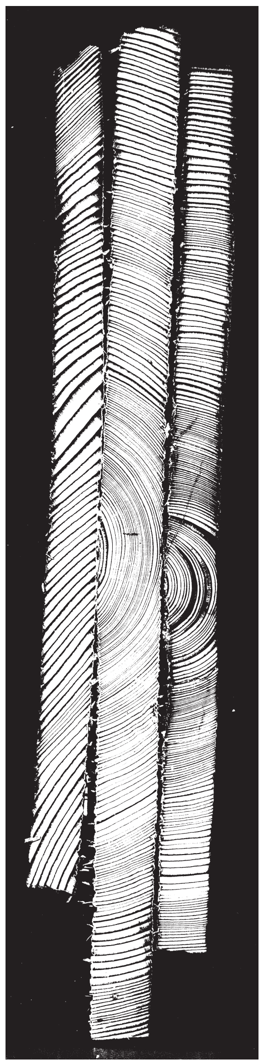
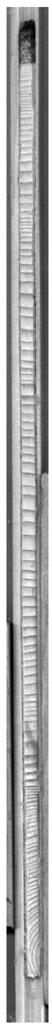
Laboratory of Tree-Ring Research
Introduction to Dendrochronology laboratory handout

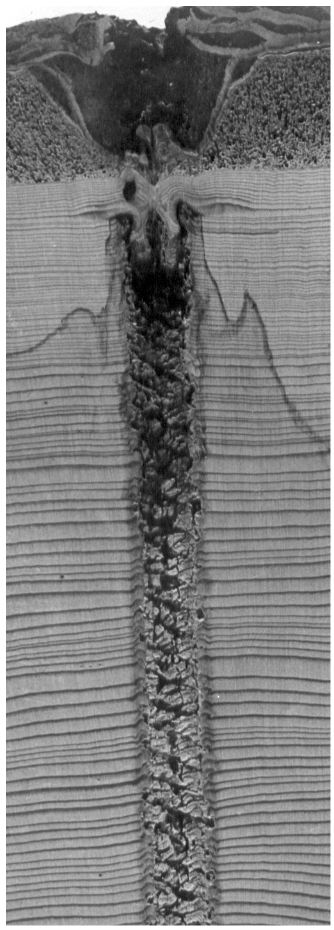


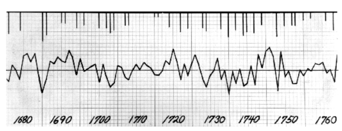








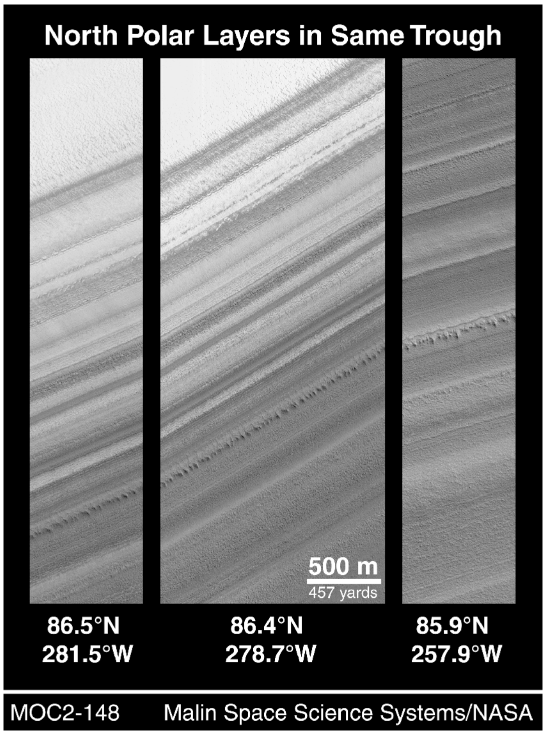




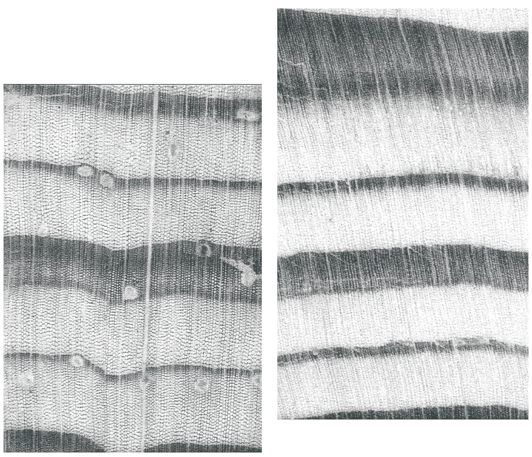
Crossdating: the fundamental principle of dendrochronology.

Dendrochronology, the ability to assign the precise year of formation to annual growth layers in trees, is based on what we call crossdating - matching the pattern of growth layers within and between trees. The imprint of a common external factor (or factors) on the rate and character of growth results in a unique pattern over time, that can be matched from tree to tree. The use of his patten matching technique to establish temporal control, while not confined to woody plants, has been most widely applied in this field. The requirement for success is a process that results in the formation of distinct layers, and that the character of the layers vary through time as the result of external influences that affect many individuals and/or large geographic areas. Other examples of successful applications include corals, ice cores, geological stratigraphy including many types of layered rocks and sediments, and mollusk shells. This laboratory portion of <u>Introduction to Dendrochronolory</u> will teach students a simple and effective way to apply pattern matching in order to establish crossdating and temporal control in tree-ring material from the Southwestern United States. Other techniques will be covered in the lecture portion of the class.

Below are some examples of pattern matching.



Layers in the Martian icecap.



Crossdating between two trees.

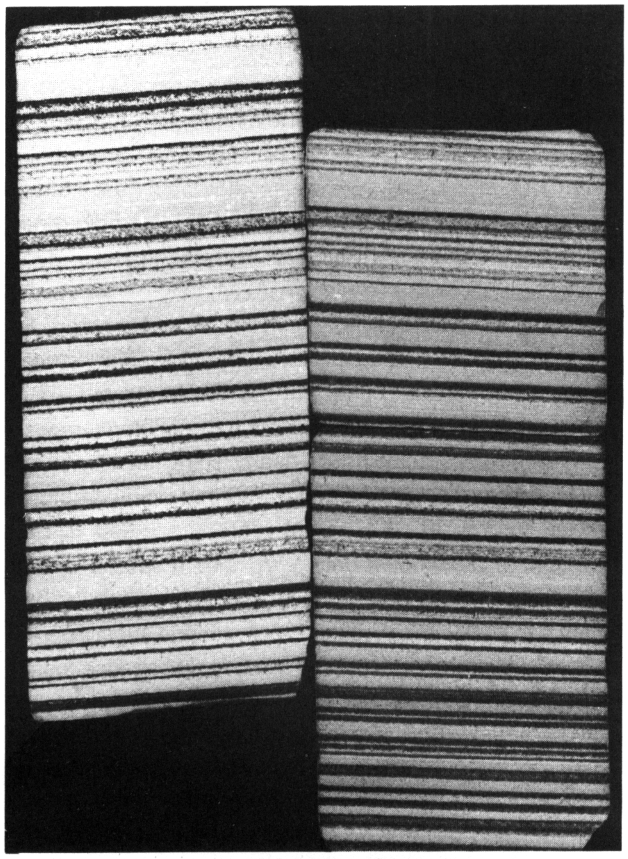


FIGURE 5-7 Two cores taken from the Castile evaporites, which were precipitated in western Texas near the end of the Permian Period. The cores are from localities 14.5 kilometers (~9 miles) apart, yet their lamination matches almost perfectly, allowing for precise correlation. The alternating dark and light bands, which range up to a few millimeters in thickness, probably represent seasonal organic-rich (winter) and organic-poor (summer) layers. If this is true, each pair of bands represents one year, in which case the 200,000 or so paired bands of the Castile Formation represent about 200,000 years of deposition. (*R. Y. Anderson et al., Geol. Soc. Amer. Bull. 83:59–86, 1972.*)

ZUNI MTNS.--TIDWELL COLLECTION BANDERA LAVA FLOW COLLECTION

Chris Baisan

LABORATORY OF TREE-RING RESEARCH

Date Sept 10, 1999

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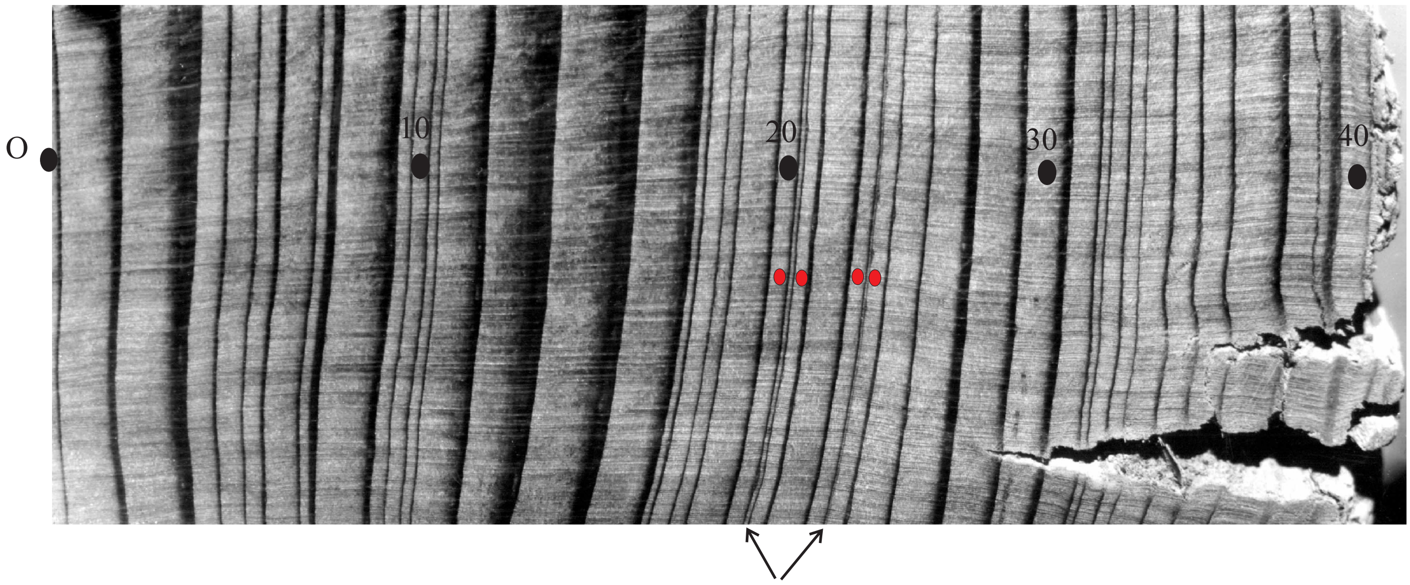
Species Multiple(See below) Site ID ZMT BLF Collection date 15-17 July98 Sample type: cores___ Xsections XX Other_______

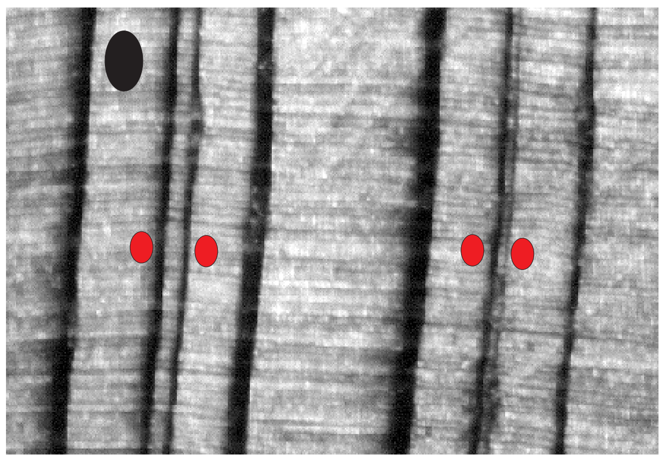
SPECIMEN ID Field	Radius	Species		Inner-year	Last year	Ty	Date by	Ckd. by	MEASURING Interval	by	Remarks, comments, observations micro rings, absent rings, etc.
ZMT08	A	Psme	P	1937	1998	B	CHB	RKA	1938-1997	CHB	1996 micro, frost ring in 1939
	B		P	1937	1998	B	CHB	RKA			
ZMT11	A	Pipo	P	1841	1998	B	CHB	RKA	1843-1997	CHB	1951 absent, 1956 micro
	B		P	1841	1998	B	CHB	RKA	1843-1997	CHB	1912 double fire scar in 1878
ZMT19		Psme									
ZMT28		Psme									

Data sheet layout with fields filled in. Please use this example as a guide for your own work. Note the sample ID, species code, inner date (and type: P = pith, I = innermost), outer date (type: B = bark, O = outer most), your initials as the cross-dater. Additionally, the last ring should be identified as complete (comp) or incomplete (inc). This indicates whether growth was complete for the final ring. The checkers initials will be filled in by the instructor who checks your piece. Use the comments field to note interesting or unusual features or problems encountered on each sample. The measuring fields would be filled in only if the sample was subsequently measured.

