



ACACIA KOA HAWAIIENSIS Roek
Koa.

Tree about 80 feet tall, with diameter of trunk about 4 feet; growing in the Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.

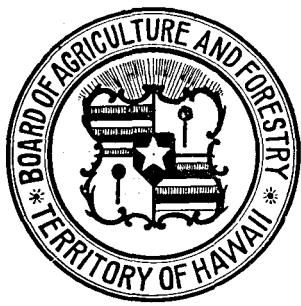
Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Arborescent Indigenous
Legumes of Hawaii

BY

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HONOLULU, HAWAII

LETTER OF TRANSMITTAL.

HONOLULU, HAWAII, Feb. 24, 1919.

*Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.*

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Arborescent Indigenous Legumes of Hawaii," by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry* and also *Botanist of the College of Hawaii*, and to recommend that it be published as Botanical Bulletin No. 5 of the Division of Forestry.

In this paper Mr. Rock has brought together botanical information concerning the few endemic arborescent species of the family *Leguminosae* found in the Hawaiian Islands which should be of particular interest because of the fact that it includes descriptions of the well-known koa.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:

*Board of Commissioners of Agriculture and Forestry,
February 27, 1919.*

CONTENTS

	PAGE
Letter of Transmittal.....	5
Preface	9
The Genus <i>Acacia</i>	11
The Genus <i>Acacia</i> in the Pacific.....	15
<i>Acacia</i> <i>Koa</i>	20
<i>Acacia</i> <i>Koa lanaiensis</i>	21
<i>Acacia</i> <i>Koa hawaiiensis</i>	23
<i>Acacia</i> <i>Kauaiensis</i>	23
<i>Acacia</i> <i>Koaia</i>	27
<i>Mezoneurum</i>	30
<i>Mezoneurum</i> <i>Kauaiense</i>	36
<i>Sophora</i>	37
Origin of <i>Sophora chrysophylla</i>	37
<i>Sophora chrysophylla</i>	40
<i>Sophora chrysophylla glabrata</i>	42
<i>Sophora chrysophylla unifoliata</i>	44
<i>Erythrina</i>	44
<i>Erythrina monosperma</i>	47

ILLUSTRATIONS

PLATE	PAGE
I.	Acacia Koa hawaiiensis Rock, Hawaii Koa Tree.. <i>Frontispiece</i>
II.	Acacia Koa hawaiiensis, Showing Tall Trees..... 12
III.	Acacia Koa Gray, Foliage, Fruit and Flowers.... 18
IV.	Acacia Koa hawaiiensis, Koa Tree Trunk..... 19
V.	Acacia Koa lanaiensis Rock, Foliage..... 22
VI.	Acacia Koa hawaiiensis Rock, Foliage..... 24
VII.	Acacia Kauaiensis Hillebr., Foliage..... 25
VIII.	Acacia Koaia Hillebr., Koaia Foliage..... 28
IX.	Mezoneurum Kauaiense (Mann) Hillebr., Uhiuhi Foliage 31
X.	Mezoneurum Kauaiense, Uhiuhi Tree and Foliage 34
XI.	Mezoneurum Kauaiense, Uhiuhi Tree..... 35
XII.	Sophora chrysophylla Seem., Mamani Trunk..... 38
XIII.	Sophora chrysophylla, Mamani Trees..... 39
XIV.	Sophora chrysophylla glabrata Rock, Mamani Trees 43
XV.	Sophora chrysophylla unifoliata Rock, Foliage.... 45
XVI.	Erythrina monosperma Gaud., Wiliwili Trunk... 48
XVII.	Erythrina monosperma, Wiliwili Tree..... 50
XVIII.	Wiliwili Tree on Kahoolawe..... 51

PREFACE

The Hawaiian Islands are very poor in arborescent *Leguminosae*; in fact, the whole family is very sparingly represented in comparison to families like *Rubiaceae*, *Rutaceae*, *Campanulaceae* tribe *Lobelioideae*.

Of truly endemic species other than arborescent ones the Islands possess only four, viz: *Canavalia galeata* Gaud. and a variety *pubescens*, *Vigna sandwicensis*, *Vigna oahuensis* and *Vicia Menziesii*; the last named has only been collected by early collectors such as Menzies, Macrae and Remy.

Of indigenous species found elsewhere we find twelve. A large number of species of *Leguminosae* have, however, been introduced and amount to about two hundred. Most of our introduced ornamental trees belong to this family.

THE GENUS ACACIA

Before discussing the three endemic Hawaiian species of *Acacia*, it may be worth while to consider the genus as a whole, at least its distribution. The name *Acacia* is of doubtful origin, but presumably has been taken from the word *akaso*, "I sharpen," in reference to the sharp spines with which many *Acacias* are fitted out, especially the African species, though a number of Asiatic species possess them also. Spines are, however, not characteristic of the Australian species, nor of any of those found elsewhere in the oceanic islands, as, for example, Hawaii, Fiji, Samoa, Tonga, and the New Hebridean group.

The genus *Acacia* is distributed over the warmer regions of the globe, but is particularly numerous in Africa and Australia. There have been described about 500 species or perhaps even more. The definite number cannot be given with any degree of certainty, as new ones are being continually discovered by botanists. The remarkable fact remains, however, that of the approximate five hundred species, more than three hundred are purely Australian. Of all these numerous species, found in Australia, only a single one, *Acacia Farnesiana*, is not endemic; the rest are peculiar to that continent. Again, the largest number of the Australian *Acacias* belong to the *phylloclineous* series, while only about twenty of the three hundred species have bi-pinnate leaves. The *phylloclineous* tribe, that is species with *phyllodia* (dilated leafstalks) instead of true leaves, are almost all Australian with the exception of a very few species found in the Pacific islands such as Hawaii, New Caledonia, Mascarene and others. These cannot be identified with any of the Australian species, but, nevertheless, they do come close to some of the tropical Australian species, as, for example, *Acacia melanoxyton* to *Acacia Koa*.

Tropical Africa possesses in the neighborhood of about fifty species, all with true leaves, so that they do not concern us here. There is, however, no doubt that the *Bipinnatae* (or *Acacias* with true leaves) are the more primitive of the *Acacias*. Xerophytic regions are responsible for the reduction of true leaves to *phyl-*



ACACIA KOA HAWAIIENSIS Rock
Koa.

Showing straight growth of bole in wet or fern forest, near Volcano
Kilauea, Hawaii; elevation 4000 feet.

lodia, as can be seen in certain bipinnately-leaved Australian species, where the leaflets of the pinnae have been reduced to a minimum, and where even the possibility exists to shed these leaflets in case of severe drought when their presence is either not necessary or dangerous to the plant. In no species of *Acacia* with typical bipinnate leaves has the occasional development of *phyllodia* been observed. The reverse has been of frequent occurrence. A number of *Phyllodineae* are known which revert back to bipinnate leaves, especially when they occur in situations with great humidity and where shade is prevalent. Bipinnate leaves will be found especially near the ground because of the proximity of humidity and shade condition, and also perhaps on account of their being primitive leaves. *Acacia Koa* in its young state, for example, especially when occurring in the rain forest, possesses bipinnate leaves only. Twigs with bipinnate leaves are occasionally found sprouting from the main trunks of large trees, especially after the winter rains.

The more primitive of the Australian *Acacias* are in all probability those with a globose (capitate) inflorescence, to which type the Hawaiian species belong. The *phyllodium* in *Acacia* is undoubtedly due to climatic conditions, and especially to light conditions. The drier and brighter the locality, the less foliage is usually developed and consequently the trees become open and shadeless. Wherever *Acacia Koa* grows in the rain forests of Oahu it forms dense globose crowns with a maximum amount of foliage, while *Acacia Koa hawaiiensis* in the upland of Hawaii produces large *phyllodes*, but the crowns are open and the foliage is scanty. Whether the described characteristics of *Acacia Koa hawaiiensis* are due to location or are inherent is difficult to state. The tendency to the development of broad *phyllodes* seems to be due to high altitude and consequent fog and mist. This has been illustrated in plants of *Acacia Koa hawaiiensis* grown from seed in San Francisco, California, whence Mr. W. M. Giffard brought the writer specimens of *phyllodia* of such width as have so far not been observed in any Hawaiian-grown plant. The narrow-leaved forms of the Oahu *Koa*, the true *Acacia Koa*, are due evidently to lower altitude and consequent absence of fog. The narrow *phyllode* is developed in greater number, resulting in a densely foliate crown.

The factors responsible for these types of *phylloides* have, then, been light, warmth, humidity and soil. We must, however, look upon the *phylloideous* character of *Acacia Koa*, not as evolved in Hawaii, but in its ancestor or ancestors on Australian soil. This character became modified by Hawaiian climatic conditions, which produced what we now recognize as *Acacia Koa*, its varieties, and *Acacia Koaia* and *Acacia Kauaiensis*.

Acacia melanoxyton R. Br. comes near *Acacia Koa hawaiiensis* especially in the vegetative organs if not reproductive organs, and fruit. The *phylloides* of *A. melanoxyton* R. Br. or the Blackwood of Australia are much closer to the variety *hawaiiensis* of *Acacia Koa* than the true *Acacia Koa* of Oahu. Both have the broad, obtuse, almost straight *phylloides*, the main difference being in the pod, which is narrow and more or less twisted in the blackwood and broad and straight in *Acacia Koa* and its varieties. The habits of the two species seem to be the same as the following extracts from Dr. J. H. Maiden's "The Forest Flora of New South Wales," and the illustrations of *Acacia Koa hawaiiensis* will corroborate. To quote:

"As far as southern New South Wales and Gippsland are concerned, the blackwood must be considered as a mountain species, though it occurs occasionally in the low coast land; but there it never attains any size. It varies a good deal in mode of growth, according to situation and geological formation. In the rich humus of the jungle of the mountain slopes, it attains a height of from 60 to 80 feet, and in Gippsland, along the boundary of New South Wales and Victoria, localities may be found where it attains a height of one hundred and twenty feet, and a diameter of nearly three feet. Their straight trunks may be seen without a limb, from sixty to eighty feet, the timber quite sound and possessing that beautiful dark color whence the species has derived its popular as well as its scientific name. When it grows on high mountains * * * amongst rocks and precipices it grows very gnarled and spreading, from twenty to forty feet high and from one to two feet in diameter, sending out thick, long, gnarled and crooked limbs quite close to the ground."

Any one who has seen *Acacia Koa hawaiiensis* on Hawaii in various stations such as humid rain forests and open lava flows, could hardly describe its habits otherwise than has been done by Dr. Maiden, in the article quoted on *Acacia melanoxyton*. The plates here introduced illustrate well these different habits.

THE GENUS *ACACIA* IN THE PACIFIC.

The number of *Acacias* in the Pacific islands is quite small, in comparison to the enormous number found on the continent of Australia. Those known are *Acacia spirorbis*, found in New Caledonia and the Isle of Pine, and *Acacia fulgens*, as well as *Acacia granulosa*, peculiar to New Caledonia.

Acacia laurifolia is one of the widest distributed species, being found in New Caledonia, Tahiti, Samoa, Tonga, and Viti Islands, as well as in the New Hebrides. *Acacia Richii* is peculiar to the Fiji Islands, where it occurs on Vanualevu and Nalao. In New Guinea a few species have been discovered, as *Acacia Simsii* in Dutch New Guinea, also *Acacia glaucescence*. Mr. Merrill, described a *phylloclineous* species (*Acacia confusa*) from the Philippines, the only one of that type known from that archipelago. To us the most interesting of all *Acacias* is *Acacia heterophylla* of Mauritius and Bourbon of the Mascarene group in the Indian Ocean, thousands of miles distant from Hawaii, with which our *Acacia Koa* is almost identical. It certainly is most peculiar to find two plants practically not at all distinct from each other in two so extremely remote geographical stations as Mauritius, in the Indian Ocean, in the southern hemisphere, and Hawaii, in the north Pacific Ocean. New Zealand, in such proximity to the source of *Acacia*, at least to the *phylloclineous* species, has not a single indigenous *Acacia*.

