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Some botanical aspects of the Hawaiian Islands

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The Hawaiian Archipelago is a group of islands of volcanic origin extending for more than a thousand miles from the northwest to the southeast between twenty and thirty degrees north latitude in the mid-Pacific Ocean. Most of the islands comprising the group are small, uninhabited, and of importance chiefly as bird sanctuaries. The largest islands of the group, and those generally referred to as "The Hawaiian Islands," are eight in number (Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii). These larger islands are believed to represent the younger in the archipelago and lie at the southeastern limits of the group. The island of Hawaii, the largest in the entire group, continues to exhibit volcanic activity and at the live crater of Kilauea one finds an excellent laboratory for the study of vulcanology. The islands of Niihau and Kahoolawe are small, low and uninhabited excepting for caretakers of stock which is grazed on them. The island of Lanai which is also comparatively small, is controlled by a pineapple canning company and is developed almost exclusively as a pineapple plantation. The other five islands are much larger and are highly developed agriculturally and support a population of about four hundred thousand persons.

Geographically the Hawaiian Islands represent the most isolated land area in the world. More than 2000 miles of great ocean depths separate them from any other high land masses. This extraordinary isolation has had a remarkable effect on the plant and animal life of the islands.

The plant life of the islands is abundant and rich in species. Because of the isolation of the islands, the origin of the flora and the manner of its migration present problems which continue to puzzle botantists and many theories have been advanced in explanation.

Whether they arrived buoyed up and floated by ocean currents, wafted by the wind, or came as passengers on floating logs or clinging to the feathers or feet of migratory birds, the great distances necessarily traversed make it appear improbable that plants or their reproductive structures reached the islands frequently or in abundance.

Hillebrand in 1880 in his "Flora of the Hawaiian Islands" included approximately 1000 species of ferns and flowering plants. More extensive and intensive explorations of the islands together with several critical monographic treatments of some of the higher groups have been made since that time. While the mosses and fungi have been studied, the other groups of lower plants are not so well known. A careful taxonomic study of the algae or lichens, for example, would undoubtedly reveal many species now unknown to science. The total number of species in the Hawaiian flora, exclusive of the large number of introduced forms, while not definitely known, must certainly now greatly exceed the number included in Hillebrand's "Flora."

A great diversity of ecological conditions is found on the islands, ranging from the tropical climate of the coast and lowlands to the occasionally snow-clad tops of Mauna Loa and Mauna Kea, and from moist, rain- and fog-swept fertile valleys and windward mountain slopes to arid and semiarid ridges and sand dunes on the leeward sides of the islands. This great diversity of ecological conditions affording maximum opportunity for growth and development, together with the isolation and consequent freedom from the influence of a surrounding flora, probably is largely responsible for the remarkably high degree of endemism which amounts to between 80 and 90 percent.

For purposes of a brief discussion, the flora may be considered under the following four categories:

a—Native plants.

b—Economically useful plants of early Hawaiian introduction and now mostly well established.

c—Weeds, chiefly of the wayside and fields.

d—Recently introduced plants of economic importance.

Several unfavorable influences have had a marked effect on the extent and distribution of the native flora. Hogs were introduced in prehistoric times, and goats, cattle and horses were early introduced by the whites into the islands. Many of these

animals, especially the goats and the hogs, became wild and have multiplied in great numbers. Because of the grazing and rooting in the forests by these wild animals, as well as by tame herds, a great amount of damage has been done to the native flora. Forested areas have been destroyed and many species of plants have been greatly reduced in numbers and in some instances exterminated.

Within the past few years tracts of land, including important water-shed areas, have been fenced and grazing in them is now prohibited. Reforestration in these and in other regions where grazing is restricted is aiding in promoting conditions favorable for the reestablishment of the original flora. In the course of time, large acreages of tillable land were placed under cultivation. Introduced weeds became more and more abundant. Many native plants, unable to successfully compete with the advance of cultivation and the more vigorous weedy species, were compelled to retreat up the valleys and mountain slopes. At the present time it is necessary to go a considerable distance from the cultivated areas before a typical native flora may be found.

At one time a considerable amount of sandalwood grew in the forests of the islands. This was in great demand in the Orient where there was a ready market for it. Exportation of the wood began in the latter part of the eighteenth century when its commercial value became recognized. Replanting when the trees were removed was not practiced and by 1850 practically every tree of marketable size had been cut. This ruthless despoiling of the forests of this formerly abundant species had no little effect on the makeup of the associated flora.

The native flora presents several interesting features. Several of the larger plant families are conspicuous because of the comparatively small number of species which are found. This is especially true of some of the larger monocotyledonous families. Only three native species of orchids are found for example, which is in striking contrast to many other parts of the world with similar growing conditions. There are no native Gymnosperms, and the palms are represented by the single genus *Pritchardia*. On the other hand, some families exhibit an unusually large number of species. The family *Lobeliaceae*, for example, is represented by over a hundred species many of which are

uniquely arborescent with tufts of leaves at the top of woody stems several feet high.

