REPORT
on the
EUCALYPTUS OF CALIFORNIA

by
Von Schrenk, Fulks & Kammerer

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ON THE
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BY
Von Schrenk, Fulks & Kammerer

TO
SACRAMENTO VALLEY
IMPROVEMENT CO.

SAINT LOUIS

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Preface

The planting of Eucalyptus trees for the industrial purposes and commercial profit is rapidly becoming a widespread movement. The wider recognition of the value of Eucalyptus lumber to replace the dwindling supply of our hardwoods is focusing public attention on this new industry of California. Practical Eucalyptus growers are keenly alive to the value of scientific investigations bearing on this important subject and are eagerly seeking every new contribution by technical experts to what may be called the Science of Eucalyptus Culture.

In making public the Report on Eucalyptus, compiled by the firm of Von Schrenk, Fulks and Kammerer, Consulting Timber Engineers, the Sacramento Valley Improvement Company, to whom this report was made, is moved by the desire to add some much desired and valuable information to the general sum of knowledge pertaining to Eucalyptus production and to make the same more widely available.

A few words may be in place here to explain to the general public the responsibility, character and standing of the firm making this report. To scientific technical timber men and timber users, the firm is so well known as to require no introduction.

Von Schrenk, Fulks and Kammerer, Consulting Timber Engineers, having a laboratory in St. Louis

in connection with the Shaw School of Botany, and the world famous Shaw's Botanical Gardens, are engineers who have specialized on timber production, uses and preservation. They act as advisors to Railroad Companies, Civil Engineers, Architects, Manufacturers of Lumber and others, as consulting timber engineers in all matters pertaining to the uses of timber, the handling of same and improvements in methods of manufacture.

The Senior member of the firm, Prof. Von Schrenk, was for many years in charge of a division of Forest Products of the United States Forest Service, and Pathologist in charge of investigation of Timber Diseases, and Methods for Preventing Same, in the United States Department of Agriculture. Finding that there was a large and constantly growing demand for knowledge and advice which timber specialists alone were able to furnish, particularly among the railroads and other large consumers of timber, he resigned this position for the purpose of entering the firm with which he is now associated. The firm has for many years been acting as advisor to Lumber Companies, Civil Engineers, and numerous Railway Systems with respect to their lumber and tie supplies. At the present time, Prof. Von Schrenk is Chairman of the Committee on Grading Timbers of the American Society for Testing Materials, a member of the Tie and Wood Preservation Committees of the American Railway Engineering & Maintenance of the Way Association; lecturer of Timber Diseases and Uses at Biltmore Forestry School, located at Biltmore, North Carolina; also a member of the American Society of

Civil Engineers, American Forestry Association, etc.; also lecturer at the University of Wisconsin and formerly at Yale. He has also been appointed Chairman of the Missouri State Forest Commission.

The following brief extract taken from "Who's Who in America," will be of interest in this connection: 'Hermann Von Schrenk, botanist; born at College Point, L. I., N. Y., March 12, 1873; son of Prof. Joseph S. Von Schrenk; graduated from Cornell University B. S. degree 1893; A. M. Harvard 1894, Ph. D., Washington University 1898. Instructor plant diseases Shaw School of Botany, Washington University; pathologist in charge Mississippi Valley Laboratory Bureau Plant Industry; U. S. Department of Agriculture; in charge investigations on timber diseases and timber preservation, special agent Bureau of Forestry; Member American Botanical Society, Society for Plant Morphology and Physiology, A. A. A. S., Deutsche Botanische Gesellschaft, National Geological Society, American Forestry Association; Secretary American Board of Editors Bontanishes Centralblatt; Treasurer American Society of Naturalists; specially engaged in investigations of diseases of forest trees and timber preservation. Author of, 'The Decay of Timber and Methods for Preventing It,' 'Seasoning of Timber,' and papers on kindred subjects.'

Messrs. E. B. Fulks and Alfred Kammerer, associated with Prof. Von Schrenk, are also technically trained men of high standing. They were both formerly connected with the United States Forest Service, and in that connection carried on extensive

investigations, dealing with the uses of timber and its adaptibility to various purposes. Their laboratory is prepared to carry on investigations, make reports on all problems dealing with the best methods for handling and utilizing timber. They make it their business to look into the closest adaptibility of the qualities of any and all kinds of wood to special uses; determine the character and value of the various preservation processes for increasing the length of life of timber; make reports on problems dealing with logging methods, the manufacture of lumber in its various phases; dry kiln operations, wood waste utilization; pulp industry, the manufacture of special articles, the seasoning and preservation of timber in its various forms, such as ties, telephone poles, mine props, posts, etc., the adaption of various timbers for building purposes, and problems relating to railway track and bridge construction. In addition to these general problems of wood utilization, they act as Consulting Forest Engineers, to handle all problems dealing with the planting and management of timber land. It will, therefore, be seen that their experience and training has particularly fitted them for making a comprehensive report of this character, and their contribution will no doubt be received with much satisfaction and will obtain the recognition which a report emanating from such authority merits.

SACRAMENTO VALLEY IMPROVEMENT
COMPANY,

St. Louis, Mo.

Report On The Eucalyptus of California

BY

Von Schrenk, Fulks & Kammerer

Introduction

The hardwood timber supply of the United States has for the last few years been growing less and less, and in many parts of the country this decrease in the supply has given rise to considerable anxiety to the hardwood using industries. Many of them have begun to look about in other parts of the country and to foreign countries for the purpose of finding substitutes for the woods hitherto employed.

