Rare and Unusual Plants: Island of Hawaii

by
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Cartographic Contributions: Martin Buchert

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This Page: *Vigna oahuensis*

Introduction

The peaks (left to right) of Mauna Kea, Mauna Loa, Kohala, and Hualalai rise from the sea, often above the clouds.

The Hawaiian Islands are among the most isolated high islands in the world, located over 2,000 miles from the nearest continental land mass. Their remote location, together with a remarkable diversity of habitat types or environments, has allowed Hawaiian native species, including plants, to evolve into many spectular and unique forms. How did these native plant species first arrive in Hawai'i? Many thousands, in not millions of years ago, long before human settlement, the original colonizing ancestors of these plant species arrived by chance in Hawai'i.

Although some seeds arrived with the aid of wind or ocean currents, most reached these islands attached to, or inside the digestive tracts of birds. Many sea bird species found and colonized Hawai'i, some bringing plant seeds. Land birds, on the other hand, very rarely can survive the long distance travel and find Hawai'i by chance, perhaps disoriented by severe storms. However, as infrequently as it might be, the rare events of stray land birds finding these isolated islands probably account for most of the original plant introductions into various inland environments of Hawai'i. Once a land plant or animal arrived in these islands, they were most often destined to extreme isolation. Under this remote separation from there original home population, many, but not all, of these native plant and animal colonizers evolved into a remarkable array of unique species only found in the Hawaiian Islands. Approximately 1,500 plant species are native

The native *'Ohia lehua* (*Metrocideros polymorpha*) has tiny seeds easily carried by the wind (right of penny).

The ancestor of *Papala kepau* may have arrived in Hawaii as sticky fruit attached to the feathers of a bird. Hawaiians used the sticky substance to catch birds.

The ancestor of *Ohelo* (*Vaccinium*) probably found its way to Hawaii as seed in the gut of a bird that had eaten the fruit.

Ie'ie (*Freycinetia arborea*) is a common forest plant **indigenous** to Hawai'i. It also grows on many other Pacific Islands. Hawaiians used the roots of *ie'ie* to make fish traps, crested helmets and gods that were then covered with feathers, handles for gourd rattles, and baskets (*'Ie*). The vine was also used ceremonially when *koa* (*Acacia koa*) trees were cut to make canoes.

to the Hawaiian Islands. Some of these can be classified as **indigenous** species. Indigenous means the species occurs naturally in Hawai'i (arrived without human help), but can also be found on other Pacific islands or continental areas. The ancestors of indigenous plant species arrived in Hawai'i but their offspring did not evolve into unique species only found here because they only arrived relatively recently, or they have not been isolated here since their seeds are spread easily over long distances. Hawaiian coastal plants for example, have seeds that are easily dispersed by ocean currents or seabirds and thus retain genetic contact with other areas of the Pacific, and have not changed into new, uniquely Hawaiian species. Many indigenous species are still commonly found in Hawai'i.

In contrast, nearly 90% of all the native Hawaiian plant species are, in fact, found nowhere else, and are thus referred to as **endemic** species. This represents one of the highest levels of endemism (uniqueness) found anywhere on Earth! This is one of the reasons why biologists and consevationists around the world recognize Hawai'i as a very special "hotspot" of biological diversity. Unfortunately, the narrow geographic range of many native, endemic Hawaiian species makes them very susceptible to decline from a loss of habitat quantity and quality. A growing human population has already damaged or destroyed much of Hawaii's

Solanum incompletum (*Popolo*) is **endemic** to Hawai'i and is one of several native plant species referred to in Hawaiian as *Popolo*. Traditionally, varieties of *Popolo* were used for medicine, tapa dye, and food.

Banana poka (*Passiflora mollisoma*) is an invasive **alien** plant that is smothering native dry and moderately wet forest on the island of Hawaii. This vine grows in the canopy, shading out the vegetation below. Feral pigs spread its seeds when they consume the fruit.

native plant habitat. The additional harmful effects of some **alien** plants and animals (species introduced by humans intentionally or by accident) have driven many Hawaiian species even closer to the brink of extinction; and extinction means gone forever!

So far, during just the past 225 years, approximately 100 endemic Hawaiian plant species are thought to have disappeared from the wild; a small handful of these have been "saved" through cultivation in botanical gardens and nurseries. Of the remaining 552

The lower slopes of the Hamakua area of Mauna Kea volcano has been converted to agricultural land with native forest between about 2-6,000 ft., and heavily disturbed subalpine, cattle pasture from about 6,000 ft to tree line, topped by the alpine stone desert surrounding the summit area.

Tape and glue hold together all that remains of extinct *Cyanea giffardii* (in forest at right), last collected in1917 near Glenwood (Volcano) by botanist Joseph Rock and now stored in the Bishop Museum herbarium.

Hawaiian plant species that botanists consider to be rare or endangered, approximately 150 have fewer than 50 individuals remaining in the wild. These statistics are a warning sign of the larger problem of environmental disturbance that reduces ecological stability and threatens the survival of entire, native Hawaiian ecosystems. Because of our small geographic area and highly evolved endemic species, Hawaii is in the dubious position of having more extinct and endangered species than all of the mainland U.S. states combined.

Haìwale, Cyrtandra tinntinnabula inhabits the Wet Forest of Hamakua.

Phyllostegia racemosa is another Wet Forest inhabitant.

Why should we save native, endemic species in Hawai'i, or for that matter, anywhere else in the world?

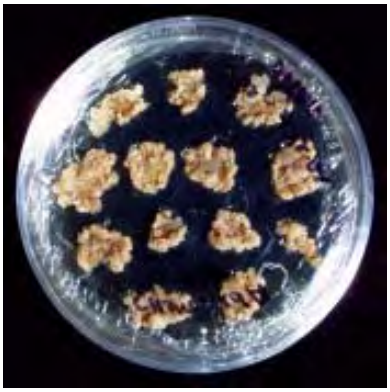
1) It can be argued that these endangered species have been in existence for very long periods of time, and have a right to live without humans accelerating their own natural rate of extinction.
2) These rare species are part of the natural ecosystems and therefore have a variety of biological roles in providing food, habitat, or additional functions for other species.
3) They have provided various traditional and modern resources for people, such as food, fiber, timber, medicine, and spiritual inspiration.
4) These uncommon species help scientists understand biological evolution and adaptation to the environment over time.
5) These same species can help the modern economy, through funding for scientific research, ecotourism, and possible medicinal remedies for people in Hawai'i and the rest of the world.

Until these threats can be managed effectively for the long term, the status of native endemic Hawaiian species will continue to deteriorate and more of these species will become threatened with extinction. Habitat conservation and the control of aggressive, harmful, alien species are both necessary for the survival and ultimate recovery of Hawaii's native plants and animals. However, for many native, endemic Hawaiian plants, these approaches will not be implemented quickly enough to prevent extinction. Immediate action must be taken before these unique species are lost forever.

Some governmental and non-governmental groups, such as the Hawaii Rare Plant Restoration Group - a coalition of participating institutions, such as the Center for Plant Conservation, federal and state agencies, private organizations, and independent botanists- have been developing programs aimed at preventing the loss of endangered plant species. Their objectives include the following:

1. Obtain comprehensive genetic samples of the surviving wild plant population for the most critically endangered species in Hawaii.
2. Store or cultivate samples collected from these plant species.
3. Propagate every high priority species in sufficient numbers to maintain genetic diversity and provide stock for reintroduction into native habitats.
4. Integrate off site (in cultivation) or on site (in native habitat) conservation projects.
5. Produce an information management system that tracks the complex actions on the off site area and sends useful information promptly to involved stakeholders and on site managers.

These groups have already made progress, and so can you as a concerned citizen interested in preserving what is truly native to the Hawaiian Islands!



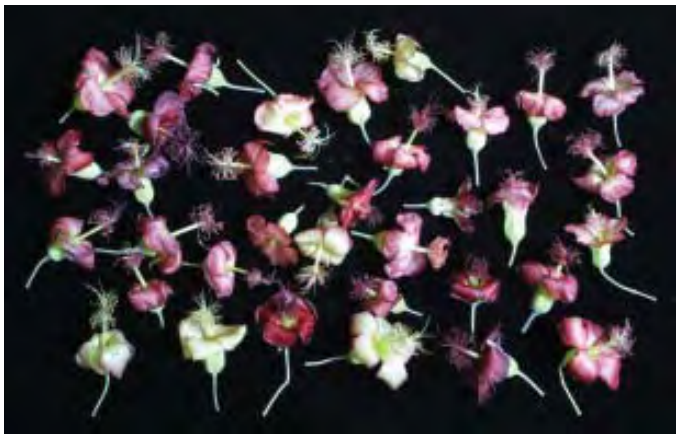
Using a process called tissue culture, pieces of plant growth tissue, such as these of *Ko'oloa'lua* (*Abutilon menziesii*), can be induced grow roots and leaves.

