

FLORAL ASPECTS OF THE HAWAIIAN ISLANDS.

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[With 25 plates.]

The flora of the Hawaiian (Sandwich) Islands is of unusual interest because the group is the most isolated upon the globe. Disregarding mere reefs or islets, the distances to land in the various directions are: Unalaska, 2,016 miles; San Francisco, 2,100 miles; Samoa, 2,263 miles; Yokohama, 3,445 miles. Because of this isolation the native flora is peculiar and the endemic element is proportionately large.

During the summer of 1916 the writer visited the Hawaiian Islands for the purpose of studying their flora. In these investigations he was assisted by his son, A. E. Hitchcock. Collections were made on the six larger islands of the group; that is, on all except Niihau and Kahoolawe. Brief accounts of this trip have been given elsewhere.¹ In the present article an attempt will be made to give a general view of the more prominent features of the flora and to record the impressions that appeal to a botanical traveler.

The climate is strictly tropical but, because of the proximity of the ocean and because of the moderating influence of the trade wind, the temperatures are not unpleasantly high. The summer daily maximum is about 85° F. at Honolulu. At higher altitudes the climate is cooler and on the summits of the high mountains of the island of Hawaii there is much snow, some of which persists throughout the year. The rainfall varies greatly in different parts of the same island. All the islands are mountainous and the mountains intercept the trade winds, causing a heavy rainfall upon the windward side of the islands. The lee side is dry or even arid in places. In the vicinity of Honolulu, which lies on the westerly side of the island of Oahu, the rainfall at the water front may be as low as 15 inches, but increases rapidly toward the mountains to the east, at the crest of which, about 6 miles away, the rainfall may be as high as 300 inches. In general the rainy season is from November to March, but in the vicinity of the mountains the rains extend

¹Explorations and Field-work of the Smithsonian Institution in 1916 (Smiths. Misc. Coll. Vol. 66, no. 17, p. 59, 1917). A botanical trip to the Hawaiian Islands (Sci. Monthly, vol. 5, p. 323, and p. 419, 1917).

throughout the year, though the amount may be greater during the winter. One of the rainiest spots is the summit of Waialeale, the highest peak of Kauai (5,170 feet), where the rainfall is as much as 600 inches. Professor Campbell records the rainfall here as follows:¹

1912, 399.35 inches.

1913, 453.00 inches.

1914, 610.00 inches.

1915, 590.00 inches.

1916, 539.70 inches.

The chief agricultural industries of the islands are, the production of sugar, the raising of stock, and the growing of pineapples. Sugar cane is grown on the lowlands of Oahu, Kauai, Maui, and Hawaii, where sufficient water is available either from the rainfall or from irrigation. The ranches for stock raising are on the plains and treeless slopes on the leeward sides of the islands, especially on western and northern Hawaii, western Molokai, nearly all of Lanai, and the western part of East Maui. Pineapples are grown chiefly on Oahu in localities not well suited to sugar.

In earlier days horses, cattle, hogs, and goats were introduced and allowed to run wild. They increased rapidly and became a menace to the vegetation. Large areas were almost denuded of native plants and their place has been taken by introduced weeds, especially such shrubs as guava and lantana. In recent years these wild animals have been hunted and killed to such an extent that they are now nearly exterminated, a few flocks of goats being found in the more inaccessible canyons, and small herds of pigs in the upper forests. Much harm to the native vegetation has been done and many species have been greatly restricted in their range, some species being actually exterminated.

Land that has been denuded by stock is subjected to the danger of further denudation by wind in the drier regions. Wind erosion is especially noticeable on the northern end of Lanai and the north-western part of Molokai. Kahoolawe, a small island not visited by us, is said to have suffered severely from the denuding effects of the strong trade wind. This island lies in the path of the trade wind that blows between the mountain masses on East and West Maui, while the low-lying part of Lanai to the north receives the full force of the wind as it blows between Molokai and West Maui.

The islands are of volcanic origin and the rocks are practically all volcanic. The island mass rises from the ocean floor about 18,000 feet below the surface. The great cones of the high mountains of Hawaii (Mauna Kea, 13,825 feet; Mauna Loa, 13,675 feet) give the unusual difference of level between the summit and base of about

¹ Douglas H. Campbell. An extraordinary rainfall record. *Science*, n. ser. 46:511. 1917.

32,000 feet. Geologically Kauai is the oldest island and Hawaii the youngest. On Kauai are found deep and rugged canyons the result of age-long erosion. On Hawaii vast stretches of lava are as fresh as if the material had barely had time to cool; and several flows have broken forth within the last century. There are innumerable small craters dotted over the main mountain mass. There is a great variety in the kinds of lava. Some of the cones are made up of cinders, a soft material that yields to the foot like sand. Others are made up of hard lava, of which two main divisions are recognized, aa and pahoehoe, Hawaiian terms meaning rough and smooth. The former is exceedingly rough and broken and presents great difficulties to the traveler who attempts to walk over its surface. In the course of time the lava disintegrates sufficiently to allow vegetation to obtain a foothold. The advent of plants is hastened by moisture, the lava becoming covered with vegetation much sooner in the regions of heavy rainfall than upon the arid slopes.

It will be impossible to give an ecological survey of the islands but it may be of interest to present a brief account of the flora and its relation to environment as it impresses a visiting botanist.

The most striking botanical feature that greets the traveler on his arrival at Honolulu is the display of ornamental plants, including flowering trees, shrubs, vines, and plants grown for the beauty of their foliage or the stateliness of their habit, practically all of which are of foreign origin.

There is a great variety of palms, including such pinnate-leaved species as the date, the coconut, and greatest favorite of all, the royal, and many fan palms and a few fishtail palms. The stately royal palm with its smooth columnar trunk is a familiar tree in parks and private grounds.

Among the street trees there are the pink shower (*Cassia nodosa*) with large racemes of beautiful pink and white flowers, the golden shower (*Cassia fistula*) with yellow flowers and woody, smooth, straight, cylindric pods 15 inches long, both with large compound leaves, and the flame tree (*Delonix regia*) with great masses of scarlet flowers on the otherwise naked branches, the leaves being deciduous. The monkey-pod or rain tree (*Samanea saman*), a large, round-topped or umbrella-shaped tree with an immense spread of branches, is common in parks.

Among the shrubs the most common is the hibiscus, of which there are scores of varieties, involving several species (especially *Hibiscus rosa-sinensis*). These are commonly used for hedges and produce a continuing crop of large, bell-shaped flowers, varying through shades of white, pink, and scarlet. Clambering over a wall around the grounds of Punahou College is a fine growth of night-blooming

cereus. This blooms en masse at intervals of several months and produces a remarkable display. The flowers open in the evening and close the following morning, so they must be observed by the light of lanterns. The writer was so fortunate as to obtain photographs of this hedge early in the morning.

Two shrubs are very commonly used for hedges, but it is the foliage instead of the flowers that is attractive. One is the acalypha (*Acalypha wilkesiana*), a plant of the family Euphorbiaceae, with simple leaves of various shades of brown, pink, and yellow. The other is a species of the family Araliaceae (*Nothopanax guilfoylei*), with pinnate leaves, consisting of five to seven white-margined leaflets. The croton (*Codiaeum variegatum*), an ally of the acalypha, is sometimes used for hedges, but more often is grown in clumps as a lawn ornamental. The narrow leaves are variously spotted and mottled and often spirally twisted.

Among the numerous ornamental, woody vines is the bougainvillea (*B. spectabilis*), which produces a great profusion of red or purple flowers. What appear to be flowers are, however, showy petal-like bracts.

In addition to those mentioned there are several that are familiar as cultivated trees in California and southern Florida, such as the pepper tree, mango, ironwood (*Casuarina equisetifolia*), banyan, and yellow poinciana (*Peltophorum inerme*).

An important and common exotic tree, but now thoroughly naturalized, is the algaroba or kiawe (*Prosopis juliflora*). Contrary to the usual experience where foreign trees or shrubs have been introduced and then run wild, this tree has proved to be a great blessing to the Hawaiian Islands. The original tree is still alive on Fort Street, Honolulu, where it was planted in 1828 by Father Bachelot, founder of the Catholic Mission. The algaroba now occupies extensive areas in the lowlands on all the islands, especially in the arid belts near the coast on the lee side, where it forms forests to the exclusion of all other plants. Fortunately it is very useful in two ways. The flowers are the source of honey of which commodity hundreds of tons are produced annually. The pods furnish a nutritious feed for stock. The foliage is not eaten but the pods as they fall from the trees are eagerly sought by all kinds of domestic animals, and in the dry season are an important or sometimes the only source of forage upon the ranches. Their value as fodder has led to the invention of machinery to pulverize the pods so that they may be more completely and economically used. The algaroba is freely planted as an ornamental tree because of its graceful aspect and feathery, drooping branches.