Of all the timbers so far investigated, none have given so much promise for very extensive utilization as the various classes of Eucalyptus wood. Large quantities of this timber have been imported during late years from Australia, notably in the car manufacturing industry. These Australian importations have raised the question as to whether it would be possible to grow the desirable species of Eucalyptus in the United States; and many persons, particularly in the Eastern States, have been surprised to learn that the growing of Eucalyptus is not a new industry in this country.

Eucalyptus has been grown to a very great extent

in California since 1860, but only recently has the large planting of timber tracts been attempted. This commercial planting has awakened an interest in the new industry, and a rapidly increasing demand has arisen for information on the part of prospective investors in all parts of the country, as to what Eucalyptus is, what it will do, and whether the investment in lands for the purpose of growing Eucalyptus is a paying investment.

The various reports that have been written on Eucalyptus deal mostly with the silvilcultural requirements of the tree. It is the purpose of this report to consider the subject largely from the point of view of uses. A considerable portion of the data embodied in this report was collected under the personal supervision of Mr. W. R. Wheaton, who for the past year has been actively employed in the investigation of Eucalyptus on the Pacific Coast.

History

The Eucalyptus, a genus of the family Myrtaceae, is native to Australia and the adjacent islands. It was first introduced into California in 1865, and was planted around San Francisco Bay. During the next few years it was planted extensively for windbreak purposes in the Santa Clara Valley. About 1865, Mr. Elwood Cooper set out large plantations on his ranch near Santa Barbara, Cal., and these plantations are today the oldest and best of the many plantations of Eucalyptus. Shortly after Mr. Cooper started his plantations, the culture of the tree was taken up in

Southern California by the Honorable Abbot Kinney. Mr. Kinney was instrumental in having established the experimental station of the University of California at Santa Monica. During the time he held office as road overseer, he planted many and various Eucalypts along the avenues of Ocean Park and Santa Monica as ornamental and shade trees. Since 1865, the Eucalypts have been extensively planted in California, mainly for the windbreak purposes around orchards and vineyards, and for fuel.

Species Grown in California

In Australia, the native home of the Eucalypts, there are upwards of 150 species known to botanists, not including the many dwarfed, scrubby, desert species, and of these 150 species about 75 have been propagated in California. The blue gum, *E. globulus*, was the first Eucalypt introduced into California, and the species which has been most extensively planted. This predominance of the blue gum is true not only of California, but of every country where this exotic has been planted. This Eucalypt has acquired a considerable reputation as a sanitary tree, the claim being put forth that, where there are extensive plantations of *Eucalyptus globulus*, there is no malaria. In his book on *Eucalyptus* Abbot Kinney gives considerable space to this property of the blue gum. In his "Eucalyptographia" Baron von Mueller says of *Eucalyptus globulus*, that "for mitigating the heat of arid, treeless regions, subject to high summer temperatures, *Eucalyptus globulus* plays a most important part also.

But the culture of the tree should be millionfold as effected already by wise statesmanship and enlightened private enterprises in Algiers, Upper India, and some of the western states of the North American Union. The rearing of forests of our blue gum tree can be accomplished more cheaply and more easily than that of almost any other tree, while the return is twice or three times earlier than that of the most productive pine or oak forests, and this raising of *Eucalyptus* forests can be extended to regions in which most pines and all oaks would cope in vain with the almost rainless clime, although *Eucalyptus* culture can never advance to cold climes."

Of the other species planted in California probably the red gum, *Eucalyptus rostrata*; the forest gray gum, *Eucalyptus tereticornis*, and the sugar gum, *Eucalyptus corynocalyx*, rank next in order of quantity planted. *Eucalyptus rostrata* has been planted in large groves and has attained a large and rapid development in the Imperial, the San Joaquin and the Sacramento Valleys. The other species have been planted extensively as shade and ornamental trees along the city streets, in the experimental stations of the University of California at Chico and Santa Monica, in the private plantations and parks of Mr. Elwood Cooper, the Honorable Abbot Kinney, and Mr. Geo. Roeding, and in the various parks of Los Angeles, San Francisco, Fresno, and other California cities.

Description of Species, Etc.

It is impossible to give space here to a detailed description of the many Eucalypts, and it is impossible for one not perfectly familiar with the growing tree, and one who has not studied it thoroughly, to detect one species from another from any written description. For those desirous of learning the various botanical differences of the many Eucalypts, we refer them to the Eucalyptographia of Baron von Mueller.

Of the Eucalypts planted in California, *Eucalyptus rostrata*, *Eucalyptus globulus*, *Eucalyptus corynocalyx* and *Eucalyptus tereticornis* rank first as timber trees. Their growth is extremely rapid, and their wood is one of the finest hardwoods known to the world. As an instance of their rapidity of growth it might be stated that, in the plantations throughout the state, the average blue gum tree 10 years old is from 90 to 100 feet high and from 10 inches to 12 inches breast diameter. *Eucalyptus rostrata*, *Eucalyptus tereticornis*, and *Eucalyptus corynocalyx* are acknowledged slower growers than *Eucalyptus globulus*, although in some plantations in the Imperial and San Joaquin Valleys *Eucalyptus rostrata* has exceeded this average growth of *Eucalyptus globulus*. Since commercial planting in California will be confined to the four species mentioned above, a short description of these trees will be given. The following descriptions are taken from Bulletin 196 of the College of Agriculture, University of California.

