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ROYAL PALMS (*OREODOXA REGIA*).

BULLETIN No. 95.

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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, Director.

REPORT

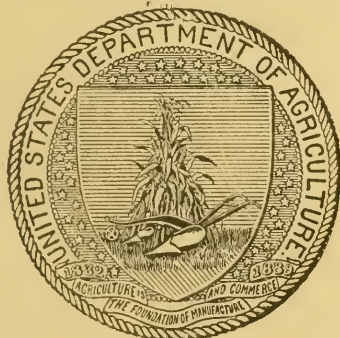
ON THE

AGRICULTURAL RESOURCES AND CAPABILITIES OF HAWAII.

BY

WM. C. STUBBS, Ph. D.,
Director, Louisiana Agricultural Experiment Stations.

JANUARY 24, 1901.—Message and accompanying papers ordered printed
and referred to Committee on Territories.



WASHINGTON:
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To the Senate and House of Representatives:

I transmit herewith a report on investigations of the agricultural resources and capabilities of the Hawaiian Islands, with special reference to the establishment of an agricultural experiment station in those islands, made in accordance with the act of Congress making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1901.

The attention of Congress is called to the request of the Secretary of Agriculture that 2,000 copies of the report be printed for the use of the Department of Agriculture.

WILLIAM MCKINLEY.

EXECUTIVE MANSION,

January 24, 1901.

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LETTER OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE.

OFFICE OF THE SECRETARY.

Washington, D. C., January 10, 1901.

SIR: I have the honor to transmit herewith a report on the agricultural resources and capabilities of the Hawaiian Islands with special reference to the establishment of agricultural experiment stations therein. This investigation was made preliminary to the establishment of an experiment station, as provided for in the appropriation act for this Department, approved May 25, 1900. The urgent necessity for an experiment station in the Hawaiian Islands is shown by the statements in the accompanying report, and I respectfully concur in the recommendations of the Director of the Office of Experiment Stations and earnestly recommend that Congress provide for the maintenance of the station as is done for the stations in other States and Territories.

If this report is printed by Congress, I suggest that 2,000 copies be furnished this Department for its use.

I have the honor to be, sir, your obedient servant,

JAMES WILSON,

Secretary.

The PRESIDENT.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., January 10, 1901.

SIR: I have the honor to submit herewith a report upon agricultural conditions and capabilities of the Hawaiian Islands. This investigation was made as a preliminary to the establishment of an agricultural experiment station, as provided in the appropriation act for this Department, approved May 25, 1900. As the agent for making these investigations, the Department was fortunate in securing the services of Dr. W. C. Stubbs, director of the Louisiana Agricultural Experiment Stations. Dr. Stubbs is thoroughly familiar with the experiment stations of the country, and in his capacity as director of the three experiment stations in Louisiana has familiarized himself with the agriculture of tropical and semitropical regions throughout the world. Dr. Stubbs visited the islands in July and August of the past year, acting under the following instructions:

The following subjects should be included in your investigations:

First. The general agricultural conditions existing in the Hawaiian Islands, and the necessary and feasible measures for the improvement of these conditions.

Second. The location most suitable for an agricultural experiment station. In this connection you should determine—

(1) Whether it is feasible and desirable to unite the Government station with the Hawaiian experiment station already established at Honolulu, the basis of the union to be as follows:

- (a) The Department to secure possession through gift or purchase of property now owned by the Hawaiian experiment station and add thereto as the requirements of new work may demand.
- (b) The Department to assume entire charge of the station, appointing the director and other officers as its agents, and becoming responsible for all work and expenditures.
- (c) The Department to undertake and pay for investigations other than those relating to sugar cane and sugar making; the Hawaiian Sugar Planters' Association to continue to pay for the investigations on sugar cane and sugar making, contributing therefor a lump sum annually, to be spent under the direction of this Department. (This arrangement will be similar to that made by the Sugar Planters' Association in Louisiana with the experiment station in that State.)
- (d) The Department to publish and distribute bulletins and reports of all work, as is done in other parts of the United States.

(2) Whether it is desirable and feasible to connect the station with the agricultural department of the Kamehameha Manual Training School at Honolulu.

(3) What other plan for establishing a station should be adopted in case it is not expedient to unite with either of the above existing institutions.

This question of location is one of the most important subjects for your investigation. The Department must control the land before operations can be undertaken. You should ascertain what Government land, if any, is available which could be set aside for this purpose, its adaptability, convenience, and water supply.

Third. In case a union with the existing Hawaiian experiment station seems feasible, an estimate should be made of the value of the buildings, land, equipment, etc., which would come into the possession of the Government station. If it seems best to inaugurate the work on an independent basis, the buildings, land, and equipment which would be needed should be determined, and estimates made regarding their cost, with special reference to the sum required for these purposes during the fiscal year ending June 30, 1901. The methods of acquiring real estate for the use of the station should also be investigated.

Fourth. The cost of inaugurating and maintaining an agricultural experiment station and disseminating information (exclusive of the buildings, land, and equipment) in a manner similar to that of an agricultural experiment station in one of the United States having an approximate area. In this connection, the staff which will be needed, persons available for such work, the approximate salaries paid in the islands to persons engaged in similar occupation, and other points bearing on the cost of maintenance should receive attention.

Fifth. The lines of experimental work which should be undertaken in the Hawaiian Islands, and especially those which should be undertaken in the immediate future. In this connection reference should be had to lines of agriculture other than the main crop of the islands. Sugar cane will naturally receive some attention from the new station, but it seems quite likely that there are other branches of agriculture to which the islands are adapted and in which investigation is quite as much needed. It has been stated, for example, that the Hawaiians buy their vegetables to considerable extent from California. You should determine what prospect there is for investigations in the growing of vegetables, and likewise in the growing of a variety of field crops for human food and for animals; experiments in the feeding and managing of animals, etc. According to reports from authentic sources, in no other place is so much money expended in securing water for irrigation by pumping. Some of the pumps are raising 30,000,000 gallons of water per day from a depth of 500 feet, using coal that costs \$10 per ton. The expense of irrigating in some cases reaches as high as \$125 per acre per year. The cost of water has led to some study of its effective distribution. You should endeavor to determine to what extent experiments in the use and economy of irrigation water might profitably form a feature of the work of the new station.

Sixth. What is the best means of diffusing information on agricultural subjects among the people, and of demonstrating to them the advantage of improved methods of agriculture?

On arriving at Honolulu you should immediately consult with the governor of the islands and such other officials as may be in a position to aid you in your investigations. You should also consult with representative residents of the islands who are prominently identified with the agricultural interests. You will please assure all persons with whom you come in contact, who are interested in the agricultural development of the islands, that it is the desire of the honorable Secretary of Agriculture to secure such information as will enable him to inaugurate agricultural investigations which will most generally benefit the agriculture of the islands, and that the Department is always glad to receive information regarding the agricultural needs of different localities, and suggestions regarding the measures necessary for the improvement of existing agricultural conditions.

Dr. Stubbs's report is herewith presented. In this report an exhaustive review is given of the agriculture of the islands in its many branches. Owing to the unusually favorable conditions, sugar growing is not only the leading agricultural occupation, but is the principal industry of the islands, the exports of sugar being more than 80 per cent of the total exports of the islands. At present this industry is in a very prosperous condition, but other agricultural industries are either not well developed or are not in profitable condition. Coffee growing is diminishing, and the other large agricultural crop, rice, is not grown on up-to-date principles. Stock raising is conducted to some extent, but there is need of improved stock and better pasturage. Dairying as an adjunct to agriculture is almost unknown, and dairy products exceedingly expensive. Parts of the islands have been denuded of their forests to the great detriment of the country, and these areas should be reforested. In many parts of the islands, especially at or near the coast on the western or leeward sides of the islands, irrigation must be practiced to successfully produce good crops. Much of this is done by pumping from artesian wells, and there is evidence to show that the methods practiced are extremely wasteful. Little has been done in the islands in the way of vegetable and fruit growing for market purposes, except with bananas and pineapples. The little that has been attempted shows that almost every kind of fruit and vegetable may be grown somewhere upon the islands. For supplying this class of produce, California and other parts of the Pacific coast are now drawn upon.

As is shown by the report, there is a great necessity for the establishment of an experiment station in the islands, in order that the problems of diversified agriculture may be given attention. No necessity exists for immediate consideration of the sugar industry, as there is already established a well-equipped station, maintained by the Sugar Planters' Association. This station is devoted to the study of manifold problems that arise in cane growing and sugar manufacture.

The instructions given above required an investigation into the feasibility and desirability of uniting the proposed Government station with some institution already established. The two institutions that commended themselves were the experiment station of the Sugar Planters' Association and the Kamehameha Training School. Conferences were held with the governing boards of these institutions, but no practical means for combination with either were found. It is therefore recommended that an independent experiment station be established adjoining the city of Honolulu, and experiments begun in diversified agriculture. A cordial spirit of cooperation for the establishment of a station was shown our agent by officials and residents of Hawaii, and it is believed that much benefit will accrue from the scientific study of the problems there presented for investigation.

For the immediate use of the station, in order to provide fences, buildings, live stock, etc., a sum of about \$17,000 is considered as necessary. This may be provided by Congress, or in case that is not considered feasible, by the Hawaiian government, as is done in other Territories. After the station is established and the urgent necessities provided for, it will require for its maintenance a sum equal to that annually provided by Congress for the experiment stations in other States and Territories. I recommend, therefore, an appropriation of \$15,000 for the maintenance of a station in Hawaii for the fiscal year of 1902.

Very respectfully, yours,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

AUDUBON PARK, NEW ORLEANS, LA.,

December 15, 1900.

SIR: Pursuant to a commission from Hon. James Wilson, Secretary of Agriculture, to visit Hawaii as a special agent of the Department of Agriculture, I have the honor to transmit herewith my report. From your letter of instructions, hereto attached, it will be seen that I have investigated the subject assigned, and have selected a suitable location for the station, and herein make such recommendations as have been suggested by my investigations.

In this report I desire to return my sincere thanks for the many courtesies received while on the islands. From the governor of the islands down to the humblest gardener I was the recipient of highly appreciated favors. Indeed every facility was afforded me for the prosecution of my investigations. Especial thanks are, however, due to Governor Dole; Commissioner of Agriculture Wray Taylor; Entomologist A. Koebele; Director of Sugar Experiment Station Dr. Walter Maxwell; Island Veterinarian Dr. W. T. Monserrat; Mr. F. A. Shafer, vice-president Planters' Association; Mr. S. Tenny, Mr. Eben Low, Mr. Paul Isenberg, and others who freely gave me their personal time and assistance. To Prof. W. D. Alexander and Mr. J. F. Brown I am under many obligations for maps, manuscripts, and other favors. To the Planters' Association, Dr. Maxwell, Hon. S. A. Cleghorn, and Hon. S. O. Damon I am indebted for other courtesies.

In the preparation of this report I have collected reliable information from every available source. My object has been to compile facts and present them as information for the public, and no claim is made here for originality. The publications of the Territory, of the Sugar Planters' Experiment Station, and of reliable authors have been extensively consulted and sometimes freely used. The manuscripts furnished me by acknowledged authorities are included in this report.

Respectfully submitted.

WM. C. STUBBS,
Special Agent.

Dr. A. C. TRUE,
Director of Office of Experiment Stations, Washington, D. C.

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REPORT ON THE AGRICULTURAL RESOURCES AND CAPABILITIES OF HAWAII.

PHYSICAL AND GEOGRAPHICAL FEATURES.

Beyond our western coast, 2,100 miles southwest from San Francisco, Cal., lies the new Territory of Hawaii. This Territory consists of a series of islands extending from northwest to southeast, resting like a cluster of emerald gems in midocean, 2,000 miles or more from their nearest neighbor. They are of recent volcanic origin, and are fringed with coral reefs. This group consists of twenty islands lying between the nineteenth and thirtieth degrees of latitude, and one hundred and fifty-fourth to the one hundred and seventy-second degrees of longitude east of Greenwich. Of these, eight—Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Kahoolawe, and Niihau—are inhabited, though the last two are small in area and in population.

The smaller ones are only temporarily inhabited by workmen of the guano companies, who collect the eggs and the manure deposited upon them by the myriads of sea birds and turtles which permanently abide there. Their names are Molokini, Lehua, Kaula, Bird, Necker, Johnson, Laysan, Lysiauski, Ocean, Midway, French Frigate Shoal, and Pearl Reef.

In the past these islands were isolated from the centers of civilization, but in recent years, with the development of commerce between the Occident and the Orient, they have become directly in the line of travel and form a halfway house or coaling point for steamers, bound from San Francisco or Vancouver to Australia, and from the same ports to China and Japan, and from the Isthmus of Panama to the same countries. Since the purchase of the Philippine Islands by this country they have become also the resting as well as the coaling station between these islands and the United States.

The smaller islands are mere rocks and reefs and are known only for their guano deposits, their shark fishing grounds, and for their sad tales of shipwreck.

Of the eight larger islands five only are considerably populated, the other three, Niihau, Lanai, and Kahoolawe, being used mainly as stock ranches.

Hawaii, the largest island, gives its name to the group and the present

Territory. It is 90 miles long from north to south, and 74 miles broad from east to west. Its area is 4,210 square miles. This island is an aggregation of three enormous volcanoes which from many points of view appear as sublime domes, bold and majestic in outline; their bases joining each other suggested the name of the "Triplets," which they sometimes receive.

Mauna Kea, 13,805 feet in height, is the loftiest, and is at present inactive. Mauna Loa presents the only living volcano in this group. On its summit is the occasionally active crater of Mokuaweoweo whose highest rim is 13,675 feet. Hollowed into the side of Mauna Loa, at an elevation of 4,000 feet, is the famous crater of Kilauea, always manifesting strong indications of eruption and sometimes, as in 1898, furiously active.

To this volcano weekly excursions are made by tourists from Honolulu. An excellent road (30 miles long) from Hilo to this volcano has been constructed, and a comfortable hotel at the crater has been erected for the accommodation of visitors. The volcano is one of the attractions of the islands, and to those who can stand a rough sea, and a long carriage ride, a visit will give great pleasure and much instruction.

Capt. C. E. Dullon, in his paper on "Hawaiian volcanoes" United States Geological Survey, Fourth Annual Report, says:

Deep-sea soundings in the vicinity have recently disclosed the fact that these volcanic piles are only the summits of gigantic mountain masses rising suddenly from the bottom of the Pacific which for many hundreds of miles around them is only moderately diversified. The slopes of Mauna Loa, east, west, and south, descend beneath the surface of the ocean with a gradient fully equal to, if not greater than, the visible slope of its flanks. The submarine slopes of all the other islands in directions perpendicular to the principal axis of the group are equally great and possibly somewhat greater. The depths attained by these continuous slopes within 30 to 50 miles of the shores vary from 2,400 to 3,100 fathoms, or 14,000 to 19,000 feet. Mauna Loa and Mauna Kea, referred to their true bases at the bottom of the Pacific, are therefore mountains not far from 30,000 feet in height. And in general the island group consists of a gigantic submarine mountain chain projecting its loftier peaks and domes above the water.

Hualalai, the third of the "Triplets," has a height of 8,275 feet. It has been inactive since 1801. Although this island is well within the tropics, hail and snow are of frequent occurrence upon these volcanoes at altitudes above 9,000 feet. Mauna Kea and Mauna Loa are capped with snow the greater portion of the year. In the extreme north of the island are the Kohala Mountains, whose highest peak reaches 5,505 feet. The coast line is regular, sometimes precipitous, but with few bays and no regular harbors. At Hilo, on the east, the bay might be made a respectable harbor. (See Pl. II, fig. 1.) Considerable shipping is done from this port, where recently a small wharf has been constructed and where a fairly safe anchorage for ships can be secured.

On the west of the island are the small, insecure bays of Kailua and

Kealakuka, and on the northwest is Kawaihae Bay. Artificial landings (Pl. I) have been established at nearly every plantation for the purpose of traffic. The island is divided into the following districts: Kohala, Hamakua, Hilo, Puna, Kau, and Kona.

Hawaii leads the other islands in size, in picturesqueness, and in diversity of soil and products. It grows the largest quantity of sugar, coffee, and live stock. The variations in climatic conditions due to altitude and location (whether windward or leeward), together with available arable soil at all altitudes, justify the belief and warrant the assertion that almost every tropical and temperate plant can somewhere be grown successfully on this island. When shipping facilities are increased and the island more densely populated, one may expect with confidence a varied agricultural development which will render famous this attractive isle.

Maui is the second island in size, with a length of 46 and a breadth of 30 miles. It contains 760 square miles. Here we have two mountain formations of unequal size. The smaller consists of a series of serrated ridges, rising in extreme height to 5,800 feet, with deep, narrow, fertile valleys between. On the northeast and southwest are sufficient level arable lands to permit of extensive sugar culture and stock raising, while steep precipices overlook the ocean in the north. Iao Valley, justly ranked as one of the most beautiful and fertile in the Territory, is found in the eastern portion of this part of the island. Haleakala, one of the largest extinct volcanoes in the world, rising to the height of 10,030 feet, may be regarded as the center of the larger portion of this island. Along its slopes tropical and temperate agriculture may both be practiced, and at its base are found some of the finest sugar plantations of the world. Maalaua Bay, on the south, and Kahului Bay, on the north of the neck of land joining the two parts of the islands, are shipping points. The districts of this island are: Lahaina, Wailuka (Pl. III, fig. 1), Makawao, and Haau.

Oahu is the third island in size, but the first in population, due to the city of Honolulu, which is the capital of the Territory and the chief seaport of the islands. It is 46 miles long by 25 miles broad, being, however, irregular in shape. The Koolau range extends from the extreme eastern point of the island to the northwestern coast, with transverse ridges running in the southern portion almost from ocean to ocean. On the opposite side of the island is the Waianae Ridge, with spurs running almost to the ocean. On this ridge occurs the highest peak, 4,030 feet. For its size this island has the largest producing power. Its sugar plantations are justly esteemed as the best in the world.

Honolulu is the only improved harbor of the coast (Pl. III, fig. 2), with a depth to the wharves of 30 feet. Pearl Harbor, 12 miles west of Honolulu, a port ceded to the United States during the reign of

King Kalakaua upon the execution of the treaty of reciprocity with these islands, is capable of being made one of the largest and safest harbors in the world. The districts of Oahu are Honolulu, Koolau-poko, Waialua, Ewa, and Waianae.

Kauai has a length of 25 miles, with a breadth of 22 miles and an area of 590 miles. Geologically it is the oldest island of this group, as will be shown later under the geology of the islands. Accordingly we find it better supplied with streams and cascades, the former originally furnishing the power to mills for grinding wheat, corn, and sugar cane. Its soils, too, have been more thoroughly disintegrated, and therefore possess more fertility than soils elsewhere in the archipelago. Hence the name so proudly applied to it by its inhabitants, the "Garden Isle." The island is noted for its excellent sugar plantations, on the ocean side of which extensive rice fields abound.

The northwestern portion of the island has a line of lofty cliffs 7 miles long. Waialeale is a large mountain mass, nearly in the center of the island. Its northern portion extends nearly to the ocean in lofty ranges, while its southern end slopes gradually to the sea. There are several small bays on the island, but no secure harbors. The districts of this island are Lihue and Koloa, Kawaihau, Hanalei (Pl. XXII, fig. 1), and Waimea. This island is so near the temperate zone that it partakes of some of its climatic characteristics. A few trees shed their leaves in winter, new ones appearing in spring. The orange and pear trees bloom in February, and the fig trees bear two crops each year, one in the spring and the other in the fall. Elsewhere in the islands these fruit trees have no definite period for blooming, but continue to bloom and fruit throughout the year, often at the same time. The temperature varies greatly, often falling in winter to 50° F.

Molokai is 40 miles long and has an area of about 310 square miles. The western half of the island is an elevated plain 1,000 feet above the sea, without running streams, but covered with grass and shrubs, furnishing feed for herds of cattle, etc., which roam over it. The eastern end has several valleys with bold, precipitous sides, with streams which frequently go dry. The northern coast is mainly precipitous, presenting but few landings, but near the center is a tongue of land projecting into the ocean, 10 miles in length and 1 in breadth, which was selected by the Hawaiian government over thirty years ago as a home for the lepers. It is a grassy plain, inclosed on three sides by the ocean and on the south by an impassable escarpment over 1,000 feet high. It is well sheltered from the strong sea winds by the highlands in the rear. It is an appropriate location for an asylum. There are about 6,000 acres in the tract, with a fertile soil, affording abundant pasturage for cattle and horses required by the unfortunate inmates. The government generously provides for this home, furnishing comfortable cottages, liberal rations, necessary clothing, and



LANDING AT HAKALAU, HAWAII.



FIG. 1.—FISHING CANOES, HILO BAY.



FIG. 2.—FISH POND, WAIKIKI ROAD.



the home comforts of flowers, fruits, and vegetables. A gymnasium, a reading room, and two churches (a Congregational and a Catholic), with clergymen, are provided specially for the patients. Even a band of sixteen leper musicians frequently plays for the public. Local physicians, appointed by the government, administer to the ills of the occupants. By law every leper on the islands is sent to this home, and none is permitted his freedom. The government has spent to date over \$2,000,000 on this home, and with the present watchful care exercised over leprosy it will be only a short time before this dread disease, introduced into the island in 1853, will be completely eradicated.

Lanai, the sixth island of the group in size, is 21 miles long and 8 in breadth, and has an area of about 160 square miles. The highest point on this island is about 2,400 feet. The mountain range has a continuous wall which incloses an interior space (an old crater) of about 20,000 acres. This land-locked valley of Palawai, 1,500 feet high, is covered with grass and resembles a huge meadow. Below this valley are circles of gradually declining elevations until they reach the sea. The island is used exclusively for grazing, and affords sustenance to thousands of sheep, goats, and horses.

Niihau, next to the smallest of the eight large islands, lies southwest of Kauai, and has an area of about 70,000 acres. It is nothing more than a large sheep ranch (owned by Messrs. Gay and Robinson), and its inhabitants are mainly shepherds. A fine grass (*Cyperus levigatus*) resembling the Guayaquil grass, used in making Panama hats, is here found indigenous and was formerly extensively used in making Niihau mats, noted for their delicacy and beauty. Shells of great beauty are found on the coast, and some of them are strung into necklaces and sold to the tourists.

Kahoolawe, the smallest of the larger islands, lies opposite to East Maui. It is used as a sheep pasture and has about 25,000 acres, covered with grass and shrubbery. Only a few shepherds live on the island.

ORIGIN OF THE HAWAIIAN PEOPLE.

The origin of the inhabitants of these islands has never been definitely solved. The botanical affinities of the plants and the ethnological resemblances of the animals, including the people, all point to the islands of the south and southwest. Professor Alexander, in his History of the Hawaiian People, states that "the inhabitants of all the groups of islands in the eastern Pacific from New Zealand to Hawaii, and also to Easter Island, scattered over a distance of 4,000 miles, may be considered as one race, which is commonly called the Polynesian race; for they all speak dialects of the same language, have the same physical features, the same manners and customs, the same general system of 'tabus,' and similar traditions and religious

rites." They have in common the names of the principal gods, stories of the origin of fire, about the deluge, etc. The Polynesian language is a member of a large and widely spread family, including those spoken in Micronesia, the Philippine Islands, the Malay Archipelago, and Madagascar. It is thought that the Polynesians originally came from southwestern Asia, but it is positively known that their progenitors were emigrants from the Indian Archipelago.

It is fairly well determined that the island of Savaii, in the Samoan group, is the point of departure for all of the Polynesians of the eastern Pacific. The Maoris, of New Zealand, closely resembling the Hawaiians, have a tradition that their ancestors came from Hawaiki. The Marquesians claim that their ancestors came from Hawaii in the West, stopping at Fiji, Vavau, and Tonga. The dialects of all of these islands are similar to the Hawaiian.

The first settlement of the Hawaiian Islands was made long ago, since human bones are found under coral reefs and ancient lava flows. Judge Fornander thinks the islands were inhabited as early as 500 A. D. Whether the earlier settlers were driven from other islands in war or left them designedly, whether they were seeking new islands or were driven out of their course by storms to known ones will never be known. The original Hawaiians were great navigators, performing voyages of many months' duration in large canoes, sailing with outriggers to the windward, well provisioned, etc. They sailed by the stars at night and by the sun in the day. Thus the settlement of all of the islands of the Pacific may be accounted for.

After separation from the world for many generations intercourse with the South Pacific islands was established, and many of these famous voyages have been celebrated both in song and story. Most of these voyages were made to Kahiki (Tahiti), but the intercourse ceasing over five hundred years ago, the Hawaiians lost definite ideas of the locality of these islands, and so in time Kahiki came to mean any foreign country.

The Hawaiians were divided formerly into three classes, with wide and permanent distinction between them: (1) The nobility, consisting of the kings and chiefs; (2) the priests, sorcerers, and doctors; and (3) the common or laboring class. The first class were the sole owners of the land and all that grew upon it. They were also owners of the fish of the sea, and of the time and labor of the people. The latter owned nothing absolutely. The feudal system was practiced here in an intensified form, the common laborers not receiving more than one-third of the products of their toil. The second class were the learned men and kept alive the knowledge of astronomy, history, medicine, etc. Wars were common and very destructive. The vanquished were either destroyed or branded on the forehead as slaves and made to serve the remainder of their life. Marriage was practiced

by all, but the tie was not strong, the husband dismissing his wife at pleasure. Polygamy was practiced by all who could afford it. Descent came through the mother only, hence, every king and chief sought a wife of noble birth. This custom lent dignity and respect to womanhood. Infanticide was universally practiced, the girls being more frequently destroyed than the boys.

Cannibalism, formerly so freely and frequently charged against the people, was unknown and was looked upon by all with horror and detestation. They lived upon taro, sweet potatoes, yams, bananas, and fish. Cereal grains, as well as cotton, flax, and wool, were unknown to them. Cloth (kapa) was made from the bark of the mulberry tree, beaten out with heavy wooden mallets elaborately carved. This kapa was of different quality and thickness, and frequently dyed and varnished. Its uses were manifold. No such thing as a loom was known. There was an entire absence of metals; no beasts of burden; in fact, no domestic animal save the dog and the pig. The Hawaiians therefore remained unduly long in the "stone age." The absence of domestic animals and the lack of extensive tracts of fertile land prevented them from being a pastoral people. They were obliged, therefore, to confine their efforts to such work as could be performed by their hands and to such burdens as could be carried on the backs of men and women. Considering their environment, the early Hawaiians made remarkable industrial progress, evidences of which are everywhere to be seen on the islands.

Terraces, artificial fish ponds (see Pl. II, fig. 2), ditches for irrigation, large trenches for their sports, immense temples, and numerous grass houses are everywhere to be seen, memorials of the ingenuity, thought, and industrial activity of these ancient people. In the magnificent Polynesian museum in Honolulu, dedicated in memory of his wife (a descendant of the line of Kamehameha I) by Mr. Bishop, are found stone and lava hatchets, knives, and fishhooks of sharks' teeth. Kapa cloth of endless qualities and colors, mats, fans, fish nets, ropes, baskets, numerous domestic implements made of hard wood or stone, calabashes of large size and beautiful finish made from the hard wood of the island, pans for the evaporating of salt from sea water, spears, javelins, daggers, slings made from the fiber of the cocoanut husk or of human hair, long and deep canoes of wonderful carrying capacity and extremely seaworthy when lashed together, and with masts carrying sails made of bark, all testified to the skill, enterprise, and industry of these wonderful people, isolated for over five hundred years from the world.

GEOLOGY OF THE ISLANDS.

These islands are of volcanic origin. The rocks are mainly basaltic lavas, with here and there a few remnants of elevated sea beaches, composed of consolidated coral sands. The islands extend from northwest to southeast, showing that through a fissure in the earth's crust volcanoes have been built up. Botanical and geological evidences go to show that the age of the different islands increases as one proceeds from east to west. Kauai, the most northwestern, is always mentioned as the oldest island, and Hawaii, the extreme southeastern, as the youngest. The eroding forces of nature have produced greater destruction upon the former island than upon any other, while the only active volcanoes in the group are found on Hawaii. Judging, therefore, from the greater disintegration of its soils, the much heavier denudation of its slopes, the presence of numerous running streams, of precipitous falls and cascades, the greater abundance of vegetation, both in quantity and variety, all apparently support the statement that Kauai is the oldest of the islands. Rightly considered, it proves only that volcanic activity ceased here earlier than elsewhere, but it does not show that it began here earlier than in Hawaii. Which island first lifted its head above the ocean there is absolutely no way to determine.

Northwesterly of the Hawaiian group there is a succession of reefs and low, uninhabited islets extending for a distance of 30° longitude, nearly half way to Japan, revealing a narrow band of elevated sea bottom with an average depth of not over 1,000 fathoms, as is shown by the chart of this portion of the Pacific. These are all in the continuation of the main axis of the Hawaiian group, along the same fissure of the earth's crust, and are doubtless the coral-crowned peaks of submerged volcanoes, antedating in activity those which have produced the present islands. Doubtless volcanic activity began at the northwest and gradually moved southeasterly, terminating in Hawaii, with subsidence of the older formations during the progress. The extensive western end of this raised sea bottom is still removed by a great distance and enormous depth of soundings from the nearest land, Japan. That this great gulf between Japan and Hawaii has always existed is shown by the absence of any affinity between the flora of the two groups of islands.

Between San Francisco and Hawaii the soundings have given nearly uniform depths of 3,000 fathoms, while farther south (2° or more) is found one of the largest depressions in the ocean, which extends nearly to the low-lying islands of Jarvis, Christmas, Palmyra, and others which trend in the direction of the Society group. There is therefore no evidence to show a terrestrial immigration of plants to these islands in former times.

Ocean currents, however slight may be the positive evidence, must



FIG. 1.—WAILUKA VALLEY, MAUI.



FIG. 2.—HONOLULU AND HARBOR.



FIG. 1.—GRASS HOUSE, BIRTHPLACE OF PRINCESS RUTH.

