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Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

(54) J.G. 143 E.B.K.

Kauila

Two plants, both growing in arid regions, are known as kauila to the Hawaiians. The one is Colubrina oppositifolia Brongn., a tree peculiar to the Hawaiian Islands; the other is Alphitonia zizyphoides (Spreng.) A. Gray, a tree of wide distribution in Pacific regions. Both belong to the Rhamnaceae, or Buckthorn Family.

The colubrina is very rare in Hawaii National Park but may be seen in considerable numbers near Puuwaawaa on the Island of Hawaii. It is a smooth tree bearing shiny leaves in opposite arrangement. These are very characteristic in possessing conspicuous glands on their under side where the veins branch off from the midrib. The flowers are borne in clusters in their axils. Each flower is small, yellowish-green, and star-shaped because of its five, spreading sepals. Between these are borne both petals and stamens. As the petals are concave and contain the stamens, it is difficult to recognize both structures. Though the flowers are not conspicuous, they are dependent on insects for pollination. These are well repaid for their labor by abundant nectar which exudes from a flat, glandular disk located between stamens and pistils.

The fruit of the colubrina is a spherical, rather woody capsule bearing the remains of the calyx at the very base. It has three shallow, vertical grooves, along which the fruit finally splits open into three segments, each liberating a single, naked, dark gray seed from its inner side.

The alphitonia may be seen in the vicinity of the Kipuka Nene south of the Crater of Kilauea. It closely resembles the colubrina but may be readily distinguished from it by a few well-marked features. The leaves are arranged alternately on the stem, and their under surface is hairy and free of glands. The fruit, instead of bearing the remains of the calyx at its base as in the colubrina, bears it as a circular ridge a considerable distance above. It also lacks the three longitudinal grooves found in the other plant and therefore does not split into three definite parts at maturity. Instead, the woody capsule gradually breaks away in irregular fragments

from the seeds. They frequently remain attached to the fruit stalk, are invested with a peculiar, brown, brittle crust termed aril, and

Both kinds of kauila have extremely heavy, hard wood which was of great value to the Hawaiians and highly prized by them. Because of a phallic symbolism connected with the alphitonia, however, the wood of this tree was not used for religious purposes. That of the colubrina was used in its place. But for non-religious purposes, the alphitonia was most commonly employed.

When priests met for the purpose of prayer and sacrifice to ward off evil, the kahuna nui, or high priest, held in his hand a piece of kauila, or colubrina, wood wrapped in dark kapa ( ) as a symbol of his authority.

The kahili, a feathered standard of the Hawaiians, was an emblem of rank carried on special occasions. It consisted of a pole or spear of kauila or koa ( ) wood usually 10 to 20 feet long. One third or less of the upper part of the pole bore many branches made from the stiff midribs of coconut leaflets. These might be simple or forking and would radiate in all directions. To their ends were tied tufts of short, bright feathers to form a regular, plumed cylinder, or hulumanu, 15 to 30 inches in diameter. After the occasion for the use of the kahili had passed, the hulumanu was dismantled and the feathers stored away in tight calabashes containing the leaves and stems of a certain, pungent, insect repelling Gnaphalium, called enaena by the Hawaiians.

The pole, which was the essential part of the kahili, to which much sentiment was attached, was often elaborately ornamented by the chiefs as a pastime. The handle was made by stringing disks of tortoise-shell on its lower end, these often alternating with disks of bone. All were then carefully filed and polished until a smooth, variegated handle resulted. The bones were frequently derived from the shins of brave warriors who had been killed in battle by the owner of the kahili and thus signally honored by him. If, however, the enemy had been despised, his bones would not be inlaid in a kahili handle, poi bowl or sacred drum, but, possibly, with his teeth, in a spittoon or slop basin instead. Or his bones might be employed in the making

of fish-hooks, those from smooth-skinned and not hairy individuals being preferred because of the belief that the fish first preferred those made from the former individuals#. Or as an especial insult, the bones might be feshioned into arrow-heads for use in the chiefly sport of shooting the native rat.

A dying chieftain, to prevent the desecration of his bones, would choose some trusted friend to conceal them after his death, with the remark that he did not wish his bones to be made into fish-hooks or into arrow-heads with which to shoot rats. Then when death was imminent, the chief's heir would leave the district so as not to be considered polluted by his father's death. Shortly after the chief's death, the corpse was wrapped in banana, taro or loulu palm leaves and placed in a shallow, temporary grave. Over this a fire was kept burning, amid the saying of prayers, for about ten days to hasten dissolution. Thereafter the body was disinterred and usually taken out to sea where the bones were carefully stripped of all flesh. They were then tied up in a bundle with coconut fiber, and covered with kapa and a red feather cloak. With the making of this bundle, the first part of the funeral ceremony was complete. A hog was offered as a sacrifice and the heir returned from his seclusion. Then followed the huna kele, or concealment of the bundle of bones, preferably in some inaccessible cave, or the bones were enshrined in the heiau as a god.

During such periods of national mourning, all clothing was cast aside by the populace, and all customs and restraints ignored. The people often knocked out their teeth and cut their hair in fantastic ways. This was done with the niho ako lauoho, an instrument consisting of a shark's tooth tied to a stick. The hair was merely bent over the tooth and then cut with a sawing motion. If this method was too painful, the hair was carefully singed off.

A certain commoner won such an enviable reputation as fisherman that it was thought his success depended on the character of his bones. If this were true, it was argued, then he would be of more value to the king and chiefs in the form of fish-hooks used by many than alive as a single, active fisherman. The experiment was therefore tried to his detriment.

The kauila was one of the trees whose wood was preferred in the building of the ancient Hawaiian grass hut ( ). It was also used in the manufacture of the is kuku, or kapa beater ( ), because of its great hardness and durability. For the same reason it was made into weapons such as the spear, or pololo ( ), 12 to 20 feet long; the javelin, or iha, about one third as long; and the dagger, or pahi kauwa. When enough of this precious wood was available, it was often fashioned into the oo, an agricultural impliment for digging. This was little more than a stick flattened and sharpened at one end. Thus the kauila, together with stone, took the place of metals in the life of the early Hawaiians until after the discovery of the Islands by Captain Cook. It is true, however, that they knew of metals before that date as Cook, himself, attests. This knowledge must have been derived from the metal parts of some wrecked Spanish vessels of which several accounts are incorporated in ancient, Hawaiian mele, or epics.

Rounded and polished rods of kauila were used as hair pins by the Hawaiian women in the early days. Because of its weight which causes it to sink slowly in water, the fishermen employed the kauila in a peculiar method of trolling. They fashioned a club, called laau melomelo, a foot or two in length, having a swelling at the thinner end. Then the juice of the meat of the coconut, sugar cane pith already chewed to rid it of its sap and various other ingredients were burned together and the club rolled around over the smoke of the mixture. Thereafter it was ready for use in trolling. A line was tied to the smaller end and the club dragged in the water from a canoe to attract fish that smelled the bait-impregnated wood. As the odor became gradually dissipated by continual submersion, this smoke treatment was repeated about once a month.

(55-56) HIBISCADELPHUS and RELATED PLANTS) 10 1/2 C

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The Malveaceae or Mallow Family is represented in these islands by the groups botanically called Sida, Abutilon, Thespesia, Pariti, Hibiscus, Gossypium, Kokia, Hibiscadelphus, Malva, Malvastrum and probably a few others. All but the two last listed are represented by one or more native kinds of plant.

The plants comprising Sida are generally called ilima by the Hawaiians. They are woody herbs or small shrubs usually growing in very arid districts. Their small, yellow flowers were formerly commonly strung into garlands, or lei, reserved for chiefs. These plants do not grow in any number in the National Park ~~XXXXXXXXXX XXXXXXX~~ excepting near sea level where the ~~weather~~ climate is hot and dry.

The milo of the Hawaiians, Thespesia populnea (L.) Soland., from whose trunk beautiful bowls were formerly made, is not found within the Park but near the ocean. The hau, Pariti tiliaceum (L.) Britton, especially mentioned on page because of its great value to the early Hawaiians, is found usually in similar places.

The plants belonging to the botanical group Hibiscus are known by that name to the layman. Many kinds with yellow, white, pink or red flowers are native to these islands. Of these the pink-flowered kind, called Hibiscus Youngianus Gaud., may be seen growing along the roadside between Hilo and Kilauea. Those that are ~~seen~~ planted in so great profusion in gardens, however, are horticultural forms derived from the common Chinese hibiscus, Hibiscus rosa-sinensis L., by artificial breeding and selection.

Gossypium is the scientific name of the group of plants we know as cotton. A beautiful kind, Gossypium tomentosum Nutt., with gray, velvety leaves and sulphur-yellow flowers is native to these islands. It grows in dry regions chiefly near the shore.

Kokia is a remarkable group found only in the Hawaiian Islands. It exhibits certain characteristics that are similar to those of the hibiscus while other characteristics resemble those of the cotton. Only three kinds are known

to have existed in the entire world. One, growing on the eastern end of Oahu, has long become extinct due to the ravages of cattle. Another, called Kokia drynarioides (Seem.) Lewt., consisted of a single tree growing on West Molokai in 1913. This is now dead. But one tree grown from a seed produced by this last wild plant is at present growing in a Molokai garden. Of the third Kokia, called K. Rockii Lewt., about two hundred trees were living in 1930 in a very localized area amid the dry lava flows between Huehue and Puuwaawaa, on the Island of Hawaii. This plant has such beautiful, large, brick-red flowers that it is well worthy of cultivation. Unfortunately, the plants are not increasing in numbers though producing abundant seed because these are eaten by rats soon after falling to the ground.

Hibiscadelphus is another strange group of plants limited to Hawaii and Maui only. Wilder's hibiscadelphus consisted of a single dying tree in 1912 on the southern slope of Haleakala, Maui. The plant is now apparently extinct. The Hualalai hibiscadelphus grows on the mountain of that name on the Island of Hawaii. In 1923 only about a dozen plants were surviving. The third and only other kind of hibiscadelphus was named after the late W. M. Giffard, Hibiscadelphus Giffardianus Rock. (Plate) Only one dying tree has ever been found, and this still survives at the time of writing, near the Kipuka Puaulu within a few miles of Kilauea Crater. Fortunately, seeds of this strange tree were planted by Mr. Giffard and now four thriving trees are growing at his former country home. Though flowering abundantly, these five plants produce no seed unless artificially pollinated. It would be a great loss to science if this strange member of the Mallow Family were neglected and should become extinct. It bears magenta-colored flowers that resemble those of the hisbiscus but never fully expand, as the accompanying drawing shows (Plate).

(57) HAU Wolfe 148

The hau, preferably known botanically as Pariti tiliaceum (L.) Britton, is a member of the Malvaceae, or Mallow Family. It appears to be native to most tropical countries, growing typically along the strand though also far from the influence of the ocean. In the Hawaiian Islands it thrives from the shore to an elevation of about 2000 feet on all but the drier regions. It is not found within the confines of the Park but may be observed by every visitor along the roadside upon driving to or from the boundaries.

The hau is usually a small tree producing numerous, long, spreading branches which readily strike root upon touching the ground. The plant with its matured seedlings therefore usually produces a dark, almost impenetrable tangle. The leaves are broadly heart-shaped, smooth above and velvety below. The large flowers are borne singly or a few together in the axils of the upper leaves and at the ends of the branches. They closely resemble those of the hibiscus excepting that the modified leaves, called bracts, surrounding each flower, are not free but are grown together almost to their tips as the illustration shows. When the petals of the flower expand, they are sulphur yellow in color, with or without a brownish center. With the advance of day, they gradually change to a reddish tinge, and the following day drop to the ground a rich brown. After several months, the capsules that have developed from the part of the flower remaining on the plant, split open to shed their seed.

The hau, because of its usefulness, was held in such high regard by the Hawaiians in former days that it was a grave offence for a commoner to cut any of its branches without first gaining permission from a chief to do so. The extremely tough, pliable inner bark, the ilihau, was stripped from the trees and then used for rope as it was first dried, and then wetted before using it for rope. Without wetting, it was too stiff for tying. Several such strands of rope plaited together formed a hawser with which logs of koa ( ), roughly hewn into the shape of canoes ( ), were dragged from the mountains to the shore. There the work of finishing the canoe was continued. Even as late as

1824 the natives on the Island of Kauai collected an enormous quantity of hau bark with which they made strong hawsers several thousand yards long. Three cables, each made from twelve of these hawsers, were then fastened to the wreck of the royal "Cleopatra's Barge" in a vain attempt to drag it ashore. The bark of the hau not only served as binding material but was occasionally beaten into a good quality of native cloth, or kapa ( ). A demulcent, hauoki, was also prepared from the bark and given as a medicine in childbirth.

Ikoi, or fish net floats, were made from the hau or from the wiliwili (Erythrina monosperma Gaud.). The branches, usually two inches in diameter, were dried and cut crosswise into pieces at least three inches long. A hole was then easily made through them by the removal of the soft, central pith. The floats were now tied, one or more feet apart, to the nets, by passing a cord through the pith cavities at intervals.

In the making of fire, the Hawaiians were obliged to resort to friction. A pointed stick, the aulima, of some hard wood such as that of the olomea (Perrottetia sandwicensis A.Gray) which is found in the Kilauea Section of the Park, was rapidly rubbed in the groove of a block, termed aunaki, of soft hau wood. The heat thus developed, ignites the little heap of powder that has accumulated. The smoldering spark was then usually transferred to a handful of dry grass and this was waved to and fro in the air until it burst into flame.

The discovery of the method of making fire is legendary. Maui and Hina had four sons, Maui-mua, Maui-hope, Maui-kiikii and Maui-o-ka-lana. One morning at sunrise the four brothers launched their canoe from the beach near their home below Kaupo Gap, at the base of Haleakala, and proceeded to the fishing grounds. They were just beginning to fish when Maui-o-ka-lana saw a fire on the beach they had just left. They turned their canoe toward shore and hastened to investigate. Upon landing, Maui-mua ran toward the spot where the fire had been burning. The curly-tailed alae or mud hens (Fulica alai Peale), who had built the fire to roast some bananas they had stolen from the brothers, scratched out the flames and flew away. Maui-mua returned to his brothers and told them what he had seen. They decided not to go fishing again but to wait for the next appearance of the fire. They waited so many days in vain that

they finally resolved to go fishing again. No sooner had they left for the fishing grounds when the fire appeared; as soon as they returned, it was extinguished. This happened repeatedly, the alae always knowing when the brothers had gone fishing. They also could tell, by counting the number of men in the canoe, whenever one of the brothers had remained behind to discover their method of making fire and consequently refrained from making it. The four brothers finally outwitted the alae by dressing up a calabash in kapa and setting it in Maui-mua's place in the canoe. Maui-mua then secreted himself on shore while the three brothers set out for the fishing grounds as usual. The unsuspecting alae, believing they had the shore to themselves, built their fire. Maui-mua crept close to the birds and then suddenly ran forth and seized one, threatening to kill it if the secret of making fire were not disclosed. The alae attempted to lead him astray by telling him to rub different substances, none of which could produce fire. Maui-mua, after trying these without success, finally forced the bird to part with her knowledge. Then in revenge for the alae's conduct in inducing him to rub so many things in vain, Maui-mua rubbed the top of the bird's head till it was red with blood. The spot remains there to this day, it is said, as evidence of Maui-mua's exploit.

