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# *Quality Evaluation Of Hawaiian Timber*

FOREST PRODUCTS LABORATORY

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the Pacific Southwest Forest and Range  
Experiment Station, of the U. S. Forest  
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# QUALITY EVALUATION OF HAWAIIAN TIMBER<sup>1</sup>

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## Summary

A brief pilot mill-scale study yielded preliminary information on lumber, log, and timber quality on Eucalyptus robusta, a Hawaiian plantation species. Field data were obtained on visible surface characteristics of logs that might affect the quality of lumber sawn from the logs. Lumber grade yield information was obtained on a sample of logs sawed. Since only 47 logs from 10 trees were sawn, however, the results have value only as an indication of the quality of the potentially merchantable E. robusta timber.

The study produced the following lumber grade yield percentages (National Hardwood Lumber Association lumber rules): Firsts and Seconds, 18 percent; Selects, 8 percent; No. 1 Common, 20 percent; No. 2 Common, 23 percent; No. 3A Common, 15 percent; No. 3 B Common, 16 percent.

## Introduction

Hawaii has an estimated 400 to 450 million board feet of potentially merchantable timber consisting of both native and exotic species. Nearly two-thirds of

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<sup>1</sup>A considerable number of people and several organizations had a part in the formulation and conduct of this study but it is impractical to acknowledge them all individually. However, the author wishes to acknowledge especially the cooperation of Walter P. Holt, Hawaii's State Forester, and L. W. Bryan, Deputy State Forester, for providing the facilities of their Department; for the assistance of Tom Tagawa, Carl Hoffman, L. Golin, technical personnel of the Department; and M. L. Wold, President-Manager of the Hawaiian-Fernwood Ltd., for his assistance and the use of his firm's facilities; and R. E. Nelson Honolulu Research Center Leader, Pacific Southwest Station.

<sup>2</sup>Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

this volume is in forest tree plantations of exotic species, such as Grevillea robusta, Fraxinus uhdei, Toona ciliata, Araucaria excelsa, and several species of Eucalyptus -- principally Eucalyptus robusta. Metrosideros polymorpha and Acacia koa comprise practically all of the volume of native species of any potential commercial importance.

Over 60 percent of the plantation timber consists of various species of eucalyptus, while ohia (M. polymorpha) comprises more than 90 percent of the native species.

The bulk of the timber consists of hardwood species for which the major marketing outlets are expected to be such industries as furniture, millwork (decorative paneling, interior trim, and cabinets), flooring, and veneer. Most of these species are not well known on American markets. Consequently, to promote an effective marketing and utilization program, it is necessary not only to develop information on the physical properties of these species, but also to evaluate the grade quality of the wood in terms of lumber grades used by the American hardwood woodworking industry. Closely related to this is the need to determine for the primary forest products producer, the logger and sawmiller, the possibility of evaluating log and tree quality from the external characteristics of logs or trees in terms analogous to lumber grades.

This report contains the details, data summary, and conclusions of a pilot mill scale quality yield study on the Hawaiian-grown timber species Eucalyptus robusta. It also sets forth recommendations for future studies. Although the data indicate certain trends in lumber grade yields and timber quality, the sample size is so small that the information has but very limited value. The data should not be used in any manner for prediction of grade yields or timber quality. The data are being published to indicate some of the job load that is needed to determine the economic potential of Hawaiian timber. It is believed that this report will serve as a guide for future studies.

### Scope and Objectives of Study

To provide information on specific grade quality, the Pacific Southwest Forest Experiment Station and the California Regional Forester's Office (Region 5) of the U. S. Forest Service began a pilot exploratory mill-scale study on three species, Eucalyptus robusta, Acacia koa, Metrosideros polymorpha, at a sawmill in Hawaii in the spring of 1959.

In the conduct of the study, the recommendations of the U. S. Forest Service National Log Grade Committee were followed. These recommendations



included sketching details on a diagram of each log (on a standard form designed for the purpose) that showed the kind and location of the various surface characteristics on each log and noted the diameter, length, and position of the log in the tree. The recommendations provided for giving the logs a tentative log grade based on Forest Products Laboratory specifications. They also provided for making a study of specific surface characteristics as related to defects on boards and for making a record of the grade and tally of lumber sawed from each log.

The objectives were (1) to estimate tentatively what factory lumber (grade) yields<sup>3</sup> might be expected from each of the eastern hardwood (log) grades, and (2) to determine whether it would be feasible to apply the eastern hardwood log grades for standard lumber<sup>4</sup> to Hawaiian timber (species).

### Field Procedure

A sample of 10 E. robusta trees was subsequently selected for study<sup>5</sup> from representative timber sites from which information was desired. The trees were selected from two plantation areas representing different elevations and different average annual rainfall. One group of four trees was selected from an area of less than 10 acres located at an elevation of about 1,500 feet, where the annual rainfall is about 250 inches. This area is referred to in this report as the Mountain View area. The other group of six trees was taken from an area of about 50 acres situated at an elevation of about 2,000 feet and with an annual rainfall of about 80 inches. This area is referred to as the Hutchinson area. The trees were reported to be about 35 years old.

The selection for quality<sup>6</sup> and size was based on a visual estimate. Judgment of quality and size was between the trees on the individual area being marked.

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<sup>3</sup>National Hardwood Lumber Association. Lumber Grade Rules (Appendix I).

<sup>4</sup>U. S. Forest Products Laboratory Hardwood Log Grades for Standard Lumber Report No. 1737 (Appendix II).

<sup>5</sup>Originally 45 trees were marked for the study, but the peculiar characteristics of the bark of E. robusta and related problems appreciably slowed the work of obtaining the basic information required on each log.

<sup>6</sup>Quality was based on the occurrence of any visible evidence of gross defects, such as limbs, limb scars, height, and general thrift of the tree. Thus, the highest quality tree had a well developed crown, few or no limbs below the crown, and practically no evident limb scars. Medium quality trees had one or two branches below the general crown and a few visible limb scars. Low quality trees had more of a sprawling crown with several limbs below the general crown level and a number of visible limb scars.

These were recorded as high, medium, and low quality, and for size as large, middle, and small diameters. At least one tree was selected for each classification in the two E. robusta areas. As each tree was selected, it was given a number that was used to identify the logs cut from it throughout the study. Logging and diagraming started on the Hutchinson area first.

### Diagraming Phase

Log lengths were marked for each felled tree according to the highest log grade value in line with the Forest Products Laboratory log grades. Top merchantable diameters were taken to approximately 10 inches. Logs were given numbers that incorporated the tree number and the position in the tree; for example, with log No. 21A, the "21" refers to the tree number, and the "A" indicates it is a butt log. A hyphenated number following the letter refers to a forked tree; that is, 21C-1 is the forked twin of the third log of the tree.

The thick, heavily ridged outer bark of E. robusta was found to be soft and spongy (fig. 1). In felling the trees, large patches of bark frequently popped off on the underside of a tree when it hit the ground. Furthermore, when logs were skidded, other large areas of the bark were skinned off. This removed the visual evidence of bark surface indicators of underlying defects, which are the basis for determining log quality, and presented a time-consuming and troublesome problem of diagraming. Consequently, it was necessary to do the diagram work on E. robusta at the stump. The diagram work was further complicated because adjoining trees and brush rubbed and scuffed the bark when the tree was felled, tending to obliterate evidence of the small scars and similar surface indicators of possible interior defects. The bark was so soft that even the loggers scuffed the logs severely in bucking them. Searching for evidence of what appeared to be very small vestigial adventitious branch scars and for tiny holes on the surface of the bark likewise proved to be time consuming. These had not been previously encountered on hardwoods on the mainland, but they appeared to be evidence of very small (less than 1/8 inch) "bird's-eye"-like blemishes in the wood underlying the surface indicators (figs. 2, 4, 6, and 8).

The forest survey crew took environment and site characteristic data on the stand adjacent to the marked trees as well as measurements of height and diameter at breast height for correlation with their forest survey data.<sup>7</sup> The crew also assisted in the log diagraming work. A few E. robusta logs

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<sup>7</sup>

These data are not included in this report.



were sawed into lumber at the beginning of the diagraming work to give the study crew some idea as to the relation of bark surface characteristics to defects and blemishes underlying the indicator.

Some indicators of bark characteristics were photographed, and their position in relation to diagram faces was noted in the diagrams to enable tracing them through the sawing phase (figs. 2 to 9). A total of 55 logs from 11 trees were diagramed although not all of the diagramed logs were sawed. All logs were sawn into 4/4 lumber during the sawing phase.

### Sawing Phase

The sawing phase was complicated somewhat because of the small size of the mill, and the lack of an edger at the mill made it necessary to edge the lumber on the headsaw.