The islands are mostly mountainous. The mountains are commonly steep and precipitous on the windward side but slope more gradually to the leeward. On Kauai, Oahu and Molokai they scarcely reach 6000 feet in height. The extinct crater of Haleakala on the island of Maui and the peaks of Mauna Loa and Mauna Kea on Hawaii, however, are more than 10,000 feet high. The moisture-laden clouds are caught by peaks 4000 to 6000 feet high with a resulting abundant precipitation. Above these levels the amount of rainfall diminishes and is comparatively small above 10,000 feet.

The great differences in altitude and in moisture have produced vegetation zones that are, in the main, well marked. The zones are not constant as to altitude or extent on the different islands. They may also vary on the different sides of the same island with the forest zones usually extending to lower levels on the windward than on the leeward side. In general, however, five principal zones of vegetation are to be recognized:

1—Littoral zone, including sand beach and swampy areas along the coast.

2—Lowland zone, open grazing and cultivated areas mostly below 1000 feet altitude.

3—Lower forest zone with upper limits of 2000 to 3000 feet altitude.

4—Middle forest zone with upper limits of 5000 to 6000 feet altitude.

5—Upper forest zone found only on the higher mountains and extending to 8000 or 10,000 feet altitude.

The coast is quite variable in character. In some places it is rocky while in others it is sandy with accompanying small sand dunes or it may be a mud flat. Typical genera of this coastal zone are: Pandanus, Cenchrus, Panicum, Scirpus, Cocos, Batis, Sesuvium, Capparis, Prosopis, Tephrosia, Tribulus, Gossypium, Hibiscus, Sida, Waltheria, Calophyllum, Rhizophora, Terminalia, Cuscuta, Cordia, Heliotropium, Vitex, Scaevola, and Pluchea.

The lowland zone extends from the littoral zone to the lower limits of the forest but generally not exceeding 1000 feet altitude although the upper limits vary greatly on the different sides of

the islands. It is mostly open cultivated or grazing land with isolated specimens or scattered clumps of trees and shrubs. It is here that one finds the great sugar-cane and pineapple plantations. Introduced weeds also find conditions most congenial for their development. Where sufficient moisture is present grass may be more or less abundant. Shrubby thickets especially of the introduced *Lantana camara* and *Psidium guajava* are abundant along the bottoms and sides of gulches and valleys and the introduced *Opuntia megacantha* Salm-Dyck is common in the more arid regions, especially on Oahu. Several of the genera which occur in the littoral zone are also to be found here as well as are some which are typically of the forest zone which generally extends down the moist gulches and valleys. Some typical genera of this zone are: Gleichenia, Sphenomeris, Sadleria, Cordyline, Dracaena, Pipturus, Osteomeles, Acacia, Leucaena, Erythrina, Pelea, Aleurites, Dodonaea, Sapindus, Sida, Waltheria, Wikstroemia, Styphelia, Osmanthus, Clermontia, Scaevola, and Heteropogon.

The forest extends from the upper edge of the lowland zone to about 10,000 feet. Three zones are recognized each with more or less distinctive species, yet showing considerable overlapping: a lower more or less open forest with Gleichenia, Cibotium, Freycinetia, Zingiber, Pipturus, Pittosporum, Aleurites, Ilex, Elaeocarpus, Xylosma, Eugenia, Metrosideros, Cheirodendron Maba, Osmanthus, Alyxia, Gouldia, Straussia, and Scaevola as common genera; a middle zone including Gleichenia, Dryopteris, Cibotium, Pritchardia, Peperomia, Broussaisia, Euphorbia, Viola, Eugenia, Metrosideros, Cheirodendron, Labordea, Suttonia, Phyllostegia, Gardenia, Gouldia, Kadua, Nertera, Lobelia, Scaevola, and Dubautia as representative genera; and the upper forest zone extending to the upper limits of the highest mountains includes Acacia, Wikstroemia, Vaccinium, Coprosoma and Argyroxyphium.

Some of the most interesting regions are the so-called alpine bogs which occur between 4000 and 6000 feet altitude in a few places in the islands. The largest ones are on Kauai near Mt. Waialeale and on Puu Kukui and Mt. Eeke on west Maui. The bogs are open with scattered islands or intrusions of dwarfed trees and shrubs and covered with tussock-forming species of grasses and sedges. *Oreobolus furcatus*, *Panicum imbricatum* and

P. isachnoides are three of the commonest species. Other characteristic genera found in the bogs are Schizaea, Selaginella, Viola, Lobelia, and Argyroxyphium.

The Hawaiians originally made considerable use of plants and of their products for food, clothing, dyestuffs, medicines, etc., and possessed much knowledge regarding plants and their products. They knew and named the plants which they found or used and in many instances employed a form of binomial nomenclature.

A number of species of economic importance now cultivated or well established, especially in the fertile valleys originally inhabited by the natives, were probably of very early introduction. Among the commonest and more important species are the sugar-cane, banana, coconut, awa (*Piper methysticum*) from the root of which a medicine and an intoxicating beverage were produced, taro (*Caladium colocasia*) from the rootstock of which poi, one of the principal foods of the natives is obtained, breadfruit, wauke (*Broussonetia papyrifera*) which furnished the bark from which the bark cloth known as tapa or kapa was manufactured, and noni (*Morinda citrifolia*) which furnished dyestuffs for tapa cloth and also was useful in preparing a beverage and medicines.