In early times certain kinds of fish were subject at definite seasons, often coinciding with spawning times, to the kapu of Kuula, the fish god, who was thought to regulate their abundance. In addition to these religious restrictions, fishing along the shore and in shallow waters, both as to certain kinds of fish and to certain periods, was subject to the kapu set up by the landlord or by the king. The placing of hau branches all along the shore proclaimed to all that the adjoining shallows were under such a kapu. The fishermen strictly respected this injunction as death was usually the penalty for its violation. During the time such fishing in shallow water was forbidden, the people resorted to the deep sea for food. With the removal of the hau branches, the kapu was lifted and everyone could fish as before. In certain cases after such a season, the first fish of any kind caught was dedicated to Kuula. With the god's right to that particular kind of fish recognized, the people were free from further obligations regarding it. This custom was religiously observed by all fishermen

throughout the islands of the Hawaiian group.

Hau branches were particularly suitable for adz handles because they are tough and light, and often grow in a convenient curve. At one end a heel was usually cut to which the tang, or base, of the blade was attached by cords of olona (Touchardia latifolia Gaud.) or coconut fiber ( ). Between the wood and blade, a piece of kapa ( ), the dry leaf of the hala ( ) or of the banana was inserted. These blades in early times were made from a compact, grayish lava exposed only in a few localities, one of the best known being Keanakakoi Crater. The name of this crater, probably spelled originally ke-hana-ka-koi and meaning "the adz-making place", was derived from the fact that the Hawaiians there found lava of a kind suitable for making their koi, or adzes. This ancient quarry was obliterated by a lava flow that most likely occurred in 1879.

Here The wood of the hau was also made into outriggers, ama, and into the struts attaching them to the canoes ( ). That of the wiliwili was really better adapted for the purpose because of its greater lightness. In more recent years, however, it had lost flavor because of the belief that sharks preferred to follow this particular wood. Whether this belief is based on some peculiar quality of the tree or is merely imaginary is not definitely known.

In the pastimes of the Hawaiians the hau also had its part. The natives often engaged in a game involving the use of long spears made of hau timber. These spears, hurled by strong men, went whizzing through the air at times for a distance of 1000 feet. Oahi, the fireworks of the Hawaiians, was by far the most spectacular of all their amusements. This took place on the northern coast of Kauai where the cliffs drop perpendicularly almost 2000 feet into the ocean. On these heights the performers station themselves with oiled, dried sticks of hau or some other light wood. At night each performer lights one of these inflamable sticks and casts it into the air to the delight of the spectators gathered in canoes hundreds of feet below. The blazing wood is buoyed up by the strong trade wind and able to drop only very slowly into the ocean. As fast as these sticks are lighted the performers cast them into

* The meaning of the name of this crater has been given as "adz case", ana meaning case in Hawaiian, since the koi quarries are sometimes called [illegible]

space until to the spectator below, the sky appears to be ablaze with scores of comets and shooting stars rising and falling, darting seaward or receding toward the cliffs, crossing and recrossing each other in the most fantastic way. This weird spectacle, sometimes supplemented with glowing kukui ( ) nuts that quickly reach their goal, continues long into the night. One by one the oiled sticks were consumed and the blazing firebrands flicker and disappear, or the winds gradually subside and they glide slowly and gracefully into the ocean where eager hands were outstretched to receive them. With these burning sticks the agile youths brand their arms as proof of having witnessed the oahi.

It was customary for those ascending these heights to carry bundles of green sticks and kukui nuts to the top and to scatter them about to dry. In this way, the proper fuel would be available for the succeeding performers to cast over the precipice.

When armies went to battle, a kahuna bearing a branch of the hau preceded each contending side. These branches were set upright in the ground by the bearer as a favorable omen. Both armies chivalrously respected the hau emblem of the enemy and the kahuna guarding it. When the one side finally realized defeat, its hau branch was allowed to fall.

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PASSION-FLOWERS

Not a single member of the Passifloraceae or Passion-Flower Family is native to the Hawaiian Islands, though more than a dozen kinds now grow here. Several of these have escaped from cultivation and now may be seen growing along the roadsides and in the forests not far from the boundaries of the National Park. All, except a few kinds, are native to tropical and sub-tropical America.

Almost all the Passion-Flowers are tendril-bearing vines. They are remarkable for their flowers which have a somewhat complicated structure. The description of a typical one should be understood with little difficulty by following the lettered drawings in figure 1.

On the very outside of the flower are three green leaves (a) which in the particular kind of Passion-Flower depicted are deeply slit into segments bearing glandular hairs. Within are borne five sepals (b), which protect the more delicate parts of the flower from injury while yet in the bud. Alternating with these and above them are five colored petals (c). Within, is borne the receptacle, a remarkable outgrowth from a part of the flower. This outgrowth consists of tentacle-like appendages, often brightly colored, collectively named the corona (d). On a stalk arising, not from the corona, but from the inner base of the flower, are attached the remaining organs. First come five stamens (e) which bear at their ends the pollen-containing anthers. A small swelling above the attachment of the stamens is the ovary (f). This contains the ovules which later will develop into seeds. The ovary, in the meantime, will mature into the fruit surrounding them. Finally, surmounting the ovary are three styles (g) bearing their stigmas at their ends.

When the Spaniards first saw the magnificent flowers of one of these plants hanging in rich festoons from the branches of the trees in the South American jungle, they regarded it as a token that the Indians should be converted to Christianity. Soon legends and superstitions connected with these plants became rampant because of the anthropocentric ideas of that time concerning the universe. For example, in 1610 Jacomo Bosio, author of an ex-

haustive treatise on the Cross of Calvary, was busily engaged on this work when an Augustinian friar named Emmanuel de Vuillegas, a Mexican by birth, arrived in Rome. He brought with him and showed to Bosio the drawing of a flower so stupendously marvelous that the latter hesitated making any mention of it in his book. Later, however, some other drawings and descriptions of the plant were sent to him by inhabitants of New Spain, and certain Mexican Jesuits sojourning in Rome confirmed all the astonishing reports of this floral marvel. Bosio, therefore, conceived it his duty to present the Flos Passionis, or Passion-Flower, to the world. In his book he tells us that the flower represents not so directly the Cross of our Lord as the past mysteries of the Passion. Alluding to the bell-like shape assumed by the bud and fading flower, he remarks: "And it may well be that in His infinite wisdom it pleased Him to create it thus shut up and protected as though to indicate that the wonderful mysteries of the Cross and of His Passion were to remain hidden from the heathen people of those countries until the time preordained by His Highest Majesty." To continue his article in brief, the five sepals (b) and the five petals (c) of the opened flower were supposed to represent the ten apostles present at the crucifixion of Christ, Peter and Judas being absent. The corona (d) was an emblem of the halo. The stamens (e) were either the five wounds or the hammers used to drive the three nails which, in turn, were represented by the styles (g). The white color of the flower denoted purity while the blue markings represented heaven. The tendrils of the plant were supposed to represent the scourges, while the digitate leaves were the hands of the persecutors. Thus this plant stimulated the Spaniards in their zeal to spread their religious ideas throughout the New World with preaching as well as with fire and sword.

In the Islands, two kinds of Foetid or Viscid Passion-Flowers are very common in arid, waste places particularly near sea level. Both are hairy vines bearing their flowers within three comb-shaped leaves, called bracts, that are thickly beset with sticky, glandular hairs. The one kind, which is more

common on the Island of Hawaii and is shown on Plates and , has the lobes of its leaves somewhat rounded and its fruit yellow in color. The other, found more commonly on Oahu, has pointed lobes and bright red fruits. Whether the yellow-fruited plant is the true Foetid Passion-Flower known botanically as Passiflora foetida L., and the red-fruited kind the variety, or vice-versa, has not yet been definitely ascertained. The flesh of the fruits of both kinds, though small in quantity, is quite palatable when carefully eaten without touching the sticky, malodorous hairs. This flesh is actually part of the seed called the aril, not part of the ovary wall.

The is a Passion-Flower that climbs some of the highest trees in wet forests. It grows near the main road about five miles from the Hilo Entrance to the Kilauea Section of the Park. It bears hairless, ovate leaves having smooth margins. It produces a strikingly beautiful flower with purplish markings which is followed by its edible fruit. This is greenish-yellow when ripe and about the size of a hen's egg.

The Purple Granadilla or Passiflora edulis Sims, a native of Brazil, was first grown in these Islands at Lilikoi, Maui. As this Passion-Flower was unknown to the Hawaiians, they called it lilikoi, a name by which it is now known to everyone throughout the Hawaiian Islands. This vine has escaped from cultivation and may be found on the lower slopes of Haleakala on Maui, and especially above Waimea Canyon on the Island of Kauai. The plant has leaves are deeply three-lobed and toothed along their margins, and white flowers are tinged marked with purple. Its fruit is two to three inches long and deep purple, containing an edible, fragrant, orange pulp.

More than a score of plants belonging to the group at present called Wikstroemia are native to the Hawaiian Islands. Many of these are yet imperfectly known and ~~masquerade~~ 90 under incorrect names in botanical literature. Most of them are found in dry districts as, for example, in the aa desert to the west of Kilauea. A few are found in moister localities, the one shown on Plate coming from the forest north-east of Kilauea. Many of these plants are called akia by the Hawaiians. All belong to the Thymeleaceae or Mezereum Family.

The akia are shrubs or, rarely, small trees usually bearing many small branches. Their leaves are simple, have a smooth margin, and are frequently somewhat thick and leathery. The flowers, borne in terminal or axillary clusters, are yellowish and inconspicuous. They, apparently, are pollinated by nocturnal insects, being particularly fragrant at night. ~~to attract them~~. After several months, these flowers have developed into rather firm, orange-red fruits which are usually less than half an inch in diameter.

It is very difficult to break off a branch of the akia because of its extremely strong bark. This was employed by the natives for many useful purposes, being one of the best binding materials that the Hawaiian Islands afforded.

The akia, though harmless to the touch, is extremely poisonous if eaten. Its root and bark were used with certain parts of several other plants as an ingredient for a deadly drink that was designed for suicide or for the execution of criminals by the order of a chief. The person presenting the poison in a cup called apukoheoheo addressed the doomed man with the expression, "He wahi mea ola ia", meaning sarcastically, "This is to keep you alive."

The shrub contains an acrid, narcotic poison which, like that of a few other plants, was useful to the Hawaiians in catching fish by a method termed hōla. This was fully described by J.F.G.Stokes, probably the foremost living authority on Hawaiian Ethnology and the able assistant to Director Brigham since the late '90s. From the accounts of Bingham and Stokes we learn that the bark

and leaves of the ~~available~~ plant were taken and then thoroughly comminuted by pounding with a convenient stone on the rocks adjoining the stream or ocean where the fishing was to take place. The fishermen, to avoid the possibility of being bitten by eels if the fishing was to be in salt water, placed double handfuls of the prepared plant in the fibrous sheath of the coconut leaf or in twisted hunches of grass. This poisonous material could thus be quickly thrust under the rocks or into crevices where the fish were thought to lurk, the sheath or grass being used for additional applications of bark and leaves later on. Such fishing was usually limited to tidal pools where the poison was not readily dissipated. At times, however, the natives even employed this method in the ocean by diving down and placing the material among the stones of the bottom. In a typical tidal pool within about ten minutes after the submergence of the poison, the fish would become so narcotized as to swim about aimlessly or float on or near the surface of the water on their sides in a dying condition. In this state, they could be easily caught. Though frequently poisoned to death, they were used for food as exposure to this poison did not render their flesh noxious to man.

TIBOUCHINA) 10½ C

The tibouchina is a very conspicuous shrub growing with great v
the roadside between the town of Glenwood and Kilauea Crater. Botani
is Tibouchina semidecandra Cogn., a member of the Melastomaceae or Me
tome Family. The plant is native to Brazil, from which country it was
to Australia. About 1910 Mrs. C.F.Furneaux is said to have introduced it
there into the Hawaiian Islands because of its striking beauty.

The tibouchina is a tall shrub growing to a height of fifteen feet or mo
Its hairy twigs are four-cornered and bear very characteristic leaves. These
are ovate in shape and have three to five prominent veins that arise from a
common point at the end of the leaf-stalk or petiole. The leaves are also
closely covered on both sides with hair, that on the under side having a sil-
very sheen. The flowers are borne in open clusters at the ends of the bran-
ches and are a light red when about ready to open. When fully expanded they
are very conspicuous with their violet to reddish-purple petals.

Though this shrub is very beautiful and attracts the attention of every-
one that passes, it should be entirely eradicated from the islands if it
threatens to escape from cultivation. A very similar plant, the Malabar melastome (Melastoma mala-
bathricum L.), introduced as an ornamental on Kauai, has become naturalized
within the last few decades. It has already replaced nearly all other vegetation in
Kilohana Crater and is rapidly spreading from that locality into neighbor-
ing regions, smothering to death the more interesting native plants that
stand in its way. (Fig. 22) The crater is now a devastated thicket of worthless shrubs
through which neither man nor beast can penetrate for any distance. (Fig. 38) The
introduction of the melastome and its ultimate spread over the lowlands of
Kauai, and of probably all islands unless these are carefully guarded, will
be as great a misfortune as was the introduction of the gorse ( ), the
lantana ( ), and the eupatorium( ).

The beauty of the tibouchina should not blind us to the fact that it,
likewise, might escape and expose the native flora, particularly that of
the Kilauea Section of the Park, to a great handicap in the struggle for ex-
istence. For the privilege of growing this plant in the garden, the

GUAVA

Three kinds of guava may attract the attention of the visitor to the Park. All belong to the group called Psidium which belongs to the Myrtaceae or Myrtle Family. None are native to the Hawaiian Islands but to tropical America.

The common guava, Psidium guajava L., shown on Plate , was introduced probably first on Oahu by Don Marin, the Spaniard who settled in the Islands in 1791 and died here in 1837. Now it is found throughout the Hawaiian Islands where it has formed considerable thickets at the lower elevations. Thousands of plants are seen in driving to either one of the Sections of the National Park. Few plants are known within the boundaries of the Park, most of them growing near the Sulphur Bank on the rim of Kilauea Crater and near Alealea Crater toward the sea. The former location is apparently about the highest elevation at which this particular kind of guava can live, only those growing near the warm volcanic vapors bearing abundant fruit.

The common guava is a very variable shrub or small tree five to fifteen feet high. Its trunk and older branches are covered with light brown bark that scales off here and there in irregular patches to expose the greenish layers beneath. This then gradually changes through yellow to brown and, in turn, falls away. The twigs, as the drawing shows, are square in cross section and bear large leaves and small, white flowers. These have numerous spreading stamens. The fruit of the guava is about three inches long and varies from ovoid to pear-shaped. It is yellow and either smooth or somewhat rough in surface texture. It contains pale yellow to pink flesh in which numerous hard seeds are imbedded. This flesh is extremely sour on some plants while on others, especially those bearing fruits with rough rinds, it is sweet. It can be eaten raw though most of it is consumed in the form of guava jelly. This fruit is one of the favorite foods of the maggot of the introduced Mediterranean fruit-fly, a very serious pest of African origin. XXXXXXXXXX

The strawberry guava, Psidium Cattleianum Sabine, is more hardy than the common guava and is therefore more numerous in certain localities at higher

elevations where the former kind is rare. The strawberry guava may be found near Glenwood, a village 60 located between Hilo and Kilauea. This plant is a small tree that bears smooth, shiny leaves. Its fruit is red, about the size of a large cherry, and has a juicy pulp somewhat resembling a strawberry in flavor. A yellow-fruited variety, known as Psidium Cattleianum var. lucidum, grows in the same locality. Both are called waiawi by the Hawaiians. The name of the common guava has been corrupted into Hawaiian as kuawa.