Mehamehame (*Flueggea neowawrea*) trees, reach for light from the fragile confines of their glass nursery at the Lyon Arboretum.

Hawaiian plants wait in a greenhouse for volunteers to plant them as part of habitat restoration efforts relying on public participation at Hakalau National Wildlife Refuge.

The seed bank at the Lyon Arboretum stores future generations of Hawaiian plants until suitable habitat is available.

Plant Evolution and Biodiversity



These *Ko'oloa' ula* (*Abutilon menziesii*) flowers of varying color were collected from beneath different plants growing in the same area.

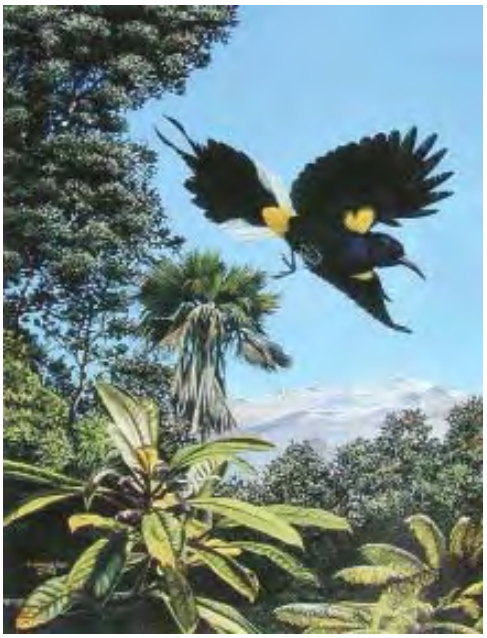
Variations between the appearance of individuals within any species can be expected, although some species display more variation than others. Color differences in flowers are one kind of biological variation. Diversity also occurs in less visible characteristics such as chemical production or root development. These variations in development (traits) are controlled by a sequence of genes. On a long term, global scale, genetic diversity is life's survival mechanism. The different genetic composition of individual members helps species respond successfully to gradually changing environmental conditions. Random mutations (changes) in the genetic code result in new variations and traits (such as petal color). Over time, these variations may accumulate and new species can develop. Some species are inherently more variable and widespread than others. When any species is exposed to sudden, severe environmental disturbance and therefore experiences a reduction in population, it is vulnerable to a loss of variability. In very small, isolated populations, inbreeding among closely related individuals can further reduce the abilty of offspring to live and reproduce successfully. Plants that are rare to begin with, like those of the Hawaiian Islands, are especially susceptible to loss of genetic diversity. This can occur through habitat disturbance or fragmentation, inbreeding, chance events, and in some cases, a loss of genetic identity from hybridization with alien plants. Flowering plants must be pollinated to make seed for the next generation. Many Hawaiian plants can pollinate themselves, but in this process no exchange of genetic ancestry takes place. Wind may spread pollen from one plant to another, but many plants rely on insects or birds to make the transfer, providing nectar as a reward. In some cases special relationships have developed between particular plants and creatures as a result of their interaction over very long periods of time. In a process called coevolution, plant and animal species may develop physical and life history

Hawaiian Spinx Moths (*Manduca*) like this one visiting *Ko'oloa'ua* (*Abutilon menziesii*), spread pollen between plants as they feed on nectar.

traits that reinforce a mutual relationship, as individuals with these mutualistic traits reproduce with greater success.

Coevolution appears to have occurred between Hawaiian lobeliad plants and some Hawaiian honeycreeper birds (Drepanidinae). The Hawaiian lobeliads have become very different from lobeliads found elsewhere. Hawaiian species have become woody and tall, like trees (arborescent). Their flowers are large with long, curved tubes that provide nectar at the base. The honeycreepers developed into variety of species with different beak shapes and tongues specialized for certain feeding habits. Some like the *I'iwi* (above) or especially the extinct Hawai'i *Mamo* (*Drepanis pacifica*), developed long, curved beaks and tongues well suited to sipping nectar from Hawaiian lobeliads. Many of the most spectacular Hawaiian species of lobeliad plants and honeycreeper birds have become extremely rare or have gone extinct in the last century. When extinction occurs, the ancient chain of evolutionary development is broken. Wondrous forms, some yet to be, are lost to the world forever.

Koli'i (*Trematolobelia*) develops branches during flowering that provide a perch for Hawaiian Honeycreeper birds like the I' iwi (*Vestiaria coccinea*) which sips nectar from the flowers with its long, curved beak and tongue.

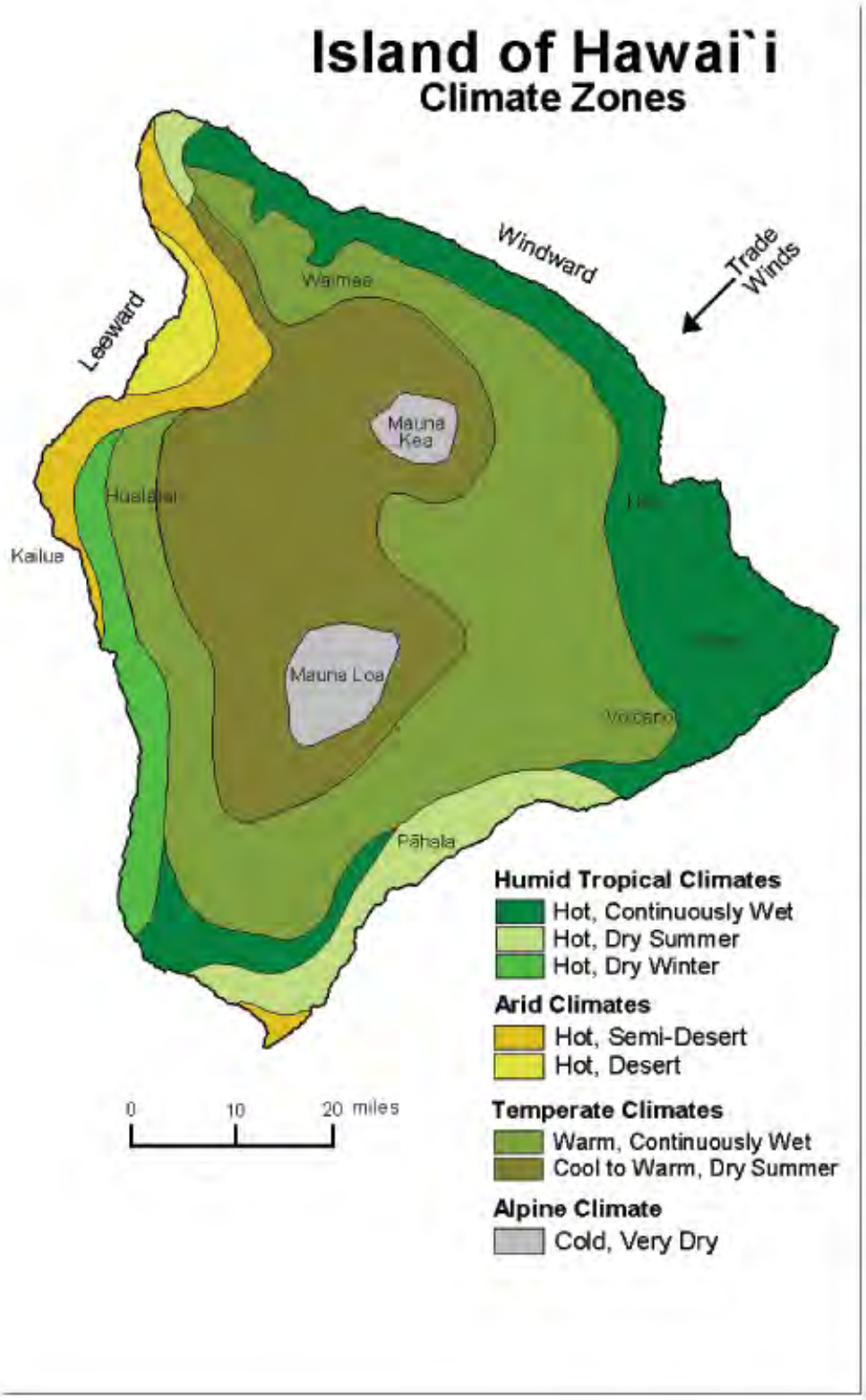


Hawaiians traditionally used the feathers of I*'iwi*, the extinct Hawai'i *Mamo* and Hawai'i *O'o* (*Moho nobilis*, left) to decorate cloaks woven from *Olona* cord. One trap to catch the birds was made by covering the tip of an *Olapa* branch with sticky gum from the fruit of *Papala kepau* or the sap of the *Ulu* tree.