The Hawaiian Islands possess three species of *phylloclineous Acacias* and two varieties of one species. The island of Kauai, by far the oldest of the group, possesses a species (*Acacia Kauaiensis* Hillebr.) which is peculiar to it. *Acacia Koa* is, however, not absent. The former species seems to be restricted to the western part of the island. The typical *Acacia Koa* occurs all over Oahu, in one locality on Molokai, and is more or less distributed on Maui. On the island of Hawaii it is represented by a variety, *hawaiiensis*, while on Lanai another variety, *lanaiensis*, represents it. *Acacia Koaia* Hillebr. is found on Molokai, Maui and Hawaii in dry situations.

Next to ohia lehua (*Metrosideros collina polymorpha*), *Acacia Koa* is one of the most common forest trees. It occupies the zone from 1000-4000 feet elevation, but in some instances

ascends to 7000 feet elevation, as, for example, var. *hawaiiensis* on Hawaii. The presence of *Acacias* in Hawaii must be attributed to birds, as the seeds of *Acacias* are not particularly adapted for dispersal by ocean currents. Yet the birds to which we could attribute this introduction, or rather which could be responsible for its presence in Hawaii, do not exist today, but were in all probability the now extinct *columbae* and their relatives. The thought of human agency must altogether be excluded when we examine the fauna to which *Acacia Koa* is host. The writer can only quote Dr. Perkins' able words:

"In judging the length of time that any particular plant or group of allied plants has existed in the islands, the botanist would be well advised to consider the fauna that is specially attached to these. When one considers that trees little modified from foreign species, e. g., *Acacia Koa* or *Sophora chrysophylla*, possess a great endemic fauna, not only species, but even genera of birds and insects, quite restricted to or dependent on them, and that some of these creatures are certainly themselves not less remarkable in their peculiarities than the most peculiar of the Composites or Lobelias, we may hesitate to attribute such plants to a later era than many other elements of the flora, which at first sight appear far more ancient."*

In following up Dr. Perkins' statement we find, however, that he had not so much *Acacia Koa* in mind as the *Compositae* and *Lobelioidææ*, which, indeed, especially the latter, have peculiar birds dependent on them more or less for their existence. Dr. Perkins seems to class *Sophora chrysophylla* as an *Acacia*. To quote: "As with *Clytarlus*, the two native acacias, *Acacia Koa* and *Sophora chrysophylla*, are favorite foods of *Plagithmysus*, for six species are found on the former and three on the latter tree."‡

This would account for his remark that the Hawaiian *Acacias* have endemic genera peculiar to them. It is true that of fourteen species of the genus *Clytarlus*, all but one are peculiar to *Acacia Koa* and the single remaining one to *Sophora chrysophylla*.†

* Fauna Hawaiiensis, Introduction, Vol. I, part VI, page 60.

‡ *ibid*, page 117.

† For this information the writer is indebted to Mr. O. H. Swezey of the Hawaiian Sugar Planters' Experiment Station.

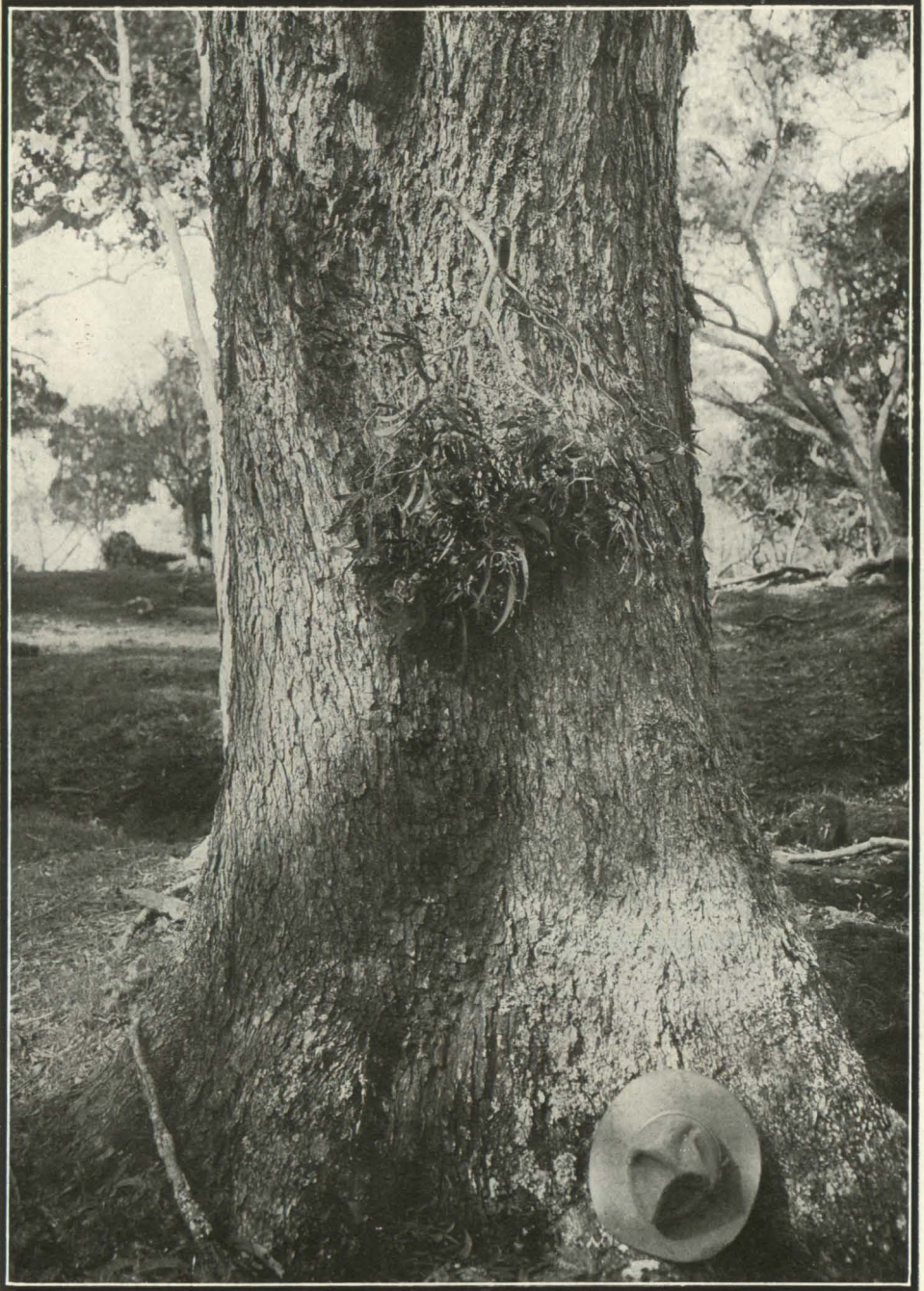
Perkins states that the remarkable bird *Pseudonestor* is continuously hunting for the larva of *Clytarlus* and those of *Platymysus*, and its stomach is often entirely filled with this food. All these facts tend to show that *Acacia Koa*, *A. Koaia* and *A. Kauaiensis* are old denizens and not recent arrivals, as must be assumed of *Metrosideros collina polymorpha*, the rival of *Acacia Koa*. Man, as the agent responsible for the presence of *Acacia* in Hawaii, must be absolutely excluded. For long before man in Hawaii, were the birds and native insects, and long before them the plants on which they are dependent for their subsistence.

The wood of the koa is a handsome brown, varying from very dark shades to a lustrous gold, often with a handsome grain, and is much prized for cabinet work. The large trunks supplied the Hawaiians with material for their dug-out canoes, and the bark was formerly used for tanning.



ACACIA KOA Gray
Koa.

About one-third natural size. Showing true leaves and phyllodia, flowers
and fruits.



ACACIA KOA HAWAIIENSIS Rock
Koa.

Showing trunk, bark and flowering branch; near tree-molds, Kilauea,
Hawaii; elevation 4000 feet.

Acacia Koa Asa Gray, Bot. U. S. Expl. Exped. 480. 1854.
Acacia heterophylla Hook. et Arn., Voy. Bot. Beech. 81. 1832.

Phyllodia falcate, coriaceous, 10-15 cm. long, varying from 6-8 mm. to 24 mm. or more in breadth, narrowed at the base, acute or obtuse at the tapering apex; the smooth surface is striate with many nerves, leaves on young plants bipinnate, each pinna consisting of 12-15 pairs of oblong emarginate, crowded leaflets; peduncles solitary or fascicled in the axils, about 12 mm. long, bearing a dense many-flowered head 8 mm. in diameter; calyx teeth very short; petals 5, oblong lanceolate, glabrous, more or less united, longer than the calyx, half the length of the stamens; legume broadly linear, straight or slightly falcate, 7.5-15 cm. long, 16-18 mm. broad, glabrous, flat, about 12 seeded, seeds flat, dark brown to black.

Acacia heterophylla Willd., with which *Acacia Koa* was first identified by Gaudichaud, who had seen both the Hawaiian plants and those of the island of Bourbon (Mauritius) growing in their respective native countries, differs from the Hawaiian *A. Koa* established by A. Gray very little, indeed, if at all. The writer has an authentic flowering specimen of *Acacia heterophylla* Willd. before him, from the Royal Gardens, Pamplemousses, Mauritius; the flowers which the writer examined of the last mentioned species differ very little from those of *Acacia Koa*; the sepals and petals in the Hawaiian plant are shortly dentiform, and like the petals united; the former are somewhat more deeply cut or in other words a little more lobed than in *A. heterophylla*. In the latter species the petals are slightly longer than in *Acacia Koa*. The *phyllodia* in *A. heterophylla* are much straighter, but are otherwise the same as in *A. Koa*; the leaflets are slightly shorter and broader. The difference, however, between *Acacia heterophylla* and *Acacia Koa* is much less pronounced than that between *Acacia Koa* and *Acacia Koala*. Asa Gray was correct in his statement: "*In distinguishing the two trees, peculiar to these most widely separated stations, perhaps I incur the charge of being influenced by geographical considerations rather than botanical characters.*"

Unfortunately the specimen in the College of Hawaii Herbarium of *A. heterophylla* has no pods, but from the description in Baker's Flora of Mauritius it can be judged that they do not differ much from those of the Hawaiian trees. On Hawaii the trees of *Acacia Koa* have certainly a different aspect from those

of Oahu, and broad *phyllode* specimens were named var. *latifolia* by Benthams; A. Gray states that it is only a state of the species. It is true that the *phyllodes* when young are of a different shape from the older ones, but in the Hawaii plants the mature *phyllodes* of any tree are much broader and ovate-oblong, and notwithstanding their width are shorter than or rarely as long as the Oahu specimens; they are, however, often more than twice as broad as those in the Oahu specimens. Whether the name *latifolia* was applied by Benthams to the young form of an Oahu specimen or to the typical Hawaii broad-leaved form cannot be determined now. The writer would suggest, then, for the Hawaii *koa* the varietal name *hawaiiensis*, and for Hillebrand's variety β , the name *lanaiensis*, since the variety has so far been found on Lanai only.

It is extremely interesting to find that in so widely separated regions as Mauritius, off the coast of Madagascar, in the southern hemisphere, and the Hawaiian Islands, in the middle of the North Pacific Ocean, there should occur two *Acacia* practically not at all differing botanically from each other. In the writer's opinion, A. Gray was not justified in establishing the Hawaiian *Acacia* as a separate species for mere geographical reasons. It may be stated that it is not taken for granted that *Acacia Koa* is derived from *Acacia heterophylla* or vice versa, but that they are an offspring from a common ancestor, the home of which was or is undoubtedly Australia, and that owing to similarity in climate and environment both have developed on common lines, notwithstanding the vast distance separating these geographical stations. The common ancestor may be looked for in relatives of *Acacia melanoxylon*, which has also connate sepals and petals, but varies mainly in the pod, which, however, comes exceedingly close to our *Acacia Koaia*.

Acacia Koa lanaiensis Rock

Acacia Koa β var. Hillebr. Flora Haw. Isl. 113. 1888.

