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EMORY OAK IN SOUTHERN ARIZONA.

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EMORY OAK IN SOUTHERN ARIZONA.

Emory oak (*Quercus emoryi*) forms one of the most important types of the open woodland forest of the Southwest, and is the most common oak in the mountains of southern New Mexico and Arizona. It affords protection to watersheds, and has high value for fuel in a region where wood is scarce. Also, there is a possibility that its bark, which is fairly rich in tannin, may become a source of tannic acid for the Southwest.

RANGE AND OCCURRENCE.

The east and west range of Emory oak is from western Texas to the western slopes of the Pajarito Mountains, Ariz.; from north to south it occurs from the south-central portion of Arizona (south of the Colorado Plateau) to the south-central part of the Province of Chihuahua, Mexico. In Texas it grows on most of the mountain ranges west of the Pecos River, and is especially abundant in the canyons and on the southern slopes of the Limpio and Chisos Mountains. Its best development in the United States is probably in the Garces National Forest, in southern Arizona, where it furnishes at least half of the timber supply. Here it is valued for fuel more than any other native oak.

CLIMATE.

The climate typical of the region within which Emory oak grows is that of the mountains along the Mexican border, where the two rainy seasons are from November to March, inclusive, and from July to September. At the base of the foothills the average annual precipitation is approximately from 11 to 12 inches; but in the mountains it may be as much as 25 inches for a series of years, or even more in exceptional years.

The winter rains, which are very irregular, originate on the Pacific coast, and are usually preceded by easterly winds. They are not as torrential as the summer rains, which originate in the Tropics. From these the precipitation comes mainly during the afternoon or evening in the form of heavy local thunderstorms, which occur daily for periods of a week or more at a time, starting usually about the end of the first week in July. While these storms furnish most of the soil water for tree growth, the evaporation, at low altitudes, is much greater than the precipitation.

In the whole region there is but little tree growth in the winter rainy season, only moderate growth in the spring dry season, much growth in the summer rainy season, and slight growth in the late dry season.

SOIL AND MOISTURE.

Emory oak so adapts itself to conditions of soil and moisture that it is able to grow on a variety of sites, though it does best in deep alluvial soils with abundant water. In the best sites in the broad valleys the soil may be 20 feet deep and have a constant supply of underground water within reach of the roots. In the narrow valleys and on the slope bases and bench lands the soil may vary, on the best sites, from 3 to 15 feet in depth, with moderately good soil-moisture conditions, and, in the best situations, some periodic surface flow of water. On the slopes the site has a very decided influence on growth, and there is marked advantage to the trees in the deeper soils of the lower slopes and in the greater moisture of north and east slopes.

ASSOCIATED SPECIES.

In broad, open valleys the commonest associates of Emory oak are mesquite (*Prosopis juliflora velutina*), acacia (*Acacia greggii*), and desert willow (*Chilopsis linearis*), though on the most moist situations there will be ash (*Fraxinus velutina*), sycamore (*Platanus wrightii*), and willow (*Salix taxifolia*). Although scarcely ever found in the bottoms of the valleys, blue oak (*Quercus oblongifolia*) is an intimate associate on the bases of the slopes that border these valleys.

In the narrow valleys, on slope bases, and on benches the stand may be pure or mixed with any one or all of the following species: Arizona white oak (*Quercus arizonica*), white-leaf oak (*Quercus hypoleuca*), Chihuahua pine (*Pinus chihuahuana*), and alligator juniper (*Juniperus pachyphlœa*). Even when all are present Emory oak usually predominates.

Since slope stands are transitional, they present the greatest diversity of associated species. Arizona white oak and white-leaved oak are the commonest associates on north and east slopes; on south and west slopes, blue oak, mountain mahogany (*Cercocarpus parvifolius*), cliff rose, manzanita (*Arbutus xalapensis*), and numerous shrubs. At elevations of from 6,000 to 7,000 feet there is a considerable mixture of Mexican piñon (*Pinus cembroides*).

FIG. 1.—TYPICAL STAND OF VETERAN EMORY OAK IN THE BROAD, OPEN VALLEYS; ALAMO CANYON, ELEVATION 3,500 TO 4,500 FEET.