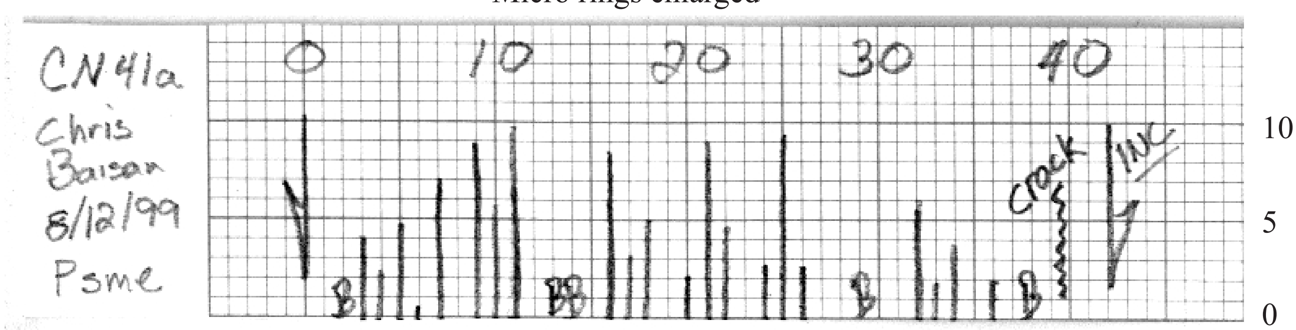


Micro rings

A surfaced specimen of Douglas-fir with an arbitrary count marked with dots each decade. The specimen count begins with ring zero.



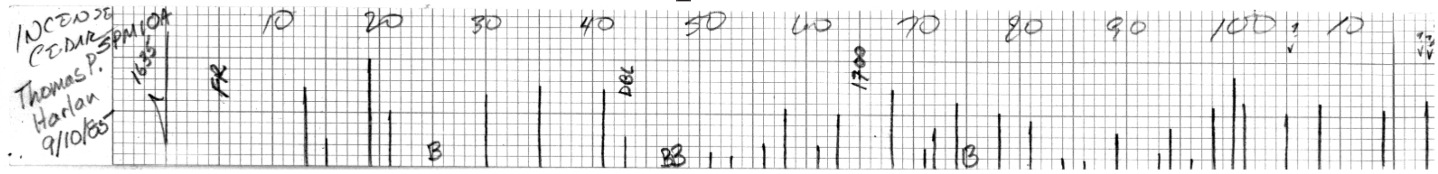
Micro rings enlarged



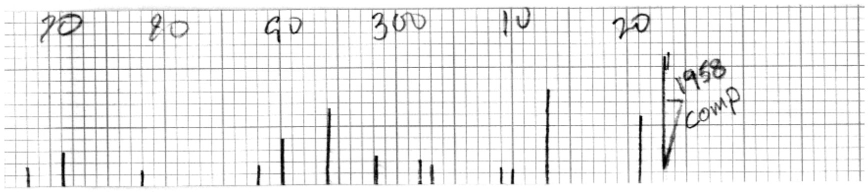
Skeleton plot made from the sample. The plot is labeled with the sample ID, name, species, and date. The plot starts five spaces in with ring zero. Ring zero is a partial ring (it's size is unknown), but is counted as a place holder. Similarly, the last ring is of unknown size, but is counted. It is marked as "Inc" for incomplete. Additionally, ring 39 is marked as having a crack.

Each vertical line on the graph paper represents a ring. The height of the pencil lines on the plot indicate the relative narrowness of the ring at that position (i.e. Rings 9, 10,and 11 are narrow). A subjective scale of 0-10 is used where zero indicates average or large rings and nine would indicate a very narrow ring.

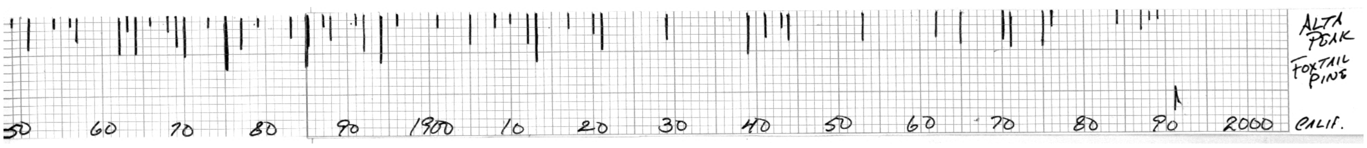
Skeleton plot basics



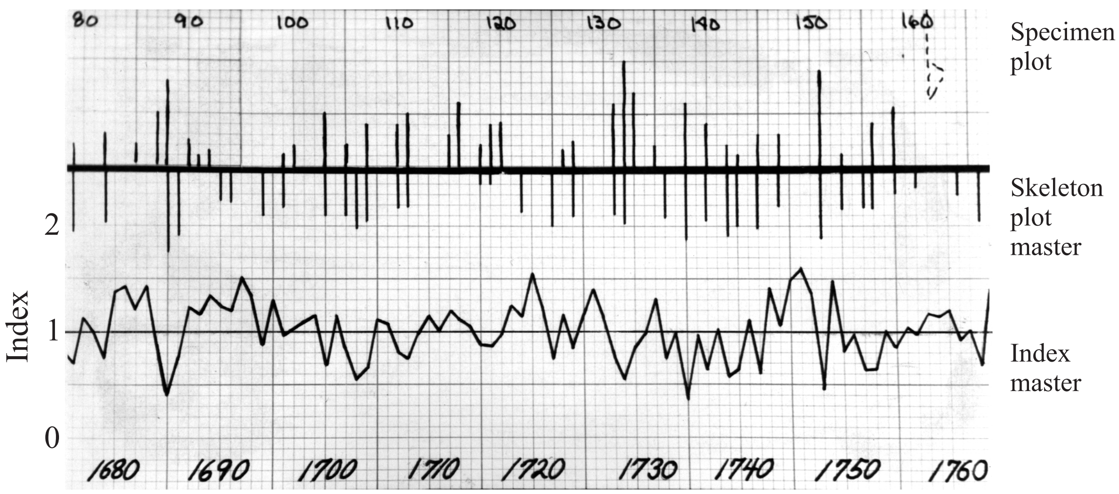
A typical skeleton plot of an individual specimen. Note the plotters name, specimen ID, and date on the left. The arrow noting ring "zero", and the arbitrary ten count at the top of the plot. Large rings are noted with a "B". Other features have been noted as well: a frost ring "FR" and a "double" or "false" ring "DBL". Dating has been established for the piece and is noted at the beginning "1635" for ring zero, and at the century "1700". Places to look for absent rings on the specimen have been noted with check marks.



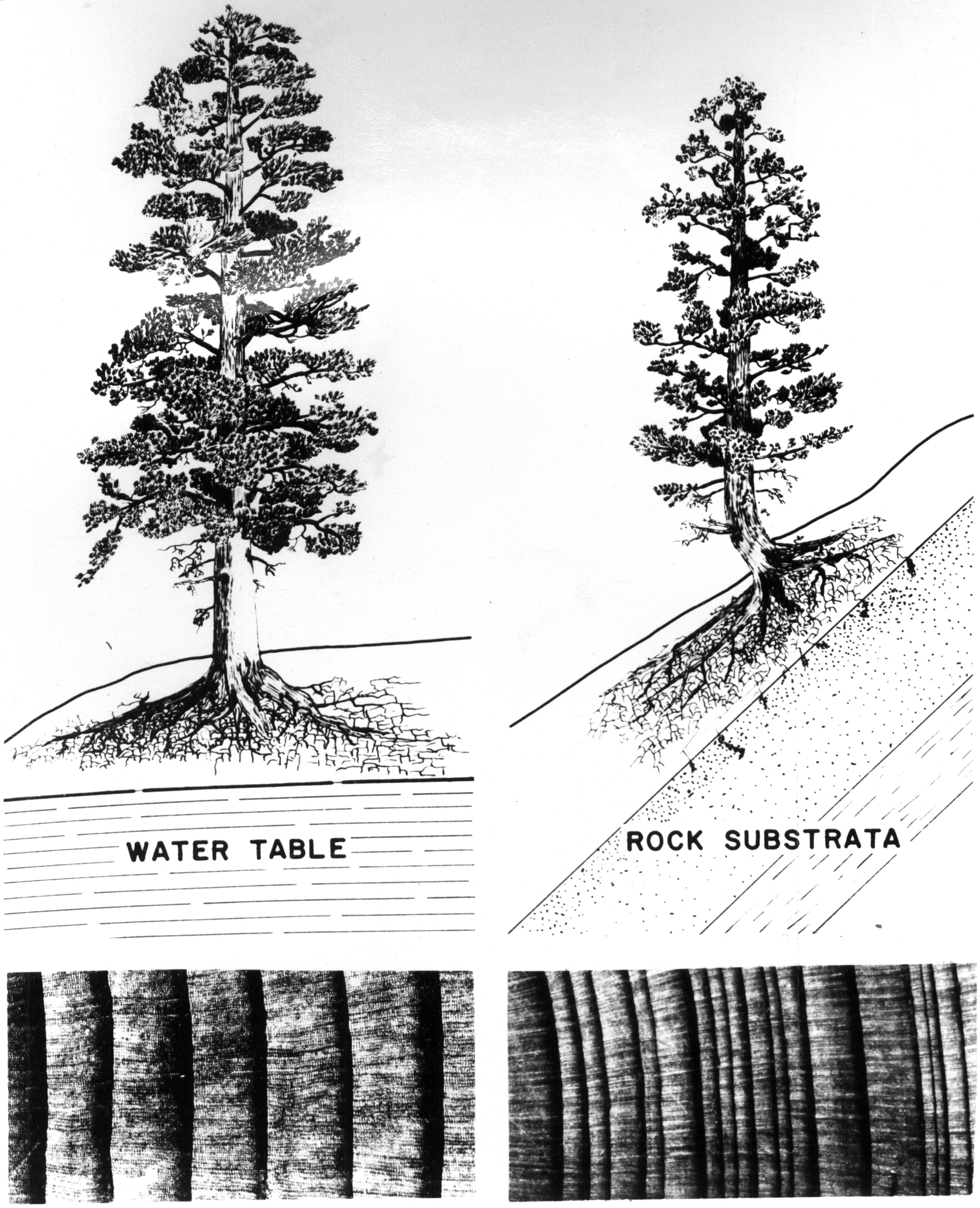
The end of the plot: the last ring has been noted with an arrow or "flag" and it's date assigned "1958". The ring is noted as "Comp" for complete indicating growth for the year was complete when the core was obtained.