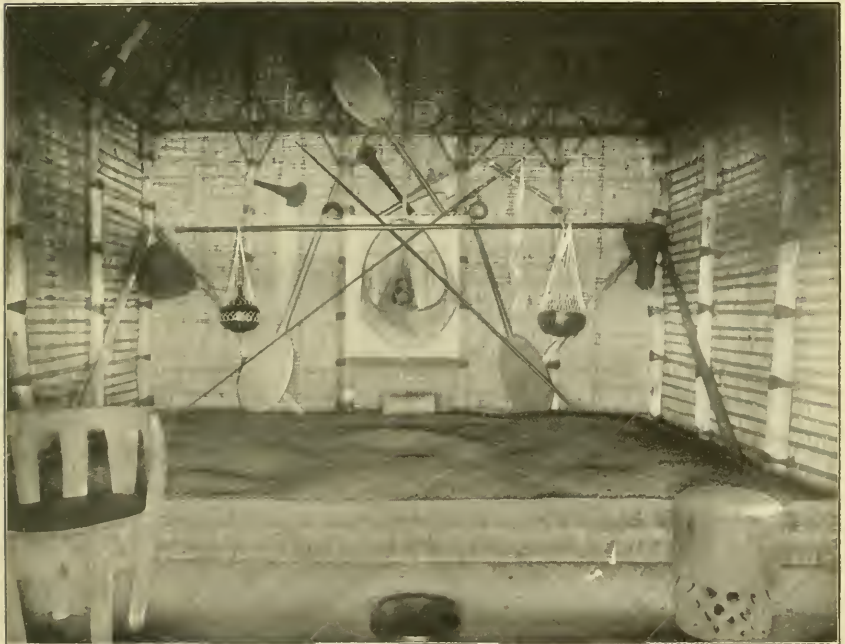


FIG. 2.—GRASS HOUSE, INTERIOR.

be assumed as the vehicle of transportation of the flora found originally on the islands. The northeasterly current of the Pacific, which strikes the continent of America and is deflected southward after contact, deposits driftwood of pine logs upon the islands. This deflected current is reenforced by a feeder on its southern boundary from Mexico and Central and South America, and bears with it the drift of these countries.

A review of the island flora shows only one or two inhabitants of California, and they from the highest mountains, while the Andean flora is quite abundant. The equatorial counter current may, during the long continuance of southwesterly gales, which frequently prevail in winter, have deposited drift on the islands.

This isolation of the Hawaiian Islands has given them a peculiar flora, containing a large proportion of plants found nowhere else. The peculiar characteristics of the islands contribute largely to such results and aid in multiplying varieties. The traveler may, in a single day, pass from the tropical heat of the coast to the region of perpetual snow, and if he crosses from the windward over to the leeward side of an island he will encounter a climate with a varying rainfall from 300 inches annually to less than 30. There is a wonderful diversity in temperature, rainfall, elevation, and barometric pressure. The soil, however, is quite uniform, derived from the basaltic lava, with a narrow band of coral limestone encircling the islands on the coast. These soils are extremely porous, and the rainfall passes quickly into them, sinking into the artesian reservoirs made possible by the encircling belt of coral, which furnish the potable and irrigating waters of the islands. Geologically speaking, the islands are therefore very young, with a very limited fauna and flora.

SOILS OF THE ISLANDS.

The recent geological origin of the islands has already been mentioned. One would naturally expect, therefore, to find the soils primitive in character and more nearly of the composition of the volcanic rocks from which they came than soils of similar origin in older countries. Such has been found to be the case, as has been portrayed in *Lavas and Soils*, by Dr. Walter Maxwell, former director of the Hawaiian experiment station, now of Queensland.

He has shown that the soils of the islands may be geologically classified as dark red soils, which have been formed from normal lavas by simple weathering in a climate of great heat and dryness, and yellow and light red soils, which are derived from lavas that suffer great alteration at the time of, or soon after, emission, under the action of the steam and sulphurous vapors resident within the lavas at the time of eruption. Through the action of these imprisoned agents these lavas have undergone such a radical alteration, both in chemical com-

position and color, as to mislead a scientist as to their origin were it not for the presence of the living volcanoes on the island of Hawaii, which permits of special study along these lines. Dr. Maxwell has shown that lateral or "tufa cones" exist all over the islands, and the lavas therefrom have given soils widely distributed over all the islands. These soils are inferior in fertility to the dark red soils. Some of them yield well when first brought under cultivation, but depreciate rapidly in productivity in a few years, requiring careful and special treatment for maintenance or restoration of fertility. There are other large areas of these soils which are not productive, due to the presence of ferrous sulphate, an active poison to plant life. These can, by proper physical and chemical amendments, be made productive.

Besides the above, which are found in situ, there are considerable areas of sedimentary soils, formed by denudation and deposition mainly on the leeward sides of the islands and in sections of small rainfall. The coral reefs which begirt the islands have served as shelves to catch the deposition produced by falling rains in the mountain regions. These sedimentary deposits have covered the coral reefs from 1 to 30 feet deep, and form to-day the most fertile soils of the islands, and are used mainly by the sugar planters, though the deltas of the small valleys next to the ocean are cultivated in rice by the Chinese.

Large areas, marked by a predominance of these soils, show that they have been derived from normal lavas which have undergone slow decomposition in a hot climate with a small rainfall. They are strong, deep soils, colored intensely with iron and darkened by an incorporation of vegetable matter. They closely resemble pulverized bricks, darkened by an admixture with vegetable mold or humus. They are uniformly fertile soils and are everywhere highly esteemed as excellent sugar lands.

The soils of the islands are marked chemically by a low content of silica, the larger percentage of which is soluble, and by the presence of a large proportion of basic elements, against an enormous preponderance of acidic constituents in American soils. The Hawaiian soils are geologically recent, and have not yet undergone that change of structural composition and type which characterizes the old and perhaps permanent soils of America.

Dr. Maxwell further divides the soils of the islands into upland and lowland soils. Under the former he includes those which have been formed under lower temperature and greater rainfall, and distinguished by a large content of organic matter and nitrogen and by a low content of the elements of plant food in an available state, these elements having been removed by rainfall. Under lowland are "soils formed under higher temperature and smaller rainfall, and distinguished by a low content of organic matter and nitrogen and by a higher content

of the elements of plant food in a state of immediate availability which is due in part to the receipt of soluble constituents from the upper lands and to a smaller rainfall over the lower levels."

The dark red soils and the sedimentary soils are credited with an average production of about 5 tons of sugar per acre, while the yellow and light red soils give only a little over 3 tons, but the latter, which grows the least cane, produces the best quality of juice.

The coffee soils, found at elevations of 1,000 to 3,000 feet, are extremely rich in nitrogen.

The greater portion of the islands are not susceptible of cultivation, being covered with rugged lava and deeply gulched, or with poor soils incapable of large production. The dry plains and seacoasts are made fertile by irrigation. The fertile valleys are highly productive, but of very limited areas.

Only a small portion of the islands is capable of sustaining a dense population. The most fertile belts are near the ocean. The interior is mountainous and craggy, with a very thin soil, adapted in many instances to pasturage, but unfit for cultivated crops. Many parts of the shore belt are barren without irrigation, but extremely productive with an abundance of water. Other parts are covered with lavas not yet converted into soil, and still others are gulched and carved into ravines so deep and precipitous that access is almost impossible. Deep, rich soils at low altitudes form, probably, not over one-fortieth of the islands. Thinner soils, perhaps capable of producing profitable crops of some kind, are far more abundant.

CLIMATE.

The climate of the islands is more semitropical than tropical, and to a visitor is quite enjoyable, though permanent dwellers complain of the lassitude which the monotonous climate produces after a sojourn of a few years on the islands.

Hawaii is fanned by northeast trade winds and laved by cool oceanic currents coming from the north, thus reducing by many degrees the temperature which its geographical position would predicate. The constancy of these winds and currents gives an equable temperature averaging about 75° F. throughout the year, with extremes of 60° to 85°. Altitude is here the most potent factor of temperature, the thermometer falling about 4° for every 1,000 feet of ascent, so that on the summits of Mauna Kea and Mauna Loa snow and ice may frequently be found.

The windward and leeward sides of the islands vary also in temperature and rainfall. The eastern or windward sides of the islands are constantly swept by strong winds, which produce heavy rainfalls and lower temperatures, while the western or leeward sides are comparatively calm, dry, and warm. On the former farming of all kinds can

be carried on without irrigation, while on the latter, especially near the coast, irrigation is essential for the production of maximum crops. Even upon the leeward side the rainfall varies with the altitude, beginning on the coast with about 20 inches annually, and increasing as one ascends the mountains. Frequently on a plantation of varying altitudes the rainfall will be abundant for crop purposes on a part of it, while on another part irrigation will be absolutely necessary to grow most any kind of plant successfully.

The heavy rains falling upon the windward side of the islands have clothed the mountain slopes with a dense forest, and cut into them numerous deep and precipitous ravines. On the leeward side a less vigorous growth of plants is found, and in many places, near the sea, none at all. The islands are said to be exempt from the terrible cyclones which so frequently devastate the central Pacific.

RAINFALL.

As previously remarked, the rainfall on the islands varies within wide limits. On the leeward side of Hawaii, on the opposite side to Hilo (Kona side), there is a coast line of over 50 miles in length, running back to an elevation of 1,000 feet, on which there is an annual precipitation of about 4 inches only. There are elevations on the windward side where the rainfall will probably reach 300 inches a year. Perhaps sections may be found where the precipitation will represent every degree between these extremes.

Again, it is difficult to realize without a visit to the islands how close together are the sections in which these extremes occur, frequently within a few miles of one another. The following is a record of the rainfall at Honolulu for the past sixteen years, taken, however, at an elevation of 50 feet. Here, too, one must realize that the city of Honolulu runs from the sea back to an elevation of over 300 feet, and the rainfall in the city varies with the elevation. At the sea level the average is below that given in the following table:

Record of the rainfall at Honolulu for the past sixteen years.

[From daily readings at the residence of Mr. W. R. Castle. (Elevation, 50 feet).]

Month.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
January.....	1.07	0.06	0.38	5.85	0.78	0.87	2.00	1.19
February.....	1.68	.67	.94	13.04	1.98	.77	9.85	4.84
March.....	4.06	2.96	1.63	2.24	2.25	.88	7.83	.69
April.....	3.52	5.11	1.19	2.35	2.36	.94	4.84	.88
May.....	.44	11.56	1.61	4.10	1.97	.81	1.20	.23
June.....	.48	2.51	.63	.95	.47	.97	.86	.43
July.....	1.40	4.27	.56	.67	.15	.48	1.30	.58
August.....	.83	2.85	.43	1.02	4.22	1.16	1.00	.58
September.....	.32	1.17	2.26	.95	2.80	1.81	.60	.47
October.....	4.66	.03	1.84	.44	1.31	.95	1.36	3.62
November.....	.54	1.40	8.74	1.84	3.39	1.50	1.80	.39
December.....	3.76	3.14	3.47	6.37	18.08	2.82	1.64	1.50
Total.....	22.76	35.73	23.68	49.82	39.76	13.46	34.28	15.40



FIG. 1.—BANANA PLANTATION.



FIG. 2.—PINEAPPLES.



FIG. 1.—GATHERING COCOANUTS.



FIG. 2.—POI FEAST.

Record of the rainfall at Honolulu for the past sixteen years—Continued.

Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
January.....	6.50	2.57	3.08	2.38	2.20	0.94	3.97	0.87
February.....	3.18	13.45	12.42	1.81	1.30	.79	7.60	3.55
March.....	.29	.75	1.51	1.46	3.11	1.20	9.66	3.73
April.....	1.60	2.22	2.25	1.01	2.40	.93	1.26	.81
May.....	5.10	1.50	.10	.93	1.51	.96	.68	1.44
June.....	.67	.29	.59	.90	.78	.99	2.07	.68
July.....	.53	.28	.45	.45	.00	.81	.63	.11
August.....	1.14	1.04	.08	1.41	1.33	.39	.58	1.04
September.....	.42	.91	.56	2.15	.39	2.66	.15	.35
October.....	3.01	.64	1.76	.41	2.04	1.61	.52	3.70
November.....	.35	8.33	8.33	4.27	2.31	1.88	.50	.17
December.....	3.97	1.30	2.41	12.02	5.54	.51	.77	1.95
Total.....	26.67	33.28	33.54	29.20	22.91	13.67	28.39	18.42

Averages for sixteen years, 28.18 inches; maximum, 49.82 inches; minimum, 13.46 inches.

FLORA OF THE ISLANDS.

In considering the present flora of the islands, including of course its cultivated plants, it would be well to separate them into three distinct groups. (1) Indigenous plants, those that were found by the Hawaiians when they first settled the islands, reckoned by Judge Fornander to have been about A. D. 500; (2) those introduced by the Hawaiians and brought from other islands in the Pacific, and (3) those introduced since the discovery of the islands by Captain Cook, in 1779.

By carefully differentiating these groups, a knowledge, not only of the botany of the islands, but also of the various crops and plants which can be successfully grown from past experience, will be obtained. Allusion has already been made to the paucity of native flora, both in genera and species, found on the islands. It has also been shown that the affinities of the native flora were Polynesian, Andean, and Californian. The complete isolation of the islands has given a peculiar flora, containing a larger proportion of endemic plants than any other known country. Hillebrand, in his "Flora of the Hawaiian Islands," describes 844 species of phanerogamic plants distributed over 335 genera, and 155 vascular cryptogamic plants distributed over 30 genera, making a total of 999 species and 365 genera. Of these it is believed that 115 species have been introduced since the discovery of the islands by Captain Cook. These are included in 101 genera, 22 of which contain indigenous species. They cover cultivated plants and trees, escapes from cultivation and accidental introductions, but well established. This number has already increased since the publication of Hillebrand's Botany, and will continue to increase with each recurring year.

Besides the above, the native Hawaiians are believed to have introduced in prehistoric times at least 24 species. Deducting both those introduced by natives and by the white man since 1779, and there will remain 860 species as original inhabitants of the Hawaiian Islands,

distributed over 265 genera. Of these 653 are endemic and peculiar to the islands; 250 of these species belong to 40 endemic or peculiar genera. Of the dicotyledonous plants over 85 per cent are endemic. The number of endemic plants on any individual island of the group depends upon the age of the island. In fact, the comparative age of an island, or any part thereof, can almost be determined by the number of endemic plants found.

The islands not only vary among themselves as to the character of flora found, but each individual island varies in its flora in proportion to altitude. Therefore the flora of the islands may be divided into groups occupying different zones of elevation. Hillebrand divides them into five groups, viz: (1) The lowland zone, the open country covered with grass only after rains, with isolated trees, represented by few genera. The littoral species are included. (2) The lower forest zone, extending to a height of 2,000 feet above the sea. The "kukui" oil tree grows exclusively in this belt. (3) The middle forest zone, which lies within the region of the clouds and develops the greatest luxuriance in trees and jungle. Here the tree ferns luxuriate, attaining enormous dimensions. This zone extends to 6,000 feet. (4) The upper forest zone, reaching up as high as 9,000 feet, is characterized by stunted trees. Here strawberries and the Ohela berry (*Vaccinium*) flourish. (5) Special groups of bog flora, found on the high table-lands of Kauai and West Maui. Here mosses, sedges, and tussock-like grasses prevail. These zones are not fixed, but vary considerably with their exposure, rising higher under the lee than on the windward side of the islands.

The size and characteristics of the plants vary in accordance with their environment. Heat and dryness of the air, a scanty soil, especially undecomposed lava, check life and dwarf the plants and sometimes impose new properties. A period of short growth follows an occasional rainfall, and then a long repose with great effort to sustain life. These varying conditions, acting through a series of years, have the power of modifying preexisting qualities and impressing new ones, thus producing variations from the normal type. Varieties change ultimately to species, and species, perhaps, to genera. Hence the large number of endemic plants on these islands. The family of gymnosperms (pine, cypress, cedar, etc.) is not represented on the islands, and this is accounted for on the ground that these islands were formed subsequent to the geological age in which they were universally distributed. A striking peculiarity of Hawaiian trees is their low height. Only the cocoanut palm exceeds 100 feet. Other trees rarely exceed 60 feet. Another peculiarity of the Hawaiian flora is that nearly all native plants are perennial and woody.

It will be impossible, in a short treatise like this, to give in detail the various useful plants now found in the islands; nor could the writer

do so, even if space permitted, without a more thorough study of the entire subject. It will not be inappropriate, however, to mention some of the most important, including native plants, those introduced by the Hawaiians, and those introduced by the white man since the discovery of the islands.

NATIVE PLANTS.

Of these, by far the most important are the woods of the islands. They served to make their enormous canoes, in which the natives crossed from island to island, and occasionally made voyages to other islands in the South Pacific. Others were used for outriggers and masts. Idols were carved from the softer as well as the hard woods. The hardest varieties furnished the mallets for beating kapa cloth. These mallets were elaborately carved and of a different pattern on each face. They were used in such a manner as to stamp the pattern upon the cloth. From the forests came the bark, leaves, and fiber out of which kapa cloth, mats, fishing lines, nets, etc., were made.

From the various trees came the dyes which they used in coloring the kapa cloth, and in tattooing their skins. The materia medica of the Kahunas (native doctors) was gathered exclusively from the forests and fields.

Pl. VII, fig. 1, shows characteristics of native vegetation.

Chief among the woods was *Acacia koa*, called by the natives Koa. It was a common forest tree, occurring at an elevation of 1,500 to 4,000 feet above the sea. It was once the most valuable tree of the islands, useful for fuel and for building purposes. In cabinet work it excels, as illustrated in several buildings in Honolulu. It is susceptible of a high polish, and when so treated and varnished its beautiful wavy lines are delicately revealed. The great war canoes of the natives were cut from the trunks of this tree. It is also used for veneers; and its bark for tanning. It is exceedingly scarce upon the islands at the present time, the great forests formerly existing having been consumed. While the body of the canoe was made from Koa, the rims were furnished by a soft, light wood, Ahakea (*Bobea elatior*), (which was also used for fuel and buildings), and the outrigger from Wiliwili (*Erythrina monosperma*), a very light wood (said to be lighter than cork). The last-named wood was also used for floats for fish nets.

The Ae (*Zanthoxylum kauaiense*), a graceful small tree, was used for Oo (diggers) handles and spears.

The Koaia (*Acacia koaia*) is a most excellent hard wood for furniture and was used both for spears and fancy paddles. It is a harder wood than the Koa.

The Kauila (*Alphitonia ponderosa*), which occurs on the dry slopes of the leeward side of the island and which attains to a greater height than any other tree, is remarkable for its close grain, hardness, and

heavy weight. Out of it the natives make spears, mallets for beating kapa, and other tools. It blackens with age.

The islands once abounded in sandalwood (*Santalum freycinetianum*), but the great demand for this wood in Canton, China, for incense and for the manufacture of fancy articles caused a trade which quickly destroyed the forests of this tree. Between 1810 and 1825 this trade in sandalwood was at its height, and while it lasted brought great wealth to the king and chiefs in guns, ammunition, liquors, boats, and small ships, which they received in exchange. It brought from 6 to 10 cents per pound. It was the first export that attracted commerce to the island. So great was the destruction of these trees that it was found necessary to lay a "tabu" on the few remaining ones. A great many sandal trees have since sprung up in the islands, but nowhere in such quantities as to justify a revival of the trade. After the sandalwood was exhausted there was exported to China the bastard sandalwood (*Myoporum sandwicense*), called by the natives Naio. The wood and roots of this tree, when dried, possess a fragrance strongly resembling that of the sandalwood. It has also good building and excellent burning qualities, and is used for torches in fishing.

The *Eugenia sandwicensis* (native name Ohia-ha) is a most durable timber, and is used for railroad ties and posts, while *Mezoneuron kauaiense* (native name Kela) is a very hard wood, closely resembling ebony. For fence posts the wood of the *Sophora chrysophylla* (native name Mamame) is said to be the most durable, while it is also a good firewood.

The *Dracena aurea* (native name Halapepe) was once used by the natives, who carved their idols out of its soft wood. So, also, was used the wood of *Metrosideros polymorpha* (native Lehua), the most generally prevailing tree on the islands. It is very hard, is a good building material, and the best of fuels.

FIBER PLANTS.

Broussonetia papyrifera, the well-known paper mulberry, called by the natives Wauke, furnishes the bark out of which the famous kapa cloth was made. It is not a native of the islands, but was brought with the Hawaiians and by them cultivated, as it was by all of the Polynesians of the Maori race. Other plants, *Pipturus albidus* (native name Mamake), which is a native, and *Bahmeria stipularis*, to a less extent, however, contributed also to the manufacture of kapa.

In the preparation of the bark for kapa, stipes of *Sadleria cyatheoides*, after being macerated in water, were beaten together with the bast of the above-mentioned trees and made to serve as a sizing, while the *Cheirodendron quadricaudii* (native Olapa) and *Myrsine lessertiana* (native Koolea) furnished dyes to color the kapa blue and red.

The *Pandanus odoratissimus* (native Hala) tree furnishes leaves out



FIG. 1.—TREE FERNS, HAWAII.



FIG. 2.—'TRAVELERS' TREE (RAVENNALA MADAGASCARIENSIS).



FIG. 1.—TARO PLANT (*COLOCASIA ANTIQUORUM*),



FIG. 2.—PAPAYA TREES (*CARICA PAPAYA*),

of which mats are made (Pl. XXI, fig. 1), while *Cyperus laevigatus* (native Ehuawa), a close relation of our irrepressible coco or nut grass (which, by the way, has found its way also to the islands), furnishes the grass out of which the beautiful and expensive Niihau mats are manufactured.

A large grass, *Paspalum orbiculare*, common in swampy or heavy clay soils and distasteful to animals, is used by the natives for covering their (grass) houses. (See Pl. IV, figs. 1 and 2.)

Valuable fibers of great tenacity and durability are obtained from *Urera sandwicensis* (native Opuhe) and *Touchardia latifolia* (native Olona). These fibers are used for ropes, fishing lines, and nets.

Several species of *Cibotium* have the bases of the leaf stalks densely covered with soft and glossy yellowish wool, which makes a very desirable article for stuffing pillows and mattresses. Under the name of pulu it forms a regular article of export to California. Large forests in Hawaii have been ruthlessly destroyed in former times to obtain pulu. The natives once practiced tattooing and used the acrid juice of the *Plumbago zeylanica* (native Illieo) to give a black tattoo and of *Sisyrinchium acre* for blue tattoo.

Pritchardia gaudichaudii (native Loulu lelo) furnishes a fruit whose kernel is edible while green, and leaves from which are made fine fans and hats. The trees are often found badly mutilated, with only one or two leaves at the top of the bare tree.

Two native species of cotton may here be mentioned as belonging to the fiber plants, though the natives, unacquainted with spinning and weaving, made no use of them. Again, their very short fiber failed, perhaps, to attract their attention: *Gossypium tomentosum*, a spreading shrub 4 to 6 feet high, hoary, with soft, white tomentum, three to four seed in each (3) valve, which are enveloped in a finely adhering tawny wool, fibers of which measure 0.3 to 0.6 inch in length. *G. drynarioides*, a small tree 12 to 16 feet high, with red flowers and each cell of the capsule with one seed covered with short, brownish wool. This plant is rare on the islands and doomed to extinction unless cultivated, since the capsules are imperfectly dehiscent and the seed are held and are eaten by worms, thus preventing reproduction. Again, cattle are extremely fond of the foliage and fruit and quickly destroy them in pastures.

FRUITS.

Nor were the islands at time of settlement bare of fruit. The Chilean strawberry (*Fragaria chilensis*) flourished on the high mountains of Hawaii and East Maui. The natives hold this berry in high esteem, and it in turn serves them well, since it bears from May to September. It is also the chief food of the wild Hawaiian goose (*Bernicla sandwicensis*). This goose also feeds upon the berries of a

low, prostrate shrub, *Coprosma ernodeoides* (native Kūkai neenee), which covers the bare lava at elevations of 5,000 to 7,000 feet. The Ohelo berry (*Vaccinium reticulatum*), famous in native song and story, and once proffered as a propitiatory offering to Pele, is also a food for the native geese. It is a shining, fleshy berry, astringent, but not unpleasant in taste, and makes an excellent preserve. (Pl. XII, fig. 1.) On the high mountains of Hawaii and East Maui it grows gregariously, often covering large tracts.

Among the Eugenias, which are numerous on the islands, may be mentioned the rose apple, *Eugenia malaccensis* (native Ohia ai), occurring in forest belts on the island of Maui. (Pl. XI, fig. 2.)

The Tahitian chestnut (*Inocarpus edulis*) is also regarded as a native of the islands.

MEDICINES.

The medicines of the natives were mainly supplied from the flora of the islands. The plants of the genus *Boerhaavia* possessed drastic properties and formed a part of the materia medica of every Kahuna.

A close relative of the sweet potato, *Ipomœa insularis*, which wraps itself in dense entangled masses about the trees and shrubs of the forest, has a root which is a powerful cathartic, much used in native medicine. It is also employed externally in bruises and fractures of bones. The yellowish spore powder from the *Psilotum triquetrum* (native Pipi) is a favorite remedy for diarrhea in children. The *Tephrosia piscatoria* possesses narcotic properties kindred to digitalis, and with similar action on the heart. It is used by the natives for stupefying fish.

LEGUMINOUS PLANTS.

The leguminous family is well represented in the native flora of the islands. Among others may be mentioned two species of *Mucuna*, the genus to which our velvet bean belongs, viz, *M. gigantea* and *M. urens* (the latter, however, is not a desirable plant, since its young shoots possess stinging hairs, and hence it is called cow-itch plant); one species of *Canavalia*, *C. galatea*; one of *Phaseolus*, *P. truxillensis*; three of *Vigna*, *V. lutea*, *V. sandwicensis*, and *V. oahuensis*.

FLOWERS.

Flowers of various types and beautiful colors were everywhere found. The *Labordea grayana* and *L. glabra* (native Kamakahala) were so highly prized for stringing into wreaths (leis) that they were tabooed to common people and reserved exclusively for the King and high chiefs.

The fragrant and glossy branches of the *Alyxia olivæformis* (native

Maile) were largely used and highly esteemed for decorating their houses and lanais on festive occasions.

The *Drosera longifolia* is an insectivorous plant, and its leaves are covered with flies in every stage of decomposition.

GRASSES.

Several excellent grasses were found growing upon the islands when settled by the Hawaiians, although no grazing animals were ever on them until Vancouver landed the first cattle and sheep in 1793. *Manisuris* (*Stenotaphrum americanum*), a creeping grass of great excellence, is found on all of the islands. *Panicum pruriens* (native Kukai puua) is also highly relished by stock. It occurs in the lower and middle regions of all of the islands. *Heteropogon contortus* (native Pili), common on all of the islands, is very troublesome to sheep on account of its awns getting entangled in the wool.

Chrysopogon aciculatus (native Piipii) covering dry and open plains and slopes, gives good pasture for cattle, but undesirable for sheep on account of adhering spikelets and awns.

A curious property of the genus *Pisonia* is turned into useful account by the native woodsman of the island. The fruiting perigone of this genus exudes a very viscid glue. It sticks tightly to any object it touches. The woodsman utilizes this property in catching birds. The native name of this genus is Papala.

PLANTS INTRODUCED BY THE NATIVES.

When the Hawaiians migrated to these islands they brought with them at least twenty-four species of plants, all of which extend throughout Polynesia into Malaysia and have accompanied the Maori race in all their migrations, yielding them food, intoxicating beverages, materials for cloth, rope, and other domestic purposes. Some were connected with their religious worship, and others were designed for shade trees.

Professor Hillebrand says that the seedless breadfruit, the sugar cane, banana, and taro could not possibly have reached the islands by any other than human agency. There is an abundance of evidence to show that frequent visits were made to southern island groups in remote times. Therefore the number of plants introduced by them may be much larger than those given above. The twenty-four known to have been introduced are the following:

Calophyllum inophyllum, a littoral tree, valuable for cabinetwork, known throughout Polynesia. It is planted around habitations. The native name is Kamani. The oil from the nuts is extensively used as a remedy for rheumatism and bruises. The yellow juice of the stem makes the Tacamahaca resin of commerce and is highly esteemed as a scent by the natives.

Paritium tiliaceum (native Hau) is planted near houses on account of its shade and trained into arbors or lanais. The wood is very light and therefore used for the outriggers of canoes, while the bark furnishes a fiber for ropes, and the flowers give a decoction highly esteemed for bronchial and catarrhal troubles.

Thespesia populnea (native Milo) is found in and around villages on the seacoast. This tree is a favorite on all the islands from Madagascar to Hawaii. The tree is connected with their religion and is esteemed as sacred, and hence its wide distribution. The home of Kamehameha I at Waikiki was surrounded by this tree and hence the inference that the Hawaiians, up to a recent date, held it in high esteem.

Eugenia malaccensis (native Ohia) is found in all of the islands in the lower forest zone, occurring in clusters or belts. This tree occurs on all of the larger islands of the Pacific Ocean and is highly esteemed for its fruit.

Lagenaria vulgaris (native Ipu) is the bottle gourd, found cultivated by the natives on the discovery of the islands. These gourds served as receiving vessels in the household, while the larger ones, covered with shark skins, were used as drums. The Kuhunas used the pulp and seed as a drastic medicine. Closely allied to this plant is the *Cucurbita maxima* (native Ipu nui), the large calabash gourd which was found growing on the islands at the time of discovery, though unknown on the other Polynesian Islands. It is used largely for serving poi and holding water and other liquids. It is sometimes several feet in diameter.

Cordia subcordata (native Kou), a tree formerly planted around settlements near the seashore, on account of the shade given by its extensive foliage, is found on all of the islands from Zanzibar to Hawaii, and seems to have been the constant companion of the Maori race in their migrations. The soft but durable wood is highly prized for cabinet-work, and it is also cut into cups and bowls which, when polished, displays wavy lines of light and dark brown colors.

Ipomoea batatas (native Uala) is our sweet potato, and next to taro constitutes the chief article of diet with the natives. They claim a large number of varieties on the island, differing in shape, color, and size of the tuber, as well as in the color and shape of the leaf. This plant, like the taro, is still extensively cultivated all over the islands.

Broussonetta papyrifera, the paper mulberry, furnishing a bark for kapa cloth, has already been mentioned. (See p. 30.)

Artocarpus incisa (native Ulu) is the breadfruit of commerce and has accompanied the Polynesian race wherever it has gone. (Pl. XIII, fig. 1.) In Hawaii, on account of its temperate climate, it has never succeeded as well as farther south. It fruits from June to August, and this short season seems not to have justified extensive culture nor



FIG. 1.—MANGOES (*MANGIFERA INDICA*).



FIG. 2.—MAMMEE APPLE (*MAMMEA AMERICANA*).



FIG. 1.—ALLIGATOR PEAR (*PERSEA GRATISSIMA*).



FIG. 2.—LITCHI NUT (*NEPHELIUM LITCHI*).

the propagation of numerous varieties as elsewhere, for only one variety is known in Hawaii against twenty or more enumerated in more southern groups of islands. This one variety is seedless and hence is propagated by cuttings. In recent years a seed-bearing variety has been introduced from the Caroline Islands, and another species, known as the jack fruit (*A. integrifolia*) has been added to the cultivated fruits. Ramie (*B. tenacissima* or *B. nivea*) has been introduced since the discovery of the islands and extensively cultivated, and several years ago the government of the islands offered a large prize in money for a machine which would successfully decorticate this plant.

Aleurites moluccana (native Kukui) is the candle-nut tree of the English. The natives string the nuts on sticks and burn them for lighting their houses. The expressed oil from the seed is also burned in lamps, and used to mix with paints. From the juice of the fleshy covering of the nut is obtained a black dye, which was also used in tattooing the skin. The tree is the prevailing one in the woods of the lower zone, and can be recognized at a great distance by the paleness of its foliage. It extends over all the Pacific isles and has the same name everywhere.