FIG. 2.—THICKET STAND OF EMORY OAK IN WHICH SIDE BRANCHES HAVE BEEN PRUNED TO A HEIGHT OF 5 FEET; NEAR MOWRY MINE, PATAGONIA MOUNTAINS.

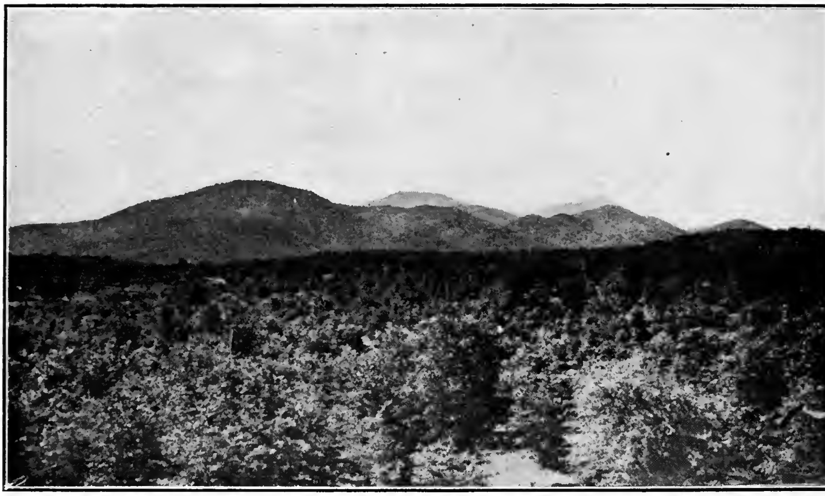

FIG. 1.—NEARLY PURE THICKET STAND OF EMORY OAK TRANSITIONAL BETWEEN BROAD VALLEY AND BENCH TYPE, WITH GOOD SLOPE STAND IN BACKGROUND; SOUTHWEST OF MOWRY MINE, PATAGONIA MOUNTAINS.

FIG. 2.—MIXED STAND OF EMORY OAK AND WHITE-LEAVED OAK ON A NORTH SLOPE; NEAR FLUX CANYON, PATAGONIA MOUNTAINS.

CHARACTERISTICS OF THE TREE.

FORM.

Emory oak varies in form and size and character of stand more than any other oaks in its range, according to its situation; its leaf and bark forms, however, are fairly constant. This silvical variation is very pronounced in the extreme forms, although the gradation between types may be very slight. In a general way there are characteristic bottom stands and slope stands, as exemplified in the Garces National Forest, and these may be subdivided according to location. For the bottom stands there are: (1) Those of the broad open valleys at elevations of from 3,500 to 4,500 feet; (2) those in narrower valleys at from 4,500 to 5,500 feet; and (3) those on slope bases and bench lands at elevations of from 3,800 to 5,500 feet. There are two subdivisions of the slope stands: (1) Those on north and east slopes at elevations of from 5,000 to 7,000 feet and (2) those on south and west slopes at from 5,000 to 7,000 feet.

In the broad, open valleys the tree reaches its maximum development, with breast-high diameters of from 2 to 3 feet and a total height of from 60 to 70 feet. Indeed, some of the trees in these situations are 3½ or 4 feet in diameter and 80 feet tall.[1] In these large trees the clear length may be from 10 to 30 feet. The shape of the crown varies according to the age of the tree, being a tall and regular oblong in the younger veterans and a broad, flat oval in the old ones. One strong characteristic is the flat plane in which the leaves and twigs grow on the branches. This peculiar growth is not particularly noticeable in standing trees, but shows very plainly in one that has been felled.

In the narrow valleys the trees are much smaller, with a breast-high diameter of from 6 to 8 inches and a height of 20 or 30 feet, though occasionally they may be from 12 to 18 inches in diameter and as much as 40 feet high. Here the clear length varies from 1 to 15 feet, and the crown is a narrow oblong, with a tendency, however, toward the oval in the older trees. Not only do the leaves and twigs grow in horizontal planes, even more markedly than in the trees of the broad valleys, but the branches themselves are nearly at right angles with the stem.