Contrasted with the satisfactory results following the introduction of the algaroba we have the conspicuously disastrous effect of in-

roducing the lantana and guava. The lantana (*L. camara*) is cultivated for ornament because of the flat-topped clusters of pink or lavender parti-colored flowers. It has run wild and now occupies hundreds of acres on the drier parts of the slopes below the rain forest. It is of no value and occupies the soil to the exclusion of pasture plants. The guava, cultivated for its fruit, about the size and appearance of a lemon, from which the delicious guava jelly is made, has also run wild and occupies large areas of pasture land, or what would be pasture if these two pestiferous shrubs could be exterminated.

Another introduced shrub or tree is the prickly-pear cactus (*Opuntia megacantha*). This plant is now common on the dry parts of all the islands, sometimes forming forests. However, it is not entirely a pest, for in times of stress it furnishes no inconsiderable proportion of the forage on the ranches, because the cattle have learned to eat the juicy joints in spite of the numerous needlelike spines.

The native flora has been almost entirely replaced by introduced weeds in all the lowlands, especially in the vicinity of the towns.

All the islands are mountainous. Kauai, a nearly circular island, is mountainous through the interior, the highest point being Waialeale, in the center (5,170 feet). Oahu has two ranges of mountains—the Koolau Range on the east and the Waianae Range on the west, the highest point being Mount Kaala, in the latter range (4,030 feet). Molokai, an oblong island, has a range in the eastern half along the north side, the highest point of which is Kamakua Peak (4,958 feet). Maui consists of two mountain masses—East and West Maui—with a low isthmus between. The highest peak of West Maui is Puu Kukui (5,788 feet). East Maui is centered around the immense crater Haleakala, said to be the largest crater in the world. The highest part of the rim, a point on the western side, has an altitude of 10,032 feet. Lanai, a small island west of Maui, is mountainous on the eastern side, rising there to about 3,500 feet. Hawaii, the largest island of the group, is truly majestic in the height of its mountains. There are four mountain groups. The mass of the island is made up mainly of the two great cones, Mauna Kea (13,825 feet) and Mauna Loa (13,675 feet.). There are two lesser mountain groups—the Hualalai Mountains (8,269 feet), near the west coast, and the Kohala Mountains (5,489 feet), in the projection at the northwest corner. These mountains have a high rainfall where they intercept the trade wind, the region of greatest precipitation being at the summit and somewhat to the leeward (except the high peaks as noted below). The Hualalai Mountains are comparatively dry because they are in the lee of Mauna Kea. In many places the slope is gradual from sea to summit. In fact, all the mountains are, in general,

rather flat cones, the precipitous cliffs and valleys being due to erosion, though there are high cliffs (palis) on the north and east sides of some of the mountains, as the Kohalas and the mountains of Molokai, and the walls of the great craters. As one looks from the sea on the northeast coast of Hawaii to the summit of Mauna Kea, a distance of perhaps 20 miles, the slope is so even that it is difficult to convince one's self that he is looking up to a peak nearly 14,000 feet above him. The famous volcano Kilauea lies on the southeast slope of Mauna Loa at an altitude of about 4,000 feet. In one part of the large crater, about 3 miles across and 500 feet deep, is the lava pit called Halemaumau, a circular depression about 1,500 feet wide at the top and several hundred feet deep. The view from the rim of this pit is extremely fascinating, especially at night. The liquid lava seems to boil from the force of the escaping gases and the waves produce a loud roar as they splash against the margins.

The distribution of the flora upon the islands depends upon rainfall, altitude, and soil. The rainfall is highest in the mountains and decreases toward the leeward side of the islands. The annual precipitation in the rain belt is usually from 100 to 300 inches, but in some localities exceeds this large amount. On the southwestern sides of the islands the rainfall becomes so slight that the climate is arid. The rain zone extends up on the mountains to only 5,000 to 6,000 feet. Consequently, on the high peaks of Hawaii and East Maui the rainfall decreases toward the summits. The character of the flora changes with the rainfall. Hence, rain forests occupy the regions of high rainfall, while the slopes of western Molokai, East Maui, and Lanai and the plains of central Oahu and Hawaii are covered with grasses and other herbaceous vegetation, with sometimes intermingled areas of open, scrubby forest. The peaks of Mauna Kea and Mauna Loa are nearly devoid of vegetation above 10,000 feet.

The grasses of the Hawaiian Islands number about 100 species, including the large number of introduced weeds. The native species are less than half the total. As grasses are inhabitants of open ground they are rare in the rain forests. A well-known, useful native grass is the pili (*Heteropogon contortus*) which is a valuable range grass. This species was used by the early Hawaiian inhabitants to thatch their cabins, the grasses being fastened to a light frame work to form the walls and roof. An introduced species, Hilo grass (*Paspalum conjugatum*), has become a pest, having become established almost to the exclusion of other plants over wide areas on the wet slopes below the rain forest. It is said to have been introduced at Hilo from tropical America about 1840. It is of little value for pasture as stock will not eat it except when forced to from hunger. Another common and equally useless species, *Paspalum orbiculare*, which seems to have received no common name, occurs widely dis-

tributed in about the kind of soil that is suited to Hilo grass. Pili-piliula (*Chrysopogon aciculatus*) is the name given to a pestiferous little grass covering much of the dry plain in the interior of Oahu. This grass, introduced from the East Indies, produces sharp-pointed seeds which penetrate the clothing of those who walk through it and produce much discomfort. Bermuda grass is thoroughly naturalized in the drier localities and is extensively used as a lawn and park grass. Its native name is manienie, a name which was applied by the Hawaiians originally to *Stenotaphrum secundatum*, another creeping grass. The latter species is frequent in tropical regions and is known in the southern United States as St. Augustine grass.

The genus *Eragrostis* is represented by several native species, most of which are endemic. One species (*E. variabilis*) is characteristic of the wind-swept open slopes of the Nuuanu Pali, a pass in the Koolau Range east of Honolulu. Upon the plain between Mauna Kea and Mauna Loa, a great stock-range country, a tall slender tufted species (*E. atropioides*) is the prevailing grass.

The genus *Panicum* is represented also by several native species. *Panicum torridum* and its allies, fuzzy annuals called by the general name kakonakona, are winter grasses that follow the rains on the semiarid plains, and furnish a considerable portion of the forage at that time. Three species of *Panicum* (*P. imbricatum*, *P. isachnoides*, and *P. monticola*) are characteristic of the open bogs of the wet mountain summits, where they form hemispherical tussocks, consisting of a mass of old roots and stems with a covering of living shoots an inch or two long.

Upon the upper slopes of Mauna Kea and other high mountains toward the limit of tree growth there are three characteristic species of grass that are found sometimes in great abundance. They are all tufted species that furnish forage to the stock that range through these regions. One of these (*Agrostis sandwicensis*) is endemic, the other two (*Deschampsia australis* and *Trisetum glomeratum*) are found in the South Sea Islands.

Several European species of forage grasses have been introduced upon the ranches and have become established at medium altitudes (3,000 to 7,000 feet). Of these may be mentioned timothy, orchard grass, meadow fescue, velvet grass, redtop, Italian rye grass, rescue grass, and bluegrass. *Paspalum dilatatum*, a native of South America, is giving much promise as a pasture grass in these regions. At lower altitudes Natal grass or Natal redtop (*Tricholaena rosea*) is being used as a meadow grass, and Rhodes grass (*Chloris gayana*) is coming into use for the same purpose. Sudan grass is being tried and seems well adapted to the drier areas.

In the central part of Kauai there is a species of *Poa* (*P. siphonoglossa*) which is remarkable in its aspect, especially for this genus

which includes the bluegrasses. The stems grow in large tufts along steep banks. The young stems and flowering shoots are not particularly unusual but the old stems elongate to as much as 10 or 15 feet, lose their blades, and hang down the bank in long green rushlike masses that are very striking in appearance.

The forest trees comprise a great many species. It is astonishing how many of these species, and in fact species of plants in general, have been given Hawaiian names by the early inhabitants. Only a few are of sufficient importance to be mentioned here. The commonest tree on the islands is the ohia or ohia lehua (*Metrosideros polymorpha*) a member of the myrtle family, having a very wide altitudinal range and growing under a great variety of conditions. In size it varies from a mere shrub at high altitudes, to a giant forest tree in the middle forest zone. The tree has white furrowed bark like that of our white oak and beautiful scarlet flowers with numerous protruding stamens. The wood is hard and durable, and is used for many purposes, including paving blocks and railroad ties.