Climate and Vegetation of Hawai‘i Island

The variety of vegetation types found on the Island of Hawai‘i is a result of its great diversity of physical environments. Soil conditions range from non-existent on young lava flows to deep and well developed in ancient ash deposits, such as those found on the agricultural lands of the Hamakua Coast. Although the surface area of Hawai‘i Island is only 4,000 square miles (60% of the total land area of the state), it contains a spectacular array of distinctive climate zones, comparable to that found in much larger continental areas. Average annual rainfall, for example, ranges from more than 300 inches on the windward slopes of Mauna Kea to less than 10 inches along the leeward coast of South Kohala. Because air becomes less dense with increasing elevation, there is a general decrease in air temperature of about 3ºF for every 1000-foot rise in elevation. Thus, the summit areas of Mauna Kea and Mauna Loa (above 13,000 ft) will typically experience nighttime freezing conditions and average temperatures that are 30-40ºF cooler than coastal locations only 20 or 30 miles away. Native plants and ecosystems have evolved different adaptations and survival strategies in response to these wide ranging conditions.

Several factors contribute to the climate diversity of of Hawai‘i Island. These include the influence of persistent northeast trade winds, the tall mountains, and the heating and cooling characteristics of the island’s relatively large land mass in relation to the surrounding ocean. The interaction of tall mountains and the prevailing trade winds results in rising air on the slopes of the exposed windward north and eastern mountains, with resulting cooling, condensation and high rainfall. After passage over the mountains air descends and warms on the leeward slopes, dramatically reducing rainfall to desert-like conditions. In addition, air from other sources, rising from near the equator, descends directly over the Hawaiian Islands, and has the effect of suppressing cloud development and precipitation at mountain elevations above 6,000-7,000 ft. This results in cool and very dry conditions on the high mountain slopes and the development of distinctive sub-alpine and alpine native ecosystems. The map on the next page shows four broad categories.


Island of Hawai`i
Climate Zones
Windward
Trade Winds
Leeward
Waimea
Mauna Kea
Hualālai
Kailua
Mauna Loa
Volcano
Pāhala
0
10
20 miles
Humid Tropical Climates
Hot, Continuously Wet
Hot, Dry Summer
Hot, Dry Winter
Arid Climates
Hot, Semi-Desert
Hot, Desert
Temperate Climates
Warm, Continuously Wet
Cool to Warm, Dry Summer
Alpine Climate
Cold, Very Dry

Climate Descriptions

Humid Tropical climates: This includes hot, windward lowland areas below 2,000 ft elevations, where monthly average temperatures always remain above 65ºF. These areas are directly exposed to the trade winds and therefore receive high and continuous rainfall, for example Hamakua, Hilo and Puna districts. Areas of the island like Ka‘u, that are transitional between windward and leeward exposure, are tropical but experience a significant dry season in the summer. A unique tropical climate has developed along the Kona Coast. This area is protected from trade winds by the blocking effects of Mauna Kea, Mauna Loa and Hualalai. As a result, it has a localized wind system based on fluctuations in daily temperature and air pressure between the land and ocean. During the day, land warms faster than the ocean, drawing moist air onshore. This air rises up the heated slopes of Kona and condenses to form afternoon rain showers in the uplands (the “coffee belt” area between 1,000-2,500 ft. elevation). Because the temperature differences between land and sea are greatest during the summer, upslope rainfall is also maximized during this period, and reduced during the cooler winter months (tropical winter-dry climate).

Arid Climates: Hot, leeward areas of South Kohala and North Kona are continually influenced by descending, warming air that has either passed over the Kohala Mountains or through the Saddle between Mauna Loa and Mauna Kea. Available moisture from this air has been largely removed on the windward side, leading to dry conditions. Desert (10-20 inches annual rainfall) or semi-desert (20-30 inches annual rainfall) conditions occur in these leeward areas.

Temperate Climates: Throughout the island, at elevations above 2,000 ft, average monthly air temperatures begin to drop below 65ºF. This is the temperature boundary separating “tropical” and “temperate” climate zones. The temperate, upland, windward and Kona slopes often remain fog shrouded and contiuously wet. At higher and more leeward locations, there is a distinctive summer dry season, for example, Pohakuloa where a “California” or “Mediterranean” type climate prevails.

Alpine Climate: At elevations above 10,000 ft (“tree-line”) on Mauna Kea and Mauna Loa, such as Hale Pohaku, average monthly air temperatures drop below 50ºF. These cooler conditions restrict the growth of tall trees, and an alpine climate prevails with its distinctive dwarf shrubland ecosystem.

Hawaiian Ecosystems

An ecosystem is a community of plants and animals interacting with their physical environment. Biological communities develop and adapt to many conditions, especially those of the climate, such as available moisture, solar radiation, and temperature which provide limitations and opportunities for plant growth. About 150 distinct native ecosystems (both land and sea) have been identified in Hawai‘i. Some ecosystems are very specialized, such as those adapted to colonize new lava fields, or survive in the total darkness of underground lava tubes, or cope with moisture saturated swamps and bogs. We have simplified these biological communities into a few broad categories that can be easily identified in the field. These are based on altitudinal location, general moisture conditions and the structure of the plant communities such as grassland, shrubland, and forest. Many of the ecosystens in the Hawaiian Islands have been greatly altered by human activities. The major ecosystem types on Hawai‘i Island include:

Lowland Dry Shrub and Grassland: This ecosystem occupies the dry, leeward lowlands of South Kohala, North Kona and Ka Lae (South Point), which receive less than 20 inches of annual rainfall. Before modern times, this ecosystem was dominated by native grasses, *Pili* (*Heteropogon* contortus) and shrubs ,*A‘ali‘i*, (*Dodonea viscosa*). Fire, overgrazing, and development have now severely disturbed the native ecosystems. The grass and shrub communities occupying this zone are now dominated by alien species, such as Fountain Grass (*Pennisteuum setaceum*) and Kiawe trees (*Prosopis pallida*).

Lowland Dry and Moderately Wet Forest: This ecosystem occupies the lower mountain slopes in leeward and other moderately wet areas of Kona, Ka‘u, and lower Puna which receives between 20-80 inches of annual rainfall. Fire and overgrazing have now greatly restricted this forest type

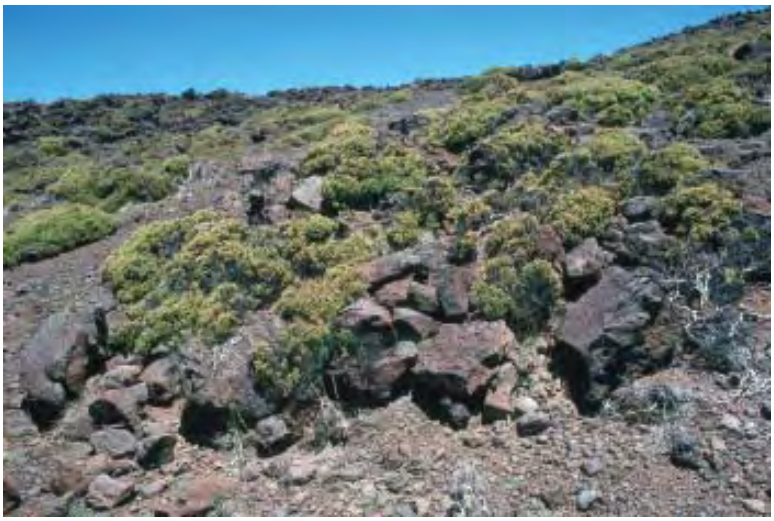
to very few, small patches in North and South Kona (Kaupulehu and Pu‘uwa‘awa‘a) and Puna. Common native trees of this zone include *lama* (*Diospyros sandwicensis*) and *Wiliwili* (*Erythrina sandwicensis*). Many endangered dry forest trees and shrubs are restricted to this ecosystem, which is now dominated by alien species such as Christmas Berry (*Schinus terebinthifolius*) and *Koa haole* (*Leucaena leucocephala*).

Wet Forest: This ecosystem originally occurred in windward areas of Kohala, Mauna Kea, and Mauna Loa from sea level to about 6,000 ft. These areas receive 80-300 inches of annual rainfall. Wet forest regions have been extensively cleared in the lowlands, first for traditional Hawaiian agriculture, and later for sugarcane plantations. The native wet forest is typically dominated by *‘Ohi‘a lehua* (*Metrosideros polymorpha*) with a distinct understory of *Hapu‘u* (*Cibotium* spp.). Today many alien plant species such as Strawberry Guava (*Psidium cattleianum*) and Koster's Curse (*Clidemia hirta*), along with game animals such as feral pigs, have invaded this forest type. However, it is still home to many endangered native plants and birds.