In the slope stands the individual trees are shorter and have a wider crown in proportion to their height. The stands on the north and east slopes are from two to three times as dense as those on south and west slopes.

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[1] Dr. Edgar Alexander Mearns states, in Bulletin 56, U. S. National Museum, "Mammals of the Mexican Boundary of the United States," that he has seen trees in the neighborhood of the Garces National Forest which are about 100 feet high.

FOLIAGE.

Although usually considered an evergreen, like the live oaks, there may be times during the year when Emory oak is leafless. Old trees are rarely without some leaves, but younger ones, up to 15 or 20 feet tall, may be bare for two or three weeks before the new leaves appear, and, in dry seasons, even for a month or two. During normal seasons Emory oak leafs in late April or early May, but, in an abnormally dry year, may not leaf until June or early July. There is a current opinion that all the old leaves are shed just before the new crop appears; as a matter of fact trees begin to shed their leaves in the fall, and continue to do so throughout the winter and early spring.

ROOT SYSTEM.

Just as the form of the tree above ground is determined largely by the site, so is the root system. The best developed roots are on the large trees of the broad valleys, where the soil is deep, porous, and moderately moist. They have well-developed tap roots and numerous laterals within the first 2 feet beneath the surface. The laterals, like the branches above, spread out in distinct planes, and at varying distances from the stem, have sublaterals that go down at right angles from 3 to 10 feet. The laterals that are close to the surface serve two purposes: First, they secure proper aeration when the ground is saturated; and, second, they are needed to anchor such large-crowned trees. The tree has an overdeveloped, or hypertrophied, root collar, because the present survivors are not of seedling growth. Even with trees of undoubted seedling origin, repeated killing back, either by fire, browsing animals, or frost and drought, make the final trunk the survivor of many sprouts or sets of sprouts.

Other marked characteristics of the root system are the intense red color of the inner bark, the small proportion of root branching, except near the root tips, and the strong development of mycorrhiza.

GROWTH.

It is comparatively easy to determine the growth of Emory oak, because its annual rings are more distinct than those of other black oaks of the region and much plainer than those of the white oaks. Generally there is an abrupt formation of the large thick-walled vessels in spring, though on poor sites, or as the result of abnormal seasons, the annual character of the rings may not be readily determined. Sometimes, as in seasons of more than one distinct growth period, with a time of comparative vegetative rest between, there will be false rings, though these are rare.

Even on the same site growth may vary with individual trees or groups of trees, and slightly better soil-moisture conditions in isolated patches will enable some trees to put on their leaves in a dry season during late April or early May, while most of the trees are leafless until June or July. This may result in a broad ring on the favored trees, while the rest of the stand can make only a narrow one.

A peculiar growth characterized thousands of acres in the Canelo Hills, where an inch of rain in early June was not followed by any precipitation for a month. Emory oak and Arizona white oak developed leaves, which were not more than from 1 to 2 cm. (0.4 to 0.8 inch) long. When the unusual rainy season started in July the June leaves failed to develop further, which indicated that the meristem tissue had lost its function, though the leaves seemed normal in all other respects. New leaves of normal size were formed, and these, at the end of the growing season, were from 10 to 20 times as large as the leaves formed in June. Still another indication of the adaptability of the species to changes in growth conditions is the appearance of new leaves and shoots as late as the first of September.

Sprouts in the valley stands were measured for height and diameter growth, and the results of these measurements are given in Table 1. "Injury sprouts" are those which are the results of accidental harm, such as would come through grazing or fire. The stump sprouts are, of course, those which spring from the stump of a felled tree.