Piper methysticum (native Awa) is the plant from which all Polyynesians extract their intoxicating beverage. It is still cultivated around the settlements of the natives, who continue to manufacture their favorite drink. While on the islands, the United States marshal recited instances where he had to break up several small factories of this vicious drink and how surprised and indignant were the natives at his interference with their immemorial customs.

Cocos nucifera (native Nin) is our well-known cocoanut tree or palm (Pl. VI, fig. 1). Though its original habitat is placed by the botanists on the western coast of the Isthmus of Panama, it is known to have been grown upon all the Polynesian islands. Hawaii is rather north and with too temperate a climate to grow the cocoanut to its full perfection, yet there are large groves everywhere and the fruit is highly esteemed, especially in its green state. The milk from unripe coconuts is quite a popular beverage in Honolulu, and several stands exist throughout the city which dispense this drink. Formerly only one variety existed on the islands, but recently several new ones have been introduced.

Colocasia antiquorum is the taro, or kalo (Pl. VIII, fig. 1) of all the Polynesians. It has been and is now the principal food of the natives (Pl. VI, fig. 2) of these and other Polynesian islands. In growth and appearance it is like our Calladium, but is usually cultivated like rice, under water, though a highland variety is grown in the rainy belt. It is propagated by the tops of the corms, which quickly take root, requiring fifteen months to mature. Like the

potato, it has many varieties, distinguished by quality of the tuber and the color of leaf stalk. The plant contains an acrid principle which is destroyed by cooking. The tuber is eaten boiled or baked, or as poi, the latter being the favorite and chief food of the natives. It is prepared by pounding the baked taro and mixing with water and permitting it to ferment for a short time, when it is cooked again into a thick sticky mass and eaten. It is said to be extremely fattening in its properties. The Chinese have several factories for the manufacture of poi in Honolulu. The leafstalks of the taro are also eaten, resembling asparagus in taste.

Alocasia macrorrhiza (native Apii) furnishes a food to the natives in times of scarcity from its coarse farinaceous stems. It is cultivated to a limited extent only, in small patches of dry land in mountain recesses or in the lower zone of forests. It is naturalized in many of the Polynesian islands.

Musa sapientum (native Maia) is the banana of commerce. Pl. V, fig. 1, shows a banana plantation on Waikiki road. It is at present found growing wild in the mountain gorges, where once the natives cultivated it. It is also largely cultivated, being one of the exports from the islands to San Francisco and other ports of the Western coast. The natives have been cultivating this plant from time immemorial, and recognize several varieties, one of which with a reddish sap, tenacious fiber, and copper-colored fruit, occasionally producing seed, is perhaps indigenous. Since the introduction of the Chinese, the Chinese banana, *M. cavendishii*, has almost superseded all other varieties. This is due to its low height—a protection against the prevailing trade winds—and its superior fruiting properties. The Brazilian variety, much taller, is also grown to some extent, and shares with the Chinese the power to withstand the destructive effects of the wind. Both of these varieties were introduced from Tahiti. The fine flavor of the latter variety gives it high favor over all others, but it is only a moderate bearer. On the islands is to be found also the *Musa textilis* of the Philippines, which furnish the Manila hemp of commerce. It was introduced in 1866 and is now well distributed over all of the islands. It has a few undeveloped black seed in its fruit, which enables an identification of this variety at once. It grows to the height of 18 to 20 feet, and freely multiplies by suckers. The growing of this plant on a large scale for its fiber in the manufacture of manila rope is one of the possible future industries of these islands. The cultivation of bananas on a large scale is performed in rows 8 to 12 feet apart, with a stream of running water between each row. The Cavendish variety is usually grown, and the large yield of fruit is disposed of by export to the United States. This industry can be profitably increased. In the gardens in and around Honolulu many varieties of bananas may be found.

Zingiber zerumbet (native Awapuhi) is a common plant covering in many instances the open grounds of the forests of the lower zone. This species extends over all of the Polynesian islands, although the natives of Hawaii seem to have no use for it. It is closely related to the ginger of commerce (*Z. officinale*).

Curcuma longa (native Olena) is our turmeric of commerce, and occurs scattered through the open glades of the entire group. From it the natives extract a dye to color their kapa cloth yellow. It, too, follows the Polynesian race in all its peregrinations. The tubers are deep yellow inside.

Tacca pinnatifida (native Pia) has large roundish tubers which furnish the arrowroot of commerce. This plant is found wild in the open woods and grassy plains of the lower regions of the islands. It begins its foliage early in the spring and loses it by the end of summer. It was once cultivated extensively by the natives, but it appears to have been entirely neglected in late years. It is common through Polynesia, Malaysia, Philippines, Madagascar, and eastern Africa.

Dioscorea sativa (native Hoi) is a yam common in the forests of the lower zone, and was once extensively cultivated for sale to the whaling ships. Its native name follows it through all of the Pacific islands to Sumatra. *D. pentaphylla* (native Piia) is a small yam, never cultivated, but found growing wild on the islands. It has the same geographic range as the preceding.

Cordyline terminalis (native Ti) is extremely common on all of the islands at the lower edge of the forests. The leaves of this plant are in universal use as wrappers for fish, food, etc., and were formerly used for plates. Fish and other meats and vegetables are cooked in them. The leaves also make good forage for horses and cattle. The natives make a crude beer from the roots, and lately have learned how to distill from the beer a strong rum. This plant has a wide geographical range through the islands of the Pacific and Indian oceans.

Saccharum officinarum (native Ko) is our sugar cane, the cultivation of which is now the chief industry of the islands, and brings to them enormous annual profits. Sugar cane was found in the hands of the natives when the islands were discovered, and hence generally believed that it was indigenous. (Pl. XVIII, fig. 1.) But since it has the identical name here as with all of the Polynesian-Maori tribes it is more reasonable to suppose that the natives brought it with them to these islands. There are to be found on the islands the following varieties thought to be introduced by the natives: Kokea, Uala, Oleana, and Pupuha, which have greenish-yellow stalks; Honuaula, Papaa, and Ohia, which have dark purple stalks; and Ainakea, Kamio, Manulele, Akilolo, and Lau Kono, which have striped stalks. These canes were introduced into the United States twelve years ago, and are now growing upon the grounds of the sugar experiment station,

New Orleans. The above varieties are adapted to the different elevations, the green varieties thriving best on the seacoast, the variegated in the middle zones, while the darker kinds may be grown successfully at very high elevations. A so-called flowerless variety, Puaole, which has a vigorous growth, rich juice, and wide adaptability, is in favor for cultivation in high altitudes, since it tassels very late, and therefore permits of a longer season for harvest.

Besides the above there has been introduced in recent years a number of varieties, but the one chiefly cultivated on the islands now is the Lahaina, or Keni Keni, which was originally brought from the Marquesas Islands by Capt. Pardon Edwards, and was first planted at Lahaina in Maui, whence its name. On lands from the sea level to an altitude of 1,500 feet, this cane is now preferred to all others. Its introduction into the islands has increased enormously the yield of sugar. The Rose Bamboo, Cavengerie, and Yellow Caledonia have also been introduced, and are grown to some extent.

PLANTS INTRODUCED SINCE THE DISCOVERY OF THE ISLANDS.

Captain Cook records the following as found on the islands in 1778:

Taro of large size and quality; sweet potatoes, 12 to 14 pounds each; plantains, five or six varieties; breadfruit scarce; a sweet root like a yam in form, probably the root of the Ti plant; sugar cane of large size and good quality; cocoanuts; ava root, and gourds; fowls scarce; hogs abundant; dogs used as food; geese, and large white pigeons.

Captain Cook, on Sunday, February 1, 1778, left on the island of Niihau one ram goat and two ewes, a boar and a sow of English breed, and the seeds of melons, pumpkins, and onions.

Captain Colnet left a ram and a ewe on Kauai some time about 1780.

Captain Vancouver, in 1792 to 1794, left vines and orange plants, almond and garden seeds, goats, geese, sheep, and cattle. He also landed some useful culinary utensils, implements of husbandry, smiths' and carpenters' tools. The cattle he gave to King Kamehameha I, and induced him to issue a taboo against eating them for ten years.

Don Francisco de Paula Marin came to the islands in 1791, and spent the remainder of his life, dying in 1837. He appears to have served the king in many capacities. His early journal shows that he cultivated pineapples, oranges, beans, cabbages, potatoes, peaches, cherimoyas, horse-radish, melons, tobacco, carrots, asparagus, maize, fig trees, lemons, lettuce; and had made Kukui oil, cocoanut oil, candles, tiles, hay, cigars, beer, and brandy.

Later he records that he planted coffee, cotton, cloves, tomatoes, turnips, pepper and chilis, wheat and barley, and manufactured castor oil, soap, molasses, lime, pickles, sirup of lemon juice, and sugar.



FIG. 1.—COFFEE IN FRUIT.



FIG. 2.—ROSE APPLE (*EUGENIA MALACCENSIS*).



FIG. 1.—OHELO BERRY (*VACCINIUM RETICULATUM*).



FIG. 2.—SAPODILLA (*ACHRAS SAPOTA*).

From the above, taken from his journal, it will be seen that much of the present wealth of the islands started from seeds, roots, and plants introduced and cultivated by Don Francisco de Paula Marin. He seems to have conducted a real experiment station, combining both agriculture and manufacture.

It seems that several plants introduced by Marin became extinct, for it is recorded that Lord Byron, in the *Blonde*, 1825, introduced coffee plants taken on board at Rio Janeiro.

This brings the introduction of seeds and plants and animals up to 1820. After that date a new and systematic agency began on the islands. The American missionaries then arrived, and under instructions from the home board looked after the material development of the islands as well as the spiritual welfare of the natives. Since that time new seeds, plants, roots, implements, and utensils have been continuously introduced.

The recital given above will show that most of the common garden, field, and orchard plants were introduced soon after the discovery of the islands. The following are some of the prominent plants that have been introduced in modern times:

FRUITS.

Tamarindus indica, the tamarind, is cultivated and also found growing wild around old settlements. Like lemons and limes it is used to make a refreshing drink.

Achras sapota, the Sapotilla pear, is cultivated largely in gardens and its fruit highly esteemed. (Pl. XII, fig. 2.)

Eriobotrya japonica, the loquat or mespilus plum, is much cultivated and fruit locally esteemed. It will not bear long transportation.

Physalis peruviana is common in open mountain slopes and in clearings in the woods. The edible berry is of a pleasant flavor and makes an excellent jelly. It is generally known as Cape gooseberry.

Ananas sativa, the pineapple (Pl. V, fig. 2), is extensively cultivated, nearly every small farmer having a patch. There are several varieties grown. The supply exceeds local demand, and considerable quantities are exported to the western United States. It seems splendidly adapted to these islands, and the fruit is of excellent flavor. In some instances this fruit has escaped cultivation and is now growing wild.

Carica papaya, known locally as the papaia, is a native of Brazil. It was introduced early, and has an extensive cultivation and exists as escapes around old settlements. The fruit is borne in clusters just below the limbs of the tree (Pl. VIII, fig. 2), each one attaining the size of a canteloupe, which it resembles in color and appearance. It is variously esteemed, some enjoying it as a morning appetizer. The

juice contains a digestible principle like pepsin, and has the property of rendering tough meat tender. The seeds are used as a vermifuge.

Passiflora quadrangulis and *P. laurifolia* are both cultivated for their delicious fruits. The former is called Grenadilla and the latter has a yellow fruit. The purple fruited water lemon, *P. edulis*, also grown for the fruit, is not only cultivated generally, but has escaped into the woods of east Maui.

Psidium guajava.—The guava is no longer cultivated. It was early introduced, and finding a congenial soil and climate has grown wild and has spread over the islands, forming dense thickets. It bears fruit in great abundance (Pl. XIII, fig. 2), which falling and decaying upon the lava soils, assist largely by their acid properties in disintegrating them. There is here a fine field for the manufacture of guava jelly on a large scale, thousands of tons of the fruit wasting every year. Locally some of the progressive housekeepers make annually a few jars of this jelly, which is of excellent flavor and attractive color. *P. cattleyanum*, the cattleya or Chinese guava, is cultivated to a limited extent.

CITRUS FAMILY.

The entire citrus family has been grown on the islands. Doubtless there are locations on the leeward side of the islands where they can be grown to perfection, when selected varieties are introduced. Up to the present no systematic attempt has been made to grow the improved varieties upon a large scale, and therefore their profitable culture is yet problematical.

The orange (*Citrus aurantiacum*) was early introduced, growing it from seed, and the agricultural history of the islands is full of accounts of the successful cultivation of this delicious fruit. It was once exported, but is now grown only for home uses and in limited quantities. Nowhere on the islands is there a large grove of selected trees. The lime (*C. limetta*) is more extensively grown and is served at all the hotels and restaurants of the city of Honolulu. The citron (*C. medica*) is cultivated in yards and gardens, but the varieties are not of the most improved type. The kumquat (*C. japonica*), both the oblong and round, is found in many gardens, but is not an article of commerce. The shaddoek (*C. decumana*) is occasionally found ornamenting the yards in the cities or on the plantations, but is not extensively raised. The pomelo (*C. pomelanus*) seems to be less extensively cultivated than any other of the citrus family. All of the above, save the pomelo, are found wild in the deep recesses of some of the valleys, having escaped cultivation.

Mangifera indica, the mango of commerce, is receiving perhaps more attention just now than any other fruit. (Pl. IX, fig. 1.) As many as twelve or fifteen varieties have already been introduced. It

is a delicious fruit, a beautiful tree, and decidedly ornamental in any ground. *Spondias dulcis*, known as the Wi fruit from Tahiti, is sparingly cultivated.

Anacardium occidentale, the cashew nut, is occasionally found in cultivation. It is a delicious fruit, larger than a peach, of a yellow color, and with the nut or seed growing on the outside of the fruit. It is worthy of more extended culture.

Mammea americana, the mamee apple, is grown to a limited extent. (Pl. IX, fig. 2.) It is worthy of more general cultivation.

Anona cherimolia (custard apple from the Ecuadorian Andes), *A. squamosa* (sweet sop), and *A. muricata* (sour sop), are cultivated to a small extent. They are of easy culture, no special pains being needed to make them a success in the Tropics. They are usually propagated from seed. The custard apple is found as an escape in many places.

The most attractive and popular fruit on the islands is perhaps the avocado, or alligator pear (*Persea gratissima*), borne on a tree of medium height and size. The fruit is usually pear shaped, though sometimes club shaped and occasionally curved like a crook-necked squash, or quite spherical. (Pl. X, fig. 1.) It is green in color until it reaches maturity, when it assumes a purplish or yellowish hue. The fruits weigh from 8 to 10 ounces each, and the single seed is about the size and shape of a boy's top. The pulp surrounding the seed has a delicate texture and is highly esteemed by the educated palate. It is usually served for breakfast with salt, pepper, and vinegar. It does not bear transportation well, and hence can never become an article of export.

The pomegranate (*Punica granatum*) is found growing in many yards, but the trees are not of the improved varieties whose fruit are so palatable and juicy. It seems to be planted here more as an ornament than for its fruit.

The Chinese have recently introduced their favorite fruit, the Litchi nut (*Nephelium litchi*), which is fast growing in popularity. The fruit resembles a very large and richly colored strawberry, being about 1½ inches in diameter, with a single large brown seed. (Pl. X, fig. 2.)

The fig (*Ficus carica*) was formerly grown in large quantities and in numerous varieties, but its cultivation is now greatly diminished on account of the attacks on its fruit by the "minah" bird, which was recently introduced to assist in eradicating injurious insects. To protect the fruit it is now necessary to inclose the trees in wire gauze, an expense indulged in by men of means only.

Fragaria vesca and *F. grandiflora*, strawberries, are cultivated and thrive well at altitudes above 300 feet, yielding fruit at least five months of summer.

A few seedling varieties of peaches are grown from seacoast to elevations up to 3,000 feet. The trees fruit and flower simultaneously.

The apple, at least some few varieties, is reported as successfully grown along with the peach, while the pear is rarely ever successful.

The cherry, almond, and apricot are failures. Blackberries, raspberries, currants, and gooseberries are not found on the islands.

Only the pineapple and banana are grown in such quantities as to permit of extensive exportation. Statistics show that in 1897, 75,835 bunches of bananas, valued at \$75,000, and 149,515 pineapples, valued at \$14,500, were shipped to the States and Canada. It is impossible to give the amount of each consumed at home. These fruits have little or no competition, and hence their cultivation may be expanded without fear of overstocking the Western markets of America. The growing of other fruits is limited by the local demands of the islands, since they will either not bear long transportation, or if so, they will compete with the home-grown articles of California.

Grape culture, now carried on to a limited extent by Portuguese, who have learned a method of having ripe grapes in their vineyard the year round, can be greatly expanded with profit.

As supplementary to above, I insert a letter with a list of fruit trees furnished me by Prof. A. Koebele.

HONOLULU, H. I., August 17, 1900.

SIR: As requested, I herewith submit to you an incomplete list of fruit trees, etc., of the Hawaiian Islands. Since no publications are at hand, the classified list of the plants of the Royal Botanical Gardens, Peradeniya, Ceylon, 1888, has been used as a guide.

Respectfully,

A. KOEBELE, *Entomologist.*

Partial list of fruit trees growing on Hawaiian Islands.

<i>Anona cherimolia.</i>	<i>Nephelium litchi.</i>
<i>Anona muricata.</i>	<i>Nephelium longana</i> —both in bearing.
<i>Anona reticulata.</i>	<i>Nephelium (Pometia) pinnatum</i> (several small trees, from Fiji, November, 1899).
<i>Anona squamosa.</i>	<i>Mangifera indica</i> , var.
<i>Nymphaea lotus</i> is largely raised to eat.	<i>Anacardium occidentale.</i>
<i>Flacourtia sepiaria.</i>	<i>Spondias dulcis.</i>
<i>Garcinia cambogia.</i>	<i>Spondias lutea.</i>
<i>Garcinia mangostana</i> —tree bearing since 1897 on Kauai.	<i>Spondias purpurea</i> (Mexico, 1897).
<i>Garcinia</i> spp.	<i>Arachis hypogaea.</i>
<i>Mammea americana.</i>	<i>Andira inermis</i> , vars.
<i>Durio zibethinus</i> —fruiting for several years.	<i>Ceratonia siliqua.</i>
<i>Cola acuminata</i> —fruiting on Kauai.	<i>Tamarindus indica.</i>
<i>Theobroma cacao</i> —doing well.	<i>Hymenaea courbaril</i> (Mexico, 1897).
<i>Erythroxylon coca</i> (seed from Ceylon, 1900).	<i>Dillenia indica</i> (Hongkong, 1900).
<i>Averrhoa bilimbi</i> (from Fiji, 1889).	<i>Prosopis juliflora dulcis.</i>
<i>Averrhoa carambola.</i>	<i>Chrysobalanus icaco</i> (Fiji, 1899).
<i>Citrus</i> , numerous species.	<i>Prunus persica</i> var.
<i>Egle marmelos.</i>	<i>Rubus</i> sp. var.
<i>Zizyphus jujuba.</i>	<i>Eriobotrya japonica.</i>
<i>Vitis vinifera</i> —two crops per year.	<i>Pyrus communis.</i>
	<i>Terminalia catappa.</i>



FIG. 1.—BREAD FRUIT (*ARTOCARPUS INCISA*).



FIG. 2.—GUAVAS (*PSIDIUM GUAYAVA*).



FIG. 1.—PREPARING FOR RICE PLANTING.



FIG. 2.—RICE FIELD.

<i>Psidium guajava.</i>	<i>Ipomoea batatas.</i>
<i>Psidium cattleianum.</i>	<i>Lycopersicum esculentum.</i>
<i>Psidium</i> sp.	<i>Solanum melongena.</i>
<i>Pimento acris.</i>	<i>Solanum tuberosum.</i>
<i>Pimento officinalis.</i>	<i>Cyphomandra betacea.</i>
<i>Eugenia brasiliensis.</i>	<i>Capsicum</i> vars.
<i>Eugenia caryophyllata</i> (clove).	<i>Piper nigrum.</i>
<i>Eugenia jambos.</i>	<i>Myristica fragrans.</i>
<i>Eugenia malaccensis.</i>	<i>Persea gratissima</i> vars.
<i>Eugenia uniflora.</i>	<i>Macadamia ternifolia.</i>
<i>Eugenia vulgaris.</i>	<i>Aleurites triloba.</i>
<i>Barringtonia alba.</i>	<i>Manihot utilissima.</i>
<i>Barringtonia edulis.</i>	<i>Celtis occidentalis.</i>
<i>Punica granatum.</i>	<i>Celtis sinensis.</i>
<i>Passiflora</i> spp.; all the species doing well.	<i>Morus</i> spp.
<i>Carica papaya</i> vars.	<i>Ficus carica.</i>
<i>Trichosanthes</i> spp.	<i>Artocarpus incisa.</i>
<i>Lagenaria vulgaris.</i>	<i>Artocarpus intergrifolia.</i>
<i>Luffa</i> sp.	<i>Dion edule.</i>
<i>Benincasa</i> sp.	<i>Elettaria cardamomum.</i>
<i>Cucumis melo.</i>	<i>Zingiber officinale.</i>
<i>Cucumis sativus.</i>	<i>Maranta arundinacea.</i>
<i>Citrus vulgaris.</i>	<i>Musa paradisiaca</i> vars.
<i>Cucurbita moschata.</i>	<i>Ananas sativum.</i>
<i>Cucurbita pepo.</i>	<i>Tacca pinnatifida.</i>
<i>Secchium edule</i> (Mexico, 1897; entirely destroyed by <i>Dacus cucurbitæ</i>).	<i>Dioscorea</i> spp.
<i>Opuntia dillenii.</i>	<i>Allium</i> spp.
<i>Vangueria edulis.</i>	<i>Caladium esculentum</i> var.
<i>Coffea arabica.</i>	<i>Areca catechu.</i>
<i>Coffea liberica.</i>	<i>Cocos nucifera</i> vars., and many other useful palms.
<i>Coffea bengalensis</i> (Ceylon, China, 1899).	<i>Olea</i> spp., not bearing.
<i>Morinda citrifolia.</i>	<i>Physalis peruviana.</i>
<i>Chrysophyllum cainito.</i>	<i>Physalis franchiti.</i>
<i>Chrysophyllum oliviforme.</i>	<i>Rubus macraei.</i>
<i>Lucuma mamosa</i> (Mammee).	<i>Vaccinium reticulatum</i> , "Ohelo berry."
<i>Achras sapota.</i>	<i>Fragaria</i> spp.
<i>Bassia latifolia</i> (Ceylon, 1895).	<i>Vanilla</i> , several species.
<i>Strychnos nux-vomica.</i>	

VALUABLE GRASSES, GRAINS, AND FORAGE PLANTS.

Mention has already been made of the introduction of corn, wheat, oats, and barley.

Corn is still grown in considerable quantities upon one or two of the islands. There is yet a spirited controversy as to the best season of the year to plant this crop. It will probably never be grown largely on the islands, since it requires practically similar conditions for growth as sugar cane, and the latter, as long as present prices obtain, will always occupy all of the available land.

Wheat was once extensively cultivated and exported to California during the gold fever of 1849, but was discontinued when the latter

country began to grow its own wheat and rendered importation unprofitable. It is said that the grain abounded in gluten to such an extent that it required the addition of foreign flour to make good light bread.

Oats and barley were grown to some extent in former times, but have almost disappeared from the islands as cultivated crops. The former is frequently found wild as an escape from cultivation.

Rice (*Oryza sativa*) is now the second crop in the islands in quantity and value. The cultivation began in 1860. Now every available acre of land adjoining the sea capable of cultivation and susceptible of being watered is under cultivation. Only the Chinese are engaged in this industry, paying for rent \$40 to \$50 per acre. They grow two crops per year on the same land. After the field is once prepared and watered, it is never permitted to be unoccupied. As fast as one crop is harvested another is planted. The soil is prepared by using a kind of iron harrow drawn by a Chinese water buffalo, imported from China, through the water to pulverize clods and stir the soil. (Pl. XIV, fig. 1.) The rice plants are taken in large bunches from a bed thickly sown, and transplanted by hand in cheeks 6 to 12 inches apart, in water several inches deep. Long lines are frequently used to keep the rows straight. (Pl. XIV, fig. 2.) It is a slow and tedious process, and only the persistent industry of a Chinaman would essay such a task. The rice is harvested with a sickle and trodden out by horses on a hard floor. It is prepared for market in the crudest of mills, located on the shores of the ocean and propelled by artesian water coming from wells at a higher elevation. The waterwheels of these mills are 10 feet or more high and 1-1½ feet wide. The wheel turns a pair of crude stones and works a set of pounders, all wrought from the surrounding lava rocks. The rice thus treated is winnowed from baskets made specially for this purpose, the prevailing northeast trade winds being the valuable motive power. After winnowing, the rice is carefully assorted by passing it through a series of sieves, when it is marketed. Prime rice was selling in Honolulu during the summer at 4½ cents per pound. After witnessing the laborious and tedious operations of growing rice and preparing it for market, the head Chinaman was asked if he could profitably grow rice and prepare it for market at the present price, after paying the usual rent. His quick reply was, "Two crops a year; one crop pay expenses; the other pay me." If the persistent Chinaman can, by such laborious methods, wring a profit out of rice culture, it is almost certain that with improved implements for sowing and harvesting and up-to-date mills to prepare the grain for market there would be enormous gains in extensive cultivation of this cereal on the islands.

The yield of clean rice was from 1,000 to 1,500 pounds per acre, which means a yield per year of twice this amount. The total yield

of the islands is not far from 10,000,000 pounds. A large amount is consumed on the islands, while the export will reach 6,000,000 to 8,000,000 pounds annually.

SORGHUMS.

Sorghum vulgare, both broom and chicken corn, are grown to some extent, but both have escaped and are now naturalized in many places. The latter is esteemed as an excellent forage crop, but is not so extensively cultivated as *S. saccharatum*, which is a great favorite with the dairies and on some plantations. It is grown largely around Honolulu by irrigation for feeding the cows which furnish milk to the city. From one sowing a large number of crops can be obtained. It is thought to be the most profitable crop for forage on the islands, and it is fed in conjunction with bran, crushed algaroba beans, etc. The large demand for seed of this plant by the islanders attests its great popularity.

LEGUMINOUS PLANTS.

The most important of this family now thoroughly naturalized is *Desmodium uncinatum*, a native of South America and common in Jamaica. It was introduced in early times and is now widely disseminated. It affords excellent grazing for all kinds of stock. It is locally known as Spanish or Chile clover. The ranchman esteems it as the best food in his pastures.

Medicago lupulina is found growing near Honolulu and was introduced in very early times. It affords a fairly good pasturage.

M. sativa, alfalfa, is cultivated by several farmers on the islands, and the writer saw a fine crop growing under irrigation on the dairy ranch of Mr. Paul Isenberg, of Waialae. With an abundance of water for irrigation, there is no reason why the coast lands can not grow this crop as successfully as they do in California.

Dolichos lablab, a native of tropical Asia, was early introduced and originally grown for its beans, but is now dispersed.

Cajanus indicus, the dhal of India, was also introduced early and is now found growing abundantly near old settlements.

GRASSES.

Bermuda grass, so abundant and so highly esteemed in the South, has found a permanent and successful habitation on the islands. The yards of Honolulu are sodded with it. It is spreading over waste places, crowding out everything else, and affording valuable pasture for stock. It is said to have been introduced by Dr. Judd in 1835. It thrives only to an elevation of 800 feet. Its botanical name is *Cynodon dactylon*, and it is called by the natives Manienie, which means creeping grass, a name given also by them to a native grass

(*Stenotaphrum americanum*) already described. It is used to bind light sands together on the coast.

Poa annua, the June grass of this country, is widely spread along the water courses in the upland pastures of all the islands.

Elusine indica is found on the rich cultivated grounds of the lower regions.

Panicum jumentorum, Guinea grass, is cultivated by many dairymen with great success. It affords, under irrigation, a number of cuttings from one seeding.

Richardsonia scabra, though not a grass, should find its place among the forage and pasture crops. It is abundant in the cornfields of southern Alabama and Florida, and a native of South America and the West Indies. It here grows wild on the pasture lands. It is only a fair forage plant. It is erroneously called in the South, Mexican clover.

The commissioner of agriculture of Hawaii has imported the following varieties of saltbushes for pastures in the arid regions: *Atriplex halimoides*, one of the best of the saltbushes, and *A. nummularia*, the tallest and most fattening of the Australian pastoral saltbushes. Sheep and cattle pastured on this plant are said to remain free of liver fluke, which seriously infects the cattle of some of the islands. Some assert that it will cure this disease and other allied ailments. Other species introduced are *A. spongiosa* and *A. prostrata*, both valuable saltbushes, and *A. vesicaria*, a dwarf variety of great resistance to extreme drought. It is both palatable and nutritious. Upon the arid ridges of the leeward sides of the islands these saltbushes, if properly attended to, would be valuable adjuncts to the capacity of the islands for stock raising.

NOXIOUS WEEDS.

The following are known to have been introduced:

Geranium carolinianum, a native of North America, which has become thoroughly established on the islands in open woods and pastures.

Portulaca oleracea, the common purslane of our gardens and cultivated grounds, is now well acclimated on all the islands. This plant may be used as a salad when cooked, and is also an excellent food for pigs. Since it occurs only in cultivated grounds, it may well be styled a nuisance.

Lepidium virginicum and *Senebiera didyma*, common peppergresses, are quite at home everywhere in the islands.

Mimosa pudica, our common sensitive plant; *Erigeron canadensis*, fleabane; and *Xanthium strumarium*, the troublesome cocklebur, which springs up after the first rains and dies down in hot dry summer, are all in evidence on the islands.



FIG. 1.—ALGAROA TREES (*PROSOPIS JULIFLORA*).



FIG. 2.—LOTUS POND.



FIG. 1.—ROYAL POINCIANA (*POINCIANA REGIA*).



FIG. 2.—MEXICAN ALMOND OR UMBRELLA TREE (*TERMINALIA CATAPPA*).

Datura stramonium, Jamestown weed, and *Plantago major*, the large plantain of our gardens and fields, here attaining enormous proportions, with spikes $1\frac{1}{2}$ to 2 feet long, seem to have followed the white man everywhere. Besides the above, a very objectionable grass, first introduced at Hilo in 1840, on the island of Hawaii, and hence called locally Hilo grass, is rapidly spreading over the islands, overrunning the pastures and destroying valuable grasses. Its botanical name is *Paspalum conjugatum*. It is a large, coarse, decumbent grass, and is found in Louisiana, where conditions are not so favorable to large and vigorous growth as in Hawaii. It is not eaten by horses, mules, cattle, or sheep. It is creating considerable alarm among the cattlemen of the islands, who know of no way of checking its progress.

TREES.

Prince of all the ornamental trees on the islands is the royal palm (see frontispiece), which by its stately straight trunk and graceful top gives picturesqueness to nearly every lawn in Honolulu. The original tree on the islands now stands in the front yard of Mr. Charles Gray, of that city. From it have come the seeds which have produced the great number now growing at nearly every home. Its botanical name is *Oreodoxa regia*.