(62)

OHIA LEHUA

The plant known by the Hawaiian name of ohia lehua is the commonest tree in the Kilauea Section of Hawaii National Park. It may be recognized by its clusters of scarlet flowers bearing numerous long stamens. Its flower structure is thus similar to that of the Guava (Plate), Eucalyptus, Rose Apple and Mountain Apple, and indicates that all these plants belong to the Myrtaceae or Myrtle Family.

Ohia lehua trees are found throughout Polynesia where they grow from sea level to the summits of all but the highest mountains. In the Hawaiian Islands the plants are so extremely variable in size, leaf-shape, presence or absence of hair, and other features that botanists are still puzzled as to the exact number of kinds found here. It is quite likely that only a few distinct kinds exist but that due to cross-pollination, many variable hybrids result that are mistaken for additional distinct kinds.

The ohia lehua found in the vicinity of Kilauea is commonly called Metrosideros collina var. polymorpha (Gaud.) Rock by botanists. It is usually a small tree or even shrub, often germinating on the hairy stumps of ferns. The Sadleria fern ( ), one of the earliest plants to grow on recently cooled lava flows in Hawaii, furnishes a ready means to establish itself in such inhospitable places. The treeferns ( ) frequently have ohia lehua seedlings growing on their trunks, even at a height of twenty or more feet. As these increase in size, their roots partly enwrap and strangle the treefern in their quest for the ground. The fern gradually decays away, leaving the ohia lehua standing on stilt roots in its place. Because of this habit of the ohia lehua to grow epiphytically on treeferns, the early Hawaiians believed that the fern was its parent.

The flowers of the ohia lehua, which in exceptional cases may vary from the usual scarlet to yellow, were formerly much used by the Hawaiians in the weaving of garlands, or leis. As the flower was considered sacred to Pele, goddess of volcanoes, these garlands were supposed to be her favorite kind. In the native "Song of the Leis of the Hawaiian Islands", the flower is men-

tioned as being emblematic of the Island of Hawaii, as was the capsule of the mokihana ( ) of Kauai. When a group of natives went into the mountains for the flowers, they seldom gathered them except on the return journey because of the superstition that otherwise mist would envelop and bewilder them. These flowers secrete abundant nectar upon which the anapanu (Himatione sanguinea) and many other birds feed. The apapane is one of the more common native birds of the Park. It can be recognized by its scarlet body, black wings and tail, and peculiar whirring noise made by its wings when in flight.

The wood of the ohia lehua is hard, durable and dark. In the manufacture of the outrigger canoe, one of which is figured on Plate and described on page , it was used for the part called moo where the paddle usually rubs. If a less durable wood were used, the canoe would show wear in that region comparatively soon. The ohia lehua was commonly made into bowls of the less valued kind and into poi boards, or troughs. It was also usually employed for the carving of idols and for the building of heiaus, or temples. The following account by Captain Wilkes of the United States Exploring Expedition of the elaborate ceremony that was performed by Kamehameha in building the heiau in Kohala on the Island of Hawaii, just previous to his conquest of Oahu, may be considered typical:

"On the 27th (Kane) of January (Kaulua), the ceremony began.

"On the 28th, a calabash of red ochre was mixed.

"On the 29th, the priest, leaning on a spear, repeats prayers and begs lands.

"On the 30th, palm leaves are spread on the roof of the house in the heiau.

"On the first day of the month (Nana), the people are placed in eight rows, when prayers and benedictions are offered, together with a sacrifice of pigs and fruit. The priest of Nukuokea appears, and asks of the king an offering of three fowls to bake at night; one for the king, one for the priest, and one for the god.

"On the second day, they go to the mountains in search of the okea [ohia lehua] idol, when a man was killed: at the time of the cutting down the okea [ohia lehua] tree the priest prayed for land, and the sacrifice was offered, with a hog and tapas, and the image carved; the direction in which the tree fell, land was sought for, and the people on it were stripped of all they had and killed; when the company returned home bearing the image and singing, 'Kuamu, Kuawa, wa - Kuawuwa lauakila la Uwa.' After prayers, the priests each take a fowl, the chief two, and two are given to the god Kaili: these are eaten by them, the god's by his keeper, after which they went to sleep. If it rained during the night, it was considered a good omen.

"On the third day, at an early hour, the people came with materials for building a house during the day. After the frame is set up, the people are placed in rows, and prayers are said. The idols were then carried in procession, prayers said, and they were placed around. The priest and chief exchange their wreaths of okea [ohia lehua] flowers, at which time the people made sixteen exclamations; the people then eat, and finish the house afterwards, which is done with much ceremony. In the evening the high-priest arrived with three fowls; one for the god, another for the king, and a third for himself. If rain fell during the night, they would conquer their enemies.

"On the fourth day, before it was light, the 'Aha' and 'Kaili' prayers were said, at which time the priest brands the land that they are to conquer. After this, the chief brings a hog, holding his snout, when the priest again prays to the idol; the chief repeating his 'Amama', (invocation) killed the hog. The priest cautiously asks the chief if he heard any noise, or voice of a mouse [rat was meant], dog, or bird: if none, it was a good omen. Then the chief and priest advance towards the people, the former wearing a feather cloak, while the latter was naked, who demanded of the people if they heard any noise; and being answered in the negative, the priest then said the god had declared they should eat of the fruit of the land of the enemies. At night nine hogs are offered.

"The fifth day opens with prayer. The king or chief gives forty hogs for each end of the temple. In the evening, the idol they had hewn out of the tree was brought down to the temple, and placed in front of the steps of the heiau. A large hole was then dug, and a man sacrificed and placed in it; on this the idol is put, and the earth thrown in around it: the multitude now retire. The priest now demanded of the king three fowls - one for the god, another for the king, and the third for himself. The god's is devoured by his keeper, while the king and priest feast on theirs, when they all go to sleep, under the impression that some omen will occur. If rain, with thunder and lightning, ensue, the omen is very favourable.

"Just before dawn, the feather god, Kaili, with a hog, is taken to the new idol, where, on a signal being given, the king kills the hog with a single blow; the priest strikes a few blows on the drum, which was the signal that the ceremony was finished. After this the taboo was removed, when children might cry, the cocks crow, and crickets chirp, without danger; then all the priests assemble within the heiau, and prayed in concert till daylight, at which time the king makes the 'Amama'.

"On the sixth day, the king presented a hog to each god, frequently to the number of forty, and two to each priest, two of which were placed in front of the new idol, with cocoa-nuts and bananas, where they are left to putrefy. The king and priest then retired to the 'Nule-Pahu', where they prayed. At nightfall, one of the priests went out in search of a fish called 'olua' [ulua], which is represented as a fathom in length; if this fish could not be found, a man, who had broken the taboo, was hooked in the mouth, killed, and dragged to the altar; if the observance of the taboo had been very strict, and none was found delinquent, a squirrel [rat was meant] was substituted, and was offered to the idol in like manner. If a man was sacrificed, the king took hold of one of the feet of both the hog and man, and thus presented them to the god, saying, 'Here is my offering to you; let me live; let me have the

country I desire to conquer." They then all retire and feast. A chief, called the 'Turtle', then came forward, and prayed with uplifted hands. If any one offended by making a noise, he was instantly killed. The women afterwards brought their tax of tapa, which is put into the fifth house in the heiau.

"On the seventh day, they all bathed; after which they were all clothed in new maros [mats] from the tapas; they then sat down in rows, placing themselves in various attitudes, with the hands raised up or placed on their shoulders, and each was obliged to remain in the same attitude until the ceremony of prayer was concluded. Afterwards eighty hogs were distributed among the people. They then repeated the 'Aha' and the 'Kaili', the prayers before spoken of; and the favorite wife of the king then came with a hog and fine mat, which she offered, with prayers and the 'Amama', and requested that she might live and be preserved by the king.

"On the eighth day, the whole ceremony was finished, all the taboo removed, and a general council of the chiefs held, as to the mode of carrying on the war, when they went to conquer the land they had sacrificed and prayed for. After the wars were ended, heiaus for peace and the prosperity of the kingdom were built, to insure fertility and plenty to the land."

The ohia lehua was an ingredient of a favorite Hawaiian tonic. The young leaves were used and mixed with the bark of the root of the uhaloa (Waltheria americana L.), the fruit of the noni (page), and the leaves of the oxalis. To this was added Hawaiian sugarcane ( ) to sweeten it. After this material had been mashed, its juice was squeezed into a calabash. As the Hawaiians could not place this wooden vessel on the fire for fear of destroying it, they resorted to dropping hot stones into it to bring the medicine to a boil. This was then administered to the patient in three doses at intervals of several days. It induced drowsiness.

The young leaves were also used as one of several remedies for thrush ( ), a common disease of children. The leaves were fed to the sick infant in the regular manner in which all small children were fed solid food. They were chewed by the mother and the thoroughly masticated morsel then offered to

the sick child by mouth.

Today the wood of the ohia lehua is used for pannels and floors because of its beautiful grain and reddish color. It is also suitable for railroad ties and for fuel. Ukulele keys are made from it because these do not slip as easily in their sockets as do those made of most other woods.

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EVENING PRIMROSE and FUCHSIA

Throughout the Kilauea region and within the Crater of Halemaumau grows a tall herb, called Raimannia odorata — —, with large, sulphur-yellow flowers that turn reddish on wilting. This is a South American Evening Primrose, belonging to the Onagraceae or Evening Primrose Family. The plant was purposely introduced by John Tait, the former Volcano House gardener, as an ornamental in 1921. By the following year, it had already escaped from cultivation and begun to spread into neighboring fields and roadsides. A smaller Evening Primrose ~~has~~ appeared near the hotel vegetable gardens in 1928 and has become completely naturalized. It is almost certain that this plant gained access to this locality in impure garden seed. The smaller Evening Primrose, if not the larger one as well, should at least be eradicated from the Islands before it has had time to spread and crowd more desirable plants out of existence.

The larger Evening Primrose bears a flower ~~that stands~~ on an intermediate stage of evolutionary development. The more primitive flowers bear free sepals and petals which are attached to the base of the pistil which they surround. In the Evening Primrose, however, both petals and sepals have united with one another for more than half their length. They have grown firmly around the base of the pistil and then extend beyond it as a slender tube. Even the lower half of the stamens have so firmly united with this tube that their presence is indicated ~~—~~ merely by lines. In still more highly evolved flowers, like those of the Morning Glory, ~~on the other hand,~~ the petals have become united to their very tips to form a funnel-shaped corolla.

The Evening Primrose, as its name in part implies, blooms during the night, the flowers withering or closing in the late morning as do those of the Silene ( ). They are yellow, as that color, or white, is about the most conspicuous in the dark. In addition to their bright color, they emit an odor. Hence moths and similar nocturnal insects in search of nectar, may see the flowers at night if flying in the neighborhood, or may smell them if flying

at a distance. As the nectar, however, is contained at the base of the narrow tube almost one inch long formed by the united sepals, petals and stamens, only moths with incredibly long tongues can reach it. As they fly from flower to flower to satisfy their hunger, they may effect cross-pollination and thus make it possible for the plant to mature vigorous seed. These are shed from the dry, capsular fruit by its splitting into four parts.

Along the roadside and in the gardens near Kilauea grow several shrubby Fuchsias of hybrid origin. These plants, native to America, were ~~first~~ introduced by the late W. M. Giffard before 1910. Though bearing waxy, crimson or purplish flowers and producing oblong, juicy berries, one can see from their fundamental flower structure that they belong to the same family as the Evening Primrose.

GUNNERA or APÉAPÉ

In taking the beautiful but usually wet Olinda Pipe-Line Trail into the rain forest on the north-east slope of Haleakala, Island of Maui, one will see in some of the ravines a giant herb, ~~Gunnera~~ Gunnera petaloidea Gaud., the apéapé of the Hawaiians. This particular kind of Gunnera is found only in these islands. It belongs to the Haloragidaceae or Water-Milfoil Family.

The plant is remarkable. It consists of a massive, herbaceous stem. In younger plants this is short and erect, but in older ones sprawls over the ground for many feet before rising. Within these stems are various cavities harboring colonies of the unicellular Nostoc gunnerae Reinke var. ~~The latter is~~ a member of the Myxophyceae or Blue-Green Algae. As the stems of the apéapé increase in length, the oldest part tends to die with age. To make up for the loss of the original root attached to it, new roots form near the old leaf scars. The petioles or leaf-stalks are one to several feet long and bear at their apex the enormous kidney-shaped part of the leaf, known as the blade. This may be two to three or more feet in diameter. It is so large that it can be made to serve as an umbrella. In the center of these leaves, as Plate shows, arises the tall flower stalk. This is yellowish to brownish-orange in color and bears thousands of small, wind-pollinated flowers.

The only known near relative of the apéapé in these islands is the introduced marsh plant called parrot's feather, or Myriophyllum proserpinacoides Gill. It was found naturalized in certain marshes near sea level by the writer several years ago. This delicate herb is extensively used as an aquarium plant on the Continent. The apé of the Hawaiians is not related to Gunnera but to taro ( ), a member of the Arum Family.

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OHELO and related plants

The group of plants scientifically known as Vaccinium and belonging to the Ericaceae, or Heath Family, comprises the huckleberry, blueberry, cranberry and less well known plants of the Continents, and the ohelo and its relatives of the Hawaiian Islands. Exactly how many ~~representatives~~ of this group are native to these islands is not definitely known. All local plants belonging to Vaccinium are shrubs bearing simple leaves, small flowers and fleshy berries of various shades of red.

The ohelo, Vaccinium reticulatum Smith, is found only on the Island of Hawaii and on East Maui where it thrives on the less ~~modified~~ lavas flows and beds of volcanic ash and cinders. It is very common in the neighborhood of Kilauea, and on the upper slopes of Haleakala as well as within that crater near Koolau Gap. On the lower slope of Haleakala ~~XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ south-east of Ulupalakua, it may be found only on a small aa ( ) lava flow, the surrounding country being devoid of these plants. This shows that the typical ohelo is apparently rather particular in its soil requirements.

The ohelo is a variable shrub rarely attaining a height of two feet. Its leaves are rather leathery and often almost orbicular in outline, as the drawing on Plate of a Kilauea plant shows. Sometimes, however, the leaves are oblong and may be either minutely hairy or practically smooth. Its clustered flowers are usually a brilliant red. All borne on the same plant develop, with very few exceptions, into fruit at the same time. It is therefore rather difficult to find a single branch ~~XXXXXX~~ suitable for illustration bearing both flowers and fruit. ~~Any number of~~ plants bearing flowers only may be found, however, within a few feet of others that bear abundant fruit and no flowers.