TABLE 1.—*Height and diameter growth of sprouts in valley stands.*

Age.	Height.		Diameter, breast high.	
	Injury sprouts.	Stump sprouts.	Injury sprouts.	Stump sprouts.
Years.	*Feet.*	*Feet.*	*Inches.*	*Inches.*
5	4.5	8.3	0.85	1.20
10	8.7	14.5	1.70	2.95
15	12.4	17.8	2.60	4.65
20	15.7	20.1	3.50	6.15
25	18.7	22.1	4.55	7.45
30	21.3	23.8	5.65	8.65
35	23.5	[1] 25.4	6.80	[1] 9.85
40	25.5	....	7.90	....
45	27.5	....	9.05	....
50	29.2	....	10.20	....
55	30.7	....	11.25	....
60	32.2	....	12.30	....
65	33.5	....	13.30	....
70	34.7	....	14.30	....
75	35.9	....	15.30	....
80	37.1	....	16.20	....
85	38.2	....	17.10	....
90	39.3	....	17.95	....
95	40.3	....	18.80	....
100	41.9	....	19.60	....
105	42.4	....	20.35	....
110	43.4	....	21.15	....
115	44.4	....	21.85	....
120	45.3	....	22.60	....
125	46.3	....	23.30	....
130	47.3	....	24.00	....
135	48.3	....	24.75	....
140	49.3	....	25.50	....
145	50.3	....	26.30	....
150	51.3	....	....	....

[1] No stumps were older than 35 years.

Table 1 shows that the height growth is slow and the diameter growth fairly rapid, and that, at the start, the growth of stump sprouts is better than that of injury sprouts. Yet, at 35 years, the rate of height growth of the injury sprouts is 2.2 feet in 5 years as against only 1.6 feet for those from the stump; and the rate of diameter growth of injury sprouts for the same period is 1.15 inches and only 1 inch for the stump sprouts. This difference is probably attributable to the fact that the injury stools are younger, and therefore more vigorous. At the same time it must be understood that the larger number of sprouts from a stump will more than compensate in actual volume of wood production for a greater growth of the individual injury sprouts. Moreover, the stump sprouts tend to have a greater clear length than the injury sprouts.

In order to secure an exact idea of the effect of elevation on growth measurements were taken at intervals of 100 feet on a northeast slope, the summit of which was 350 feet above the valley, with an absolute elevation of 5,800 feet. That increase in elevation results in decreased growth is shown in Table 2. The differences in growth may be ascribed primarily to differences in soil depth, soil moisture, and protection from wind, all of these influences being more favorable at the bases of the slopes.

TABLE 2.—*Influence of elevation on height and diameter growth in slope stands.*

Altitude.	Average age.	Average height.	Average diameter, breast high.	Average yearly height growth.	Average yearly diameter growth.
Feet.	*Years.*	*Feet.*	*Inches.*	*Foot.*	*Inch.*
5,550	10.6	8.03	1.17	0.758	0.110
5,650	15.7	7.70	1.09	.427	.070
5,750	18.8	7.05	1.03	.375	.055

REPRODUCTION.

Although Emory oak produces seed abundantly, and much of this seed germinates to furnish the original seedlings from which subsequent sprouts develop, reproduction is due almost entirely to sprout growth. Coppice growth is evident everywhere, but even where this is only one straight stem, as in the broad valleys, careful examination will reveal its sprout origin. In fact, diligent search for a distinctly seedling growth failed to disclose a single example. While more actual seedling reproduction would ensue if fires and grazing did not kill back the growth, another reason for the comparative lack of seedling growth is the destruction of the acorns themselves. These usually ripen in August and are a staple article of food with the Indians and Mexicans, who collect them in immense quantities, gathering them from the ground. In a good year one man can pick up 50 pounds of acorns in a day, and they sell for not less than 5

CHARACTERISTIC ROOT COLLARS OF EMORY OAK.

LEAVES OF EMORY OAK AND ARIZONA WHITE OAK, SHOWING THE RELATIVE SIZE OF FOLIAGE PUT FORTH BEFORE AND AFTER A RAINY SEASON; COLLECTED IN THE CANELO HILLS DURING THE LAST WEEK OF SEPTEMBER.

cents a pound, even when the supply is plentiful. Birds, bears, and rodents eat the acorns, and many are spoiled by insect larvæ.