Mountain Dry and Moderately Wet Forest: Originally this ecosystem occupied both windward and leeward slopes between 3,000 to 6,000 ft. elevation with annual rainfall in the 40-80 inch range. This is generally described as the "*koa* forest belt" (*Acacia koa*). Much of this zone was cleared by timber logging, wild cattle and sheep herds, and livestock ranching over the past 200 years. Aggressive alien plant species such as Gorse (*Ulex europea*) have also invaded large areas of this ecosystem on windward Mauna Kea.

Subalpine Dry Forest and Shrubland: This ecosystem occupies the high slopes of Mauna Kea and Mauna Loa and the summit area of Hualalai, between elevations of 6,000-9,000 ft. It receives 20-40 inches of annual rainfall. The dry forest and woodlands of this zone are dominated by *Mamane* (*Sophora crysophylla*) and *Naio* (*Myoporum sandwicense*). Endangered native birds such as the *Palila* (*Loxioides bailleui*) are largely restricted this ecosystem. These subalpine forest areas have been heavily impacted by feral and wild game animals such as sheep, goats, and pigs. Public land management issues in these mountain areas, with respect to sustainable hunting or eradication of alien game animals, remain controversial.

Alpine Desert: This ecosystem lies above the treeline (9,000 ft) on Mauna Kea and Mauna Loa. The environment is harsh, with annual rainfall below 20 inches, frequent strong winds, and nighttime frosts. The natural vegetation is dominated by dwarf native shrub communities, especially with *Pukiawe* (*Styphelia tameiameiae*) and *'Ohelo* (*Vaccinium reticulatum*). The Mauna Kea Silversword or *Ahinahina* (*Argyroxiphium sandwicense* subsp. *sandwicense*) is restricted to this zone. On Mauna Kea, dramatic reductions in feral sheep and

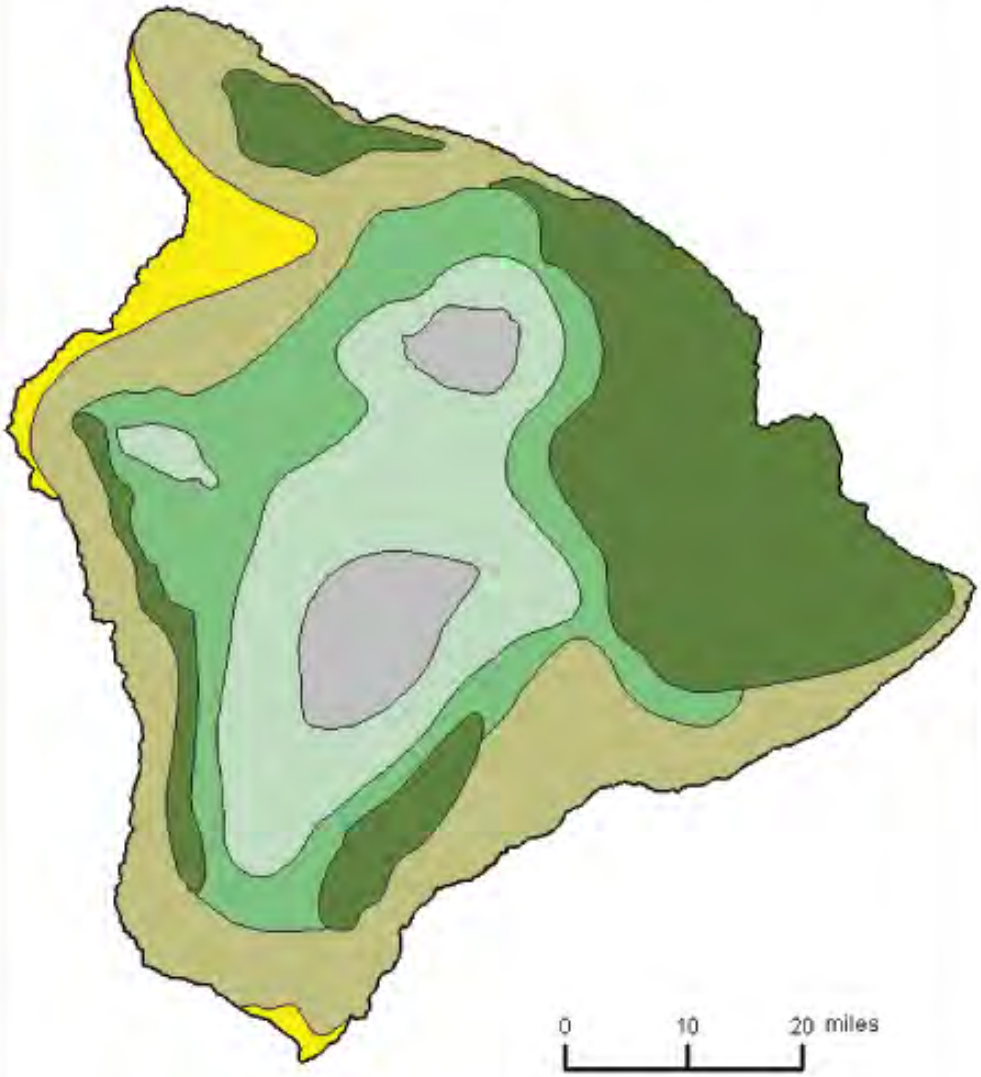


goats in recent decades have allowed these shrubland communities to begin recovering from two centuries of overgrazing. Browsing pressure results in characteristic "gumdrop" shaped shrubs.

Land transformed by human use: Transformation of the lowlands began with native Polynesian settlement of the Islands more than a thousand years ago with their agricultural development. Human alteration of the native Hawaiian ecosystems has continued with plantation agriculture, urbanization, and the many introduction of alien plants and animals. Miconia trees (*Miconia calvescens*) and the coqui frog (*Eleutherodactylus coqui*) are only two examples of recent successful alien invaders. Large areas of the Hawai'i Island are now dominated by human cultural landscapes where native ecosystems are largely or completely absent.

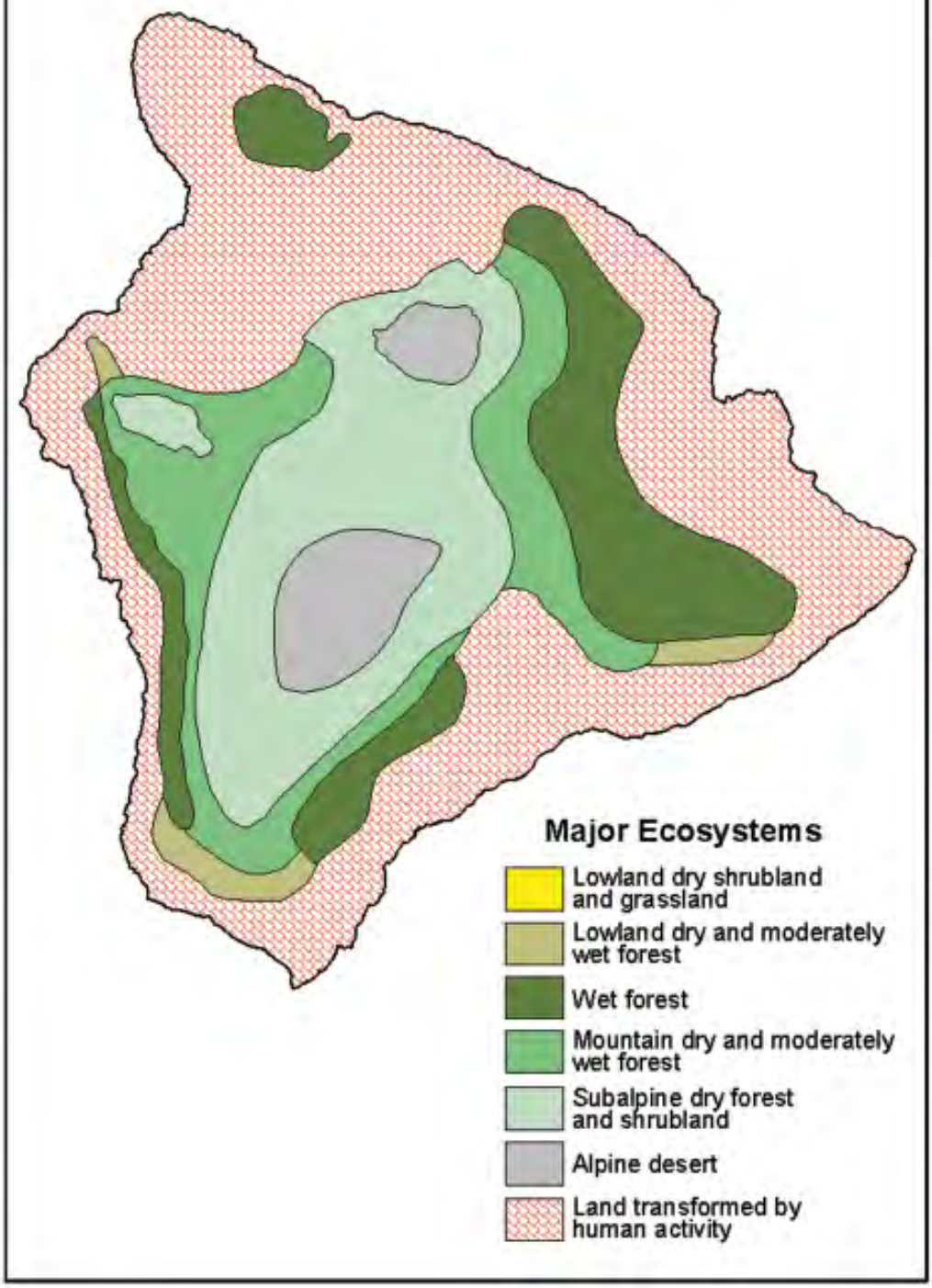
Two maps, on the following pages, show (1) the proabable distribution of native ecosystems on the island before human settlement and (2) the distribution of ecosystems as they exist today, after centuries of human modification. It can be seen by comparing the two maps that human impacts, in the form of increased fire frequency, land clearing for agriculture, urbanization, and the destructive effects of alien plants and animals, has dramatically reduced or totally eliminated some native ecosystems. The once extensive "lowland dry shrub and grassland" and "lowland dry and moderately wet forest" ecosystems have been almost completely replaced by environments largely created by people. Many of the native plants and animals of these lowland ecosystems are already extinct or restricted to small endangered populations. Remote, upland native ecosystems, although not under direct human use, have also been penetrated and impacted by alien species ranging from tiny insects, such as mosquitoes that transmit disease to native birds, to large grazing and browsing mammals that eat ad trample native plants. It is largely in these remaining, forested, public lands that conflicts have developed between competing user groups with different management objectives. Hunters advocate sustainable hunting of alien birds and mammals, while others concerned with watershed and native wildlife protection promote eradication of aggressive alien species.