Eucalyptus Corynocalyx

“Trees of this species in close planting grow erect, having a very open crown, while individual specimens branch low, with the branches scattering. The bark of the trunks of the old trees is deciduous, and of a scale appearance, due to the unequal flaking off at different times of the year. In color it varies from a cream to a dark gray.

“The branches are smooth, shading off in color to a light green, while the twigs, young seedlings and sprouts are of a reddish hue. The leaves of the young plants are ovate, dark green in color on the upper side of the leaf and several shades lighter underneath. Those of the old trees are long, slightly curved and sharply pointed, somewhat leathery in texture, dark green on the upper side and lighter in color beneath.

“The buds are borne laterally and bloom during August and September; umbels alternate, solitary, pedicles short, the buds with their deciduous calyx caps are dumb-bell shaped, while the mature fruit is egg-shaped, with the valves three to four in number, generally three, enclosed. The seed ripens during the summer months and is brown in color and the size of the seed of *Eucalyptus globulus*, but not so angular.”

Eucalyptus Globulus

“Individuals of this species grow erect as a rule, branching low in isolated specimens, while those in

close plantings have small crowns and are particularly free from lateral branches. The bark of the seedlings is light bluish green in color, while that of the trunks of the old trees varies from a light brown to a gray or greenish color due to the flaking off of the bark in long strips. The limbs are generally smooth.

“The stems of the seedlings are rectangular in shape, while their leaves and those of the sprouts of the old trees are opposite, oblong, bluntly pointed, and of a light bluish green color, darker on the upper side of the leaf. Those of the old trees are elongated, sickle shaped, leathery in texture, and equally dark green on both sides.

“This species is in bloom from January to May, the flowers being white in color, generally solitary, axillary and borne on short stalks. The whitish buds are angular, with a bluntly saucer-shaped deciduous cap, while the mature fruit is dark green in color, with from three to five valves, generally four barely enclosed.”

Eucalyptus Rostrata

“The bark of the seedlings and the twigs of the old trees have a reddish hue, while that of the trunks of the mature trees is a very dark gray, varying from smooth and non-persistent in some trees to others where it is deeply furrowed and persistent. The limbs are much lighter than the trunk and smoother.

“The leaves of the seedlings are broad lance-shaped, darker in color on the upper side, while those of the older trees are elongated, narrow sickle-shaped, and

equally green on both sides. The umbels are solitary and axillary. The flowers are borne in clusters of from three to fourteen, generally seven, on one-fourth inch pedicels.

“The buds with their hemispherical, sharply pointed lids, are nearly round and a little larger than a BB shot, valves three to five in number, generally four, very much protruding on the mature fruits.”

Eucalyptus Tereticornis

“This species is of a very erect habit of growth, both in close planting and isolated specimens. The branches are few and scattering, leaving the crown open. The deciduous bark of the trunks of the old trees is generally smooth and of a mottled color, from light brown to cream, directly after the bark has been shed.

“The buds are in bloom during May and June, and are borne laterally in solitary umbels, in clusters from five to nine, on short stalklets. The deciduous lid is horn-shaped; reddish brown in color, just before blooming time.

“The seed cases are slightly larger than those of *Eucalyptus rostrata*; with the valves, three to five in number, generally four, protruding and hemispherical.

“The leaves of the young plants are broad lance-shaped, while those of the old trees are long, of medium width and light green on both sides. The pendulous branches with their long leaves give to the trees a weeping effect.”

Climatic Requirements

The Eucalypts growing in California range from the head of the Sacramento Valley at the foot of Mt. Shasta to the Tehachipi range, from the Imperial Valley north to the Tehachipi range and on the Coast from San Francisco Bay to the Mexican line.

For their best development, the Eucalypts require a deep, rich soil with plenty of moisture. *Eucalyptus globulus* attains its best development on the coast where it has the benefit of the heavy coast fog. It is not a drought resistant tree, nor will it stand extremes of temperature, the range being from 27° F. to 105° F., and it must have moisture. In the hot climate of the Imperial Valley the tree is scalded by the hot winds in the summer.

Eucalyptus corynocalyx, the sugar gum, is the most drought resistant tree of the four timber Eucalypts mentioned, but it will not withstand frosts. It has never been raised successfully in large plantations in the San Joaquin Valley, as it succumbs to the frosts. It has been raised principally in the frostless regions of Southern California.

Eucalyptus rostrata, the red gum, thrives in a climate subject to extremes of temperature. In the Imperial Valley, with its hot days and cold nights, this tree attains a rapid growth and fine development. It will endure a minimum temperature of 20° F., and a maximum temperature of 130° F., and is a very drought resistant tree, although it attains its best development when given considerable moisture.

Eucalyptus tereticornis, the forest gray gum, resembles *Eucalyptus rostrata* very closely, and it will

thrive under the same climatic conditions required for the development of the red gum. It so closely resembles *Eucalyptus rostrata* in its botanical aspects that in his first edition of the "Eucalyptographia" Baron von Mueller classed it as *Eucalyptus rostrata*.