Another forest tree is the koa (*Acacia koa*), important because of its abundance and because of its economic value. Next to the ohia it is the most numerous among the larger trees, and is widely distributed throughout the islands. When growing in the open the koa forms a comparatively low widely spreading tree with a thick short trunk. But when growing in the rain forest among other trees it forms tall shapely trunks 40 or 50 feet to the branches. The wood is used in cabinetwork and is becoming familiar to Americans through its use for ukuleles, the mandolinlike musical instruments now so popular. The foliage is interesting because of its polymorphism. On the young trees or on vigorous shoots of old trees the leaves are twice pinnate, much like those of our honey locust, but have laterally compressed or flattened petioles. The normal mature foliage, however, consists of these flattened petioles or phyllodea, the remainder of the leaf not developing.

Another species of koa (*Acacia koaia*) is found in the drier regions of the southern islands.

The traveler is certain to inquire concerning a common tree that attracts attention because of its peculiar light or olive green foliage that is in marked contrast to the prevailing green of the forests. This is the kukui (*Aleurites moluccana*), found widely distributed in the islands at lower altitudes up to about 2,000 feet. The leaves remind one of those of the castor oil plant, which the young kukui plants closely resemble. The nuts of the kukui are rich in oil, which is an important article of commerce. The species has a wide range in Polynesia and tropical Asia. In the English colonies it is called candleberry or candlenut tree.

In the regions where they grow, two monocotyledenous trees of peculiar habit, the halapepe and puhala, attract attention. The halapepe (*Dracaena aurea*) belongs to the lily family and is allied to our yuccas. The narrow lilylike leaves are clustered at the ends of the branches, where are produced also the flowers and fruit, the latter a cluster of bright red berries about the size of marbles. The halapepe is a xerophyte, being found in the dry districts especially on aa lava. The leaves are relished by cattle. The puhala (*Pandanus odoratissimus*) belongs to the genus of screw pines. It is a scraggly tree with long narrow coriaceous prickly-margined leaves clustered at the ends of the branches in the spiral or corkscrew arrangement, numerous stilt roots at the base, and aerial roots from the branches. The large red or orange-colored compound fruit resembles a pineapple. There is a fine forest of these trees near Hilo. Belonging to the same family is a tall woody climber (*Freycinetia arnotti*) which is common in the lower woods.

If one ventures on to the upper slopes of the mountains of Hawaii he is sure to come in contact with the mamani (*Sophora chrysophylla*) a member of the family Leguminosae. It grows on several of the islands but is particularly noticeable toward the upper limit of tree growth on the mountains, where it forms small round-topped trees, with silvery-brown pinnate leaves like those of our black locust, drooping racemes of golden-yellow, pea-shaped flowers, and long pods constricted between the seeds.

The wiliwili tree will attract attention in the autumn at the lower levels on the dry side of the islands. At this season it is devoid of leaves and is conspicuous among evergreen vegetation. The seeds are a bright scarlet and are used for ornament. The wood is said to be the lightest of any kind growing on the islands, and is used for outriggers upon canoes.

The mountain apple (*Jambosa malaccensis*) is of interest because of its edible fruits. These are spheroidal, 2 or 3 inches in diameter, white or red, thin-skinned, very watery, but pleasant-flavored, and contain usually one large seed. The mountain apple is found in lowland valleys.

There are several species of trees of the mallow family that are worthy of remark because they are on the verge of extinction and illustrate the harm done to vegetation by the grazing industry. One is the kokio or native red cotton (*Kokia rockii*) described recently by Lewton.¹ This is a small tree with magnificent hibiscus-shaped red flowers about 4 inches long. It is endemic on the island of Hawaii and is confined to the dry region on the western side of the island, where it is scattered here and there on the rough lava of

¹ Smiths. Misc. Coll. 60:5. 1912.

North Kona. The species comprises a comparatively few individuals and these are decreasing in number because of the incursions of cattle. Mr. Robert Hind, upon whose ranch at Puu Waawaa the trees are growing, is giving them protection and thus preserving the species from extinction.

Another species, a close ally of the preceding, is called *Kokia drynarioides*. A few years ago the species was reduced to a single plant growing in the dry western part of Molokai. Recently this individual succumbed to the inevitable. Fortunately seeds from this tree had been planted and it is hoped that the species may be perpetuated in cultivation. The writer inspected one of the seedlings in the grounds of Mr. George P. Cooke of Molokai.

Another genus of this family contains three species, remarkable for the paucity of individuals. All are nearing extinction. Professor Rock states¹ that of *Hibiscadelphus giffordianus* there is but a single tree near the Kilauea volcano, and of *H. wilderianus* there is a single one on the southern slope of Haleakala. Of *H. hualalaiensis* there are about a dozen trees. All are succumbing to the ravages of cattle.

Aside from the shrubs already mentioned as being pestiferous weeds, the guava and the lantana, there are two others that were introduced at an early date and are now thoroughly naturalized but are not so troublesome as the two just mentioned. These are the klu (*Acacia farnesiana*) and the false koa (*Leucaena glauca*). They are found in waste land especially on the dry side of the islands. The klu is a prickly scraggly shrub with heads of yellow flowers. The false koa is without spines, has heads of white flowers and very flat pods. This species is giving promise as a forage plant. By proper treatment the woody stem may be kept trimmed close to the ground, a succession of young shoots that are suitable for forage being sent up.

The sensitive plant (*Mimosa pudica*) a well-known and interesting undershrub common in tropical America, has become established in open dry pastures. The twice pinnate leaves are very sensitive to the touch, so sensitive that they respond to the slight jar of the earth in walking, and will close in the vicinity if one steps heavily among the plants.

The isolation of the islands has led to the unusual development of certain families or genera of plants. One of these families that attracts the attention of the visitor, is the family Lobeliaceae. There are over 100 species belonging to 6 genera, making it one of the largest families of plants on the islands, the number of species being twice that in the whole of the United States north of Mexico. The family is interesting not only from the number of species, but from the

¹The Indigenous trees of the Hawaiian Islands, 297. 1913.

striking habit of most of these. The prevailing form is palmlike, a slender trunk crowned with a cluster of narrow leaves. In some of the larger species the trunk may be as much as 40 feet high. The flowers are clustered at the base of the leaves or are borne in showy racemes, and in many species are remarkably beautiful.

To the botanist and layman alike, there is no group of plants that presents more of interest than the ferns. They are everywhere from desert to rain forest and from sea level to the upper limit of vegetation on the high mountains. In size they vary from the gigantic tree fern to the minute epiphytic ferns less than an inch long. In some regions they are so numerous in both species and individuals that they impart the dominating aspect to the scene, and other plants appear as individuals scattered among them. The ferns and their allies number about 185 species. As individuals the tree ferns are the most conspicuous. They comprise 3 species belonging to the genus *Cibotium*. A common and widely distributed species is *C. menziesii* in which the twice pinnate fronds are as much as 12 feet long and 5 feet broad, raised upon trunks usually only a few feet tall but sometimes as much as 30 feet (Rock). At the base of the leafstalk there is a growth of soft yellowish wool called pulu by the Hawaiians and used by them for stuffing pillows and mattresses.

Contrasted with these giants are the pygmies in the form of numerous species of epiphytes. In the rain forest the epiphytes, including ferns, mosses, and lichens, cover every available trunk and branch with a soggy coating dripping with moisture. Some of the ferns creep over the surface by means of rootstocks; others are tufted. In some of these epiphytic forms the fronds are narrow and only an inch long with one or two fruit spots upon them.

A common and, to the explorer, troublesome fern is a climbing species (*Gleichenia dichotoma*) with repeatedly forked stems. These trail over bushes and often form impenetrable thickets over large areas.

On lava flows on the upper slopes of the high mountains, extending to the upper limit of vegetation, is a tufted coriaceous species (*Polypodium pellucidum*) about a foot high, with pinnatifid fronds. In dry areas the lobes incurve until the tips touch over the upper surface. Plants of this species may be found in holes in the lava as the last outposts of vegetation on Mauna Loa.

To the layman a description of the flora of the Hawaiian Islands would be incomplete without a reference to the silver sword (*Argyroxiphium sandwicense*). This rare and striking plant is found on the cinder slopes in the crater of Haleakala and on upper slopes of the high mountains of Hawaii. The form in the crater of Haleakala is slightly different from that on Hawaii and has been distinguished

as a variety (var. *macrocephalum*). The plants produce a tuft of numerous narrow stiff sharp-pointed leaves about a foot long, entirely covered with a silvery white closely appressed wool. The tufts appear to increase in size for several years from little balls up to tussocks 2 feet in diameter. Finally a flower stalk shoots up from the center bearing numerous heads of flowers about an inch in diameter with yellow center and purple rays. On the cinder cones in Haleakala the plants grow scattered here and there far above other vegetation in the most desolate and arid spots. At a distance these groups of plants, shiny white against the bleak brown slopes, have the appearance of a flock of sheep. On Mauna Kea the silver sword was seen on the north slope above the Kukaiau ranch. No living plants were observed on Mauna Loa, but many dead stems indicated its presence.