A section of a "Master" skeleton plot. Note that the lines are drawn down from the top, the calendar decades are noted at the heavy lines, and the plot is identified as "Alta Peak Foxtail pine" master from California. Master skeleton plots are made by visually averaging the values from many individual core or sample plots.



An example on an index master, it's rendition as a master skeleton plot, and the plot of an individual specimen in it's dated position. Low index values have been noted with correspondingly long lines on the skeleton plot master. Also note that while the match between specimen and the master is good, it is not perfect. This shows the normal variability between radii and among trees at a site. An "index master" plotted from the index values of a tree-ring chronology.

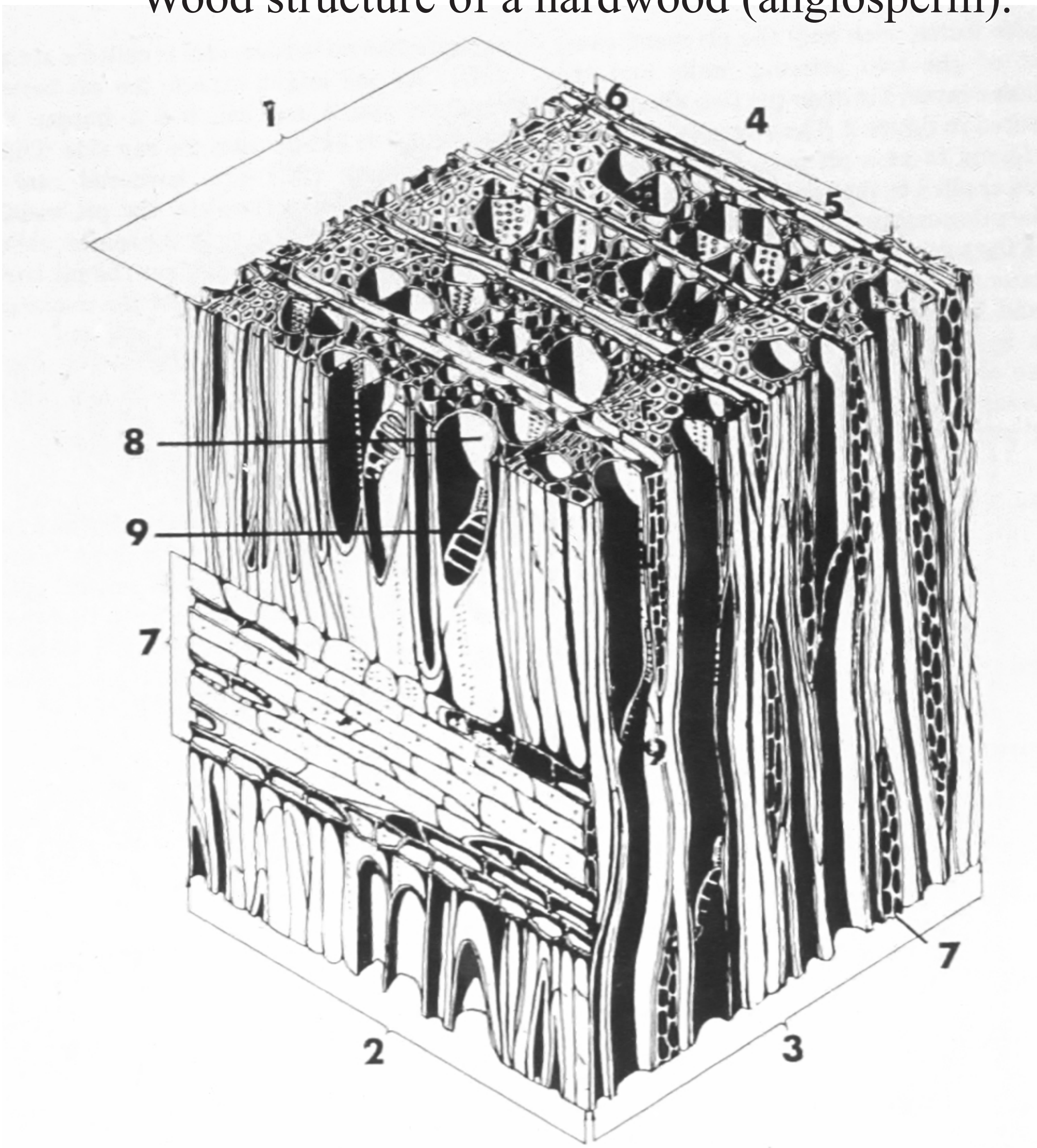


COMPLACENT
RING SERIES

SENSITIVE
RING SERIES

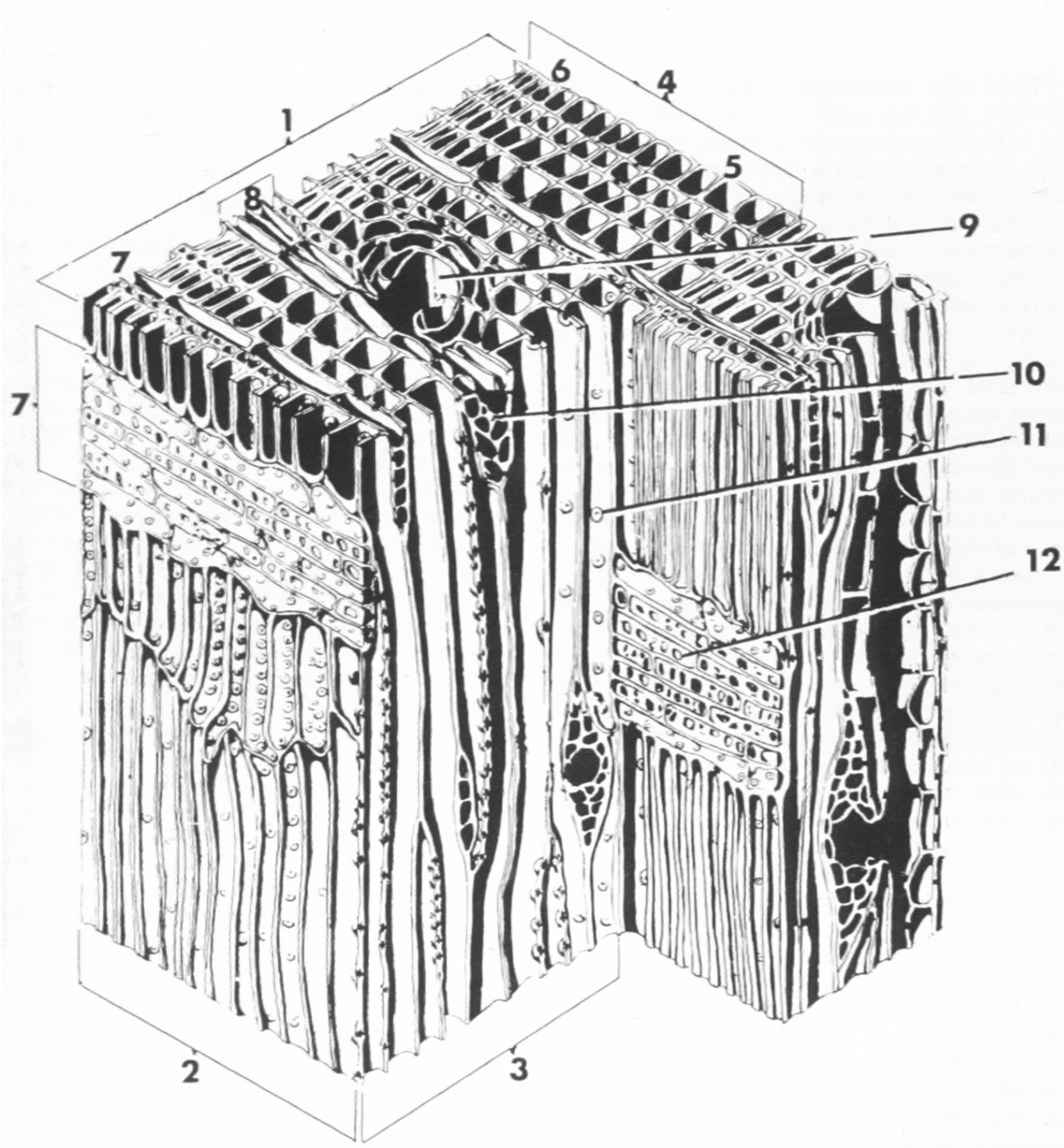
Pinon section with branches showing in crossection. While the branch is alive growth rings are continuous from the trunk to the branch. Rings that are locally absent in the stem sometimes show more clearly where the branch joins the stem. Generally in the trees we study, all branches originate at the pith. In the section pictured here this connection occurs beneath the visible surface.

Wood structure of a hardwood (angiosperm).

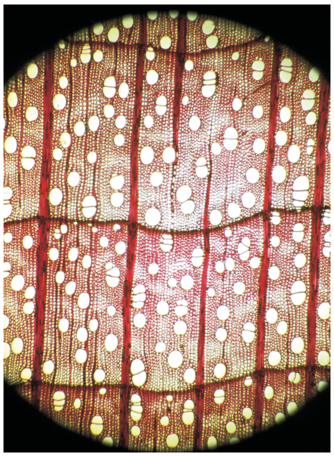


1. Cross-sectional face
2. Radial face
3. Tangential face.
4. Annual ring
5. Earlywood.
6. Latewood
7. Wood ray.
8. Vessel.
9. Perforation plate.

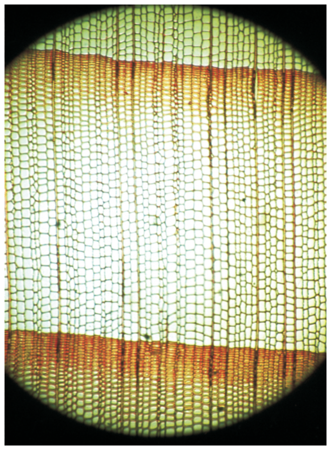
Wood structure of a softwood (conifer).



1. Cross-sectional face
2. Radial face
3. Tangential face.
4. Annual ring
5. Earlywood.
6. Latewood.
7. Wood ray.
8. Fusiform ray.
9. Vertical resin duct.
10. Horizontal resin duct.
11. Bordered pit.
12. Simple pit.