Native Ecosystems before Human Settlement



Maps adapted from: L.W. Pratt and S.M. Gon III
Atlas of Hawai'i , 3rd Edition, 1998

Ecosystems Today



State Endangered Species Law:
The Hawai‘i endangered species law (Hawaii Revised Statutes Ann. §§ 195D-4-21) prohibits any taking, transporting, buying or selling of species officially listed as “endangered.” It further outlines conservation programs that mandate continued research on listed species. Broad arrest and search and seizure provisions are given to law enforcement officials to enforce these acts. Violation of the regulations result in a misdemeanor conviction, with both criminal and administrative fines that increase for subsequent convictions. Under section 9 of the federal Endangered Species Act, a violation of State endangered species law constitutes a violation of the federal Endangered Species Law.

State Permits: Hawai’i State Government issues permits through the Department of Land and Natural Resources for activities (otherwise prohibited under state law) that further the conservation of listed species, such as cultivating endangered species in private homes or botanical gardens, such as shown below.

The official State flower of the Hawai’i is an endangered species, *Mao hau hele* (*Hibiscus brackenridgei*). It is shown above, on the left, being cultivated at the National Tropical Botanical Garden on Kaua‘i. The flower shown on the right, has blossomed on a *Mao hau hele* plant cultivated in the botanical garden in the Botany Department of the University of Hawai’i at Manoa. Native, endemic, Hawaiian *Hibiscus* species have been crossed thousands of times by horticulturalists to produce colorful and useful ornamental species, contributing to a significant aspect of our economy. For information concerning *Mao hau hele* subspecies found on Hawai’I Island see page #.

Federal Endangered Species Law:

Congress passed the Endangered Species Preservation Act in 1966. It only allowed the listing of native *animal* species as endangered. It also only provied limited protection of listed species. In 1969, the Endangered Species Conservation Act was passed banning importation and sale of listed species. This provided additional protection for species in danger of extinction. The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) restricts international commerce in plant and animal species harmed by trade. Later that year, the Endangered Species Act of 1973 (ESA) was passed, which combined and considerably strengthened the provisions of its predecessors. Significant amendments were enacted in 1978, 1982, and 1988, while the overall framework of the 1973 Act has remained essentially unchanged. The ESA prohibits activities that jeopardize the continued existence of listed species or adversely modify their *critical habitat*. However, unlike the State law, the provisions of the ESA for plants pertain only to federal agencies and their activities, and place no restrictions on state, local, and private activities except where they violate State law. The ESA outlines programs that help in the recovery of listed species and their habitats. Violations of the ESA are punishable by fines up to $50,000 and one year in jail.

Federal Permits:

Permits are available to allow persons to carry out activities otherwise prohibited. For federally endangered plants, permits may be issued for (1) scientific purposes, (2) enhancement of propagation or survival of the species, and (3) economic hardship.

Haha (*Cyanea stictophylla*) shown above is a federally endangered species only found on Hawai‘i Island where it is now being outplanted in natural areas to help its survival.

Critical Habitat:
There are currently 295 federally endangered plant species within the state of Hawaii. Sixty-eight of those occur on the island of Hawai‘i. Half (34 species) are officially recorded as occurring only on the Big Island. In 1992, U.S. Fish and Wildlife Service was sued by the Earth Justice Legal Defense Fund, representing the Sierra Club, Hawai‘i Botanical Society, and the Conservation Council of Hawai‘i to list 245 plant species that warranted listing under the ESA. Five years later, the same plaintiffs sued the Service again for failure to designate critical habitat at the time of listing for those same 245 species. The final critical habitat determinations for those 245 species were completed on July 2, 2003, Hawai‘i Island plants being the last list of endangered plant species of all the islands to be finalized. The Hawai‘i Island rule designated critical habitat for 41 species, bringing the total number of Big Island species with designated critical habitat to 44 (see map next page).

Some Important Definitions:
Conservation: Use of all methods necessary to bring any endangered or threatened species to the point at which the measures provided by ESA are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, population census, law enforcement, habitat acquisition, maintenance, propagation, live trapping, and transplantation, and, in extraordinary cases, “taking” that is regulated.

Critical Habitat: A) Specific areas within the geographical range occupied by a federally endangered species, at the time of listing, on which are found those physical or biological features that are: 1) essential to the conservation of the species; and 2) which may require special management considerations or protection. B) Specific areas outside the geographical range occupied by the species at the time of listing that are essential for the conservation of the species.

Endangered species: Any species that is in danger of extinction throughout all or a significant portion of its geographical range.

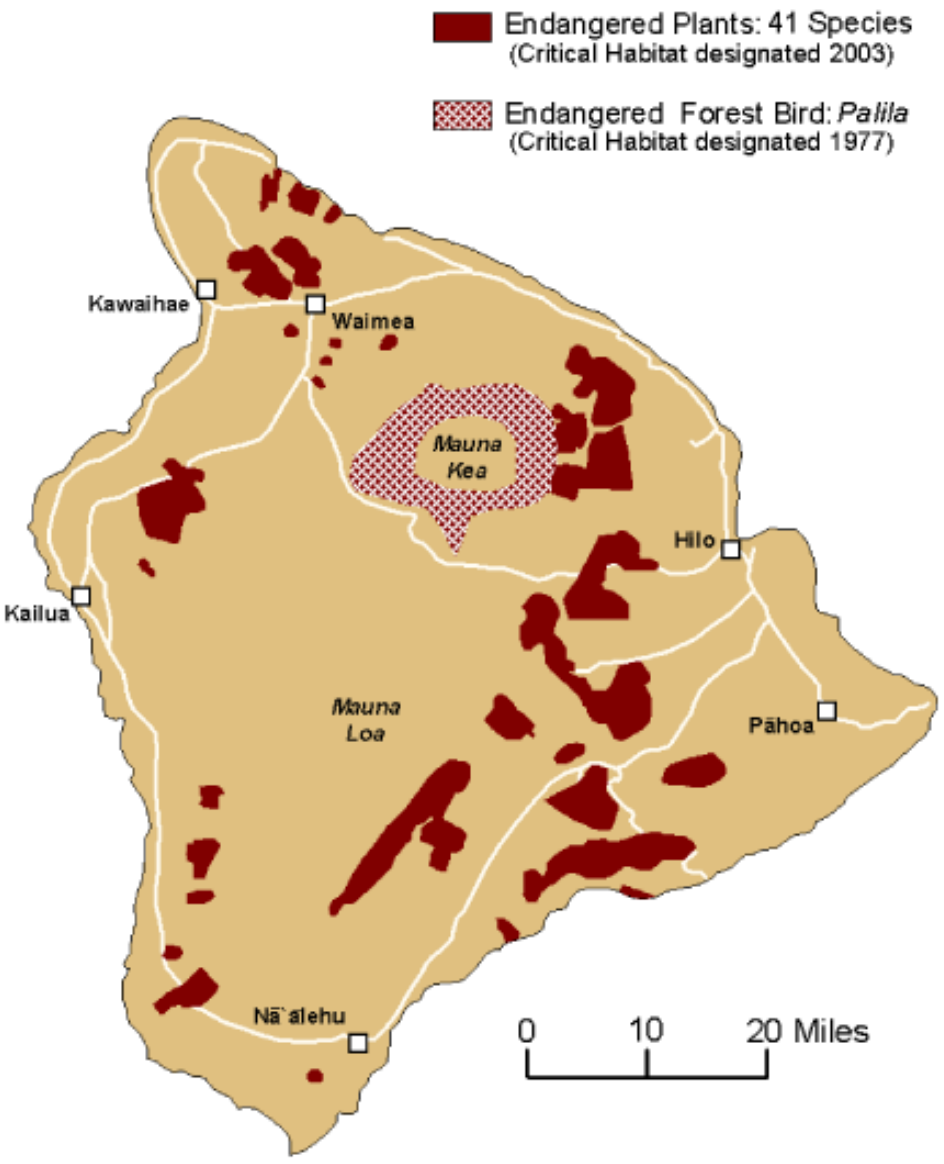
Population: A grouping of individuals of the same species that exchange genetic material through reproduction. For many rare native Hawaiian plants, populations are very small (1-50 individuals) or spread over a small geographic area (one square mile).

