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THE HAWAIIAN FORESTER AND AGRICULTURIST

VOL. XIX. HONOLULU, JULY, 1922. NO. 7

REPORT ON EXPERIMENTAL FOREST PLANTING AT HIGH ALTITUDES OF MAUI AND HAWAII

BY C. J. KRAEBEL, *Asst. Supt. of Forestry*

In June 1909 there was made the first planting of temperate-zone coniferous trees in an experiment conducted cooperatively by the Territorial Division of Forestry and the Federal Forest Service, with funds set aside by the latter service. In August 1911 the last sowing of seed and the last planting of seedlings concluded the establishment of the experiment. Between these two dates numerous plantings and sowings were made in the selected areas as plants and seeds became available. Since 1911 the only activities directed upon the experiment have been the maintenance of the plot fences during the first few years after establishment, and periodic examinations of the areas until April 1913. A partial examination was made in 1917 by Mr. C. S. Judd. Six progress reports were submitted by Mr. R. S. Hosmer to the District Forester at San Francisco as follows: April 15, 1911—June 2, 1911—February 28, 1912—March 24, 1913—April 1, 1913 (Memorandum)—February 2, 1914 (General summary).

The present statement is therefore the first decade report, since it presents a résumé of conditions ten years after the complete establishment of the experiment. Previous reports were made so shortly after the starting of the experiment that safe conclusions were not possible, but it seems reasonable that a full decade of growth might have produced results which can be useful in guiding any policy of future plantings. Although previous reports have stated the purpose and plan of the experiment it appears advisable to recapitulate briefly these features at this time.

OBJECT

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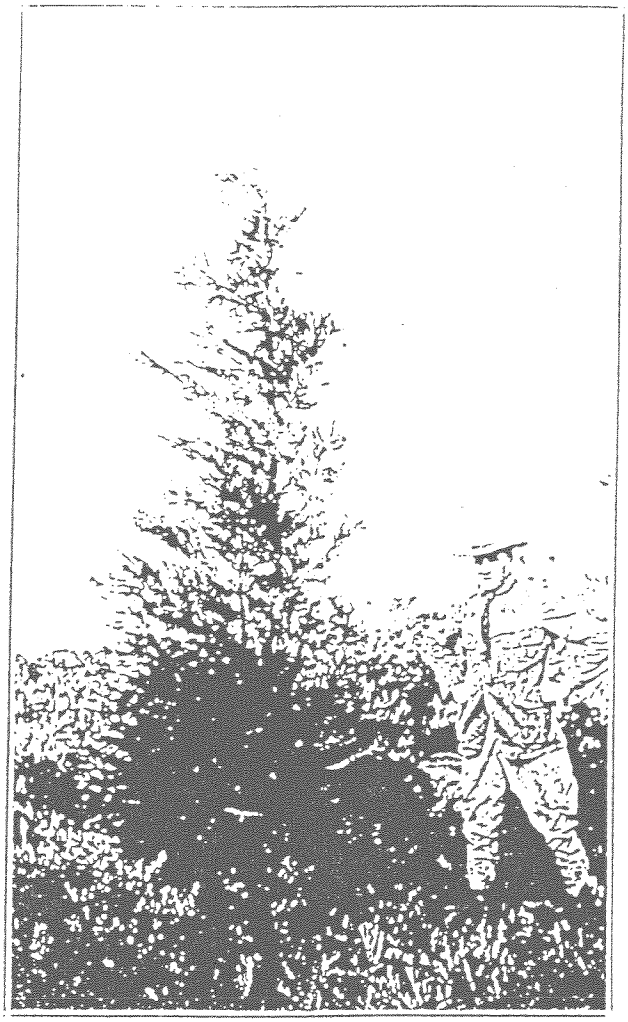

Plate II
Incense cedar (*Libocedrus decurrens*) at 6,500 feet on Haleakala. Planted in 1910, photographed in 1921.

Species Tested Hardwoods (37)

Acacia melanoxylon
Acer campestre
" macrophyllum
" platanoides
Buxus sempervirens
Fagus ferruginea
Fraxinus americana
" viridis
Gleditsia triacanthos
*Grevillea robusta
Ilex opaca
Liquidambar styraciflua
Liriodendron tulipifera
Nyssa multiflora
Platanus occidentalis
Quercus rubra
Robinia pseudacacia
Sophora japonica
Syncarpia laurifolia
Tilia americana
Ulmus campestre

Eucalyptus amygdalina
" botryoides
" citriodora
" cornuta
" corymbosa
" corynocalyx
" delegatensis
" diversicolor
* " globulus
" macrorhynca
" obliqua
" pilularis
* " robusta
* " rostrata
" rudis
" siderophoia