As one walks from the ash plain near the Sulphur Bank toward the moss-covered ground of the Treefern Forest, one will notice that the ohelo plants gradually change in appearance. The plants ~~become usually~~ more slender and bear hard, leathery leaves. These are recurved along their sharply toothed margins and rather hairy on the lower side. The berries instead of being

depressed-globose are somewhat elongated. This latter plant has been named Vaccinium pahalae Skottsberg. That this plant is sufficiently different from the ohelo growing near Kilauea to bear this distinctive name is not absolutely certain. This question can be settled best by planting samples of the Sulphur Bank plants in the Treefern Forest and some plants from the latter locality at the Sulphur Bank. If both types retain their definite characteristics we will know that we are dealing with two distinct kinds of ohelo. If, on the other hand, these features become modified because of a change in the environment, we will know that V. pahalae is identical with V. reticulatum or but a variety of it.

The typical Kilauea ohelo berries are globose, with usually somewhat flattened top and bottom. They vary from a dark red to a pale yellow, and may or may not be covered with a bloom. They may be eaten raw or cooked in the form of pies or sauces. This berry as well as the introduced thimbleberry (page), blackberry (page) and poha (page) may be gathered within the boundaries of the National Park provided they are eaten there. It is an infringement of the Park regulations, however, to break their branches or to destroy or injure any other kind of plant, ~~& to bring the fruit out of the Park.~~ (?)

The high-bush ohelo, or ohelo kaulaau of the Hawaiians, is Vaccinium calycinum Smith. It may be found on all the larger islands of this group in the more open rain forest. It is ~~quite~~ neither common in the forest east of Kilauea on Hawaii as well as below the Koolau Gap of Haleakala Crater on Maui. This plant can be readily distinguished from other plants of the same group by its height of three to six feet or more, by its large ~~leaves, of~~ relatively thin ~~texture~~ leaves, by its greenish flowers, and by its bitter berries. The latter are sometimes added in small numbers to the true ohelo berry before cooking to impart a special flavor to them.

Kilauea had always been an object of awe to the natives as it was considered the home of Pele, goddess of Hawaiian volcanoes. When in the vicinity of the crater they were careful not to strike the ground nor to dig in it for fear of disturbing her. They ~~formerly~~ offered locks of human hair to her

and threw both live and cooked pigs and vegetables into the molten lava to appease her anger. The worshippers of Pele even cast the corpses or some of the bones of their deceased relatives into the crater. They were under the impression that the spirits of their deceased dead would then be admitted to the society of the various deities living in the volcano and would use their influence in guarding their friends from lava flows and other volcanic dangers. Living human beings, however, were never immolated there. The ohelo was a plant especially sacred to Pele. It was therefore customary on arriving at the crater to break a branch bearing the berries and while facing the center of volcanic activity, to throw half of the branch over the cliff, saying, "Pele, here are thy ohelo. I offer some to thee; some I also eat." Only after this rite had been performed could the visitor eat freely of the berries without danger of incurring her wrath.

Though the Hawaiians had officially abolished the kapu, or tabu, system and their religious practices before the coming of the American missionaries, many still adhered to the old customs. Kapiolani, a high chiefess, in Dec. 1824 dramatically weakened the superstitious beliefs remaining. In spite of the entreaties of her husband and her friends to give up her undertaking which appeared so dangerous to them, she set out from Kaawaloa, where Capt. Cook was slain, for Kilauea with a following of about eighty natives. She made the greater part of this one hundred mile journey over rugged lava flows on foot. Reaching the vicinity of the crater, a priestess from one of the three heiau dedicated to Pele met her. She threatened Kapiolani with the displeasure of the goddess if she were to go nearer to the crater and predicted her death if she violated any kapu. Kapiolani, instead of being discouraged from completing her mission, discomfitted the priestess with arguments and kept on toward the crater. Here a hut, or hale, probably of amaumau ( ) fern as customary, was built for her, and she and her followers passed the night. The following morning she descended about 500 feet to a black ledge, no longer existent in Kilauea today, to be in closest proximity to the swirling lava and its fountains. Here Kapiolani insulted the god-

dess by hurling stones into the pit and eating the sacred ohelo berries without first making the required offering. Then she addressed her company, "Jehovah is my God. He kindled these fires. I fear not Pele. If I perish by the anger of Pele, then you may fear the power of Pele; but if I trust in Jehovah, and he shall save me from the wrath of Pele when I break through her kapu, then you must fear and serve the Lord Jehovah. All the gods of Hawaii are vain." After singing a hymn, the company set out for Hilo. Only after considering with what fear the natives had regarded Pele can one justly evaluate the great courage of Kapiolani and her followers.

PUKEAWE

Two closely related and rather variable plants belonging to the group called Cyathodes are native to the Hawaiian Islands. One or both kinds grow from an elevation of 2000 feet almost to the summits of the highest mountains. They thrive on the arid lava flows as well as in the more open rainforest or in mountain bogs. Although they very superficially resemble heather, they do not belong to the Heath Family but to the Epacridaceae or Epacris Family which is native mainly to Australia.

The Cyathodes found in the Hawaiian Islands are shrubs or even small trees bearing small, stiff leaves, inconspicuous flowers and very showy, rather dry fruits. These are about a quarter of an inch in diameter and may be white, pink or dark red. The Hawaiian names for all these plants are pukeawe, puakeawe, maiele, maieli or kawau. Technically, the plant growing in the vicinity of Kilauea, here figured, is known as Cyathodes Tameiameiae Cham. It was named in honor of the famous Kamehameha who united the islands into one kingdom under his rule. The unusual spelling of his name is due to the fact that the letters t and k are more or less interchangeable in the Hawaiian language. As at Kilauea, this plant develops into a shrub three to five feet high on the drier slopes of Haleakala. In the rainforest along the Olinda Pipeline Trail, however, it may reach a height of fifteen feet. On the higher regions of Mauna Loa and Haleakala may be found the closely related plant named Cyathodes imbricata Stschegleew. This is described as a trailing shrub bearing leaves whose veins rarely divide.

The bright fruits of the pukeawe are added by the Hawaiians to their leis, or garlands, to give them color. In the early days, the entire plant was held in high esteem. According to N.B. Emerson "When a kapu-chief found it convenient to lay aside his dread exclusiveness for a time, that he might perhaps mingle with people on equal terms without injury to them or to himself, it was the custom for him and according to one authority those with whom he intended to mingle joined with him in the ceremony - to shut himself into a

over

little house and smudge himself with the smoke from a fire of the Pukeawe, [illegible]. At the conclusion of this fumigation a priest recited a Pule Huikala, a prayer for a dispensation."

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#68 SUTTONIA or KOLEA

Many peculiar kinds of suttonia are found in the Hawaiian Islands and not elsewhere. They belong to the Myrsinaceae or Myrsine Family. All the local plants are trees bearing thick leaves with rather smooth margins. The small, inconspicuous flowers, which are borne on stalks, are clustered in the axils of leaves that usually soon fall. The fruits are almost always globose, about an eighth of an inch in diameter, yellowish, brown or usually black, and contain a single large seed.

Suttonia Lessertiana (A. DC.) Mez may be found in the forests of Kilauea, from which the figured specimen was derived, as well as on Haleakala. It is characterized by thick leaves which are about four inches long and wedge-shaped at their base. With a lens one may discern resin glands and ducts on their under surfaces as the enlarged drawing shows. These leaves are frequently red in color when young. The fruits are reddish to black.

Another suttonia that may be found within the boundary of the Park, especially near Makaopuhi Crater in the Kilauea Section, is S. sandwicensis (A. DC.) Mez. This can be distinguished from all other related plants by its small leaves which are less than one inch long. Besides these two kinds, several other suttonias possibly may be seen by the visitor who makes a special search for them. S. lanaiensis (Hillebr.) Mez, S. spathulata Rock and S. volcanica var. laverum Rock may be found on [illegible] Haleakala on the Island of Maui, while S. volcanica Rock may be found on Mauna Loa on the Island of Hawaii.

The Hawaiians named all suttonias kolea. They formerly employed the wood for the posts and beams of their grass huts, and for kapa logs, kua kukui. They also collected the red sap that freely exudes from incisions made into the bark and used this to dye their kapa ( ). More commonly, however, the bark stripped from the trunk of the tree was pounded and then placed in a calabash with water. After straining through coconut fiber or some similar material, the resulting liquid constituted the dye. Charcoal derived from the plant was likewise used in making a dye.

The maile of the Hawaiians is botanically known as Gynopogon olivaeformis (Gaud.) Heller. It is found in the forests on all islands of this group in several varieties or forms, the figured specimen coming from the forest near Kilauea. These plants are not found elsewhere. They belong to the Apocynaceae or Oleander Family.

The maile is a straggling or weakly twining shrub emitting, like the oleander, milky juice when wounded. It bears smooth, shiny leaves that are arranged in twos, threes or fours. The flowers are small, yellow, and in structure somewhat resemble those of the oleander. They consist of five minute sepals, five petals that have grown together for the greater part of their length, five minute stamens that have partly grown to the united petals, and two carpels. These last are very peculiar. They are separate, or free, below but firmly united above. After the flowers have become pollinated by some insect, these carpels increase in size with the development of the seeds. The result is that the matured carpels, now called fruits, may consist of a single ring of beads, or breaking apart above, may appear as two diverging rows of beads. This moniliform, or bead-like, effect is caused by the enormous swelling of each seed which naturally must distend the old carpel wall surrounding it. The walls between the seeds, on the contrary, remain little changed. The resulting odd fruiting-structure is well shown near the center of the plate, while toward the extreme left may be seen single fruiting segments that have not yet fallen to the ground like erstwhile their neighbors.

The maile was one of the favorite plants of the Hawaiians and is still much used in combination with other plants in the weaving of lei, or garlands. For that purpose, the long leafy branches are divested of their wood. This is easily accomplished in the young twigs by merely loosening and freeing the bark from the base, winding it a few times around the exposed wood of the stem, and then quickly pulling the slippery wood out of the surrounding bark. In the older stems, however, the bark must first be loosened from the wood for its entire length before it can be drawn away.. This one can

OVER

usually see the lei women doing with their teeth. As long as a maile lei is fresh, its odor is not as noticeable as when it begins to wilt.

In the early days during war times if an armistice were desired, the contending chiefs met in a heiau and there wove together a lei from the branches of the maile. When the lei was completed, heralds announced the news to the populace. The fresh leaves of the maile and other fragrant material was often placed in calabashes where the kapa was kept to perfume it. Maile was also used medicinally. In the halau it was one of the common decorative plants.

(70)

LANTANA

The lantana, botanically known as Lantana camara L., belongs to the Verbenaceae or Vervain Family. It is a variable plant native to tropical continental America. Because of its colorful flower clusters, it has been introduced as an ornamental in many warm countries. It usually escapes from the garden and shortly overruns the country to become an extremely costly and troublesome weed. It was purposely introduced as a garden plant into the Hawaiian Islands in 1858. Various birds feed on its berry-like fruits. As the contained seeds passed unharmed through their digestive tract, the plants soon had the opportunity to spread. Now they may be found throughout the lowlands on all the islands in dry as well as moist localities. The plant became such an objectionable pest that in 1902 eight different kinds of lantana-feeding insects were introduced from Mexico to check its growth. These, in conjunction with the lantana scale-insect accidentally introduced before that date, have almost exterminated the plant in a few localities.

The lantana is a shrub ordinarily to five feet high, but in particularly favorable situations where other plants may lend it support, it may attain a height of fifteen feet or more. Like most members of the Vervain and Mint Families, the lantana bears a square stem. This, in the particular form brought to the Hawaiian Islands, is armed with sharp, recurved prickles. The stem bears its leaves in opposite arrangement. These are rough to the touch, especially on the upper surface, and when bruised emit a penetrating, aromatic odor. From their axils frequently arise peduncles or stalks bearing a single flower cluster at their ends. The flower-buds on the periphery of the cluster are the oldest. As they begin to bloom, they are usually orange. With age they become pink, while the younger buds adjoining them in turn become orange. Thus a vigorously blooming cluster exhibits two colors; pink near its edges and orange in its center. These flowers at length develop into small, blue fruits (fig.).

Just as a detailed study of the buttercup flower ( ) explains the fundamental plan upon which all Hawaiian flowers are built, so a comparison of the flower cluster of the lantana with the complex "head" or capitulum of the <u>kokolau</u> ( ) explains how that highly specialized structure typical of the Composite Family may have arisen. The flower cluster of the lantana, for example, is essentially a greatly modified twig bearing a group of degenerated leaves, each with a small flower in its axil. This twig, instead of growing in length to scatter its leaves and flowers along a distance of a foot or more, has become arrested in growth just as soon as sufficient space has arisen for their development. Hence it is but a fraction of an inch in length and bears the small flowers and yet smaller leaves in an almost flat, circular group. The youngest leaves and flowers, being at the tip of the shortened twig, are naturally the central flowers of the cluster while the older are arranged, in order of their age, around them. The highly specialized flower cluster or "head" of the <u>kokolau</u> as explained on page might have been derived by further specialization from a cluster of flowers similar to that of the lantana. This can be visualized best by comparing the cross-section of the one (Plate , fig.) with that of the other (Plate , fig.).

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1045

PRUNELLA or SELFHEAL

One of the very common weeds of lawns and waste places in North America is the Selfheal or Prunella vulgaris L., a member of the Lamiaceae or Mint Family. This is actually a Eurasian plant that accidentally reached America in the early days. In 1927 the writer found this same plant growing in great numbers on the cattle ranges of Haleakala as well as within the crater itself. At that time it was also observed in the rainforest, but only along the Olinda Pipeline Trail and along the mountain torrents. It is probable that saddle-horses passing along this trail carry the seed-like nutlets of the plant on their hoofs and thus cause wide dissemination; and the nutlets of plants growing at the sources of the Haleakala streams are carried by the water to find a final resting place, perhaps suitable for growth, here and there along their banks. It is not known whether this plant reached these islands in impure garden or grass seed or whether it arrived in cattle fodder from the coast.

The selfheal is an herb two inches to almost two feet high, bearing small, opposite leaves. Its upright stem terminates in a dense cluster of purple to blue flowers. Each flower bears five unequal petals, all of which have grown together at their base to form a tube. In addition to that, two of these have united to their very ends. In this way, they form a hood to protect the four stamens that lie beneath them.

The selfheal was used medicinally by the Europeans in the early days, but is now considered a worthless weed.

A

72

CAPE GOOSEBERRY or POHA

The Cape Gooseberry, known locally by the Hawaiian name of poha, is botanically Physalis peruviana L. It is not a Gooseberry but a member of the Solanaceae or Nightshade to which the potato + tomato belong Family. The plant is native to Brazil but was introduced into the Islands previous to 1825. Now it is one of the more common plants found along roadsides and in clearings from 1000 to 8000 feet elevation. It is very common in the Kipuka Puaulu near Kilauea as well as within the Crater of Haleakala. Even as early as 1840, Commander Wilkes of the United States Exploring Expedition reported it as common near Napau Crater, not far from Kilauea. Though the fruits of this plant are very palatable, he notes that "The natives do not make any use of them, and seemed quite surprised to see us eat them."