Logs from the Hutchinson areas were the first at the mill, and consequently, were the first logs sawed. During the sawing phase, the lumber from each log was graded and tallied separately. Since a question arose, however, whether some of the bird's-eye-like blemishes occurring on the boards might not be defects (fig. 5), the boards with the most obvious of these were given an alternate grade in which the bird's-eye blemishes were included in the clear face cuttings. In addition, boards that required edging were graded and scaled by eye, because edging on the headsaw was not dependable.

It became evident after sawing the Hutchinson area logs that time would not permit sawing all of the logs diagramed. Consequently, when logs from the Mountain View area were sawed, effort was concentrated first on sawing as many logs from an individual tree as possible, down to at least an 11-inch top diameter, and second on sawing the larger diameter logs first (butt log, second log, and so on). In this way it was believed that a limited comparison of quality might be made between trees from the individual areas.

A total of 47 logs were sawed from 10 trees; 25 logs (6 trees)<sup>8</sup> from the Hutchinson area and 22 logs (4 trees) from the Mountain View area. An additional five logs from the four trees in the Mountain View group were not sawed because of the lack of time. These were the top log of tree No. 25, the next to the top log of the fork of tree No. 21, and three logs from tree No. 26 (only two logs from tree No. 26 were sawed). Tree No. 27 was the only tree in the Mountain View group from which all of the logs were sawed.

No time remained after sawing the E. robusta logs to make an attempt at studying the quality of Metrosideros polymorpha. Nevertheless, three logs

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<sup>8</sup>—One tree was a small diameter, one log tree that had been broken a year earlier in a windstorm.

of the species were sawn to give the survey crew an opportunity to observe the relation of the surface characteristics of the bark to the quality of the wood underlying them.

### Office Procedure

The tally sheets for each log were summarized by grade and scale, and the scale for each grade was reduced by 5 percent to allow for shrinkage in drying. This shrinkage allowance was in accordance with the Forest Products Laboratory's practice to convert green lumber data to a dry lumber volume to determine monetary values for lumber and logs on a commercial dry lumber basis.

Monetary values computed for each log included both the value per log and value per thousand board feet. Values were computed both for the standard National Hardwood Lumber Association lumber grades and for the alternate lumber grade. Similarly, values were computed for each tree by combining the total grade yields and monetary values for all logs in it. These summary data are given in table 2. The value per thousand board feet serves as an index for comparing log or tree quality by visual inspection of the table. It can also serve as a quality index for use in statistical analysis. The values used to compute these data were based on a published market report<sup>9</sup> of June 1959 for 4/4<sup>10</sup> cherry as follows: Firsts and Seconds \$305, Firsts and Seconds One Face<sup>10</sup> \$295, No. 1 Common \$220, No. 2 Common \$130, No. 3A Common \$87<sup>11</sup> and No. 3B Common \$61.<sup>12</sup> Cherry was selected for pricing purposes because E. robusta has color and certain figure characteristics comparable to cherry and possibly will be marketed for similar purposes. A further consideration was that in the future it may be desirable to use the National Hardwood Lumber Association grading rules specifications for cherry to grade this Hawaiian wood.

These data were also separated by log diameters to show frequency of diameters. The data by log diameters were summarized and included in table 1.

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<sup>9</sup>National Hardwood Magazine, June 1959. Quotations listed are average lumber prices F. O. B. Chicago, Ill., for cherry from the Appalachian Mountain region.

<sup>10</sup>Firsts and Seconds One Face is similar to Selects.

<sup>11</sup>Price not given -- computed by taking 2/3 of the price of No. 2 Common.

<sup>12</sup>Price not given -- computed by taking 7/10 of the price of No. 3A Common.



The log diagrams were carefully scanned and a tentative grade based on the specifications in Forest Products Laboratory Report No. 1737 was given each log. It became quite apparent, however, upon applying these specifications that very few logs would meet factory log grade specifications if all defects were considered. Consequently, it was decided that adventitious buds (fig. 4) should not be regarded as a defect. The data by log grades were summarized and are included in table 3.

The data on logs from the two different logging areas (Mountain View and Hutchinson) were separated and summarized by lumber grade yields, average log values, and average lumber value per thousand board feet -- both for the standard lumber grades and the alternate lumber grades. These data are contained in table 4.

### Discussion of Results

The Forest Products Laboratory hardwood factory log grades are based on a correlation of the specifications of the hardwood lumber grades (NHLA grades) to the bark surface characteristics of a log, particularly the specifications for "cutting." Since this report is largely concerned with grade quality standards, it is believed that a brief discussion of some of the basic principles of hardwood lumber grades will be helpful in understanding some of the points covered in the report.

A cutting is the part of a board that theoretically could be sawed from between the defects on the board to make a furniture part or a piece of small dimension. Within a specific grade are limitations as to a minimum size and a maximum number of cuttings. In addition, the cuttings used to establish factory lumber grades are sound and, for the most part, are clear of defects on one face. The number of cuttings for a board is related to a certain fraction of the measurement of a board being graded. Naturally, the high grades require relatively long and wide clear-faced cuttings (clear of defect on one face). Some species have certain exceptions in the grade rules for specific end uses, and special rules cover such exceptions. Thus, although defects may not be the primary factor in determining grades, their position and the distance between them on a board are of primary importance in determining the size of cuttings. The interpretation of what constitutes a defect is also of considerable importance.

This theory of cuttings and defects relationships has been used as one of the basic principles of the hardwood log grades.

When this study began, practically nothing was known about the character of wood blemishes and defects occurring in Hawaiian-grown timber species that might influence the determination of these cuttings.

Defects that are recognized in the hardwood lumber grades include stain, rot and unsound wood, pith, shake, bird peck, wane (bark or lack of wood), bark pockets, holes, and knots. In the standard factory lumber grades the clear face of cuttings excludes all knots -- even bird's-eye blemishes less than 1/8 inch in diameter, if they show evidence of pith. Those that do not show a pith are considered burls or bird's-eye and generally are not considered defects. Conversely, burls and similar grain distortion that show a bark pocket or even a tiny black spot which will not surface out are considered defects and are not permitted on clear faces of cuttings.

The stated grade rules (NHLA) for a given species can and do have exceptions from the standard rules (NHLA) which will allow ignoring certain defects, but these must be agreed upon by the end users.

Cherry is a notable example of this type of exception, which is the reason the price of cherry was chosen for the monetary evaluation of the data.

The alternate grade which was used in grading the lumber during the study (and is included in the summary data) includes these blemishes. More of them, however, may be defects than was realized during the grading. Practically nothing is known as to how the blemishes will behave when seasoned, and too little is known about the real character of the blemishes considered to be burls.

Subsequent to the study, some E. robusta boards from the logs sawn were sent to the Laboratory for a more detailed check on these blemishes after kiln drying. Some of these are shown in figures 10 to 12, which are views of portions of planed, flat-sawn, kiln-dried boards that show a number of the blemishes. Burls shown in the upper right-hand corner of figure 11 were not considered to be defects at the time of the original grading and were admitted in the cuttings for the standard grade.

Figure 12 is a close-up view of two defects, together with a longitudinal section of similar defects developed from another board. It shows how the overgrowth of the branch stub develops, possibly a result of self-pruning, and also the character of the branch stub and the surrounding wood (at the board surface of the longitudinal cut), which are quite similar. It is believed that on green boards, the colors of the stub and normal wood blended so well that some of the more obscure of these possibly were overlooked during the study or were anticipated as not forming a defect. These conditions could have had an effect on the lumber grade yield and indirectly on the relation of surface indicators to log grade.

Another point regarding defects is a condition called brittleheart, which is somewhat analogous to brashness in American hardwoods. It possibly is the



result of compression failures caused by a combination of high winds and fast growth. The hardwood grade rules do not recognize this condition as a defect, although it possibly could be considered unsound wood and thus cannot be admitted in cuttings. Some local opinions state that brittleheart can be identified by the pale pink color of the wood as against a more rose-pink of the normal wood. Although this method may have some merit, it is not believed to be the answer. Examination of some kiln-dried boards taken from the heart section next to the pith of a log shows this color differential. The pale pink area, however, is not brittleheart but appears instead to have the characteristics of tension wood found in American hardwoods. Although tension wood can cause end use problems, it likewise is not recognized as a defect in the hardwood grades. A corrugation-like condition was also noted in some of the quarter-sawn boards that were kiln dried. This condition was attributed to differential shrinkage of interlocked grain. It may, however, have some influence on end use performance.