A second species of the genus grows in the crater of Haleakala, but is confined to cliffs and inaccessible rocks where the plants have escaped the ravages of goats. This species (*A. virescens*) has been called the green silver sword because the leaves are green instead of shiny white.

Another remarkable plant is the apé apé (*Gunnera petaloidea*). In appearance it reminds one of a giant pieplant or rhubarb, the leaves being circular and as much as 4 feet in diameter. This species grows in the rainy zones mostly on the sides of precipitous valleys. The leaves are very conspicuous because of their size in a region where broad leaves are unusual.

At the lower edge of the forest zone there is a common shrubby liliaceous plant, with cannalike leaves 1 to 2 feet long and 3 or 4 inches wide, known as ti or ki (*Cordyline terminalis*). The leaves are much used for wrapping fish in the markets. The natives had many uses for the leaves, roots, and stalks.

The rain forests include a large number of different kinds of trees and shrubs, mostly with inconspicuous flowers and indistinctive foliage. The trunks are frequently smooth and light colored and the leaves usually small. In much of the area where the rainfall is high the forest, though dense and impenetrable, is scrubby, the trees being small and gnarly, often not over 20 to 30 feet tall. This condition seems to be due to the character of the soil, which is not sufficiently fertile to support a growth of large trees. Under more favorable conditions, in some of the richer valleys, the forest may reach a higher development, including trees 100 feet tall.

From the ecological standpoint the open bogs present an interesting phase of the Hawaiian vegetation. These are found on the summits of the mountains that reach an altitude of about 5,000 feet and consequently receive a maximum rainfall. They occur to a limited

extent on Molokai, are well developed on West Maui, and reach a maximum on the central mountains of Kauai. They are found at or near the summit of ridges where the land is level or slightly sloping. The vegetation consists of herbs and low shrubs; tall shrubs and trees are lacking, except as intrusions from the surrounding flora. Many of the plants grow in tussocks so that the surface is a succession of irregular clumps and mounds. A characteristic and often dominant plant of these bogs is a kind of sedge (*Oreobolus furcatus*) which forms beautiful dark-green hemispherical tussocks as much as a foot in diameter, the stiff short leaves closely packed forming an even surface. Three species of tussock-forming panicums are found in these bogs (see a preceding paragraph on grasses). Two beautiful species of Lobelia (*L. gaudichaudii* on West Maui; *L. kauaiensis* on Kauai) are found here. The plant is 4 to 10 feet tall with a large panicle of cream-colored or pinkish flowers 3 or 4 inches long, as many as 100 in a single inflorescence. Resembling the lobelia as to shape of the plant is a composite (*Wilkesia grayana*) with sword-shaped leaves and long racemes of globose flower heads.

Among the smaller plants is a little sundew, apparently the same as the American species (*Drosera longifolia*), and two species of beautiful little blue violets (*Viola kauaiensis* and *V. mauiensis*). Growing in the scrubby rain forest more or less epiphytic, is a shrubby violet (*Viola robusta*), the flowers resembling those of our little Johnny-jump-up, but the plant, a shrub 3 to 5 feet tall.

When the flora of the Hawaiian Islands is compared with that of other tropical lands, more especially when compared with the flora of tropical America, certain families that give a dominating impress to the latter regions are found to be poorly represented in the former. The orchid family, so characteristic of tropical lands throughout the world, is in the Hawaiian Islands conspicuous by its absence. The family is not absolutely without representation, but there are only three species, belonging to as many genera, and all are rare, inconspicuous terrestrial forms, strangely in contrast with the showy epiphytic orchids of other tropical regions.

The characteristic palm family is represented in the native flora only by about 10 species of *Pritchardia*, a genus of fan palms, most of the species having been published since the appearance of Hillebrand's Flora of the Hawaiian Islands. All the species are rare, being represented by scattered specimens in remote localities.

The tropical family Melastomataceæ, with its triple-nerved leaves, is entirely unrepresented and the great family Compositæ, the largest of our plant families, is represented by surprisingly few native species. The mint family (Labiatae) like the preceding has a disproportionately small number of species, these belonging mostly to

the two endemic genera *Phyllostegia* and *Stemogyne*. Entirely absent from the islands are the mangroves, those swamp trees so characteristic of most tropical shores.

Taking everything into consideration, the American botanist will be amply repaid for all the time and effort expended in visiting the Hawaiian Islands. He will be brought in contact not only with a new plant world, but with many curious and remarkable natural phenomena. He will be able to prosecute his researches under unusually pleasant and favorable conditions, a salubrious climate, helpful and sympathetic inhabitants, and an absence of those banes of the botanical collector, pestiferous insects and poisonous reptiles.



1. SNOW BANKS NEAR THE SUMMIT OF MAUNA KEA. THE CONE IN THE DISTANCE IS NOT THE SUMMIT, WHICH WAS IN THE REAR OF THE CAMERA.



2. GRAZING LAND ON MOLOKAI RANCH, CENTRAL MOLOKAI, LOOKING EAST TOWARD THE MOUNTAINS.

The western half of the island is a level or rolling plain.



1. NORTHEASTERN PART OF LANAI, SHOWING THE EFFECT OF WIND EROSION.

The columns are hard lava, from which the surrounding material has been blown away.



2. NORTHWEST PART OF MOLOKAI; A ROLLING PLAIN DENUED BY THE STRONG TRADE WIND.

The hillocks are held by Bermuda grass.



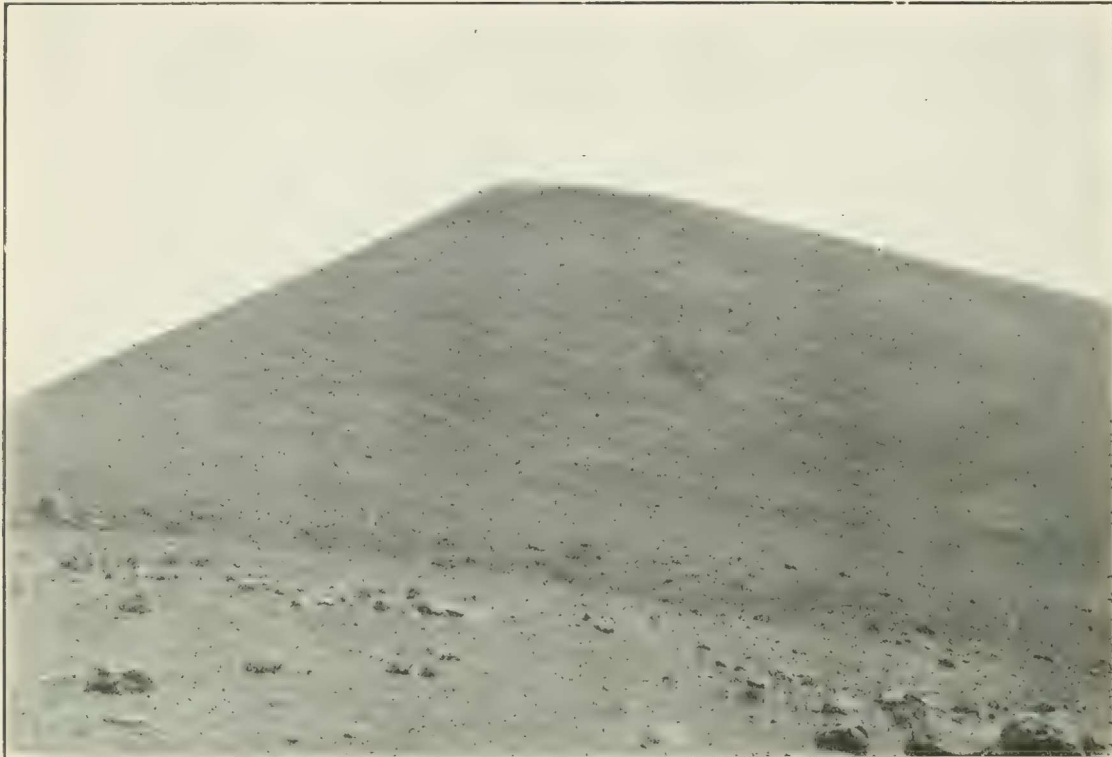
1. OLOKELE GULCH, KAUAI. A DEEPLY ERODED CANYON
CHARACTERISTIC OF THIS ISLAND.