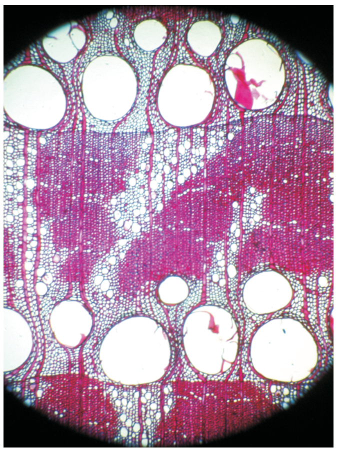


Acer (diffuse porous)

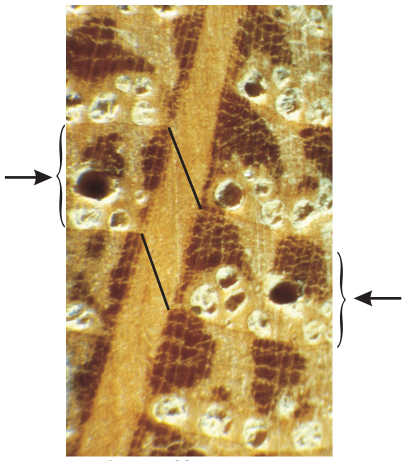


Abies (no resin canals)

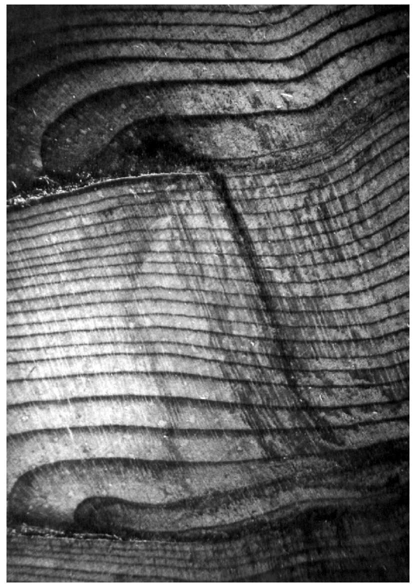
Pinus (resin canals)



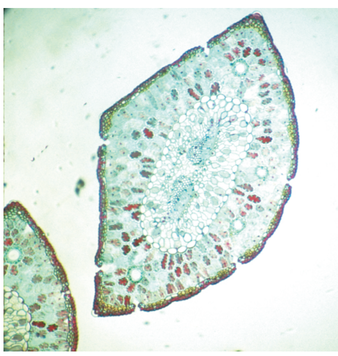
Quercus (ring porous)



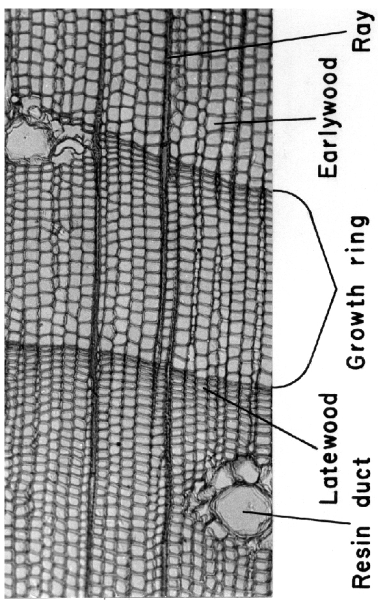
Ring offset across a ray in *Quercus*



Fire scars in Sequoia

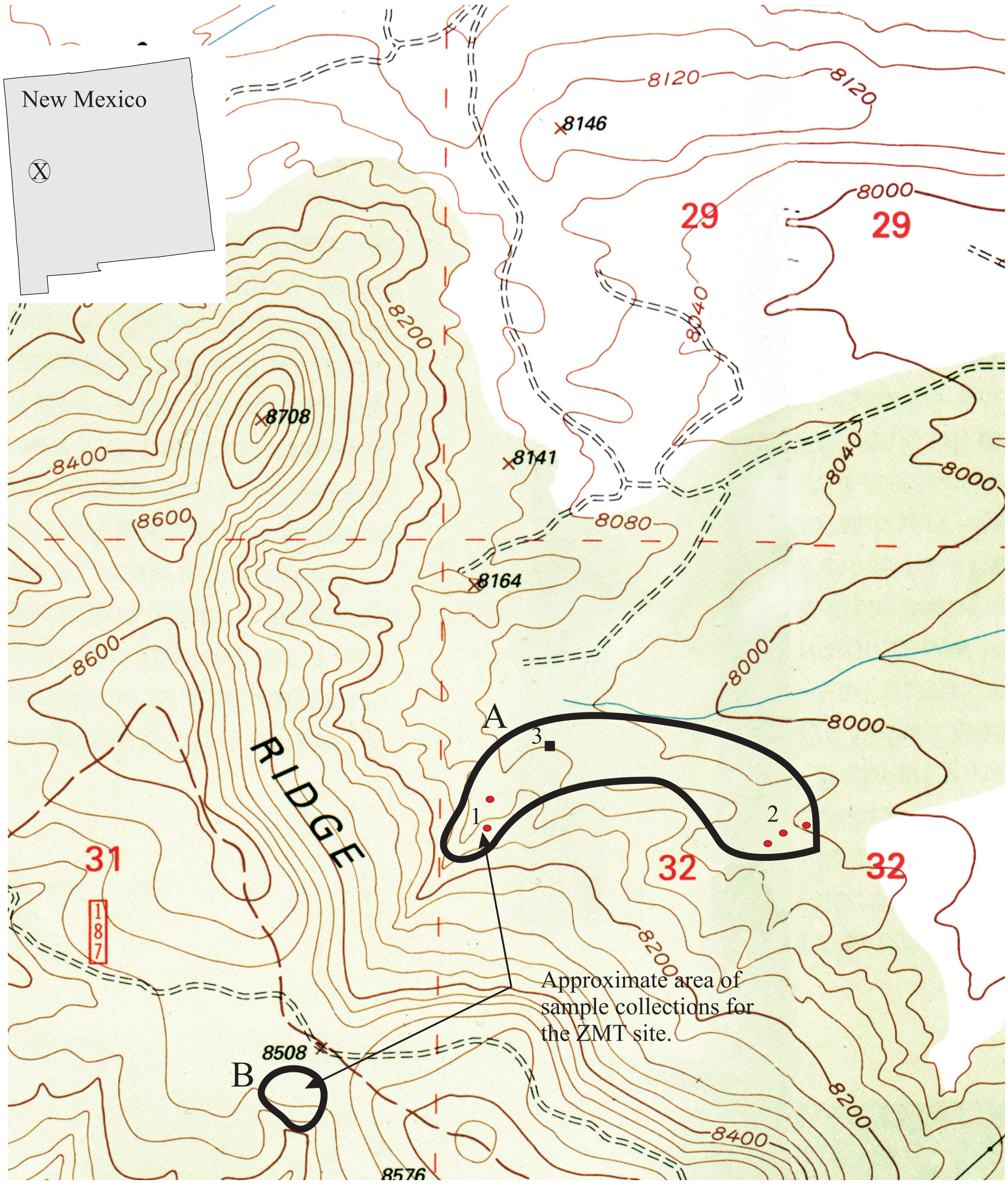


Conifer leaves in cross section.

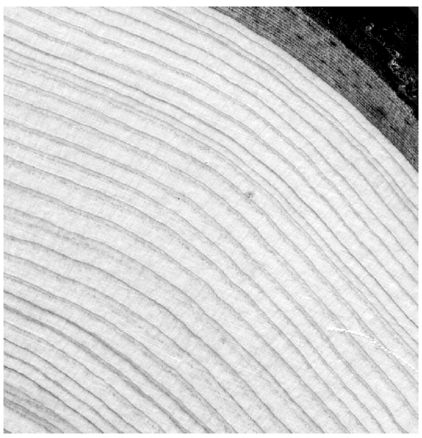


Pinus anatomy

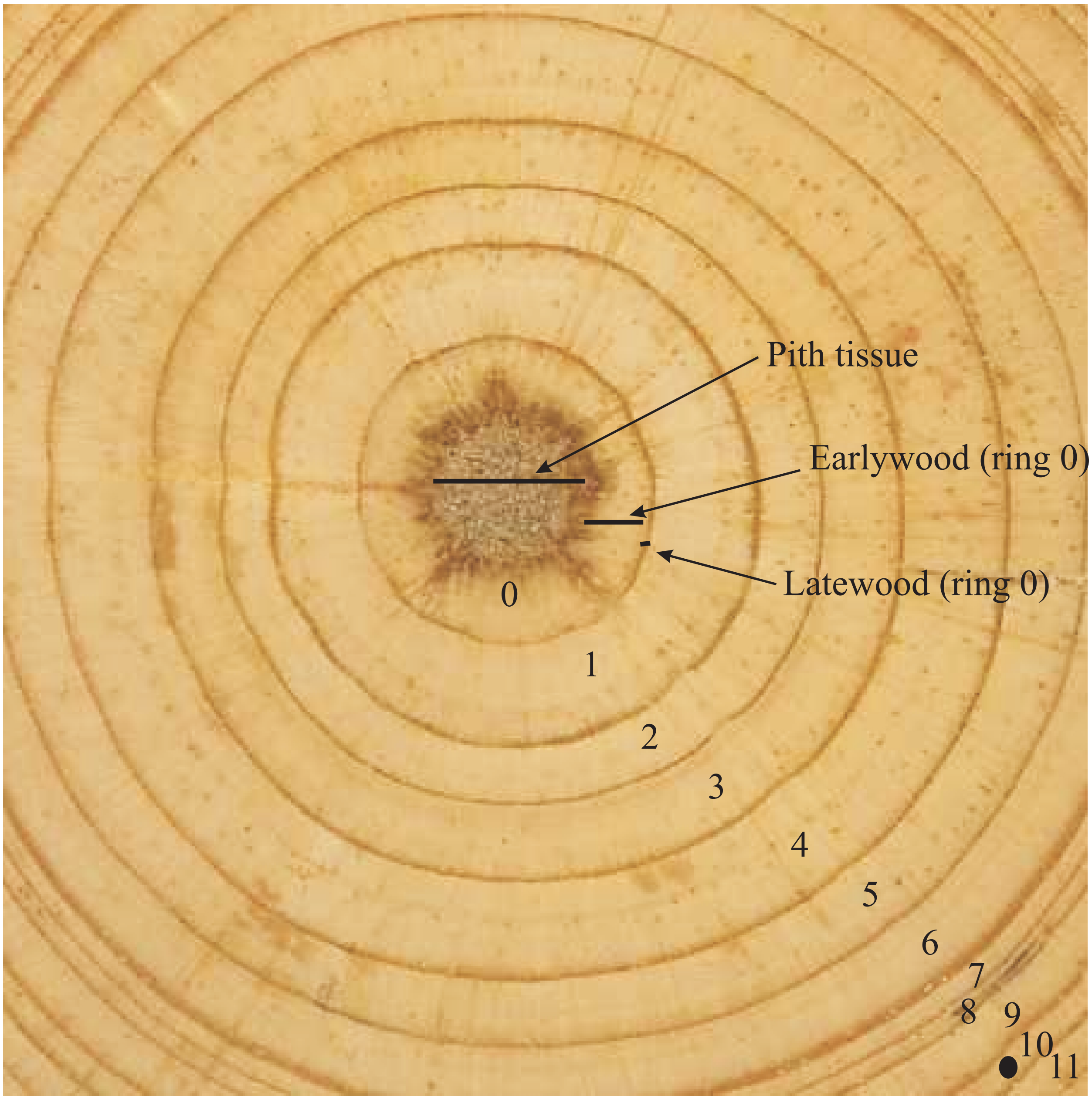
Beetle galeries on pine



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.