A medium-sized tree, branching habit of the species, *phyllodes* 3.5-8 cm. long, 8-15 mm. wide, very little curved, almost straight, obtuse, mucronate, petiole about 4 mm., with the usual gland on the upper side; racemes very short, flowerhead and flowers as in the species; pod not seen.



Ex Museo botanico Berolinensi.

Acacia Koa
var. B.
Lanai.

COLLEGE OF HAWAII HERBARIUM

LANAI: Hillebrand in Herbarium Berlin and part of type in the Herbarium of the College of Hawaii;—Puu Manu, elevation 1000 feet, also Waiakeaku, the last valley of the main ridge, flowering July 29, 1910, Rock no. 8028 in herbarium College of Hawaii.

Hillebrand's specimens of this variety are much more distinct than the writer's from Waiakeaku. While short obtuse *phyllodes* occur, long acuminate ones occur also. As a whole the plant from Waiakeaku is little distinct, but Hillebrand's specimens are undoubtedly worthy of varietal rank.

Acacia Koa hawaiiensis Rock

A lofty tree reaching 25-33 m., and a diameter 1.7-2 m.; branches gnarled wide spreading; glabrate when old, densely tomentose when young, with a yellowish green velvety tomentum; leaflets broadly sessile with an oblique base, narrower towards the apex, rounded, with minute mucro, glabrate on both sides, but rachis tomentose; phyllodia broad obovate to ovate to linear-oblong, hairy when young on both surfaces, but soon glabrate, slightly curved, acute at both ends or obtuse at the apex and uncinata, many nerved (usually ten), 12.5-16 cm. long, 2.5-5 cm. wide, coriaceous, on petioles of about 5 mm., with a gland on the upper side at the base of phyllode; flowerheads single or two or three on a common peduncle of 1.5 mm., and the lateral ones, 3 mm.; heads densely flowered small; sepals one-third the length of the calyx, hirsute at the apex; stamens numerous; petals ovate, obtuse more than one-third the length of the corolla, pod about 11 cm. long, 2.5 cm. wide, flat, the suture straight or slightly wavy.

HAWAII: At the higher levels from 4000 to 6000 feet elevation;—Mt. Hualalai-Hinakapauula, fruiting June 10, 1919, Rock no. 3759;—Pulehua plains and forests, South Kona, flowering January 1912, Rock no. 12866;—Kau desert, elevation 3600 feet, July 15, 1915, Rock no. 12566—all in the College of Hawaii Herbarium.

This variety seems to be peculiar to the island of Hawaii, where it reaches very large dimensions. It can be distinguished mainly by its broad *phyllodes*, which are almost straight.

Acacia Kauaiensis Hillebr. Flora Haw. Isl. 113. 1888.

A large tree with many tortuous branches; phyllodia falciform, narrow-linear, 10-16 cm. long, about 12 mm. or less wide, with usually two or three prominent nerves, apex somewhat obtuse, mucronate-uncinate, with



ACACIA KOA HAWAIIENSIS Rock



type. No. 27586.

FLORA OF THE HAWAIIAN ISLANDS
HERBARIUM
BOARD OF AGRICULTURE & FORESTRY, TERRITORY OF HAWAII
COLLECTOR J. T. RICKS

Acacia *koa* *kauaiensis* (Hillebr.)
typical. Rock
Date Oct. 1911. Locality Kahoolumaui
Kauai

ACACIA KAUIENSIS Hillebr.

a pitted gland on the somewhat thickened petiole; inflorescence paniculate, terminal, foliose, or rather a paniculate raceme with phyllodia in the upper axils and below which are situated the peduncles of about 1 cm. in length, each bearing several single-headed pedicels 4-6 mm. in length, tomentose with a rusty tomentum; bracts minute; sepals 5-6, free to near the base, spatulate-obtuse, glandular pubescent as are the petals, the latter oblongeolate, one-half longer than the sepals, ovary puberulous; pod straight thick, coriaceous, 15 cm. long, 2 cm. wide, about 15 seeded, seeds as in *A. Koa*.

KAUAI: Halemanu, Knudsen no. 55;—Halemanu, fruiting February 14-26, 1909, Rock no. 2154 in College of Hawaii Herbarium;—Kaholuamano, outskirts of the forest, flowering October 1911, Rock no. 2755-b (type);—same locality, flowering October 1916, Rock no. 12868 in the herbarium of College of Hawaii.

The apparently typical form is no. 2755 from Kaholuamano and no. 2154 from Halemanu, where V. Knudsen collected his specimens. The free sepals and petals, and the racemose-paniculate inflorescence, distinguish this variety at once from the species; otherwise it has the same habit as *A. Koa*. This rather interesting tree, which Hillebrand established as a species, distinct from *A. Koa*, has hitherto been overlooked owing to its great resemblance to *Acacia Koa*. It inhabits the dry open slopes on the leeward side of Kauai on the edge of the canyons, especially on the Halemanu side along the Waimea canyon to Milolii. At the Kaholuamano side, where there seems to be a little more rainfall, the *phyllodia* are larger and the inflorescence is not exactly paniculate, though the sepals and petals are free. The tree does not reach such dimensions as the variety *hawaiiensis* of *Acacia Koa*, the trunk being usually short and the branches a good deal twisted and sometimes reclining nearly on the ground. The *phyllodia* are long, sickle-shaped and narrow, the upper ones being uncinat. Similar to *Acacia Koa hawaiiensis*, when growing in damp or wet mixed forests in company with other trees, it develops a tall straight bole some forty feet without branches, after which the crown commences. Beyond the Kopiwai forest it grows in company with *Xanthoxylum dipetalum Hillebrandii* Rock (*X. dipetalum* var. γ Hillebr.), *Alphitonia excelsa*, *Antidesma platyphyllum*, *Pelea Kauaiensis*, *Santalum pyrularium*, and others.

Acacia Koaia Hillebr. Flora Haw. Isl. 113. 1888.

A small gnarled tree, wood hard, close grained; branches terete, true leaves not seen; phyllodia coriaceous, falcate, linear, narrow, acute at the apex, acuminate at the base, with three prominent nerves, 6-12 cm. long, 8-10 mm. broad, the apex with a recurved mucro; petiole about 5 mm., with a thickened gland on the convex side of the petiole or rather base of the phyllode; racemes axillary with not more than three heads, generally reduced to a single one; flowers as in **Acacia Koa**; pod very narrow, 8-10 mm. in width, 10-15 cm. long, somewhat curved, not of even width, but with slight constriction between the seeds; seeds oblong, the long diameter (6 mm.) in the direction of the valves, flattened, with a funis of about the same length.

MOLOKAI: Kalae, Hillebrand in Herbarium Berlin and in the College of Hawaii Herbarium;—ridge above Kaunakakai and Kauluwai, March 1910, Rock in College of Hawaii Herbarium.

MAUI: E. Maui, Kula? Hillebrand.

HAWAII: Puukawai, Kawaihaeiuka, elevation 2000 feet, near Waimea, flowering and fruiting June 1910, Rock no. 8346 in the College of Hawaii Herbarium;—observed back of Puuanahulu, near Puuwaawaa boundary, on rough ancient aa lava flows.

Acacia Koaia Hillebr. differs from *Acacia Koa* A. Gray mainly in the pods, which are very narrow and somewhat curved. Also in the *phyllodes*, which are narrow linear and less curved. *Acacia Koaia* or *Koaie*, as the natives call this species, and which name was adopted by Hillebrand as the specific name, has a rather restricted distribution. It seems to be the older of the two species occurring in these islands. So far as known, it is absent from Kauai, Oahu and Lanai, also Niihau and Kahoolawe. On the three remaining islands it occurs only sparingly. On Molokai the writer collected it at Mapulo-u immediately below Kamoku on the dry exposed ridges leading towards the dry stony slopes of the Kaunakakai-Kauluwai district. It is a small bushy tree on the crest and protected declivities of a ridge, where it grows in company with *Myoporum sandwicense*, *Nothocestrum latifolium*, *Sideroxylon molokaiense* Rock (*S. spathulatum molokaiense*) and a species of *Lipochaeta* (*Nehe*). On the same island it was collected by Hillebrand at Kalae. On Maui it was collected by Hillebrand only on the lee slopes of Haleakala at



No. 8346

FLORA OF THE HAWAIIAN ISLANDS
 HERBARIUM
 BOARD OF AGRICULTURE & FORESTRY, TERRITORY OF HAWAII
 COLLECTOR J. F. ROCK

Acacia koaia Hillebr.

Date June 1910. Locality *Puu Kawai*
Waimea, Hawaii

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ACACIA KOAIA Hillebr.

Kula. The Kula region is now almost barren and waste, save for a few *Dracaena aurea* (*Halapepe*) trees which were in existence a few years ago.

Until 1909 *Koia* had not been recorded from the island of Hawaii. The writer discovered it on the upper slopes of Kawaihae in the neighborhood of the extinct crater Puukawai along the road leading to Waimea. Quite a number of trees were then in existence. It was also quite common on the Puuanahulu side of Puuwaawaa, where it grew in company with tall *Osteomeles anthyllidifolia* (*Ulei*) bushes. As it occurs in the very arid rocky regions, it is doomed to extinction, for such regions on Hawaii have been given over to cattle and sheep grazing; young plants which would perhaps germinate after southerly rains are eagerly devoured by both cattle and sheep. Owing to the causes just mentioned, *Koia* has already disappeared from Maui. On Molokai a similar fate awaits it if it has not already been exterminated by roaming horses, cattle and sheep.