The poha is a coarse herb becoming two to three feet high. Its hairy leaves are not strictly opposite but are usually borne in pairs, one of the two leaves being smaller than the other. This unusual condition is caused by the intimate union of the larger leaf with the main stem up to the next higher node. The axillary flowers are yellow with a brownish eye. As these develop into fruit, the calyx inflates and increases enormously in size. The result of this development is that the delicious, yellow, tomato-like fruit is protected from injury and dirt within a paper-like bag, as figure a of half a fruit shows.

The fruit of the poha may be eaten raw. It is, however, best when cooked in the form of a jam or jelly. These possess a very distinctive flavor.

POPOLO, POTATO, and JERUSALEM-CHERRY

Solanum is the scientific name for the largest group of plants belonging to the *Solanaceae* or Nightshade Family. Of this group at least three ~~representatives~~ may be found within the boundaries of Hawaii National Park.

The *popolo* of the Hawaiians, *Solanum nigrum* L., but occasionally called *Solanum nodiflorum* Jacq., by some botanists, is ~~practically~~ of cosmopolitan distribution. It ~~occurs in~~ has several ill-defined varieties and forms. It is found throughout the Hawaiian Islands in clearings and waste places. Two slightly different kinds grow in the Kilauea Section of the Park, one of which is native. The plants called Wonderberry and Morelle are merely American and European strains of *S. nigrum* which have been improved by artificial selection to increase their value as food for man.

The *popolo* is a prostrate or erect herb, varying in height from three inches to about three feet. It may be either hairy or smooth, and may bear leaves that possess even or ~~more or less~~ somewhat angular margins. The plant has not only ~~exhibits~~ the strange leaf-arrangement found in the *poha* (   ) but also a very strange arrangement for its flower clusters. Each cluster ~~actually~~ develops actually in the axil of a leaf. Its basal half, however, has grown together with the main stem halfway to the next higher node. Its upper half thus extends freely into space from the internode, a very unusual position as the plate shows. The flowers borne on these clusters are either white or lavendar in color. They have a five-parted calyx which does not enlarge in fruit as does that of the *poha*. The corolla, likewise, is five-parted~~, as the enlarged figures of the flower indicate~~. After fertilization these flowers, ~~in time~~, in time develop into juicy, black berries about one-fourth of an inch in diameter. These contain numerous seeds as may be seen from the figure of a cross-section of the fruit.

The fruit of the *popolo*, called *huapopolo*, ~~were~~ was eaten by the Hawaiians. They have a peculiar flavor that is agreeable to many. The fruit ~~were~~ was also fed to infants suffering from the disease, thrush, being used as a remedy in the same way as were the leaves of the *ohia lehua* (   ). The juice of the plant was used as a laxative. For a man suffering from some digestive disturbance, the bruised leaves were made into a [illegible]

The ancient Hawaiians in times of famine throughout the islands, or habitually in districts where taro lands were few as between Kawaihae and Mahukona on the Island of Hawaii, gathered the leaves and young branches of the plant. These were either tied in la i ( ) leaves or placed in calabashes and cooked in the imu ( ). This spinach-like vegetable was then eaten, as a substitute for poi ( ), with fish. Young ponolo leaves were occasionally used as a cough medicine and as a remedy for sore throat. They were either eaten raw or first wrapped in la i leaves and put on charcoal to roast. The leaves, either in a dry or fresh state, were also made into a tea which was taken as a tonic. As some foreign strains of the ponolo are distinctly poisonous, having caused the death of some who have eaten the fruit on the continent, visitors are cautioned against tasting any part of the plant.

The common potato, Solanum tuberosum L., is not native to the Hawaiian Islands but was introduced by the white man in the early days. Soon it was extensively grown on the slopes of Haleakala. It is interesting that this plant, producing abundant, poisonous, yellow, tomato-like fruits, has escaped from cultivation and now grows wild in the wet meadows of the crater near Kaupo Gap. The plant has apparently reverted to its ancestral condition.

The Jerusalem-cherry, Solanum pseudo-capsicum L., is a light green, herbaceous shrub becoming one to four feet high. It is native to the Old World but was introduced into these islands probably before 1875. It may be seen on the drier slopes of Haleakala as well as in the vicinity of the Kipuka Puaulu north-west of Kilauea. This plant is frequently grown as an ornamental in pots in temperate regions because of its small, white flowers and long persistent, bright red berries.

R

(75)

BRUGMANSIA or FLORIPONDIO

Along the roadside between Hilo and Kilauea may be seen a coarse shrub bearing enormous, white, pendant flowers. This is the Floripondio or Brugmansia arborea (L.) Steud., another member of the Solanaceae or Nightshade Family. Locally it is known by the less correct names of Angel's Trumpet, and Datura arborea L. The plant is native to South America but has been introduced as an ornamental into these islands apparently before 1875. The Floripondio like its close relative, the Jimson Weed, contains narcotic poisons. These impart to it a tobacco-like odor when bruised.

(76-77) NAIO, FALSE SANDALWOOD or MYOPORUM

The naio or false sandalwood is found exclusively in the Hawaiian Islands. Distantly related kinds, however, grow in Australia. All belong to the Myoporaceae, or Myoporum Family.

A study of the Hawaiian Myoporum is very instructive in indicating how extremely difficult it is to write a reliable flora of these islands without conducting exhaustive field work. It is easy enough to gather together all Hawaiian plants preserved in herbaria or their photographs, to arrange all ~~having~~ similar appearance in separate piles, then to write a distinctive description to include all plants in each pile, and finally as a climax to publish each description with a scientific name. Yet how often will such a procedure give us the true answer to the riddle of the relationship of one Hawaiian plant to another unless performed by a foreign specialist on a definite group or two, or by a resident botanist who can devote the greater part of his life ~~to~~ collecting his material in the field and continuing its study in the herbarium?

To date, all Hawaiian myoporums have been passing under the name of Myoporum sandwicense (DC.) A. Gray although they have significant differences. ~~are by no means alike.~~ In general, at lower elevations they are small shrubby trees bearing thick, hairless, often viscid leaves lacking marginal teeth. At higher elevations, on the contrary, they are usually tall, sometimes attaining a height of 50 feet, and bear non-viscid leaves. The cause for this difference in appearance is probably an ecological one. The plants growing in the lowlands merely are dwarfed and have fleshy leaves because of their exposure to a drier and hotter environment. Because they are the same, though superficially molded each to a different form by the special environment in which they live, both types of plants must bear the same scientific name. Or if these apparent, though not actual, differences are well defined and constant under the two diverse conditions, the one ecological form, to which the type specimen does not belong, may be given a distinctive, pseudoscientific name for the sake of convenience. This name, however, must be preceded by the word ecoform or ecovariety and has no official nomenclatorial status. Thus, the common false sandalwood is

called Myoporum sandwicense (DC.) A. Gray, while the stunted, thick-leaved specimens, botanically known by the same name, might have "ecoform crassifolia" appended.

In studying a rather comprehensive collection of Hawaiian myoporums like the writer's, one will note that plants with leaves either hairy, especially on their lower surfaces, or with leaf-margins serrate, or with a combination of both these characters, exist. Such plants, as field observations prove, may be found usually in considerable numbers in widely separated regions surrounded by the typical kind. For example, in a certain region on Hualalai on the Island of Hawaii and above Waikolu Valley on the Island of Molokai, the myoporum bears leaves resembling those of a peach — they are smooth and have serrate margins. On Lanai, a similarly unusual kind of tree may be found which, however, bears hairy leaves with serrate margins. In a certain valley on the upper slope of Haleakala near Ulupalakua, Island of Maui, grow very characteristic trees bearing hairy leaves with almost smooth margins as Plate clearly shows. On a single ridge on Molokai may be found plants which produce, especially when wounded, some branches with the smooth type of leaf and other branches with the hairy type, and both these types of leaf may have either entire or serrate margins. These two characteristics — hairiness and presence of serrations — are obviously traumatic, or wound, reversions in the Molokai plants to the ancestral state, just as the koa ( ) when wounded will produce its ancestral type of compound leaf.

From the evidence which the Molokai plants in particular furnish, we can assume with little risk of error that the ancestor of the Hawaiian myoporum, which reached these islands presumably from Australia ages ago, bore leaves having a hairy surface and a serrate margin. These features were gradually lost from visible expression as the plants became modified into the common Hawaiian plant now to be found on most of the islands of this group. These ancient leaf characteristics, however, are yet lying latent and occasionally crop out in various degrees of intensity independently in plants inhabiting different regions. Such a change or mutation may per-

haps be stimulated by certain ecological conditions or may arise independently of external causes. If such a distinctive plant breeds true and persists as an element in the flora of these islands, it is deserving of a special botanical name either as a distinct form, variety, or even species. Such an example is the Haleakala plant depicted on Plate , which is technically described and named in the Illustrated Flora.

It is obvious that the various hairy-leaved myoporums or the peach-leaved kinds are not necessarily closely related among themselves. They are more likely close relatives of the common M. sandwicense growing in their immediate neighborhood. If the plants, on the other hand, were identical in appearance in two widely separated regions, we might suspect that these are not examples of more or less parallel progressive or regressive evolution but rather that the plants in one station had been derived by the transport of seed from the other. This might have been accomplished by the agency of birds or in some other way. Such, however, is not the case in the myoporums studied.

After most of the true sandalwood trees (page) had been cut down for the Canton market, the Hawaiians began the export of naio wood as a substitute. Though the wood becomes very fragrant on drying, it did not meet with a ready sale.

The naio was also frequently used in the building of the Hawaiian house. In ancient times every man of importance was supposed to have at least six separate houses in his establishment. Since none of these had any partitions, such an establishment practically corresponded to a single large house containing separate rooms. The hale mua was the eating house for the husband and men, and was distinct from that for the women because the latter were forbidden, on pain of death, to eat with adult members of the opposite sex. The hale noa was the separate house of the wife to which, however, her husband was allowed access. The hale aina was the eating house of the wife, daughters, and immature sons. The hale kua was the house where the wife and daughters beat out the kapa ( ), while the hale pea was the house of separation for the wife at certain periods. The hale heiau, on the other hand, was the house of worship and here the family idols were kept.

From the late Director Brigham's excellent monograph on "The Ancient Hawaiian House", we learn that the natives in the early days preferred used the naio or such trees as the kauila (Alphitonia zizyphoides (Spreng.) A Gray), page , and probably Colubrina oppositifolia Brongn., page) and mamane (Edwardsia chrysophylla Salisb., page) for the main timbers of their best houses. Ohia lehua (Metrosideros sps., , page) and inferior trees, on the other hand, were used for the commoner ones, while the lama (Maba sps.,) or ebina was usually used in heiaus, or temples. Though many kinds of wood could have been used equally well in building the main frame of a single house, only one kind was used because of the superstitious fear that otherwise discord would be caused among its future inhabitants. All structures were built on the same general plan though the building of those for the chiefs and priests were often preceded by gruesome ceremonies in their special honor. The corner posts of their structures were lowered into holes in each of which might be a man standing to encircle it with his arms. Earth was then filled in around the post and over the unfortunate victim. The death of such a sacrifice was thought to stabilize the structure. This seems to have been an almost universal custom practiced occasionally even by the Europeans as recently as the Middle Ages.

William Ellis, who lived in the Islands about a hundred years ago, wrote the following very reliable description worth quoting of the construction of the native Hawaiian house:

"They begin to build a house by planting in the ground a number of posts, six or eight inches in diameter, in a row, about three or four feet apart, which are to support one side of the house. When these are fixed in a straight line, they erect a parallel row, to form the opposite side. In the small houses, these posts are not more than three or four feet high, while in the larger ones they are twelve or fourteen feet in height, and proportionally stout. Those used in the chief's houses are round, straight, and smooth, being prepared with great care, but in general they are fixed in the ground without even having the bark stripped off. Grooves are cut in the top of

the posts, along which small poles are laid horizontally, instead of wall-plates, and tied to the posts with the fibrous roots of the iē [Ieia, page], a tough mountain plant. A high post, notched at the top, is next fixed in the middle at each end, and supports the ridge-pole, on which the tops of the rafters rest, while, at the lower end, they are fixed on the wall-plate, each rafter being placed exactly above the post which supports the horizontal pole, or wall-plate. When the rafters are fixed, small poles are laid along, where they cross each other above the ridge-pole; sometimes poles are fastened across like tie-beams, about half way up the roof, and the separate parts of the whole frame are tied together with strong cinet, made of the roots of the iā [Ieia] plant, or fibres of the cocoa-nut husk. The space between the posts at the sides and ends is now closed up with sticks, larger than a common-sized walking-stick, which are tied with cinet in horizontal lines, two or three inches apart, on the outside of the posts, and extending from the ground to the top of the roof. A large house, in this stage of its erection, has a singular appearance.

"If the sides and roof are of plantain [page] leaf-stalks, and the leaves of the pandanus [page], or of ti [page] leaves, each leaf is woven around the horizontal sticks, which gives it a neat appearance, resembling a kind of coarse matting on the inside, while the ends of the leaves hang down without. But if they are covered with grass, which is most commonly the case, it is bound up in small bundles, and these are tied to the small sticks, along the side of the wall of the house, with cinet or cord. They always begin at the bottom, and tie on the grass with the roots upward, and inclined toward the inside, and continue one row above another from the ground to the top of the roof. The roof and sides are always of the same material, except where the latter are of plantain or ti leaves. The corners and ridge are sometimes covered with fern [Sadleria, page]-leaves, with which they can secure these parts better than with grass, &c. The shell is now finished, and generally, except in the lowness of the sides and steepness of the roof, looks much like a hay-rick, particularly as until recently

they never thought of making windows, and had only one aperture, which was the entrance. [illegible].

"The shell of the house being finished, they proceed to fit up the inside, which is soon accomplished, as they have neither partitions nor chambers, and, however large the house may be, but one room and one floor. In preparing the latter, they sometimes level the ground, and spread grass over it, which they cover with large mats made of the leaves of the pandanus. But the best floors are those formed with pebbles,--------which are always dry, and less likely to be infested with vermin than those covered with grass.

"The size and quality of a dwelling varies according to the rank and means of its possessor, those of the poor people being mere huts, [eight or ten feet square, others twenty feet long, and ten or twelve feet wide,] while the houses of the chiefs are from forty to seventy feet long. [Their houses are generally separate from each other: even in their most populous villages, however near the houses may be, they are always distinct buildings.] Although there are professed house-carpenters who excel in framing, and others who are taught to finish the corners of the house, and ridge of the roof, which but few understand, yet, in general, every man builds his own house. If it be of ~~a middling or large~~ any size, this, to an individual or a family, is a formidable undertaking, as they have to cut down the trees in the mountains, and bring the wood from six to ten miles on their shoulders, gather the leaves or grass, braid the sinet, &c., before they can begin ~~to build~~.

"But when a chief wants a house, he requires the labour of all who hold lands under him; and we have often been surprised at the despatch with which a house is sometimes built. We have known the natives come with their materials in the morning, put up the frame of a middling-sized house in one day, cover it in the next, and on the third day return to their lands. Each division of people has a part of the house allotted by the chief, in proportion to its number; and it is no unusual thing to see upwards of a hundred men at a time working on one house.