The splitting that occurred immediately on all logs that were felled or bucked (fig. 13) may also need consideration for further study. Most of the splits extended no more than 12 inches but in a few cases they extended more than 30 inches, and even when sawing lumber the splits continued to develop. Although splits as such are defects only in the Firsts and Seconds grade (Appendix I), they may interfere with obtaining cuttings in the other grades. In this study, however, the splits did not affect the grade or volume recovery because their position did not interfere with the cuttings. Nevertheless, it may be necessary to remove severe splits from boards to maintain their utility for certain end uses, thereby reducing volume recovery.

These are only a few of the wood imperfections that no doubt will influence grading of the lumber. Consequently, additional study is needed to properly identify and evaluate blemishes, grain distortions, and seasoning problems in relation to end use requirements, and subsequently, their effect in lumber grades.

The very brief sawing test of M. polymorpha produced a few boards with evidence of the tiny burl-like blemishes. Close examination of some pieces of Grevillea robusta included in the shipment of E. robusta also revealed several of the tiny knot-like blemishes (fig. 16). This observation indicates that this characteristic may be common to other species on the Islands.

Within certain limits (as has been stated), the concept of the principle of cuttings as used for lumber grades is reflected in the specifications for hardwood log grades. Consequently, to make a good evaluation of the performance of log grades, it becomes necessary first to determine lumber defects and then to search for evidence of them on the bark surfaces and end surfaces of logs. Lack of this information had considerable bearing on the interpretation and evaluation of the performance of the Forest Products Laboratory log grades.

In reviewing the results of this study, it should be understood that the data are based on a very limited sample--47 logs taken from 10 trees of only one species that developed 5,323 board feet of lumber tally.

Table 1 summarizes, by log diameters, the grade yield information obtained on the logs sawed. Grade yields are given for both the standard (NHLA) rules and the alternate grade. The data include all logs regardless of quality. For the purposes of comparison with American hardwoods, grade-yield averages for yellow birch and hard maple are included at the bottom of the table. Data on black cherry are not included because Forest Products Laboratory Report No. 1737 does not include cherry. However, since yellow birch, hard maple, and cherry are each used for many of the same high value end uses for which E. robusta possibly will be used, they are believed logical ones to use for comparison purposes. The averages for yellow birch and hard maple were computed by combining summary data for grades Nos. 1, 2, and 3 logs taken from Forest Products Laboratory Report No. 1737 and obtaining a weighted average. These are not highly accurate averages, but they are believed to be sufficiently close to an average to serve for comparison purposes.

Table 2 lists the individual logs by the numbers given at the time of diagraming. The table summarizes all of the pertinent data obtained on each log. The most important information in this table from the standpoint of log grades is the grade of each log sawed and the value per thousand board feet of the lumber obtained from each log. A further recapitulation of these data, summarized by log grades, is contained in table 3.

From table 3, it can be seen that nearly one-half of the logs fall below the Forest Products Laboratory factory-grade specifications but that the value per thousand board feet of this group is greater than the value per thousand board feet of factory grade No. 3 logs. This high value is greatly influenced by 6 of the 23 logs that contain nearly one-half of the lumber tally of the "below-grade" logs. Further, although the below-grade logs came from 10 trees, only 2 trees (both on the same area) contributed 9 of the 23 below-grade logs, including butt and second logs. A review of the diagrams of these logs revealed a large number of symbols indicating overgrown knots from 1/2 to 1-1/2 inches in size. Thus, some of the bark indicators that give the appearance of overgrown knots simply indicate bark distortions resulting from other causes or that some overgrown knots are deep and have less influence than originally anticipated. On other diagrams there were indications of a large number of tiny branches and holes as well as adventitious buds. It is possible that some of the tiny branches and holes have less influence than anticipated.

If this is the situation with below-grade logs, it might occur similarly on logs in the other log grades. This appears to be borne out further by the spread



of values between the highest and lowest value (table 2) within a given log grade. Grade No. 1 logs range from \$205.76 to \$240.19, a range of about \$35; Grade No. 2 logs range from \$142.84 to \$240.15, a range of about \$97; Grade No. 3 logs range from \$106.96 to \$175.04, a range of about \$68; below-grade logs range from \$66.20 to \$261.86, a range of about \$194. The highest value for grades No. 1 and No. 2 logs is about \$20 below the highest value for the below-grade logs. Actually, however, very little consideration can be given to grade No. 1 logs, because only two logs are in this grade. Undoubtedly, several of the below-grade logs would fall within this grade if the log surface characteristics were better understood. Likewise, the high-value logs in grade No. 2 possibly would fall within grade No. 1. The highest value for grade No. 3 logs is about midway between the highest and lowest value for grade No. 2 logs, a possible further indication that some of the defect indicators shown may not be so serious as anticipated and that some logs may have been grade No. 2. Thus, even though the average values for grades Nos. 1, 2, and 3 indicate a fair segregation of values, the wide range of values within grades and the overlapping of values between grades demonstrates a strong need to isolate the factors or defects which are causing them.

The results in table 4 compare the data from the two different sites. These data appear to indicate that the site with less rainfall at high elevation produces lumber of higher value than the site with greater rainfall at low elevation. This difference possibly would have been more pronounced if all the logs from the trees in the lower elevation had been sawn and the data included. These were for the most part small logs from the upper portions of the tree, and it can be seen that the small diameter logs from the upper sections of the trees produce lumber of relatively low value. On the other hand, it is probably questionable to make such assumptions because the sample was small, the sampling areas were not randomly selected, and the selection of trees was based on personal judgment rather than any proven quality standards. Each of these could contribute a bias that would distort the results.

### Conclusions and Recommendations

#### Objective No. 1 -- Lumber Grades

#### Conclusions

The National Hardwood Lumber Association lumber grade specifications might adequately serve as a quality guide in marketing swamp E. robusta, if and when minor blemishes are evaluated as they affect end use.

The yields of Firsts and Seconds, Selects, and No. 1 Common may be lower than actually recorded because certain burls, blemishes, and "juvenile" branches were not easy to recognize or their degrading characteristics were not known at the time of the study.

For certain decorative and specialty uses, such as paneling, and cabinets, the imperfections noted above might be considered character marks and thereby serve to increase the quality potential of the lumber when marketed for such uses.

Eucalyptus robusta appears to have some of the color and figure characteristics of American black cherry and possibly could be marketed under the same rules. On the other hand, because this is an exotic species (to American markets), it could be placed under American tropical woods with separate specifications.

The occurrence of the burl-like blemishes on the M. polymorpha boards sawn and the similar knot-like blemishes found on G. robusta and E. robusta lumber may indicate that this is common to all species on the Islands and may be associated with climatic conditions.

#### Recommendations

Conduct a series of statistically designed studies on the several Hawaiian species that have commercial potential to determine the wood characteristics influencing grade quality, as recognized by NHLA (for example, bird's-eye, burls, brittleheart, and juvenile branches), and grade yields, as well as the wood characteristics that influence end uses (for example, tension wood, and shrinkage differential).

Consult with the National Hardwood Lumber Association about incorporating Hawaiian-grown hardwood timber species in the NHLA hardwood grade rules (for example, under cherry or tropical wood). Likewise, consult with the U. S. Department of Commerce on the relation of Hawaiian-grown softwoods to the American Lumber Standards as well as to grade promotional nomenclature (for example, "Hawaiian mahogany" or "Roseheart").

Develop and conduct studies to determine the effect that silvicultural management, site characteristics, and the like may have on tree and log characteristics that contribute to quality.



## Objective No. 2 -- Log Grades

### Conclusions

The Forest Products Laboratory hardwood factory log grade specifications, when applied to the E. robusta logs in the study sample, appear to promise a fair performance. The limited number of logs in grade No. 1, coupled with the high values of the below-grade logs and the wide range of values within grades Nos. 2 and 3 logs, however, indicates some shortcomings in the data; for example, the limited size of the sample and the proper correlation of bark surface characteristics with blemishes in the underlying wood which degrade lumber.

Grading E. robusta logs on the basis of bark surface indicators must be done at the specific spot the tree was felled because even slight scuffing or rubbing on the soft, spongy bark tends to obliterate bark surface indicators of possible internal defects.

Some evidence that the quality of the butt log of a tree may be an indication of the quality of the tree was found, but additional knowledge of the degrading influence of bark surface, overgrowths, distortion, and other factors is required to further substantiate such evidence.

Numerous overgrowths, bark distortions, holes, and similar interruptions of the normal bark pattern, particularly on butt logs, that apparently do not indicate a degrading influence in line with their prominence will require further study to determine their relation to defects that may underlie them.

### Recommendations

Develop and conduct a comprehensive defect study on Hawaii's important commercial species to determine the specific influence of various abnormal bark characteristics and other visible surface defects (both end surface and bark surface) on the quality and character of the wood underlying them.

