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LIGNIN STAINING . . .

a limited success in identifying koa growth rings

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ABSTRACT: Among the lignin stains tested in trying to identify growth rings in koa *(Acacia koa* Gray*)*, phloroglucinol was the most effective. The light colored sapwood of mature trees stained readily, with growth rings apparent. But staining failed to emphasize rings in the dark colored heartwood. Growth rings were not apparent on samples from young fast growing, sapling size trees. In none of the samples could growth rings be used to estimate tree age or periodic growth.
OXFORD: 176.1 *Acacia koa;* 551:U547.565.3.
RETRIEVAL TERMS: Acacia koa; age determination; ring counts; lignin staining; phloroglucinol.

The traditional technique of counting annual growth rings to determine a tree's age has not been effective for numerous tropical and subtropical tree species.[1] Koa *(Acacia koa* Gray*)* appears to be no exception to this general rule. This species is a member of the thornless, phyllodinous group of the genus Acacia, subfamily Mimosaceae of the Leguminosae.[2]

Data on the growth rates, site index, and maximum age of koa in Hawaii are scanty to nonexistent. Such information is essential for intensive management of koa—now considered to be one of the most valuable native timber species in the Islands.[3] The measurement of annual growth rings could provide a means of collecting growth data. To see if koa growth rings could be identified, I tried several of the common lignin stains and staining techniques on increment cores and stem cross sections.

I found that. . .

- Staining with phloroglucinol amplified growth rings in the light colored wood but not in the dark colored heartwood.

- On some samples, sanding and polishing were enough preparation to make ring counting possible.

- Bleaching showed promise in discoloring the heartwood so that rings could be counted.

- It was impossible to correlate growth rings with annual rings; some samples showed no rings, and others showed variable numbers along different radii.

- Growth rings were in general complete, but enough incomplete rings were found to prevent the use of increment cores as indicators of age or growth.

METHODS

Increment Cores

Increment cores of koa were stained with phloroglucinol by using the techniques described by Patterson.[4] Increment cores were soaked in a 1 percent solution of phloroglucinol in 95 percent ethyl alcohol for 1 minute, placed in a 50 percent solution of hydrochloric acid for an additional minute, and then removed from the acid and washed in water. As the cores dried, the area of lignin concentration was stained red. The naturally light colored sapwood stained readily, with the "early-wood" portion of the growth rings becoming dark reddish purple. Some of the light-colored heartwood also picked up the stain, but the color contrasts were much less apparent. In the normally dark colored heartwood, staining did not emphasize rings.

Stem Cross-Sections

Next, entire stem cross-sections were treated to determine the significance of stained rings. They were collected from small mature trees (10 to 14 inches d.b.h.) and from 4-year-old saplings (2 to 8 inches d.b.h.). The mature samples had a transition from light-colored sapwood to brown to a very dark brown heartwood *(figs. 1,2).* The young samples were nearly all sapwood, with slight darkening near the pith on the larger trees *(figs. 3,4).*

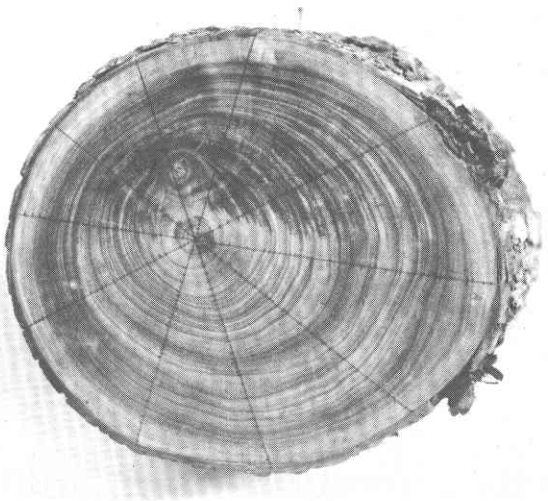

Figure 2—*Cross-section of old-growth koa. The entire 8-inch cross-section was stained with phloroglucinol. The bottom half was then bleached with household bleach after the stain had dried. The number of major rings counted with binocular microscope along the marked radii ranged from 35 to 50.*

It proved more difficult to prepare stem cross-sections for staining than the increment cores. With increment cores it was possible to cut a smooth surface with a razor blade, but not so with stem cross-sections. I tried a hand plane but found it to be