The trees with light-colored foliage on the lower slopes are kukui (*Alcurites moluccana*). The plant in the foreground and on the sky line at the left is ti or ki (*Cordyline terminalis*).



2. STRATIFIED LAVA ON THE ROAD TO SCHOFIELD
BARRACKS, OAHU.

Sugar cane in the field above.



1. THE SUMMIT OF MAUNA KEA, A CINDER CONE ENTIRELY DEVOID OF VEGETATION;
ALTITUDE 13,825 FEET.



2. NEAR THE SUMMIT OF MAUNA KEA.

At the left is an ancient quarry to which the early Hawaiians came for material for stone axes. The lava is very hard and will take a sharp edge.



1. VIEW ON MAUNA LOA AT ABOUT 10,000 FEET ALTITUDE. SEVERAL SMALL CRATERS IN THE DISTANCE.



2. CRATER AT THE SUMMIT OF MAUNA LOA. VIEW FROM THE EAST RIM.



1. PUU WAAWAA, A HILL OR OLD CRATER NEAR THE HUALALAI MOUNTAINS.
In the foreground is the aa (rough) lava of an old flow. In the middle distance is a meadow of Rhodes grass (*Chloris gayana*).



2. SCRUBBY FOREST ON AA LAVA, PUU WAAWAA RANCH.

Note the exceedingly rough surface of the lava.

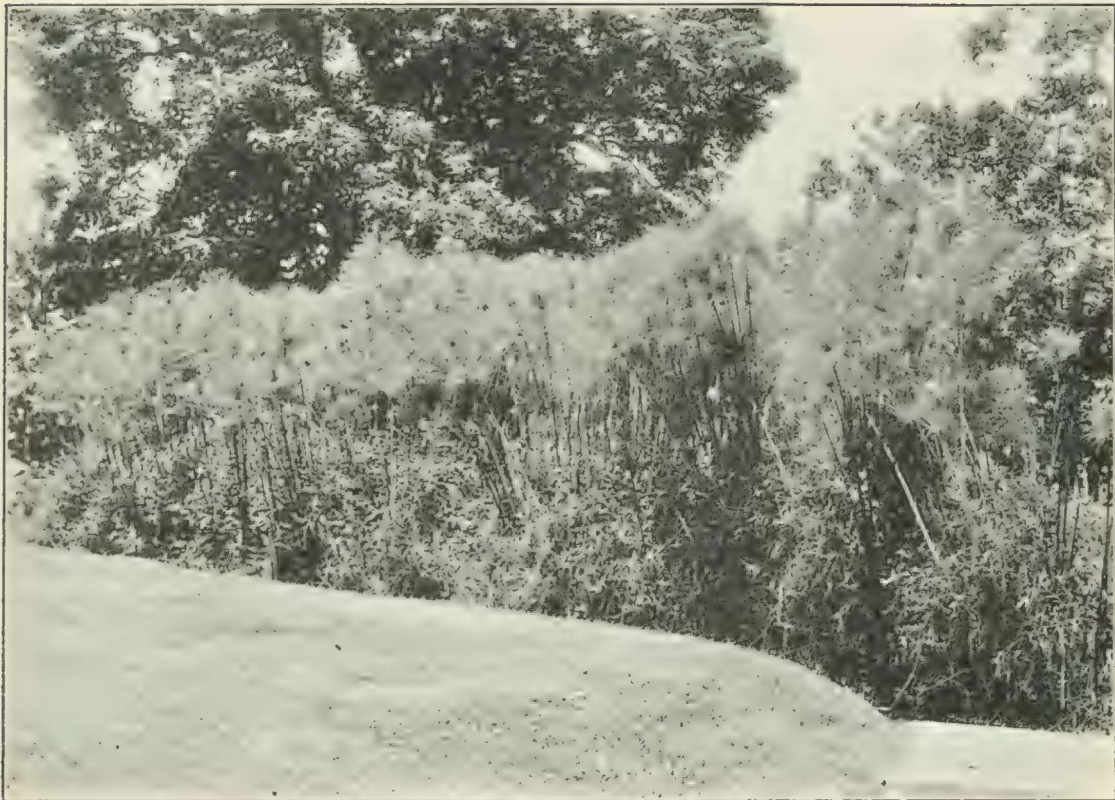


1. VIEW IN THE HILLEBRAND GARDEN.

This garden now owned by Mrs. Foster, formerly belonged to Dr. Hillebrand, the author of the Flora of the Hawaiian Islands.



2. AN AROID (*MONSTERA DELICIOSA*) CLIMBING ON A COCONUT IN MOANALUA PARK, HONOLULU.

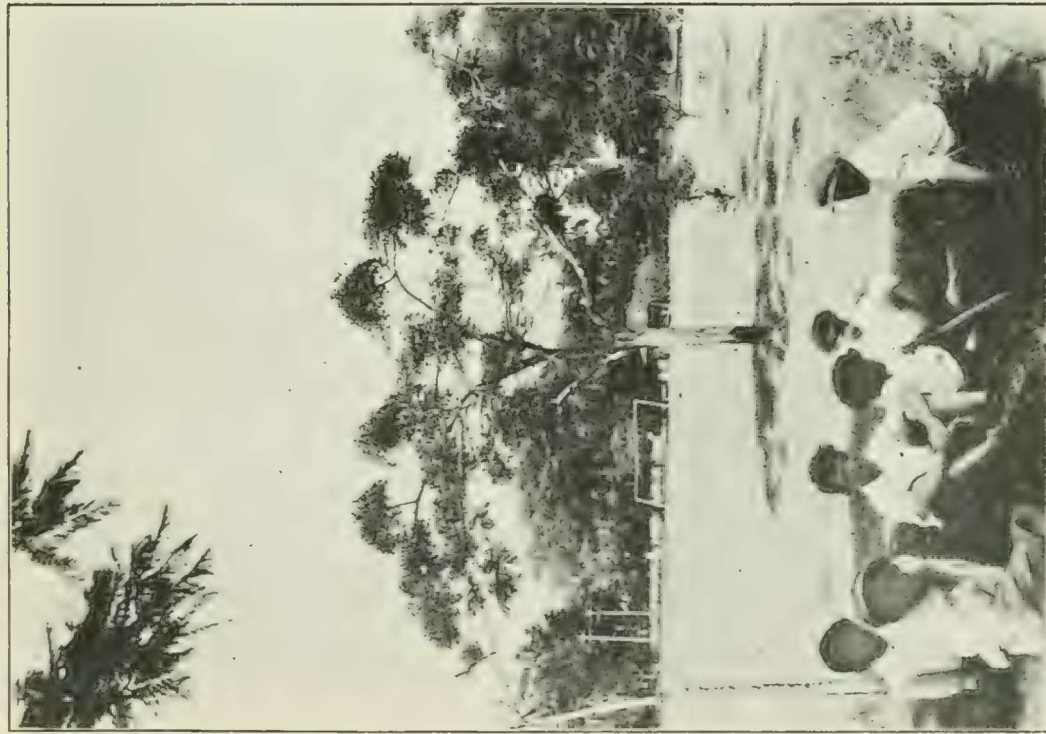


1. A GROUP OF PAPYRUS REEDS IN MOANALUA PARK.



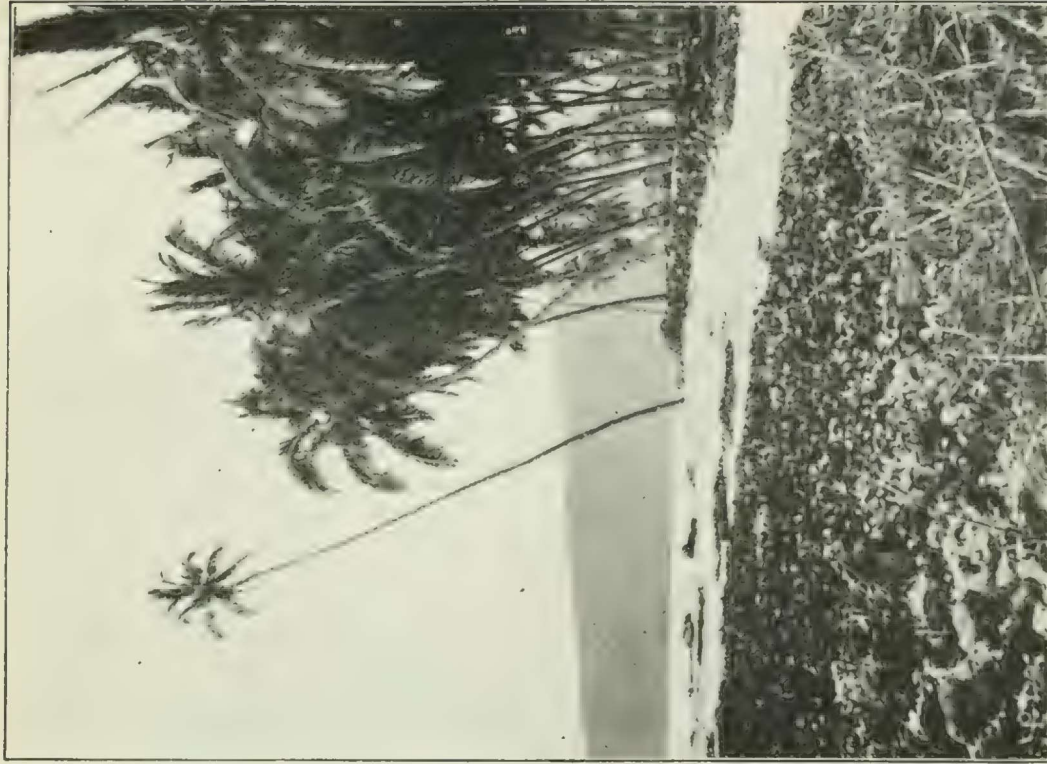
2. DIAMOND HEAD, FROM KAPIOLANI PARK, HONOLULU.