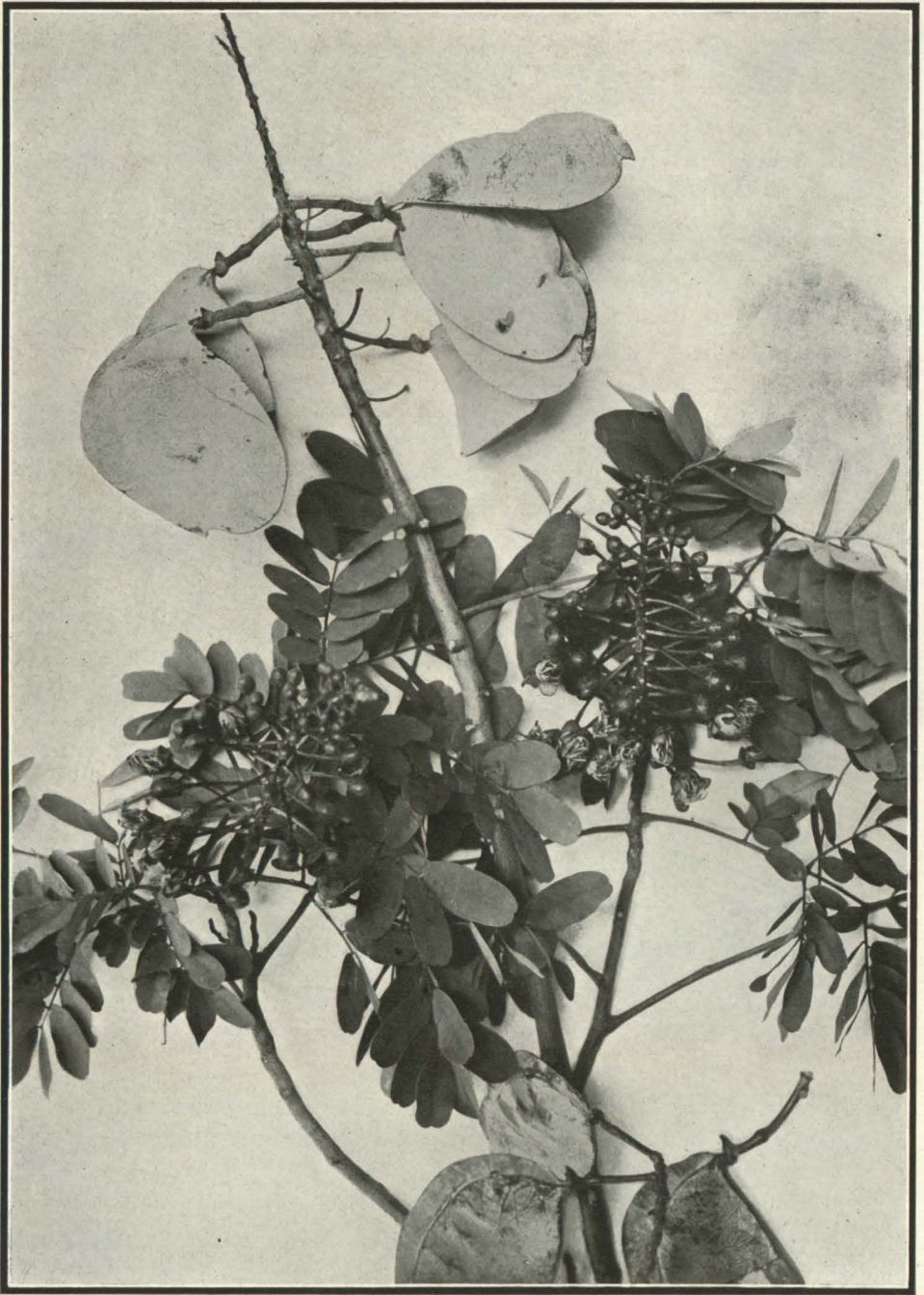
Acacia Koaia is easily distinguished from *koa* in the more rigid phyllodes and narrow, curved pods. It can be recognized even from a distance by its shape; its stature is much smaller than that of *Acacia Koa*, reaching rarely more than 25 feet. The trunk is usually gnarled and twisted. On Hawaii it associates with *Nothoestrum breviflorum*, *Sophora chrysophylla*, *Myoporum sandwicense*, *Nototrichium sandwicense* and *Dracaena aurea*. It is strictly a subxerophytic plant, inhabiting only the more arid lava regions or volcanic tufa soils such as predominate on Puukawai, Hawaii. It is never found on the newer lava flows as is, for example, the *Acacia Koa*, but in older geological regions. The Waimea side of Hawaii known as the Kohala mountains are extremely old and were evidently once a separate island from Hawaii. *Koia* does not occur on the younger portion of Hawaii save near Puuanahulu, a place not distant and adjoining Kawaihaeiuka. It is probable that ages back it occurred only on the Kohala range and that it spread afterwards towards the plains and north Kona. Unfortunately, we know very little of the plant-covering which must have existed on the vast plains between Waimea and Mauna Kea. Evidences are still visible of former forests, but so meager are they that it is impossible to draw conclusions. Mamani. (*Sophora chryso-*

phylla) forests must have extended considerably over this plain, as the upper part of that region would indicate by the scattered trees around Punohu and Makahalau. Kawaihae-uka, judging from Hillebrand's reports, must have supported a similar vegetation, as does Puuwaawaa today, and *Acacia Koaia* may have been quite numerous there. Another factor influencing the (restricted) distribution of *Koaia* is undoubtedly the adaptability of the species to lower levels only, while *Koa* has been observed up to 7000 feet. *Koaia* does never ascend higher than 2500 feet, consequently the arid regions at such altitudes suitable to its existence are rather limited, while *Koa*, with its wonderful adaptability, which can be compared with that of *Metrosideros*, has a very wide distribution in these Islands and can be found from practically sea level to 7000 feet, in most varied stations, as to soils, and lava flows.

MEZONEURUM Desf.

The genus *Mezoneurum* is represented in the Hawaiian Islands by a single arborescent species originally discovered by H. Mann on the island of Kauai, hence the specific name *Kauaiense*. The species had undoubtedly a much wider distribution in this archipelago. It is found on Maui and Oahu (according to Hillebrand) and also on the island of Hawaii in the dry forests of North Kona, where it was found by both Guppy and the writer. That the tree was much more common in the days of the old chiefs than now can be judged by the great many tapa beaters (made of the exceedingly hard wood of this species) which can be found in the Bishop Museum and private collections all over the Islands. Undoubtedly, the usefulness of the wood of this tree, which was very highly prized by the natives, not only for tapa beaters, but also for the *laau melomelo*, a club-shaped piece of *Mezoneurum* wood employed in a peculiar method of fishing, is responsible for the scarcity of this tree nowadays, and the writer ventures to say that there are hardly two dozen trees of this species in existence.

The presence of this species in the Hawaiian Islands is certainly a riddle for the student of plant dispersal, especially as *Mezoneurum Kauaiense* belongs to a genus of which no littoral



MEZONEURUM KAUIENSE (Mann) Hillebr.
Uhihi.

Flowering and fruiting specimen. About one-third natural size.

species is so far known, from which the Hawaiian one could have been derived. The seeds of this species are quite large, about an inch long, little more than half an inch wide, and are enclosed in a very papery thin pinkish-white pod winged at the upper margin. The seeds, like those of *Erythrina monosperma*, are not buoyant, and as the genus *Mezoneurum* possesses no littoral species from which it could have been derived, we must look for other agents than ocean currents as responsible for its presence in Hawaii. The Hawaiian species is endemic, which is not the case with *Erythrina monosperma*, as the latter is also found in Tahiti and New Caledonia.

Since we cannot look upon its presence here in these Islands as due to ocean currents, we can only take bird agency into consideration, and if a bird was capable of carrying such a large seed as that of *Mezoneurum Kauaiense* across a wide expanse of ocean, then surely it was also capable of carrying the much smaller seeds of wiliwili, *Erythrina monosperma*, and thus the presence of *Mezoneurum* in Hawaii strengthens and confirms, rather than contradicts, the arguments in favor of bird agency in the case of *E. monosperma*, as set forth in the discussion of that species.

That *M. Kauaiense* belongs to an ancient floral element in these Islands rather than to a later one, there remains no doubt.

The distribution of the genus proper would also indicate it to be a rather ancient one; and although the genus numbers only about fifteen species, so far as is known today, it enjoys certainly a very wide distribution. The majority of its species are Indo-Malayan, occurring in Java, Sumatra, India, Malay, Burma, the Philippines and even China, while others are found in tropical Africa, Madagascar, Australia, and one in Hawaii. None of the other Pacific islands possesses a species belonging to this genus, and the remarkable fact remains that the species found outside of Hawaii are all strong climbers, often thorny, or scandent shrubs, while the Hawaiian species is apparently the only tree in the genus. In Hawaii the tree reaches a height of over thirty feet, with a diameter of trunk of over one foot. The relationship to other *Mezoneura* is very vague, and at present no particular country of origin could be suggested.

The relationship of *Mezoneurum* to *Caesalpinia* is very close,

and as the latter genus possesses a number of littoral species, it may be that it originated from that genus; this is Guppy's theory. The writer is inclined to believe that *Mezoneurum* is older than *Caesalpinia* and that it is perhaps more probable that the littoral species have been derived from the inland species, and he would suggest that *Caesalpinia* is perhaps a satellite of *Mezoneurum*. The genus *Canavalia* in Hawaii does not help to elucidate the problem. Though of very wide distribution, it possesses both littoral and inland species. In Hawaii it is represented by an inland species, *C. galeata*, which species is represented by a variety *pubescens* on the southernmost island of this group, Hawaii. Until recently *C. galeata* was considered the only representative of this genus in Hawaii, but in 1910 the writer discovered *C. sericea*, a South Sea Island littoral species, on the eastern shore of the small island Lanai.

It is interesting to note that *C. sericea*, although a shore species, had the habit of *C. galeata*. It grew, not in the sand, but among lava rocks near old *Cordia subcordata* trees which the plant had climbed and festooned in a similar manner as *C. galeata* festoons trees at 2000 feet elevation.

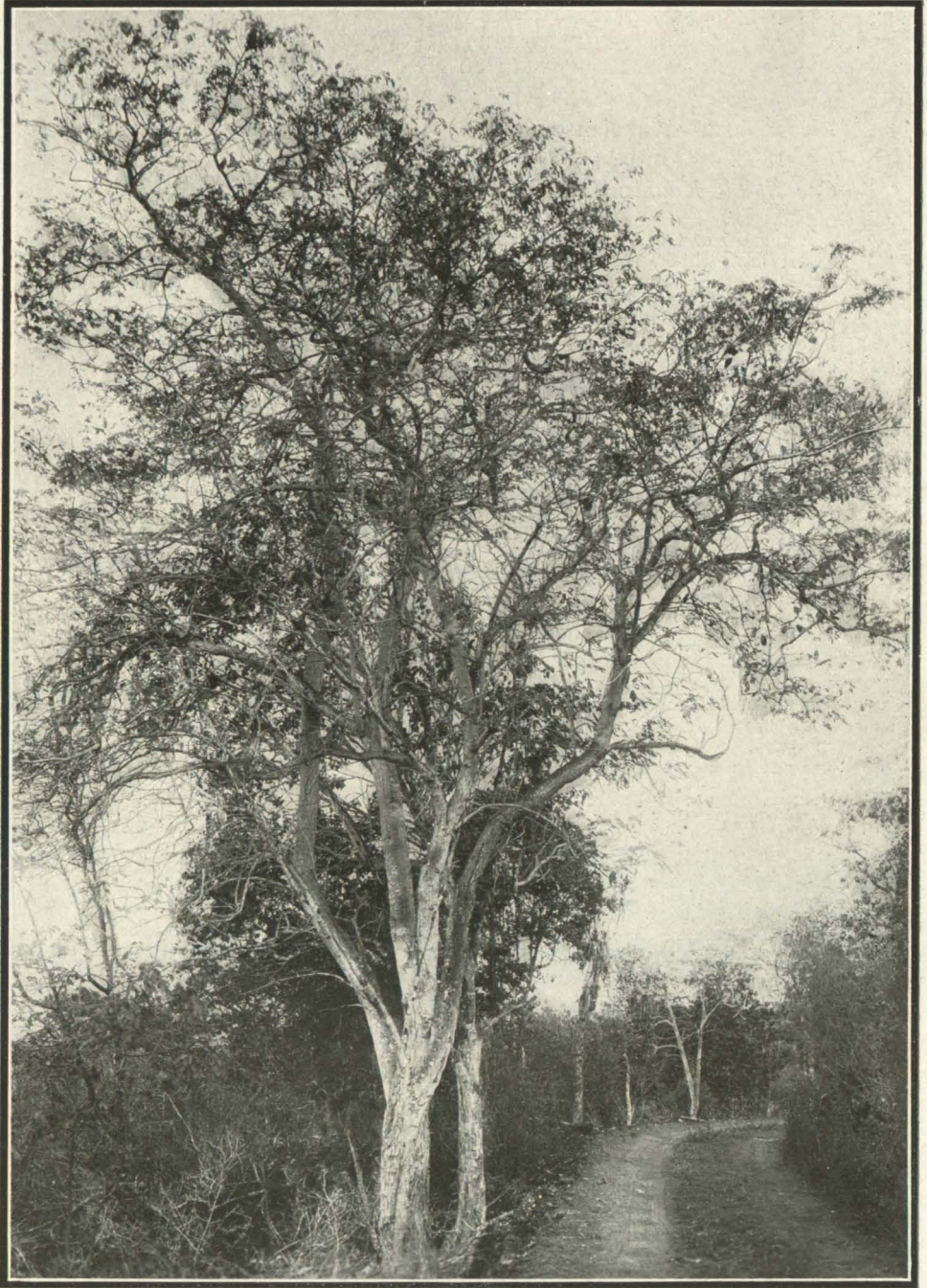
The seeds of *C. galeata* are slightly smaller than those of *Mezoneurum Kauaiense*, and are also non-buoyant. *Mezoneurum* is by far the older genus as compared with *Canavalia* and *Caesalpinia*, from the mere fact that *Mezoneurum* possesses only inland species, while the other genera possess both littoral and inland species. Had the inland species of *Mezoneurum* been derived from one or various littoral species, we would probably have found somewhere a littoral species related to some or one of the inland species. The negative findings would indicate *Mezoneurum* to be older than the genera with both littoral and inland species to which it is apparently related. The arborescent character of the Hawaiian species adds still more to the difficulty of solving its origin and relationship.