Recovery: A species reaches recovery when it has 8 to 10 stable, reproducing populations and its threats to survival are being actively managed or eliminated.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Take: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Endangered Species Critical Habitats



Source: U.S. Fish and Wildlife Service

Rare and Unusual Plants of Hawai'i Island

All but three of the species described in this section are official, Federally-listed endangered species.

Sesbania tomentosa *'Ohai*

Pea Family: *Fabaceae*

Bipinnate Leaf

Distribution

Primarily Dry Coasts to 2,700' in Ka'u.

Description

'*Ohai* is highly variable in all the characteristics of its appearance. It may sprawl on the ground like a vine up to 45' long or grow as a tree up to 20' tall. The branches and leaves are often covered with many soft hairs. The leaves are divided into two rows of individual leaflets with up to 19 pairs. Each leaflet can be up to 1½" long and ¾" wide. This leaf structure is referred to as pinnate because it resembles a feather (top right diagram). The flowers occur in clusters of up to 9, and may range in color from red to yellow, exhibiting various combinations. Its petals give the flower an appearance of 2 distinct parts, each up to 1¾" long. The joined petals of the broad upper portion are referred to as the wings. The lower petals form a folded tube called the keel. The narrow seedpods can be up to 9" long with pointed tips.

Comments

The species name, *tomentosum*, refers to the hairs that often cover the surface of this *Sesbania*. Hawaiians traditionally used *'Ohai* flowers for *lei*. Unfortunately, this endemic (uniquely Hawaiian) species is very rare today. This species has lost much of its natural habitat due to human-related environmental change, such as urbanization, fire, and overgrazing.

Isodendrion hosakae — *Aupaka*

Violet Family: *Violaceae*

Distribution

Dry Shrubland: 3,000'-3,400' in North Kona and the Saddle Area.

Description

This is a sparsely branched, woody shrub that grows up to 30" tall. The narrow oval leaves, up to 2¾ " long and ¾ " wide, have pointed tips. The leaves have a leathery texture, toothed edges, and veins that form a net pattern (reticulate). Leaves tend to cluster at the tips of the upright branches. The tubular, yellow-green flowers are about ½ " long, and have 5 petals that curve back at the tips with the lower petal conspicuously longer than the rest. The green seed capsules are clearly divided into three parts. They begin as bulbous spheres about ½ " across with a long, pointed tip. At maturity the capsules open to reveal dark, shiny, round fruits about [!" in diameter.

Comments

Isodendrion hosakae is one of four rare species in this uniquely Hawaiian genus (*Isodendrion*) that Hawaians referred to as *'Aupaka*. The genus name refers to the form of these plants as compared to other violets. *Isodendrion* species have petals of more equal (*iso*) length and are woodier, like a tree (*dendron*), than most violets. Some threats to this species include wild fires and alien species impact.

Haplostachys haplostachya ***Honohono***

Mint Family: *Lamiace*

Distribution

Dry Shrubland and Grassland: 3,200'-7,000' in North Kona and the Saddle Area.

Description

Honohono is a square-stemmed herb that grows about 2' tall. The plant is covered with small white hairs and has leathery, heart-shaped leaves up to 6 ½“ long and 2” wide with toothed edges. The leaves are arranged in opposing pairs where each successive pair along the stem is at a right angle from the last pair. The white flowers are also arranged at right angles to one another, clustered near the tip of the stem. Each flower is curved and tubular at the base, which is less than 1" long. It opens into small upper, petal-like lobe and a larger, lower lobe. Each lobe curves back upon its self, widens towards the tip, and appears ruffled at the end. *Honohono* has tiny dark fruits.

Comments

This is the last living member of *Haplostachys*, a uniquely Hawaiian genus, once represented by 5 species. The name for this plant comes from the Greek word for single spike, referring to the flower arrangement. Some threats to this species include wild fires and alien species impact.

Stenogyne angustifolia
Mint Family: Lamiacea

Distribution
Dry Shrublandand Grassland: 5100'-7100' in the Saddle Area.

Description
This vine may sprawl on the ground for a portion of its length before becoming erect, but can also occur as a climber. It has thin, oval leaves up to 2" long and ½ " wide. The leaf edges have fine teeth that point towards the tip. The narrow, tubular flowers, about ¾ " long, grow at the base of the leaves. The flowers vary from yellow to red or purple and form a long, upper lobe and short, lower lobe. The fruits have a leaf-like covering called the calyx that has five pointed tips

Comments
There are 8 species in this Hawaiian genus (*Stenogyne*) found on Big Island. This mint does not smell but it does produce nectar. The nectar supply and flower shape indicate that native Hawaiian honeycreeper birds may pollinate this plant. Some threats to this species include wild fires and alien species impact.

Tetramolopium arenarium ***Mauna Kea Pāmakani***

Sunflower Family: *Asteraceae*

Distribution

Dry Forest or Shrubland: 2,600'-4, 900' in the Saddle Area.

Description

This standing shrub grows up to 6' tall and has pairs of upright, forking branches of similar length. The stems are covered with hairs and glands. The narrow leaves (to 1½" long and ¼" across) are slightly wider in the middle than at the ends. They are covered with fine hairs, pointed tips, and smooth edges. The flowers are tightly bunched in groups of 5-9 at the branch tips. Each composite flower is about ½" across with a funnel-like profile and a circular cross section. Many white petal-like structures called rays surround a purple to yellow central disk of additional flowers. The dry fruit is less than [!" long and is covered with hairs and glands. The appearance of the fruit is the distinguishing feature of this genus. The genus name, *Tetramolopium* refers to the four veins that run the length of the fruit. Wispy tufts like dandelion.

Comments: Three of the original 11 Hawaiian species in the genus are considered to be extinct, and 5 of the remaining 8 species are endangered. *Tetramolopium humile*, the only common species is also found on the Big Island. It grows only 8" tall, has smaller, hairier leaves, only one faint vein at the base of the fruit, and is generally found at higher elevations (above 6200') than *T. arenarium.* The subspecies *Tetramolopium arenarium* s*sp arenarium* is one of two subspecies on Hawai'i Island. It is distinguished from the other subspecies (*confertum*) that has 4-5 flowers in each cluster and leaves with toothed edges. Some threats to these species include wild fires and alien species impact.

Hibiscus brackenridgei ssp. brackenridgei ***Ma‘o hau hele***
Mallow Family: *Malvaceae*

Distribution
Dry Forest or Shrubland 400'-2,600': North Kona, Leeward Kohala

Description
This large shrub or small tree may exceed 15' in height with red hairs on its upright branches. The roughly circular leaves can be over 6" across and are borne on long stems (3" or more). The leaves have an irregular lobed edge and hairs on the surface. The many lobes give the leaves a tattered appearance. The large flowers have 5 yellow petals, each up to 3" long, with a purple base. The conspicuous column at the center of the flower is a reproductive structure called the stamen. The red tipped projections contain pollen and are called filaments and anthers. This form of reproductive structure is referred to as *monodelphus*. All members of the Mallow Family share this form. The egg-shaped fruits are ½ “ to ¾ “ across, have a narrow tip and are covered with hairs. The angular, kidney shaped seeds are also have hairs and are less than 1/8” across.