Phoenix dactylifera is the date palm, and it grows quite extensively on the islands.

Traveler's palm, *Ravenala madagascariensis*, is a tree more closely related to the banana than to the palm, and is cultivated all over the islands. It derives its common name from the fact that its leaves when tapped will furnish water to the thirsty traveler. (Pl. VII, fig. 2.)

Perhaps the most valuable introduced tree on the islands is the algaroba. It grows immediately on the seacoast and in situations so dry that scarcely any other tree or shrub can live. (Pl. XV, fig. 1.) It makes a fair shade and bears an enormous quantity of pods filled with beans which contain considerable quantities of sugar. These beans are highly relished by cattle, horses, sheep, and hogs. They are in many instances harvested, dried, and ground into a meal for stock feeding. The following analysis is furnished by the Department of Agriculture from a sample furnished the writer by Mr. Paul Isenberg from his Waialae ranch:

Analysis of algaroba bean meal.

	Per cent.
Water	9.59
Ash	5.19
Protein	8.75
Fiber.....	20.33
Nitrogen, free extract.....	54.18
Fat.....	1.96

The botanical name for this tree is *Prosopis juliflora*. It is of quick and easy growth, freely planted in lowlands, and spreads spontaneously. Honeybees are exceedingly fond of the nectar of the flowers and the sugar of the beans. Many apiaries in algaroba groves produce honey of attractive appearance and delicious flavor. The parent tree from which all in the islands have come still stands near the Roman Catholic Cathedral on Fort street, Honolulu. A permanent shade tree, attaining a large size and growing a dense foliage, is the samang, or monkey pod, known botanically as *Pithecolobium samang*. It is in high favor all over the islands, nearly every yard or square containing one or more trees. Prominent in nearly every yard of Honolulu and lending a charm and beauty to the tropical scenery of this city is the royal poinciana, with its large, brilliant red flowers and deep green foliage. Its botanical name is *Poinciana regia*. (Pl. XVI, fig. 1.)

Intermixed with the red and green poinciana may be seen the golden shower, with its pendants of yellow flowers. It is one of the many species of cassia which thrives so well on these islands, its botanical name being *C. fistula*.

The *Morus regia*, black mulberry, was early introduced and originally cultivated for silkworms, but is now naturalized.

A number of species of the genus *Cæsalpinia* are cultivated or found escaped. Among them may be mentioned the following: *C. pulcherrima*, pride of Barbados, which has escaped from cultivation. Two varieties are recognized, one with yellow, the other with orange-red flowers. *C. sepiaria* is planted in hedges; *C. sappan* yields a well-known dye, and *C. coriarea*, a plant rich in tannic acid.

Schinus molle, the pepper tree, grown so extensively around San Francisco, is also cultivated largely on the islands.

The pride of India, *Melia azadirach*, is found in all of the islands.

Terminalia catappa (native Kamaui), called Mexican almond, is a beautiful shade tree popular in and around Honolulu. (Pl. XVI, fig. 2.) It bears an almond-shaped fruit inclosed in a very thick hull.

Bougainvillea spectabilis is a grand shade tree and very justly esteemed by all. (Pl. XVII, fig. 1.)

The banyan tree (*Ficus bengalensis*), with its numerous trunks or roots penetrating the ground from its limbs, is frequently found. (Pl. XVII, fig. 2.) Several enormous trees are found in Honolulu. Among the largest may be mentioned the one in Governor Cleghorn's yard, the late home of Princess Kiolani. Several species of eucalyptus are grown, constituting the chief trees in the lately-planted forest between Punch Bowl and Tantalus. These, according to the island authorities, will in time furnish timber for piles, railroad ties, bridges, fence posts, telegraph poles, boat building, wagons, wheelwrights' work, and agricultural implements.

Monterey cypress (*Cupressus macrocarpa*) is occasionally planted.

Arbor vitæ (*Thuja orientalis*) is found growing in the Nuwana Cemetery in Honolulu. These are the only conifers found by the writer growing on the islands.

The following list of plants bearing seeds in the neighborhood of Honolulu has been kindly furnished by Prof. A. Koebele:

Plants bearing seeds in the neighborhood of Honolulu.

<i>Abrus precatorius.</i>	<i>Eucalyptus robusta.</i>
<i>Aleurites moluccana</i> (Kukui).	<i>Eugenia jambolana.</i>
<i>Acacia koa.</i>	<i>Eugenia malaccensis.</i>
<i>Adenantha parviflora.</i>	<i>Eugenia michelii.</i>
<i>Achras sapota.</i>	<i>Fourcroya gigantea.</i>
<i>Anacardium occidentale.</i>	<i>Guazuma tomentosa.</i>
<i>Anona cherimolia.</i>	<i>Grevillea robusta.</i>
<i>Anona muricata.</i>	<i>Hibiscus populnea.</i>
<i>Anona squamosa.</i>	<i>Mammea americana.</i>
<i>Barringtonia speciosa.</i>	<i>Macadamia ternifolia.</i>
<i>Berrya ammonilla.</i>	<i>Mangifera indica.</i>
<i>Bombax ceiba.</i>	<i>Melia azedarach</i> (pride of India).
<i>Bauhinia</i> sps.	<i>Murraya exotica.</i>
<i>Bixa crellana.</i>	<i>Nephelium litchi.</i>
<i>Brachycton acerifolium.</i>	<i>Nephelium longana.</i>
<i>Casalpinia pulcherrima.</i>	<i>Nerium oleander</i> (from seed or cuttings).
<i>Casalpinia sappan.</i>	<i>Parkia africana.</i>
<i>Calophyllum inophyllum.</i>	<i>Persea gratissima.</i>
<i>Carica papaya.</i>	<i>Phyllanthus rosea pictus</i> (root cuttings).
<i>Casuarina equisetifolia.</i>	<i>Pithecolobium saman.</i>
<i>Cassia fistula.</i>	<i>Plumieria</i> (from cuttings).
<i>Cassia grandis.</i>	<i>Poinciana regia.</i>
<i>Cassia nodosa.</i>	<i>Punica granatum.</i>
<i>Cinamomum zeylanicum.</i>	<i>Ricinus communis.</i>
<i>Cinamomum camphora.</i>	<i>Sapindus</i> spp.
<i>Coffea arabica.</i>	<i>Spondias dulcis.</i>
<i>Coffea liberica.</i>	<i>Schinus molle.</i>
<i>Cordia subcordata</i> (Koa).	<i>Tanarindus indica.</i>
<i>Croton</i> (about 100 species may be procured by cuttings).	<i>Tecoma stans.</i>
<i>Duranta plumieri.</i>	<i>Tectonia grandis.</i>
<i>Duranta plumieri</i> alba.	<i>Terminalia catappa.</i>
<i>Eriobotrya japonica</i> (Loquat).	<i>Thevetia nerifolia.</i>
<i>Eucalyptus citriodora.</i>	<i>Saraca indica.</i>

Palms of the Hawaiian Islands.

[Those marked with asterisk (*) bear seeds.]

* <i>Areca rubra.</i>	<i>Chamærops excelsa.</i>
<i>Areca alba</i>	<i>Chamærops humilis.</i>
<i>Areca catechu.</i>	<i>Chamærops elongata.</i>
<i>Areca monostachya.</i>	<i>Chamædorea elegans.</i>
* <i>Arenga saccharifera.</i>	* <i>Cocos nucifera.</i>
* <i>Caryota urens.</i>	<i>Cocos romanzoffiana.</i>
<i>Caryota obtusa.</i>	<i>Cocos plumosa.</i>
<i>Caryota cumingii.</i>	<i>Cocos blumenaria.</i>

- Cocos gærtnerii.*
Cocos campestris.
Cocos bornettii.
Cocos australis.
Cocos flexuosa.
Corypha australis.
Corypha umbraculifera.
Dæmonerops marginatus.
Diplotheñicum martimum.
 **Elæis guineensis.*
Hyphæne thebaica.
 **Hyophorbe americanaulis.*
 **Kentia fosteriana.*
Kentia belmoriana.
Kentia baueri.
Kentia canterburiana.
Kentia exhorrhiza.
Kentia sapida.
 **Lantania glaucophylla.*
Lantania loddigesii.
Lantania barbonica.
Livistonia subglobosa.
Livistonia rotundifolia.
 **Macarimiliana panamensis.*
 **Oreodoxa regia.*
 **Oreodoxa oleracea.*
 **Pritchardia gaudichaudii.*
 **Pritchardia martii.*
 **Pritchardia filifera.*
 **Ptychosperma alexandrae.*
 **Phytalephas macrocarpa.*
 **Phoenix canariensis.*
 **Phoenix dactylifera.*
Phoenix reclinata.
Phoenix tenuis.
Phoenix leonensis.
Phoenix rubicola.
Rhapis flabelliformis.
 **Sabal blackburniana.*
Sabal umbraculifera.
 **Sabal adansonii.*
Sabal palmeto.
Sagrus vitiensis.
 **Thrinax argentea.*
Verschaffeltia splendida.
 **Cycas revoluta.*
 **Cycas media.*
Macrozamia denisonii.
Macrozamia miquelii.
Macrozamia plumosa.
Macrozamia spiralis.
Macrozamia corallipes.
Macrozamia cylindrica.
Macrozamia douglassii.
Borenia spectabilis.
Carludovica planata.
 **Pandanus odoratissimus.*
 **Pandanus candelabrum.*
Pandanus utilis.
Pandanus javanicus.

MISCELLANEOUS PLANTS AND SHRUBS.

Of these, some may be classed as weeds, and some as highly useful plants. Among the former may be mentioned the *Lantana camara*, which was introduced in 1859 and soon escaped cultivation. The birds scatter the seeds everywhere, with the disastrous result of covering every vacant field and lot with a dense growth of this plant. The flowers vary in color from light yellow through the reds and into purple. This plant is frequently grown in hothouses in the South. In Hawaii it is a great nuisance.

Opuntia tuna, cactus, one of the cochineal feeding species, is found growing to a very large size, especially on the lower portions of the islands. The fruit is not unpleasant, though difficult to handle on account of its prickles. Two kinds are recognized, one bearing white and the other red flowers. The leaves of the latter are eaten by cattle for the water they contain.

Canna indica, Indian shot, was introduced at an early day and has now spread very extensively over the islands. Two varieties occur, one with red speckled and the other with yellow flowers.



FIG. 1.—BOUGAINVILLEA; ROYAL PALM ON LEFT.



FIG. 2.—BANYAN TREE (FICUS BENGALENSIS).



FIG. 1.—SUGAR CANE IN BLOOM.



FIG. 2.—SUGAR MILL, WAILUKO.

The century plant (*Agave americana*) may be regarded as thoroughly naturalized.

The dill of our gardens (*Peucedanum graveolens*), an early introduction, has become a common weed.

Bambusa vulgaris, the bamboo from China, called by the natives Ohe, is used by them only for fishing poles and outriggers for canoes, while in other countries it has a wide range in the building and furnishing of houses and in the manufacture of tools and other articles of trade. It is both cultivated and wild in the low valleys of the island of Oahu.

Of water plants the following may be mentioned: *Nelumbium speciosum*, the lotus (Pl. XV, fig. 2), which is found in ponds in Honolulu, and *Nasturtium officinale*, the common watercress, which fills the water courses in the neighborhood of Honolulu and elsewhere, but rarely flowers.

Among useful plants were found:

Bixa orellana, a low tree 10 to 12 feet high which was formerly cultivated for its red dye obtained from the seed pulp by maceration. It is the Arnotto or Kocou tree, which furnishes the oil of arnotto for coloring butter. It is thoroughly naturalized on the islands.

Indigofera anil was introduced in 1836 from Java by Dr. Serriere, who manufactured a good quality of indigo from it. This plant is now preferably cultivated to other species of indigo.

Manihot utilissima, which is used for making tapioca starch, is both cultivated and wild. So, too, with the Japanese wax plant *Stillingia sebifera*.

Abrus precatorius, known as prayer beads, has escaped cultivation and is now found wild. Its shining scarlet seed with a black spot at base are strung into beads by the natives.

Night blooming cereus (*Cereus triangularis*), a plant so highly prized in hothouse culture in this country and whose blooming becomes a neighborhood event of importance, is perfectly at home on the islands. It is grown extensively upon stone fences, giving the semblance of an evergreen hedge. It blooms every three or four weeks throughout the summer. At Oahu College, just outside of Honolulu, is a hedge over 200 yards in length on which thousands of blooms occur at one time.

Nicotiana tabacum.—Tobacco has been cultivated by the natives from early time. It thrives well and yields a weed of good flavor, but excessively strong. It is said to contain an excess of nicotine. The native cigars and tobacco are not of high grade, though perhaps improved culture, curing, and fermenting might modify the tobacco into a very acceptable quality. Experiments with Havana and Sumatra varieties by learned experts might demonstrate results different

from those heretofore obtained and start a profitable tobacco industry on the islands.

Peanuts (*Arachis hypogea*) are said to grow to perfection on the islands, and yet, strange to record, large quantities are annually imported for eating purposes. Some varieties mature in five months, thus permitting the growth of two crops a year on the same soil. Besides being extensively eaten, the nut yields an oil but little inferior to the best olive oil. It is recorded that salads made with this oil will keep several days longer than those made with olive oil. Vegetable oils are largely displacing animal fats, and since the oil from this plant is used for lamp, kitchen, table, and in the manufacture of soap and chocolate, there are no valid reasons why an extensive industry in the growth of peanuts and manufacture into oil should not spring up on the islands in the near future. It is as easy to raise as ordinary vegetables, and yields from 20 to 60 bushels of nuts per acre.

Ricinus communis, the castor oil plant, was early introduced and is now common in waste places. It grows well on the islands, and numerous successful attempts on a small scale have been made to extract an oil from the seed. Mr. C. Koelling has established a plantation and mill at Kaneohe, Oahu, and has manufactured an oil which has been pronounced by local druggists as a good commercial article. His first planting of 20 acres in 1898 was not a success. The plants came up and grew well, but when they began to bear, all at once they wilted and decayed. Better land was selected and fresh plantings made with excellent success. The first crop was harvested and manufactured into oil in 1899. He is increasing the area in this plant annually. The machinery in the mill is of the most improved kind. He is planting an improved variety of beans.

FIBER PLANTS.

Sisal hemp (*Agave sisalana*) is attracting considerable attention on the island of Oahu. In the Waianae district, the Hawaiian Fiber Company has planted several hundred acres in this plant and will continue planting until 1,000 acres are in cultivation, when it will go into the manufacturing of fiber. It is expected to yield at least 600 pounds fiber per acre. The plant can be grown on rocky, barren lands unfit for general agriculture, and as there are large areas of these lands now worthless which can be utilized for the growth of this plant, the outcome of the experiment now being made by the Hawaiian Fiber Company is watched with considerable interest by the owners of these soils.

Sansevieria zeylanica, bowstring hemp, has been experimented with on the islands, but the results are not known to the writer. It is peculiarly adapted to small cultivators. Five acres planted in good

moist land would yield a good livelihood for a small family. It yields a crop every year for ten years. Allusion has been made elsewhere to the combined culture of this plant with coffee.

Ramie, described elsewhere, can be grown anywhere in the moist regions almost without cultivation, as well as in the arid regions with irrigation. It could be grown abundantly and profitably if a machine for decorticating its fiber were available.

Musa textilis, manila hemp, has already been described under the head of bananas.

New Zealand hemp (*Phormium tenax*) has been introduced and cultivated to a limited extent only. So far no definite results have been obtained.

Cotton, either the upland or sea island, could certainly find a congenial home amid such a diversity of climate, altitude, and rainfall. If any experiments have been made with this plant, the writer has failed to hear of them, but his individual conviction, based upon a knowledge of the plant and a study of the conditions prevailing on the islands, is that abundant crops of excellent staple could be profitably grown.

TANNINS.

Many of the trees on the islands produce tannic acid in quantity to justify extraction. When one considers the fact that the hides of animals killed on the islands are shipped to other countries for tanning into leather and this leather utilized for shoes, harness, etc., the question naturally arises, Why not tan these hides at home? It is certainly not for the want of tannin. Numerous species of acacia furnish tannic acid, conspicuous among which is the black wattle (*Acacia decurrens*), whose bark is extremely rich in this ingredient, being superior to that of the English oak. The tree grows well on the dry ridges, attaining a height of 20 to 25 feet in five years. A peculiarity of this plant is to send up shoots from its roots as soon as the tree is cut down. By cutting down the tree and utilizing the bark from its stem and limbs, a good firewood is left. Shoots from the roots of trees thus removed will in five years reach a size which will permit of another cutting. Hence a forest of black wattle will, if care be taken, supply tannin for an indefinite time. With the hides, and an abundance of tanning material, there is no reason for exporting the raw hides. A large number of these trees are now growing successfully on the dry ridges of Mahiki forest near Honolulu. There is another species, *A. dealbata*, which is called silver wattle, that has also been planted in the Mahiki forest. Besides furnishing bark for tanning, its wood is highly esteemed by coopers and carpenters. It also has great heating power, and therefore ranks high as fuel. It grows faster than any tree on the islands.

The carob (*Ceratonia siliqua*), called also St. John's bread, has been successfully introduced and promises future usefulness. It grows well in dry soil, and its pods possess much nutriment. In the island of Crete over 180,000 tons of these pods are annually exported. A large portion of the rocky ridges of the island might be profitably planted with this tree.

COFFEE (*Coffea arabica*).

Coffee has become well naturalized in many places on the islands of Hawaii, Kauai, Maui, and Oahu. It was first introduced in 1823 by Mr. Marin, who established a small plantation on the island of Oahu. It was again introduced by Lord Byron in 1825, from Rio Janciro. Its cultivation soon spread over the above-mentioned islands until a large number of plantations were established (mainly on Kauai and Hawaii) which promised excellent results. But the coffee blight, due to a woolly coccus, suddenly made its appearance after the rainless winter of 1855 and 1856 and gave a decided check to the expanding industry. From the punctures of this insect exuded a sweet gummy substance which furnished a nidus for the spores of a black fungus, patches of which soon appearing upon the leaf and stem impedes respiration and destroys the vigor of the plant. The rains drive the insects in colonies from the plant to its roots under the ground, where they remain until dry weather, when they are again borne to the leaves by a small red ant.

A few years after the appearance of this insect many plantations were cut down and planted in sugar cane. The insect disappeared and the blight abated. A fresh impetus was given to the reestablishment of plantations, which reached fair proportions and were yielding profitable results until the recent low price of coffee and the comparative high value of sugar suspended further planting and even induced many to plow up their coffee bushes and plant their lands in sugar cane. The plant is, however, a decided success on the islands, the trees attaining early maturity and bearing heavy crops. (Pl. XI, fig. 1.) Coffee is grown on the four larger islands, but production has reached a commercial basis only on Hawaii, where there are four main districts, viz, Puna, Oloo, Kona, and Hamakua. It is impossible to ascertain the exact acreage now under cultivation or the amount and value of the annual crop produced. It is estimated that at least 15,000 to 20,000 acres are now under cultivation. The coffees consumed on the islands are chiefly home grown, and therefore the amount exported represents an uncertain part of production. The exports for 1897 were over 337,158 pounds, valued at \$100,000.

The coffee tree requires about four years to reach maturity and produce profitable crops. (Pl. XX, fig. 2.) Had not whole acres been



FIG. 1.—EWA PLANTATION PUMPING STATION.



FIG. 2.—RAILROAD ON EWA SUGAR PLANTATION.



FIG. 1.—PLANTING CANE.



FIG. 2.—COFFEE PLANTATION.

uprooted and replanted in the more remunerative sugar cane, the total crop at present would be larger than that of 1897, since many young trees were then not bearing. The crop of 1899 was the largest on record, but low prices caused by overproduction have shorn it of profit. The industry is in the hands of men from many countries—the German, Portuguese, American, English, Chinese, and Japanese. Plantations were inaugurated mainly by Anglo-Saxons, but some of them have been abandoned for the dominant industry of the islands—sugar. The Portuguese and Japanese have occupied some of them and are now the chief laborers in the coffee fields.

Some coffee planters have been and are now successful. Others have failed. The causes of failure are lack of capital to carry a plantation to the bearing age, and want of experience and intelligence in the cultivation of this crop. Just here it may be remarked that coffee under proper conditions has never received scientific assistance, and hence a most important and worthy field for investigation by the experiment station soon to be established on these islands.

It is asserted that natural conditions of soil, elevation, and climate justify the prevailing opinion that coffee growing can be made a permanent profitable industry of the islands. Whether this industry will be developed in the future, along large plantation lines as in other tropical countries, or upon small farms with other crops, is yet uncertain. Experience has taught the wisdom of large plantations, enjoying a steady supply of labor, and providing the best mechanical devices for cleaning and grading. But the cotton, sugar, and rice plantations are rapidly giving way to the cotton, sugar, and rice farms with neighborhood central gins, mills, and factories owned by corporations of capital, which will buy or work the entire products of the farms and convert them into merchantable forms. This has been largely accomplished in the cotton, sugar, and rice districts of Louisiana, and I see no reason why a similar course can not be pursued in the coffee industry. In fact, thorough study of the conditions prevailing in Hawaii force us to the conclusion that the fullest development of this industry can best be obtained by disintegration and division of the prevailing large coffee plantations into small farms, each owned and cultivated by an intelligent farmer, and with an independent central mill in each section to prepare the berries for market, at which the products of each farm can be handled, either by direct purchase or a regular charge for cleaning and grading.

Since the altitude for coffee planting begins where sugar cane ceases to be profitable, it has been suggested that a combination of the two industries might be feasible. The labor required by the latter might at times be profitably spared for the former. There are several successful examples of this union which would indicate the truth of this suggestion.

The coffee of the islands has a marked flavor and aroma, and pure Kona is said to be superior in every way to Mocha, or Old Government Java, and selected samples sold abroad have brought prices which attest its high quality. It is therefore expedient to establish an intelligent culture of this berry in order that this deserved reputation may be maintained.

It is not to be understood that enormous areas with large volumes of shipments can be had in Hawaii. The lands suitable to coffee culture, like those adapted to sugar, are exceedingly restricted in area, and hence, at the best, only limited quantities can be produced. But the present area and output can be largely increased, and it is the part of wisdom of the economists of this country to determine how this can best be accomplished.

It is a matter of regret that the interest in coffee growing has greatly decreased in the last few years. The low price of coffee everywhere, together with the scanty and high value of labor, have checked the usual annual plantings, and now attention is paid to the bearing trees only. The area under cultivation instead of being extended is being decreased rapidly by the transferring of many of the Oloa coffee plantations into vast sugar estates.

When sugar falls in value and coffee returns to its usual price, then perhaps another and more permanent impetus will be given this industry. The commissioner of agriculture for the islands has recently introduced and disseminated over the islands a large number of Liberian coffee plants, which are said to be blight proof. However, the danger of blight is now reduced to a minimum, due to the introduction of parasites which have destroyed the insects causing the disease. This is one of the many beneficial acts of that devoted scientist, Prof. A. Koebele, entomologist of the islands. In the cultivation of coffee a large supply of labor is required at picking time, which lasts only three to four months. The rest of the year a very small force is needed. It is therefore recommended that the coffee farmer should also engage in the cultivation of other crops in order to profitably utilize the year round the labor required for harvesting the coffee. Experiments are being made to combine with coffee the cultivation of tea, sisal hemp, bowstring hemp, and other plants. Allusion has already been made to the combination of sugar and coffee culture.

Tea (*Thea chinensis*) has been tried and the plants are reported to have grown well, making vigorous, well-leaved shrubs. It is hardly expected that the unskilled labor of the islands would understand the proper curing of its leaves. The writer is not definitely informed as to the attempts made to produce a merchantable article.

Theobroma cacao, cacao (chocolate), was introduced by the commissioner of agriculture in 1894, from Ceylon, and planted in the government nursery. Several varieties were introduced. Although they

grew well, the writer has not heard of any commercial attempt at growing this plant, though promises of remunerative employment were made to the growers in the moist districts of Hawaii. At the same time and in the same way the following plants were introduced: Camphor (*Cumphora officinalis*), producing camphor gum; (*Manihot glaziovii*) Para rubber, one of the best rubber-producing trees, and adapted to open forests; cardamom spice (*Elettaria cardamomum*), producing the highest-priced spice and adapted to elevations of 400 to 2,500 feet, and nutmegs (*Myristica fragrans*), suited to the moist climate of Hilo, Puna, and Kona districts of the island of Hawaii.

SUGAR.

The dominant crop of Hawaii is sugar. Everybody is interested in it directly or indirectly. It dwarfs and belittles every other agricultural crop grown upon soils capable of yielding sugar cane. Every attempt hitherto to establish a colony of farmers in one community has eventuated in a sugar estate. As long as the present prices of sugar are maintained it is extremely doubtful whether farming as practiced in the States will ever become permanent or popular on the islands. Wherever diversified farming can be carried on, there, perhaps, sugar cane can be grown at a greater profit than most any other crop; and as there are mills in almost every part of the main islands which are ready and anxious to buy cane, the farmer is more than apt, on account of greater profit, to gradually gravitate to the exclusive cultivation of this crop. Few places in the island where cane can be grown at all will yield less than 30 to 40 tons per acre. The present price of cane per ton is \$5 to \$6, thus yielding a gross income of \$150 to \$240 per acre. Even deducting expenses of growing and harvesting, there will be left a net income per acre hardly possible to be obtained by any ordinary farm crop.

As mentioned elsewhere, large portions of the Oloa coffee plantations have been transformed into sugar estates since the decline in the price of coffee.

Sugar culture began on the islands over sixty years ago. In 1850 the product of sugar per acre, with the crude wooden and stone mills and inferior kettles, was not over 1 ton per acre. In 1880 the total crop of the islands was reported at only 30,000 tons. The sugar industry was given a tremendous impetus by the reciprocity treaty with the United States in 1875, by which all raw sugars were admitted free of duty. The industry moved forward by almost "leaps and bounds" after the ratification of this treaty. It was seriously depressed by the passage of the bill which permitted all raw sugars to be imported free of duty into the United States and gave a bounty upon domestic sugars. It was claimed by some that under the reciprocity treaty the United States ought to have paid the bounty to the Hawaiian

planters. It rallied again upon the removal of the bounty and the reestablishment of a duty. The passage of the Dingley bill was extremely fortunate for this industry, since which time it has enjoyed a period of unprecedented prosperity. Immense improvements have been made, consisting of up-to-date capacious machinery in the sugar house, steam plows and harrows in the field, enormous pumping plants for irrigation, etc. Annexation, which increased the confidence of the public in the future of the industry and gave higher values to plantation stock, has also caused a considerable increase in the price of labor, the latter being the largest factor which enters into the expense of making sugar. Sugar is cultivated on the islands of Hawaii, Kauai, Maui, and Oahu, at elevations of from 20 to 2,000 feet. The table lands surrounding the islands at elevations of from 20 to 500 feet constitute the chief sugar areas. Nearly every acre adapted to cane culture on these four islands is under cultivation, and the probability of a much larger extension of the industry is small. In the efforts to obtain the large profits now incident to sugar culture, extensive estates have been recently opened, cultivated, and irrigated. An experience of two years has proved that on some estates irrigation water is too salty for sugar cane, and hence these estates had to be closed, and all prospects of growing sugar thereon abandoned. There are about 60 plantations on the islands, which yielded in 1898-99 about 300,000 tons of sugar. These plantations have about 100,000 acres in cane, one-half of which is harvested every year. The yield per acre varies greatly, according to character of the soil, position of the plantation on the island, whether in the rainy or rainless belts, etc. Under irrigation as much as 10 $\frac{1}{4}$ tons sugar per acre has been the average of one plantation. Individual acres have given much higher yields. Upon the rainy side of the islands the yields are less, but so are the expenses, and the net gains from each do not vary much. The following, taken from the books of the company, has been kindly furnished me by Mr. Geo. F. Rendon, manager of Ewa Plantation, Oahu:

Expenses per ton of sugar grown and per acre.

Plant cane.	Per ton.	Per acre.
Clearing	\$0.54	\$5.51
Mule and steam plowing	1.41	14.50
Ditches .....	.20	2.05
Cutting and hauling seed .....	.80	8.22
Preparing and planting .....	.88	9.04
Fertilizing	4.01	41.13
Watering	3.63	37.18
Hoeing and weeding .....	.76	7.85
Stripping	1.49	15.25
Cutting and hauling cane	3.48	35.62
Pumping expense	2.42	24.84
Sundry accounts (rent, interest, and all other expenses)	5.33	54.63
Manufacture	2.65	27.15
Containers .....	.99	9.77
Total	28.59	292.74

Planting from August 10 to November 27, 1897. Grinding from February 1 to August 25, 1899.



FIG. 1.—SCREW PINE OR "HALA" (*PANDANUS ODORATISSIMUS*).



FIG. 2.—HEREFORD CATTLE, LOW'S RANCH.



FIG. 1.—HANALEI VALLEY.



FIG. 2.—PUNCH BOWL; EXPERIMENT SITE IN FOREGROUND.

Plant cane:

Total yield of cane.....	tons..	117, 835
Yield of cane per acre.....	do...	78. 9
Purity of juice.....	per cent..	87. 07
Amount of cane required to produce 1 ton of sugar.....	tons..	7. 71
Total production of sugar.....	do...	15, 289. 5
Yield sugar per acre.....	do...	10. 24

Mr. Rendon, in an accompanying letter, says:

Since these figures were made up, however, you will of course understand that wages have materially increased in these islands. To get at present conditions you would probably have to add 25 per cent to the figures given in the statement.

Apropos of the Ewa Plantation, it may be mentioned that it has eight enormous pumping plants (Pl. XIX, fig. 1) costing \$1,750,000, which supply 75,000,000 gallons per day of irrigation water to the fields (about 5,000 acres); 29 miles of railroad track, with necessary cars, engines, etc. (Pl. XIX, fig. 2); a splendidly equipped sugarhouse, and nearly \$100,000 invested in farming implements, mainly steam plows, harrows, etc.

On the leeward side of the islands, where irrigation is practiced, the land is broken with steam plows to a great depth. Rows are laid off at 5-foot intervals with very deep double-mold-board plows. Into these deep furrows the tops of the cane are dropped in a continuous row, the soil is drawn in lightly with hoes, and a shallow stream of water sent over the buried tops. (Pl. XX, fig. 1.) In six to seven days a continuous stand of young canes is obtained. For the purpose of economizing water the rows are laid off as nearly on a level as possible, and an open furrow for irrigating is maintained during growth. After each irrigation hoes draw in from the adjoining ridges small quantities of soil in order to conserve the moisture applied. Save irrigation, and its incident hoe work and the trashing of cane, no other cultivation is given. A contract is usually made with a head Chinaman to irrigate and trash the cane from planting to harvest at so much per ton of cane harvested. The contract is usually for 100 acres, the company furnishing the water. Contracts are also made by the ton for the cutting and delivery of the cane at the sugarhouse, the company furnishing the cars and engines. The breaking of the land and the planting of the cane is usually done with hired labor.