Subsequent to the preceding recommendation, develop and conduct statistically designed studies to adequately test the application of the Forest Products Laboratory Hardwood Log Grades for Standard Lumber to the several Commercial Hawaiian timber species, and to determine the possibility of estimating the relative quality of standing trees based on the application of some features of the FPL log grade rules to a portion of the tree bole. This has special reference to soft-bark species.

Table 1.--Lumber grade yields by log diameters--Eucalyptus robusta (Hawaii)

Diameter inside bark--small end		Basis	Lumber grade yields										Dollar value index	
			Total No. of logs	First and Seconds	Selects	No. 1 Common	No. 2 Common	No. 3A Common	No. 3B Common	feet (lumber tally)		per thousand board		
			Standard: Alternate											
			Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.			
			Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Dollars		
In.	Bd. ft.											Dollars		
8	66	2					29	(29)	41	(41)	30	(30)	91.50	
9	74	2				9	(9)	(38)	53	(53)			115.85	
10	176	3	(4)			11	(11)	(28)	57	(53)	4	(4)	112.54	
11	372	5		5	(5)	6	(9)	(33)	25	(25)	31	(28)	111.04	
12	496	6		1	(1)	24	(29)	22	(17)	(33)	33	(15)	136.81	
13	416	5		13	(15)	11	(11)	29	(37)	25	(21)	17	(11)	148.72
14	327	4		5	(6)	22	(27)	36	(28)	14	(14)	15	(16)	155.05
15	696	5		11	(17)	36	(36)	16	(15)	11	(9)	14	(14)	186.48
16	231	2		40	(40)	16	(16)	15	(15)	8	(8)	12	(12)	217.90
17	823	5		21	(39)	16	(16)	25	(17)	10	(7)	20	(18)	176.66
18	0	0												
19	630	3		26	(32)	29	(25)	18	(16)	4	(4)	15	(15)	202.79
20	135	1		19	(47)	11	(6)	31	(11)	9	(7)	25	(19)	159.76
21	613	3		38	(41)	18	(20)	21	(17)	2	(2)	13	(12)	215.49
22	268	1		42	(68)	19	(10)	7	(7)	2	(2)	3	(3)	261.86
Totals	5,323	47												
Averages			18	(25)	8	(6)	(20)	23	(20)	15	(14)	16	(14)	175.33
Yellow birch <sup>1</sup>			20		5		27	16		5		27		
Hard maple <sup>1</sup>			10		7		27	19		9		28		

<sup>1</sup>Summarized from Forest Products Laboratory Report No. 1737.



Table 2.--Summary of lumber grade yields and values by logs and trees--*Eucalyptus robusta* (Hawaii)

Log No.	Diameter: inside bark--small end	Length: scale (Scribner Decimal C)	Log factory	Estimated: log <sub>1</sub> FPL specifications	Grade yields (lumber tally)								Total lumber tally	Tree <sub>2</sub> area	Tree <sub>3</sub> class	Value (lumber tally)	
					First: and Sec-onds	Se-lects	No. 1: Com-mon	No. 2: Com-mon	No. 3A: Com-mon	No. 3B: Com-mon					Log	Thousand board feet	
	In.	Ft.	Bd. ft.		Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.				Dollars	Dollars	
21 A	21	16	300	1	173	17	54	19	50	313					75.18	240.19	
21 B	19	16	240	2	57	41	75	32	51	256					53.25	208.01	
21 C	19	8	120	BG	13	4	49	42	14	122					22.60	185.27	
21 C-1	12	16	80	3	23	13	38	19	76	74					10.06	135.89	
21 D	14	10	70	2	15	17	25	19	76	76					13.07	171.95	
	Alternate lumber grade				(5)	(10)	(17)	(25)	(19)	(76)					(13.12)	(172.61)	
21 D-1	11	8			(Not sawn)												
21 E	13	10	60	BG	5	8	7	19	29	6	74				10.78	145.73	
21 E-1	8	16	30	3	19	22	41	21	82	41					4.38	106.93	
21 F	11	16	70	3	12	3	36	10	21	82					11.03	134.52	
21 G	11	10	40	BG	3	4	8	21	36	36					3.16	87.69	
	Alternate lumber grade				(7)	(5)	(8)	(16)	(36)	(36)					(3.86)	(107.28)	
Tree total	486	1,010			248	97	231	209	140	149	1,074	MV	L-A		203.51	189.49	
25 A	19	16	240	1	91	6	62	41	9	43	252				51.90	205.96	
	Alternate lumber grade				(131)	(6)	(34)	(29)	(9)	(43)	(252)				(56.38)	(223.73)	
25 B	17	16	180	2	84	15	36	11	51	197					42.51	215.77	
	Alternate lumber grade				(120)	(15)	(11)	(11)	(51)	(197)					(44.44)	(225.59)	
25 C	15	16	140	3	92	34	9	26	161	161					27.03	167.88	
25 D	14	14	100	2	9	17	44	13	17	100					14.28	142.83	
	Alternate lumber grade				(15)	(36)	(19)	(13)	(17)	(100)					(16.98)	(169.83)	
25 E	14	8	60	BG	3	9	22	13	15	62					7.77	125.34	
25 F	13	16	100	BG	35	13	43	91	91	91					8.30	91.25	
	Alternate lumber grade				(69)	(5)	(17)	(91)	(91)	(91)					(10.44)	(114.75)	
25 G	11	12			(Not sawn)												
Tree total	98	820			175	33	216	187	57	195	863	MV	L-G		151.79	175.89	
26 A	12	16	80	3	4	7	17	32	8	68					8.20	120.62	
26 B	11	16			(Not sawn)												
26 C	10	16	60	BG	7	44	7	58	58	58					5.17	89.05	
26 D	8	16			(Not sawn)												
26 E	8	10			(Not sawn)												
Tree total	74				(Not summarized)								MV	M-G			
27 A	17	16	180	3	14	17	16	90	20	34	191				28.32	148.27	
	Alternate lumber grade				(27)	(4)	(16)	(90)	(20)	(34)	(191)				(28.45)	(148.95)	
27 B	16	8	80	3	4	26	4	24	27	85					11.16	131.34	
27 C	13	12	70	3	9	27	25	18	79	79					8.76	110.89	
27 D	12	16	80	BG	18	14	38	42	112	112					11.65	104.00	
27 E	11	16	70	BG	1	24	35	26	86	86					7.97	92.69	
Tree total	68	480			14	21	70	159	142	147	553	MV	L-P		67.86	122.71	
35 A	22	12	250	BG	113	71	51	20	6	7	268				70.18	261.86	
	Alternate lumber grade				(179)	(28)	(28)	(20)	(6)	(7)	(268)				(72.56)	(270.76)	
35 B	21	8	150	BG	42	5	27	32	18	124					25.48	205.51	
35 B-1	15	16	140	3	29	42	29	21	26	147					25.27	171.89	
	Alternate lumber grade				(29)	(42)	(65)	(17)	(10)	(26)	(147)				(27.81)	(189.19)	
35 C	17	12	140	BG	52	6	25	34	11	7	135				28.93	214.33	
	Alternate lumber grade				(62)	(6)	(25)	(24)	(11)	(7)	(135)				(30.68)	(227.29)	
35 C-1	15	14	120	BG	19	34	24	7	23	107					18.22	170.25	
	Alternate lumber grade				(11)	(19)	(23)	(24)	(7)	(23)	(107)				(19.15)	(178.99)	
35 D	16	12	120	BG	30	11	28	15	19	103					22.16	215.13	
Tree total	44	920			226	112	207	154	64	81	884	H	M-P		190.24	215.20	

Table 2.--Summary of lumber grade yields and values by logs and trees--Eucalyptus robusta (Hawaii)--Continued