Propagation

In raising nursery stock the first requirement is seed true to name. Such seed may be obtained from reliable seedmen or may be gathered from the existing groves. The seed should be sown in the nursery during the month of June and the plants will be sufficiently large to set out in the field the following spring. The usual method of procedure is to sow the seed in boxes containing prepared soil, these boxes being "kept damp through the heat of the day until the young plants break ground, then care should be taken not to use too much water, and that there is a good circulation of air over the flats or the fungous disease of dying off is liable to occur." When the young plants are two to three inches high, they should be transferred to the shipping flats. These are usually made about 16"x22"x3", capable of holding one hundred (100) plants.

The trees should be transplanted in the spring after all danger of late frost is over and when the young trees can have the benefit of the late spring rains. Before planting, the ground should be thoroughly plowed and harrowed. After planting, the seedlings should be frequently and thoroughly cultivated so as to form a mulch which checks evaporation, kills the weeds and retains a maximum amount of moisture in

the soil. This cultivation should be continued until the branches have developed enough to prevent the passage of a horse. During the growth of the plantation, thinning out should be practiced, and the trees which fall behind in the race for sunlight and life should be taken out, and the food supply, which they would absorb, should be given to the trees which will live and mature. This is merely helping nature out in her process of the survival of the fittest.

After the tree has been cut, sprout growth springs from the parent stump. These sprouts should be cut down to one or two to each stump. The sprout growth is much more rapid than that from the seed. Some nurserymen even advocate the cutting of the seedlings one year after planting, to obtain the most rapid growth and best development.

Enemies

The California Eucalypts are remarkably free from the attacks of insects or fungus growths. It is only in the very rarest instances that any of the trees will suffer from the diseases common to most of the native forest trees of the United States. This is an exceedingly striking fact and one which makes the growth and propagation of Eucalyptus trees for commercial purposes an almost assured success.

When one remembers that our trees almost without exception suffer more or less from both insects and disease, thereby entailing considerable loss to the owner, it will be recognized that this is one of the most striking features which Eucalyptus has to recommend it for commercial development.

Utilization

The principal interest in any wood, which is grown for commercial purposes, lies in the various uses to which the wood can be put when ready for marketing. With the large number of woods which are available for different purposes in the United States, it becomes a matter of particular interest to know what specific quality or qualities the various woods possess which render them more or less fit for any specific purpose. For example, we have been accustomed to consider white oak and longleaf yellow pine as the principal wood for structural timbers: in the wagon industry ash has been the chief wood used for whatever lightness and strength were the chief requisites: in making tool handles hickory has been the chief wood employed, etc. The wood of the Eucalypts possesses certain distinguishing qualities which make them particularly fitted for a large variety of purposes, which must be considered fortunate in view of the rapidly decreasing supply of the high grade hardwoods, which we have been accustomed to use. A careful study of these specific qualities of the various Eucalypts has shown that this class of timber is particularly adapted to those industries requiring great strength and elasticity, and likewise to such uses where strength and lasting power are important.

The Structure of the Wood

The wood of the Eucalyptus family is intensely hard and strong; it ranking foremost in strength among the world's supply of hardwoods. In its

Cross Section Hickory.
(Highly magnified.)

Cross Section American Ash.
(Highly magnified.)

Eu. loxophleba
(York Gum)

Eu. salubris
(Gimlet Gum)

Eu. globulus
(Blue Gum)

Eucalyptus Cross Sections.
(Magnified three times.)

structure the wood differs materially from that of any of the hardwoods of the United States, the main difference consisting in the closely interlocked structure of the wood fibres, which gives the wood the appearance of great density. When looked at in cross section, Eucalyptus wood appears almost solid, that is, the pores commonly seen very plainly in timbers like oak, ash and hickory, are found to be very few in number and more or less closed. A great amount of the year's wood production consists of solid wood fibres. This will become very evident by a comparison of the attached photograph showing a cross section of one of the Eucalypts, with similar photographs of hickory and ash. The closely interlocked character of the wood fibres is best shown by the appearance of a piece broken in shear. The broken surfaces of the specimen present a peculiar, corrugated appearance.

Color of the Wood: Grain and Hardness

The color of Eucalyptus wood varies materially with the different species from a very light straw color to a dark red-brown.

When cut into lumber the wood shows a beautiful grain, which is easily brought out by any process of natural finishing. Some of the species, notably Eucalyptus rostrata, when finished, look almost like the true mahogany; in fact so close is the resemblance that they could easily be mistaken for each other. The presence of this figured grain is a striking quality in most of the species, and it is on this account that the wood makes particularly attractive finishing

material for the interior of houses and for the manufacture of furniture.

As a rule the various kinds of *Eucalyptus* wood are very hard, most of them being among the hardest woods known. Even the softer woods, like *Eucalyptus globulus*, are usually classed in hardness grade 2, a grade usually called "extremely hard," and comparable in this country to the box wood. It will be seen that this is a very hard wood when it is stated that American ash is usually given a grade of hardness 5; chestnut, beach and oak, hardness 6.

Weight of the Wood

Most of the varieties of *Eucalyptus* are very heavy. For instance, *Eucalyptus globulus* weighs from 43 to 54 lbs. per cu. ft., *Eucalyptus rostrata*, 53 to 65 lbs. per cu. ft., and *Eucalyptus tereticornis* 52.5 lbs. per cu. ft.