On the rainy or windward side of the islands the conditions require entirely different methods from those just described. The lands are broken in a similar manner but less deeply, and the tops are planted in an open furrow and covered. When the plants are large enough, the work of cultivation begins, which is usually done with plows, cultivators, and hoes. This cultivation is continued until the canes are sufficiently advanced to "lay by." Every operation is similar to the best practice in the cornfields of the West. Here reliance is placed

entirely upon the rainfall for furnishing the needed moisture to canes. Sometimes the rainfall is excessive, at others deficient. Severe and protracted droughts which occasion great loss to the planters occur at rare intervals. As a rule, however, the rainfall is ample for good crops, and the extra expense of irrigation is avoided. Hence, frequently the windward plantations are just as good dividend payers as the leeward estates, though the yields per acre are much less. Trashing of cane is practised here as on the leeward side. In both instances the dead leaves are piled up between the rows, where they remain until after harvest, when they are burned. "Ratooning" or "stubbling" is not largely practised. Only first year ratoons or stubbles are cultivated. Whenever in the judgment of the manager these will not produce 30 tons of cane per acre, they are plowed up and the land replanted. Just here is one of the secrets of the large success attending sugar growing on these islands. Two-thirds, if not three-fourths, of the area each year is in plant cane. In Cuba, Porto Rico, and other tropical islands cane is permitted to run for six to even sixteen years, with the unavoidable result of annually diminished acre yields, and a low average sugar output. Sugar planters elsewhere are disposed to doubt the accuracy of the large published yields of Hawaii. Let them consider their own enormous yields from plant cane, and then apply such results to their entire plantations before they begin to question outputs obtained in these islands. It is true that irrigation upon fresh lands, upon the warmer leeward sides, in a climate almost perfect for maximum growth, has greatly increased the average output of Hawaii, but the carrying of the largest portion of the crop as plant cane, is unquestionably the main cause of the large yields. This is evidenced by the yield obtained on the rainy or windward side of the islands, which are much larger than those obtained in Cuba and other tropical countries, even though much below the returns of the irrigated plantations on the lee side of the same islands.

The cane when harvested is delivered to the sugar mills (Pl. XVIII, fig. 2) by wagons drawn by oxen or mules, by rail, with horses or steam, by water flumes sometimes crossing deep gulches, and by trolleys. Plantations use either one of the above methods, to suit their peculiar environments.

THE DISTRIBUTION OF VALUABLE PLANTS.

The commissioner of agriculture for the islands is sending out annually from the Botanical Gardens an enormous number of different varieties of plants and trees, covering both the useful and the ornamental, to the citizens of the islands. In this way new plants are being introduced and tried.

In the last year the following have been distributed in large numbers:
Fruits.—Papaia, *Carica papaya*; Avocado pear, *Persca gratissima*;

sour sop, *Anona muricata*; Tahiti vi, *Spondias dulcis*; lime, *Citrus limetta*; pomegranate, *Punica granatum*; Java plum, *Eugenia jambolana*; strawberry guava, *Psidium cattleianum*; Sapodilla plum, *Achras sapota*; Granadilla, *Passiflora alata*; and coffee, *Coffea liberica*.

Palms.—*Latania barbonica*, *L. glaucophylla*, *Livistona rotundifolia*, *Ptychosperma alexandrie*, *Seaforthia elegans*, *Pritchardia gaudichaudii*, *Oreodoxa regia* (royal palm), *Phoenix dactylifera* (date palm), *Thrinax argentea*, *Sabal blackburniana*, *Areca alba*, *Brahea filamentososa*, *Areca rubra*, *Eleis guinensis*, *Cocos plumosa*, and *Hyophorbe americana*.

Timber, shade, and ornamental trees.—Eucalyptus, several varieties; *Grevillea robusta*; Casuarina, several species; *Prosopis dulcis* (algaroba); *Acacia melanoxylon*; Bauhinia, several species; *Macadamia ternifolia* (Queensland nut); *Cesalpinia haematoxylon* (logwood); *Cupressus macrocarpa* (Monterey cypress); *Poinciana regia*; *Schinus molle* (pepper tree); *Sterculia acuminata* (red-kola nut); *Camphora officinalis* (camphor tree); *Theobroma cacao* (chocolate tree); *Hibiscus populneus*; *Cassia fistula* (golden shower); *Ceratoniu siliqua* (carob bean); *Phyllanthus*; *Thevetia nerifolia*; and Crotons, several species.

Vines.—Vanilla, *Aristolochia siphon* (Dutchman's pipe); *Physianthus albens* (cruel plant); *Piper nigrum* (black pepper); Clerodendron, and Ylang Ylang.

In addition to the above, plants of the following (new) varieties were sent for experimental purposes to responsible persons throughout the islands: Olives, mulberries, peach, pear, camphor, pineapple, and Para rubber (*Hevea brasiliensis*).

In 1898 the commissioner of agriculture imported among others the following plants: *Croton tiglium* (croton oil plant), *Sterculia acuminata* (kola nut), *Garcinia mangostana* (mangosteene), *Erythrina lithosperma* (for coffee shade).

FRUIT AND VEGETABLE GROWING.

The following letters from Governor Sanford B. Dole and Mr. Franz Buchholtz, of south Kona, Hawaii, give descriptions of the varieties of fruit, vegetables, etc., which are grown on the island of Hawaii:

PUUWAAWAA, KONA, HAWAII, August 12, 1900.

DEAR MR. STUBBS: While on this island I visited Mr. Buchholtz, a coffee planter of the extreme southern part of south Kona. His house is on the government road at that place, at an elevation of perhaps 1,500 feet above the sea. His plantation is from the road running up the slope. The soil is among broken lava and generally washed below the surface of the ground, which is composed almost entirely of broken black lava from the size of a walnut to that of an apple or larger.

Mr. Buchholtz has had scientific training in agriculture in some German institution and is always experimenting in fruits, vegetables, and grasses; in fact, he is conducting a private experimental station which I deem to be of great importance, and as

he keeps careful accounts and records of each experiment, his experience is available through his courtesy to the public.

I found growing on his place coffee, figs, grapes, fruit trees (of the United States), pineapples, cocoa, carob trees (St. John's bread), mango, papaia, water lemon vine, and a good variety of roses and other garden flowers. All of these were growing vigorously, and the coffee, fig, grape, mango, papaia, apple, pineapple, and water lemon, were bearing fruit. The plantation is surrounded by native forest.

At my request Mr. Buchholtz has kindly consented to prepare a statement of his experiments for you, which I will forward as soon as I receive it. In north Kona, at the place of Mr. Coerper, also a German, I picked and ate fine apples from his trees. He has abundant crops every year, though his trees are as yet young and small.

North and south Kona stretch for 60 miles or more under the lee of the great mountains of Hawaii, which effectually shut off the trade winds from these districts. In place of them they have land breezes at night and sea breezes by day, both of which are little more than zephyrs. Sometimes the sea breeze is augmented by an eddy of the trade wind, and then blows with more force and from a more northerly direction. This region is made up almost entirely of lava flows, some of them very ancient, so that considerable soil has formed both from the decomposition of lava and the contribution of vegetable growth. The rainfall throughout the year is perhaps more evenly distributed than is the case in any other part of the islands. The soil is rich and fine.

For these reasons the Konas are probably the most suitable part of the islands for the production of fruit and perhaps tobacco, though the soil may be too rich for the production of a good quality of the latter. Tobacco grows wild here as well as in other parts of the islands.

I am now at Mr. Low's ranch house, over 2,700 feet elevation, on the slope of Hualalia. The ranch is all lava flows and contains extensive forests of a large variety of trees, and produces first-class pasturage of a considerable variety of grasses and other herbage. Alfalfa, rye grass, and blue grass have been successfully introduced and stand cropping. There is no water, and the stock eat enough while the dew is on the grass to supply their wants. At the ranch house and a few hundred feet higher up in elevation, Mr. Low has planted a variety of northern fruits, and budded oranges and olives. All are doing well—the apples are beginning to bear, and also the olives, one variety of the latter being covered with flower buds. Figs do well here.

The native forests on the ranch are dying. The cause is doubtful. I have examined with Mr. Low a number of trees. We have found six or seven kinds of borers, bugs, and worms in the (dying) trees, but have not found any in healthy, growing wood. Whether these pests cause the destruction or only follow on its heels, I do not know, but am inclined to the latter theory. I shall try to have Mr. Koebele come here and investigate. Mr. Low will prepare a paper, as requested by you, which will be forwarded to your address.

In regard to the subjects of inquiry set forth in your letter of instruction from Washington, I would say as to the first point—leaving out the consideration of sugar, rice, and coffee—nearly all edible vegetables of good quality can be produced from the sea level to over 2,000 feet elevation; some doing better low down and others high up. Certain vegetables, like cauliflower and celery, seem to require the cooler climate of elevated places.

Maize grows to perfection from the sea level to over 2,000 feet elevation. The same is true of the majority of forage plants. Wheat, oats, and barley do well, but the wheat product is of too poor quality to compete with imported flour. None of these grains are cultivated at the present time, except perhaps in a small way, as forage.

Hay can be easily raised, but owing to the liability of rain in the localities where

it can be grown, it is liable to be spoiled in the curing process. There are some localities where it could be safely cured if it could be raised with the assistance of irrigation. Irrigation, however, is too valuable in the raising of more profitable crops, such as sugar and rice, to allow it to be used in growing hay. Experiments already made would justify the belief that nearly all of foreign grasses will do well over a wide range of elevation and will stand grazing.

Of the fruits of temperate climates, it is fairly well established that apples and some of the berries will thrive and bear at the right elevations. I do not think that this is settled as to other Northern fruits, although pears have been known to produce fruit. The peaches that can be successfully produced are an oriental variety, which has been cultivated here for fifty years, and the Ceylon peach, which has been brought from Florida and cultivated for perhaps ten years.

It has been found difficult to raise some of the tropical fruits in these islands, especially those which belong to such extremely tropical regions as Java, Sumatra, and similar localities; yet both the durian and the mangosteen have been produced on the island of Kauai, the trees, as I understand producing regular annual crops.

Native fruits are limited as to kinds.- The banana stands at the head as to importance, with several well-marked varieties. It is easily raised and is delicious for eating, both raw and cooked. The banana used for export is an exotic, generally called the Chinese banana. It bears large bunches on low plants so well provided with roots that neither the weight of the bunch nor high winds will prostrate it, whereas the indigenous varieties are easily blown over. The Chinese banana ripens well if cut green, and is suitable for cooking.

Except the banana, little has been done in the way of raising fruit for profit. The natives in Kona raise quite a quantity of seedling oranges of fine quality, many of which are brought to Honolulu and sold. Little attention, however, is paid to the cultivation of oranges, and the fact that oranges of such excellent quality are produced from trees substantially in a wild state promises well for the future of the Hawaiian production of this fruit.

I am very much interested in the prospect of the establishment of an experiment station here. Such an enterprise could not fail to be of vast benefit to the small farming interests of this Territory. If such stations were located at places where they might be conveniently visited by those interested in the experimental work, the results of such work would, it seems to me, better and more forcibly reach those whom it is desired to reach than in any other way. Free monthly bulletins would be very useful and would reach many who could not often visit the stations.

Very sincerely, yours,

SANFORD B. DOLE.

BUCHHOLTZ PLANTATION, HOOPULOA, S. KONA,
Hawaii, August 28, 1900.

His Excellency Governor DOLE, *Honolulu.*

MR. GOVERNOR: There appears to be no limit as to the growth of any vegetables, fruit trees, grapes, etc., in this district; all of them do well and a great many bear fruit the whole year round. I have grown the following kinds:

Potatoes, four times in succession on the same piece of land within twelve months, at an expense of one-half cent per pound, average. I got two large and two small crops, according to the season.

Cabbage grows the whole year round, appearing to make no difference if planted in summer or winter, in spring or autumn. The cabbage grows to an enormous size, as big as 2 feet in diameter, and has the quality to ratoon. For a year in succession, after the first head is cut off, small heads spring up out of the stump which, although not as hard as the first one and of no use for market purposes, make just as fine eating. Cauliflower grows in the same manner as cabbage, and ratoons in the same way. Kohl-rabi, or turnip-rooted cabbage, once planted may remain growing for a

year or longer without becoming stringy or woody. Brussels sprouts grow well, but I can not judge how it would do, because when it just started to form the little heads my turkeys ate it up, and I had no chance to plant again. Artichokes grow much slower than the above-mentioned vegetables, which become eatable within three months, whereas artichokes do not develop in less than nine months, but they continue to deliver flower heads for four to six months. Parsley, once sown, grows forever, apparently; mine is now 4 years old. Parsnips may remain in the ground for a year or longer without becoming woody, and can be eaten within two months after planting. Celery, both the turnip rooted and the blanched, grows well. The latter, nowever, is preferable, as it is very nice and crisp all the time, whereas the first is liable to become stringy. Celery may also remain in the ground until you wish to use it, a year or longer apparently makes no difference, if properly attended to. Carrots grow the whole year round, and may also remain in the ground until needed.

Red beets, the same as above. Lima beans continue to bear and grow for over a year; have to be gathered every week after starting to bear. All other kinds of beans grow very well, maturing within three months after planting. Turnips grow all the year round, and may remain for a long time in the ground, but I am unable to tell how many months. Cucumbers grow the whole year round, and, particularly the climbing kinds, bear for a long time. Tomatoes grow the whole year round and bear, with proper attention, for years. Peas yield very small crops, but grow very quickly, and may be planted at different times of the year. Corn can be planted with success only once in a year and does not even then yield as good crops here as in other parts of the country. Onions grow very well, are of a fine quality, and very large size; may be planted any time of the year; mature in about six to seven months; can be raised at one-half cent per pound. Leeks grow very well; may remain for a year in the ground. Radishes become eatable ten days after sowing. Eggplants do as well as the rest and bear for a long time. Lettuce can be planted any time of the year; it develops very quickly. Peppers grow in profusion and bear the whole year round and for many years in succession. Watermelons do not do well at this locality (1,650 feet), but no doubt would grow very nicely lower down, where it does not rain so much. Muskmelons grow very well, but suffer greatly from a little fly. Pumpkins and squashes do very well and sometimes bear for two years. The fruit has to be gathered every month. Strawberries bear fruit all the year round, of a fine flavor. Raspberries bear fruit during perhaps six months, also of a very fine flavor. Gooseberries and currants grow rather slowly, and have so far not been in bearing; gooseberries apparently do better than the latter. Two-year-old apple trees imported last year from California are in bearing this year and yield a fine-flavored, juicy fruit. Pears grow slowly, but apparently well; walnuts, the same. Olives grow very well. Sweet almonds planted last year were in flower this year and do very well. Plums, prunes, cherries, peaches, and apricots planted last year did remarkably well, and if it had not been for the drought last winter would have been in bearing now, I presume. Oranges and limes grow rather slowly in the beginning, but do very well afterwards. Alligator pears grow well. Wine grapes bear twice in a year and do very well. Figs bear within a year after planting, and bear in abundance during four months every year after. Pineapples start bearing eighteen months after planting and bear every year regularly for years to come.

Sweet herbs, dill, lavender, majoram, sage, thyme, all do well. Peppermint grows like a weed.

Mangoes and papaias grow very well and bear a better-flavored fruit than in other places. St. John's bread and Sapodillo plum grow very well.

Of ornamental and useful trees I have planted the following, all of them growing very well: *Grevillia robusta*, ironwood, Jaceranda, date palms, cedar, acacia, kamono, bogie, *Dracena draco*, calabash tree, rubber vine, cacao, vanilla beans, camphor, castor beans.

Coffee and sugar cane grow very well here.

Wheat, barley, and oats come to maturity and bear well, but my place is too rocky to allow of plowing, and I have only experimented to find out what could be done.

Alfalfa, burr clover, red clover, white clover, Australian rye grass, orchard grass, buffalo grass, and Kentucky blue grass I have sown, and all of them do well and make fine pasture. Australian saltbush I have also tried on the rocks below with good success.

Looking the list over which I have given, it appears that almost everything a man may think of will grow in this district. All the mentioned fruits, vegetables, grasses, etc., I have grown myself and very successfully here, and anyone who cares to find out if I have reported facts may come and have a look himself.

It is my opinion that with good roads and proper transportation facilities this district of Kona has a great future, but there are a great many drawbacks which make progress here very slow. In the first case the very high steamer charges make it almost impossible to grow anything profitably, although things grow here certainly as luxuriantly and abundantly as anywhere else; second, by the commissions and profits which the Honolulu middleman insists on making. No one in Honolulu is satisfied with a profit of 20 per cent, and they do not work at less than 100 to 200 per cent. For instance, onions are never bought for less than 4 to 5 cents per pound, but the most I was offered was $1\frac{1}{2}$ to 2 cents per pound. I had the same experience with Lima beans, corn, etc., and I have therefore almost given up raising anything except for my own use.

If the United States Government would assist an interisland steamer line and compel it to charge reasonable freight rates this would be a great step in the right direction. It would also be necessary to compel the vessels of such a line to arrive and depart at stated hours, not as now, where people are compelled to wait for the steamer from twelve to twenty-four hours, the loss of time, and in consequence money, preventing farmers here from sending things to Honolulu, because all the profits they could make would be easily lost through such tremendous loss of their time.

Another thing which would greatly help to develop this district and the country generally is the starting of an experiment station, not in Honolulu, however, but right here in Kona. An experiment station in Honolulu is all right as far as sugar cane and some other tropical products are concerned, but the climate and surroundings of Honolulu are not very well adapted for experiments with any such things as I have mentioned in the foregoing list. The small farmer, however, will be compelled to raise just such things as I have mentioned in this report in order to make a living and to develop the country. If farmers could be told authoritatively not only what they could grow, but at what season and at what expense, I should say it would not be so very hard to encourage desirable people to immigrate to Hawaii and try their luck here.

I hope that the little information which I am able to give may be what your excellency expected and may prove of some use to someone here and abroad. With expressions of my highest esteem, I remain, Mr. Governor, very respectfully,

FRANZ BUCHHOLTZ.

LIVE STOCK.

CATTLE.

The growing of live stock is one of the profitable industries of the islands. Nearly all of the meat consumed on the islands is home grown, and the supply available for home consumption has up to the present time been equal to the demand. It is estimated that there are

about 120,000 head of cattle on the islands, distributed, according to Mr. E. B. Low, as follows:

Island of Hawaii.—Mr. Samuel Parker has the largest cattle ranch on the island, 400,000 acres, which are grazed by 25,000 cattle. Cattle are inferior; no effort to improve them.

Puuwaawaa Ranch, Kohala, owned by Hind and Low, has 52,000 acres, with 4,000 head of cattle. Grading up herd with Shorthorns, Herefords (Pl. XXI, fig. 2), and a few Holsteins; prefer Herefords; will "eat water" like native cattle (see p. 70).

Kukaiua Planting Company, or Horner Ranch, 40,000 acres, 5,000 head of fine cattle—Hereford, Shorthorn, and Holstein. Supplies Hilo with butter.

Mr. W. H. Shipman has a ranch of 35,000 acres, with 4,000 head of cattle. The cattle are medium in quality, but are being improved by the introduction of Herefords. His ranch is on the windward side of the island.

Kahua Ranch has 17,000 acres, and 4,000 head of common cattle, and is on the leeward side.

Puuhue Ranch has 25,000 acres, with 4,000 head of medium cattle. It is on the leeward side.

Puakea Ranch has 7,000 acres, with 1,500 head of fair cattle, which are being improved with pure-bred bulls. It is on the leeward side.

John A. McGuire has a ranch of 25,000 acres, with 4,500 head of good cattle, on the lee side. They are being improved by the use of imported bulls. Mr. J. D. Paris has 20,000 acres and 2,500 head of good cattle on his ranch, on the lee side of the island. Col. S. Norris's ranch occupies both sides of the island and contains 180,000 acres, with 7,000 head of medium cattle. Hutchinson Plantation Company has 8,000 acres, with 1,500 head of good cattle, on the windward side of the island. Kapapala Ranch, on the windward side, next to the volcano, has 60,000 acres, with 5,000 head of medium cattle. Mr. O. T. Shipman, on the same side of the island, has 5,000 acres, with 1,000 head of cattle.

Besides the above there are two or three natives with about 2,500 head on leased lands, giving a total for the island of Hawaii of about 74,000 head, on about 900,000 acres of land.

Island of Oahu.—Mr. Samuel O. Damon has a ranch on both sides of the island of 25,000 acres, with 3,000 head of good cattle, which are being improved by Angus bulls. Mr. J. J. Dousett has a ranch on lee side of 50,000 acres and 7,000 head of good cattle, also improved by Angus bulls. Oahu Rail and Land Company has 7,000 head of good cattle, improved by Shorthorn bulls, on 75,000 acres.

Besides the above, there are several small ranches containing in the aggregate about 3,000 head of medium cattle, making for this island about 20,000 head.

Island of Maui.—W. H. Cornwell has a ranch on lee side with 2,500 head of cattle. No improved bulls. Haleakala Ranch, on both sides of the island, has 3,500 head of medium cattle. Alupalakua Ranch, on the lee side, has 2,500 head of indifferent cattle. A. Enos & Co., of Kahikinui Ranch, has 5,000 head of good native cattle. No improved bulls. Smaller ranches have an aggregate of about 1,500 head.

Island of Kauai.—Mr. W. H. Rice has a ranch with 2,500 head of cattle, and other small herdsmen aggregate as many more, or 5,000 for the island.

Island of Molokai.—Molokai Ranch, owned by the American Sugar Company, has 4,000 head of inferior cattle, but has 40 pure-bred Hereford and Shorthorn bulls. The smaller ranches will aggregate 1,500 more, making a total for this island of about 5,500 head.

Island of Lanai.—Lanai Ranch has 1,000 head of medium cattle.

Island of Nihoa.—On this island are 400 to 500 improved Shorthorn cattle belonging to Gay & Robinson.

156° 00'

MAUI, MOLOKAI, AND HAWAII.

PREPARED FOR
THE HAWAIIAN DIRECTORY,
1896-97.

Ka Lae o Ka Ilio

Laaw Pt.

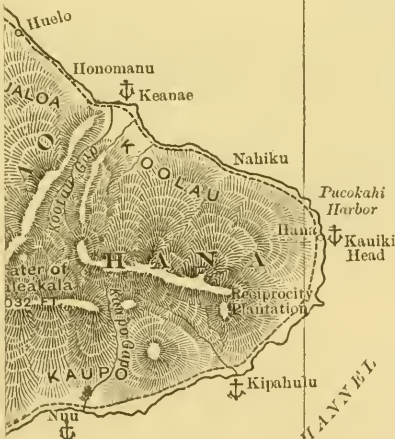
Maui Harbor

Harbors ⚓
Roads ————

KAIWI CHANNEL
KAI O K

21° 00'

21° 00'



20° 30'

20° 30'

ALENUIHAHA CHANNEL

156° 00'

157°00'

156°30'

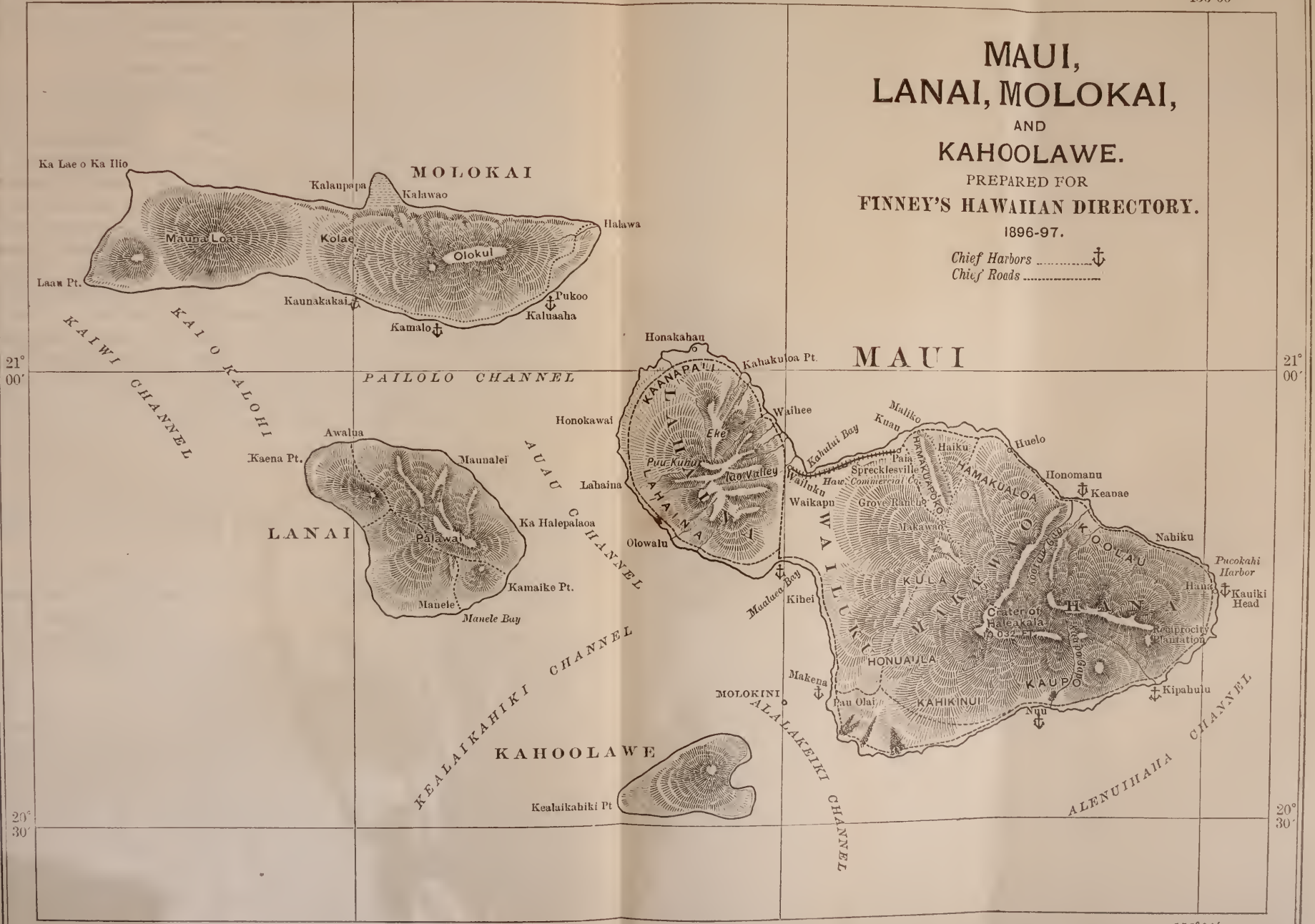
156°00'

MAUI, LANAI, MOLOKAI, AND KAHOOLAWE.

PREPARED FOR
FINNEY'S HAWAIIAN DIRECTORY.

1896-97.

Chief Harbors ⚓
Chief Roads ————



21°
00'

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157°00'

156°30'

156°00'

This is seemingly a small quantity for the present population of Hawaii (154,000). Formerly cattle were so numerous in proportion to the population that many were slaughtered for their hides and tallow. To-day the demand is so great that dressed carcasses are selling to the slaughterhouse corporation at 12 cents per pound. The meat-eating population has increased, and the areas devoted to grazing considerably diminished. The plantation demands are furnished by their immediate localities. Frequently a plantation will raise its own cattle on lands unfit for sugar growing, and thus supply its hands with meat.

Honolulu draws its supply from the other islands. The large ranches prevailing on every island, after supplying local demands, ship their surplus to this market. It will thus be seen that Honolulu is served last and, as the supply of cattle is not keeping pace with the increasing demand for meat, the time is not far distant when this city will have to import its beef. The quality of the beef sold in Honolulu is not first class, nor is the quantity abundant, as the price paid for it will show. Formerly excellent beef was brought in cold storage from New Zealand, but the trade was discontinued upon annexation on account of the duty of 2 cents per pound collected.

The following number of cattle, calves, and sheep has been slaughtered in the city of Honolulu from 1895 to 1899:¹

	1895.	1896.	1897.	1898.	1899.
Cattle.....	7,681	7,373	8,225	9,115	8,657
Calves.....	1,551	1,570	1,852	1,815	1,523
Sheep.....	7,596	7,473	8,316	10,698	13,220

It will be seen that the number of cattle, including calves, slaughtered has not increased very much in the last five years, while the sheep show decided gains.

The average weight of the dressed carcasses for 1899, as shown by the books of the slaughterhouse, was 420 pounds, showing the size of the beeves. Through the courtesy of Dr. William T. Monsarrat, veterinarian for the city of Honolulu, the writer several times visited the slaughterhouse and inspected the animals killed. They were only fairly fattened and were common island cattle and sheep.

Diseases.—Upon investigation it was found that Texas fever, so common in the South, was unknown on the islands. I also learned from Dr. Koebele, the entomologist, that the cattle tick (*Boophilus bovis*) had not yet found a lodgment upon any of the islands. It would, therefore, be well to extend the quarantine restrictions now prevailing in the United States with regard to the movement of cattle from the infected to the noninfected districts to these islands at once, to

¹ Information furnished by Mr. Eben Low.

prevent the introduction of the cattle tick. It is possible that the latter when once introduced may find most suitable conditions for rapid multiplication, and doing so destroy many of the cattle of the islands.

Upon investigation it was learned that both tuberculosis and liver fluke were common among the cattle on the islands of Oahu and Kauai, rare on the island of Maui, with very few cases of the former and none of the latter on Hawaii and the other islands. Efforts were being made to eradicate the tuberculosis from the dairy herds around Honolulu, using tuberculin as the diagnostic agent.

Quite an effort is being made, as the above list of ranches will show, to introduce better beef blood on the islands. Herefords, Shorthorns, and Angus have all been tried. They have been brought mainly from New Zealand. Preference seems to have been bestowed upon the Herefords, as adapting themselves more quickly to the prevailing ranch conditions of the islands. Mr. Low informs me that he imported about forty bulls of the Shorthorn and Hereford breeds, and upon arrival turned them on his ranch with his native cattle. In a few days it was found that the Herefords had acquired the habit of the natives of "eating" water, and were doing well, while the Shorthorns had to be removed to lower altitudes and furnished with water to save their lives.

There is great room for the further improvement of the island cattle, and there should be profit in fattening improved grades for the shambles of Honolulu. As a rule, cattle are raised on ranches to an elevation of 4,000 feet; beyond this, sheep are more profitable; wild cattle, however, range much higher up.

DAIRIES.

There are but few dairies on the island except those that directly supply the markets of Honolulu and Hilo. Nearly all of the butter used on the islands is imported, and the prices of both milk and butter are high.