	No Resin Canals	Resin Canals
Thick Latewood	**Douglas-fir** 	**Ponderosa pine** 
Thin Latewood	**Juniper** 	**Pinon pine** 

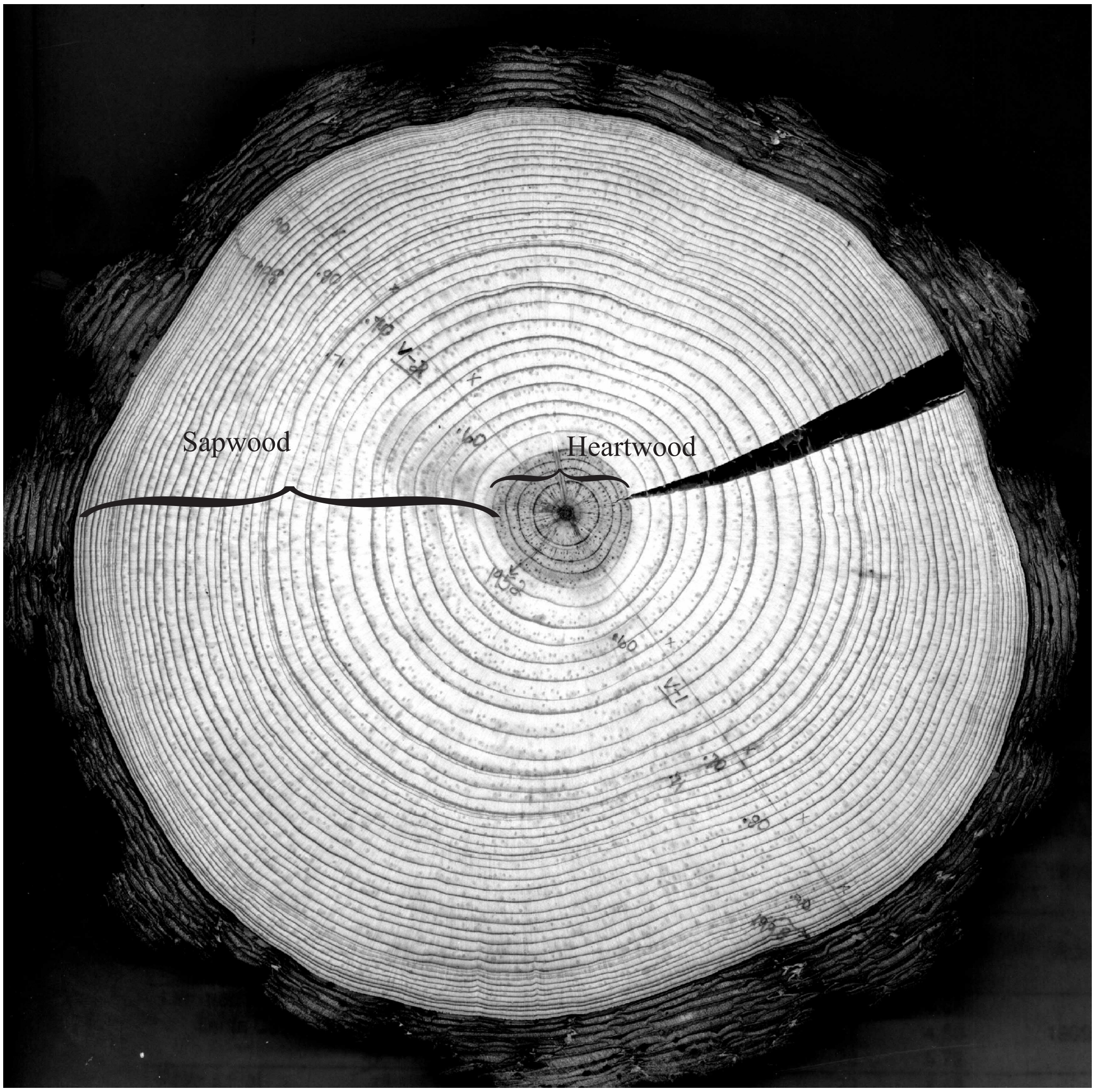
Species identification matrix for common SW archaeological specimens.



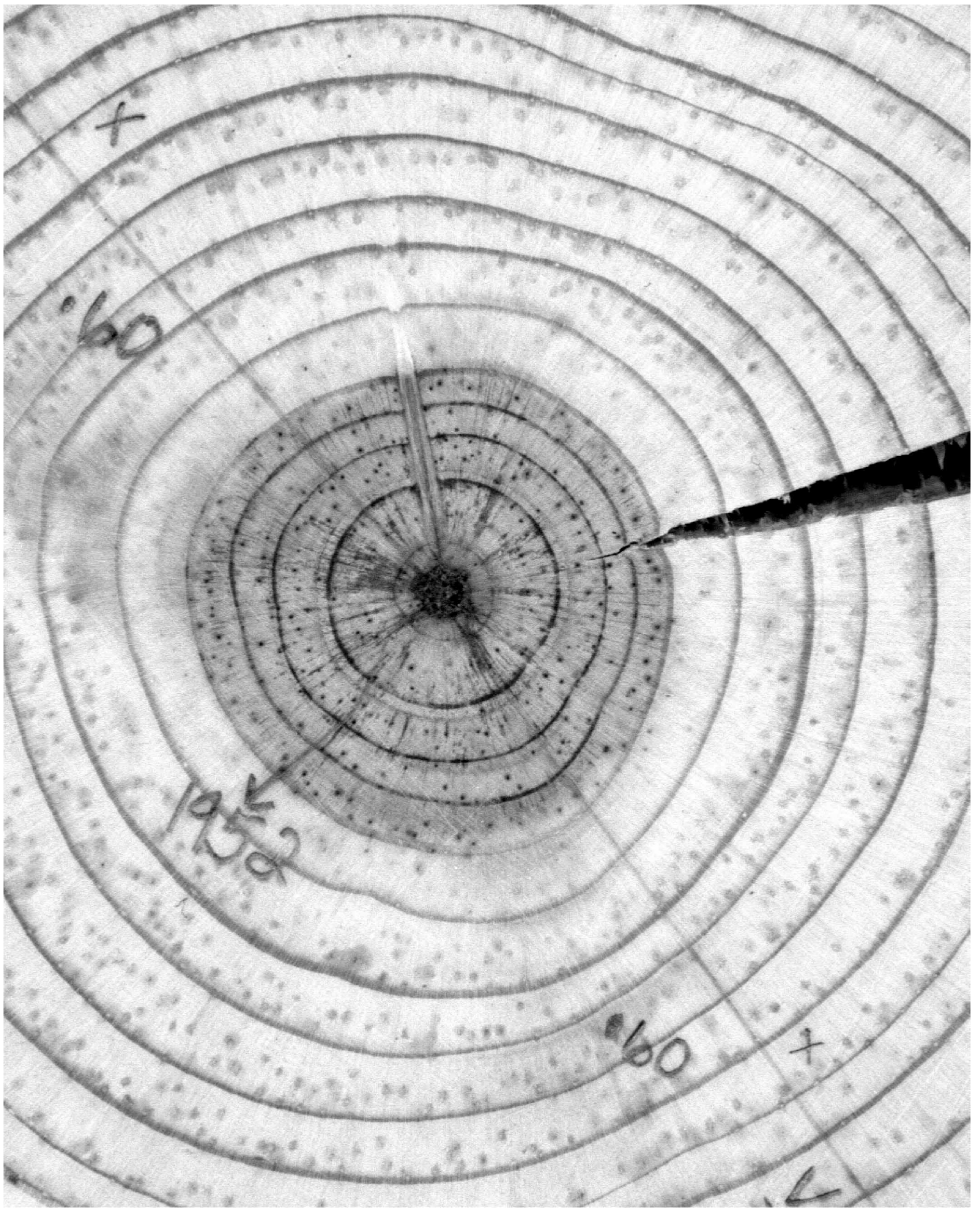
Close-up of the pith area of a ponderosa pine section. Rings are numbered from 0 through 11 with a dot in the 10th ring.

Douglas-fir (*Pseudotsuga menziesii*) section. Two radii are marked with a count for plotting and the calendar dates have been applied with each decade marked. All marks on the sample should be made with a #2 soft lead pencil that can be easily erased and will not damage the wood surface as ink or hard lead might.

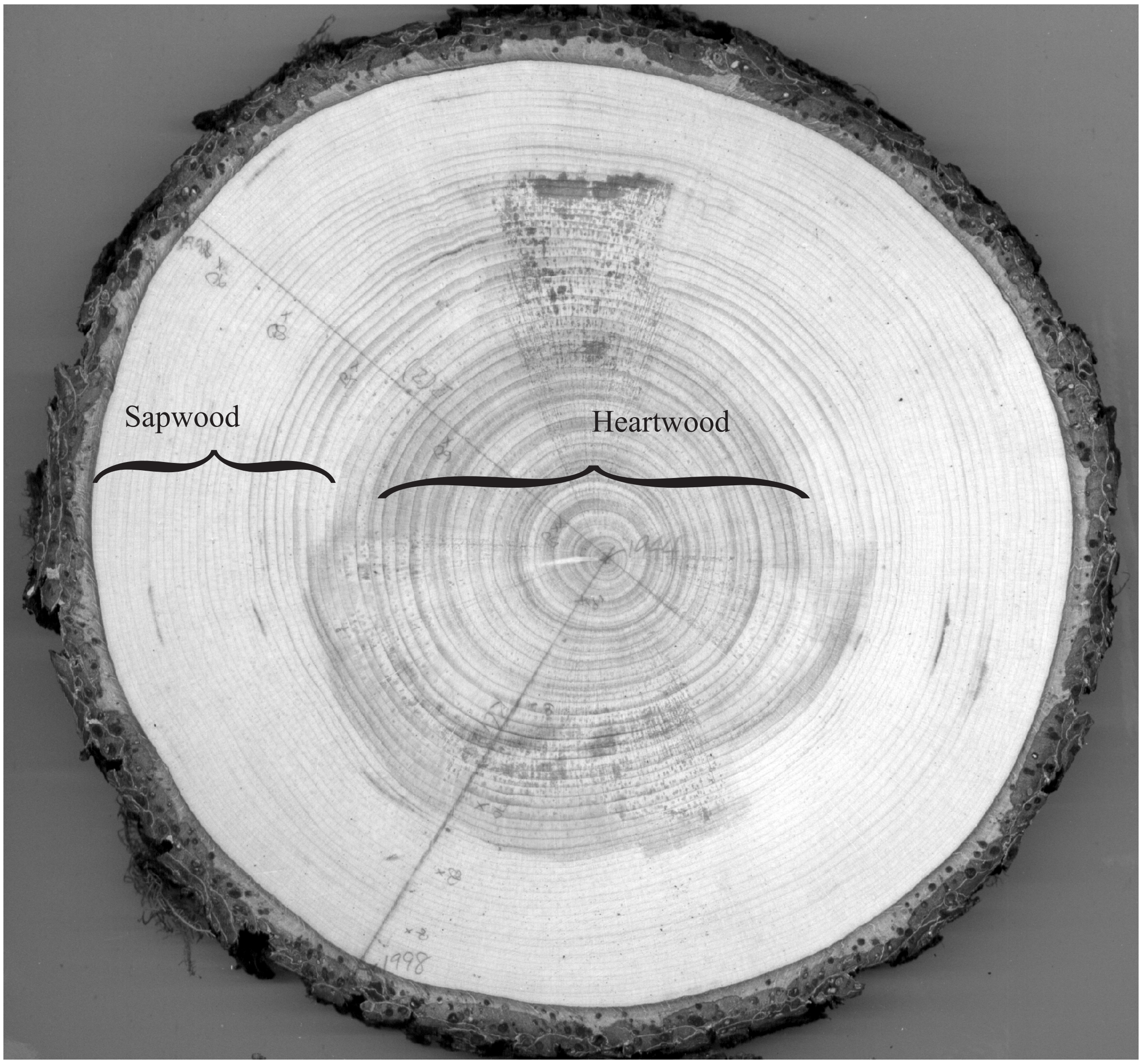
Note the dark latewood and lack of resin canals characteristic of Douglas fir.