"A good house, such as they build for the chiefs, will keep out the wind and rain, and last from seven to ten years. But, in general, they do not last more than five years;------.

"When the house was finished, it was soon furnished. A sleeping mat spread on the ground, and a wooden pillow, a wicker basket or two to keep their tapa [page]or native cloth in, a few calabashes for water and poë [page], and some wooden dishes, of various size and shape, together with a haka, were all they required. This latter article was sometimes like a stand used by us for hanging hats and coats on. It was often made with care, and carved, but more frequently it was a small arm of a tree, with a number of branches attached to it. These were cut off within a foot of the main stem, which was planted in some convenient part of the house, and upon these natural pegs they used to hang their calabashes, and other vessels containing food. They ~~generally~~ always sat on the ground, and took their food near the door of their house."

Have picture of Grass hut.

LAUKAHI or TRUE PLANTAIN

The visitor to Hawaii National Park may see four or possibly a few more kinds of true plantain. All belong to the group called Plantago which is a subdivision of the Plantaginaceae or Plantain Family. Three are introduced weeds while the others are harmless plants peculiar to these islands. Their Hawaiian name is laukahi, a word applied to many other plants as well. Their common English name, plantain, is unfortunately the same as that of the cooking banana ( ) also found here.

A close relative of Plantago princeps Cham., discovered by the writer, grows on the cliffs of Haleakala Crater near Kaupo Gap on the Island of Maui. This plant is of an archaic type, being a shrub several feet high. At the ends of its branches are borne tufts of long, narrow leaves. In their axils slender flower stalks called spikes occasionally develop which are thickly beset with small, inconspicuous, wind-pollinated flowers.

Plantago pachyphylla Gray, the Thick-Leaved Plantain, is a strange plant growing in great abundance in the fog-swept Koolau Gap of Haleakala Crater. This plantain is not upright but creeps along the ground, the older part of the stem gradually dying away. Only the growing end bears a tuft of leaves. Though quite variable, these leaves are usually extremely thick, and bear silky hair on the underside at least when they are young. At flowering time, tall spikes, bearing numerous flowers, rise into the air. A similar plant, called Plantago pachyphylla var. hawaiiensis Gray, grows usually above 6000 feet altitude on Mauna Kea on the Island of Hawaii.

The Common Plantain, Plantago major L., is native to parts of North America and Europe. In some unknown way it reached these islands where it was first collected in 1865 by W. T. Brigham, long Director of the Bishop Museum, and by Horace Mann Jr., the son of the famous educator. Now it may be found in both Sections of the Park in moist meadows and along roadsides. This plant is more highly evolved than the plantains previously described. Instead of producing a tall, branching stem or a long, creeping one, the stem never becomes more

than a fraction of an inch in height. The delicate growing point is therefore level with the ground and protected from browsing animals while only the leaves, which can be readily replaced, are exposed to such danger. These are oval in shape and more or less upright in position. At flowering time one or more spikes arise which are from two to fifteen inches long. These bear flowers for more than half their length. The seed-bearing capsules that finally develop are surrounded by the dried corolla in an expanded state.

The Virginia Plantain, Plantago virginica L., (Plate) is native to the Eastern United States. It probably reached the Island of Hawaii in impure grass seed imported from the Continent. It was first collected on that island in the pasture lands near Waimea in 1909. Thirteen years later it had reached the vicinity of the Volcano House at Kilauea, and at the present writing it is continuing to spread along the roads that pass through that region. The plant is partial to rather dry, barren or rocky soil. Though closely resembling the Common Plantain, it can be readily distinguished by its usually prostrate leaves, purplish spikes, and seed capsules surrounded by the persistent, closed corollas.

This plantain exhibits the rosette type of leaf arrangement so commonly seen in many herbs like the Evening Primrose ( ), Senecio ( ) and Thistle [illegible], particularly when they are yet young. As the stem is even shorter than that of the Common Plantain, the plant has been obliged to modify its leaves in a special way to prevent the upper ones from shading those that are beneath. This has been accomplished by successively lengthening the stalks of the lower leaves so that their blades project beyond those above them as the smaller figure on the plate illustrates. The second difficulty that the plantain has been obliged to overcome is that of remaining at the level of the ground and not growing above it as the stem lengthens to produce new leaves. This is accomplished by the active contracting and shortening of the root, thus pulling the leaves firmly down against the soil. As the inner woody part of the root contracts more than the outer part, one may often see the bark

adjoining the stem deeply wrinkled horizontally. By ~~being in~~ this rosette ~~state~~, the entire plant is well protected from grazing animals and against extremes of temperature and dryness. At the same time, it has its leaves fully exposed to sunlight.

The Lance-Leaved Plantain, Plantago lanceolata L., is the third foreign plantain found ~~in~~ the islands. It is a native of Eurasia but has become widely disseminated. It became naturalized in Australia many years ago and from there, Gay and Robinson introduced it as an impurity in grass or flower seed around 1890. In the Kokee Region on ~~the~~ island of Kauai, it soon became such an aggressive weed that it threatened to displace the valuable grasses. This plant may be found in small numbers within the boundaries of the Park, particularly along trails and roads, and in moist meadows. It may be distinguished from the other plantains by its rosette type of growth, lance-shaped leaves, and spike bearing flowers only near its end.

By the Hawaiians the fresh leaves of the laukahi were pounded and used as a poultice, while the dried leaves were made into tea. The juice of the plant was applied to bleeding wounds to act as a styptic.

(79) 1084 COFFEE 197

Though the coffee plant is not found within the boundaries of the National Park, it is so commonly planted in the islands and so frequently seen by visitors that an account of it is here worthy of inclusion.

Two kinds of coffee, Arabian and Liberian, have been introduced into the Hawaiian Islands, both of African origin and both members of the Rubiaceae, or Coffee Family. The seeds of the Liberian coffee, Coffea liberica Bull, were introduced into the islands by the government in 1894 because of its great resistance to a serious fungus disease and because of its adaptation to growth near sea level. It is a tree sometimes attaining a height of 40 feet, bears leaves eight or more inches long, and produces flowers having six to eight petals. The plant was grown commercially in some of the valleys at the western base of Mt. Kaala, Island of Oahu. Though this planting has long been abandoned, offspring of the original trees may be found to this day growing wild in the neighborhood. The Arabian coffee and not this kind, as reported erroneously by two previous writers, is found as an escape in the vicinity of Honolulu. In spite of the relative resistance of the Liberian coffee to disease, it never gained in popularity, largely because of its inferior aroma, and is now regarded locally as little more than a curiosity.

Exactly when the Arabian coffee, Coffea arabica L., was introduced is not known. It is certain, however, that it was brought here previous to Dec. 30, 1817 because Don Francisco de Paula Marin, a Spaniard who arrived in the islands in 1791, stated definitely in his journal, now lost, that he planted it that day. Marin, known affectionately by the Hawaiians as Marini or Manini, was a remarkable man who helped the king in many ways and was responsible for the introduction of numerous valuable plants.

John Wilkinson, a gardener whom Governor Boki (page) of Oahu brought from England on the Frigate "Blonde" to develop agriculture in the islands, gathered coffee plants in Rio de Janeiro when the vessel put into that port for fresh supplies. Thirty of the plants that survived the five-month voyage around the Cape to the Hawaiian Islands were planted probably on May 28,

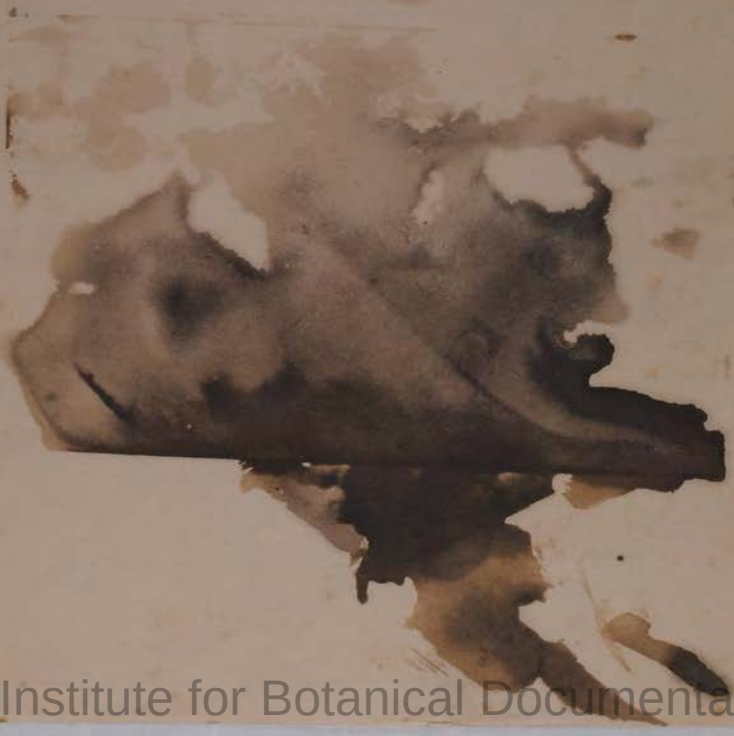
1825, and became finally established on Governor Boki's plantation in Manoa Valley near Honolulu. Although these plants were neglected two years later after Wilkinson's death, many grew to maturity and produced seed. The present coffee plantations in the islands owe their stock almost entirely to these plants introduced from Brazil by Wilkinson and to seed introduced shortly after from the Philippines by Richard Charlton, the very troublesome and rather undiplomatic consul who was fortunately recalled by England. The plants grown by Marin had apparently died or been ignored for propagative purposes, Stephan Reynolds stating in the records of the Royal Hawaiian Agricultural Society of 1850 that if the coffee had been brought to the islands before it had been introduced "in the 'Blonde' in 1825", ----- "it had become extinct."

Due to the successful growth of the coffee in the vicinity of Honolulu, plantations were begun on the Island of Hawaii in 1828 or '29 and on Kauai in 1842. The industry was even encouraged by the king who on May 11, 1842 made the following proclamation: "------The officers and people are hereby informed, however, that there is a new article which is very valuable, and that is Coffee. The people will do well to pay their land tax in coffee, rather than in swine, particularly in places well adapted to the growth of coffee. And those persons who are in pursuit of wealth would do well at the present time by planting coffee. Those who raise coffee will find it the same to them as money. The price allowed for the present year will be five pounds to the dollar. But that price will not be permanent, it will fall at no distant period."

The entire coffee crop of the Hawaiian Islands was marketed locally until 1845 when 248 pounds of coffee was exported. This trade steadily increased until a shortage of labor occurred in 1849 due to the California Gold Rush, a fungus became prevalent in 1851 that attacked the trees, and a scale insect became common a few years later which further injured the trees by feeding on their sap. As an instance of the loss to which growers were subjected from these fungi and insects, one can cite the experience of one of them in the Kona District of the Island of Hawaii. In 1858 he gathered 18,000 lbs., of coffee from his fields; in 1859 the crop was reduced to 12,000 lbs.; the

parchment", are placed in bags weighing 75 to 90 pounds each and sold to one of the local coffee mills, for example in 1927 at the rate of 16 to 18 cents per pound. After the "dry parchment" has been cleaned, it is passed through a hulling machine which removes the horny covering and part of the true seed-coat, or "silver skin". The latter is later entirely removed by a polishing machine. The remaining naked seeds, or "green coffee", are thereafter separated mechanically into seven to nine different grades. The better grades are then further inspected usually by women and children who remove by hand all foreign material and defective seeds that may have remained. Thus about 550 pounds of coffee fruits will produce 138 pounds of "parchment coffee", 11 pounds of "green coffee" and, after proper roasting, about 100 pounds of roasted coffee "beans".

Description of commercial processes adapted largely from mss., of Y.B. Goto and E.K.Nishimura.



(80)

BLACK-FRUITED COPROSMA or LEPONENE

The black-fruited coprosma is known botanically as Coprosma ernodeoides A. Gray, while by the Hawaiians it is known as kukainene, punene or preferably leponene. Like so many other native plants, it belongs to the Rubiaceae or Coffee Family. It grows only on Kauai, Maui and Hawaii at higher elevations. It is particularly abundant in the craters of Haleakala and Kilauea where its long branches may be observed trailing over the barren lava and volcanic ash. Although more than a score of different kinds of coprosma grow in the Hawaiian Islands, this one can be easily differentiated from its relatives by having black instead of reddish-orange, berry-like fruits.

During the early summer, one can notice that the coprosma plants are of two sexes. Some are distinctly "male", or staminate, plants while others are "female", or pistillate. The staminate plant bears inconspicuous flowers stretching four long pollen-filled stamens into the air (a). The pistillate bears similar flowers but, instead of stamens, these possess two thread-like stigmas (b). If pollen grains blown by the wind should become stuck to a stigma, each cracks open to emit a microscopic thread called the pollen tube. This elongates and thus actually bores its way down through the stigma toward the base, called the ovary, where two ovules are located. The first two pollen tubes to reach the ovules then effect fertilization without which act no seeds could mature. By late summer the fertilized ovules have developed into seeds, while the ovary surrounding them has grown into a black, fleshy fruit (c). By being palatable to birds and swallowed by them, the fruit containing the two indigestible seeds aids in disseminating the plant.

The fruits of the coprosma are greedily eaten by the nene, the strange Hawaiian mountain gobse (Mesochen sandvicensis Vig.) that usually inhabits deserts rather than marshes. Though these birds were quite numerous until a few generations ago in the Kilauea Section of the Park and elsewhere, they were lately on the verge of extinction. With the wise protective measures recently enacted, they are increasing in numbers and may again become one of the more common kinds of wild birds in the Park, continuing to distribute coprosma seeds from region to region as in the past.

To the Hawaiians the plant was of little value. At times its berries were eaten as a laxative.

(81) NONI 1042 J.A.Ok. 200

The noni, Morinda citrifolia L., is a member of the Rubiaceae, or Coffee Family. This plant has an exceedingly wide distribution, being found in the lowlands throughout warmer parts of the Pacific. In the Hawaiian Islands it now grows chiefly near abandoned native dwellings. For this reason and because of its importance to the Polynesians, some botanists believe that it was purposely brought to these islands by the progenitors of the Hawaiian Race during their great migrations.

The noni is a small tree very rarely attaining a height of 20 feet. It bears coarse, angular branches and large, shiny leaves. These are borne in pairs excepting where a flower cluster is formed. This consists of a stalk having at its end closely packed flowers in various stages of development. Those near the apex of the cluster are yet small, green buds, while below them stand older buds that are unfolding as small, white flowers ready for the visit of an insect possibly laden with pollen from another noni plant. Below these, in turn, stand the remains of former flowers that now consist merely of enlarging, green ovaries. Even before the last flowers in the cluster have bloomed, the older ovaries ripen into small, pale yellow fruits. Because of the close proximity of the flowers in a single cluster and their large number, the small, swelling fruits developing from them finally press against each other with such force that their sides become flattened. Each fruit, instead of being spherical, has acquired an angular shape. As the entire cluster continues to grow and ripen, the single fruits tend to lose their individuality and unite into one large collective fruit like that of the pineapple (page) or breadfruit ( ). This (fig.) may resemble a potato in size and shape but shows on its surface the outline of each individual ovary as a faint pentagonal or hexagonal line. This surrounds the less obliterated, circular corolla scar.