Comments
Hibiscus brackenridgii is Hawaii’s official State Flower. The Hawaiians noted its likeness to the coastal *hau* (*Hibiscus tiliaceus*) plant that has similar flowers. There are two sub-species of *Hibiscus brackenridgii*, this subspecies is the only one found on the Island of Hawaii. It has smaller flowers than its northern relative.

Kokia drynarioides ***Hau-hele‘ ula, Koki‘o***

Mallow Family: Malvaceae

Distribution

Dry Forest, 1,500'-3,000': North Kona.

Description

This tree grows up to about 25' tall and has few branches that curve upwards. The large leaves can reach 8" across and occur at the branch tips. They have 7-9 angular lobes and hairs on the undersurface at the base. The deep red flowers of *kokia* have curved petals about 4" long and a prominent tubular structure called the stamen, rising from the center. The stamen is covered with small projections called anthers. Both the stamens and the anthers are involved in pollen transfer (for more see *Hibiscus brackenridgii*)..The petal-like structures on the fruit are actually lobes of a dried protective covering (calyx). The 5 egg-shaped, seedcapsules are about an 1" long with a pointed tip. They contain hair-covered seeds about ½ “ long and ¼ “ wide.

Comments

Kokia drynaroides is one of four species in the native genus *Kokia* that the Hawaiians collectively named *Koki‘o*. Three of the species are endangered and one is already extinct. *Drynaroides* is the only species of *Kokia* found on Hawaii Island and is known only from there. Hawaiians made charcoal from the wood of *Kokia* species and used the flowers to make dye. Hawaiians must have noted the likeness of this plant to *hau* (*Hibiscus tileaceus*) because the specific Hawaiian name for this species means “red traveling *hau*”. *Kokia* plants also resemble that of *Mao (Gossypium tomentosum)*, the native Hawaiian cotton and also a member of the Mallow Family.

Abutilon menziesii ***Koʻoloaʻlua***

Mallow Family: *Malvaceae*

Distribution

Dry Forest 700'-1700': North Kona

Description

This woody plant is usually less than 10' tall and covered with fine hairs. It has light green or gray, heart-shaped leaves up to about 4" across with toothed edges. Each leaf is joined to the branch by 1-2" long stem. The light green, cup-shaped structure (the calyx) at the base of the flower is covered with fine hairs and has 5 spreading tips. The flowers have 5 petals up to 1" long that vary in color from white to yellow, red or purple. The cluster of filaments protuding from the center of the flowers is composed of organs involved in pollen exchange. The multi-part fruits separate into 6-8 pairs of narrow, brown seed coverings about ¼" long and covered in tiny hairs. These fruits have pointed tips and contain three tiny seeds.

Comments

Habitat for *Koʻoloaʻula* is threatened by land development and grazing. During a drought, cattle ate all the plants of a known population in Kona. Cattle also suppress the regeneration of forest species by consuming young plants, leaving only old decaying trees, and eventually creating a grassland that may become dominated by grass or shrub species unpalatable to the cattle themselves.

Colubrina oppositifolia ***Kauila, Kauwila***

Buckthorn Family: Rhamnaceae

Distribution

Dry to Moderately Wet Forest From 800'-3000'North Kona

Description

Kauila can grow to be a large tree up to 50' tall. Pairs of thin oval leaves that can exceed 4" long and 2" wide are arranged opposite one another. Each pair is arranged on stems at right angles from the next pair along the branch. The leaves have smooth edges and distinctive veins that emerge in a "feathery" pattern. The upper surface is dark waxy green. Glands are visible on the lighter green undersurface of the leaf. Tiny greenish-white flowers with triangular petals occur in clusters at the branch tips. The small round fruits have swollen lobes that burst open when ripe to release the narrow seeds.

Comments

The opposite leaf arrangement is indicated to by the species name *oppositifolia*. This species may have lost its ancestral dispersal mechanism as its relatives in other places have seeds that float but the Hawaiian species lacks this ability. Hawaiians also referred to *Alphitonia ponderosa*, a closely related and rare native tree, as *kauila*. The very hard wood *kauila* species had many traditional uses. Kapa making tools of *kauila* included the board and beater(right), pattern tool and block printer. Fishing tools of *kauila* included spears, net making tools and bait sticks. Weapons made of *kauila* include spears, clubs, daggers (*pahoa)*, and a pole for tripping. Digging sticks *o'o*, hula sticks, *kahili* poles, and *holua* (sled) runners were also fashioned from *kauila*.

Pleomele hawaiiensis ***Hala pepe, Le'ie, Golden Dracena***

Agave Family: *Agavaceae*

Distribution

Dry or Moderately Wet Forest from 1000'-2800': North Kona, Leeward Kohala, Ka'u, Puna.

Description

Halapepe is a small tree that grows about 20' tall and has a gray trunk that lacks bark. The tree has thin branches that snake upwards and are ringed by scars where old leaves have fallen off. The somewhat leathery leaves grow in clusters directly from the branch tips. The leaves are narrow, about 1" wide at the base and 15" long with pointed tips. The tubular, yellow-orange flowers hang in clusters. They have spreading tips and are about 2" long. *Halapepe* has round, reddish-brown fruits about ½" in diameter and each fruit contains one or two seeds about ¼" long.

Comments

This is one of 6 native species of the genus *Pleomele* that Hawaiians collectively referred to as *Halapepe*. They named this tree for its likeness to *Hala (Pandanus tectoris).* The Hawaiian name means, "baby hala". The Greek name *Pleomele* refers to the abundant fruit produced by this tree. Observers may also note its similarity to the common alien ornamental "money tree" (*Dracena sp.*). Hawaiians carved statues from *Halapepe* wood. The flowers were used for leis and the plant served as ornamentation on the altar for the hula goddess *Laka*.

Nothocestrum breviflorum ***ʻAiea, Hālena***

Nightshade Family: *Solanaceae*

Distribution

Dry or Moderately Wet Forest 1800'-6000': North Kona, Kaʻu, Kohala

Description

ʻ*Aiea* has a thick trunk with soft bark. It can grow up to 40' tall. The oval leaves can exceed 4" in length and 2" in width. They have smooth edges and a surface texture like thick paper with hairs on the lower surface. Leaves and flowers are concentrated at the branch tips. ʻ*Aiea* loses its leaves in the dry season. The many yellow-green flowers have an orange center and the ¼", round berries are also orange at maturity.

Comments

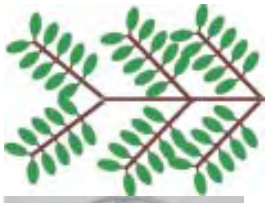
This is one of four species the native genus *Nothocestrum*. Hawaiians refer to all of these spies as ʻ*Aiea* or *Halena*. The genus name *Nothocestrum* refers to its likeness to *Cestrum,* a South American genus from which ʻ*Aiea* may be derived. ʻ*Aiea* is the host plant for the Blackburn Sphinx Moth (*Manduca blackburnii*) whose caterpillars feed on the leaves of this tree. Sphinx moth populations are threatened by introduced ants and by reduced populations of Aiea and The founder of ʻ*Aiea* may have arrived as seed in the gut of a bird since the fruits are attractive to those flying animals.

Caesalpinia kavaiensis *Uhiuhi*

Pea Family: *Fabaceae*

Distribution

Dry or Moderately Wet Forest: 300'-3,000' North Kona



Description

Uhiuhi grows as a tree or shrub about 30' tall with scaly gray bark. Each leaf is divided into smaller leaflets arranged in a branching pattern called bi-pinnate from the Latin meaning two feathers, referring to the resemblance of both individual leaflet bearing branches (*pinnae*) and the leaf as a whole, to the structure of a feather. The leaflets can be close to ¾ " wide and 2" long arranged roughly opposite one another. They are widest at the blunt tip that has a small notch at the center and have red hairs on the lower surface of the rib at the center. The red or pink flowers occur in clusters on a branched spike. They have overlapping petals an prominent white filaments called stamens The flat, egg-shaped seedpods can be up to 5" long and 2½ " wide with a pointed projection at the tip about ½" long. Each pod contains several similarly shaped brown seeds about ¾ " long and ½ " wide.