Strength of the Wood

The various kinds of *Eucalyptus* wood are among the strongest woods known. From tests made by the United States Forest Service, it appears that a comparison of the various kinds of gum with hickory shows that thirty-year-old *Eucalyptus globulus* is stronger than hickory, and that fifteen-year-old *Eucalyptus corynocalyx* is nearly as strong as black hickory and 91% as strong as second growth hickory.

In the following table is shown a comparison of the moduli of rupture of several varieties of Australian *Eucalyptus* with the same species grown in

California; also a comparison with some of our most important domestic structural timbers:

Moduli of Rupture in Cross Bending Tests

Eucalyptus Globulus (Australian)	17,000
Eucalyptus Globulus (Californian)	23,265
Eucalyptus Diversicolor (Australian)	17,300
Eucalyptus Diversicolor (Californian)	18,386
Eucalyptus Resinifera (Australian)	16,500
Eucalyptus Resinifera (Californian)	14,500
Eucalyptus Rostrata (Australian)	10,400
Eucalyptus Rostrata (Californian)	14,380
Long Leaf Southern Pine	12,600
Short Leaf Southern Pine	10,100
Douglas Spruce	7,900
White Oak	13,100
Post Oak	12,300
Shagbark Hickory	16,000
Mockernut Hickory	15,200
White Ash	10,800
White Elm	10,300

It will be noted from the tests thus far made that the statement above quoted that the Eucalyptus woods are among the strongest, is not exaggerated. This is, of course, of considerable importance in view of the fact that most of the industries using hardwoods require certain qualities of strength and elasticity, which are particularly characteristic of the Eucalyptus species.

Forest Service Tests

	Average Bending Strength.	
	Lbs. per Sq. in.	Percent-age.
<i>E. citriodora</i>	17,970	156.1
<i>E. corynocalyx</i>	16,480	143.1
<i>E. hemiphloia</i>	14,000	121.7
<i>E. cornuta</i>	14,440	125.5
<i>E. punctata</i>	13,170	114.4
<i>E. polyanthema</i>	11,480	99.7
<i>E. occidentalis</i>	14,060	122.1
<i>E. gonioocalyx</i>	12,050	104.7
<i>E. rostrata</i>	11,830	102.8
<i>E. sideroxylon</i>	11,360	98.8
<i>E. tereticornis</i>	11,350	98.7
<i>E. globulus</i>	11,510	100.
<i>E. stuartiana</i>	11,010	95.7
<i>E. viminalis</i>	9,880	85.8
<i>E. diversicolor</i>	10,320	89.7
<i>E. resinifera</i>	9,170	79.7

Percentages based in all tests

on Green Eucalyptus

Crushing Parallel to Grain.		Crushing Perpendicular to Grain.		Shear Parallel to Grain.		Average Strength
Lbs. per Sq. in.	Percent-age.	Lbs. per Sq. in.	Percent-age.	Lbs. per Sq. in.	Percent-age.	Percent-age.
8,620	179.4	2,450	187.0	1,900	115.9	159.6
7,220	150.2	No Tests		2,140	130.5	141.3
6,240	129.8	1,780	139.5	1,860	113.4	125.2
6,170	128.3	1,640	125.2	1,840	112.2	122.8
6,010	124.9	No Tests		No Tests		119.6
6,690	139.1	1,550	118.3	No Tests		119.0
5,920	123.1	1,390	106.2	1,720	104.9	114.0
5,420	112.7	1,560	119.1	1,780	108.5	111.2
5,340	111.1	1,620	123.7	1,740	106.1	110.9
5,120	106.4	1,780	135.9	1,640	100.0	110.2
5,400	112.3	1,320	100.8	1,530	93.4	101.3
4,810	100.0	1,310	100.0	1,640	100.0	100.0
4,800	99.9	1,420	108.3	1,470	89.7	98.4
4,310	89.6	1,170	89.4	1,520	92.8	89.4
4,850	100.9	920	70.3	1,460	89.1	87.5
4,430	92.2	No Tests		No Tests		85.9

on Eucalyptus globulus = 100%.

Lasting Power

As a rule the various kinds of *Eucalyptus* are very durable. This, of course, refers largely to the heart wood, because the sap wood of any kind of tree, no matter where it is grown, has a comparatively short length of life. Instances of a very long length of life for various purposes, particularly for ties and posts, are very numerous. *Eucalyptus rostrata* has given an average length of life of 25 years, and there are instances on record where ties of this timber have lasted 40 years. *Eucalyptus tereticornis* gives an average length of life of 18 years, and others have given equally long service. Where any of the trees have a considerable amount of sap wood they can readily be treated with preservative.

Finishing Qualities

One of the chief characteristics of *Eucalyptus* wood is the ease with which the wood can be finished. Most of the *Eucalypts*, owing to their hardness, can be polished so as to give a very high lustre. The wood likewise takes stains very easily, and when dull finished, gives an appearance which will rival any of the hardwoods used for finishing purposes. It would be difficult to conceive of a more beautiful piece of wood than *Eucalyptus*, for instance, when given a natural finish. The delicate grain is brought out in a striking manner when the wood is polished.

Defects

The presence or absence of defects in lumber increases or decreases its value for all kinds of uses. As already indicated, the various species of *Eucalyptus* are practically free from any form of defect caused by insect or fungus disease, so that when manufactured into lumber, the wood is found to be free from the defects usually present in many hardwoods. The long straight trunks are comparatively free from knots, which results in the manufacture of practically clear lumber. The freedom from rot or decay of any sort is a quality which will not be under-estimated by users of hardwoods, and is one of the most striking attributes of the *Eucalyptus* family.