The seeds of the noni are well adapted for distribution by ocean currents. To each is attached a bladder-like air-cavity that gives it buoyancy. It is therefore probable that this shrub owes its great distri-

bution to its flotation mechanism as well as to the Polynesian navigators.

The Hawaiians in the early days ate the foetid fruit of the noni in times of famine. It was eaten either raw or preferably cooked to make it less disagreeable in taste. The plant was also used medicinally. The leaves and the bark of the stem were pounded, cooked, and strained. This liquid was then drunk as a tonic. As a remedy against tuberculosis, or akepau, ~~on the other hand~~, the Hawaiian patient drank a medicine called aumiki awa. This was prepared by taking the fruit of the noni, the native black-stemmed sugar cane called kooeleele, and the root of the awa (Piper methysticum Forst.), pounding and straining each of these ingredients separately and then mixing their juices in a calabash. If a certain blood-red clay, called koae, were available, a little was added. This was found most abundantly in Kauai. After hot stones had been placed in the calabash to boil the medicine, it was ready for use. The over-ripe fruit of the noni was also used as a poultice.

The drink, aumiki noni, was prepared of fresh spring water and the juice of the noni fruit. This was usually placed near people who were drinking the Polynesian intoxicant awa ( ) so that they could take some of this to counteract any unpleasant effects.

The juice of the fruit, acting as an insecticide, was on occasion used by the Hawaiians in cleansing their hair. Thereafter they repeatedly passed the dried meat of the coconut against it until it had become oily and lustrous. Or, instead, the meat of the coconut was grated or chewed, a little water added, and then smeared on the hair. This shampoo was ~~considered~~ completed ~~after~~ washing the hair to remove the particles of coconut remaining.

Probably the greatest use of the noni was for dyeing kapa ( ). A red dye, called pokohukohu, was made from the bark of the root after boiling with lime derived from coral. A yellow dye, on the other hand, was made from the trunk of the plant.

The chemical nature of the noni fruit bears study, particularly as to its value in the treatment of diseases of the kidneys.

(82-83-84) LOBELIA and relatives 1047 c

More than 150 members of the Lobeliaceae, or Lobelia Family, are known to be native to the Hawaiian Islands. Our knowledge of these famous plants is due largely to the labors of the botanist and explorer J. F. Rock. Every one of these plants is peculiar to the islands, and by far the greater number belong to botanical groups not represented elsewhere. Though many different kinds of lobelia may be found in Hawaii National Park, few visitors will see any excepting possibly the blue-flowered Lobelia neriifolia A. Gray which grows on the inner walls of Haleakala Crater and elsewhere, and the greenish-flowered Clermontia hawaiiensis (Hillebr.) Rock which grows in the Kipuka Puaulu not far from Kilauea. The former plant is closely related to a specimen, shown on Plate , which was collected on West Maui.

In spite of their rather soft, fleshy stems, most of the lobelia in the Hawaiian Islands are shrubs with candelabra-like branches, or striking palm-like trees becoming usually 5 to 15 feet high. They are at their best in the rain forest and on fog-swept cliffs. One plant, Brighamia insignis A. Gray, found almost exclusively along the precipitous coast of windward Molokai, resembles an upright, naked pole with a cabbage at its end from the center of which arise long, white, fragrant flowers. All these plants contain a sticky, milky juice and bear rather large, coarse leaves. Their flowers are usually fleshy, are peculiarly curved, and bear five petals and are usually fleshy. These petals are more or less united from their base into a partial tube that is typically deeply slit on the upper side. In this and other features, the Lobeliaceae resemble the Goodeniaceae (page) to which they undoubtedly gave rise.

The curved flowers of the Hawaiian lobelia secrete a quantity of nectar at their base as a means of inducing certain birds and flying insects to visit them, thus becoming dusted with sticky pollen and unconsciously transferring it to some other flower of the same kind. By such cross-pollination the plants are enabled to mature vigorous seed. Because the flowers of the lobelia are curved, birds with a straight bill would be unable to probe them effectively for food. These islands, however, were at least until recent times, inhabited by thirty-five kinds

of strange, nectar-feeding birds belonging to the endemic Drepanididae, or Honey Sucker Family, of which the famous mamo ( ) and iiwi, and the common apapane are representatives. Many of these birds possess beaks having a curve similar to that of the lobelia flowers in the base of which they find their food of nectar and secreted insects. As both the honey suckers and the lobelia are distinctly Hawaiian and have inhabited these islands for an incredibly long time as their numerous specialized groups indicate, it is ~~practically~~ virtually certain that the curve in the bill of some of these birds was evolved to fit the curve of the flower. This is an unusual ~~instance~~ illustration of ~~the~~ interdependence of birds and flowers. Moreover, so that these birds can also suck the nectar from flowers having a different curve from that of most lobelia, the outer third or fourth of the long upper bill is flexible not unlike rubber.

The lobelia, usually called oha in Hawaiian, were not of much value to the natives. The leaves of cert in kinds (Cyanea) were ~~eaten~~ cooked like cabbage, while the orange fruit of others (Clermontia) were eaten raw. Brighamia, called by various natives puaala, alula and ~~kamakou~~ ohaha, was eaten raw as a reputed remedy for consumption and various other diseases. Certain kinds, such as Clermontia hawaiiensis mentioned above, were called oha kapau because their sticky juice was a favorite bird-lime with the native fowlers ( ), the crushed berry at the same time furnishing suitable bait. The juices of entirely different plants were likewise employed in this way as, for example, that of the breadfruit ( ). After the birds had been deprived of their choicest feathers, they were often washed free of the entangling juice with the oil of the kukui ( ) nut kernel before being liberated.

One lobelia (Plate), introduced from the West Indies, ~~bears~~ deserves mention because of its ~~occurrence~~ growing along the roadside between Hilo and the Kilauea Section of the Park. It is locally known as the Star-of-Bethlehem and botanically as Isotoma longiflora Presl. It is an herb rarely growing more than two feet high. It bears white, erect flowers that resemble those of the native Brighamia. This introduced plant, which now also grows wild on Kauai, should be eradicated as it is one of the most poisonous plants known. A drop of its

85 - 86

SCAEVOLA or NAUPAKA

About a dozen kinds of scaevola, called naupaka in Hawaiian, may be found in the Hawaiian Islands. All, with possibly the exception of one growing near the shore, are peculiar to these islands. They are members of the Goodeniaceae or Goodenia Family.

The various native scaevolas thrive from the arid dunes within reach of the waves in stormy seasons to the clearings in some of the wettest rain-forests at considerable elevations. All are shrubs or rarely small trees. Unlike their relatives, the lobelias, they lack milky juice. They bear simple leaves and white, or rarely blue or yellowish, flowers. These, like the flowers of the lobelias, are slit on their upper side. In Scaevola, however, the slit is so prominent that it appears as though the upper side of each flower had been torn away.

The somewhat spherical fruit of the scaevolas, like that of the cherry, is technically a drupe. It consists of two to four seeds which are enclosed by a hard, woody covering or "stone". This , in turn, is inverted by white or black flesh. This group of plants is thus well supplied with means for dissemination. If the juicy drupes of certain scaevolas are swallowed whole by birds or other animals for their flesh, the stone protects the enclosed seeds from the digestive juices of the alimentary tract. They are therefore enabled to grow when voided, sometimes many miles from the parent plant. The flesh in other kinds contains corky tissues enabling the seeds to be carried long distances by ocean currents. In still others, the fruits are made buoyant by the displacement of half the seeds by air cavities.

(Plate)

Chamisso's scaevola or naupaka, Scaevola Chamissoniana Gaud., is found in the open forest in both the Kilauea and Haleakala Sections of the Park. It is a shrub or tree 3 to 8 feet high bearing white flowers partly tinged with purple, and purplish-black drupes.

The Kilauea scaevola or naupaka, (Plate) to be technically described and named Scaevola kilauene in the writer's New Illustrated Flora of the Hawaiian Is-

lands, is known only from the rather dry ash fields south-east of the crater for which it will be named. This is a low shrub rarely attaining a height of two and a half feet. Its leaves are thick, pale, about one and a half inches long and half an inch wide, and sparsely dentate toward their ends. Their surface is entirely smooth excep~~ting~~t when young, at which time it is covered with a coarse, yellowish bloom. The flowers are borne in clusters of three, are dull yellow and have their corolla lobes prominently winged as in most scaevolas. The drupe is black. It contains a stone surrounding two seed cavities. In about half the drupes examined both cavities contained good seed, while in the other half one cavity contained a viable seed and one was empty. The latter cavity apparently represents a flotation mechanism which may have been functional in the drupe of the littoral ancestors of the plant but is no longer of any value in its present habitat.

The beach scaevola, S. frutescens (Miller) Krause but locally often called S. lobelia, is the plant that is possibly not peculiar to the islands. It may be found within the boundaries of the Park growing chiefly along the shore. It has large, fleshy, rounded leaves with smooth margins, and white flowers. Its drupes, in contrast to those of most Hawaiian members of this family, are white. Because of its occurrence along the coast the Hawaiians knew it as naupaka kahakai. The scaevola was of little use to the Hawaiians. ~~The one growing near the beach was occasionally employed as a medicine.~~

The peculiar split of ~~the~~ its flowers ~~of all the scaevolas~~ was naturally noticed by the natives. They found a plausible explanation for this appearance in the story that a maiden, called Puna, on accusing her lover of infidelity, ~~while quarreling with her lover~~, tore the originally symmetrical flower in half. She declared in her anger that she would never renew her love until her lover had found a perfect flower. As all ~~the~~ ~~scaevolas~~ have been ~~had become~~ half flowers from that time on, he frantically ~~searched~~ but in vain to find the flower that would regain the maiden, and finally died of a broken heart.

(87) ~~should go after Bidens~~ EUPATORIUM) 106/c 206 5

About the beginning of the twentieth century, a Mexican weed, _Eupatorium adenophorum_ Spreng., became common on the Island of Maui, spreading over the drier slopes of Haleakala and smothering to death the native vegetation standing in its way. It is a relative of the Joe-Pye weed or boneset of the United States, and a member of the _Compositae_, or Composite Family. This pest spread to the Island of Molokai where by 1925 it had formed troublesome thickets in the valleys of the leeward side. In 1923 only a few plants were found on the Island of Oahu, all growing in one locality, but by 1930 this weed had already established itself in several widely scattered stations, ~~on that island~~. It is obviously spreading over the entire group and will surely speed many kinds of native plants to extinction.

This eupatorium, occasionally called _pamakani_ by the Hawaiians, is a woody, upright herb becoming three to five feet high. As in all other _Compositae_, its minute flowers are combined into complex clusters termed heads. These are white in color. ~~Probably due to~~ Its air-borne seed-like fruits probably enable this plant ~~is enabled~~ to spread rapidly from place to place.

Since 1926 a second Mexican eupatorium, _E. riparium_ , appeared in the islands, probably purposely introduced as an ornamental. It was first observed in the vicinity of Hilo, Island of Hawaii. Within four years it has spread along the Hamakua coast as well as along the roadside from Hilo toward the Kilauea Section of the Park. This plant thrives in wetter districts than does the preceding one and therefore threatens to invade the Park where it will most likely compete with the native plants to their disadvantage. It is considerably smaller than the eupatorium so common on Maui, and has branches that tend to recline. These readily strike root in wet places, in this way producing clumps of plants ~~that are~~ of considerable extent. It is a great pity that these two eupatoriums have become naturalized ~~in the islands~~. ~~They should bet as a lesson to~~ They exemplify the possible danger that occurs when the layman ~~who~~ attempts to introduce foreign plants into these islands. He is rarely capable of judging whether his introductions will ultimately be highly beneficial or cause untold damage.

(8)

BIDENS or KOKOLAU)

More than sixty kinds of Bidens, called kokolau by the Hawaiians, are known from these islands mainly through the researches of E. E. Sherff of the Field Museum in Chicago. These plants grow from the shore to an elevation of 8000 feet, and from desert-like lava flows to the wettest rain-forests. They are members of the Compositae or Composite Family, the largest and one of the most highly evolved families of flowering plants existing today.

All kokolau in the islands, excepting two introduced kinds mentioned below, are harmless, annual or perennial herbs, many of them of considerable beauty. They bear minute flowers that are aggregated into clusters, called "Heads" or capitula, which superficially resemble a single flower to such an extent that most visitors to the Park are deceived regarding their true nature. It may not be amiss, therefore, to explain how these structures may have evolved to their present condition. This is best done by comparing the longitudinal section of a hypothetical ancestral flower cluster, such as that of the lantana (Plate , fig.), with a diagram of the corresponding structure of a typical kokolau (Plate , fig.).

The stalk bearing the flower cluster of the lantana and that bearing the head of the kokolau are fundamentally alike. At the top of the stalk in the case of the former plant is a conical stem bearing closely set leaves and flowers. In the kokolau, on the other hand, this structure, now called receptacle, differs chiefly by being more flattened so as to become dish-shaped. The outer row of leaves, each of which bears a single flower in the lantana cluster, bears no axillary flowers in the kokolau. These leaves, on the contrary, simulate the green calyx of a typical flower and make up the involucre of the Composite head. The numerous flowers of the lantana, each standing in the axil of a leaf, correspond to the numerous small flowers called florets of the kokolau. Even the axillating leaves are present in the latter, though now greatly modified into scale-like chaff. In the introduced kokolau, commonly called Spanish Needles, which is such a common weed in these islands,

all florets may be alike. But in a form of this same plant growing at higher elevations and in the native kinds, the peripheral florets have become modified into petal-like structures. This occurrence of small florets and of petal-like florets in a single head, a condition observed in a vast number of Compositae, is the cause of the common error in confusing a complex flower cluster composed of many, distinct flowers with one single, large flower.

By comparing the two large scale figures on Plate —, one notes that the small floret, or disc floret, and the petal-like, or ray, floret are homologous structures each highly specialized for a definite purpose. The one is for seed production; the other, for display to attract insects to the neighboring, inconspicuous disc florets so that cross-pollination may result. Both florets contain an ovary surrounded by the calyx-tube. The ovary of disc floret the ovary contains a single maturing seed, and the calyx bears two tooth-like sepals. These bear downwardly pointing hairs, which upon the ripening of the ovary into a one-seeded fruit, catch in the fur of animals and thus enable the seed-like fruit to be carried long distances. The ray floret likewise has an ovary, but it is functionless and never bears a seed. There is, therefore, no advantage in resulting it and, because of the absence of barbed sepals, no special opportunity for doing so. Both florets bear a corolla consisting of five petals which are more or less united from their common base. In the disc florets, these petals are small and inconspicuous. But in the ray florets three or more of them have united and enlarged into a single petal-like structure of considerable length. The presence in many cases in the ray florets of three or more apical teeth, which are the free ends of that many petals, proves their complex origin. In addition to these elements, the disc floret bears five stamens of which the upper parts of which consist of pollen-bearing anthers and are united, to form a single tube around the upper part of the pistil. The pistil is hairy and, on elongating, brushes the pollen into the open where insects may be dusted with it. After a certain length of time, the upper part of the pistil divides into two spreading lobes termed stigmas. These now contain the remaining pollen on their outer, reflexed surface where

it is discarded. The inner and upper XXXXXX side, which is the only surface suitable to enable pollen to fertilize the ovule contained in the ovary for the development of seed, is now exposed. Since its own pollen has been shed or rolled out of the way, the floret cannot be self-pollinated and, at the same time, with the enlarged stigmatic surface increases the chance of being cross-pollinated. In-breeding often results in loss of vigor in the offspring, and so this pollination mechanism is of particular value to the plant.