Log No.	Diameter inside bark--small end	Length: scale (Scribner Decimal C)	Log estimated: factory log <sub>1</sub> grade FPL specifications	Grade yields (lumber tally)								Total lumber tally	Tree <sub>2</sub> area	Tree <sub>3</sub> class	Value (lumber tally)	
				First: and Sec-onds	Se-lects	No. 1: Com-mon	No. 2: Com-mon	No. 3A: Com-mon	No. 3B: Com-mon				Log	Thousand board feet		
	In.	Ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.			Dollars	Dollars		
40 A	15	16	140	2	27	51	37	9	9	8	141			33.86	240.15	
		Alternate lumber grade			(61)	(28)	(26)	(9)	(9)	(8)	(141)			(35.03)	(248.41)	
40 B	13	16	100	2	45	7	19	23	21	.....	115			24.79	215.54	
		Alternate lumber grade			(50)	(8)	(19)	(23)	(15)	.....	(115)			(26.09)	(226.83)	
40 C	12	16	80	3	6	6	31	15	.....	23	81			13.77	170.04	
40 D	10	16	60	BG	.....	.....	12	14	34	.....	60			7.42	123.63	
40 E	9	12	30	BG	.....	.....	7	12	13	.....	32			4.23	132.22	
Tree total		76	410		78	64	106	73	77	31	429	H	M-G	84.07	195.96	
41 A	11	16	70	3	.....	6	8	19	15	31	79			9.20	116.41	
		Alternate lumber grade			.....	(6)	(16)	(19)	(15)	(23)	(79)			(10.47)	(132.51)	
41 B	10	16	60	3	.....	.....	7	29	22	.....	58			7.22	124.55	
		Alternate lumber grade			(7)	.....	(7)	(29)	(15)	.....	(58)			(8.75)	(150.86)	
41 C	9	16	40	BG	.....	.....	.....	16	26	.....	42			4.34	103.38	
41 D	8	14	20	BG	.....	.....	.....	.....	5	20	25			1.66	66.20	
Tree total		62	190		.....	6	15	64	68	51	204	H	S-G	22.42	109.90	
42 A	17	16	180	2	23	26	27	67	29	43	215			34.48	160.38	
		Alternate lumber grade			(109)	(13)	(52)	(15)	(0)	(26)	(215)			(52.06)	(242.12)	
42 B	16	12	120	2	62	10	10	19	.....	27	128			28.18	220.13	
42 C	15	16	140	2	19	15	42	18	31	15	140			25.41	181.51	
42 D	14	12	90	3	16	.....	28	26	.....	19	89			15.58	175.04	
42 E	13	8	50	BG	5	6	10	17	14	5	57			9.23	161.89	
Tree total		64	580		125	57	117	147	74	109	629	H	L-G	112.88	179.46	
44 A	21	8	150	BG	18	26	27	81	13	11	176			31.43	178.59	
		Alternate lumber grade			(37)	(24)	(44)	(53)	(13)	(15)	(176)			(36.37)	(206.65)	
44 B	20	8	140	BG	25	7	15	42	12	34	135			21.57	159.76	
		Alternate lumber grade			(64)	(13)	(8)	(15)	(9)	(26)	(135)			(29.43)	(218.03)	
44 B-1	12	14	70	BG	.....	8	40	22	17	.....	87			15.50	178.15	
		Alternate lumber grade			.....	(8)	(48)	(14)	(17)	.....	(87)			(16.22)	(186.44)	
44 B-2	11	16	70	BG	.....	.....	7	40	25	17	89			9.95	111.82	
Tree total		446	430		43	41	89	185	67	62	487	H	L-P	78.45	161.09	
45 A <sup>5</sup>	12	16	80	BG	.....	5	.....	28	41	.....	74	H	S-P	8.68	117.32	

<sup>1</sup><sub>1</sub> = No. 1 factory grade (FPL Report No. 1737).

2 = No. 2 factory grade (FPL Report No. 1737).

3 = No. 3 factory grade (FPL Report No. 1737).

BG = Below factory log grade specifications in FPL Report No. 1737.

<sup>2</sup>Tree area--M.V. = Mountain View; H = Hutchinson.

### 3-Tree Class

Size: L = large; M = medium; S = small.

Quality: G = high; A = medium; P = low.

440 feet of total for tree No. 21 is the fork stem--merchantable height is 86 feet.

30 feet of total for tree No. 35 is the fork stem--merchantable height is 44 feet.

30 feet of total for tree No. 44 is the fork stem--merchantable height is 38 feet.

<sup>5</sup>-One log tree--broken from windstorm.

Note: Tree total shown for column 2 (Log scale (Scribner Decimal C)) includes only logs sawn.



Table 3.--Lumber grade yields by FPL hardwood factory log grades--Eucalyptus robusta (Hawaii)

Log grade:	Basis	Lumber grade yields												Dollar value index		
		No. of Volume	Firsts and	Selects	No. 1	No. 2	No. 3A	No. 3B	feet (lumber tally)				per thousand board			
		logs (lumber	Seconds		Common	Common	Common	Common								
		tally)		Std.: Alt.									Standard: Alternate			
			Std.: Alt.		Std.: Alt.	Std.: Alt.	Std.: Alt.	Std.: Alt.								
		Bd. ft.	Percent	Percent	Percent	Percent	Percent	Percent					Dollars			
1	2	365	47	(54)	4	(4)	20	(16)	11	(8)	2	(2)	16	(16)	224.92	(232.85)
2	9	1,368	23	(36)	14	(10)	20	(21)	18	(13)	9	(6)	16	(14)	197.24	(215.31)
3	13	1,235	5	(7)	4	(3)	24	(26)	29	(28)	19	(18)	19	(18)	145.73	(150.16)
Sub-grade:	23	2,155	14	(21)	9	(6)	17	(17)	26	(24)	20	(20)	14	(12)	165.37	(176.07)
All logs	47	5,323	18	(25)	8	(6)	20	(20)	23	(20)	15	(14)	16	(15)	175.33	(186.17)

Table 4.--Summary of grade yields and values by logging  
area--Eucalyptus robusta (Hawaii)

	Area			
	Mountain View		Hutchinson	
	Standard:	Alternate:	Standard:	Alternate:
	grade	grade	grade	grade
Number of logs.....	22	:	25	:
Number of trees.....	4	:	6	:
Volume	:	:	:	:
Log scale (Scribner Decimal C)....bd. ft.:	2,450	:	2,610	:
Lumber tally.....bd. ft.:	2,616	:	2,707	:
Grade yields	:	:	:	:
Firsts and Seconds	:	:	:	:
Bd. ft.....	437	:	512	:
Percent.....	17	:	19	:
Selects	:	:	:	:
Bd. ft.....	155	:	285	:
Percent.....	6	:	11	:
No. 1 Common	:	:	:	:
Bd. ft.....	524	:	534	:
Percent.....	20	:	20	:
No. 2 Common	:	:	:	:
Bd. ft.....	579	:	651	:
Percent.....	22	:	24	:
No. 3A Common	:	:	:	:
Bd. ft.....	415	:	391	:
Percent.....	16	:	14	:
No. 3B Common	:	:	:	:
Bd. ft.....	506	:	334	:
Percent.....	19	:	12	:
Average value per log.....Dollars:	19.84	:	19.87	:
Average lumber value per thousand board	:	:	:	:
feet.....Dollars:	166.87	:	183.50	:





Figure 1. -- The heavily ridged, soft spongy bark of E. robusta is easily crushed by hand.

ZM 117 455

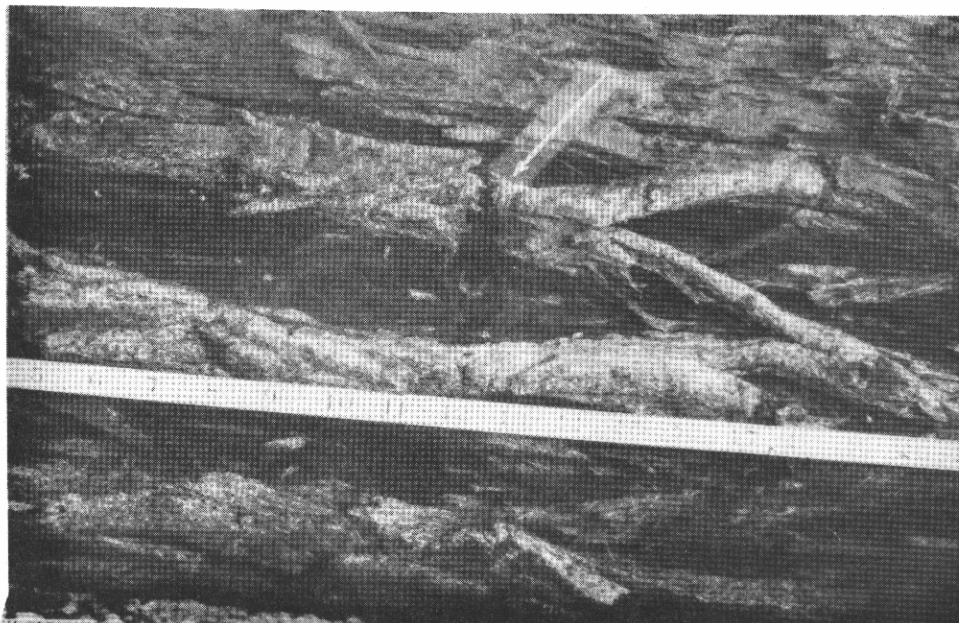


Figure 2. --Bark surface indicators of underlying "bird's-eye" like blemishes on E. robusta logs. Tiny spot in center (above 12 on tape) and at right edge appear to be adventitious buds.