Uses of *Eucalyptus*

Eucalyptus wood has been used for many years in the native home of this tree, and the various species are there regarded as among the most important timbers of the country. The government of Australia has spent a great deal of time and money in the investigation of the qualities of the various *Eucalyptus* species, and their adaptability to various purposes.

In the United States the manufactured products of the California grown *Eucalyptus* have not been exploited to any very great extent, owing probably to the fact that the value of the wood has not been sufficiently recognized outside of California. The wood of *Eucalyptus globulus* in particular has been used for all kinds of purposes for the past twenty years or more. It is striking to note that, almost

without exception, the products of the local saw mills in California have been found superior to the products of the Eastern hardwood mills. Several small planing mills have been operating in San Francisco, Los Angeles and San Jose for twenty years or thereabouts, and these have supplied, in a small way, the local blacksmith, wheelright and carriage manufacturer. Recently some of the larger lumber manufacturers of California have been handling products from Eucalyptus groves, and several companies have been organized to exploit the products manufactured from California grown Eucalyptus.

The rapid introduction of Eucalyptus wood into the wagon industry, the tool industry, etc., will in no way interfere with the continued use of native American hardwoods, such as hickory, ash, oak, etc., because all these woods have qualities of their own to recommend them for the uses to which they have been put for many years, and the introduction of Eucalyptus for similar purposes will simply serve to stimulate the use of American woods and will give a source of supply for needed articles, wherefor the amount of native hardwoods available is becoming limited.

In enumerating the uses for which Eucalyptus has been employed or might be employed, it must be remembered that the utilization of Eucalyptus is comparatively recent in this country, and while a large number of instances can be mentioned where this wood has been successfully employed, it must not be overlooked that the qualities above referred to should recommend its use in many fields where it has not yet

been tried, with every reasonable assurance of complete success.

Wagon Industry

On account of its great strength and elasticity Eucalyptus wood is particularly adapted to the manufacture of all kinds and parts of wagons. About eight years ago a wagon, which was made entirely of Eucalyptus manufactured in a Los Angeles mill, was sold to some parties for use in the desert. In this dry country, where ordinary wood usually shrinks with the result that parts of the wagon become loose, this wagon was used two years without a tire having to be set or repairs of any kind having to be made. The value of Eucalyptus wood for single and double trees is known to every rancher in California, and it is no exaggeration to state that the Californian will hew out a green single or double tree from Eucalyptus in preference to the best oak or hickory product on the market.

A Los Angeles company, doing a heavy trucking business, began eight years ago using Eucalyptus wagon poles and reaches, and prefers them to any product of ash, oak or hickory.

Without going into further details, it may be stated that from the experience thus far obtained, Eucalyptus wood is adapted to the manufacture of wagon stock of all kinds.

Furniture

On account of the beautiful grain and the ease with which it can be finished, Eucalyptus lumber is rapidly coming into use for the manufacture of all kinds of

interior finish and furniture. If more of this timber were available, there is no doubt but what its use for these purposes would increase with great rapidity. Large quantities of Eucalyptus have been imported for many years by car companies to be used for the interior finish of cars. Many of the Pullman cars have been finished in this wood, and have excited the admiration of many, although few have known that the beautiful wood was really Eucalyptus.

The value of Eucalyptus wood for furniture is enhanced by the fact that it can be made into veneer just like any other hardwood.

Tool Handles, Implements, Etc.

Eucalyptus wood is well adapted to the manufacture of all kinds of tool handles, felloes and other implements. The wood polishes very readily and has the advantage in that it does not split or splinter. When these qualities are combined with great strength, it will be readily seen that its value for these purposes is very great.

For several years many of the western telegraph companies have been using Eucalyptus wood for the manufacture of pins. These pins are valued as highly as the much prized black locust pins, and the price received for them is about the same; that is, about \$14.00 per 1000 for 1½"x9" pins. Among the firms using Eucalyptus pins may be mentioned the Pacific Gas & Electric Co., of San Francisco; the Mt. Whitney Power Co., of Visalia, Cal.; the Spokane & Inland Ry. Co., of Spokane; the Los Angeles Pacific Ry. Co.,

of Los Angeles, and the United Railways of San Francisco.

Flooring

Eucalyptus lumber makes one of the very finest floorings and has been used in some of the best residences in California. Flooring made from *Eucalyptus globulus* sells in California for from \$65.00 to \$110.00 per 1000 ft., B. M.

Poles, Piles, Ties and Posts

Owing to their great lasting power, many of the species of *Eucalyptus* are particularly adapted for uses where great length of life is an important factor. As stated above, some of the species have given a length of life of from 25 to 40 years. *Eucalyptus rostrata* is particularly fitted for this purpose, and so also *Eucalyptus tereticornis*. Saplings should make excellent fence posts when properly treated. One of the great advantages of *Eucalypts* for all kinds of poles, piles and posts is that they make straight, uniform, round poles, a very valuable quality for purposes of this character. The probability that this wood will be used more extensively for poles, and piling in the future is very great, and one of the reasons why it has not been used more extensively in the past, was the absence of a sufficient supply. What has been said of posts and piling will also apply to mine timbers. The chief requirement for mine timbers is that they shall last and have great strength. With the decreasing supply in the available mine timbers for the mines in the West, the market for small poles should be excellent.