Since most of the stands have not been touched by the ax, the sprouts originate from injury to seedling growth, the principal sources of injury being fire, grazing, drought, or frost. These sprouts have been designated "injury sprouts," in contrast to the utilization or stump sprouts. Fire has been the chief source of injury, the fires having been set in the interest of the grazing industry, and rarely extinguished except where they threatened houses. Most of the stools represent many generations of sprouts, and none less than two generations. Since the damage from grazing and from unfavorable climatic conditions is restricted to seedlings or shoots, fire and cutting account for the origin of most of the stands.

Trees have been cut only near towns and mining camps, and since the stumps persist for at least 35 years, the resulting sprouts clearly show their origin. Stump sprouts, like injury sprouts, spring from the root collar, with but few exceptions. In the valleys only from 1 to 6 per cent of the stump sprouts come from the stem, and in all cases these were fewer in number and weaker in growth than those from the root collar. The reason for this lack of sprouting above the roots is found in the dryness of the climate and the consequent shrinking of the wood away from the bark, so that there is but slight chance for the formation of a callus. In the narrow valleys at higher elevations there was a slightly greater proportion of stem sprouts—from 2 to 10 per cent—due largely to lower stump heights, smaller diameter, and better atmospheric conditions. But even in stumps cut close to the ground most of the growth comes from dormant buds at the root collar.

Careful counts showed that there is little if any difference in the sprouting capacity between the north and south sides of the stumps, and the shade of the stump evidently has no protective influence.

Small stumps are more likely to produce sprouts and sprouts of greater vigor than large stumps.

As with other broadleaf trees, the season of cutting has a decided influence on the sprouting capacity of the resultant stump, and summer cutting is most likely to result in the death of the stump. When land is to be cleared for cultivation the trees are cut in August or are girdled then and cut the following year. Emory oak is locally considered a tree which it is hard to kill simply by cutting. Nevertheless, on many cut-over slopes in the Pajarito Mountains the sprout growth has failed entirely on areas immediately adjoining thrifty stands of stump coppice. It appears, therefore, that the season, or possibly the method of cutting, or the occurrence of a severe drought have caused the failure. It seems reasonable that the best time for cutting to secure coppice growth is between November and April.

CAUSES OF INJURY.

FIRE.

Emory oak constitutes no exception to the general truism about any tree in America—that fire is its greatest enemy. Fire is not only a source of injury in itself but is the antecedent of secondary injury by insects or fungi, or both combined. The worst fire season lasts from February until the heavy rains of July, and the most severe fires occur in May or June.

In the open valleys the thick bark of the old trees forms a sufficient protection against most of the fires, but younger trees, up to 2 or 3 inches in diameter at the base are seriously injured, and smaller sprouts and young shoots are killed outright. In narrow valleys and on bench lands, where the thickets reach a maximum density and there is likely to be a good deal of litter on the ground, the fires are extraordinarily bad, and may kill as much as 30 per cent of the dominant stand and all of the shoots and suppressed growth. Slope stands are damaged in direct proportion to their density and the amount of ground cover.

The usual fire damage on all growth more than 2 inches in diameter breast high—below that diameter the trees are killed—consists of a scorched bark which is rarely burned through, though it is usually cracked and loosened from the trunk. This permits the entrance of fungi which cause a heart rot that is very common.

When sprouts are killed back to the ground, from 5 to 25 new shoots spring from the root collar and make a height growth of from 1 to 4 feet the first season. If the fire is late in the season this growth fails to harden sufficiently to withstand winter conditions and is partially killed back. Occasionally some of the very tender shoots are affected by sun scald.

FIRE PREVENTION.

The people of the region have yet to learn the necessity of fire protection. Yet the effect of prevention of fire on the Garces National Forest can not fail to have an educative value, and the practice of allowing fires to run unchecked will come to an end. Fire fighting is comparatively easy because of the open nature of the stands, which makes most of the fires merely surface fires, except in the thickest stands or during severe winds. Where the grass is thick, the most effective method is judicious back-firing supplemented by beating the fires out with squares of canvas or wet gunny sacks; where the grass cover is thin or broken, the beating alone will suffice. The ground is not rough, it imposes no difficulties of transportation, and there are plenty of roads and trails, so that fire fighters can go readily from one place to another. The one difficulty is the scarcity of labor available, but this can be partly met by an adequate system of patrol supplemented by the use of the telephone.