This crater is a prominent landmark from the ocean.



1. THE FLAME TREE (*DELONIX REGIA*), IN FULL FLOWER.

The flowers are bright scarlet and appear when most of the leaves are gone.



2. COCONUT TREES ALONG THE SHORE NEAR NAPOOPOO, WESTERN HAWAII.



1. A HEDGE OF NIGHT-BLOOMING CEREUS ON A WALL AT PUNAHOU COLLEGE,
HONOLULU.

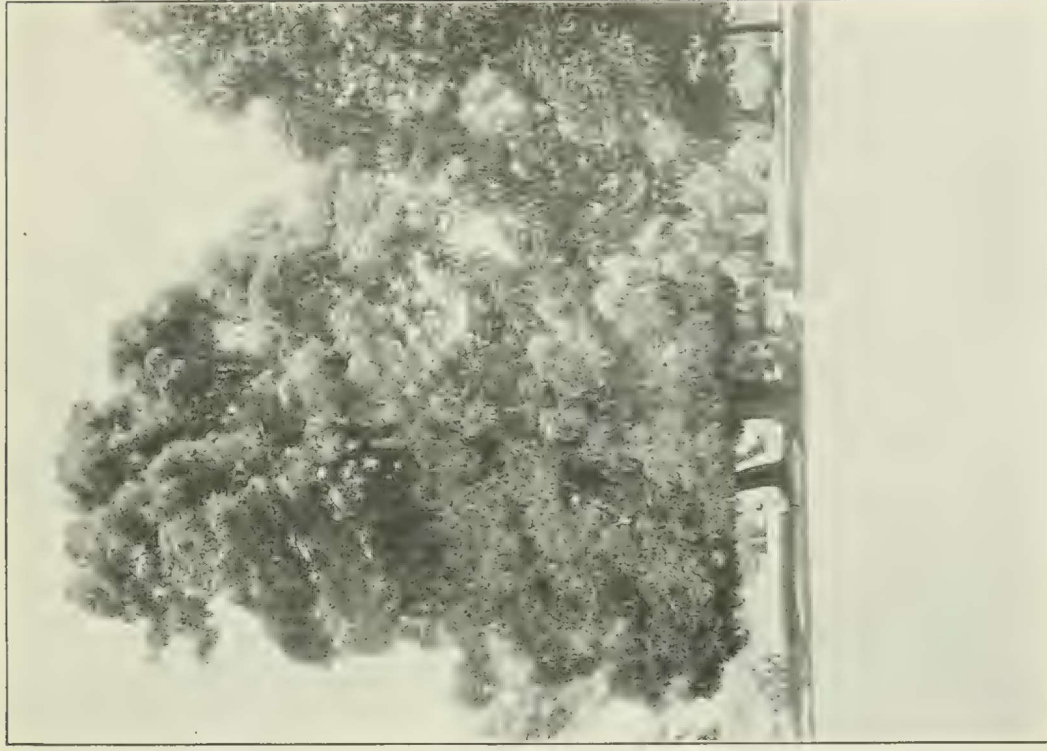
Taken before sunrise.



2. A FEW FLOWERS OF THE NIGHT-BLOOMING CEREUS.



1. THE YELLOW POINCIANA (*PELTOPHORUM INERME*),
A RATHER COMMON STREET TREE IN HONOLULU.



2. A MANGO TREE.

The mango is a delicious tropical fruit, common in the islands.



1. VIEW IN MOANALUA PARK.

Monkey pod at left, royal palms at right, three coconut palms in the distance, manienie (Bermuda grass) in the foreground.



2. A TYPICAL WASTE LAND SCENE.

A road near Honaunau with a tangle of guava and lantana which has taken possession of the soil. In the center a dilapidated bread-fruit tree.



1. SCHOFIELD BARRACKS, IN THE CENTRAL PLATEAU OF OAHU, LOOKING WEST TOWARD THE WESTERN OR WAIANAE RANGE OF MOUNTAINS.

Mount Kaala at the right is the highest point on the island.



2. HALEAKALA CRATER FROM THE WEST RIM.

Several smaller cones and craters may be seen within the main crater.



1. MAUNA KEA FROM HUMUULA AT AN ALTITUDE OF 6,700 FEET, LOOKING NORTH, SHOWING THE GRADUAL SLOPE TO THE SUMMIT (13,825 FEET).



2. SOUTHERN MOLOKAI NEAR THE SEA. LOOKING EASTWARD, SHOWING THE EVEN SLOPE OF THE MOUNTAINS.

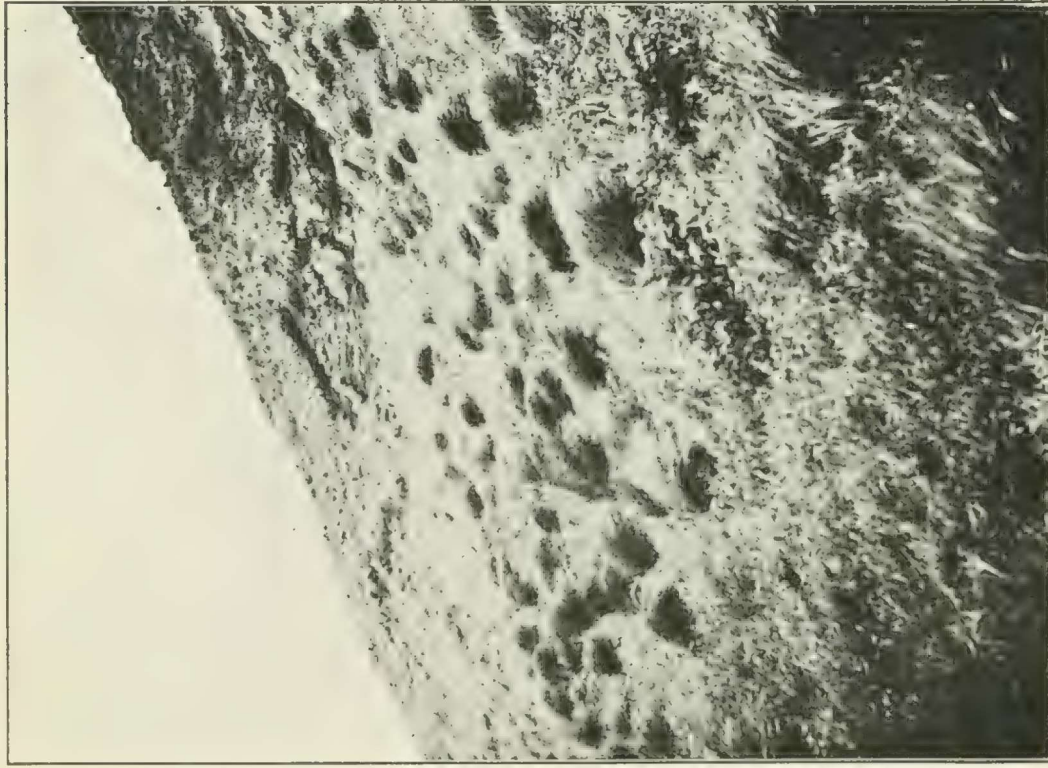
A belt of algaroba trees in the middle distance.



