

MICROSCOPIC ANATOMY OF THE WOOD OF
THREE SPECIES OF JUNIPERS

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An attempt has been made to seek criteria for separating three American species of junipers on the basis of the microscopic structure of their wood. Peirce (4) has a key to genera of the Cupressaceae. Phillips (5) has described the microscopic wood anatomy of certain members of the genus *Juniperus* and has separated *J. virginiana* L. and *J. lucayana* Britt. from *J. procera* Hochst. (an East African form) on the basis of thin horizontal walls in the ray cells in the last named species (figs. 1, 5). *J. virginiana* L. and *J. lucayana* Britt. both were noted to have nodular thickenings on the vertical end walls of the ray cells (as shown for *J. monosperma* (Engelm.) Sarg., fig. 4), and in this respect are unlike any other species of conifer that he reported except *Libocedrus decurrens* Torr. *J. virginiana* L. is then separated from *L. decurrens* Torr. on the basis of the presence, in the former species, of intercellular spaces at the corners of the tracheids as observed in traverse section (fig. 7). He noted also that the cross-field pits are generally larger and are more regularly arranged in *J. virginiana* L. and *J. lucayana* Britt. than in *Libocedrus*.

Phillips also lists abundant wood parenchyma (relatively abundant for conifers), the presence of nodular thickenings on the transverse walls of parenchyma cells (fig. 6), and the cupressoid cross-field pits (fig. 4, 5, 6, 10) as characters serv-

ing to delimit the three junipers he reported from most other conifer woods. All three species reported by him have the typical "cedar-like" odor of pencils.

The writer has used *J. virginiana* L.; *J. Ashei* Buchh.; young (3-5 year old) twigs of hybrids of *J. virginiana* L. X *J. Ashei* Buchh.; *J. monosperma* (Engelm.) Sarg.; and *J. procera* Hochst. for comparative purposes. Wood samples were prepared in the usual manner (6) and sections were cut 20-30 microns thick. Macerated wood was prepared in Jeffrey's Solution.

Acknowledgment is made to the following people for assistance in providing materials: To Dr. B. Francis Kukachka, U. S. Forest Products Laboratory, Madison, Wisconsin, for *J. virginiana* L., from Linn, Florida; *J. Ashei* Buchh., from Austin, Texas; and *J. monosperma* (Engelm.) Sarg., from Arizona. Dr. Marion T. Hall, Henry Shaw School of Botany, Washington University, St. Louis, provided the hybrid *J. virginiana* L. X *J. Ashei* Buchh. which was collected on MeVey Knob in Ozark County, Missouri, the most eastern known distribution of *J. Ashei* Buchh. Mr. Milton Scott of Miami, Florida, furnished the *J. procera* Hochst., from the U. S. Plant Introduction Garden. The *Metasequoia glyptostroboides* Hu and Cheng wood specimen was collected by Dr. Ralph W. Chaney from the Hupeh Province of China

and presented to Mr. O. A. Oakes of Wilmette, Illinois, from whom the writer procured a sample. It is used to illustrate the taxodioid type of cross-field pitting, as is also the *Podocarpus Comptonii* Buchh. that was collected by Dr. John T. Buchholz on Mt. Mou, New Caledonia (figs. 11, 12).

Local collections provided material for *Pinus sp.* and *Picea polita* (Sieb. and Zucc.) Carr. Figure 8 shows the large window-like pit found in certain of the pines, besides small pits of the pinoid type. Figure 9 shows the piceoid type of cross-field pit.

Table 1 summarizes the data for the species analyzed (1). The tracheid study from early wood disclosed the "very thin" wall character. The size of cross-field pit apertures, on a basis of ten random measurements, showed somewhat smaller sizes, on the average, in *J. Ashei* Buchh. and *J. monosperma* (Engelm.) Sarg. than in *J. virginiana* L. or *J. procera* Hochst. All were of the cupressoid type, although there have been reported occasional ones of the taxodioid type (5) (figs. 11, 12). Small tangential bordered pits were noted in all species though only rarely. Tangential pits are rare in early (spring) wood of conifers (3).