INSECTS.

Observations indicate that the wood and bark boring insects do considerable damage. In certain stands as much as 95 per cent show the borings from the base to near the top of the tree. The openings in the boles and branches seem to give entrance to wood-decaying fungi.

WIND.

Windshake is prevalent, affecting one-eighth of the trees in even the most sheltered stands, and as much as three-fourths in the most exposed. Combined with the beetle galleries, the shake adds greatly to the liability to severe heart rot.

GRAZING.

In the spring, when the range grasses are not available, cattle and horses browse on Emory and other oaks, mesquite, acacia, and other woody growth. Where this growth is limited and there is much stock the young oak sprouts may suffer considerably, and some stools may be killed outright as the result of grazing, though such severe injury is uncommon. Indeed, browsing may have a beneficial effect as a form of pruning early in the dry season, and certainly the evergreen oaks are an important asset to the grazing industry in helping to carry the stock over to the rainy season.

FUNGI AND MISTLETOE.[1]

The heartwood of living trees of the Emory oak is attacked by a number of species of fungi. *Polyporus dryophilus* Berk. frequently causes a brown and white mottled rot, commonly known as the piped rot; next in frequency of occurrence is *Fomes everhartii* (Ellis and Gall.), which causes a whitish rot varying to brown on the outer edges; *Polyporus sulphureus* (Bull.) Fr. occurs occasionally, producing a brown, coarsely checked rot; *Polyporus obtusus* Berk. and *Hydnum erinaceus* Bull. cause whitish rots of less frequency.

The wood of dead trees and timbers of oaks of this species are attacked by a number of species of fungi, which as a rule attack first the sapwood and later may rot the heartwood. *Ganoderma cortissii* (Berk.) Murr. causes a whitish, stringy rot of the butts of dead trees and stumps; *Polyporus gilvus* (Schw.) Fr. is found attacking the sapwood of defective living trees, as well as that of dead trees and logs; *Polyporus adustus* (Willd.) Fr., *Polystictus versicolor* (L.) Fr., *Polystictus sanguineus* (Mey.) Fr., and *Stereum* spp. are also common causes of decay in dead oak trees and timbers of this species.

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[1] Contributed by Dr. George G. Hedgcock, Office of Investigations in Forest Pathology, Bureau of Plant Industry.

The mistletoe (*Phoradendron flavescens* (Pursh.) Nutt.) frequently attacks the Emory oak, evidently gaining entrance in the younger portions of the twigs. The clusters of mistletoe rob the limbs attacked of a portion of their nutrition, often causing the outer portion to dwindle and die. Severe attacks stunt the trees, and may in extreme cases kill them.

OTHER INJURIES.

Occasional terrific hailstorms of a local character defoliate whole stands, break tender shoots, and even scar the branches. A few trees are girdled and killed by lightning.

UTILIZATION.

While there has been a limited utilization of Emory oak for poles, posts, and mine timbers, it is used almost exclusively for fuel, for which it is preferred to the other woods of the region. Where Emory oak sells at $5 a cord for domestic firewood, the other oaks sell at from $3.50 to $4. At the mines the usual price for Emory oak is $3, and there is not a ready sale for the other oaks at $2. It is commonly reputed to make a hotter fire and to leave less ash; yet the comparative showing of Arizona white oak, under a careful test, indicates that there is no warrant for the existing strong prejudice against it. The results of this test are given in Table 3.