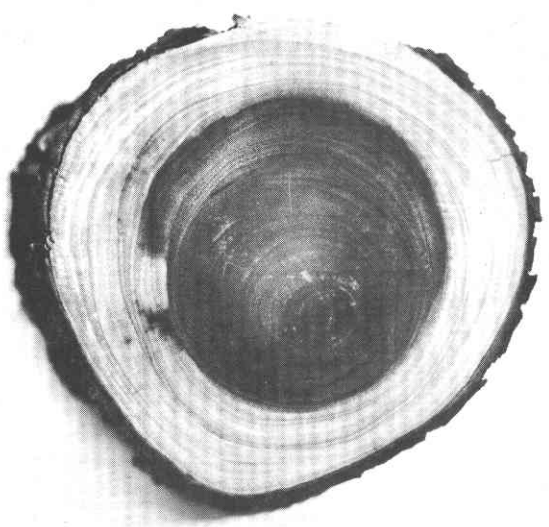

Figure 1—*Cross-section of mature, unstained koa. After this 5-inch cross-section was polished with very fine sandpaper, growth rings could be counted and measured. The ring count varied from 13 to 28 along different radii.*

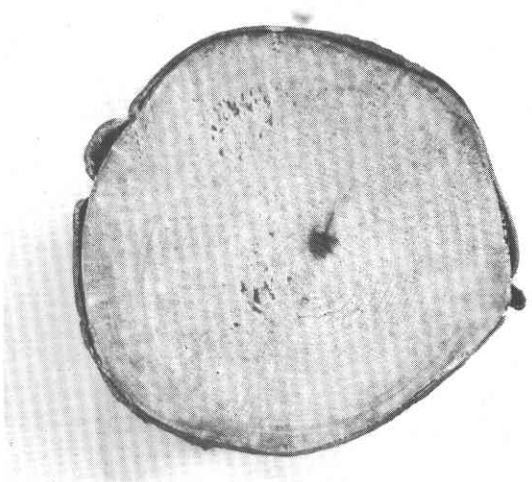

Figure 3—*Four-inch cross-section from 4½-year-old unstained koa. The many light discontinuous growth rings present could not be correlated with "annual rings." Staining immature samples with phloroglucinol tended to turn the surface a dull reddish color.*

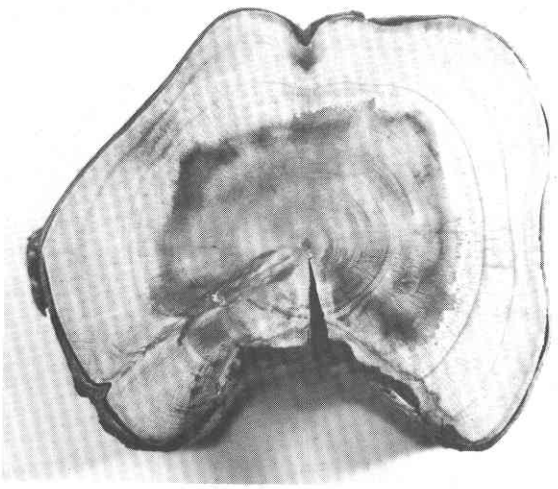

Figure 4—*Seven-inch cross-section from 4½-year-old koa stained with phloroglucinol. Rings are distinct in sapwood, but indistinct in heartwood.*

too slow and too crude. To date, the best method tried has been smoothing with a jointer and sanding with a disc sander. This is slow, but gives a good smooth surface. Care should be taken not to overheat and burn the sample while sanding, because koa burns easily. Besides being difficult to sand out, burned spots obscure growth rings and impede staining. In some samples, sanding and polishing without staining were effective in bringing out growth rings *(fig. 1)*.

The cross-sections from the older trees responded to staining treatments in much the same manner as the increment cores. The light-colored wood stained readily, the darker colored heartwood did not. The cross-sections from the saplings were much softer than the mature samples. And they were much more difficult to prepare for staining. Few indicators of growth rings were noted on several samples *(fig. 3)*. On these, staining did not bring out rings that were not visible before staining. The cross-sections from saplings stained a nearly uniform dull reddish color.

The cross-sections from the mature samples show what appeared to be continuous growth rings. In addition, I noted discontinuous growth rings and indistinct rings that appeared to merge in and out of the major rings *(figs. 1,2)*.

STAIN TECHNIQUES

Phloroglucinol is the most commonly used stain for identifying growth rings[4,5] but several other stains and procedures are available. I tried several with little or no improvement over phloroglucinol, including a technique reported by Harkin.[5] He suggested soaking hardwoods in a 1 percent solution of potassium permanganate with a water wash, followed by a wash in concentrated hydrochloric acid. On koa the stain turned out too dark, with little or no color contrast. To contrast growth rings, Hough[6] suggested soaking hardwoods in a 10 percent solution of ferric chloride. In koa this solution stained the entire stem cross-section a dark color. I also tried tannic acid and concentrated hydrochloric acid, but they showed little effect. Household bleach was used in an attempt to lighten the dark colored heartwood, but it failed to clear up the parts where rings were not apparent or were discontinuous.

Notes

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