Mezoneurum seems to be more a continental genus, for Hawaii is apparently the only oceanic island on which a representative is found. Java, Sumatra, the Philippines and Madagascar are always considered islands of continental origin.



MEZONEURUM KAUIENSE (Mann) Hillebr.
Uhihi.

Showing trunk with bark and flowering and fruiting branch pinned to it.
Trunk about 1 foot in diameter. On lava fields of Puuwaawaa, North
Kona, Hawaii; elevation 2000 feet.



MEZONEURUM KAUIENSE (Mann) Hillebr.
Uhihi tree.

Along the government road in North Kona, Hawaii; elevation 2000 feet.

Mezoneurum Kauaiense (Mann) Hillebr. Fl. Haw. Isl. 110.
1888.

Caesalpinia Kauaiensis Mann in Proc. Am. Ac. VII:164. 1866.

A shrub ? or tree 10 m. in height with a diameter of trunk of 3 dm. or more; bark thick, rough dark gray, checked into rectangular or long oblong plates; branches loose, spreading, unarmed, young shoots covered with a rust to cinnamon-brown pubescence; leaves pari-pinnate, with 1-5 pairs of pinnae, each pinna with 4-8 pairs of leaflets, pinnae 4-8 cm. long; the common rachis up to 12 cm.; leaflets oblong, somewhat uneven-sided at the base, emarginate at the apex up to 4 cm. long, 16 mm. wide, membranous to chartaceous, pale green with rusty-brown pubescent midrib and petiolule, the latter 2-2.5 mm.; stipules and stipellae none or small wart-like; racemes terminal hoary to rusty-brown pubescent, 12-18 cm. long with flower, 22 cm. with fruit, densely floriferous from the base; pedicels 2.5-4 cm. long, jointed in the upper fourth, bracts acute, ciliate, 4 mm., caducous; bracteoles wanting; calyx glabrous, pinkish or rose red, the short tube 4 mm., the lowest lobe concave 12-14 mm., the others oblong, obtuse about 8 mm. long, 5 mm. wide; petals pinkish purple to rose red, not or slightly stipitate, shorter than the calycine lobes, the uppermost one obovate, folded 6-8 mm. in diameter, of deeper color (blood red especially towards the apex), the lateral ones suborbicular, the two lowest obovate, 10-12 mm. long; stamens exserted, declinate, filaments broad and flat below with reddish brown hair; anthers 2 mm., of carmine color; ovary glabrous, sessile 3-5-ovuled; style glabrous incurved; stigma small; pod broad obovate-oblong 10 cm. long, 6 cm. wide, including the 7 mm. wide dorsal wing, ending in an uncinat point, flat, thin, indehiscent pale pinkish to gray when old; seeds 2-4, transverse, pale brown, ovate flat 18-20 mm. long, 14-16 mm. wide, with a punctiform hilum at the base.

KAUAI: Hillebrand in herbarium Berlin and herbarium College of Hawaii;—Puukapele, Waimea canyon, flowering March 1909, Rock no. 2435 in herbarium College of Hawaii.

OAHU: Waianae Mts. and Wailupe, Hillebrand.

MAUI: East Maui, Ulupalakua, and West Maui, dry fore hills, Hillebrand.

HAWAII: Between Huehue and Puuwaawaa, North Kona (district of Owe), elevation 2000 feet, flowering and fruiting June 14, 1909, Rock no. 3904 in herbarium College of Hawaii;—same locality, fruiting August 1915, Rock no. 12591 in herbarium College of Hawaii.

In the Hawaii specimens the dorsal wing does not end in an uncinat point as in the Kauai specimens; at least the point is very obscure. Hillebrand records this species as a shrub, but on Hawaii it is always a tree up to thirty feet in height. The writer

has collected it only on Kauai and Hawaii. In the former island it is very rare and perhaps extinct now; from Maui, Ulupalakua, it has disappeared, as the locality recorded by Hillebrand has been entirely denuded of its native vegetation.

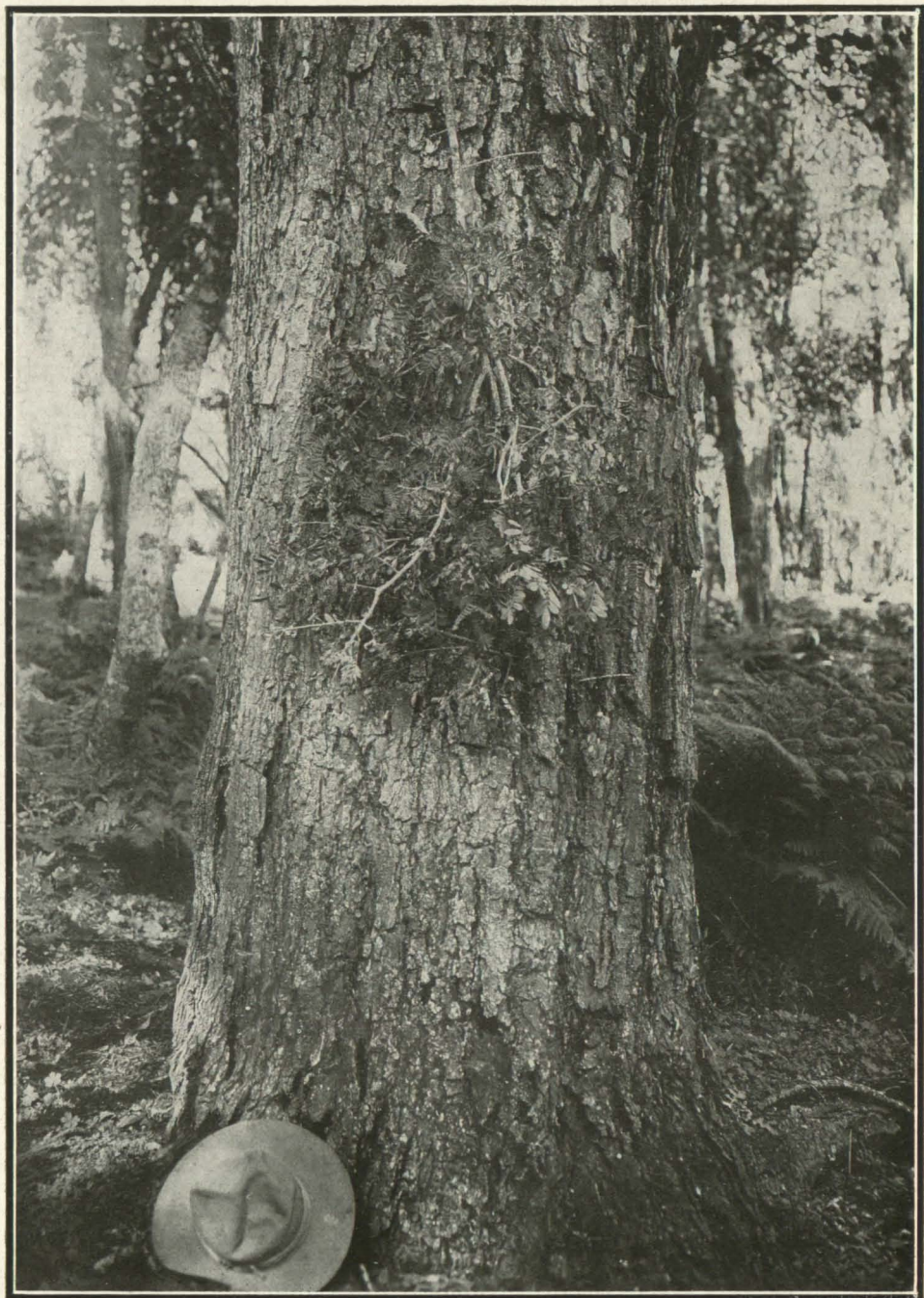
According to natives, it exists along Kaupo below the southern outlet of Haleakala crater, Maui, where the natives know it by the name *Kea*.

The wood of this species is exceedingly hard, close-grained and very durable. It is of almost black color, with a very narrow (one-quarter of an inch thick) sapwood of a light color. The natives made their spears of this wood, also a fishing implement known as *laau melomelo* or *laau makaalei*. The native name of the tree is *Uhiuhi*.

SOPHORA L.

ORIGIN OF *Sophora chrysophylla*.

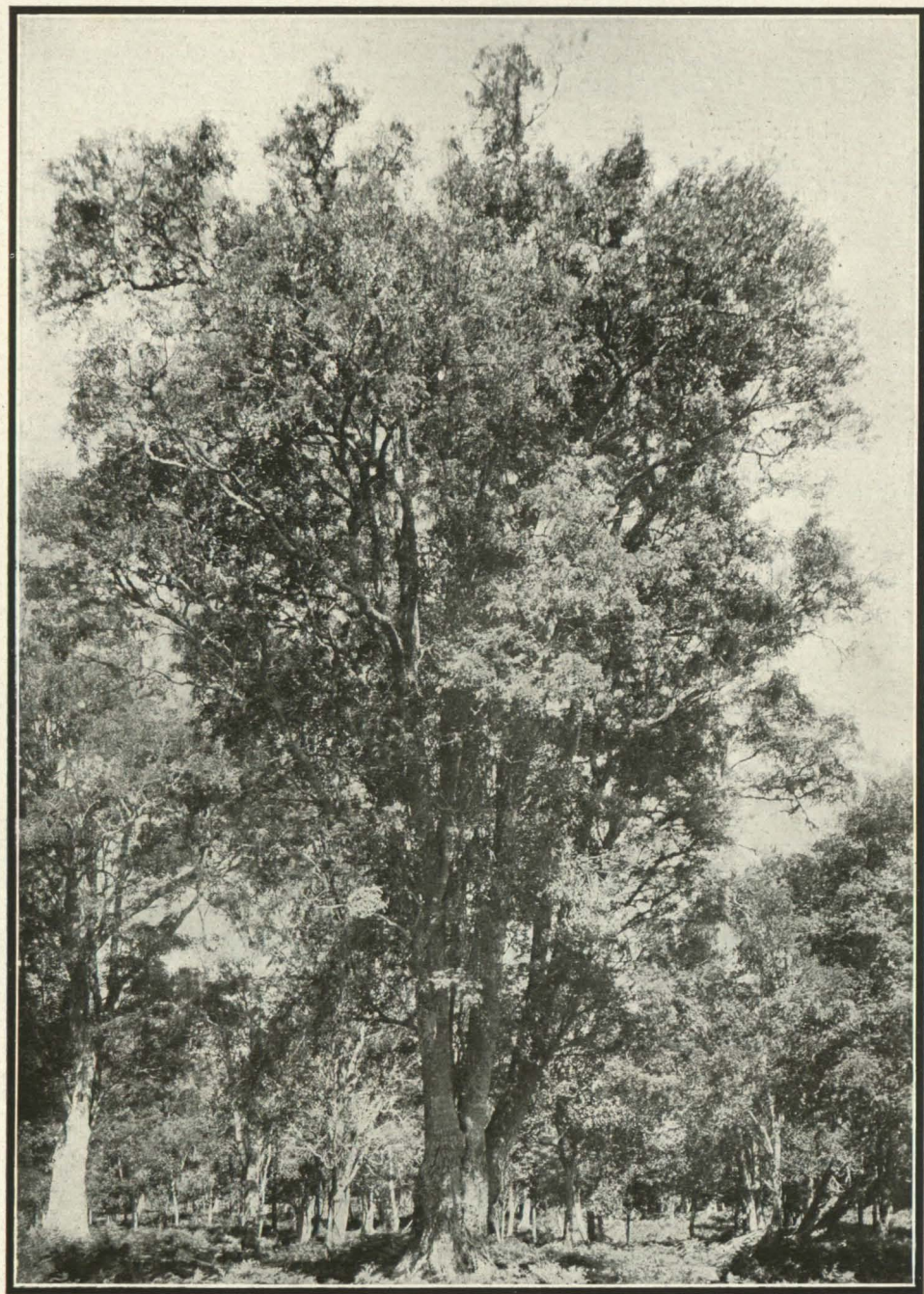
That the *Mamani*, as the natives call *Sophora chrysophylla*, is an old denizen of these Islands there is little doubt. It may be of the same age as *Acacia Koa*, or may even antedate the latter. The *Mamani* belongs to the subgenus *Edwardsia*, in which we find *Sophora tetraptera*, *S. macrocarpa*, *S. microphylla*, *S. denudata*, *S. mollis* and *S. interrupta*. They are distinguished by their winged pods. In looking at the species which form this subgenus, we find that *Sophora tetraptera* occurs not only in New Zealand, but also on the Island of Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island and in Chile. *S. mollis* and *S. interrupta* occur in India, *S. macrocarpa*, *S. microphylla* and related species in Chili and Peru, while *S. denudata* is peculiar to Bourbon. That the Hawaiian *Sophora* is very closely related to *Sophora tetraptera* there is no doubt. It also occurs from sea level to 2500 feet elevation. At the lower altitudes it is a shrub, while at higher altitudes it is prostrate, while at favorable locations it becomes a tree 30-50 feet in height. *Sophora tetraptera*, the *Kowhai* of the Maoris, is very variable; a number of varieties have been described. A similar variation we meet in the Hawaiian *Mamani*. On comparing the New Zealand name "*Kowhai*" with "*Mamani*" from Hawaii we find no resemblance,



SOPHORA CHRYSOPHYLLA Seem.