TABLE 3.—*Comparison of the heating values of Emory oak and Arizona white oak.*[1]

Part of tree.	Proportion of ash.		Heating value per pound.		Heating value of oaks compared with available coal and oil supplies per unit of weight.					
					Emory oak.			Arizona white oak.		
	Emory oak.	Arizona white oak.	Emory oak.	Arizona white oak.	Dawson coal.	Cerillos anthracite.	Bakersfield crude oil.	Dawson coal.	Cerillos anthracite.	Bakersfield crude oil.
	P. cent.	P. cent.	B.t.u.[2]	B.t.u.[2]	P. cent.	P. cent.	P. cent.	P. cent.	P. cent.	P. cent.
Trunk, average	3.70	7.36	8,339	7,499	67	63	43	60	57	39
Heartwood	12.47	3.70	7,497	8,239	60	56	39	66	62	43
Sapwood	2.54	5.53	8,203	7,620	66	62	43	61	57	40
Bark	9.13	17.38	7,839	5,618	63	59	41	45	42	29
Top, average	4.65	3.09	8,080	8,244	65	61	42	66	62	43

[1] Determined by H. S. Betts, Forest Service.

[2] British thermal units.

Table 3 shows that the heat value of an average sample, including heartwood, sapwood, and bark, from a butt cut, is about 10 per cent less in Arizona white oak than in Emory oak. The greatest difference is in the bark, Emory oak being 28 per cent better than the white oak. Since there is confusion in the popular mind between white oak and blue oak, which is admittedly inferior as a fuel, this may be an explanation of a part of the prejudice; but men

FIG. 1.—A VETERAN EMORY OAK TYPICAL OF THE LOW BROAD VALLEYS.

FIG. 2.—THE EFFECT OF POLLARDING OLD EMORY OAK; ONE OF THE TREES HAS BEEN KILLED.

who have used the three species and who readily identify them favor Emory oak, probably because its wood is more sound and less subject to heart rot than the other two species.

CORDWOOD.

Most of the cordwood is cut by Mexicans, who prefer the ax to the saw, as most woodsmen do; in their case, however, part of the preference for the ax is due to their inability to keep a saw in proper shape to do good work. Before the establishment of the National Forests in the region studied it was their custom to pollard large trees, or those which they thought would be hard to split. Even when trees were felled the stumps were likely to be 3 feet high. They never made a clean cutting, and although their wastefulness may be condemned as far as individual trees are concerned, the resultant effect on the forest has been better than that which would have followed indiscriminate clean cutting.

The wood is supposed to be cut and stacked into cords; yet not a single full cord was found in Nogales or at any of the mining camps. Instead of 4-foot lengths, the sticks were not more than 3½ feet long, and, where the buyer was unsuspecting, not more than 3 feet. Every effort is made to make the stack look large with the least possible amount of wood. The branches are crooked, and the piles are as loose as they can be made—as the saying is, "so you could throw a dog through them anywhere." Under these conditions the actual solid content of wood is much short of what it should be and of what it would be if the sticks were cut full length and were well stacked. The usual short cord contains about 65 cubic feet, whereas a full cord should contain about 72 cubic feet, or about 10 per cent more. With the usual 3½-foot stick length, 65 cubic feet can be used as a converting factor for cordwood volume tables.

Table 4 gives the solid cubic contents of Emory oak trees in cubic feet by diameter at breastheight:

TABLE 4.—*Cubic contents of Emory oak, of various diameters.*[1]

Diameter, breasthigh.	Volume.	Basis trees.	Diameter, breasthigh.	Volume.	Basis trees.
Inches.	*Cubic feet.*	*Number.*	*Inches.*	*Cubic feet.*	*Number.*
3	0.5	20	17	41.0	4
4	.9	35	18	49.5	5
5	1.6	12	19	59.0	1
6	2.4	10	20	68.7	3
7	3.4	7	21	78.4	1
8	4.5	9	22	89.7	4
9	6.0	15	23	101.8	1
10	8.0	4	24	113.8	3
11	10.4	9	25	126.0	2
12	13.4	7	26	140.0	2
13	17.0	6	27	155.0	2
14	21.5	2	28	170.0	1
15	27.0	7			
16	33.5	4	Total..	....	176

[1] Includes trees over 3 inches in diameter and cordwood sticks down to 1½ inches middle diameter.

TANNIN POSSIBILITIES.

The use of the tannin content of Emory oak has often been suggested, although the tannin would be very dark colored unless clarified. In the scarcity of other tannic agents it ought to furnish the supply for an industry in its region. Table 5 shows the quantity and sources of the tannin in the three most prominent oaks of Arizona.