Two kinds of introduced kokolau are known from Hawaii National Park. Bidens pilosa L., locally called Spanish needle, is an introduced weed native to tropical America. It was first collected in the islands as early as 1864 by the late Dr. Brigham, long director of the Bishop Museum and one of the early collectors of Hawaiian plants. This plant is now the commonest kokolau in the islands and the most troublesome because of its two- or three-pronged fruits that become attached to the clothes of people and the fur of animals. It is extremely common at lower elevations in dry as well as moist, sunny localities. The plant is usually one to three feet high bearing, when fully developed, compound leaves consisting each of three leaflets. Its heads usually look petalloid florets, though at higher elevations, as for example in the vicinity of Kilauea these are present. They are creamy white in color.

A second introduced Bidens, B. cynapiifolia H.B.K., is native to the West Indies and Central America. It is evidently of rather recent introduction as it has not been reported from these islands before and at the time of this writing is known only on the Island of Hawaii. It may be found within the boundary of the Park on the arid plains south of Kilauea as well as in similar localities as far north as Kealakekua Bay. This plant is characterized by having dissected leaves and small, yellow ray florets in its heads. Its fruit is long and surmounted by three spreading, barbed teeth. In dry regions, this weed bids fair to become as common as B. pilosa.

The third kokolau growing within the Kilauea section of the Park is B.

hawaiensis var. conglutinata Degener & Sherff. This plant, peculiar to the Island of Hawaii, was first discovered by Antone Borges in 1929 in the District of Puna and subsequently one specimen was found growing in the first crater south of Kilauea Iki along the Chain of Craters Road. It is no doubt after this plant that one of these craters was named Kokolau by the Hawaiians. This herb is a perennial bearing ovate leaves and showy heads containing yellow, petalloid ray florets.

The fourth kokolau found in the Park is known only from the Koolau Gap of Haleakala Crater, Island of Maui, where it was discovered by the writer and Henry Wiebke in 1927. This plant has been named B. connexlotheca var. pentamera Sherff. It is a tall perennial herb that sprawls over neighboring vegetation to display its large, ornamental, yellow heads. This plant bears leaves resembling a fern frond that are once or more pinnate.

The native kokolau were greatly valued by the Hawaiians. The leaves were stripped from the plants, dried, and then made into a tea that was considered a tonic or blood purifier. ~~Because of this use, some maintain that the name of the plant was derived from koko, the Hawaiian word for blood, and lau, the Hawaiian for leaf or herb.~~

This plant, like many others ( ), was also a remedy for thrush, a fungous disease formerly common in children. For small infants, the disc florets were gathered, chewed, and then fed to the patient from mouth to mouth. But if the child were more than a year old, the Hawaiians might also employ the leaves, bark from the stems, and root.

89-90

RAILLIARDIA or KUPAOA

Railliardia, named by Gaudichaud in honor of one of his companions in the exploring expedition under Freycinet in 1819, is the scientific name of a large group of the Compositae or Composite family found exclusively in the Hawaiian Islands. By the natives these were known as kupaoa. These plants generally thrive on barren lava flows and on exposed ridges especially at higher elevations. They are herbs or shrubs sometimes reaching a height of 12 feet, and have simple, often leathery leaves. Their heads are yellow to almost white. These are simpler in structure than those of the kokolau (   ), bearing but one kind of floret. The fruits of the Railliardia, instead of having the persistent sepals modified into barbed teeth as in most kinds of kokolau, have them modified into a single ring of spreading hairs. These act the part of a parachute to keep the seed-like fruit suspended in the air during windy days. Thus the fruit is enabled to leave the vicinity XXXXXXXXXXXXXXXXXXXXXXXXXXXXX of the parent plant for some distant locality where the opportunity to germinate and grow to maturity is perhaps more favorable.

In the vicinity of Kilauea grow two kinds of railliardia or kupaoa. Railliardia scabra DC., preferring sunny thickets, is a low, decumbent herb with purplish branches rarely rising higher than two feet. Its leaves are in alternate arrangement and its grayish white heads are erect. Railliardia laxiflora DC., on the other hand, is a small, erect shrub most common in the more open localities, especially between the Kilauea Military Camp and Uwekahuna Observatory. Its leaves are typically borne in whorls of three and its yellow heads are drooping. The root of this plant is fragrant and was often used by the Hawaiians to perfume their kapa (   ) and precious feathers. Within Haleakala Crater as well as on its slopes three or four other kupaoa may be found.

The heads of the kupaoa, as well as those of the silversword (   ) and its relatives, are badly parasitized by peculiar Hawaiian flies. The eggs are laid in the young heads and hatch into maggots. These maggots then feed on the developing XXXXXXXXX florets until it is time to pupate in the

...heads preparatory to developing into flies. These insects are not harmful to the parent plant but greatly reduce its ability to perfect seed by feeding on the florets.

91

E.B. ok 212

EUROPEAN WOOD GROUNDSEL

Within recent years the European wood groundsel, Senecio sylvaticus L., has gained entrance to these islands where it finds conditions favorable for growth at higher elevations. It is rather common in central Molokai in clearings, and extremely abundant on Maui within Haleakala Crater just below the Rest House, but rather rare in the Kilauea Section of the Park.

It is a member of the Compositae or Composite Family and bears its small, bright yellow flowers, or florets, in heads. All appear at first glance alike, but with a lens one can see that those in the outer peripheral row are petalloid in structure. As in the Railliardia (   ), the fruits are tufted with hair to enable the plant to be disseminated by the wind.

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SILVERSWORD and GREENSWORD

Probably the most striking Hawaiian plants are those belonging to Argyroxiphium, a group classified as members of the Compositae or Composite Family. These plants are exclusively Hawaiian.

Contrary to popular belief, there are five distinct kinds of Argyroxiphium. The best known is the famous Haleakala silversword, A. macrocephalum A. Gray. To the Hawaiians it is known as pohinahina or ahinahina, merely variants for their word for gray.

The Haleakala silversword, when young, is a beautiful silvery sphere of incurved, linear leaves. The plant owes its color to a dense covering of hair which, ~~as in the case of~~ the native geranium ( ), repels some of the penetrating rays of the sun. This protection seems desirable as sunlight is more intense at high elevations than at low. The hair also guards the plant from too rapid loss of moisture ~~due to~~ by evaporation through its leaves.

When the plant has attained a diameter of about two feet, it shoots up a magnificent cluster of flowering heads to a height of three to six feet. In that stage it resembles the illustration on the cover. This flowering stalk bears sticky, glandular hairs, as does the Silene ( ), to prevent crawling insects from reaching the flowers for pollen and nectar, the plant thereby reserving these two foods exclusively for flying insects. The flowering heads themselves are not particularly beautiful, bearing small yellowish disk florets and about twenty-five purplish ray florets.

After maturing their seed-like fruit, of which many thousand are normally produced, the silversword dies ~~similarly to~~ unlike the century plant after it has seeded. This is probably ~~due to the fact that~~ because the flowering stalk terminates the growing tip of the plant, and no side shoots develop to continue growth. Of all the silverswords studied during three weeks' botanizing within the crater, the writer saw only one plant that had produced a secondary branch. This arose about an inch above the top of the root.

See note

The Haleakala silversword was ~~quite~~ very common within the crater and on its rim until the beginning of this century. According to reliable accounts, the

plants were so abundant in the latter half of the nineteenth century make "the hillside look like winter or moonlight." Where a garden of silverswords ten acres in extent was growing in the '90s, not one plant could be found in 1927. Silverswords were so common on the cinder cones in the early days that tourists were accustomed to uproot the largest specimens merely to watch them roll down the slopes like giant snowballs. As late as about 1915, these plants were ruthlessly gathered in great numbers and dried to be shipped to the Orient as ornaments. In 1927 considerable hunting for this plant within the crater barely disclosed a hundred specimens.

From its former abundance and its present scarcity, the Haleakala silversword appears to be on the road to extinction. Two main factors are responsible, namely man and insects. Dangers to the plants due to thoughtlessness and sheer vandalism by man has already been mentioned. This is now being reduced to a minimum by education and, in the very few cases where necessary, by fines. Danger to the plants from insects is more complex. At least six kinds of insects, many of them new to science, are more or less injurious to the plants. A leaf-hopper (Ilburnia argyroxyphii Kirk.), for example, is sometimes found in great numbers sucking the sap from the silversword. This insect, fortunately, is partly controlled by a wasp (Polynema sp.) that is so small as to be barely visible. It presumably searches for the eggs of the leaf-hopper into each one of which it lays a single microscopic egg of its own. The latter hatches into a larva that feeds on the contents of the leaf-hopper egg and then pupates. Instead of a leaf-hopper emerging from the shell, an adult wasp crawls forth.

An undescribed phycitid moth and a gray fly (Tephritis craterícola Grimshaw) are the two kinds of insects that prevent the silversword from increasin number. The caterpillars of this moth begin to feed in the centers of the very young flowering heads. Then when these are ready to open, hardly a floret remains to produce seed. The fly causes as much if not more damage than the moth. Its yellow maggots feed on the florets and pupate among their remains. In 1927 because of the ravages of these two insects, the loss of seed

was so enormous that only a few could be gathered for propagating purposes. Naturally as the plants always die after flowering and few seeds escape destruction, only in exceptional cases will many young plants grow to take the place of the old since.

The most practicable way to increase the number of silverswords in Haleakala is to spray the plants judicially with insecticides from the time the flowering cluster develops until the seeds are mature. This work should be supplemented by placing fine-meshed cages over a few clumps of sprayed plants just before these are ready to reproduce, and at the correct time later on, insuring cross-pollination. This would enable the ripening of many thousands of good seed. These could be scattered or raked into the cinders in favorable places for growth.

The Hawaiian silversword is known as A. sandwicense DC. It is limited to the Island of Hawaii, thriving on the barren stretches of Mauna Loa, Mauna Kea and Hualalai above an elevation of 7000 feet. This plant closely resembles the one on Haleakala. The upper part of its flowering cluster is shown on Plate . The plant was probably first collected by David Douglas who had been sent by the Royal Horticultural Society of England to gather interesting plants in the New World. The Douglas spruce or Oregon pine (fir ?) was one of his finds and named after him. While collecting on the slopes of Mauna Kea in 1834 there is little doubt but that he was purposely pushed by a former convict into a pitfall containing a wild bull. Douglas was gored to death and now lies buried in historical Kawaiahao churchyard, Honolulu.

Mt. Eke is the well-preserved core of an extinct volcanic cone north of Iao Valley, western part of the Island of Maui. Due to its elevation of almost 4500 feet and the topography of the surrounding country, this mountain is covered with clouds most of the time. Only on rare occasions is its summit exposed to the direct rays of the sun and that occurs almost always in the early morning. This summit is essentially a circular plateau about half a mile in diameter, covered with an impervious clay. Here and there are shallow pools of water fed by the heavy rains and mists, and in a few depressions seemingly bottomless pits with slippery sides of clay. This entire plateau has the Tundra and is treeless, being covered almost entirely by low sedges as with a lawn.

Among these, curious silverswords grow in such profusion that, in spite of the disinclination to do so, it was often necessary to step on the plants to get from one place to another. To see such a field of silverswords was the more startling as none can be found below the summit.

This Eke silversword, named Argyroxiphium caliginí Forbes, is characterized by dividing and creeping profusely over the ground and progressively dying back at the base, thus isolating the branches into independent plants. It does not produce silvery spheres two or more feet ~~across~~ through as does the Haleakala plant, suetad, Its mass of leaves is rarely 6 inches ~~wide~~? Of the many thousand plants growing, all of which could be easily seen, only one showed the remains of a flowering stalk in the late summer of 1927. This was about two feet high. Besides growing on Mt. Eke, this plant may be found in small numbers on Puu Kukui, a higher mountain located across a deep ravine to the south.

Before ~~continuing with a discussing~~ of a second kind of Argyroxiphium on Mt. Eke, it is best to consider another Haleakala plant. In the Koolau Gap of that region the rainfall is considerable, ~~this being~~ so it is the lowest spot through which the trade wind can ~~push~~ blow into the bowl of the crater. Here a rare counterpart of the silversword may be found. This plant is neither exposed to such extremely dry conditions nor to such intense sunlight as the silversword that grows on the cinder cones barely three miles away. It therefore requires a sparser covering of hair and can have broader leaves for exposure to the sun. The plant, consequently, has a greenish tinge and a less compact appearance. Because of its color it is best known as the Haleakala greensword or, botanically, as Argyroxiphium virescens Hillebr. ~~Similar~~ Like to the silversword, these plants are ~~also~~ magnificent spectacles ~~requiring~~ deserving effective protection from man and insects.

The greenswords observed become taller than the silverswords at flowering time. The area in which they grow is just beyond the present boundary of the Haleakala section of the ~~National~~ Park. Here also may be found the rare geraniums and the sandalwood trees previously described. Though only one silversword was observed to branch while in the vegetative stage, of about thirty greenswords seen, several had

each produced a second branch. In one plant, the older branch had flowered, seeded and died, while the younger was still growing vigorously. This latter, no doubt, would produce its own flowering cluster later on.

On the northern side of the summit of Mt. Eke and on Puu Kukui to a lesser extent, a very rare Argyroxiphium may be found. This, hitherto, has been considered merely a variety of the Eke silversword because of its similar habit of branching. This is not strictly correct. The plant is a second kind of greensword and hence will later bear the name of Argyroxiphium Kai.

In studying all the different representatives of the Composite family found in the world, of which more than 25,000 have already been described, only 70 have heads of an unusual type of construction. Sixty-two of these plants grow from Oregon to Chili, one grows in the Galapagos, while the remaining seven are found only in the Hawaiian Islands. Two of these last are called Wilkesia, and grow on the Islands of Kauai and Maui; the remaining five are either silver- or greenswords. As the Wilkesia and the Argyroxiphiums are very closely related, one comes to the conclusion that both groups of plants on these islands came from a common ancestor which had reached these islands from the American continent untold ages ago. From the structure of their heads and from their vegetative features, it is evident that these plants have become highly specialized in order to survive most efficiently in an unusual and harsh environment. Their characteristics are simple not due to primitiveness but due to the degeneration or reduction of useless or even harmful features.

The silversword and the greensword, as far as known, were not used by the Hawaiians.

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drawn attention to the unique character
ian Islands, particularly in respect to their flora; should have
teach ew fundamental principles of Botany; and should have imparted a
feel respect for the ancient Hawaiians and their customs, both perhaps
recal Homeric Greece to mind.

For the comprehensive flora, the writer is collecting additional information on native plants and their relationship to the Hawaiians as well as circumstances and the time of introduction of foreign plants into these islands. Such information, and the correction of facts in the present text, will be greatly appreciated.