In and around Honolulu are many dairies which supply the city with milk. There is a central association, the stock of which is owned by the dairies, which buys all of the milk of the dairies and then retails it to the city. This association pays the dairyman $7\frac{1}{2}$ cents, and retails it to the consumer at 12 cents per quart. Butter sells readily at 60 cents per pound. These dairies largely grow sorghum, guinea grass, alfalfa, etc., for soiling their cows. They gather the algaroba bean and, grinding it to a meal, feed it with wheat bran or cottonseed meal. Wheat bran and algaroba meal, properly compounded, supplemented with green sorghum, constitute a most excellent ration for milch cows.

In the dairies adjoining Honolulu may be found some excellent

Jerseys. Mr. William G. Irwin, one of the wealthiest citizens of Honolulu, has a herd of improved Jerseys that would be highly prized in any country.

SHEEP.

Sheep occupy mainly the smaller islands of the group, though the largest island, Hawaii, has two enormous flocks, one of 30,000, owned by Hon. Samuel Parker, and another of 25,000, owned by the Keamoku Sheep Ranch.

The island of Kahoolawe, as previously noted, is one large sheep ranch, having over 15,000 head. Besides the sheep, there are a few mules.

Lanai has 30,000 head of sheep, besides the 1,000 head of cattle previously given.

Molokai has about 1,000 head, while Niihau has over 30,000 head of grade merinos, the property of Messrs. Gay & Robinson, whose herd of grade Shorthorns has already been noted. The other islands are reported without sheep.

With the exception of the merino flock just mentioned, no effort at improving the native sheep has been made. The average weight of the dressed carcasses of the sheep slaughtered in Honolulu is not far from 40 pounds, as was tested in the presence of the writer during the month of August. However, such carcasses bring 12 cents per pound, which, together with hide and tallow, gave a value to sheep beyond that obtained ordinarily for the best grade mutton in the Chicago markets

HORSES AND MULES.

There is a small interest in the raising of horses and mules, the latter being an adjunct to cattle or sheep ranches. The large demand of the plantations for the latter, and the city of Honolulu for the former is almost exclusively met by importation, chiefly from the United States. However, it is pleasant to record the fact that the Kukaiau Ranch is raising improved blooded horses, both of the trotting and running strain. It has colts of Electioneer and Idylwild in the stud. It is also raising fine, large mules.

HOGS.

Very few hogs are raised on the islands, though the number consumed is very large. They are imported in vessel loads directly from the United States. The Chinese are extremely fond of pork, and their demand for this meat maintains an active trade with high prices for hogs. The cargo which arrived in Honolulu in August sold readily at 10 cents per pound on the hoof.

Conditions on the islands are not favorable to the profitable growing of hogs on a large scale, yet there seems to be room for the house

or lot pig, which can be used to "turn an honest penny" into the exchequer of the small farmer.

PASTURES.

Elsewhere allusion has been made to the native plants which furnish the food of the pastures. Pili grass (*Heteropogon contortus*) is found from sea level to elevations of 4,500 feet. It has been mentioned as good for cattle and sheep, and is usually abundant on all ranches.

The Ti plant (*Cordyline terminalis*), of which so many uses have been recorded, is good for cattle and said to be fattening. Horses do not care for it. It is found covering thousands of acres of the lands devoted to pastures.

Bermuda grass (*Cynodon dactylon*), called by the natives Manienie, is found on lower plains, but is not esteemed as a very fattening food. It and other valuable grasses are being crowded out by the Hilo grass (*Paspalum conjugatum*), which is not eaten by animals.

Spanish clover (*Desmodium uncinatum*) is considered the finest feed of the pasture and is highly relished by stock of all kinds.

Pualele (*Sonchus oleraceus*), a species of sow thistle, is highly esteemed in every pasture. It grows to a height of 5 to 6 feet. It is an erect annual, coming out in February and grows to July, and extends from the low plains to the mountain tops. It is considered very fattening. It is sometimes called California milkweed.

Kukai puaa (*Panicum pruriens*) is a broad leaf grass of the lower and middle regions of all the islands. It grows the year round and furnishes excellent grazing.

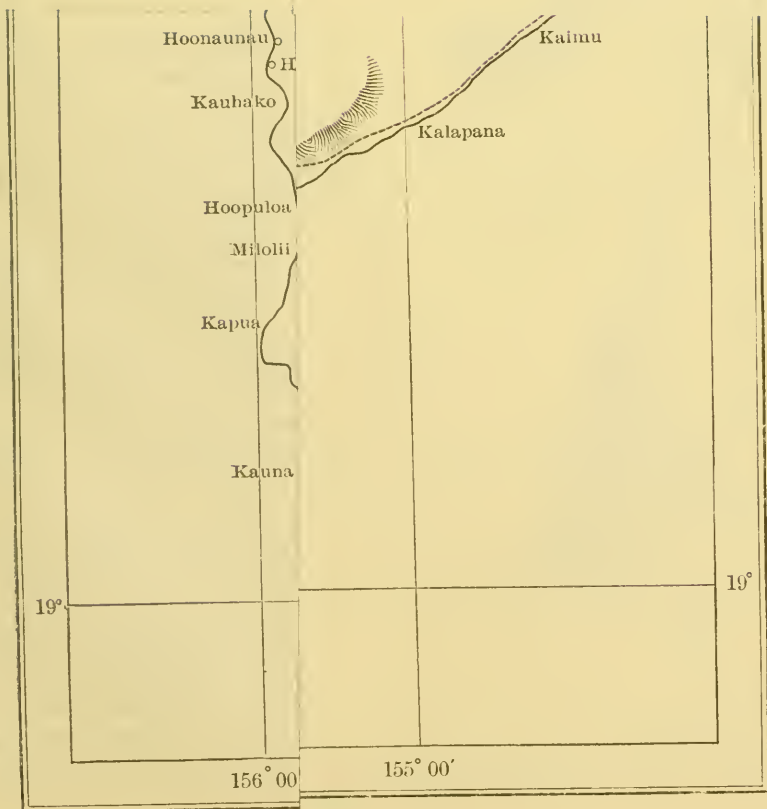
There is an introduced grass, common in the pastures of Hawaii, which is esteemed of the best quality, and is called Dr. Trousseau's grass. The botanical name is not known.

The above constitute the native plants of the pastures, but in the cultivated paddocks or inclosed ranches alfalfa and perennial rye grass are grown at and above elevations of 2,000 feet. Below this elevation it is too dry for their growth. Kentucky blue grass, tried at the same elevation, has succeeded. It is estimated by cattlemen that in a ranch at an elevation of 2,000 to 6,000 feet, 6 acres are required for a cow weighing 1,000 pounds. As before remarked, at this elevation there are no running streams, the rain, which is abundant, penetrating the earth as fast as it falls. The cattle, therefore, eat rather than drink water, getting their supply entirely from the plants wet with dew and rain.

IRRIGATION.

Mention has been made of the systems of growing cane on the windward and leeward sides of the island. It was stated in a general way that the crops grown on the windward sides received the needed mois-

REVUE GÉOGRAPHIQUE
DE LA FRANCE
PUBLIÉE PAR LE COMITÉ GÉOGRAPHIQUE
DE FRANCE
FONDÉ EN 1871
PAR LE GÉNÉRAL DE LA FLEUR
ET LE GÉNÉRAL DE LAUNAY
Sous le patronage de
M. le Ministre de l'Instruction Publique
M. le Ministre de la Marine
M. le Ministre des Colonies
M. le Ministre de l'Agriculture, de l'Industrie
et du Commerce
M. le Ministre de l'Enseignement Supérieur
M. le Ministre de l'Intérieur
M. le Ministre de la Guerre
M. le Ministre de la Justice
M. le Ministre de la Marine et des Colonies
M. le Ministre de l'Armée
M. le Ministre de l'Éclaircissement Public
M. le Ministre de l'Instruction Supérieure
M. le Ministre de l'Intérieur
M. le Ministre de la Justice
M. le Ministre de la Marine et des Colonies
M. le Ministre de l'Armée
M. le Ministre de l'Éclaircissement Public



156° 00'

155° 30'

155° 00'

HAWAII

FROM THE LATEST SURVEYS
PREPARED FOR
FINNEY'S HAWAIIAN DIRECTORY.

1896-97

By

S.M. Kakanui.

20°

20°

19° 30'

19° 30'

19°

19°

156° 00'

155° 30'

155° 00'

Upolu Pt.
Honolulu
Mahukona
Kohala
Halawa
Keokea
Pololu
Honokane
N. KOHALA
Waimana

KOHALA MTS.
KAWAIIHAE
WAIMEA
S. KOHALA

MAUNA KEA
13,805 FT.

MAULUA

TABLE-LAND

HUALALAI
13,275 FT.

MAUNA LOA
13,675 FT.
CRATER OF MOKUAUWOWEO

CRATER OF KILAUEA

KAPAPALA

PAHALA

HILEA

NAALEHU

WAIDHINU

Ka Lae

Kawathae Bay

Punako

Kiholo

Nawili Pt.

Kalwi Pt.

Kailua Bay

Keanohou

Kealahou Bay

Kahaloa

Napooee

Hoonanau

Hookona

Kaunako

Hoopulou

Mihili

Kapus

Kauna Pt.

Na Puu o Pele

Walpio

Kukuliiale

Hilawe Falls

Honokan

Paaulla

Ookala

Laupahoehoe

Maulua

Hakalau

Hononu

Peepeekeo

Shumee

Wainaku

Hono Bay

Keokea

Hilo

Waakea

Lelelwi

Olaa

Halfway House

Volcano House

Halfway House

Keanohou

Halfway House

Kalapanas

Kidimu

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ture from rainfalls, while those on the leeward side were irrigated from artesian wells. The last assertion is correct in every way, but the first needs slight modification.

Sometimes on the windward side the rainfall may not be adequate for the maximum production of crops, and the deficiency is supplied by irrigation. The water supply for irrigation is not drawn from artesian reservoirs, but is taken from running streams and delivered to the soil through canals. This latter system is prevalent in California and other Western States.

On the windward side the large rainfalls prevail, giving streams which flow down the sides of the mountains, carrying washings of soils and forming deltas where they enter the sea. These alluvial valleys constitute the chief cultivable lands of the windward side. Sometimes immense storage basins or reservoirs are constructed which are filled during the rainy season and exhausted for irrigation purposes, as the crop requires extra moisture during growth.

There are many estates on Hawaii and several on Maui where the rainfall was formerly abundant for all crop purposes, but in recent years droughts have prevailed which have entailed severe losses. These droughts have been attributed directly to the rapid deforestation going on around them. In 1892-93 the districts of Hamakua and Kohala, on Hawaii, suffered severely from the protracted droughts, the springs and natural reservoirs in the gulches dried up, and water for animals and domestic uses was difficult to procure. In some instances it had to be shipped from Honolulu in barrels. The cause of these droughts is accredited by all of the residents of these districts to the unrestricted roaming of cattle in the forests, by which tens of thousands of acres of land, formerly a dense forest, are now reduced to a barren desert, useless alike to the grazier and planter.

In another chapter is given a discussion of the relations of water supply to forest growths. Allusion is made to the above in order to emphasize the fact that whether crops are watered directly by rainfall or by irrigation from either surface streams or underground artesian reservoirs, the supply comes from rainfall and the amount of the latter appears to be directly related to the forest growth.

On the island of Hawaii most of the cane is grown without irrigation, and though the crops are smaller than in the irrigated districts, yet the profits are said to be equally as great.

Irrigation is an enormous additional cost to the expense of growing crops. The cost of an irrigation outfit is very large. At Ewa the eight pumping plants, capable of supplying 75,000,000 gallons per day, have cost \$1,750,000. They draw entirely from artesian wells. This plantation is situated below the altitude of 200 feet, and has to lift its water 50 to 160 feet. It has now 5,000 or more acres in cane, and contemplates increasing this area. Roughly speaking, 1,000,000 gallons

of water is required for each 100 acres in cane. Of course this amount varies with the soil, exposure, and rainfall. In the expenses for 1898-99, given elsewhere for this plantation, it will be seen that the expense for pumping per acre was \$24.84, and for watering the cane, which was performed by contract, \$37.18; for ditches, \$2.05; or a total due to irrigation of \$64.07 per acre. Upon the 5,000 acres now under cultivation this will give \$325,350 as the total cost of irrigation for the present year. Coal was worth in Hawaii in August last \$7.50 to \$10 a ton, slightly higher than before annexation. It comes from New Zealand, and now pays a tariff of 66 cents per ton, when formerly it was admitted free. It should be mentioned, however, that Ewa Plantation has a comparatively low lift.

Stimulated by Ewa's success, other plantations have embarked in similar enterprises with higher lifts. Their success has yet to be proven. The prices of sugar, coal, machinery, etc., must always determine the line which will be the limit at which pumping can be performed at a profit. The depth of artesian water below the surface at various points can be determined only by trial. In Honolulu the best water-bearing strata are reached at depths of 400 to 500 feet, and the water rises 30 feet above the sea level. It formerly rose about 40 feet. At Ewa it rises 20 feet, necessitating a lift of 50 to 160 feet. East of Honolulu it barely rises to the sea level. The hydrostatic level of artesian wells varies with rainfall and the amounts pumped out. No geological survey has yet been made by which the exact depths of these artesian basins can be told in any locality. Hence, trials at great expense are necessary before any important enterprise involving a large use of water can be successfully projected in any locality.

The quantity of water used in irrigation per acre is here always too large. Excessive irrigation is sometimes as destructive to plant growth as an absence of moisture. Pumping water from great depths with costly machinery, using high-priced coal, involves such a heavy expenditure of money as to require special study of the economy of its use. Dr. Maxwell has shown that 800 to 900 pounds of water to 1 pound of sugar grown is ample. He also asserts that many plantations are using twice, thrice, and even up to seven times this quantity. Mr. Rendon, of Ewa Plantation, informed the writer that upon a field of 100 acres he had, in accordance with Dr. Maxwell's suggestion, lowered the quantity of water used one-half, with apparently beneficial results. The wasteful manner in which this high-priced irrigation water is used calls for special study in soil physics. Every soil should be irrigated just in proportion to its capacity to hold and evaporate water. By such a knowledge just the amount of water can be applied which will insure continuous nitrification, and with it an abundant supply of one of the chief foods of the cane plant.

FORESTS.

Originally forests covered the upland plateaus and mountain slopes of all the islands. In them were to be found the finest timbers and the best of fuel. The early trade in sandalwood began the destructive process which has been continued, until to-day large areas formerly clothed with forest cover are bare and devoid of any kind of growth. Again, large ranches, upon which roam numbers of cattle, sheep, and goats, exist above the altitudes at and below which the sugar estates are established. The animals have trampled down the undergrowth and destroyed the bushes protecting the roots and trunks of the trees which made up the superb forests. Thus exposed, these trees have died, and soon after death are found filled with insects which hasten their complete destruction.

Through indiscriminate and wholesale removal of timber by man and the destructive influences of mountain cattle and fires, much of the original forests covering the mountain slopes have been removed and large areas of naked, bare soils or rocks remain. For years the more thoughtful students of the islands' prosperity have inveighed against this wholesale destruction. They have shown the intimate relations of forests with rainfall. They have demonstrated how essential to every industry on the islands was an abundant water supply. Not only the farms and plantations on the windward sides of the islands require regular rainfalls, to make profitable crops, but those rice and sugar estates on the lee side which depend upon an elaborate and costly system of irrigation for their water supply, must have an abundance of rainfall elsewhere on the islands to fill the artesian reservoirs from which they pump. Human life on the island is dependent upon the continuation of the usual rainfall. The city of Honolulu, with a population of 40,000, through its thoughtful guardians, have demonstrated the necessity of providing against a future contingency of diminished water supply. It has re clothed at a large expense the mountain slopes in its rear and has placed sentinels thereon to protect these artificial forests against marauders, roaming cattle, and fire. At the same time it has constructed immense reservoirs in the mountains to catch the winter rain, to supplement, in case of necessity, the numerous artesian wells within her corporate limits. How to maintain an abundance of water for all of the present and prospective wants of the islands is to-day one of the most important questions in Hawaii. It is claimed that the cool forests wring from the northeast trade winds blowing continuously over the islands much of the moisture which they contain and precipitate it as rain. It is also claimed that the thick undergrowth and brush aid in conserving this moisture, sending it downward into the artesian reservoirs within and beneath the mountains rather than permitting it to discharge precipitously down the sides of the

mountains to the sea. Conceding these claims to be true, the question arises: What shall be done to check the diminishing rainfall and insure the islands an abundant water supply for the future? Everybody is interested in this question. So great is the public interest in this matter that the governor has requested the secretary of agriculture to send a trained forester as soon as possible to the islands to study the situation and recommend definite lines of policy to be pursued. It is, however, apparent to everyone that the reckless roaming of cattle through the forests, destroying directly the undergrowth and brush and ultimately the trees, must stop. The appended report of Prof. A. Koebele to the commissioner of agriculture, recently made, shows the absolute necessity for immediate and prompt action along this line. Such action will stay further destruction of the present forests.

But shall the forests already destroyed be restored? Individual efforts on a small scale have resulted favorably to the localities where they were tried. The city of Honolulu is greatly benefited by the restoration of the Makiki forest. These serve as object lessons for future guidance. But local efforts fail to benefit the entire island. A systematic plan of reforestation of all the islands, made by expert foresters after careful survey and study of the islands, to be executed by the Territorial government, is, in the opinion of many, imperatively demanded. Hawaii must enact wholesome laws relating to forests for her future preservation and prosperity.

The following report was recently made to Hon. Wray Taylor, commissioner of agriculture for the Territory, by Prof. A. Koebele, the Territorial entomologist.

Mr. Low is the owner of a ranch, a part of which is covered with forest. Recently the trees in his forests have been dying very rapidly, and he was disposed to assign as a cause the depredations of insects. The investigations of Professor Koebele clearly show the true enemies to the growing forests, and his suggestions must be heeded else fifty years more may find much of the island uninhabited and uninhabitable.

HONOLULU, TERRITORY OF HAWAII,

September 12, 1900.

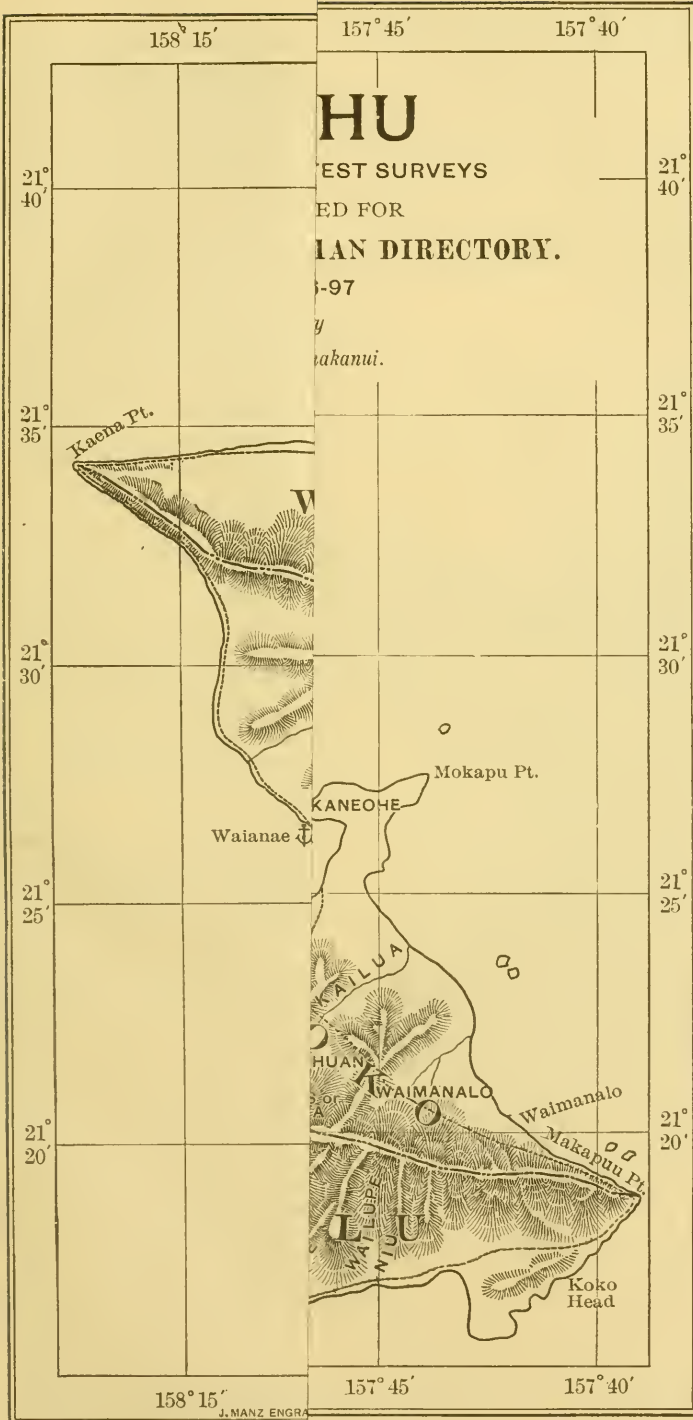
WRAY TAYLOR, Esq.,

Commissioner of Agriculture and Forestry.

SIR: As requested by you, I have made a trip to Mr. E. P. Low's ranch at Puuwaawaa, Hawaii, to look into and report on the depredation of insects on the forest trees.

Within the last year or so *Icerya purchasi* has been very destructive to some of the trees, and chiefly to the Mamani (*Sophora chrysophylla*), but at the present time this destructive scale insect has practically disappeared. Its formidable enemy, the *Vedalia cardinalis*, was found in full force. Owing to the isolated appearance of *Icerya*, often miles apart, this pest has at times become numerous, as has been the case in times gone by at Kona, Kohala, and at Hamakua.

At the present time the insect was noticed all along the road from Kailua to Puuwaawaa, yet only in single, individual, or small colonies, showing that the *Vedalia* is present throughout this district. The more the *Icerya* becomes disseminated, the less is the danger of its becoming a pest, as its enemy will follow wherever it appears.



Of other insects, two species of Lecanium were found present in numbers. *L. nigrum* is the most numerous, attacking a great variety of trees and shrubs, yet it is badly parasitized by Chalcid flies. Specimens were found upon a mulberry tree, nearly every single individual destroyed by the Chalcid flies.

In addition to the parasites, two fungus diseases are present, as all over the islands, having been introduced some six years since. It is owing to the want of sufficient moisture that these do not develop sufficiently in the Puuwaawaa district. A few days of rain and cloudy weather will immediately spread the deathly disease among them. *L. longulum* was found also well represented, and as the foregoing, it has sufficient enemies to keep it in check.

Pulvinaria psidii, at one time threatening the coffee industry of the islands, is present here and there, yet always accompanied by its enemy, the *Cryptolæmus montouzieri*, which will make it impossible for the Pulvinaria to ever again become a destructive pest. When in China last spring we collected and successfully introduced to the islands additional enemies for this scale. One of these, a Chalcid fly, destroying the insect in its earliest stages, is of great value.

One or two species of Aspidiotus are spread throughout the district upon wild and cultivated trees, preyed upon by internal parasites. Nowhere has this insect been seen to do any noticeable injury to plant life, except upon a couple of cultivated trees, which, with a little attention given to the same, can easily be avoided. Moreover, we shall forward additional parasites and predaceous insects to this locality.

Dactylopius ceriferus, the common tropical mealy bug, formerly so numerous in Honolulu, was found to infest some of the Wiliwili (*Erythrina monosperma*); here also the *Cryptolæmus* beetle was found to be present and devouring the same.

All of the above insects are of foreign origin, and without the assistance of the introduced predaceous and parasitic insects they would be detrimental to plant life.

It is different with the various indigenous forms of insects preying upon forest trees. All these have their parasites, and are in consequence hardly detrimental to the particular trees they prey upon, since most of them have existed for thousands of years.

According to the observations of Mr. Perkins the larva of *Scotorhynchus idolias*, a spanworm found on all the islands, almost annually denudes the Koa trees of their leaves; doubtless these conditions have not always existed. In former times the Koa trees have had a dense underbrush consisting of various young trees, and especially ferns, keeping the ground and the base of the trees continually moist. The *Scotorhynchus* larvae in pupating come down to the ground; then it is that most of them are destroyed by a fungus disease indigenous to these islands, which requires moisture for its development; the same disease was successfully made use of against the depredations of the Japanese beetle. Since the total destruction of undergrowth in the Koa forests, and the even drying up of the ground, this disease is becoming less effectual and naturally the insect more numerous. It is but for a few weeks that the worms are numerous enough to defoliate the trees; very soon the new leaves reappear again and no trace of the worms is noticed, this only appearing periodically. As to the natural enemies of this Geometrid larva very little is known; we have no opportunity of breeding the same. Of the very numerous specimens of various indigenous species some doubtless will prey upon them.

The Asiatic *Chalis obscurata*, which is doing such splendid work on this island, where it has just been introduced, has not been met with, as yet, in large numbers. On Kauai, where this insect was introduced some five years ago, it has become very common.

The seeds of the Koa trees are destroyed to some extent by the larvæ of a Tortricid, apparently a species of *Carpocapsa*, and, as Mr. Perkins informs me, it is represented on all the islands. We are breeding the same at present from a lot of seeds of Mamani (*Sophora chrysophylla*), brought down from Puuwaawaa. Judging from the large

quantities of parasites issuing, these larvæ are never so numerous as to destroy all the Koa seeds. Perhaps more numerous is a weevil, of foreign origin, represented on all the islands wherever the Koa tree is growing, upon the seeds of which it breeds. This is not the only tree upon which it is found, but the seeds of most of the acacias, and especially those of *Prosopis dulcis*, are destroyed by this Bruchus. Nevertheless, any part of a Koa forest fenced off, or entirely undisturbed, will soon reproduce large quantities of young trees of this valuable timber, as can be seen at Lihue, Kauai.

What is most apparent throughout the dying forests are the numerous small holes seen on some of the trees, in an unhealthy condition. It is supposed that the insects producing the same are the cause of the ultimate decay of the trees, which is by no means the case. In any undisturbed forest such signs are indeed a rarity, save perhaps on the Naeo (*Myoporum sandwicense*), which practically has these holes during the entire time of its existence, with but little detriment to the plant itself. If by any cause, natural or otherwise, a tree becomes injured, a branch blown off, etc., the first insects to appear are the indigenous Cerambycidae, which produce the holes referred to. As a fact, it is the greatest help to a collector of these insects to cut down one of the particular trees, upon which the desired beetle feeds; in a few days they will appear in large numbers ready to deposit their eggs.

I will now refer to the more common and well known form of these Cerambycids, and the respective trees upon which they breed. It must be borne in mind, however, that the insects referred to will never attack trees in a perfectly healthy condition. A peculiarity of these insects is their habit; instead of being nocturnal, they are active during the hottest part of the day, from 10 a. m. to 3 p. m., when the sun is highest.

Plagithmysus varians is found upon the Koa tree on Hawaii, where it breeds both in the trunks and larger limbs, as do the rest of the genus. *P. pulverulentus* and *P. cristatus* are found upon the same tree on Oahu. On Kauai two other species are found upon the same tree; these are *P. æqualis* and *P. arachnipes*.

Four species are known to breed upon the Mamani (*Sophora chrysophylla*). Of these, two are found on Hawaii, *P. darwinianus* and *P. Blackburnii*. The first was found very common at Puuwaawaa, where the tree is numerous as yet. *P. funebris* is found on Maui, and *P. bilineatus* on this tree on Kauai.

The large genus of Alani (Pelea) has so far four known species; two of these are known to occur on Hawaii. *P. bishopi* and *P. vicinus* have been found on these trees by Mr. Perkins, and the first named has been met with at Puuwaawaa. *P. collaris* occurs on Maui, and *P. diana* on Kauai.

The Ohia Lehua (*Metrosideros polymorpha*) has four known species at least—*P. fmschi* and *P. pulvillatus* are on Maui, *P. lanaiensis* on Lanai, and *P. æstivus* on Molokai. We know that this tree is also attacked on Hawaii.

The Ohia-ha (*Eugenia sandwicensis*) is affected on Kauai by *P. concolor*, and on the same island *P. permundus* infests the Ahakea (*Bobea* sp.). The same trees are attacked on Oahu by *Callithmysus microgaster*.

P. perkinsi is the insect upon the Naso (*Myoporum sandwicense*), on Hawaii. *P. lamarkianus* is found upon the Mamake (*Pipturus albidus*) on the island of Hawaii, whilst on Oahu, upon the same tree, an undescribed species was found.

At Puuwaawaa we found two new species of *Plagithmysus*, one inhabiting the Aiea, (*Nothocestrum breviflorum*), and the other found breeding in the Koko or Akoko (*Euphorbia lorifolia*), a dead tree of which was found filled with larvæ, which are rather badly parasitized.

Another genus, of rather small Cerambycidae, lives chiefly in the dead branches of various trees, and as far as known they are attached to *Sophora chrysophylla* and *Acacia koa*. *Clytarlus filipes* and *C. mediocris* have been found on the first-named tree on Hawaii and Maui, respectively. Ten species are known to infest the Koa tree, as follows: *C. debilis*, *C. clariger*, and *C. nodifer* on Hawaii; *C. modestus*, *C. latifollis*, and *C. pennatus* on Maui; Oahu has but one known species, *C. fragilis*, which

was bred from dead branches of Koa from Nuuanu Valley. The branches were brought in during December, 1898, and on January 16, 1899, there had issued seven beetles, together with 46 female and 25 male parasites. Again, on March 3, 1899, we counted 14 beetles, 110 female and 55 male parasites; all these of one species which is common to all the islands and is parasitic upon *Plagithmysus* as well. It has also been bred upon larvæ of introduced Cerambycids. The three other species, *C. modestus*, *C. longipes*, and *C. annectens*, were found by Mr. Perkins to breed upon the Koa tree on Kauai.

We have bred a species of *Clytarlus* from trunk of Papala (*Charpentieria oborata*), on places where the bark had been badly eaten by cattle at Puuwaawaa.

The above are about the first indigenous insects to appear on diseased timber trees. After these come a large number of various genera and species preying upon dead wood. As a fact, the most of the Hawaiian Coleoptera are known to live upon trees in such condition. In addition, larvæ of Tineidæ make their appearance, readily noticed by the webs intermixed with remains and excrement of the same. Usually this remains as long as the trees are in an upright condition, or until the last stage of their existence.

The greatest enemies of the beautiful Hawaiian forests, the worst and most destructive ever introduced among tropical forests, are cattle, which will sooner or later but positively and entirely destroy the forests. I doubt that anything else in nature, ax and fire included, would have in the same space of time brought the once densely clothed islands to the present condition.