The weedy species observed along the roadsides and in the fields and pastures have gained entrance mostly as stowaways and have come from many different parts of the world. To the visitor from midwestern America such plants as *Cenchrus echinatus*, *Rumex acetosella*, *R. crispus*, *Portulaca oleracea*, *Prunella vulgaris*, *Solanum nigrum*, *Erigeron canadensis*, *Leontodon taraxacum*, and *Sonchus oleraceus* are a few plants he can recognize in an otherwise almost wholly alien flora. Some species purposefully introduced have also become pernicious weeds. A notable example is the lantana (*Lantana camara*) which was introduced many years ago for the decorative value of its flowers. The seeds are scattered by the introduced myna bird and the bushes now occupy large areas of land thus destroying its usefulness for grazing or other purposes. Strenuous and more or less successful efforts have been made by entomologists and botanists to introduce natural insect or fungous enemies in an attempt to control or destroy the plants. Another introduced plant which has spread and become a nuisance as a weed in pas-

ture lands is the lemon guava (*Psidium guajava*). Both the guava and the lantana form dense and almost impenetrable shrubby thickets.

There are few native Hawaiian plants that are useful for decorative landscaping purposes which succeed under the unnatural conditions of cultivation. Through the efforts of various individuals and organizations hundreds of species of tropical and subtropical plants useful for their ornamental or other economic value have been introduced during the last fifty years. These plants have been widely distributed throughout the islands where they have been planted in profusion about dwellings and along the streets. Advertising billboards have been banned from the roadsides and in their stead beautiful flowering trees and shrubs have been planted. Honolulu is indeed "a city built in a botanical garden," but the same could be truthfully said of practically every community in the islands. The streets, parks and private gardens present a year-round profusion of varicolored foliage and blossoms on hundreds of varieties of exotic plants. While there is an ever-present abundance of flowers throughout the year, the finest display comes during the spring and summer months. It is then that the avenues and gardens put on a most gorgeous exhibition of flowering trees and shrubs probably equalled nowhere else in the world. To enumerate the different species that one finds on a ramble through the parks and gardens or along the streets of Honolulu would result in a list of a very large number of the tropical and subtropical species worthy of cultivation.

Among the most abundant and conspicuous of the flowering trees are the purple jacaranda, the several varieties of shower trees (Cassias) with pink, pink and white, or yellow flowers; the scarlet flame tree (*Delonix regia*) and African tulip trees (*Spathoda campanulata*), the broad umbrella-shaped monkey pod tree (*Samanea saman*) with its delicate pink blossoms, and the yellow-flowered be-still tree (*Thevetia nereifolia*). Of the shrubby plants the more common are the pink and the white oleanders (*Nerium oleander*), the Plumerias with their pink or white star-shaped flowers, the yellow candle bush (*Cassia alata*), the scarlet Ixora, hundreds of forms of hibiscus, the scarlet and yellow Poinsettias, and the christmas-berry trees (*Schinus terebinthifolius*) with their red berries. Over walls and trellises or trees clam-

ber the fragrant yellow Allamanda, the various shades of perpetually blooming bougainvilleas, the yellow cup-of-gold (*Solandra guttata*), the pink Mexican creeper (*Antigonon leptopus*), the night-blooming cereus, and many others of great beauty. A number of different species are employed for hedge plants. The hibiscus, a great variety of the variegated-leaved Codiaeums and the perpendicularly branched Nothopanax are among the favorites, but hedges of the *ti* (*Cordyline*), Poinsettia, crown of thorns (*Euphorbia splendens*), and Phyllanthus are not unusual. Palms of many species are used in great profusion. Several fine avenues of the stately royal palm are to be seen in Honolulu, while the coconut palm is to be seen everywhere.

Many species useful for reforestration purposes, protection of water-sheds and for windbreaks have been planted including the Australian beefwood (*Casuarina equisetifolia*) and several varieties of Eucalyptus. The beefwood is also used to some extent as a street tree, where it appears to thrive well. The genus Ficus is represented by a large number of species including many fine specimens of the Indian banyan (*Ficus indica*) and peepul trees (*Ficus religiosa*). Many unusual and curious trees such as the Baobab tree, the African sausage tree (Kigelia), and others may be seen.

One of the introduced trees which has been of enormous value to the islands is the Kiawe or Algaroba (*Prosopis chilensis*). This plant which becomes a tree fifty to sixty feet high in Hawaii is erroneously believed to be the same species as the Mesquite of southwestern America. The tree propagates itself with ease and has spread throughout the islands where it has reclaimed and now almost exclusively occupies thousands of acres of rocky, formerly mostly waste lands near the coast. The trees if properly trimmed develop into picturesque shade trees. A large number are used for this purpose on the grounds of the Kamehameha schools in Honolulu. The wood is of good quality and is used for fuel. The pods which are produced in abundance have considerable food value and are relished by horses, cattle and hogs. A large amount of an excellent grade of algaroba honey is also produced.

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