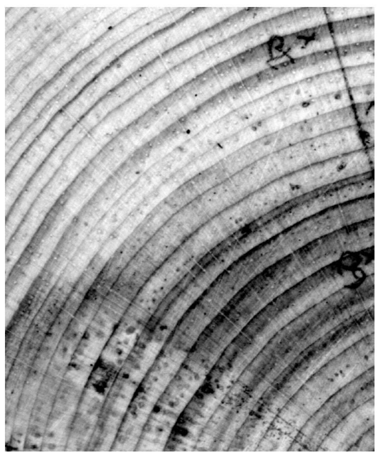
Ponderosa pine (*Pinus ponderosa*) section. Two radii are marked with a count for plotting and the calendar dates have been applied with each decade marked. The heartwood area is much smaller than on the douglas-fir section.

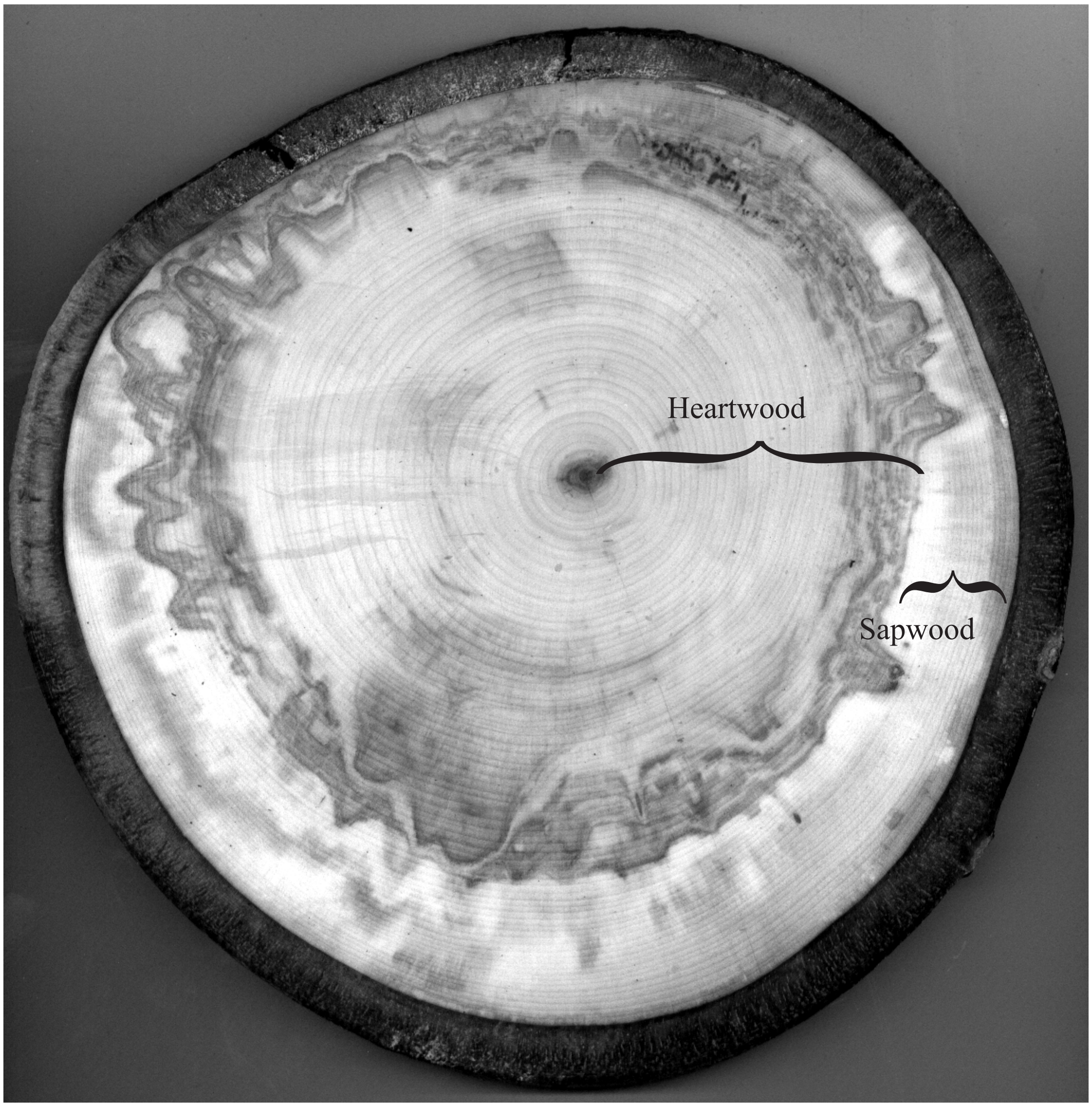


Pith area of the ponderosa pine section. Note the “X”s for the arbitrary 10 count used for plotting and the dot with the calendar decade noted: “60” for 1960. The pith ring includes the dark pith tissue in the center and is noted as “1952”. Note the lighter latewood and abundant resin canals (gray dots) characteristic of the Genus *Pinus.*

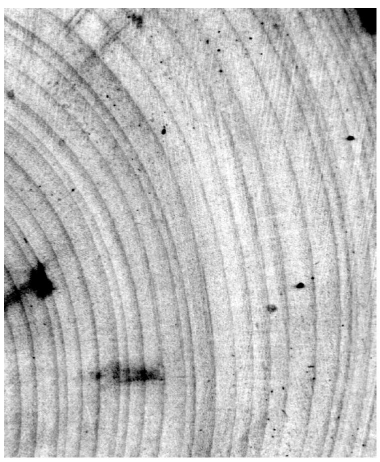


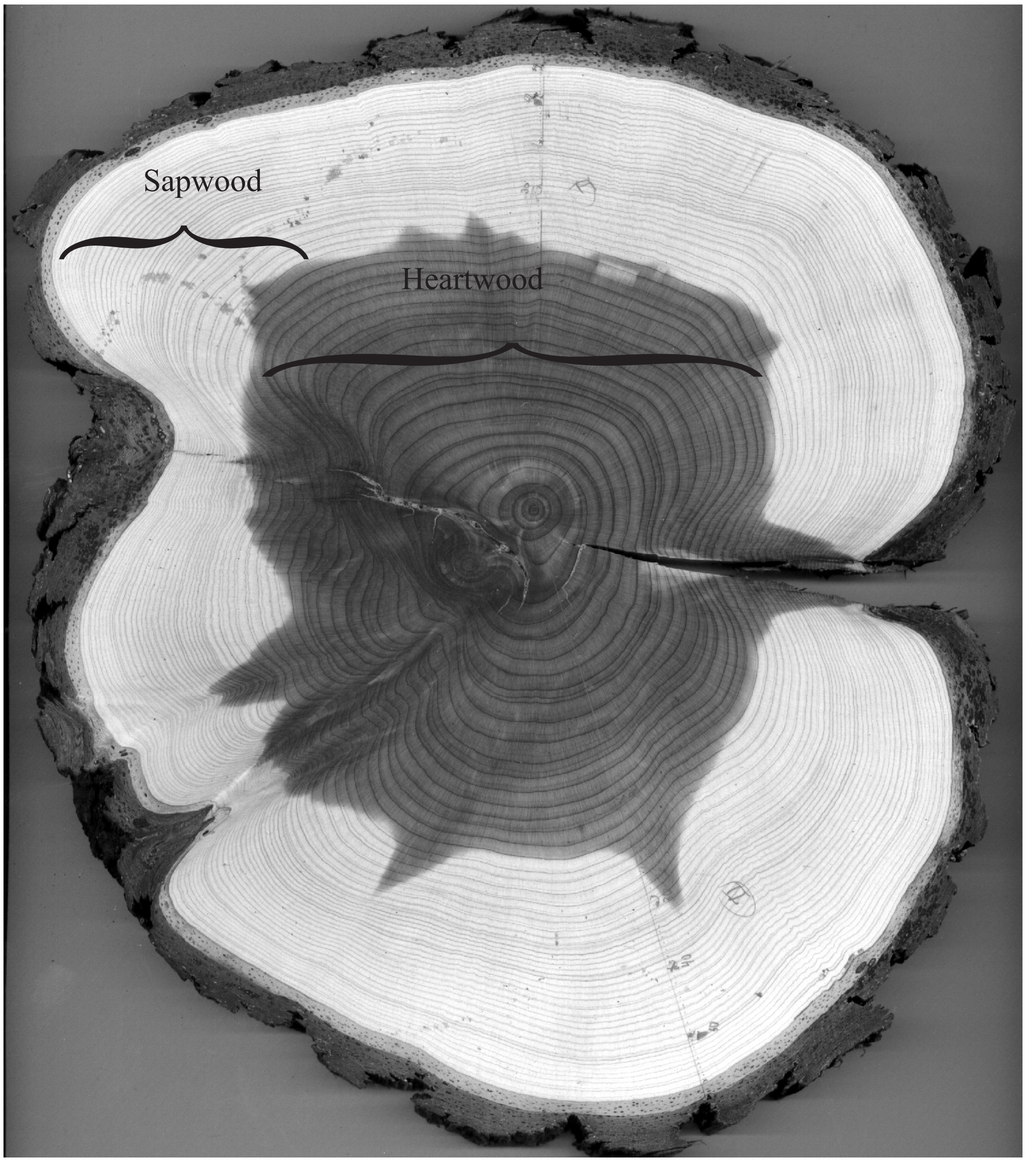
Pinyon pine (*Pinus edulis*) section. Radii plotted at right angles. Latewood is typically thin in these trees.





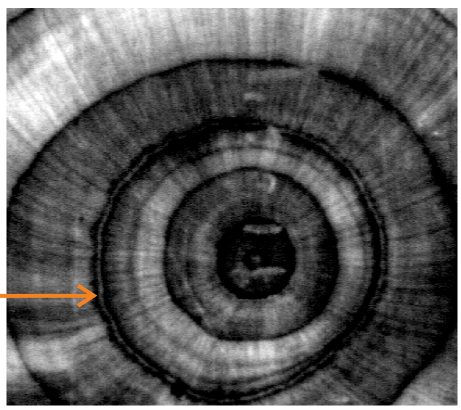
Aspen (*Populus tremuloides*), a diffuse-porous wood.



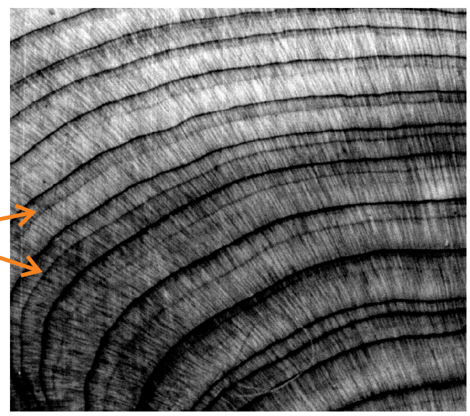


Juniper (*Juniperus scopulorum*). Note the distinctive heartwood. False rings are common in junipers. This may complicate crossdating samples.