If we look backward fifty or sixty years we would see the two large mountains of Maui met by trees on the plains; Lanai and Molokai clothed with forests; Oahu the same, native trees in numbers down to Honolulu; four miles or more of a dense and impassable virgin forest in Nuuanu Valley; the Waianae Mountains with a mantle of beautiful green vegetation; Kauai the fairest of all, the Lihue plains an undisturbed forest, as all along the west on the windward side, and the forest on the leeward side coming down to the sea, in parts at least. We would see in places uniformly running streams and ever-flowing springs. Doubtless such has been the condition of the islands. The changes have been brought on to the benefit of the very few, to the detriment of the whole island and community. To-day, especially on the leeward side of the island, the cancer spots are visible everywhere and growing continuously; the grass has disappeared, each successive rain takes away more of the soil, and during the sunny days the wind is taking the same far out to sea. With these conditions, these barren spots will grow into barren rocks, where not even the denounced Lantana (the salvation plant of the islands) will grow. I fear to express an opinion of the state of conditions fifty years hence, yet we must trust in a body of men to form laws and regulations filling the demands of the islands. What is mostly and immediately wanted are strict laws to compel every cattle owner to fence in his or her cattle, and liberty to any one to take or shoot any animal found outside such inclosures, even paying a bonus for any such beast so destroyed.

On the lower end of Puuwaawaa Ranch we find a mixed forest of a large number of trees, among them some of the most valuable timber, such as the sandalwood (*Santalum freycinetianum*), the Kauwila (*Alphitonia ponderosa*), and many others growing among the lava rocks. Some four or five species of trees like the Wiliwili, the Papalo, and other soft-wooded species, are destroyed by the cattle eating off the bark.

The principal food of cattle in this district is the underbrush, breaking the rays of the hot sun on the lava rocks. The animals will browse upon the young trees and eventually destroy the same, leaving the older plants with the surface wood exposed.

It is only a question of a few years until all the trees on such places disappear entirely, as may be seen by the piece of land between Mr. John McGuire's house

and the lava flow north, with former forest dead. It took the cattle a very few years to accomplish this.

The upper part of the ranch comprises some 12,000 acres of fertile government land, covered with valuable forest trees, among them the famous Koa. It is here where we have seen the sandalwood tree over 18 inches in diameter. Five years ago the present leaseholder had to hew a trail to see the condition of the land; to-day we find a handsome open park land, so to speak, where one can ride anywhere on horseback. I venture to say that at the expiration of the lease, twenty years hence, we will find an open pasture land, very much in want of moisture.

With the kind help, and the furnishing of the native names by Mr. Low, we collected and brought down seeds of the following species of trees, now planted at the government nursery and at Moanalua:

Wauke (*Broussonetia papyrifera*).

Kauwila (*Alphitonia ponderosa*).

Alani (*Pelea* sp.).

Aiea (*Nothoestrum breviflorum*).

Kea, or Kalamona (*Mezoneuron kauaiense*).

Halapepe (*Dracena aurea*).

Obapa (Olapa) (*Cheirodendron gaudichaudii*).

Hoolei (*Ochrosia sandwicensis*).

Iliahi (*Santalum freycinetianum*).

Naio (*Myoporum sandwicense*).

Aulu, or Kaulu (*Sideroxylon sandwicense*).

Mamani (*Sophora chrysophylla*).

Respectfully,

Pua (*Olea sandwicensis*).

Papala (*Charpentiera obovata*).

Pilo (*Kadua grandis*).

Aalii (*Dodonaea viscosa*).

Awikiwiki (*Canavalia galeata*).

Wiliwili (*Erythrina monosperma*).

Kookoolau. An ornamental, yellow-flowering composite shrub. Also seeds of one of the numerous Lobeliaceæ.

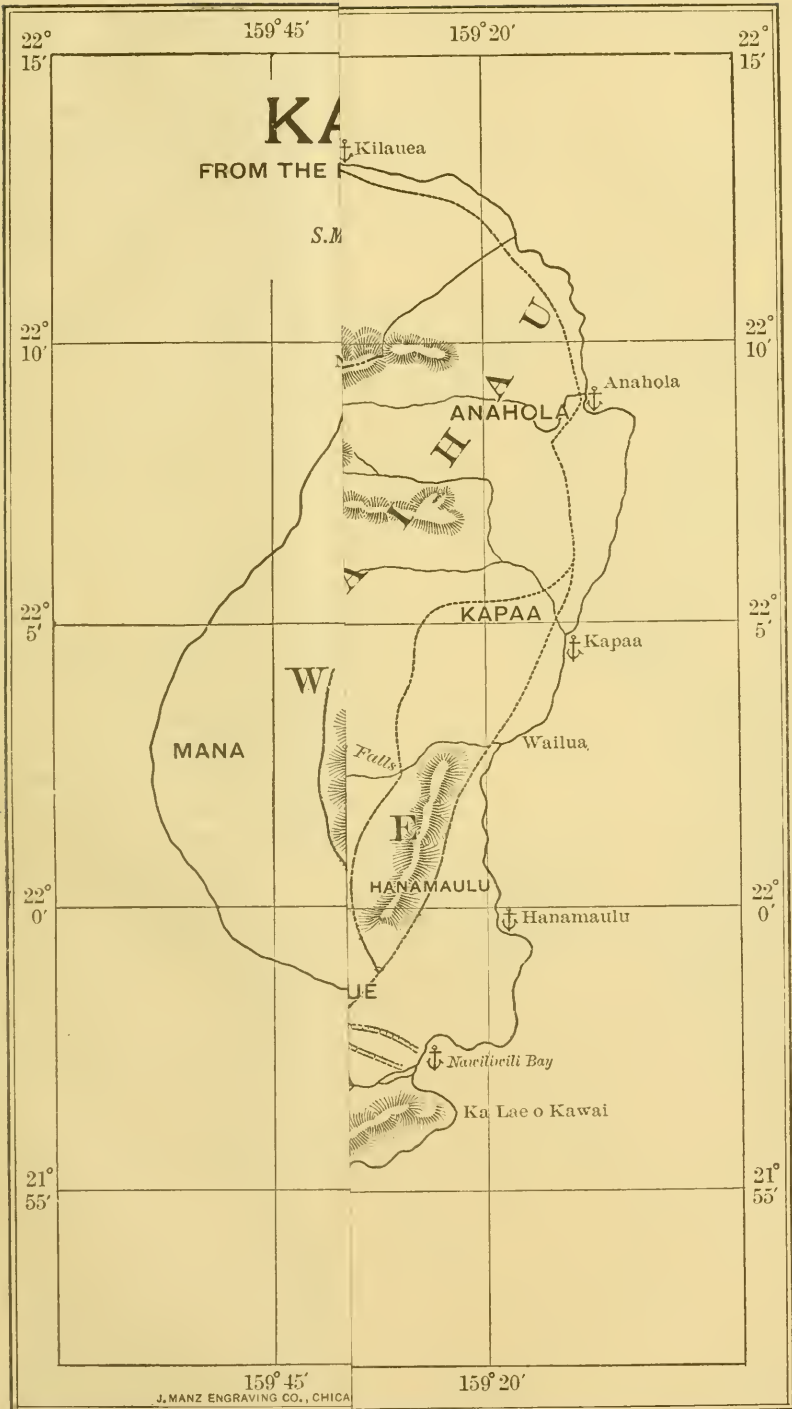
Alahee. Can not be found in Hillebrand.

Aa. A large tree, only known to Mr. Low in a couple of specimens.

A. KOEBELE,
Entomologist.

LABOR.

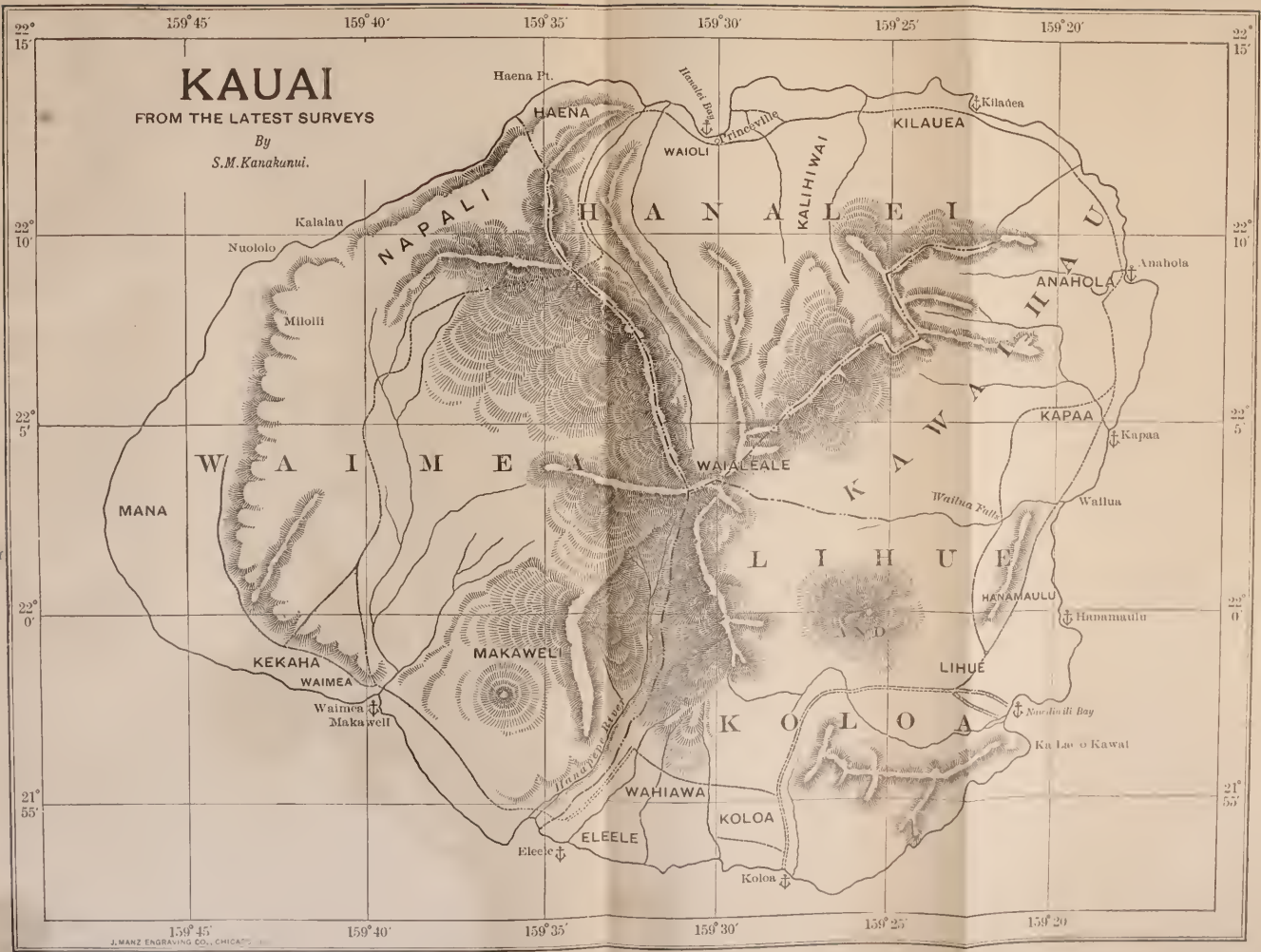
It is difficult to treat this subject in a short article, and yet a study of the agricultural conditions of the islands would be complete without reference to this important factor. For a half century the resources and ingenuity of the planters of these islands have been taxed to their utmost in devising the best means of procuring laborers suitable for their work. Special commissioners have been dispatched to distant parts of the globe for the purpose of securing the desired immigration. Earnest efforts have been made in the way of carefully prepared reports and extensive correspondence. Large sums of money have been expended for costly voyages in the hope of obtaining permanent additions to the population of the islands which would develop and maintain the growing agriculture. And yet the struggle continues. From the first arrival of coolies, in 1852, up to the present time there has been no cessation in the arduous efforts to obtain an adequate supply of labor for the plantations. The Royal Hawaiian Agricultural Society, established in 1850, issued a circular stating that "the introduction of coolie labor from China to supply the places of the rapidly decreasing native population was a subject of great importance." In 1852 the first introduction of coolies was made and the experiment was satisfactory. They proved able and willing



KAUAI

FROM THE LATEST SURVEYS

By
S.M. Kanakunui.



KANALI

REKONSTRUKCIJA IZ 1900. GODINE

1900. GODINE



laborers and quieted for a while all apprehension of future trouble in obtaining labor. Other cargoes were soon sent for and received.

But while the coolies were and are good workers it was soon discovered that laborers imported for plantations could not be relied upon as permanent settlers and homeseekers, and were therefore, from a state standpoint, very undesirable immigrants. The planters wanted laborers for profit: the King desired permanent settlers for the benefit of the country. To bring in immigrants required funds, which the former alone could supply, but they were unwilling to burden themselves with the trouble and expense of families. Hence the plans of the King failed. In 1859 a few South Sea Islanders were landed on Kauai to work on a plantation under contract. They resembled Hawaiians, were educated, and had Christian names. It was hoped that this beginning would be the means, ultimately, of repopulating the islands and supplying the needed labor, but the hope was never realized, as will be shown later. In 1863 another cry for importation of labor was heard, but the inquiry was everywhere made: Whom and how? The importation of white men as laborers was inadmissible; ditto with negroes. The coolie was an undesirable citizen and as a laborer of no great value. Private planters would import only men, rejecting women and children. Laborers could not be obtained from Pacific islands; therefore resort must again be had to China.

In the meanwhile sugar production increased rapidly. New plantations were opened and more labor demanded. The statesmen decried plantation morals, due to the large excess of men over women; they deprecated the class of coolies imported, and appealed to the patriotism of the planters to aid the Government in introducing carefully selected agriculturists.

A plan was suggested of introducing to Hawaii certain races of the Malay Archipelago, but the Government was without the means of consummating so favorable a project. In this imperative demand for labor the only alternative left was to introduce more coolies, which was done. The "Chinese coolie system," as it was called at this time, had an odium attached to it almost equal to that of the slave trade. It was reported that men had been actually purchased from the mandarins for a few dollars each, while the contractors picked up vagrants and sold them at public auction in the markets of Peru and elsewhere. The horrors of the slave trade were in some instances repeated and the deported coolies often succumbed to brutal privations and hardships. Here the British Government intervened by the appointment of agents at the ports of departure to see that no laborer was taken away without his full consent.

These abuses gave birth to the coolie laws of the United States, and simultaneously in Hawaii a bureau of immigration was established, taking the business of importing laborers from the hands of the planters

and placing it under the charge of the Kingdom. The Hawaiians claim that no such iniquity as above mentioned ever disgraced the efforts of their planters in their work of importing laborers. The "coolie system" as known elsewhere never existed on the islands; the law between employer and employee known as the "master and servant law" was mild, equitable, and compulsory for the specific fulfillment of contracts.

In 1864 the board of immigration was established for the purpose of superintending the importation of foreign laborers and the introduction of immigrants. One of its first ordinances was to prohibit private persons from introducing laborers into the Kingdom under heavy penalty. Another was to adopt measures looking to the introduction of free immigrants, males and females, from the Azores, Canaries, and Cape de Verde in the Atlantic, and from any of the Pacific isles. Passages were to be paid by the Government and a bounty per head to the captain of the ship. Still another was the chartering of a ship to send to China to procure more Chinese laborers. The first ordinance gave great offense to the planters, but the board firmly adhered to it.

In 1865 Dr. Hillebrand was appointed commissioner to go abroad and study the possibilities of obtaining desirable immigrants from India, Japan, and Malaysia. In the meanwhile, to meet the present demands, he was first to visit China and forward a shipload or two of coolies to the islands. In December, 1865, the first installment of immigrants arrived from the Caroline Islands. The bureau sanctioned the contracts with the planters. Simultaneously a small number of Marquesans were introduced. Dr. Hillebrand simultaneously forwarded from Hongkong two shiploads of coolies. The planter acquired the needed laborer, but the people desired immigrants who would assimilate with them, infuse vigor into the impaired constitutions of the natives, check the decrease of the inhabitants of the Kingdom, and give strength to the national constitution.

King Kamahameha III saw with sorrow and alarm his people rapidly declining in numbers, and naturally sought some means of arresting this decay and permanently re-peopling his dominions. To accomplish his purposes he authorized Mr. Wyllie to negotiate with the British Government with the view of obtaining consent to remove to the islands all of the inhabitants of Pitcairn's Island and settle them as proprietors or tenants on his own lands. The project unfortunately failed.

In the meanwhile other coolies were introduced.

In 1865 King Kamehameha IV, in his speech to the legislature, said of the coolies: "They are not so kind and tractable as was anticipated, and they seem to have no affinities, attractions, or tendencies to blend with this or any other race." He recommended trying "the inhabitants of other Polynesian groups; they would be easily acclimated;

would soon learn the language, and might bring with them their wives, whose fecundity was much greater than that of the Hawaiian females, and, besides furnishing labor, would pave the way for a future population of native-born Hawaiians indistinguishable from the aboriginal parents." But Mr. Wyllie, minister of foreign affairs, saw danger ahead in such a project. He feared the numerical superiority of the aborigines over the whites, and did not believe they would devote themselves willingly to work, unless under contract under the act for the government of "masters and servants," as was done with the Chinese.

Nothing came out of this controversy. Small importations of coolies continued. At first their labor was very unsatisfactory. Not understanding the language nor the character of the work required, friction between master and servant frequently occurred. But the laborers gradually improved.

In 1866 occurred the convention between China, England, and France, at which the right to draw labor from Chinese ports was exclusively restricted to treaty powers. The Hawaiian Kingdom was not a treaty power, and therefore had to transact all future business under the protection of a foreign flag and through a foreign firm.

This restriction turned again the attention of the board to Polynesia, where settlers and not merely hands for the planters might be obtained, but upon further investigation the plan was abandoned.

In 1869 two eminent persons were sent on an expedition with two ships to visit the various isles of the Pacific and Atlantic to secure if possible voluntary laborers for the Kingdom. One ship returned with a cargo from Caroline and Humphrey islands, having visited many others without success.

These immigrants were cleanly, intelligent, docile, Christian, speaking a language similar to Hawaiian. The other ship brought a cargo from the Danger Islands. These were far from being satisfactory to their subsequent employers, many of whom were ultimately released and returned to their native islands.

Soon after these importations another controversy arose as to the class of future immigrants. Great dissatisfaction was felt by the King and council at the large number of Chinese already in the islands, since they desired immigrants more nearly related to the Hawaiians. An anti-coolie party, consisting chiefly of mechanics and tradesmen, strongly opposed the further introduction of Chinese by the sugar planters. Mass meetings were held, with verdicts against the Chinese and in favor of South Sea Islanders or other races ethnologically related. Efforts were made to secure immigrants from India, Japan, and Malaysia, and the Dutch and English East Indies. All proved abortive, after much discussion, diplomacy, and a large expenditure of time and money, except with Japan. After much delay and long and specific

contracts a shipload of Japanese reached the islands in 1869. They made good laborers, and were themselves satisfied and satisfactory to the employers. But the Japanese Government became alarmed through false rumors of maltreatment of its subjects and sent commissioners to Hawaii to investigate their true conditions. To their surprise they found everything mutually pleasant and satisfactory to both Japanese and planters. While discussions were going on in the board relative to the advisability of importing Swedes and Portuguese, several more cargoes of Chinese were introduced by the planters. A new and untried system of cooperative labor was introduced on a small scale in 1870. Thirty white men from the States were carried over to labor on the plantations to receive as compensation one-half of the crop made. On account of drought, inexperience, etc., the cooperative experiment was far from being a decided success. The Hawaiian Immigration Society to promote immigration was next formed, but few fruits of its labors were apparent. In the meanwhile another importation of Chinese was made, soon to be followed by others, many of whom on arrival went into rice culture.

Again attention was directed to the Azores and the possibility of obtaining desirable immigrants therefrom. Italy was also considered as a source of supply of future laborers. But nothing tangible was accomplished. In July, 1876, the treaty of reciprocity between the Hawaiian Kingdom and the United States was ratified. It created great joy and much inspiration in every planter in the islands. Extensive improvements were undertaken at once and energetic efforts made to secure more laborers.

In 1878 the first batch of Portuguese from Madeira, secured after patient efforts, was landed in Honolulu, followed soon after by a cargo of South Sea Islanders, all of whom proved satisfactory to the planters. This arrival of Portuguese proving so desirable, negotiations were made at once to introduce them on a large scale. Accordingly many vessels soon after reached Honolulu, bringing exclusively cargoes of Portuguese from Madeira.

In 1881 two vessels filled with Norwegians arrived. But few of them were agriculturists and therefore were soon dissatisfied with life on plantations.

The propriety of introducing negroes from the Southern States was discussed by the board, with the result of a decided opposition to the scheme.

More cargoes of South Sea Islanders were introduced, followed soon after by several vessel loads of Germans. The islands were rapidly filling up with a desirable population. The Chinese and Japanese were for the time being neglected by the Government. Though neglected by the Government, the Chinese, however, came of

their own accord in large numbers, until it was found necessary to restrict this immigration by suitable laws.

In 1885, after a favorable treaty with Japan had been ratified, the introduction on a large scale of Japanese laborers under the contract system began, which continued up to the annexation of the islands to the United States.

Several large cargoes of Portuguese from the Madeira Islands were also landed in Honolulu during the year.

Since 1885 up to the time of annexation the introduction of Chinese, Japanese, and Portuguese has been made to meet the wants of the islands. The Japanese and Portuguese have been brought in mainly on contract, and having completed the time of service required by the latter they have either renewed service or been returned to their homes. The Chinese have always come on their own accord.

In studying the history of immigration to the islands it is difficult to conceive of a country that the bureau of immigration and the planters have not considered as a source of supply of labor. They have repeatedly been disappointed, but they have persisted with a zeal and an energy worthy of the highest type of intelligence.

The following, furnished by Prof. W. D. Alexander, historian and surveyor-general of the islands, gives a summary of "immigration and population," which is reliable and instructive:

IMMIGRATION AND POPULATION.

The pressing demand for labor, created by the reciprocity treaty, had led to great changes in the population of the Hawaiian Islands. It has been the policy of the Government to assist immigrants from widely different countries, not only as laborers, but also as prospective citizens.

In the year 1877 arrangements were made for the importation of Portuguese families from the Azores and Madeira, and during the next ten years about 7,000 of these people were brought to the islands. Others have since been added to their number, and their natural increase has been very rapid. At the present time the total number of Portuguese in the islands, including those born there, is not far from 16,000. About 2,400 of them are employed in sugar plantations. They have shown themselves to be an industrious, thrifty, and law-abiding element in the population.

Persistent efforts have also been made to introduce Polynesian islanders, as being of a cognate race with the Hawaiians, but the results have been wholly unsatisfactory. About 2,000 of these people, mainly from the Gilbert Islands, were brought in at the expense of the Government, between 1878 and 1884, but they did not give satisfaction, either as laborers or as citizens, and most of them have since been returned to their homes.

There has never existed any treaty or labor convention between the Government of Hawaii and the Empire of China. In early days a limited number of Chinese settled in the islands, intermarried with the natives, and by their industry and economy were generally prosperous. About 750 of them were naturalized under the monarchy. The first importation of Chinese laborers into the country took place in 1852. In 1878 the number of Chinese had risen to 5,916. During the next few years there was a steady influx of Chinese free immigrants, which finally reached

alarming proportions. In the spring of 1881 the Hawaiian Government was obliged to send a dispatch to the governor of Hongkong to stop this invasion. Again, in April, 1883, it was suddenly renewed, and within twenty days five steamers arrived from Hongkong, bringing 2,253 Chinese passengers, followed the next month by 1,100 more, with the news that several thousand more were ready to embark. Accordingly, the Hawaiian Government sent another dispatch to the governor of Hongkong refusing to admit any further immigration of male Chinese from that port.

Various regulations restricting Chinese immigration were enacted from time to time, until in 1886 the landing of any Chinese passenger without a passport was prohibited. The number of Chinese in the islands had risen to 21,000, and in 1899 it is estimated to be about 27,000, of whom about 6,000 are employed on sugar plantations.

They have reclaimed many useless swamps for the cultivation of rice. Many of them are shopkeepers, market gardeners, laundrymen, and fishermen. They have been truly described as industrious, persevering, frugal, peaceable, and law abiding. Their mercantile credit stands as high as that of any other nationality. The principal vices of their lower class are opium smoking and gambling. Nearly all of them have come from the province of Kwangtung (Canton), being divided into two clans, speaking different dialects, known as the Punti and Hakka tribes.

The consent of the Japanese Government to the emigration of its subjects to Hawaii was obtained with difficulty in 1884, and in 1886 a labor convention was ratified. Since then the increase of the Japanese element in the population has been constant and rapid. It rose from 116 in 1884 to 12,360 in 1890 and 24,400 in 1896. At the close of 1899 it is estimated to be about 58,000, of whom about 26,000 are employed in sugar plantations. They have for the most part been recruited from the lowest classes in Japan. Unlike the Chinese, they show no inclination to intermarry with the Hawaiians. They may fairly be characterized as versatile, ingenious, imitative, but clannish to an extreme, fickle, and vain. In regard to labor unions and strikes they can give points to other nationalities. Crimes of violence are more frequent among them than among any other race in the islands.

The effect of annexation to the United States will be to put an end to all assisted immigration of whatever race, and to exclude all Chinese laborers. But under the recent treaty between the United States and Japan, there is nothing to limit the free immigration of Japanese, and several companies have been formed to promote it.

The excessive preponderance of males over females in Asiatic immigration constitutes a serious menace to the morals and health of the commonwealth. In 1896 the ratio of males to females was 8 to 1 among the Chinese, nearly 5 to 1 among the Japanese, 8 to 7 among the Portuguese, and 8 to 5 among other whites, the proportion for all the inhabitants being 2 to 1.

The decrease of the aboriginal population has still continued, from 44,088 in 1878 to 40,014 in 1884, 34,436 in 1890, and 31,019 in 1896, the rate of decrease being about 1.6 per cent a year. At the same time the part Hawaiians, the offspring of intermarriages between Hawaiian women and men of other races, have been constantly increasing from 3,420 in 1878 to 4,218 in 1884, 6,186 in 1890, and 8,485 in 1896. All these facts point to the gradual extinction of the full-blooded Hawaiians, and the absorption of the remnant of the race by the European and Asiatic population.

LAND MATTERS.

The ancient system of land titles in the Hawaiian Islands bore a close resemblance to the feudal system of the Middle Ages.

When Kamehameha I conquered the islands, he divided out the lands among his principal chiefs, retaining a goodly portion for himself to be cultivated or managed by his own servants or attendants.

Each chief again divided his portion among his subordinates, who in time divided again among the lowest tenants. From tenant on to highest chief was exacted not only a land tax for use of land, but also service when demanded by the King. A failure to respond to these demands might forfeit the right to the lands. The King really owned the allodium, while the persons to whom he intrusted the land held it in trust. The land taxes were really a rent, and constituted the revenues of the King. Formerly every tenant was required to work one day in every week (Tuesday) for the King and one day (Friday) for the landlord. Upon the accession of a new king it was customary to redivide and distribute the lands among his chiefs and favorites.

The common people were merely tenants at will, and could be dispossessed of their lands at the pleasure of king or chief, until 1839-40, when laws were passed preventing evictions without cause. The ancient system being incompatible with progressive civilization, the King and chiefs decided to separate interests and define the rights which each held in the lands of the Kingdom. After patient investigation, it was decided to divide the lands between the King, the chiefs, and the tenants, and vest the titles in each.

ORIGINAL DIVISIONS OF LAND.

Each island was divided into moku or districts, names of which have already been given in the description of the islands. The subdivisions of a "moku" are "ahupuaa," which is really a unit of land in the islands. Its name, derived from "ahu," an altar, and "puaa," a hog, referred to the ancient custom of erecting an altar at the point where the land intersected the main road which encircled the island, and upon this altar was erected the image of a hog carved out of Kukui wood.

The typical ahupuaa is a long, narrow strip, running from the mountain to the sea, and includes the mountain, the cultivated plateau, the taro patches and the sea. On the windward sides, each valley constituted a distinct ahupuaa, and was of unequal areas. These divisions were made generally along natural lines, such as ridges, ravines, etc.

The ahupuaas were sometimes divided into "ilis," of which there were two kinds, one paying tribute to the chief, while the other did not.

LAND COMMISSION.

In 1846 an act was passed providing for the appointment of a board of commissioners to quiet land titles. These commissioners were organized February, 1846, and continued till March, 1855. This board had full powers to investigate the claims and rights of all to the lands of the Kingdom. After exhaustive work, performed with great zeal, they gave their awards which are recorded in ten huge folios, which are deposited in the land office of the islands.

The work of this board was finally brought up before the King and

the chiefs in privy council on December 11, 1847, and after much discussion was settled in the following resolutions December 18, 1847:

Whereas it has become necessary to the prosperity of our Kingdom and the proper physical, mental, and moral improvement of our people that the undivided rights at present existing in the lands of our Kingdom shall be separated and distinctly defined:

Therefore we, Kamehameha III, King of the Hawaiian Islands, and his chiefs in privy council assembled do solemnly resolve that we will be guided in such division by the following rules:

I. His Majesty, our Most Gracious Lord and King, shall, in accordance with the constitution and laws of the land, retain all his private lands as his own individual property, subject only to the right of the tenants to have and to hold to him, his heirs and successors, forever.

II. One-third of the remaining lands of the Kingdom shall be set aside as the property of the Hawaiian Government, subject to the direction and control of His Majesty, as pointed out by the constitution and laws, one-third to the chiefs or konohikis in proportion to their possessions, to have and to hold to them, their heirs and successors, forever, and the remaining third to the tenants, the actual possessors and cultivators of the soil, to have and to hold to them, their heirs and successors, forever.

III. The division between the chiefs or konohikis and their tenants, prescribed by rule second, shall take place whenever any chief, konohiki, or tenant shall desire such division, subject to confirmation by the King in privy council.

IV. The tenants of His Majesty's private lands shall be entitled to a fee-simple title to one-third of the lands possessed and cultivated by them, which shall be set off to the said tenants in fee simple whenever His Majesty or any of said tenants shall desire such division.

V. The division prescribed in the foregoing rules shall in no wise interfere with any lands that may have been granted by His Majesty or his predecessors in fee simple to any Hawaiian subject or foreigner, nor in any way operate to the injury of the holders of the unexpired leases.

VI. It shall be optional with any chief or konohiki holding lands in which the Government has a share, in the place of setting aside one-third of the said lands as Government property, to pay into the treasury one-third of the unimproved value of said lands, which payment shall operate as a total extinguishment of the Government right in said lands.

VII. All the lands of His Majesty shall be recorded in a book entitled "Register of the lands belonging to Kamehameha III, King of the Hawaiian Islands," and deposited with the registry of land titles in the office of the minister of the interior, and all lands set aside as the lands of the Hawaiian Government shall be recorded in a book entitled "Register of the lands belonging to the Hawaiian Government," and fee-simple titles shall be granted to all other allottees upon the award of the board of commissioners to quiet land titles.

After some litigation and some patience, the lands were divided and titles confirmed in accordance with above resolutions and the divisions recorded in the "Mahele Book."