Mamani.

Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.



SOPHORA CHRYSOPHYLLA Seem.

Mamani.

Growing in Kipuka Puau, near Volcano Kilauea, Hawaii; elevation 4000 feet. Tree 35 feet high.

but on investigation we find the Hawaiian name *Ohai* used for *Sesbania tomentosa*, also a papilionaceous legume, with large red flowers, which resemble those of the *Mamani*.

The wide distribution of *Sophora tetraptera* and its occurrence in Chili would point to an American origin, rather than that it originated in New Zealand and was thence distributed to the other islands and the mainland of South America. The Hawaiian *Mamani* is in all probability of American origin and perhaps only an offspring of the ancestor of *Sophora tetraptera*. That the *Mamani* is an ancient inhabitant of Hawaii is proven by the fauna inhabiting it; we find two species of *Plagitmysus*, an endemic genus, peculiar to the *Mamani*, as well as species of *Clytarlus*. The peculiar endemic bird *Pseudonestor* feeds in turn on the larvae of these beetles, which it extracts from the wood of both the *Koa* and *Mamani*. From these facts we can see that both the *Koa* and *Mamani* must be old inhabitants and were perhaps contemporaneous in their arrival with the early *Compositae*.

Sophora chrysophylla (Salisb.) Seem. Flora Vitiensis 66. 1865.
Edwardsia chrysophylla Salisb. in Transact. Linn. Soc. IX:302,
t. 26, f. 1. 1808.

Young shoots silky pubescent; leaves 15.5 to 15 cm. long, with 6 to 10 pairs of leaflets; leaflets obovate oblong, 20 to 36 mm. x 8 to 12 mm., obtuse, often retuse, with a cinerous silvery or tawny pubescence (when growing at high altitudes) or glabrous (at low elevation); racemes terminal and lateral, 12 to 25 mm. long, tomentose; calyx about 6 to 10 mm., cup-shaped lobes broad and obtuse; petals 25 mm. long, yellow, the broad vexillum recurved, the suberect alae and carina nearly as long; stamens as long as the carina; ovary tomentose; pod 10 to 15 cm. long, 8 mm. wide, often deeply constricted between the seeds, four-winged; indehiscent; seeds 4 to 8, oval, somewhat compressed, yellow, 8 mm. long.

OAHU: Waianae Mts., Keaau, elevation 950 feet, flowering and fruiting January 23, 1919, Charles S. Judd, specimens in College of Hawaii Herbarium.

KAUAI: Knudsen in Herbarium Hillebrand (Herbarium Berlin).

MAUI: Slopes of Haleakala, flowering April 26, 1909, R. S. Hosmer no. 2624 in the herbarium of the College of Hawaii;—Haleakala upper slopes, flowering May 1911, Rock in herbarium College of Hawaii.

HAWAII: Hualalai upper slopes, elevation 7000 feet, flowering June 9, 1909, Rock no. 3502 in the herbarium of the College of Hawaii;—Mauna Kea, Parker Ranch, 1909, Rock in herbarium College of Hawaii;—Kalua-makani crater, Mauna Kea, flowering July 1, 1909, Rock no. 3225 in herbarium College of Hawaii;—Waikii, Mauna Kea, flowering June 1910, Rock no. 8418 in herbarium College of Hawaii.

Sophora chrysophylla has also been collected by Menzies, Meyen, the U. S. Exploring Expedition, Remy, Mann and Brigham, Hillebrand, Forbes, Faurie, Curran, and others.

The *Mamani*, which may be found on all the islands with the exception of Molokai, grows from almost sea level up to nearly 10,000 feet elevation. It inhabits the high mountains of Hawaii, Mauna Kea, Mauna Loa and Hualalai up to 10,000 feet, where it forms the upper forest zone together with shrubby Composites, such as *Raillardia arborea* and *R. struthioloides* and other plants peculiar to these regions. On Kauai and Oahu it never grows to a tree, while on the slopes of Mauna Loa, on Hawaii, near the volcano of Kilauea, it reaches its best development. Trees of 40 feet in height are not uncommon at an elevation of 4000 feet. Below and above the snow-line it is covered with silvery-gray hair, which protects it from the severe cold which it experiences, not only during the winter, but also in the summer months. The writer experienced a temperature of 19° Fahr. during a night spent on Mauna Kea in the month of July.

The specimens from Haleakala have glossy leaves with a grey pubescence; the latter disappears from the upper side entirely, but remains on the lower surface. The Mauna Kea specimens have narrow leaves, as have those from Haleakala, Maui, while the trees from the higher slopes of Hualalai, Hawaii, have broad ovate leaves; the latter specimens have also the largest flowers.

The wood of the *Mamani* is exceedingly hard and very durable in the ground. It is therefore mainly used for fence posts by the cattle ranchers on the large estates on Hawaii. On Haleakala, Maui, the trees are of medium size, though reaching a similar development at Auahi as that found near the volcano of Kilauea at Puaulu on Hawaii. On the upper slopes of Haleakala they

are shrubby. The wild cattle and horses, which are very numerous on the upper slopes of Mauna Kea, live almost exclusively on the young leaf shoots of the *Mamani* during the dry season, when there is no grass available. But, thanks to the hardiness of the trees, which are exceedingly deep-rooted, they are able to withstand the ravages of the descendants of Vancouver's cattle.

The *Mamani* is peculiar to the Hawaiian Islands, while *S. tomentosa* is found in the South Sea Islands, where it grows on the beach; in Viti or Fiji it is known by the name *Kau ni alewa*, or women's tree.

The *Mamani* is very closely related to *Sophora tetraptera* of New Zealand, Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island, and Chili.

Sophora chrysophylla glabrata Rock

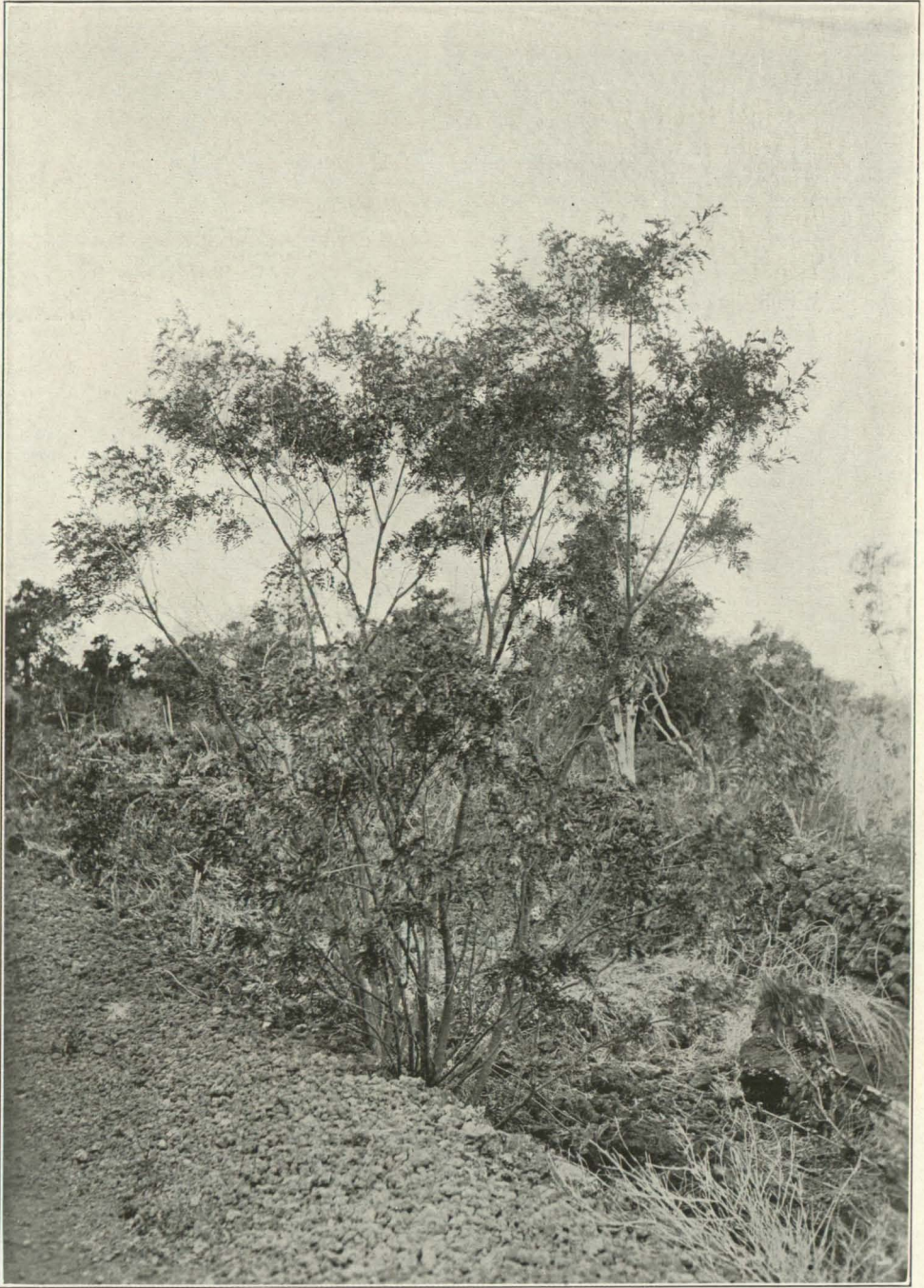
Edwardsia chrysophylla var. β *glabrata* A. Gray U. S. Explor. Exped. 459. 1854.

A shrub, 4-5 m. high, never a single trunk, more or less glabrate throughout, the leaflets are long, linear-oblong, 2.5 cm. long, 6-8 mm. wide, glabrate or slightly pubescent on both sides, flowers smaller of a paler yellow, calyx thin, brownish pubescent; the pods (in the Lanai specimens) with very narrow wings, the latter only 1 mm.

LANAI: On the plateau leeward side, near Koele, back of Gibson Homestead, flowering and fruiting July 29, 1910, Rock no. 8012 in the herbarium of the College of Hawaii.

Sophora chrysophylla was first recorded from Lanai, by the writer, and published in his book on "The Indigenous Trees of the Hawaiian Islands." The Lanai plant is certainly worthy of varietal rank and may be classed with Asa Gray's var. β *glabrata*. To this latter variety Asa Gray referred specimens from the lowlands of Hawaii. The writer observed *Sophora chrysophylla* as low as almost sea level at Puuwaawaa, North Kona, and elsewhere on Hawaii.