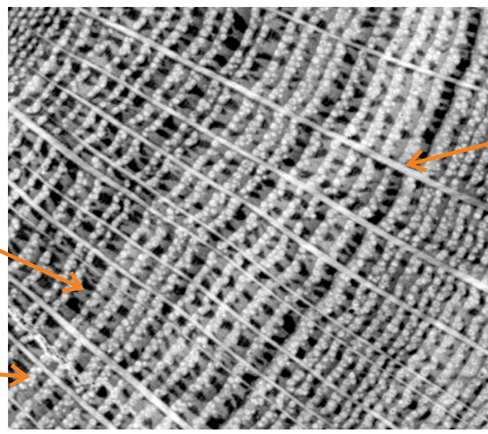
Frost damage



False rings

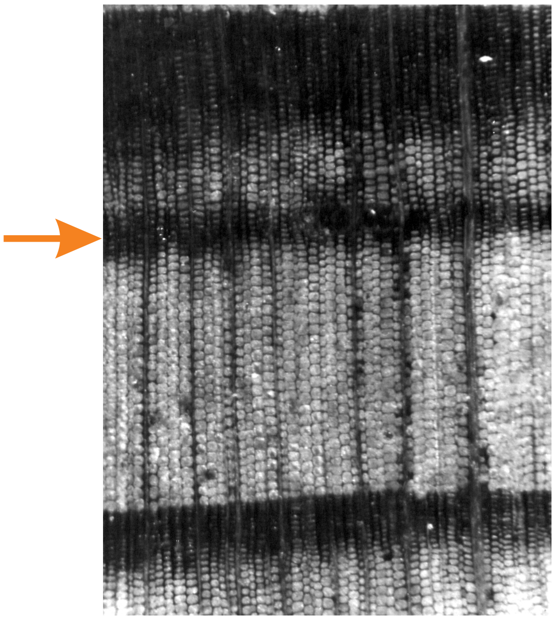


Oak (*Quercus gambelii*), a ring porous wood. Note the narrow sapwood band.

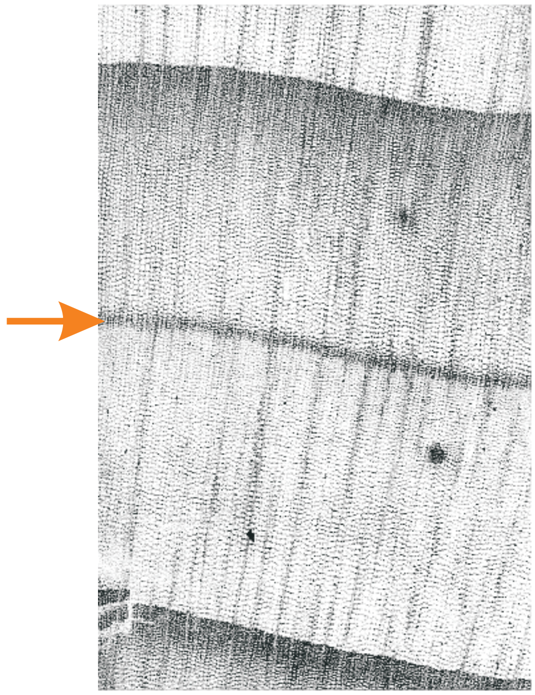


Rings consist of large earlywood vessels and dark latewood cells.

Anatomy of false rings



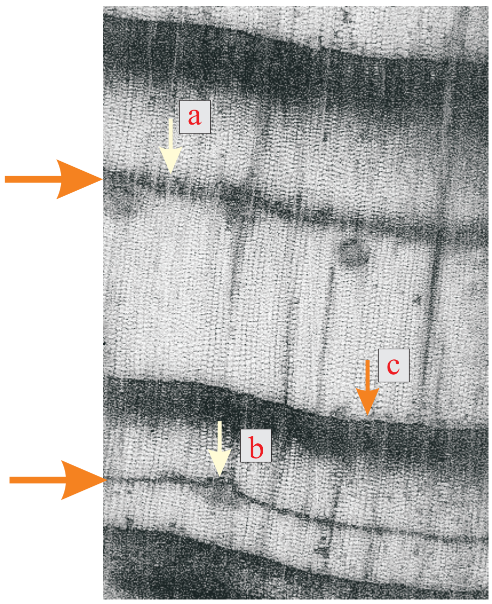
False ring in Douglas-fir



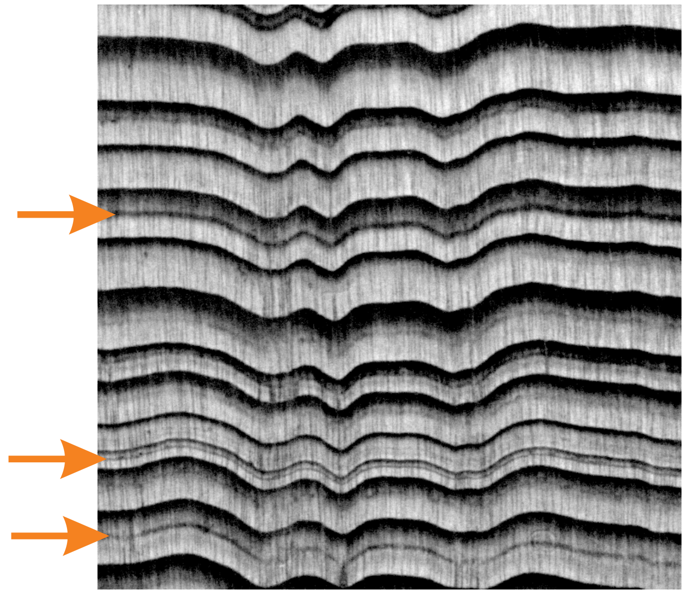
False ring in ponderosa pine

False rings, or false latewood bands, are common in some species and some environments. In sites where conditions during the growing season become limiting and slow growth dramatically a band of small, thick-walled cells may be formed that is anatomically similar to a true ring boundary. Rules of thumb have been developed that make identification of false rings easier. These include diffuse areas where the apparent boundary fades or becomes less distinct and interruption of the boundary by resin canals in pines. True ring boundaries are sharply defined and distinct around the entire circuit of the tree. This is because growth has ceased for the entire organism. False rings represent only a partial cessation of growth that produce boundaries that become diffuse or indistinct or are interrupted.

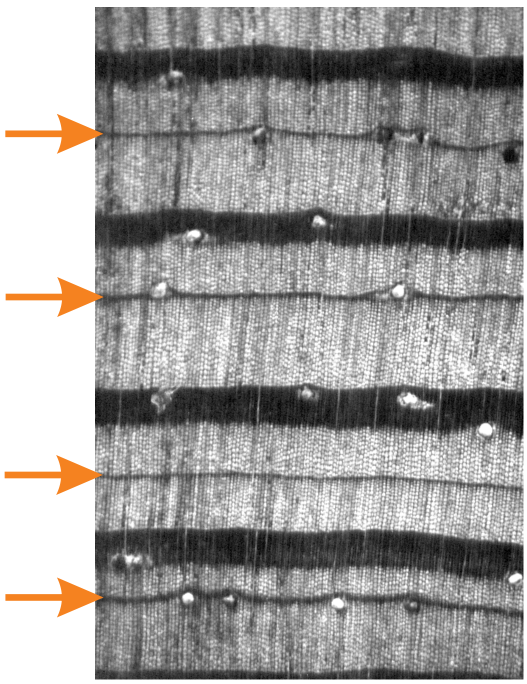
False rings in ponderosa pine



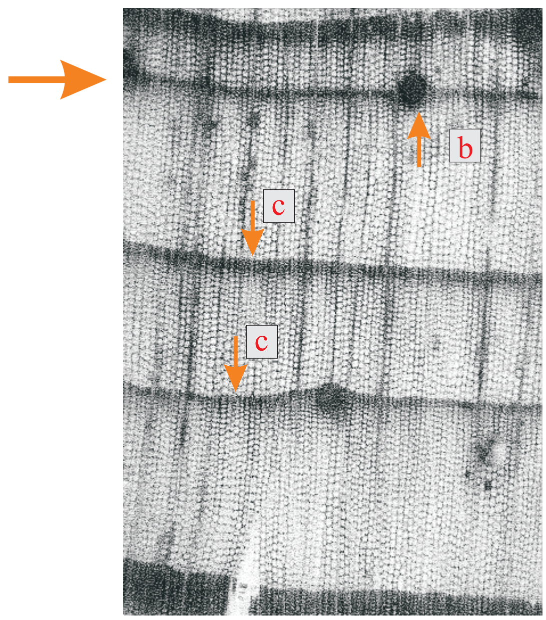
False rings in Douglas-fir



False rings in a Mexican pine

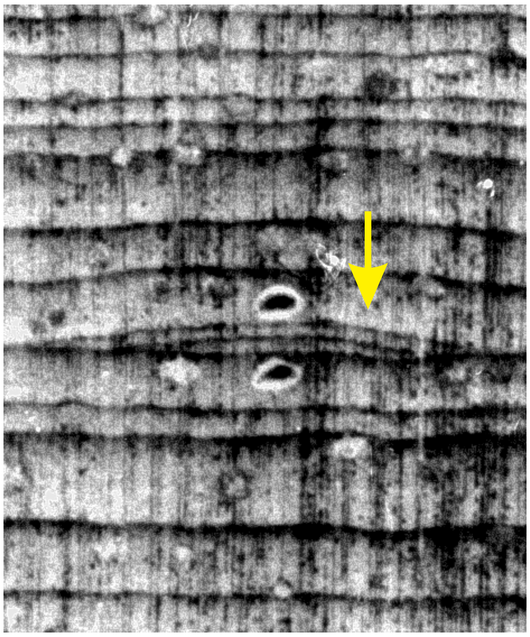


False ring in Apache pine

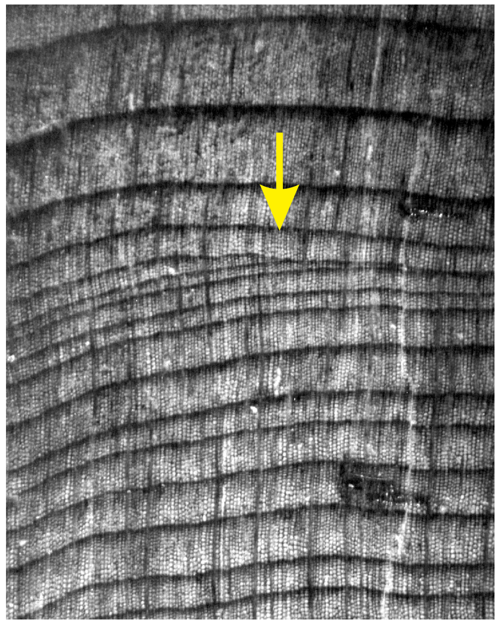


(a) interruption of boundary by diffuse area; (b) interruption of boundary by resin canal; and (c) dense continuous band of true annual ring boundary. The false rings in the Mexican pine are impossible to define anatomically.