Fuel

Eucalyptus wood makes an excellent fuel. The California grown Eucalypts have been marketed to a very great extent for this purpose, it being one of the best fuel woods obtainable in Southern California. The wood sells for from \$6.00 to \$14.00 per California cord of 96 feet. Some of the groves which have been cut for fuel have made very good returns to the owners. Even where the groves were used solely for this purpose, they were very profitable. One of the reasons why the wood makes such good fuel is because of its great density. It is a well known fact that with the increased hardness of wood, the fuel value increases. A hardwood like Eucalyptus, for instance, will have a very much higher fuel value than pine.

Bi-Products

While the chief value of Eucalyptus lies in the timber, it should be pointed out that one of the bi-products, which is frequently obtained from Eucalyptus trees, is the oil which is manufactured from the leaves, twigs and branches of most of the Eucalyptus species. The oil is a very good antiseptic, and is highly valued for its medicinal properties. The residue left from the distillation of the leaves is said to make a very good boiler compound, and is used by the United States Navy for removing the scale and incrustation from boilers. This residue also contains a large amount of tannic acid and makes a very good tanning solution for the manufacture of leather.

Description and Uses of the Four Most Important Species

Eucalyptus Rostrata

Weight per cu. ft. 53.5 lbs. to 65 lbs.

The wood of this species is the most beautiful of all the Eucalypts. It has a fine, wavy grain, is of a warm, rich red color, takes a very high and beautiful finish, and resembles mahogany closely enough to deceive even expert cabinet-makers. Its close, complicated grain makes it difficult to split. It is remarkably uniform, durable, strong and hard.

USES: It is highly valued for ship's beams; ties; piles; posts; paving blocks; bridge timbers; furniture and interior finish. This is the chief wood used for paving material in Melbourne.

Eucalyptus rostrata promises to be one of the most successful species in the United States.

Eucalyptus Globulus

Weight per cu. ft. 43 lbs. to 57 lbs.

The wood has a pale straw color, with a twisted and curly grain, planing well. It is hard, heavy, moderately strong, elastic and durable. The pith rays

are very numerous and fine; the pores moderate sized, grouped or in lines.

USES: Fencing; telegraph poles; bridge timbers; piles; ship building; felloes; shafts; spokes; implements and carriage building. It was formerly used for ties, but now *Eucalyptus rostrata* is preferred for this purpose.

Eucalyptus Tereticornis

Weight per cu. ft. 52.5 lbs.

This wood is red-brown in color, resembling cedar, having a curly cross grain; is lustrous; heavy; hard and very durable; is easy to dress.

USES: Fencing; naves; felloes; ties; telegraph poles; and paving blocks.

Eucalyptus Corynocalyx

This wood is yellowish white in color; very heavy; hard; strong; durable and is said to be termite and terredo proof. It seasons easily and does not warp.

USES: Ties; piles; planks; fencing; utensils and wheels.

Conclusion

It has been shown in the foregoing that the wood of the Eucalyptus has been used for many years in Australia and other countries, where these trees have been grown, for a large variety of purposes. It has been found particularly valuable for all sorts of uses because of its great strength, uniform quality, lasting power and the beautiful finish which it will take. Abundant evidence is at hand that the various kinds of Australian Eucalyptus, which have been imported into this country for many years, have given similar satisfaction here, and wherever Eucalyptus has been used in the United States it is highly prized. When one takes into consideration the great value of the wood; its adaptability and fitness for a large number of purposes which are applicable both to the large and small consumer, it is only logical to conclude that Eucalyptus, with its rapidity of growth and superior qualities is destined to form a most important factor in the hardwood timber industry of the United States.

Appendix

Tables giving data concerning the various
Eucalyptus plantations in California.

Table 1

Growth and Yield of

SANDY LOAM SOILS

Name of Owner.	Location.		Age, Years.	Area Measured, Acres.
	Town,	County,		
*Hoff.....	Florence ..	Los Angeles.	2	1
Newman..	Santa Ana.	Orange	2	1
Walters..	Galivan ..	San Diego...	3	1
*Hoff.....	Florence ..	Los Angeles..	3	1
Draper...	Coyote ...	Orange	3	1
Anderson.	Oceanside .	San Diego...	3	1
Evans... .	Bairdstown	Los Angeles.	3	1
Hunter...	Bairdstown	Los Angeles.	4	1
*Steele....	Compton ..	Los Angeles.	4	1
*Hickey...	Santa Ana.	Orange	4	1
*Hoff.....	Florence ..	Los Angeles.	4	1
Clothier..	Cypress ..	Los Angeles.	5	1
*Hoff.....	Florence ..	Los Angeles.	5	1
Clark.....	Compton ..	Los Angeles.	5	1
Martin...	Santa Ana.	Orange	6	1
Anderson.	Oceanside .	San Diego...	3	1
O'Bryan..	Sweetwater	San Diego...	4	1

* Sprout Growth.