The plant from the lowlands of Hawaii belongs in all probability to Gray's var. β *glabrata*, but differs from the Lanai specimens in the much broader winged pods, while the plants from Lanai have wings only one millimeter in width. The variety



SOPHORA CHRYSOPHYLLA GLABRATA Rock
Mamani.

Growing on the lava flows of Puuwaawaa, North Kona, Hawaii;
elevation 2000 feet.

glabrata is always a shrub. It is peculiar to the arid ancient lava flows, where it grows in company with *Myoporum sandwicense*, *Nototrichium sandwicense*, *Dracaena aurea*, *Charpentiera obovata*, *Santalum Pilgeri* var. *luteum*, *Pittosporum Hosmeri*, *Rockia sandwicensis*, etc. At the same elevation on the slopes of Hualalai near Puuwaawaa occurs var. *unifoliata*, a much larger shrub or small tree, which may be described as follows:

***Sophora chrysophylla unifoliata* Rock var. nov.**

A tall shrub or small tree, about six meters in height, with more or less straight branches, leaves simple not pinnate, broadly ovate-oblong up to 4.5 cm. long, 2.5 cm. wide, alternate on the woody branches, on petioles of 2-3 mm., finely pubescent on both sides; floral racemes terminal, pedicels 10-13 mm.; flowers small, pale yellow; calyx small 4 mm. high, pubescent, the lobes very broad and blunt; ovary densely pubescent; pods not seen.

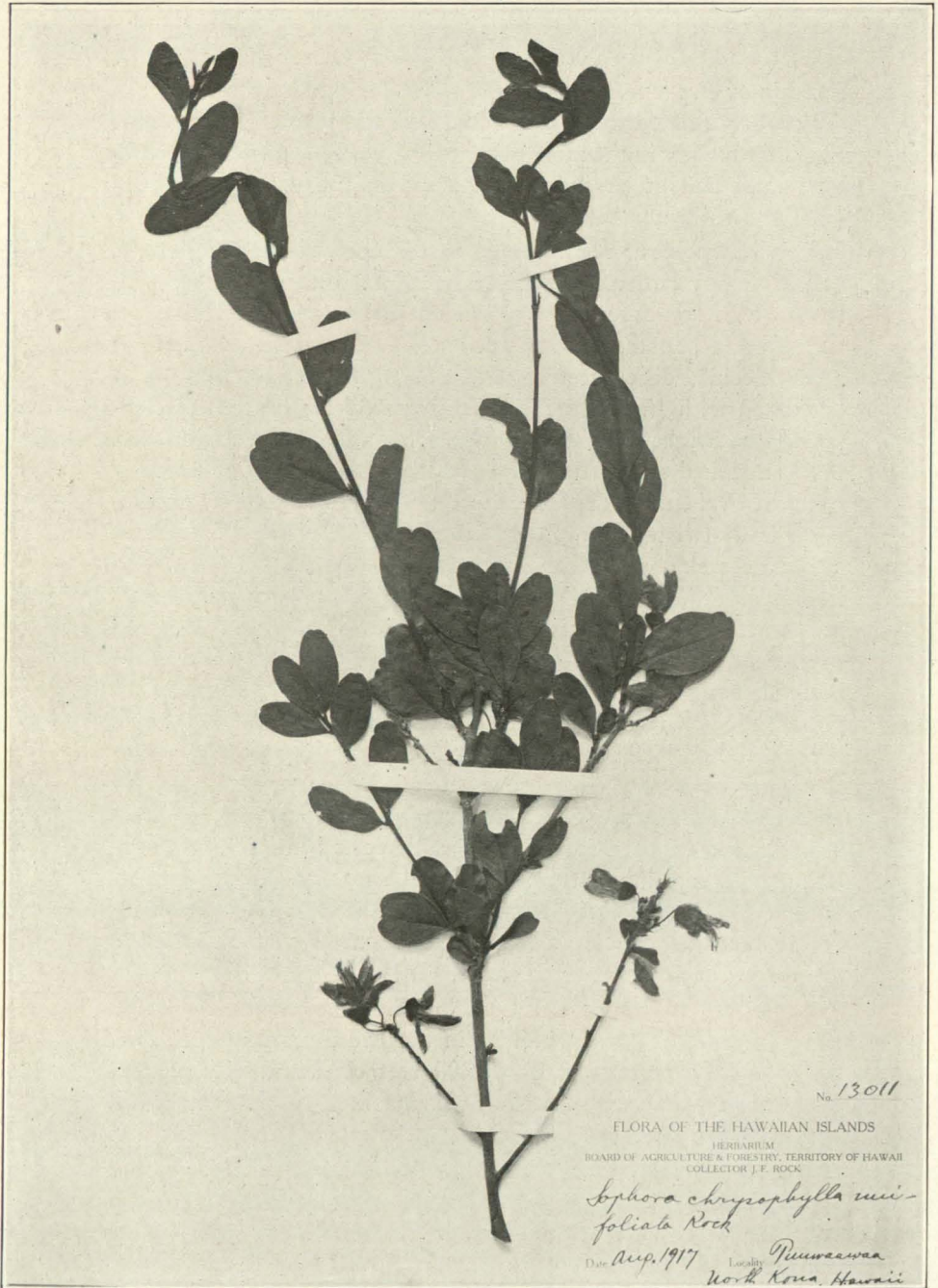
HAWAII: Mr. Young without further locality, 1913, in the herbarium of the College of Hawaii, no. 12648;— Puuwaawaa, slopes of Hualalai, on old aa (rough) lava flow, elevation 2000 feet, flowering August 1917, Rock type no. 13011 in the herbarium of the College of Hawaii.

This variety was first discovered by Mr. Young of the fibre textile department of the United States Department of Agriculture. The writer met with a single tree at Puuwaawaa. Not one single pinnate leaf could be found on the tree.

ERYTHRINA L.

Guppy in his interesting work on seed dispersal ("Observations of a Naturalist in the Pacific") takes the viewpoint of *Erythrina monosperma* Gaud., the Hawaiian wiliwili, as having been derived from *Erythrina indica*, a widely-distributed species. This assertion would mean that *Erythrina monosperma* must have been once upon a time a shore species with buoyant seeds, and later became an inland species whose seeds lost their floating power due to location and environment.

Guppy simply quotes Drake del Castillo in regard to the rela-



Type of *Sophora chrysophylla unifoliata* Rock in herbarium College of Hawaii.

tionship of *E. monosperma* to *E. indica*, saying that the former is very nearly related to the latter and that the former differs from the latter mainly in the more hairy calyx, in the more permanently tomentose and much shorter pod, and in the paucity of seeds (one or two in number).

This viewpoint as regards relationship, the writer cannot share, and if Guppy had compared the pods of *Erythrina indica* with those of *E. monosperma* he could not have followed Drake del Castillo and adopted his statements without question. There is a very decided difference in the pod of *Erythrina monosperma* as compared with *E. indica*. The former dehisces on the tree, exposing the bright red (scarlet) seeds for a long time as they are firmly attached to the funis; the pod itself is hard and of a woody texture. When thoroughly mature the valves dehisce by becoming spirally twisted due to the heat of the sun, which shines from a cloudless sky wherever *Erythrina monosperma* occurs. In *Erythrina indica* the pod consists of a thick papery pulp which drops to the ground in its entirety, where it rots, but does not dehisce on the tree, and at no time are the seeds exposed while the pods hang on the tree, which is for a considerable period; the pods are indehiscent, thickly fleshy when green, the valves of which acquire the consistency of a thick papery pulp at maturity. The seeds are of a very dark brownish-carmine color, which hardly would attract birds. The Hawaiian species, however, with its scarlet seeds exposed for a considerable period in the bright sunlight, must certainly attract birds. The mature dehiscent seed-pods exposing these bright red seeds can be seen from a considerable distance, while even the large but somber pods of *E. indica* are discernible only at close range.

According to Drake del Castillo, *E. monosperma* occurs in Tahiti and also New Caledonia; in the former island it inhabits the valley of Fautana at 2100-2400 feet elevation. It is, however, not the only species of *Erythrina* in Tahiti, as *E. indica* occurs on the beaches as a native tree.

Had *Erythrina monosperma* been derived from *E. indica*, and if the former was dispersed in bygone ages by means of ocean currents, why is it that the ancestor *E. indica*, which still has its buoyant seeds, is absent from Hawaii? And why is the satellite *E. monosperma*, with non-buoyant seeds, present in Hawaii?

The answers to these questions seem not to be difficult, especially after comparing the characters of the pods of the two species.

There is no doubt that *E. monosperma* is a much older species than *E. indica*, and that it belongs to a period of dispersal much antedating that of *E. indica*. On comparing the other species of plants found on the islands of the Eastern Pacific, especially of Tahiti, the Tonga and Cook group, with those of the islands of the Western Pacific, we find that the former are much older and in many respects quite peculiar, and that the endemism is much higher than that of the species occurring in the Western Pacific islands, which received their plant stockings mainly from the Malayan region. The absence of *Lobelioideae* and the peculiar ancient arborescent *Compositae* of Hawaii and Tahiti, in the Western Pacific, would confirm the theory that the Western Pacific regions are undoubtedly younger. This question has been thoroughly discussed by the writer in his monographic study of the Hawaiian *Lobelioideae*.

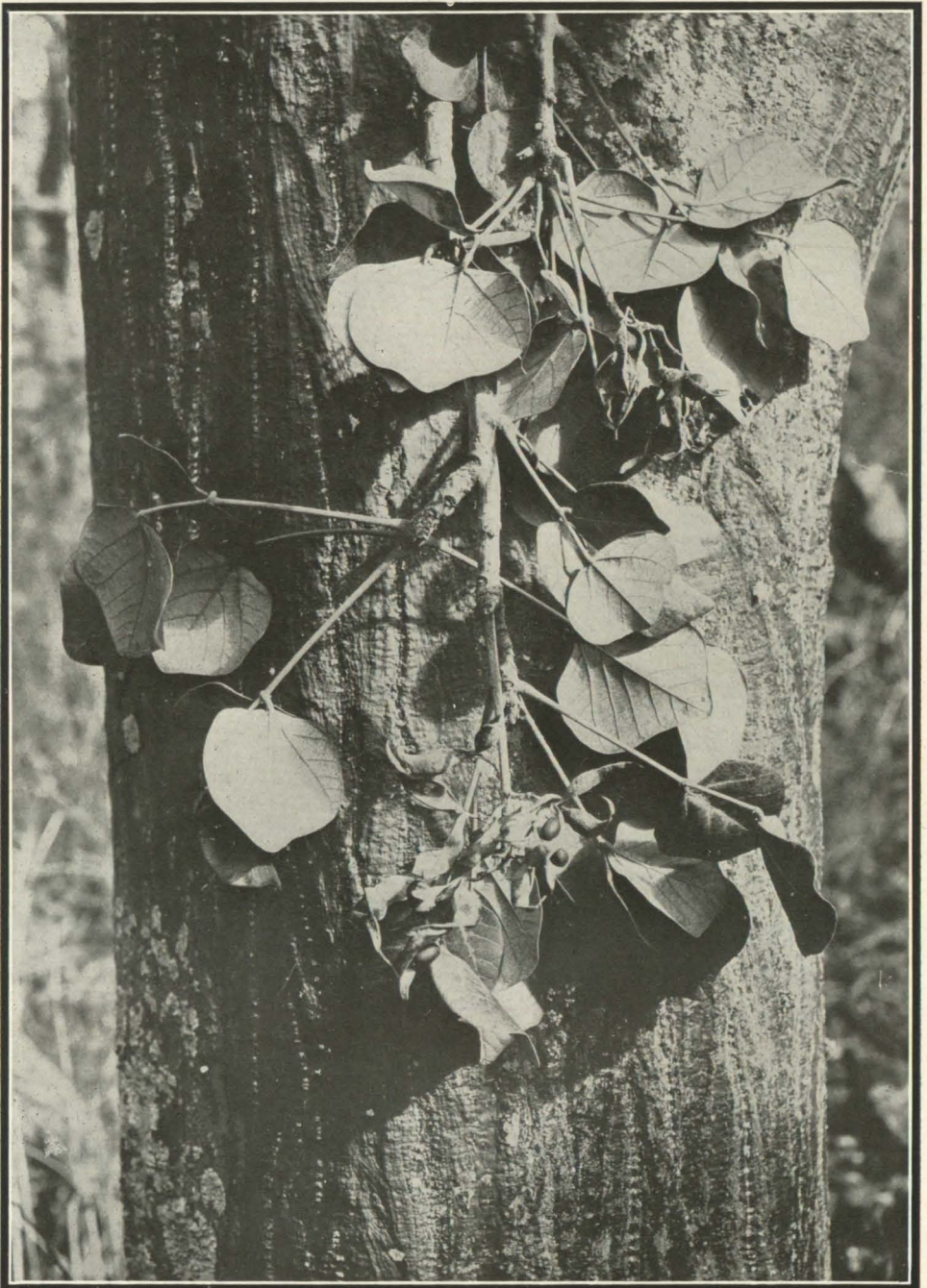
That *Erythrina monosperma* was dependent on birds for its dispersal is very probable, though the agent responsible for its distribution has long since passed out of existence. The peculiar dehiscence of the pod of *E. monosperma* on the tree, exposing the bright scarlet glossy seeds for a considerable period, would certainly indicate bird dispersal, as it would undoubtedly attract birds.