Results

Approximately 16,000 coniferous seedlings and transplants of all species were set out in all the plots. Of these there was found growing in October, 1921, a total of 743 or about 4.6%. Of the 70 species of trees, both conifers and hardwoods, which were tried in the seedpots only 173 individual seedlings were alive in October 1921. These striking figures, however, should not be taken at their apparent value, for this is greatly discounted by numerous factors. Many of the species tried were palpably unsuited to the sites; a considerable number of plants were poorly planted; rodents and livestock destroyed entire groups; severe and untimely droughts took heavy toll of tender seedlings; unskilled labor and lack of trained supervision were responsible for still more loss, etc. etc.

Below are presented the record of conditions in October 1921 in each of the eight experimental plots.

Trees Growing in October 1921

Plot I—Haleakala—6,500 feet

Species	Number	Av. Ht.	In Seedpots
Cedrus deodora	3	4'	...
Cryptomeria japonica	81	4'	...
*Cupressus arizonica	...	...	57
Juniperus virginiana	39	3'	...
Libocedrus decurrens	17	5'	78
Picea canadensis	21	5'	...
*Picea excelsa	83	6'	...

Species	Number	Av. Ht.	In Seedpots
*Pinus contorta (3 groups)	13	15'	...
*Pinus coulteri	67	4'	...
Pinus jeffreyi	9	6'	...
Pinus palustris	...	...	11
Pinus ponderosa?	...	...	24
*Pinus strobus	28	12'	...
Pinus sylvestris	15	6'	...
Pseudotsuga taxifolia	8	2½'	...
	384		170
Eucalyptus rudis			

*Asterisk denotes species which have begun to produce cones.

Trees Growing in October 1921

Plot II—Haleakala—7,000 feet

Species	Number	Av. Ht.	In Seedpots
Cupressus arizonica	...	...	69
Juniperus virginiana	1	4'	...
Libocedrus decurrens	2	2'	...
Picea canadensis	2	3'	...
Picea excelsa	4	3'	...
Pinus coulteri	8	1'	...
Pinus jeffreyi	2	2'	...
Pinus strobus	2	3'	...
Eucalyptus globulus	3	2½'	...
Eucalyptus rostrata	24	3'	...
Eucalyptus sp.	6	1'	...
Grevillea robusta	22	3'	...
	68		

Trees Growing in October 1921

Plot III—Haleakala—8,000 feet

8400

Species	Number	Av. Ht.
Cupressus arizonica	2	4'
Juniperus virginiana	4	3'
Libocedrus decurrens	3	2'
Picea excelsa	1	2'
Pinus contorta	1	8'
Pinus strobus	2	4'
Eucalyptus globulus	3	2½'
Eucalyptus sp.	2	5'
Eucalyptus sp.	4	2'
	40	

Trees Growing in October 1921

Plot IV—Haleakala—9,000 feet

Species	Number	Av. Ht.
(No conifers)		
Eucalyptus globulus	12	3′
Eucalyptus sp.	2	6′
	14	

Trees Growing in August 1921

Plot I—Mauna Kea—7,000 feet

Species	Number	Av. Ht.
Cedrus deodara	70	8′
Cupressus arizonica (cones)	1	..
Libocedrus decurrens	53	11′
Pinus coulteri (2 bearing cones)	29	14′
Pinus jeffreyi	44	6′
	202	

Trees Growing in August 1921

Plot II—Mauna Kea—9,000 feet

Species	Number	Ht.
Cedrus deodara	16	4′
Libocedrus decurrens	3	4′
Pinus coulteri	14	11′
Pinus jeffreyi	11	10′
Pinus palustris	2	5′
	46	

Trees Growing in August 1921

Plot III—Mauna Kea—11,000 feet

Species	Number	Ht.
Libocedrus decurrens	1	2′

Trees Growing in August 1921

Plot IV—Mauna Kea—8,000 feet

Species	Number	Av. Ht.
Cupressus arizonica (seedspot)	2	*
Eucalyptus robusta (planted)	7	25′

*The two cypresses were mere sprouts from the roots of dead trunks of former trees which had been trampled and killed by cattle and sheep. One twig bore three cones. Might have formed trees if protected from cattle.