Table 1
Eucalyptus Plantations

SANDY LOAM SOILS

Original Spacing.	Present Stand per Acre.	Diameter.	Height.	Yield per Acre.	
	Trees.	Average, Inches.	Average, Feet.	Total, cubic ft.	Total, Cords.
9x9	2,224	2.2	25	899	13.
8x8	620	4.2	30	1,860	27.3
8x8	648	3.1	28	648	9.5
9x9	2,006	3.8	35	6,018	88.5
8x8	436	3.4	45	654	9.6
8x8	636	2.7	22	636	9.3
6x6	646	4.8	35	3,230	47.5
6x6	838	5.6	45	5,028	73.9
8x8	1,608	4.2	35	4,824	70.9
8x8	1,518	3.8	45	4,554	66.9
9x9	1,062	3.1	45	1,062	15.6
8x8	504	5.7	45	2,772	40.7
9x9	1,536	3.8	55	4,608	67.7
9x7	488	5.4	40	2,684	39.4
10x6	524	5.0	55	2,620	38.5
8x8	644	2.8	25	644	9.4
8x8	636	4.3	40	1,908	28.0

Hunter Eucalyptus Plantation

GLOBULUS

BAIRDSTOWN, CALIFORNIA

Planted 8x8. Seven Years Old

Number of Trees.	Diameter Breast High.	Cubic Feet.	Cords.	Ties.	Board Feet.
50	4	150	2.2	...	....
44	5	220	3.2	...	....
48	6	336	4.9	...	....
18	7	180	2.6	...	....
28	8	364	5.3	...	1,204
40	9	680	10.0	...	2,800
60	10	1,320	19.2	...	5,700
58	11	1,624	23.9	...	6,960
62	12	2,046	30.0	62	8,060
26	13	1,040	15.0	52	5,200
30	14	1,410	20.7	60	6,450
20	15	1,080	15.9	60	4,900
22	16	1,320	19.1	88	6,270
14	17	924	13.5	80	4,480
12	18	900	13.2	120	4,000
6	19	510	7.5	72	2,520
Tot'l, 538	..	14,104	206.2	594	58,544

Bailey Eucalyptus Plantation

GLOBULUS

SANTA ANA, CALIFORNIA

Planted 10x6. Eight Years Old

Number of Trees	Diameter Breast High.	Cubic Feet.	Cords.	Ties	Board Feet.
31	3	31	.4	.....	.....
62	4	186	2.7	.....	.....
31	7	310	4.5	.....	.....
54	8	702	10.3	.....	2,332
8	9	146	1.1	.....	560
47	10	1,034	15.2	.....	4,465
47	11	1,326	19.2	.....	5,640
86	12	2,638	38.3	.....	11,610
93	13	3,720	54.8	186	16,275
101	14	4,747	69.7	202	21,715
55	15	2,970	43.3	165	13,475
54	16	3,240	47.6	216	15,390
7	17	462	6.7	42	2,240
39	18	3,025	44.4	390	15,015
16	19	1,360	20.0	196	6,720
Tot'l, 731	..	25,897	378.2	1,397	115,437

Mecham Eucalyptus Globulus Plantation

MECHAM, SONOMA COUNTY, CALIFORNIA

Planted 6x6. Nine Years Old

Diameter Breast High.	Number of Trees.	Cubic Feet.	Cords	Board Feet.	Poles Feet.			
					40	45	50	60
2	39	16	.2	.....	..	..	..	...
3	30	30	.4	.....	..	..	..	...
4	18	54	.7	.....	..	..	..	...
5	66	330	4.8	.....	..	..	..	...
6	3	21	.3	.....	..	..	..	...
7	99	990	14.5	.....	..	..	..	...
8	78	1,014	14.3	3,354	..	..	..	...
9	93	1,581	23.2	6,510	..	..	..	...
10	69	1,518	22.1	6,550	69	..	..	...
11	69	1,932	28.3	8,280	..	69	..	...
12	99	3,267	48.0	13,360	..	..	99	...
13	123	4,920	72.3	24,600	..	..	..	123
14	111	5,217	76.7	23,860	..	..	..	...
15	51	2,397	35.2	12,495	..	..	..	...
16	12	720	10.5	3,420	..	..	..	...
Total	960	24,007	351.5	102,429	69	69	99	123

Baldwin Eucalyptus Plantation

GLOBULUS

ARCADIA, CALIFORNIA

Planted 10x10. Twenty-five Years Old

Number of Trees	Diameter, Breast High.	Cubic Feet.	Cords.	Ties.	Board Feet.
10	6	70	1.0	...	....
18	7	180	2.6	...	....
8	8	104	1.5	...	344
14	9	238	2.5	...	980
6	10	132	1.9	...	570
10	11	280	4.1	...	1,200
28	12	924	13.5	28	3,780
30	13	1,200	17.6	60	6,000
18	14	846	12.4	36	3,870
16	15	864	12.5	48	3,440
12	16	720	10.6	48	3,420
26	17	1,716	25.2	156	5,440
10	18	750	11.0	100	3,850
16	19	1,360	20.0	192	6,720
24	20	2,400	35.3	336	14,720
8	21	976	14.2	136	6,187
14	22	2,072	30.4	252	12,053
14	23	2,352	34.5	336	14,187
18	24	3,330	48.9	468	20,280
12	25	2,424	35.6	336	13,570
6	26	1,272	18.7	180	7,427
8	27	1,744	25.6	256	11,147
4	28	892	13.1	136	5,760
4	29	912	13.4	144	5,973
6	30	1,392	20.3	228	9,200
4	31	960	14.1	160	6,290
8	32	1,888	27.7	336	12,850
10	33	2,510	36.9	440	16,530
Tot'l, 362	..	34,508	505.1	4,412	195,788

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