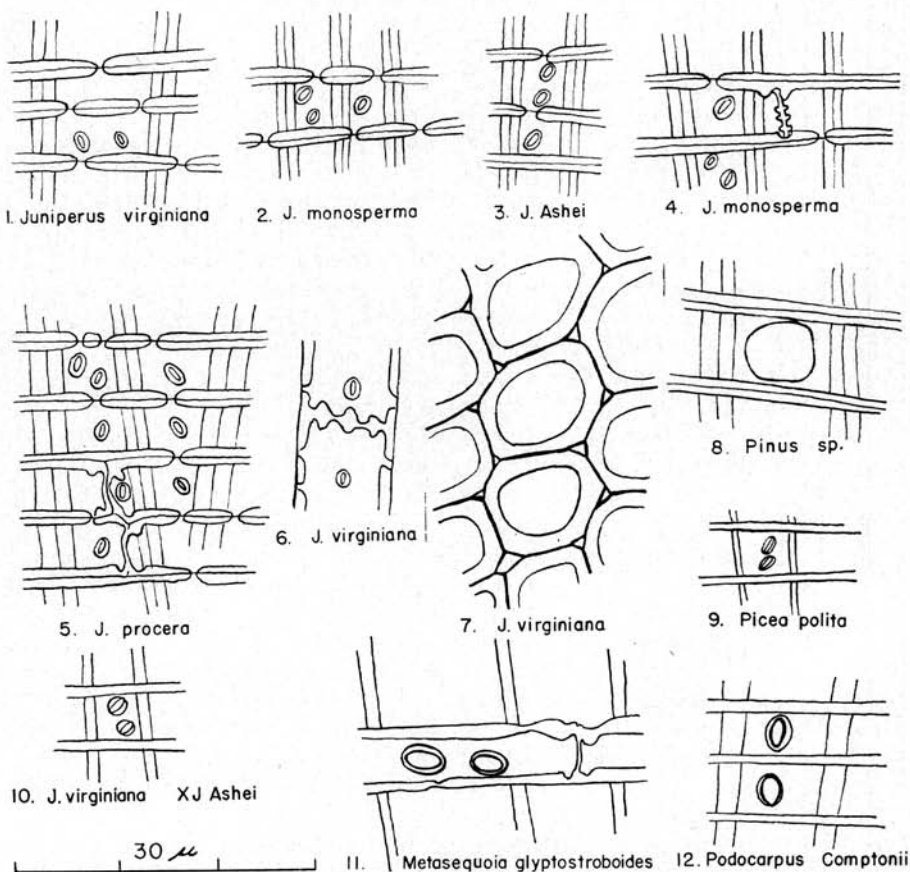
Tracheid length measurements from random counts of macerated wood were made of 100 tracheids for each species. The table gives means with their standard errors and standard deviations with their standard errors. Statistical treatment to measure the significance of the difference between means (2) i.e., the square root of the sum of the squares of the two standard errors of the means, was undertaken to compare the species with one an-

other. This root is the standard error of the difference between the two means. In every case the difference between the means exceeded twice the root and is, therefore, to be regarded as significant. The hybrid was treated similarly and again showed significant difference from the parent types, as well as the other two species. However, the samples were of young wood only, the foliage of which was more like *J. Ashei* Buchh. than *J. virginiana* L. Further work is needed on mature wood. Tracheid length was greatest in *J. virginiana* L., with *J. Ashei* Buchh. and *J. monosperma* (Engelm.) Sarg. in descending order. There was less difference in tracheid length between the last two named species than when compared to *J. virginiana* L. Although *J. virginiana* L. and *J. Ashei* Buchh. hybridize easily, *J. virginiana* L. belongs to the polyspermous complex whereas *J. Ashei* Buchh. and *J. monosperma* (Engelm.) Sarg. both belong to the monospermous complex.

Intercellular spaces between tracheids were present in all species (fig. 7).

Except for *J. procera* Hochst. (fig. 5) the horizontal walls of the ray parenchyma are as thick, or nearly as thick, as the tracheid walls in early wood cross-field views (figs. 1, 2, 3, 4, 6). The end walls are nodular in all species except *J. procera* Hochst. (figs. 4, 5). Primary pit-fields occur in the horizontal walls of all species studied (figs. 1, 2, 3, 4, 5), and indentures are also consistently present (figs. 4, 5).

Xylem parenchyma is more abundant than five cells per square millimeter under magnification of X50 or more and is indicated as "Abundant for Conifers" for all species (5). It is present in all forms re-



FIGURES 1 TO 12

1. From radial section of wood showing cross-field pits of *Juniperus virginiana* L. of cupressoid type; primary pitfields in horizontal walls of ray parenchyma cells.
2. Same for *J. monosperma* (Engelm.) Sarg.
3. Same for *J. Ashei* Buchh.
4. Same for *J. monosperma* (Engelm.) Sarg.; also showing nodular walls of ray parenchyma cells and indentures.
5. From radial section of wood of *J. procera* Hochst. showing smooth end walls of ray parenchyma cells and indentures.
6. From tangential view of wood parenchyma cells of *J. virginiana* L. showing nodules on transverse walls and primary pitfields on vertical walls.
7. From transverse section of early wood of *J. virginiana* L. showing intercellular spaces.
8. From radial section of early wood of *Pinus sp.* to show large window-like or primary pitfield.
9. From radial section of early wood of *Picea polita* (Sieb. and Zucc.) Carr. to show piceoid type of cross-field pits.
10. From radial section of early wood of *J. virginiana* L. X *J. Ashei* Buchh. to show cupressoid type of cross-field pits.
11. From radial section of early wood of *Metasequoia glyptostroboides* Hu and Cheng to show taxodioid type of cross-field pits.
12. From radial section of early wood of *Podocarpus Comptonii* Buchh. to show taxodioid type of cross-field pits.

ported. Primary pit-fields were noted in the vertical walls, and transverse (end) walls were nodular in all species as observed in tangential sections (fig. 6). No consistent zonation was noted although tendencies from sporadic to a type of zonation about midway in early (spring) wood were observed in transverse sections. Many more samples need to be studied, however, before this feature or the variants observed could be safely applied.

Counts were also made of the number of cells in the uniseriate rays as observed in tangential sections. Fifty microscopic field counts at

X440 were made for each species. The most frequent range was five cells in height for *J. virginiana* L., three for *J. procera* Hochst., and two for all the others. The total number of wood ray cells was higher for *J. Ashei* Buchh. and *J. monosperma* (Engelm.) Sarg. than for *J. virginiana* L. The hybrid young wood showed the lowest total number of ray cells.

The data presented in table 1 on tracheid length and on ray height in number of cells would appear to support further the criteria used for specific taxonomic differences among the forms listed.

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