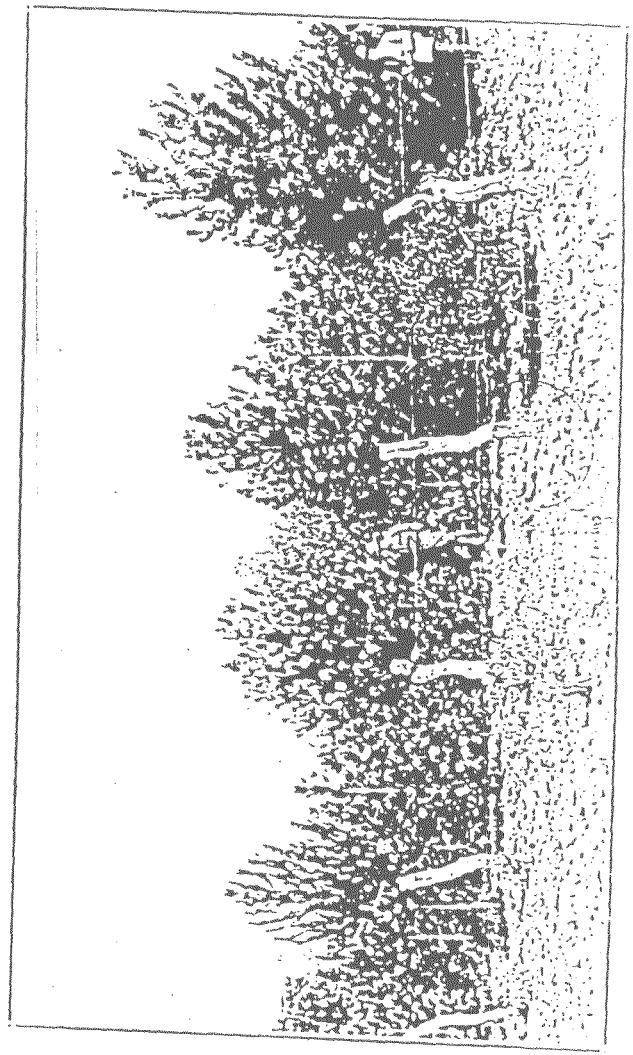

Plate IV

Coulter pine and Jeffrey pine at 7,000 feet on Mauna Kea. Smaller trees along fence are Jeffrey pine. Planted in 1910, photographed in 1921.

Plate III

Group of Coulter pines (*Pinus coulteri*) at 6,500 feet on Haleakala. Planted in 1910, photographed in 1921.

SUMMARY AND RECOMMENDATIONS

Out of a total of 86 species tested, 19 proved more or less successful, these being divided between conifers and hardwoods, as follows:

Conifers—49 species tried, 15 established.

Hardwoods—37 species tried, 4 established (all Australian species).

It is significant that among the hardwoods none but the Australian species was able to endure the severe site conditions of drought and extreme exposure. The complete failure of the mainland hardwoods dismisses them from further consideration, although it must be remembered that these were all tested in seedspots only, and that if transplants from the mainland had been used some of them might have proven successful.

The following table presents a condensed comparison of the fifteen successful conifers, plot by plot, on the two mountains Haleakala and Mauna Kea. The overwhelming superiority of the Haleakala plots is at once apparent:

	HALEAKALA				MAUNA KEA			
	I	II	III	IV	I	II	III	IV
Cedrus deodara	3	..	..	..	70	16	..	..
Cryp. japonica	81	..	..	..	..	..	..	..
Cup. arizonica	57*	60*	2	..	1	..	..	2
Junip. virginiana	39	1	4	..	..	..	..	..
Liboc. decurrens	17 78*	2	8	..	58	3	1	..
Picea canadensis	21	2	..	..	..	..	..	..
Picea excelsa	83	4	4	..	..	..	..	..
Pinus contorta	13	..	1	..	..	..	..	..
Pinus coulteri	67	8	..	..	29	14	..	..
Pinus jeffreyi	9	3	..	..	44	11	..	..
Pinus palustris	11*	..	..	..	..	2	..	..
Pinus ponderosa	24*	..	..	..	..	..	..	..
Pinus strobus	28	5	7	..	..	..	..	..
Pinus sylvestris	15	..	..	..	..	..	..	..
Pseudotsuga taxif.	8	..	..	..	..	..	..	..
	554	85	27	0	202	46	1	2

*In seedspots.

It will be appreciated at a glance that the lowest altitude plots were most successful. The tendency of future plantings should therefore be to concentrate upon available land at the lower elevations, leaving the upper levels for further experiment in which, perhaps, species better adapted to those altitudes will be found.