1. A MOUNTAIN GORGE BACK OF LAHAINA, MAUI,
SHOWING THE STEEPNESS OF THE VALLEY SIDES.

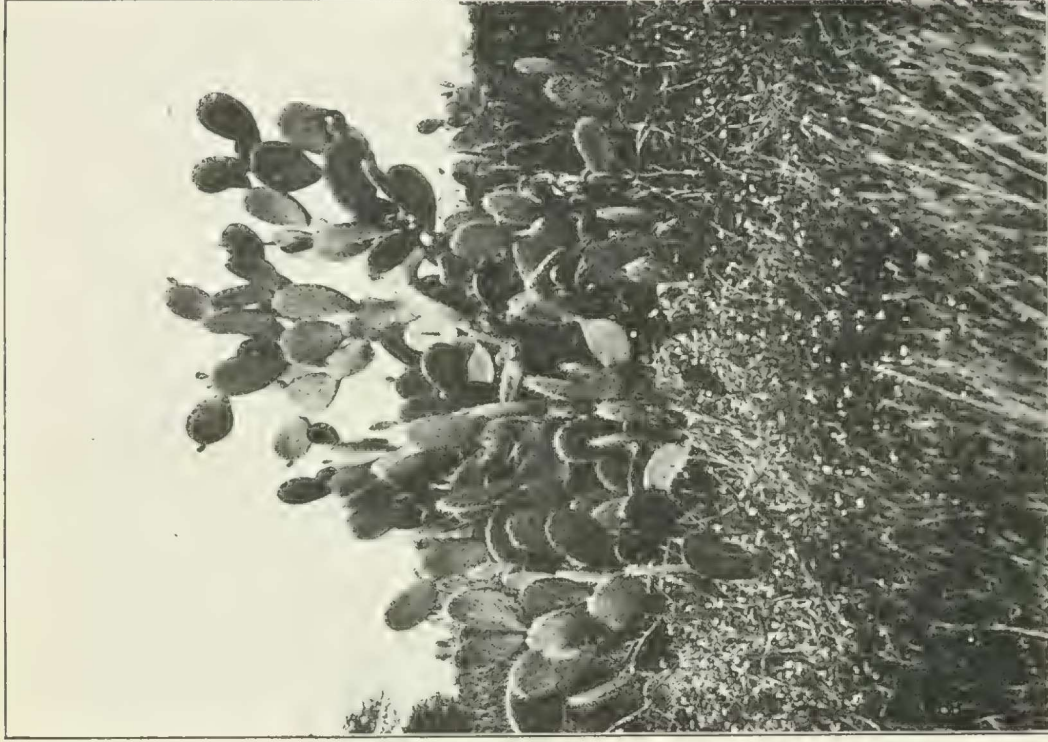


2. WEST WALL OF HALEAKALA CRATER.



I. A GRASSY SLOPE ABOVE NUUANU PALI.

The trade wind is always very strong through this pass. The tufts of grass are *Eragrostis variabilis*.



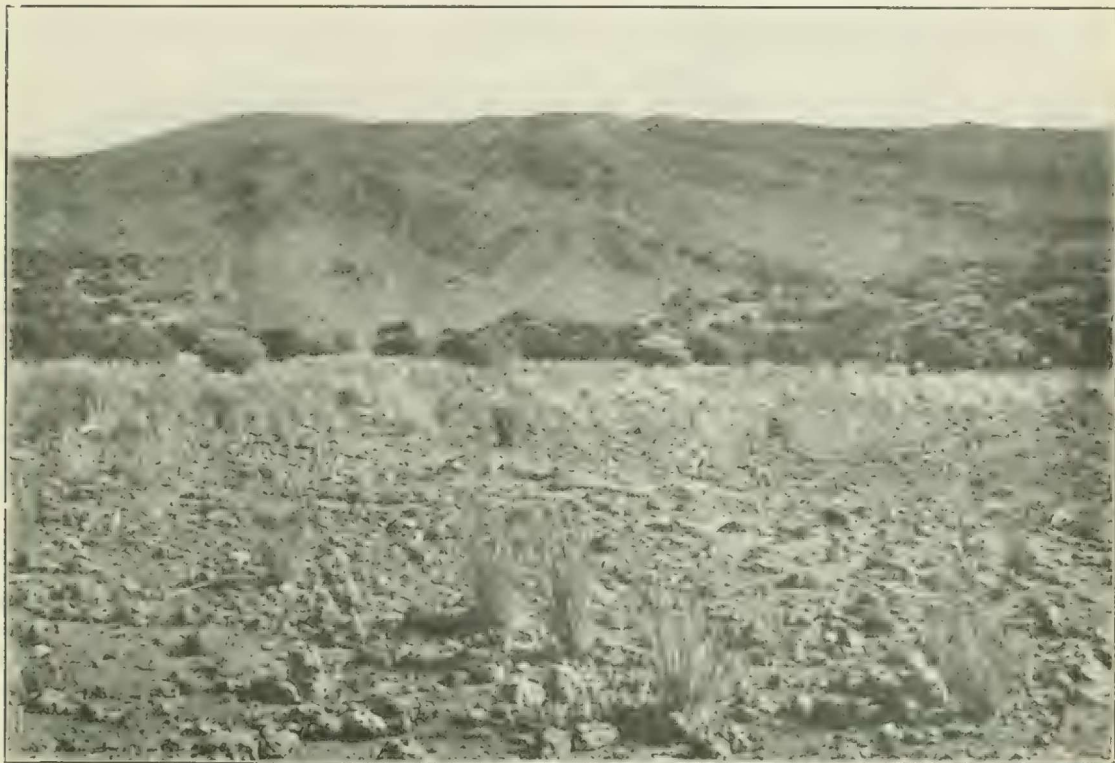
2. PRICKLY-PEAR CACTUS (*OPUNTIA MEGACANTHA*).

Introduced from Mexico, now common in the drier regions of all the islands.



1. SCHOFIELD BARRACKS, LOOKING EAST TOWARD THE KOOLAU RANGE OF MOUNTAINS.

Papayas in the middle distance; pilipiliula (*Chrysopogon aciculatus*) and other grasses in the foreground.



2. GRASSES AT TIMBER LINE ON MAUNA KEA.

The bunch grass in the foreground is *Agrostis sandwicensis*.



1. GRASSES AT TIMBER LINE ON MAUNA KEA.

The grass with narrow inflorescence is *Koeleria glomerata*; that with feathery inflorescence, *Deschampsia australis*. The trees are mostly mamani (*Sophora chrysophylla*).



2. KUKUI TREES (ALEURITES MOLUCCANA).

The shrubs in the foreground are young kukui plants.



1. KOA TREE ON NORTH SLOPE OF MAUNA KEA. AN ISOLATED SPECIMEN WITH SPREADING TOP.



2. A FIELD OF NATAL GRASS OR NATAL REDTOP (TRI-
CHOLAENA ROSEA) ON THE MOLOKAI RANCH.
The part to the right of the fence has been allowed to reach maturity.
The part of the left has been grazed.



I. A YOUNG PLANT OF *KOKIA DRYNARIOIDES* ON THE GROUNDS OF MR. M. C. COOKE, MOLOKAI.

The species has become extinct as a wild plant. A few small trees have been grown from seed from the last plant known.



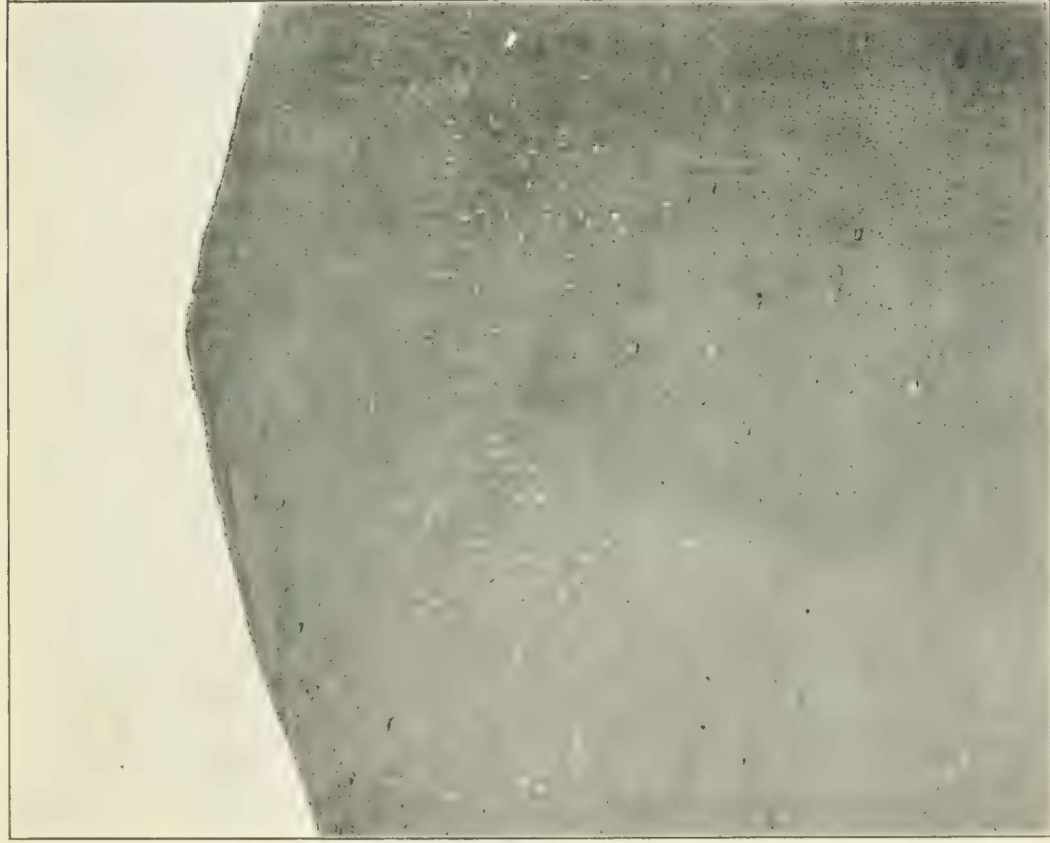
2. ARBORESCENT SPECIES OF PALMLIKE *LEDELLIACEAE* NEAR KAHOLUAMANO, KAUAI.