ZM 117 445

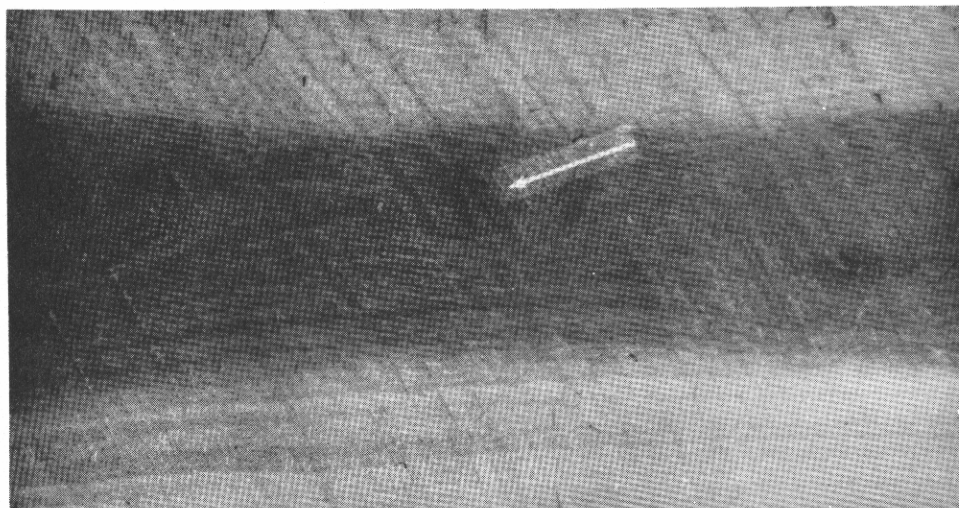


Figure 3. --"Bird's-eye" blemishes underlying bark-surface indicators shown in figure 2 at depth of about 3 inches. The blemishes in center and at right are the ones indicated, the blemish at left of center apparently is not visible on bark surface.

ZM 117 439

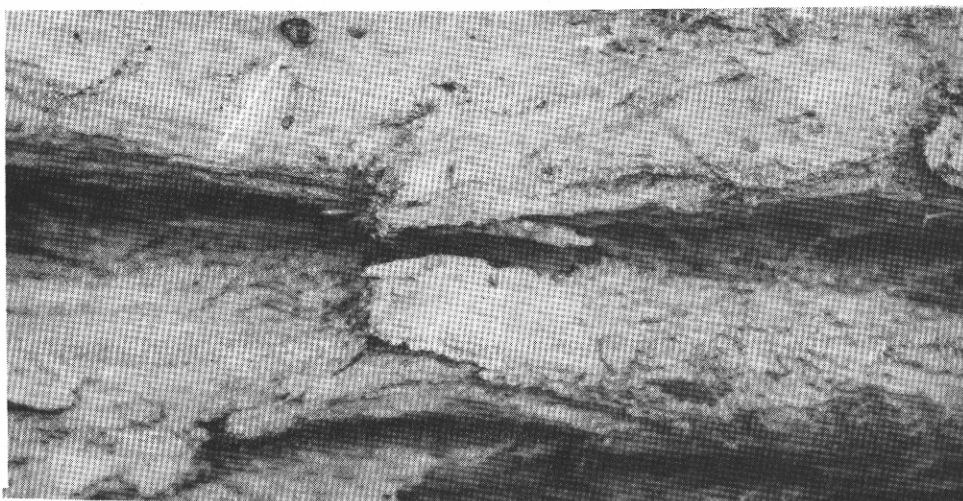


Figure 4. --Bark-surface indicator of underlying blemishes--top center-- about 1/8 inch diameter. This appears to be a vestigial twig. Note heavy ridges and bright condition of bark.

ZM 117 443

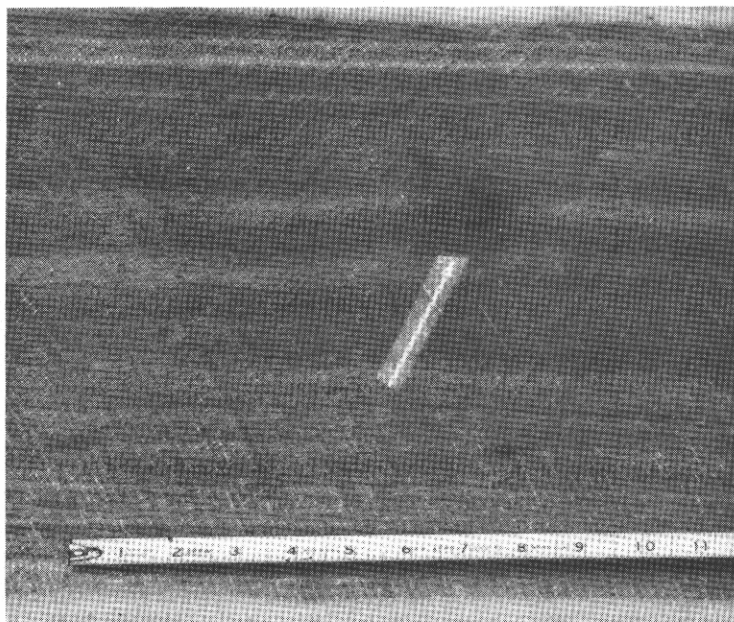


Figure 5. --Blemish underlying bark-surface indicator shown in figure 4--above right center--at depth of about 3 inches. Note a second blemish at lower right center which was not evident on bark surface in figure 4. These blemishes do not appear to have definite pith centers.

ZM 117 444



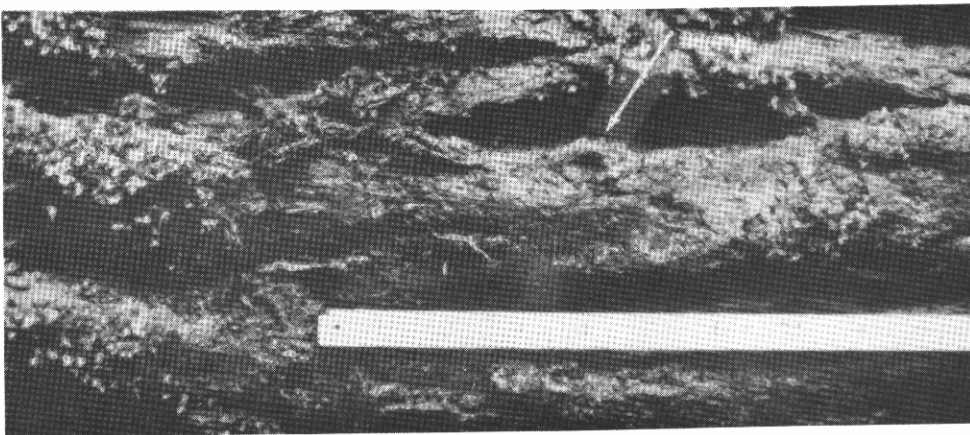


Figure 6. --Bark-surface indicators of underlying defects--possibly a vestigial twig. Note that the bark is not as heavily ridged nor as bright as in figure 4.

ZM 117 448

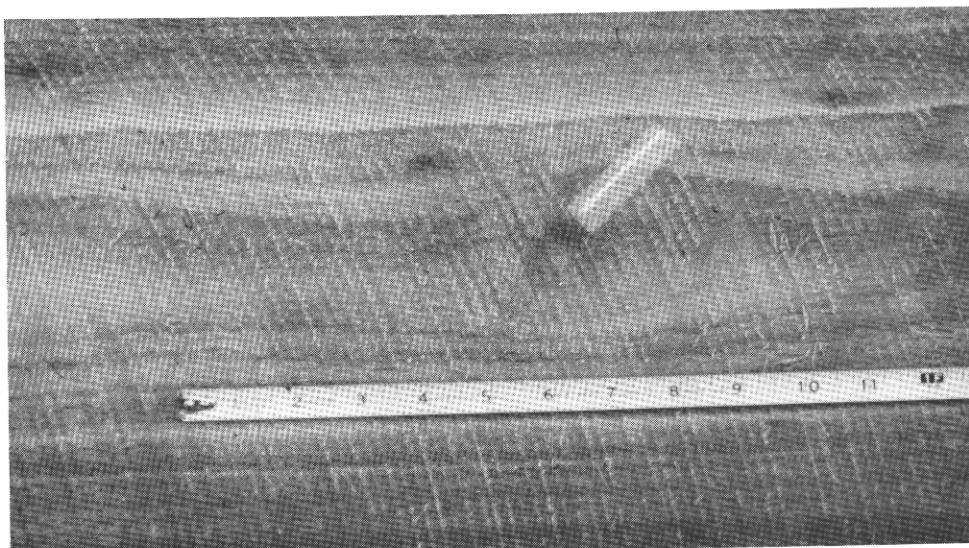


Figure 7. --The blemish underlying the bark indicator shown in figure 6--right center--about 5 inches deep. Note three other similar blemishes which apparently are not visible on the bark surface in figure 6. All of these blemishes have definite pith centers.