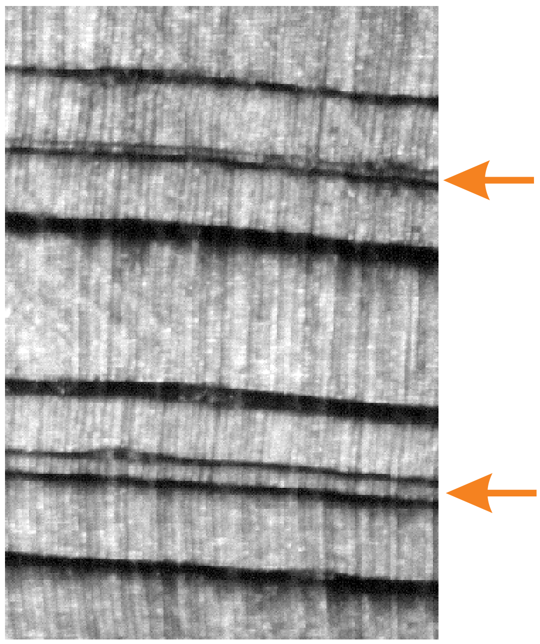
Locally absent rings and micro rings



Locally absent micro rings in bristlecone pine



Wedging rings in juniper



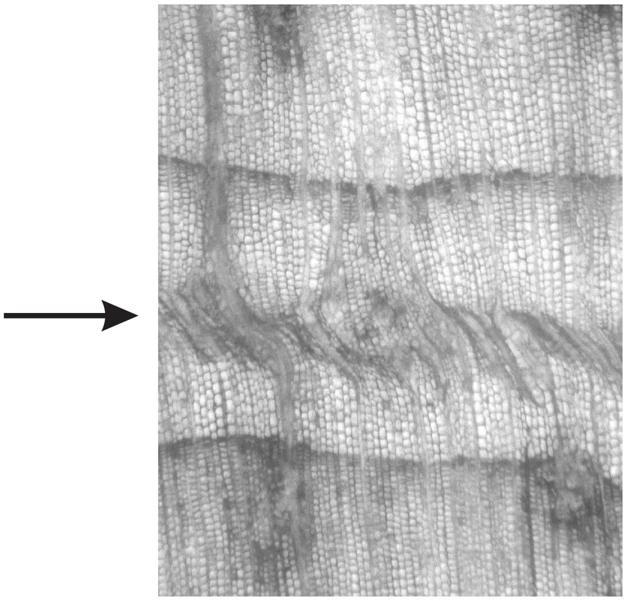
Micro rings in Douglas-fir.

Occasionally growing conditions may be so poor for a tree that it lacks the resources to form a complete ring or the ring formed is only a few cells in width. Such rings are known as locally absent rings or micro rings.

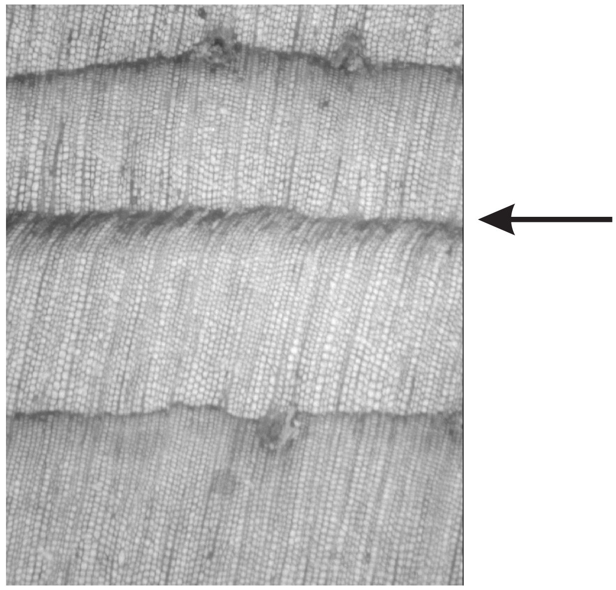
Micro rings have clear, distinct boundaries when observed at high magnification on a finely prepared surface. A poorly sanded surface may obscure detail needed to determine whether a ring is a true annual ring or a false latewood band (false ring). When a decision cannot be made anatomically it must be determined with cross dating, or the ring series is undatable.

Latewood frost rings from Sheep Mountain, Ca.

Latewood frost rings are formed in trees growing at upper treeline near or at their ecological limits when freezing conditions occur late in the growing season. These occur in mature trees and have been associated with outbreaks of cold arctic air following volcanically induced atmospheric cooling.



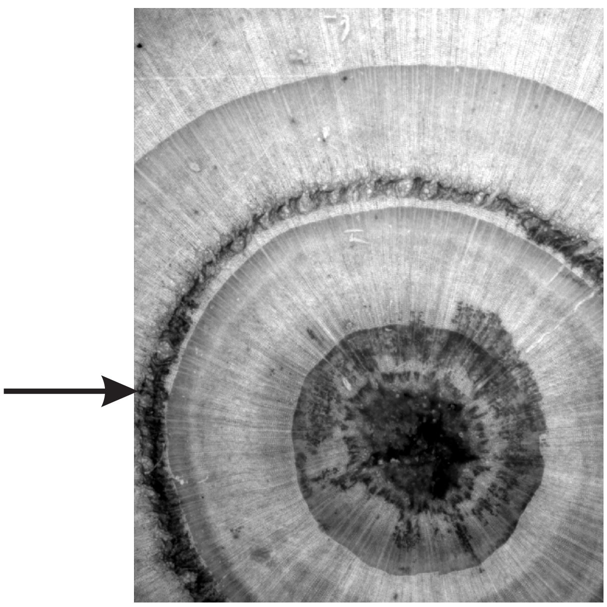
570 bc severe



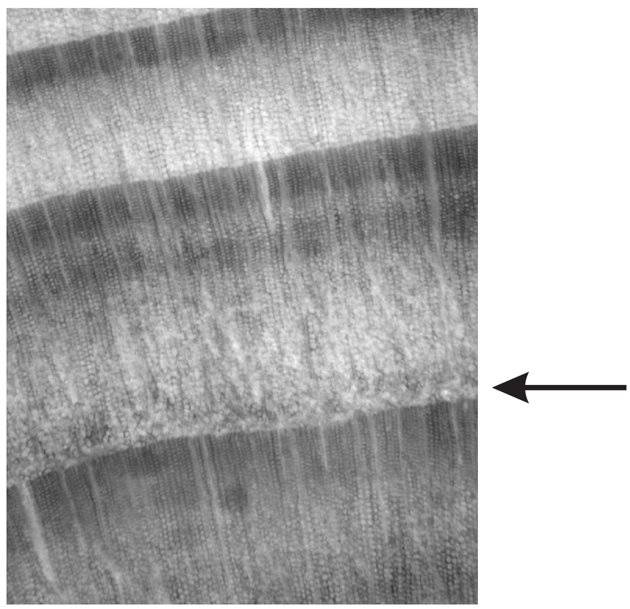
599 bc light

Earlywood frost rings ZMT 08 and 19.

Earlywood frost rings often form in juvenile trees during the spring when freezing temperatures damage the poorly protected tissue. Older trees with thicker bark are not affected.

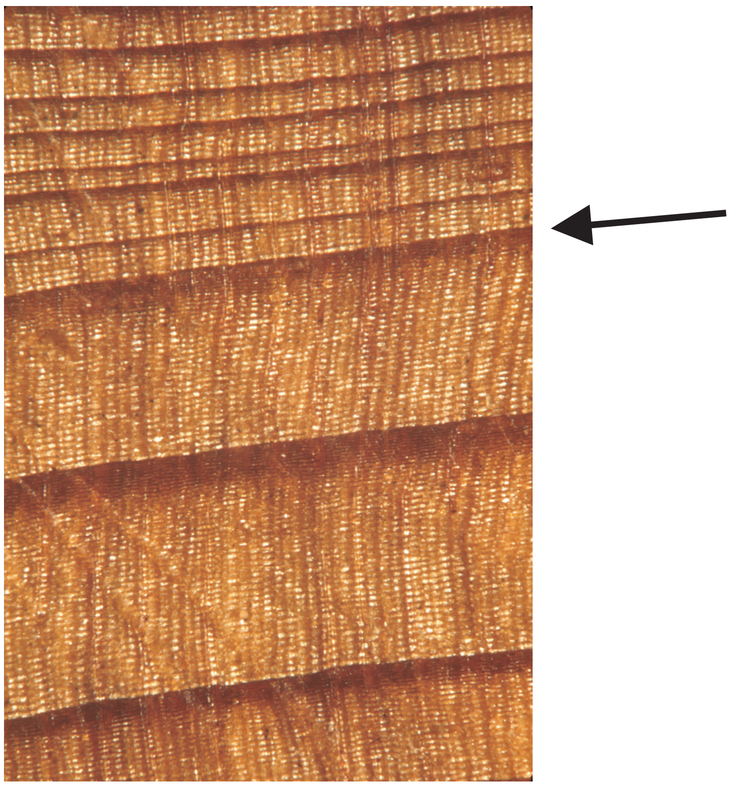


1943 severe

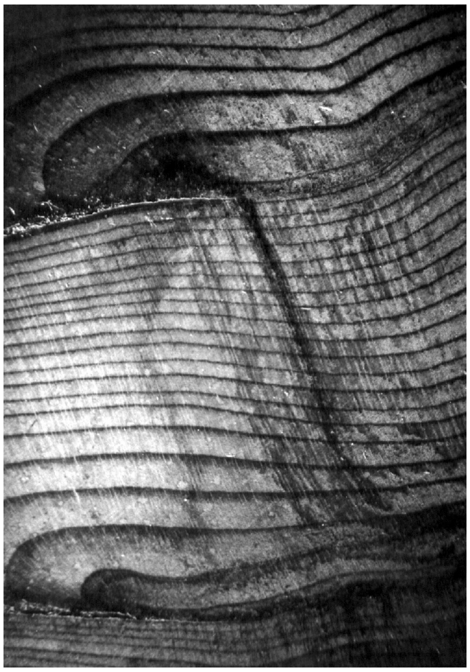


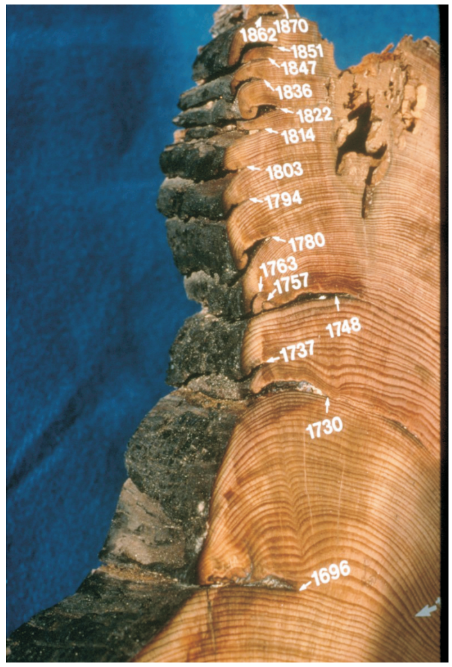
1950 light

Debris-flow damage and embedded rocks.



Growth decline following burial by volcanic ash





Fire scars form at the base of a tree when an area of cambium is killed by heating beneath the bark. The resulting dead area is susecptible to being re-scarred by subsequent fires. Fire scars can be dated the the year and often season in which they were formed.

A "peeled tree" scar created when people striped the bark to remove the inner bark for use.

Scar created by a rock fall. Note the torn fibers indicating the cause of this injury.