1. A FOREST OF KOAIA (*ACACIA KOAIA*) ON THE SOUTHWESTERN SLOPES OF THE KOHALA MOUNTAINS.



2. A HEAVY GROWTH OF FERN (*DRYOPTERIS FUSCOATRA*) IN THE HUMID FOREST ON THE SLOPES OF THE HUALALAI MOUNTAINS.



1. A CINDER SLOPE IN HALEAKALA CRATER.

The white points near the top of the slope are plants of silver sword.

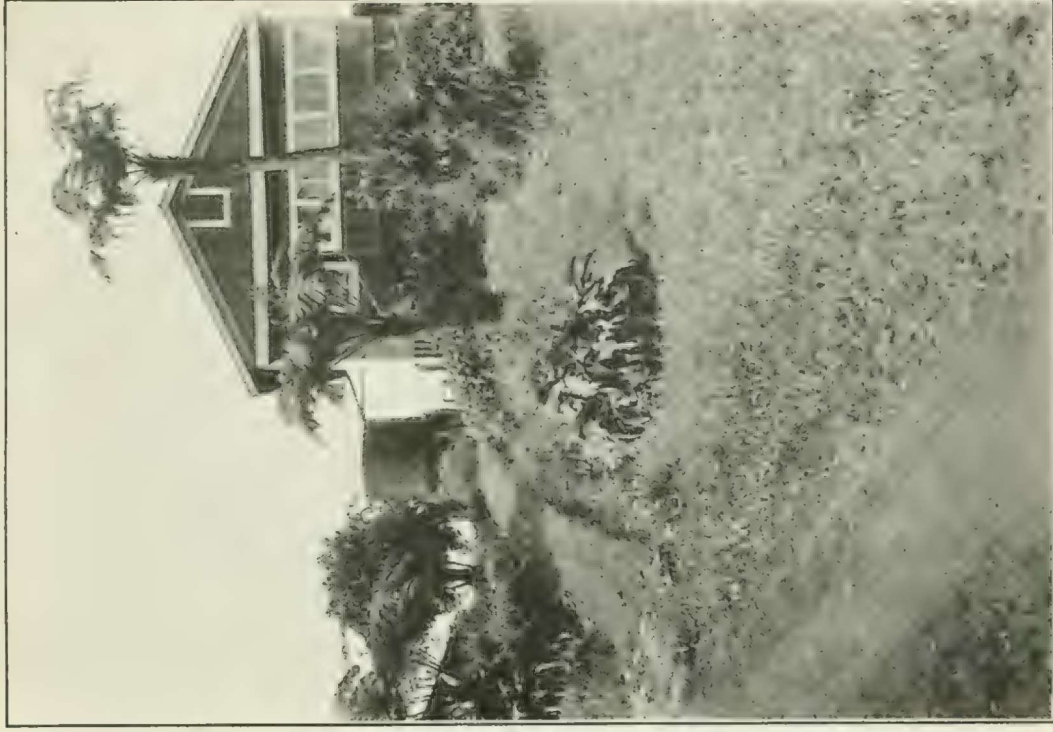


2. SILVER SWORD (*ARGYROXIPHUM SANDWICENSE*), A STERILE PLANT BROUGHT DOWN FROM THE UPPER SLOPES OF MAUNA KEA. OUR PART-HAWAIIAN GUIDE.

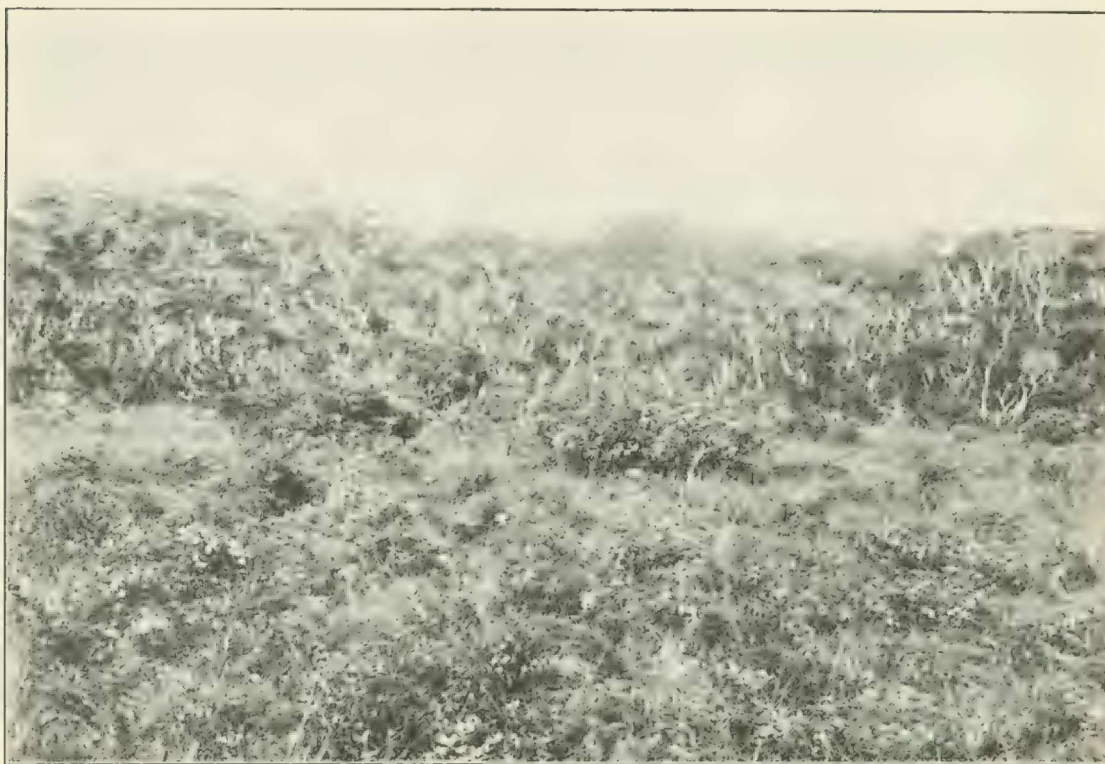


1. CHARACTERISTIC MOUNTAIN FOREST NEAR
KAHOLUAMANO.

The tree trunks are white and glisten in the distance.



2. TREE FERNS (*CIBOTIUM MENZIESII*) AT THE UNITED
STATES EXPERIMENT STATION, GLENWOOD, HAWAII.



1. A SMALL OPEN BOG NEAR KAHOLUAMANO, KAUAI. FOREST IN BACKGROUND.



2. A SMALL LAKE NEAR THE SUMMIT OF MAUNA KEA, ALTITUDE ABOUT 13,000 FEET.

Because of the porous lava soil lakes or ponds are rare.



1. TWO CHARACTERISTIC SPECIES FROM THE OPEN BOG
AT THE SUMMIT OF PUU KUKUI, WEST MAUI.

The plants were brought down and photographed at camp near the lower edge of the rain forest. Mr. G. C. Munro, manager of the Lanai Ranch, is holding in his left hand *Lebelia gaudichaudii*, in his right *Wilkesia grayana*.



2. A LEAF OF *GUNNERA PETALOIDEA* BROUGHT DOWN
TO IDLEWILD FROM THE HUMID FOREST ALONG THE
OLINDA PIPE LINE, EAST MAUI, ON THE NORTH SLOPE
OF HALEAKALA.