ZM 117 438

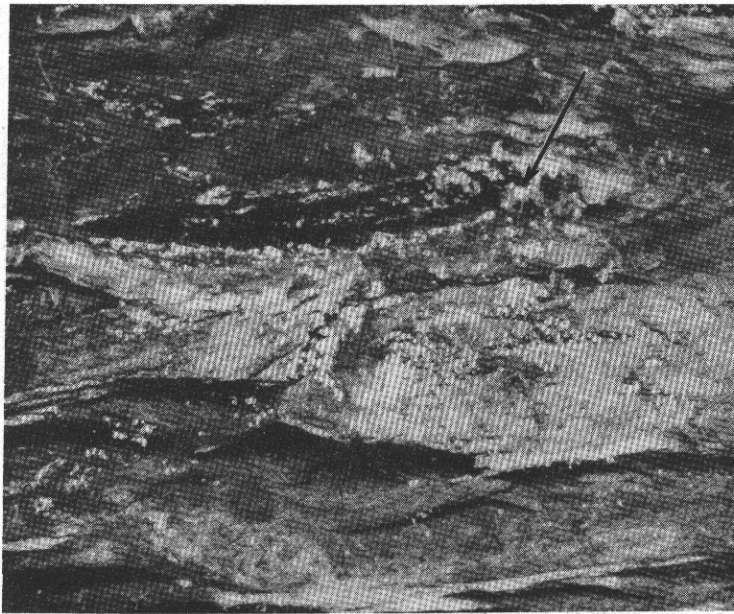


Figure 8. --Bark-surface indicator of small underlying knot--the bark is distorted in an area of about 2 inches square.

ZM 117 441

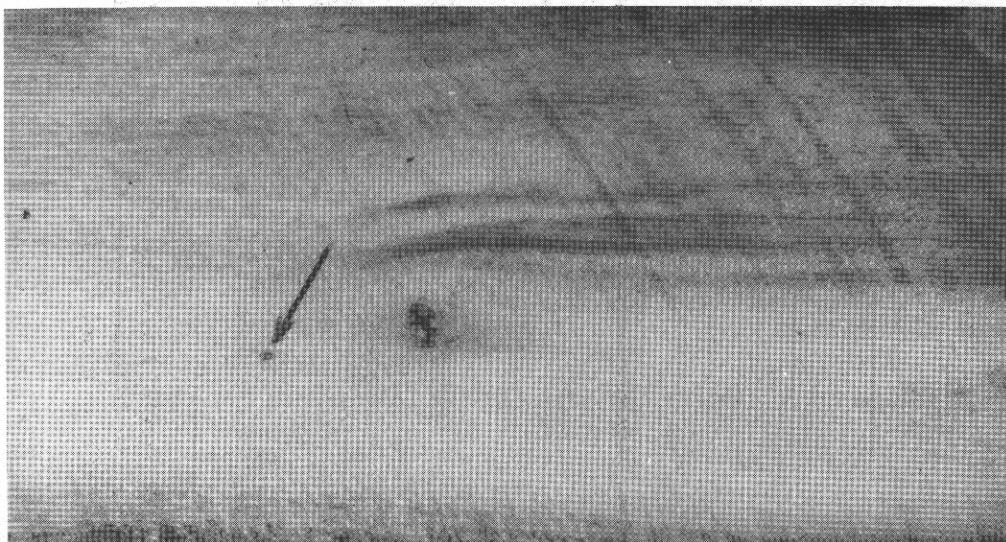


Figure 9. --A 1/2-inch knot underlying the bark-surface indicator shown in figure 8--about 4 inches deep. Note tiny blemish about 1 inch to left of knot. This appears to be a vestigial twig.

ZM 117 440



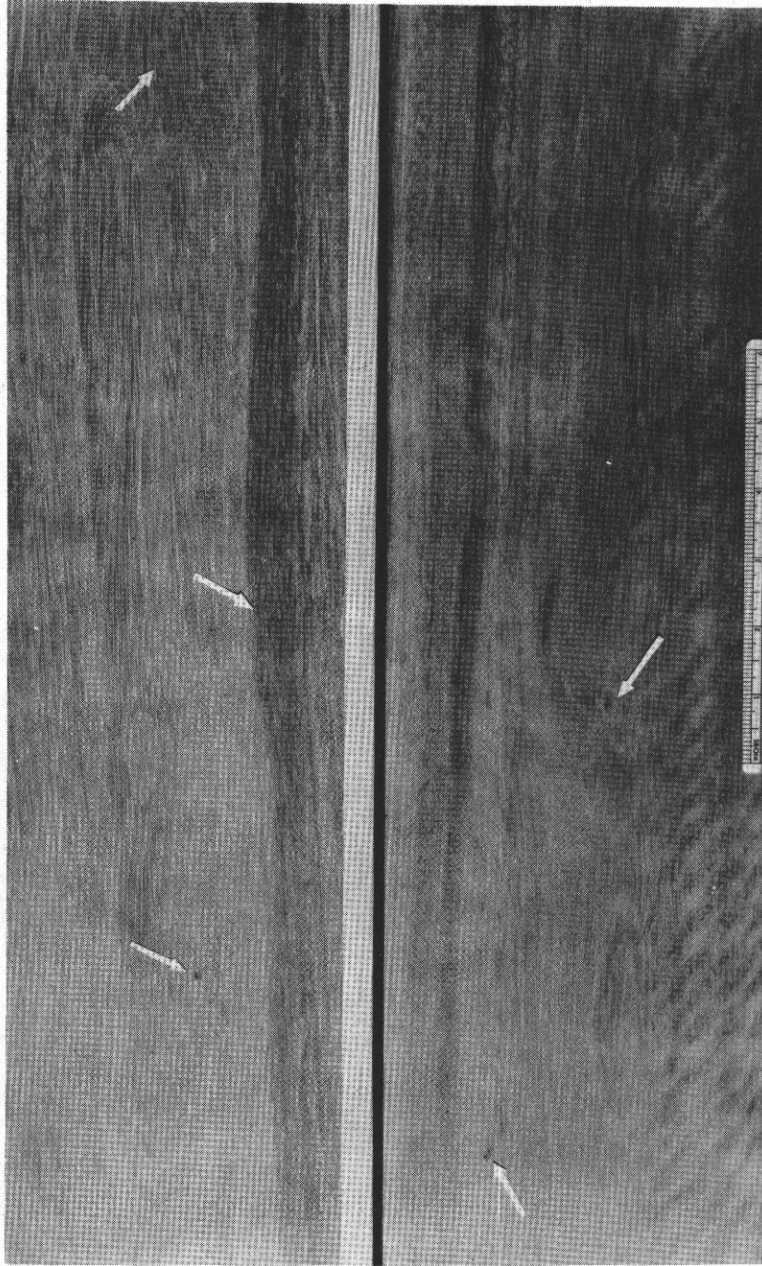


Figure 10. --View of tiny blemishes on two kiln-dried and planed E. robusta boards. These are similar to those shown in figures 3, 5, and 7. Note that some are more prominent than others, and have tiny season checks in them.