TABLE 5.—*Tannin content of the different parts of Emory oak, Arizona white oak, and blue oak.*

Species.	Live or dead section.	Location of section.	Sample.	Insoluble solids, reds, etc.	Soluble solids.	
					Non-tannin.	Tannin.
				Per cent.	*Per cent.*	*Per cent.*
Q. emoryi	Live	Base of trunk	Bark (32.5 per cent)	2.1	6.6	7.4
			Wood (67.5 inches).	.8	4.4	3.1
			Average	1.2	5.1	4.5
		Ultimate branches.	Total	.7	5.7	3.7
		Twigs	do	.8	7.2	2.6
		Twigs and leaves	do	1.5	5.8	2.7
	Dead	Lower branch of 12-inch tree.	Bark (33.3 per cent)	.6	3.3	2.9
			Wood (66.7 inches).	.6	2.5	1.8
			Average	.6	2.8	2.2
		Lower branch	Bark (28.7 per cent)	1.2	4.9	5.4
			Wood (71.3 inches).	.8	4.9	3.4
			Average	.9	4.9	4.0
Q. arizonica	Live	Base of trunk	Bark (27.8 per cent)	1.4	5.7	3.1
			Wood (72.2 inches).	.9	7.3	1.7
			Average	1.0	6.9	2.1
		Branch 5 feet above ground on 12-inch tree.	Bark (26 per cent)	1.0	2.7	2.6
			Wood (74 inches)	1.1	5.9	5.8
			Average	1.1	5.1	5.0
		Ultimate branches.	Total	.6	5.1	3.1
	Dead	Lower branch	Bark (13.9 per cent)	3.7	4.0	3.0
			Wood (86.1 inches).	1.0	4.1	3.8
			Average	1.2	4.1	3.7
Q. oblongifolia	Live	do	Bark (27.3 per cent)	.9	4.7	2.4
			Wood (72.7 inches).	.8	6.1	4.5
			Average	.8	5.7	3.9
		Branch	Total	.5	5.2	1.9

According to Table 5, Emory oak shows a fairly rich tannin content—7.4 per cent—in the bark at the base of the tree, as compared to the average for American tanbarks of about 10 per cent. The prospects for the commercial use of Emory oak are limited to the Southwest, but they seem so good there that its possibilities should be thoroughly studied.

OTHER USES.

There is but little activity in mining in the region, but even in the past, when the mines were being worked, Emory oak was rarely used for mine timbers. Yet most of the available conifers have been cut, and, as the region is very rich in minerals, there is likely to be a strong local demand for mine timbers, for which Emory oak will be used to some extent with other native oaks.

Though it is not of high value for posts, there is a limited use, in the absence of good post material.

MANAGEMENT.

Two principal recommendations are at the basis of the very simple rules necessary to the proper management of Emory oak: One is to keep fires out; the other is to prohibit cutting from July to September, and especially in August. The best results in securing coppice growth will accrue from a system which confines cutting to the period from November to April, inclusive.

The stands of large trees in the broad open valleys are the hardest to reproduce. Badly defective trees should be cut, and the density of the stand increased by protecting the shoots from stock. Since the range animals are not herded, and fences are out of the question, a trial might be made of piling brush over the stumps to protect the young coppice. This will, of course, increase the likelihood of injury by fire, but these stands are more easily protected from fire than from grazing.

In the narrow valleys and on the slopes reproduction is more assured. The stools are smaller, and have a stronger sprouting capacity than the large trees in the broad valleys. Because of this difference in size, it is easier to cut low stumps in the small stands. To save wood, the saw should be used in felling and in cutting up the timber above 6 inches in diameter. In thicket stands, where there are several sprouts to the stool, if the poorer ones are thinned out it will give the better sprouts the advantage of increased light.

Clear cutting should never be practiced, and the wasteful pollarding practiced by the Mexican woodchoppers, bad as it was, is preferable, as a sort of rough selection system, to a clear cutting, which tends to lay bare a large area and render all the unprotected new growth susceptible to all sorts of injuries.

Approved.

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Secretary of Agriculture.

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