Guppy's contention that the seeds would swell too quickly if swallowed by a bird, and thus destroy the germinating power, is not correct, for seeds of that species may remain for weeks in water without the seed coating being destroyed or even wrinkled. The writer had seeds of *Erythrina monosperma* planted for months before they germinated, though they were kept in a hot moist atmosphere. Some, of course, germinate rather quickly, while others are extremely slow.

Erythrina monosperma Gaud. Bot. Voy. Uranie, 486, pl. 114.
1826.

Erythrina montana Forst. in Pancher, Herb., et in Cuzent, Tahiti,
240. 1860.

Erythrina tahitensis Nadeaud Enum. no. 499. 1873.



ERYTHRINA MONOSPERMA Gaud.
Wiliwili.

Showing trunk, bark, and fruiting branch. Lava fields near Puuwaawaa,
Hawaii; elevation 2000 feet.

Corallodendron monospermum O. Ktze. Rev. Gen. Plant I:173.
1891.

A tree 6-10 m. high, sparsely aculeate with short conical prickles; trunk short or occasionally 5 m. long and vested in a thin yellowish bark with longitudinal ridges; crown broad spreading, with glabrous, stiff, gnarled branches, fulvo-tomentose at their ends; leaflets ovate-deltoid, broader than long, 5-6.5 cm. long, 6.5-9 cm. wide, obtuse, entire, truncate to subcordate at the base, chartaceous, tomentulous beneath; the petiole 8.5-25 cm. long, extending considerably beyond the lateral leaflets, petiolule of the terminal leaflet about 1 cm., that of the lateral ones about 5 mm. and articulate; stipules gland-like, one or two for the base of the petiole, one for each lateral and two for the terminal petiolule; racemes in the axils of the ultimate leaves, fulvo-tomentose, stout when with fruit, but often slender when with flower, nodose in the upper third, with one or two or three flowers at each node, 8-15 cm. long; bracts triangular, 2 mm. or less; pedicels 4-8 mm. with flower, 10-12 mm. with fruit; calyx thickly tomentose tubular-spathaceous, minutely toothed, 15 mm. or more long; standard 2.5 cm. in diameter (up to 5 cm. teste Hillebr.), scarcely stipitate; wings oblong obtuse 12 mm. (up to 18 mm. teste Hillebr.); keel 10-16 mm., its two petals free; stamens as long as the standard, the alternate ones shorter, that opposite the standard connate at the base; anthers pointed versatile; ovary tomentose, stipitate, three to five-ovuled, narrowing to a slender straight or curved style 15-20 mm. long; pod torulose, pubescent acuminate at both ends, coriaceous-ligneous, dehiscent 1-several-seeded; seeds scarlet or darker red, 15 mm. long, hilum elliptical 5 mm.; flowers brick red, orange or pale yellow.

KAUAI: Makaweli gulch, fruiting March 3-10, 1909, Rock no. 2156 in herbarium College of Hawaii.

OAHU: Koko Head, Rock no. 5839 in herbarium College of Hawaii.

MOLOKAI: Mahana, west end, fruiting March 1910, Rock, in herbarium College of Hawaii.

MAUI: Auahi-Kahikinui, southern slopes of Haleakala, Rock, in herbarium College of Hawaii.

LANAI: Mauna Lei, flowering and fruiting July 13, 1910, Rock no. 8118 in herbarium College of Hawaii.

HAWAII: Puuwaawaa, N. Kona, Rock in herbarium College of Hawaii;—observed at Kapua, S. Kona, Naa-lehu, Hilea, Kau, etc.

KAHOOLAWE: Observed by R. S. Hosmer.

Specimens with pale yellow flowers were observed both on Lanai and Hawaii.

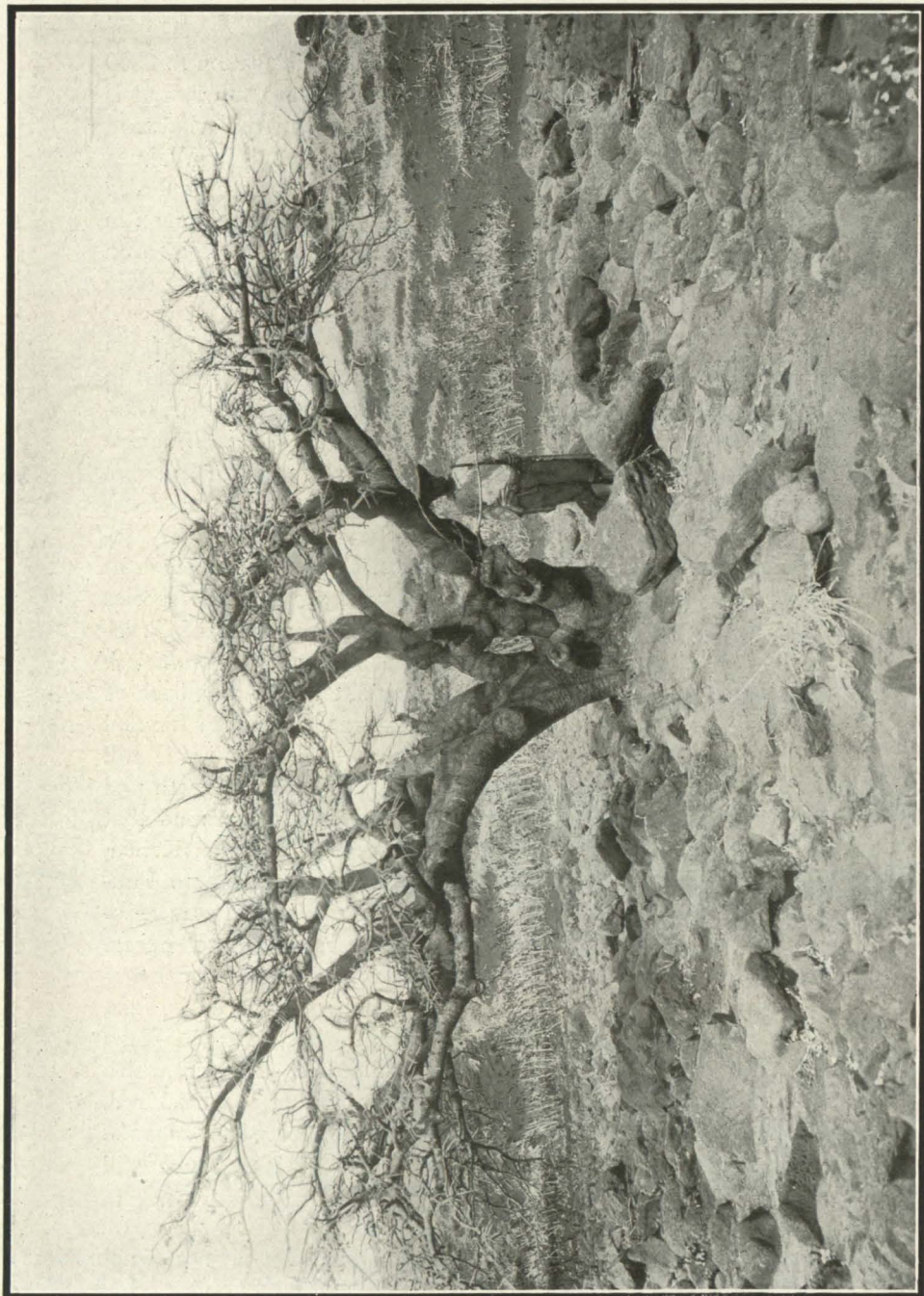
The native name of this tree is *Wiliwili*.

E. monosperma inhabits the dry regions on all the islands of



ERYTHRINA MONOSPERMA Gaud.
Wiliwili.

Growing on the lava fields of Puuwaawaa, North Kona, Hawaii;
elevation 2000 feet.



ERYTHRINA MONOSPERMA Gaud. (Wiliwili), the only native tree species left on the barren island of Kahoolawe.

the archipelago. It occurs from about 500 feet elevation to 2000 feet, but rarely higher. It loves the hot arid lava flows, and is always found on the leeward side and never on the windward side of the islands. On Kauai it may be found in Waimea canyon, the rocky slopes back of Kekaha and Waimea, and also on the drier part of the Haupu range. On Oahu it is common in the valleys of the Waianae range, as at Mokuleia, etc., also on the extreme eastern end of the Koolau range at Wailupe, Niu and Koko Head. On Molokai it occurs back of Kaunakakai, and must have been very common all over the western end of the island, where it still occurs in clumps or as isolated individuals in dry canyons. It is associated with *Reynoldsia sandwicensis*, *Gardenia Brighami*, *Plectronia odorata*, *Xylosma Hillebrandii*, *Kokia drynarioides*, *Osmanthus sandwicensis*, *Breweria Menziesii*, *Maba sandwicensis*, *Chrysophyllum polynesianum* and *Nototrichium sandwicense*. On Maui it is not uncommon back of Makawao and especially so on the southern slopes of Haleakala at Auahi and Kahikinui, where it grows with some of the species above mentioned and *Rauwolfia sandwicensis*, species of *Pittosporum*, *Alectryon macrococcus*, *Pelea Knudsenii* var. *multiflora* and others. On Lanai it can still be found on the slopes back of Manele, as well as in the deep and arid gorges of Mauna Lei and Nahoku, also in the desert region of Kaa. On Hawaii it is still most numerous, especially on the lava flows of both North and South Kona and Kau. It forms practically a belt around that part of the island, beginning at Hilea, through Manuka, Kapua, Honomalino, Papaa, Kealakekua, Huehue, Puuwaawaa to Puuanahulu, Kawaihae-uka and Puukawai near Waimea. Its associates in Kona are *Mezoneurum Kauaiense*, *Dracaena aurea*, *Charpentiera obovata* var., *Alphitonia excelsa*, *Colubrina oppositifolia*, *Kokia Rockii*, *Sideroxylon auahiense* var. *aurantium*, *Pittosporum Hosmeri* and its variety *longifolium*. In the Kona district it develops huge trunks of several feet in diameter, which are of a dirty orange yellow; the flowers are either red, brick red, yellowish or white. The trees are often festooned with *Canavalia galeata* var. *pubescens*. Even the island of Kahoolawe still supports a few trees of this species, about the only native tree in existence there.

It is on the islands of Kauai, Molokai and especially Oahu that

the tree is on the verge of extinction, while on Hawaii it is still abundant owing to the uselessness of the land on which it grows, being mainly found on rough *aa* lava flows inaccessible to cattle, the arch enemy of Hawaiian trees and forests in general.

The wood of the *Wiliwili* is soft and very light, and was used by the Hawaiians for the float in the outrigger of their dug-out canoes.