ZM 117 942



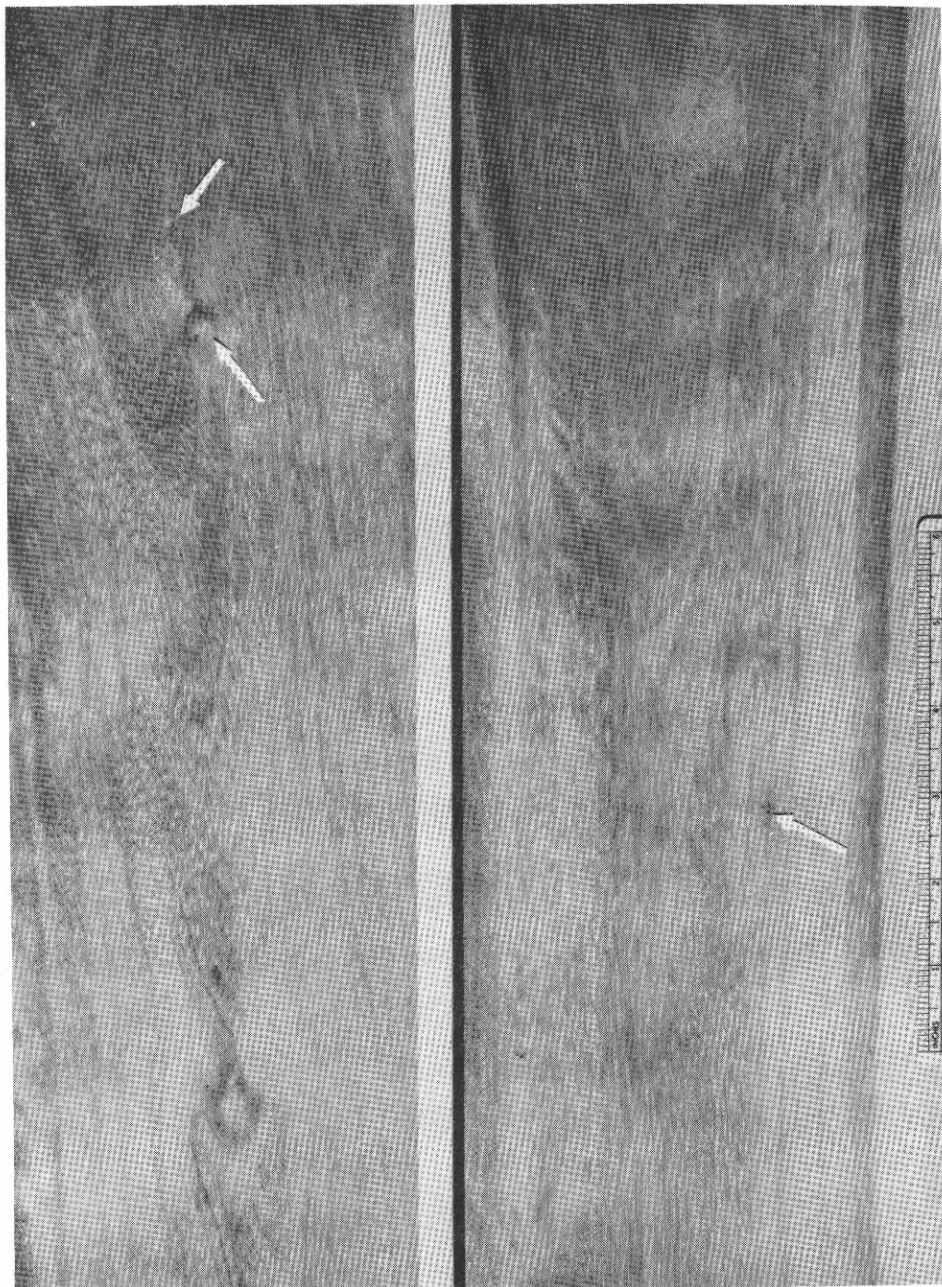


Figure 11. --Views of tiny blemishes and apparent burls on two kiln-dried and planed boards. The second arrow from the right on the top board points to an apparent burl.

ZM 117 943

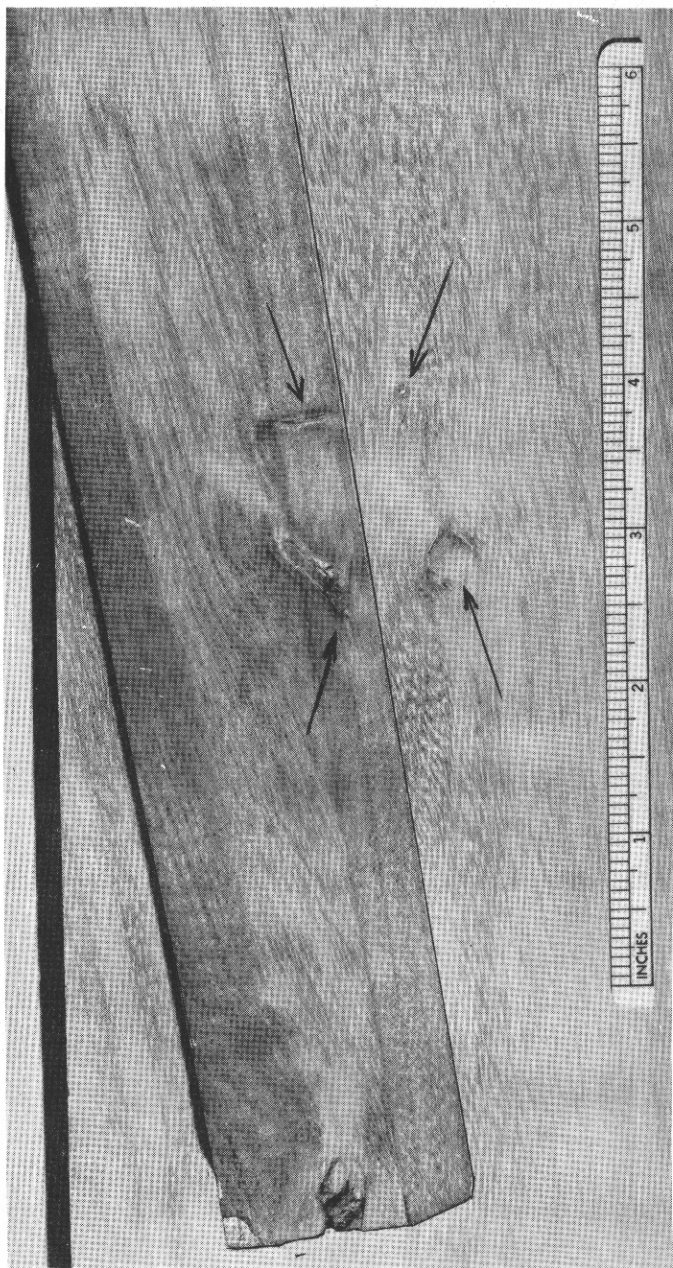


Figure 12. --Close-up view of parts of two boards showing the characteristics of small knots formed by juvenile branches. Board on top shows longitudinal sections of such knots, while the board on the bottom illustrates the corresponding surface views. Note the burl-like character of the overgrowth (arrows at left). The vestigial twig (arrows at right) is apparently associated with the knot.

ZM 117 939





Figure 13. --View of the butt end of an E. robusta log. Note the cracks which developed immediately after felling.

ZM 117 452



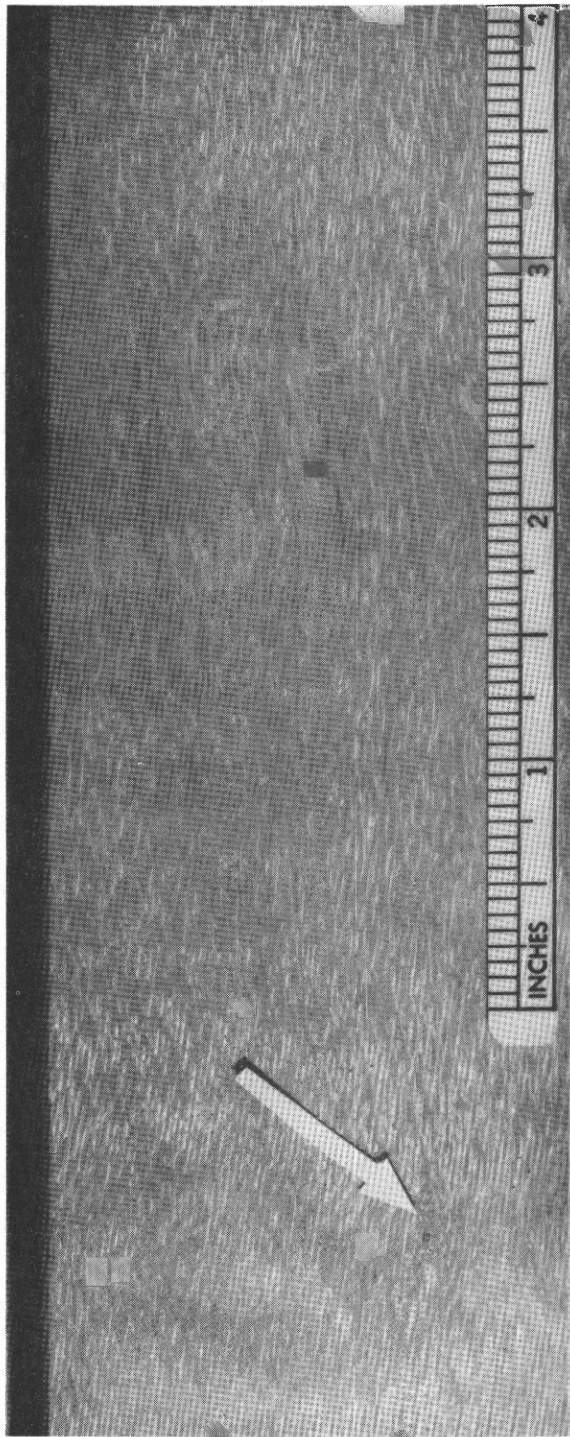


Figure 14. --A view of a portion of a seasoned and planed Grevillea robusta board indicating the tiny blemish that may be a vestigial twig.

ZM 117 940