From the standpoint of numbers alone it is a simple matter to select the most successful species from the foregoing table. But in selecting the most desirable species for future extensive planting other considerations than mere numbers have weight. Such are the utility or commercial value of the wood, the habit and rate of growth, adaptability to the site, and particularly the reproductive powers of the species. In the present instance Coulter pine has made by far the best growth, has begun producing cones on plots at 7,000 and 8,000 feet elevation and has generally proven itself excellently adapted to the site. Physically it has made the best showing of all the species, and with its vigorous cone production gives promise of becoming self-perpetuating. Yet, because of the low value of its wood for any useful purpose, it can not be given first place in plantations intended for timber production.

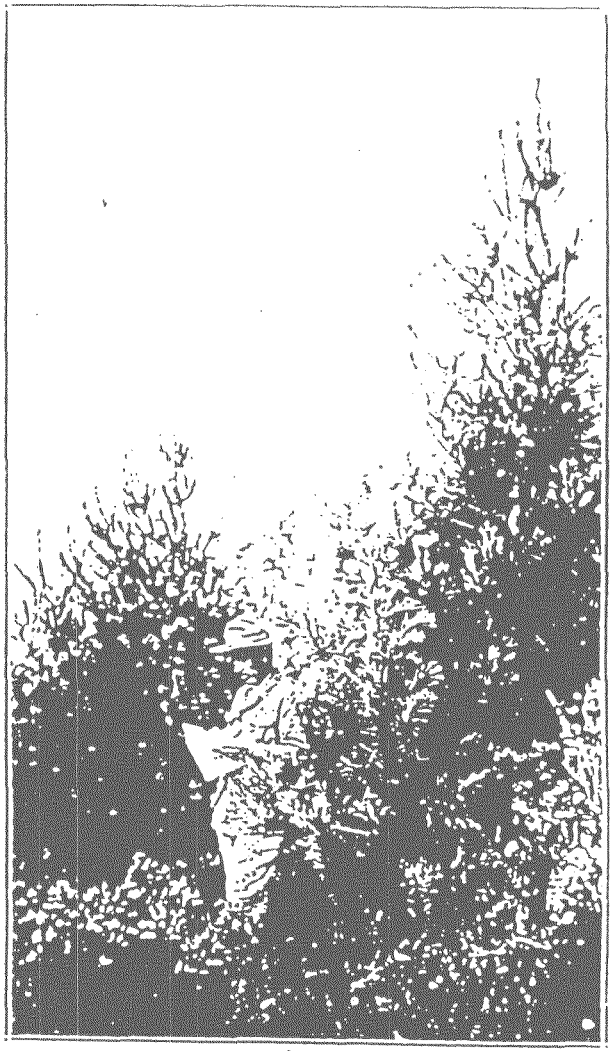

Plate I

White pine (*Pinus strobus*) at 6,500 feet on Haleakala. Planted in 1910, photographed in October, 1921

After careful consideration of the numerous factors involved, the following is the order in which the twelve best species recommend themselves for future plantings, based upon their behavior in the present experiment:

1. Pinus strobus
2. Pinus coulteri (as nurse tree, to establish good forest conditions)
3. Libocedrus decurrens
4. Picea excelsa
5. Pinus jeffreyi
6. Pinus contorta
7. Pinus canadensis
8. Pinus sylvestris
9. Pinus ponderosa
10. Juniperus virginiana
11. Pseudotsuga taxifolia
12. Cedrus deodara

With regard to the method to be pursued in establishing future plantings it is felt that the local nursery idea is the best. The comparative failure of this method in the present experiment was not the result of the method but of extraneous circumstances which upset the proper procedure. It is, of course, difficult to maintain a nursery at high altitudes, but the chief difficulty seems to be one of personnel rather than site. It is hard to get a reliable nurseryman to live in the remote upper slopes. If the work were to be undertaken on a large scale it would be the best economy to make the inducements sufficiently attractive to keep a good man continuously at the nursery. Seeds could be collected from desirable localities on the mainland, probably by the Federal Forest Service, and propagated in such a nursery at a reasonable distance from the planting site. Topographically the situation on Haleakala and Mauna Kea is better than in many commercial reforestation projects on the mainland.

The degree of success attained in the present experiment, in spite of vicissitudes and many adverse circumstances, demonstrates clearly that the afforestation of the intermediate slopes of Hawaii's mountains is entirely feasible. Moreover, the rate of growth of several of the species tested, and their vigorous appearance in their unhospitable, windswept sites, compares favorably with the growth of similar species in their native habitat on the mainland. The fact that the peerless White Pine (*Pinus strobus*) and Incense Cedar (*Libocedrus decurrens*) stand among the most successful of all the trees experimented with may well be taken as the final convincing testimony in favor of extensive timber-forest planting in Hawaii.

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