The following are the approximate results of this division:

	Acres.
Government lands.....	1,495,000
Crown lands.....	984,000
Chiefs' lands.....	1,619,000
Kuleanas (ordinary tenants) lands.....	28,600
Total.....	4,126,600

The area assigned the kuleanas or ordinary tenants was comparatively very small, but included some of the choicest lands in the islands. In the awards to tenants the latter were permitted to take water, wood, thatch, and ti leaf from the lands on which they lived for their own purposes. They also had the right to catch fish from the sea appurtenant to the land and sell the same. In default of heirs the tenants' lands reverted to the owner of the ahupuaa from which it was originally escheated.

As the chiefs generally ran into debt and died in many cases without heirs, their lands have largely passed into the hands of foreigners.

Upon the abolition of the monarchy in 1893 the Crown lands were declared to be public lands and are now held, together with other Government lands, by the United States. The Crown lands, made inalienable by law in 1865, have hitherto been held for the most part under long leases. The biennial report of the commissioner of Crown lands gives situation, description, price paid for lease, expiration of lease, and names of lessees of all the Crown lands. The policy to be pursued when their leases expire is not yet definitely settled. Many of them are held by sugar estates and are yielding maximum acre results. If it be desirable to break up these large holdings into homesteads and encourage the growth of an agricultural population, the aggregate income of the islands will be greatly diminished, though a permanent agricultural population will be secured.

Directly after the division given above, the Government began the sale of its public lands at private sale and at low rates of 12 cents to \$1 per acre. The lands were selected and surveyed by the purchaser and many thousands of the best acres of Government lands were thus early disposed of at nominal prices, leaving numerous scattered remnants of undesirable and unsalable lands throughout the islands. At least 500,000 acres were thus disposed of, mainly to the natives.

An act was passed in 1876 requiring all sales and leases of public lands over \$300 in value to be sold at public auction, and the provisional government in 1893 required all sales and leases of every kind to be made at public auction after thirty days' notice.

HOMESTEAD LAWS.

The first homestead act to acquire small holdings was passed in 1884. It was amended several times, but remained in force until the passage of the land act of 1895. It gave the privilege of acquiring lots not over 20 acres in extent, payable in ten years, and requiring the erection of a dwelling and a residence of three years on the land. A substitute might reside on land with the consent of the minister of the interior, as amended in 1892. Under these homestead laws 527 persons took up 8,490.81 acres, valued at \$62,794.55, of which patents have been granted to 377 persons for 5,820.76 acres, valued at

\$45,312.30, leaving the remainder yet to be patented. Under the amendment "without residence" there have been taken up 3,552.84 acres, valued at \$10,610.63, of which 2,942.44 acres, valued at \$8,023.13, have been patented. The results of these homestead laws were beneficial in placing homes, which have been greatly improved, into the possession of numerous families of moderate means. They did not, however, meet all of the requirements, hence these laws were supplanted by the land act of 1895, which consists briefly as follows:

Part I. Interpretation of words and terms used in the act.

Part II. General provisions, classification of lands into (1) agricultural, (2) pastoral, (3) pastoral agricultural, (4) forest, and (5) waste land.

Part III. General administration, designating board of commissioners and defining duties, and dividing the islands into land districts.

Part IV. Land patents, how sales shall be made and patents issued, and disposition of processes of sales.

Part V. General leases.

Part VI. Homestead leases.

Part VII. Right of purchase, leases, and cash freeholds.

Part VIII. Settlement associations.

Part IX. Oloo reservation.

Part X. Puukapu, Kaimu, and Waiakolea reservations and native reservations of Oloo.

Part XI. Repealing all former acts.

THE LAND ACT OF 1895.

The following paper, prepared at my request by Mr. J. F. Brown, commissioner of public lands for Hawaii, explains the operations of the above act, and gives valuable statistical data relative to the public lands of the islands:

To promote the settlement and improvement of the remaining Government land, under conditions favorable to the settler, but not to speculators, and to meet the needs of different classes desiring lands, the land act of 1895 was enacted as being specially adapted to the requirements of the case.

An important feature of this fact was the general requirement of cultivation and improvement of lands taken up, as well as residence thereon for a term of years. There was authority, however, under the act for the sale of lands at auction under special conditions, as to payments for same and cultivation without residence, to meet the cases of persons who desired to improve and cultivate land, but having occupations elsewhere were unable to live on the same.

METHODS OF ACQUIRING LAND UNDER THE LAND ACT OF 1895.

General qualifications required of applicants.—Must be over 18 years of age, be citizen by birth or naturalization, or have letters of denization, be under no civil disability nor delinquent in payment of taxes.

Homestead lease.—Nine hundred and ninety-nine year lease, conditions upon main-

taining a home upon the premises, paying taxes, and cultivating small percentage areas that might be required, 8 to 45 acres, dependent upon quality; no payments other than small application fees; husband and wife might not both be applicants; applicant must not be owner of other land (except taro or wet land); lease inalienable; not subject to attachment, levy or sale, or to any process of the courts, might not be mortgaged, assigned, or sublet.

Right of purchase lease.—Lease for twenty-one years with right to purchase at original appraised value any time after two years' residence and cultivation of 25 per cent; area that might be acquired, 100 to 1,200 acres, dependent on quality; husband and wife might not both be applicants; applicants could apply for only such amount as taken with any lands owned by them would come to the limits name; rental at 8 per cent on appraised value to be paid until purchase was made.

Cash freeholds.—Lands sold at auction at an appraised value as upset price; purchase price due in four installments during three years; two years' residence and 25 per cent of cultivation further required to perfect title; qualifications and areas that might be acquired same as under right of purchase lease.

Special agreements.—Sale at auction under special conditions as to payment by installments, with requirements of cultivation, with or without residence limit of area that might be sold under special agreement, 600 acres. (Practically the area has been limited to 100 acres of first-class land, as under the other systems.)

Cash sales.—Sales made unconditionally for cash at public auction. These sales usually made to meet cases where exceptionally costly improvements were contemplated, as buildings, reservoirs, pumping machinery, etc.

Olaa district sales.—Special sales, at a value appraised in the act of 1895, of lands held under Crown leases in the district of Olaa, Hawaii. Lessee could purchase his leasehold up to 200 acres when 15 per cent of same had been put under cultivation and further improvements to the value of \$200 made; distinct from the general systems of the land act and applying only to the Olaa district.

Summary of transactions under the land act of 1895.

Lands taken up.	Number.	Acres.	Value.
Homestead leases	115	1,549.56	\$5,000.00
Right of purchase leases	356	18,665.78	118,665.56
Cash freeholds	23	783.82	4,117.54
Special agreements	122	7,066.17	50,689.06
Cash sales	40	2,996.89	39,923.73
Olaa district sales	142	15,532.00	61,171.00
Total	798	46,594.22	279,566.89

¹ Value of homestead-lease land is an arbitrary estimate. Formal appraisement not required under the law.

A comparison of transactions during the period 1884-1895 with those of the period from 1895 (under "land act") shows for the latter period a very much larger proportion of lands taken up under conditions of homestead or improvement as compared with "cash sales."

Transactions during 1884-1895 (eleven years).

Lands taken up.	Acres.	Value.
Cash sales	37,675.34	\$195,588.95
Under homestead or improvement conditions	12,043.65	73,465.13
Total	49,718.99	268,994.13

Under land act of 1895 (four years).

Lands taken up.	Acres.	Value.
Cash sales.....	2,996.89	\$89,923.73
Under homestead or improvement conditions.....	43,597.33	239,643.16
Total.....	46,594.22	279,566.89

The land act of 1895 has proved well suited to the condition in the Hawaiian Islands. Under it the demand for public land has been active, and fair prices have been realized for the benefit of the public treasury.

Speculation and land grabbing has been minimized and a marked improvement and development of lands taken is evident. The success of the act would not be questioned by any impartial observer familiar with the facts.

The extremely varied quality of the lands, the intermingling of public and private lands, and the special needs of the people, together with the duty of best utilizing the limited public domain required land laws drawn to meet such special conditions, and these, in all essential points, have been met by the land act of 1895.

GENERAL LEASES.

The foregoing statements have been applied to those lands directly sold or taken up under conditions looking to ultimate purchase. It remains to consider the question of lands held under leases for terms of years, upon the expiration of which all interest of lessee terminates.

From the time of the great division of 1848 to the present time the policy of the leasing lands for a term of years has been pursued, both in the case of the Government lands and of the Crown lands controlled by the commissioners for the same.

In 1876 the first law requiring sale of Government leases to be made at auction was enacted, but such law did not apply to the Crown lands, which were not put under this regulation until the passage of the land act of 1895.

Under the lease policy lands were freely leased both by the Government and by the Crown commissioners in large areas and for long terms, but in 1891 the Government, while continuing the policy of leasing land, improved upon former methods by reserving to itself the right to take up any portion of the leased land suitable for settlement, which reservation proved later of much value.

This policy was continued after the passage of the land act of 1895, but with stricter regard to amounts leased, terms of lease, and reservations necessary for public interest.

Until the date of the land act of 1895 the Crown lands were leased without auction sale, in such amounts and for such terms of years (until limited by law in 1865 to thirty years) as the commissioners approved, and although by the land act of 1895 these lands were merged in the general domain of public lands and became subject to that act, practically they had nearly all been leased in large tracts and for long terms without reservation.

As between the two classes of land, therefore, now constituting the public lands, the former Crown lands are more generally encumbered with long-term leases.

VALUE OF LEASE SYSTEM.

Although the old method of leasing was shortsighted and with little or nothing to commend it, a proper lease system is of distinct value.

Numerous tracts of land are found of which it is difficult to estimate agricultural possibilities, if indeed any exist. Other tracts, owing to the intermingling of public and private lands and the fragmentary character of some of the public lands, are so

surrounded by private lands owned or controlled by a single party that the sale of the same would be at a distinct disadvantage to the Government, and result only in swelling the holdings of already large owners at an adequate price.

Practically it is found that many persons will pay a rental representing a larger value than the purchase price that could be obtained.

A lease, therefore, may be made to return the best results in revenue, while a reservation of the right to take up portions suitable for settlement leaves the way open at any time for such use if later conditions require it.

The revenue from rent of lands has steadily increased, although the area of lands leased has in the same period been reduced by many thousands of acres. In 1890-1898 the annual rent roll, Government and Crown lands, was as follows: 1890, \$80,268; 1894, \$91,983; 1898, \$95,225. Town lots, buildings rented, etc., are not included. The additional income from such sources is about \$34,000 annually.

Under the land act of 1895 general leases were limited to a term not longer than twenty-one years.

Leases might not contain any privilege of renewal, nor be made for any land on which an unexpired term of two years remained.

The commissioners of public lands could impose conditions necessary in the public interest.

TRANSACTIONS SINCE JULY 7, 1898.

The Newlands resolution, passed by Congress July 7, 1898, for the annexation of the Hawaiian Islands, created much uncertainty as to the status of the public lands and the laws governing them. Upon the understanding and belief, however, that the laws of the United States relative to public lands did not apply to such lands in the Hawaiian Islands, and that the local land laws were to remain in force pending further action of Congress, the usual transactions of the land office were continued until September 28, 1899, the date of receipt of the executive order of President McKinley suspending further transactions. The following table shows lands taken up from July 7, 1898, to September 28, 1899:

Lands taken up.	Number.	Acres.	Value.
Homestead leases	45	551.50	(¹)
Right of purchase leases	57	4,507.09	\$22,239.75
Cash freeholds	4	67.82	169.54
Special agreements.....	41	1,035.87	7,821.00
Cash sales	18	1,172.59	18,719.00
Olaa patents under Part IX of land act	69	7,999.39	29,177.57
Total	234	15,334.26	78,126.86

¹Not appraised.

Land patents issued since July 7, 1898.

Number	199
Acres.....	12,534.53
Value	\$67,821.54

Of the above amount, patents for 11,643 acres, valued at \$48,548.54, were issued in completion of agreements made prior to the annexation resolution of July 7, 1898.

General leases since July 7, 1898.

Number	8
Acres.....	1,856.86
Rental (yearly).....	\$2,847.00

Remaining public lands.

	Acres.
Combined area of Government and Crown lands (by the original division in 1848), as near as can be determined.	2, 479, 600. 00
Patents and deeds have been issued for	728, 200. 00
	<hr/>
Remainder (including lots taken up, but not yet patented).....	1, 751, 400. 00
Old homesteads	2, 670. 05
Old special-agreement sales	610. 40
Under land act (not patented).....	28, 065. 33
	<hr/>
	31, 345. 78
	<hr/>
Total remaining.....	1, 720, 054. 22

The remainder (1, 720, 055 acres) of public land may be roughly classified as follows:

	Acres.
Valuable building lots	145
Cane lands.....	25, 626
Rice lands	977
Coffee lands.....	26, 825
Grazing lands.....	448, 200
High forest lands.....	681, 282
Rugged, inaccessible mountain	227, 000
Barren (of nominal value only)	310, 000
	<hr/>
Total	1, 720, 055

The above classification is of necessity somewhat arbitrary. As stated in my report of 1894—

The lack of positive knowledge of quality and adaptability of the soil in untried sections and the imperceptible gradations by which the best land merges into the indifferent and indifferent into that of nominal value only makes a report of this nature to a considerable extent a matter of personal opinion rather than of scientific certainty.

It is probable that much classed above as "grazing land" and "high forest land" will be found later to have good agricultural possibilities, these lands being now practically undeveloped.

THE CROWN LANDS.

By article 95 of the constitution of the Republic of Hawaii that portion of the public domain known as "Crown land" was declared to be the property of the Hawaiian Government, and to be free and clear of any trust of or concerning the same, and from all claim of any nature whatever upon the rents, issues, and profits thereof. All existing valid leases were declared to be confirmed.

By the land act of 1895 these lands were included with other Government lands under the general head of public lands.

The following extract, by permission, from "A brief history of Hawaiian land titles," by W. D. Alexander, surveyor-general, is a concise history of these lands prior to the establishment of the Republic of Hawaii:

The term "Crown lands" is here applied to those lands reserved by Kamehameha III, March 8, 1848, "for himself, his heirs, and successors forever," as his private property. To these may be added a few lots in Honolulu and Lehaia, awarded to him by the land commission, award 10806.

It is admitted by all that both Kamehameha III and his successors dealt with these lands as their private property, selling, leasing, or mortgaging the same at pleasure. These royal deeds of sale constitute titles equally valid with royal patents.

At the death of Kamehameha IV it was decided by the supreme court that under the above-mentioned instrument, executed by Kamehameha III, reserving the Crown lands, and under the confirmatory act of June 7, 1848, "the inheritance is limited to the successors to the throne," "the wearers of the crown which the conqueror had won," and at the same time "each successive possessor may regulate and dispose of the same according to his will and pleasure as private property, in like manner as was done by Kamehameha III." (Hawaiian Reports, vol. 2.)

Afterwards an act was passed, January 3, 1865, "to relieve the royal domain from incumbrances and to render the same inalienable."

This act provided for the redemption of the mortgages on the estate and enacted that the remaining lands are to be "henceforth inalienable and shall descend to the heirs and successors of the Hawaiian Crown forever," and that "it shall not be lawful hereafter to lease said lands for any term of years to exceed thirty." "The board of commissioners of Crown lands shall consist of three persons, to be appointed by His Majesty the King, two of whom shall be appointed from among the members of his cabinet council and serve without remuneration and the other shall act as land agent and shall be paid out of the revenues of the said lands such sum as may be agreed to by His Majesty the King."

SETTLEMENT OF THE CLAIM OF R. KEELIKOLANI, AS HEIR OF KAMEHAMEHA V.

Under date of September 13, 1880, Ruth Keelikolani, as heir of Kamehameha V, released and quitclaimed to Claus Spreckles, for consideration of \$10,000, all her title and interest in "the lands reserved by Kamehameha III as his own private property, commonly called and known as the 'Crown lands.'" (Recorded in book 64, p. 342, registry office.)

By act of Hawaiian legislature, approved July 21, 1882, for the satisfaction of the claim of Claus Spreckles to an undivided moiety of the Crown lands, by virtue of a conveyance from Ruth Keelikolani, the commissioners of Crown lands were authorized to make proper deeds, and the minister of interior to issue and deliver a royal patent to said Claus Spreckles for the "Ahupuaa of Wailuku, Maui, and Iiis" therein or thereunto belonging, containing about 24,000 acres.

Before the execution of such deed and assurances said Claus Spreckles to relinquish and quitclaim all his right and interest in residue of Crown lands.

August 11, 1882, Claus Spreckles and wife released and quitclaimed to the commissioners of Crown lands undivided moiety or interest claimed by him in, to, or out of the lands known as Crown lands, more particularly the lands conveyed to grantor by Ruth Keelikolani, September 13, 1880. (Recorded in book 76, p. 198, in registry of deeds.)

August 11, 1882, the commissioners of Crown lands grant and convey to Claus Spreckles the Ahupuaa of Wailuku, Maui, and the Iiis thereunto belonging, in accordance with act of legislature, approved July 21, 1882. (Recorded in book 75, p. 282, registry office.)

September 30, 1882, patent grant 3343 issued by minister of interior to Claus Spreckles for the Ahupuaa of Wailuku and Iiis thereto belonging, containing 24,000 acres, more or less.

SUPPLEMENTARY.

HONOLULU, *August 13, 1900.*

The area of public land of this date is about 1,700,000 acres, but of this area a large amount is of such absolutely barren quality that it can not be regarded as suited to any agricultural purpose. There is also a large area so rugged and inaccessible that its occupation for agricultural purposes is very unlikely. Much of the best land, more particularly those formerly known as Crown lands, are covered by leases made years ago.

It is the policy of the land office to open up lands for settlement whenever the expiration of an old lease gives opportunity to do so and as rapidly as surveys can be made, which, owing to the heavy jungle and rough nature of much of the country, are tedious and expensive. The question of suitable roads adds greatly to the difficulty of opening lands, as much of the public land lies from existing roads. In the nature of the case, the division and settlement of public lands must be a gradual process.

In a general way it may be said that the lands suited to cane culture and rice growing are well occupied at this time.

Coffee lands are to be had, but coffee planters in general appear to be discouraged at the outlook, and are seeking other uses for their land.

The banana industry is hampered, except on the island of Oahu, by lack of direct communication with the United States.

Small farming (of general farm products) is at present in a "tentative" condition, there being at present but little positive data from which to draw conclusions.

J. F. BROWN,

Commissioner of Public Lands.

AUGUST 13, 1900.

EXPERIMENT STATION.

A brief résumé of the facts recorded above will show in an unmistakable manner the absolute necessity for an experiment station on the islands.

The sugar industry dominates all other interests and constitutes the chief money crop of the islands. It is operated mainly by corporations which run large estates and cultivate sugar extensively, no attention being given to other and secondary crops. Neither the laborer nor the stock used on the plantation is maintained by the products of the estate, feed, food, etc., being imported and paid for in current values.

These corporations are divided into shares which are marketable under the provisions of their charters, and are subject to daily fluctuations upon the stock exchange in Honolulu, and bear no necessary relation to the state or value of the estate. These corporations live or sink solely by sugar. They must pay their way or close up. When the tariff bill of 1890 passed Congress, placing raw sugars on the free list and giving a bounty to the domestic producers, thus depriving Hawaii of the benefits of the reciprocity treaty, the great agencies and plantations of Hawaii tottered to their fall. Some fell; others were saved by outside capital. A labor crisis, a prolonged quarantine, or a suspension of ocean traffic would work sore disaster even to those estates which have enormous capital, since at no time is there a superabundance of food for man and beast, either in the pantries of the plantations or in the stores of Honolulu. To maintain the fertility of the soil where only one crop is grown, and that in maximum quantities biennially, requires great sagacity. On the estate the one thought is how to keep the average quality of land from going out of cultivation. How can expenses be reduced and crops enhanced so as to secure the largest dividends on stock is the object of their existence.

Such estates are destructive of family ties and home comforts; single men are always preferred and objection made to the incumbrances and expenses of women and children. Hence, adaptability of Asiatics to such work, who serve their contract time and then return to China or Japan, or rush to the cities or towns to engage in urban pursuits. Such estates are not conducive to permanent settlers—steady yeomanry, prosperous farmers—which are regarded as the pride and reliance of every nation.

In the islands a strong antagonism prevails against such estates, and a demand is made that the large areas formerly owned by the Crown and now leased to the sugar corporations shall be divided and subdivided, at the expiration of lease, into homesteads for occupancy by permanent farmers or gardeners.

On the contrary, it may be stated that there is probably no industry besides sugar that can give such enormous acre yields in money and bear the heavy cost of expensive irrigation plants, steam plows, etc. The exports of the island were last year \$22,628,741, of which over \$22,000,000 was furnished by sugar. Again, these large acre yields give enormous taxable values to the lands, from which public revenues are raised for public improvements, public schools, etc.

It is therefore a question of serious moment whether the present conditions will be improved by the establishment of small farmers, market gardeners, dairymen, stockbreeders, etc., over the islands. I believe that the experiment station can aid largely in paving the way and inaugurating the proper methods upon which these smaller industries must be established, in order that they may (if ever) successfully supplant the present large estates. Again, these estates employ over 40,000 laborers, concentrated upon about 100,000 acres of land, engaged in an intensive industry, capable of giving support to more people within a given area than any other agricultural industry. Will the present population be decreased by the change?

IRRIGATION.

As practiced upon the islands, irrigation has been shown to be very wasteful. The quantity of water used on the various plantations has been found to be as high as 3,600 to 5,600 pounds to every pound of sugar grown. Dr. Maxwell has found, in his careful experiments, that the crops of 1898 and 1899 required, respectively, 865 and 859 pounds of water per pound of sugar grown. These figures tell the story, and call for urgent reform and economy of an element so valuable as water within the irrigated districts. Different plants are known to thrive at different elevations. Since water is the most variable factor concerned in plant growth at different elevations on the islands (temperature and soil varying but little), an experiment station may sub-

serve a most useful purpose in accurately determining the water requirements of the different plants, fruits, and vegetables which may be grown on the islands.

RICE CULTURE.

The primitive methods already described as practiced by the Chinese in the growing of rice and its preparation for market call loudly for reform. The annual production of this crop is about 10,000,000 pounds, a part of which is consumed on the islands. The size of the crop, together with the fact that it constitutes the chief food of a large portion of the laborers on the islands, would justify serious attempts in introducing improved methods. The plow, harrow, grain drill, and harvester ought to be profitably introduced in the field, and an up-to-date rice mill supplant the crude water mill of the Chinese. An experiment station, if the director be informed on rice culture, could assist greatly in introducing these improvements.

STOCK RAISING.

The inferior stock elsewhere described and the primitive methods of preparing it for market can be used as a basis for extensive experiments by the station. Accurate feeding experiments and the growing of suitable forage crops; the introduction of the best types of beef cattle, mutton sheep, and bacon hog, and the judicious crossing of them upon selected native stock are experiments badly needed to guide and instruct the stock raisers and graziers of the islands. Stock raising of every kind must be largely increased on the islands, since the supply is now insufficient to meet the demands. Who knows but that the fertile plains which now yield so bountifully in sugar when properly irrigated may not under similar treatment produce enormous crops of alfalfa or some other legume which will solve the profitable raising of stock on the islands?

POULTRY.

Enormous quantities of ducks are raised by the Chinese upon the edges of the ocean. Twice a day, within restricted areas, they are permitted to eat the young fish which swim in the inclosed adjacent coves. Fish are reported to be growing scarcer every year, and by some this diminution is attributed to the wholesale destruction of young fry by the ducks of the Chinese. Be this as it may, the duck experiments by the Chinese demonstrate the feasibility of growing poultry extensively on the islands. Chickens and eggs are excessively high and are raised on the islands in very limited quantities, the bulk of the latter coming from China. It is believed that the poultry industry could be largely developed by proper experiments conducted by an experiment station.

VEGETABLES.

Enough has been done to demonstrate the fact that at some altitudes somewhere on the islands every vegetable known to modern gardens can be successfully grown. The letters of Mr. Buchholtz and Governor Dole, together with the testimony of hundreds of others, fully attest this assertion, yet Honolulu derives her main supply from San Francisco, the rest being furnished by the Chinese, who grow their vegetables in the lower lying areas of the islands adjoining their rice and taro patches. It was found, moreover, that the varieties cultivated by them were not of the improved kinds distributed by our large seed houses. Coupling location and indifferent varieties together may account for the failure to produce all of the vegetables needed in Honolulu in close proximity to this city.

Several settlements of American farmers have been made in Oahu and Hawaii with a view to developing the vegetable and fruit industries. Those on the former island have every reason for success. Transportation facilities and high commissions, as described by Mr. Buchholtz elsewhere, may prevent a realization of profits on the latter, but the big island has the reputation of growing the largest and best of all kinds of vegetables.

FRUITS.

Experimental work in fruits is most inviting, both on account of the diversity of kinds and the excellence of quality which can be grown on the islands. Up to the present only home orchards of limited areas and of few varieties have been grown, but these have demonstrated the capacity of the islands to produce a large number of subtropical and tropical fruits. Elsewhere mention has been made of the kinds which have been tested and the probability of their being grown successfully at some elevation or location somewhere on the islands. It is in the province of an experiment station to test all varieties at different elevations and under different exposures, with and without irrigation. It may be found that each fruit has its own peculiar zone, its preferable side of the islands, and a definite need of water, all of which may be determined by the station.

COFFEE CULTURE.

No systematic methods have ever been pursued in coffee culture, and it is highly probable that careful scientific experiments with this berry may prove highly profitable not only to the coffee growers of Hawaii but to the rest of the world.

Kona coffee has a world-wide reputation, commanding twice the price in the markets of Brazilian varieties. It should be more extensively grown and selection should be made of trees, and the conditions

well established by which this reputation was made, in order that the excellence of this variety may be propagated with certainty, and perhaps yearly improved. The present low price of coffee, the encroachment of sugar plantations upon coffee estates, due to the more profitable culture of the former; the absence of the knowledge of the proper environments for the best development of coffee, and the existence now and then of blight, have all conspired to discourage the growth of this plant, and accordingly areas and yields have gradually decreased in the last few years. This industry should be resuscitated, and the experiment station can do much toward its revival.

DAIRY INDUSTRY.

But little butter is made on the islands, and milk is sold at such prices as to prohibit its extensive use. A model dairy for instruction in the best methods should at once be established by the station. Dairy rations for cows, and how to grow the most of the foods entering therein, is also a part of the instruction to be afforded by the station.

From the above it will be seen what the work of an experiment station located on these islands should be.

LOCATION OF THE STATION.

After careful consultation with the board of trustees of both the Sugar Planters' Association and the Kamehameha Manual School, it was decided that a union of the experiment station with either of the above was undesirable. The former is excellently equipped and well officered, and will relieve this station of the necessity of studying the islands' greatest staple.

It was also found that the land around Honolulu was so exorbitantly high as to preclude the possibility of buying a sufficient quantity for station purposes.

An examination of the Government lands revealed the fact that a tract of 222 acres, running from the base of Punch Bowl (Pl. XXII, fig. 2) well up to the top of Tantalus, had been surveyed and set aside for an experiment station by the minister of the interior, in June, 1893, in accordance with section 7, act to establish a bureau of agriculture and forestry, approved January 4, 1893.

The upper portion of this tract was at once utilized in experiments in forestry, which are to-day continued under the commissioner of agriculture. The lower portion, designed for an experiment station, has never been utilized for want of the necessary funds and the reservation by the bureau of agriculture and forestry prevented its occupancy by settlers, who have located up to the very edge of the tract.

The ground is covered with a dense and luxuriant growth of *Lantana camara*, a native of the subtropical regions of South America, introduced in 1858, but now well naturalized and scattered over all of the

islands. To clear the ground of this pest will cost from \$10 to \$15 per acre. Besides Lantana there are some few trees of Algaroba (*Prosopis juliflora*) and cactus (*Opuntia tuna*). These can be easily and cheaply removed. It will probably be necessary to fence a considerable portion of this ground prior to cultivation.

EQUIPMENT AND ORGANIZATION.

There will be needed on this farm the following buildings and equipment:

	Estimated cost.
Director's house.....	\$4,000
Foreman's house.....	2,000
Laborers' quarters.....	2,000
Horse stable with feed rooms.....	1,000
General barn.....	1,000
Cattle stable.....	1,000
Fences, pumps, etc.....	500
Laboratories and equipment.....	3,000
Dairy and equipment.....	1,000
Total cost.....	15,500

In estimating for buildings it must be remembered that in Honolulu lumber is worth \$30 to \$50 per thousand feet and brick \$24 to \$30 per thousand. Carpenters and masons receive from \$2.50 to \$5 per day. It is possible that the above buildings may be erected at a cost slightly below the above estimate.

There will also be needed as a part of the equipment of the farm at least—

3 horses, worth.....	\$600
6 head of cattle, worth.....	600
Wagons, tools, implements, etc., worth.....	200
Total.....	1,400

These buildings can be erected at once or as the funds of the station may permit.

After due consideration of the environments of this station and the wants of the islands, I am persuaded that the following staff will be required: A director, a chemist, a biologist, an horticulturist, and a farm foreman.

The Territory of Hawaii in conjunction with the Planters' Association employs a very competent entomologist, Prof. A. Koebele, and therefore there is no immediate necessity of such a scientist for this station. There are several very competent veterinarians in Honolulu whose services can be obtained when desired.

To connect the station officially with the Territory and to insure for it the full measure of local sympathy and support, I recommend that a local advisory board, consisting of the governor, the commissioner

of agriculture and forestry, and the commissioner of public lands be appointed, which shall have such powers delegated to it in the management and control of the station, in conjunction with the director, as the Secretary of Agriculture may prescribe. The present occupants of these positions have been consulted and will readily assume such duties pertaining to this station as may be prescribed by the honorable Secretary of Agriculture. They are enthusiastic in the interest of the proposed station, as manifested by their personal courtesies during my recent visit, and will, I am sure, use every effort possible to make it a grand success. Their official positions will also enable them to create popular public favor on behalf of the station among the inhabitants of the islands, while their private interests, patriotic zeal, and personal integrity give assurance of honest action and faithful service in their official relations to the station.

SUMMARY OF LINES OF WORK.

The lines of work specially recommended are:

- (1) Raising of vegetables—
 - (a) For home markets.
 - (b) Variety tests.
 - (c) For winter use on the Pacific coast of the United States.
- (2) Raising of fruit—
 - (a) Strawberries, grapes, etc., with a view to determining how best to obtain them throughout the year.
 - (b) Tropical and subtropical varieties.
 - (c) Testing commercial value.
 - (d) Introduction and testing of new kinds.
- (3) Raising of forage crops—
 - (a) Leguminous.
 - (b) Grasses.
 - (c) Sorghum and similar forage crops.
- (4) Raising and fattening stock for market.
- (5) A small dairy, to illustrate the possibility of supplying the home demand for butter.
- (6) Experiments in coffee culture, e. g., variety, conditions of growth, shade, half shade, or open; fertilizers; amount of water required, etc.
- (7) Study of the economical use of water.
- (8) A study of the forest areas in their relation to the water supply of the islands.
- (9) Improved planting and culture of rice.
- (10) Poultry experiments.

LIBRARY OF CONGRESS



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