Comments

Uhiuhi has very hard wood and had many traditional Hawaiian uses. Hawaiians used it to for fishing tools including spears, bait sticks and shark hooks. *Holua* sleds, weapon spears, digging sticks, fruit pickers, carrying sticks and house frames, as well as tapa making tools were made from *Uhiuhi* wood. The genus *Caesalpinia* is named for an Italian botanist and the term *caesalpinous* is used to refer to the characteristic form of the flowers, which have overlapping petals and are symmetrical along one plane. The seeds of *Uhiuhi* sink in water although its relatives in other places have floating seeds. Thus the ancestor of *Uhiuhi* may have floated here and later the Hawaiian species that developed lost its dispersal ability.

Zanthoxylum hawaiiense ***A‘e, Mānele, Hea‘e***

Citrus Family: Rutaceae

Distribution

Dry or Moderately Wet Forest, Lava Flows. 1,800'-5,600': Saddle Area, North Kona.

Description

This tree may grow up to 25' tall with a 10" wide trunk covered in gray bark. The leaves are divided into 3 leaflets on stems up to 2" long (top right photo) that are thickened or jointed at one or both ends. The leaflets are often roughly triangular, up to 2" wide and 4" long, and have a lemon fragrance. The white flowers are about ½ “ across, have 4 petals and occur in clusters of up to twenty. The mature fruits are about ½ “ across and slightly longer than they are wide. The fruits dry to a rough texture and split open to reveal a single dark, round seed about ¼ “ across. The young leaves, fruit stems, and fruits may have a purple or reddish color.

Comments

The genus name (*Zanthoxylum*) describes the yellow wood of this group. There are 4 Hawaiian members of *Zanthoxylum*, 3 of which are found on the island of Hawaii. Bullet holes and shell fragments riddle the trunk of this Zanthoxylum in Pohakuloa Training Area. In recent years military bases have become refuges for endangered species.

Zanthoxylum dipetalum — *Kāwa'u kua kuku kapa*

Citrus Family: Rutaceae

Distribution

Dry or Moderately Wet Forest, 900'-4,200': North Kona

Description

This tree can grow up to 50' tall with a 1' thick trunk covered by rough, often cracked, bark. Each leaf is divided into up to 7 short-stemmed leaflets where the two furthest from the leaf tip are often much smaller than the rest. The leathery leaflets are thick and broad, up to 3½ " wide and 6" long with smooth edges and jointed stems. The yellow-white flowers occur in clusters of up to 15 and are up to ½ " long with two petals (half flower shown mid-right). The egg-shaped fruits are up to 1" long with a narrow pointed tip and contain a dark seed nearly as large.

Comments

Traditionally Hawaiians used the resonant wood *Kāwa'u kua kuku kapa* as a surface to beat *Kapa* or send messages using tools made from *Kauila* (*Colubrina oppositifolia*) or *Uhi uhi* (*Caesalpinia kavaiensis*). The Hawaiian name means, "an anvil to scrape or beat tapa." The species name, *dipetalum* refers to the flower petals, in which the 4 petals common to the genus *Zanthoxylum* have joined in pairs that appear as two petals. There are two varieties of this species: *dipetalum* with hairless leaves, and *tomentosum* with hairs on the undersurface of the leaves.

Flueggea neowawraea ***Mehamehame***

Spurge Family: Euphorbiaceae

Distribution

Dry or Moderately Wet Forest, 800'-3300': South Kona.

Description

Mehamehame trees can grow up to 100' tall with a trunk exceeding 6' in width (top left photo). The leaves have a papery texture, smooth edges, and a pale green undersurface. They are arranged one after the other along opposite sides of the branch and can be up to 5½ long and 3½ wide. Young leaf growth may have a reddish color. Large old trees often have many younger shoots sprouting from the base of the trunk. The tree has clusters of male and female flowers usually found on separate plants. The very tiny green-yellow flowers lack petals but have a leafy structure that spreads out at the at the base. Above this, female flowers have an egg-shaped ovary with three bumps visible at the top. Instead of an ovary, male flowers have tiny filaments rising from the leafy base. The round fruits are dark at maturity, a ¼ or less in diameter and bear tiny seeds.

Comments

The introduced Black Twig Borer (*Xylosandrus compactus*) is the greatest direct threat to *Mehamehame* because it tunnels into the wood of living trees to lay eggs. The hatched young then feed on fungus brought to the tree by the beetle. This invasive species associated with coffee crops but also attacks other rare Hawaiian plants like *Kauila* (*Colubrina oppostifolia*) and *Uhiuhi* (*Caesalpinia kavaiensis*).

Cyanea shipmanii *Hāha*

Bellflower Family: *Campanulaceae*

Distribution

Moderately Wet Forest 5,900'-6,200': Windward Mauna Kea and Mauna Loa.

Description

This tree usually has only one stem that grows up to 12' tall. The plant is covered with prickles, especially when young. Its large fernlike leaves radiate from the tip of the stem and can be several feet long with 1' wide lobes. The greenish white flowers occur in clusters near the base of the leaves and can grow up to 1½ " long. They have a curved tubular base that opens into 5 spreading lobes with pointed tips around a central column. Two of the lobes are horizontal and three point down. The column is covered with fine white hairs and longer, sometimes purple, hairs are visible at its tip. The fruits are slightly longer than wide, are about ½ " across, and turn orange at maturity.

Comments

Cyanea is a uniquely Hawai'ian genus with over 50 species all believed to have developed from one founding ancestor. The genera, *Cyanea*, *Delissea*, and *Clermontia* may also have developed from the same founder.

Delissea undulata

Bellflower Family: *Campanulaceae*

Distribution

Dry or Moderately Wet Forest 3,200'-5,700': North Kona

Description

This tree usually lacks branches may grow to be over 30' tall with a trunk as thick as 2" and leaves that cluster near the top. Raised circular scars can be seen along the trunk where dead leaf stems have fallen off. This *Delissia* has oval leaves with pointed tips and wavy (undulating) edges that have small teeth. The leaves grow to about 8" long and 3" wide and are borne on stems up to 6" long. The numerous greenish-white flowers can reach 1" in length and are tubular at the base, opening into five spreading points around a central column. The round, purple berries up to ½ " in diameter, have very small seeds.

Comments

Delissea undulata is one of nine species in the endemic (uniquely Hawaiian) genus (*Delissea*), most of which are considered extinct (gone forever). Previously, variations (subspecies) of *undulata* were reported on Hawai'i, Kaua'i, Ni'ihau and possibly Maui. It is now precariously represented by two subspecies from Hawai'i andKauai. *Delissea undulata* subspecies *undulata* has longer leaves and flower stalks as well as wavy leaf edges (undulate) compared the other subspecies of *Delissea undulata*.

Bonamia menziesii

Morning Glory Family: *Convulvaceae*

Distribution

Dry Forest to Moderately Wet Forest and rarely in Wet Forest 500'-2,400' North Kona

Description

This woody vine up to 30' long winds its way around itself and other vegetation as it climbs upward or sprawls on the ground. It has leathery, oval leaves up to 1½ " wide and about 3½ " long on stems up to 1" long. The leaf edges are smooth and sometimes wavy. Lower surfaces of the leaves are often covered with brown hairs. The white, funnel-shaped flowers emerge on stems near those of the leaves. Each flower is about 1" long and has 5 rows of hairs. The brown, papery, egg-shaped fruits about ½" long contain one or two dark seeds about ¼ " long.

Comments

This is the only Hawaiian species of *Bonamia*, a genus named after a French botanist. The species is named for Archibald Menzies who climbed Mauna Loa in 1794 while serving as botanist aboard the ship *Discovery*, captained by George Vancouver. In 1793 Vancouver had introduced cattle and sheep to Hawaii. Kamehameha then put a *kapu* on the animals and their numbers grew**,** creating heavy grazing pressure, especially in dry forest habitats.

Diosporos sandwicensis ***Lama, elama***

Ebony Family: *Ebenaceae*

Distribution

Dry to Wet Forest, 15'- 4, 000'

North Kona, Leeward Mauna Loa, Mauna Kea?

Description

This tree may exceed 30' in height. It has oval leaves arranged one after another on opposite sides of the branch, which has bumps visible on the branch near the leaf base. The thick and leathery leaves are red when young, and generally up to 3½ long and 1½ wide with smooth surfaces and edges. *Lama* has tiny male and female flowers, usually found on separate plants. The female flowers occur alone while male flowers may occur in groups of up to 5. The white, urn-shaped flowers emerge from a green, leafy covering and open into 3 triangular lobes covered in fine hairs on the outside. Male flowers have up to 18 pollen producing structures (stamens) at the center and female flowers have a single round ovary. The oval fruits are yellow to red when mature, as long as 1", and contain up to 3 dark, triangular seeds up ½ long.

Comments

Lama is related to Persimmon and the fruit is edible. Hawaiians had many traditional uses for dark, hard wood of *Lama,* which means “light” in Hawaiian. It was used for fish traps, sluice gates for fishponds, a poultice for skin problems, *heiau* house frames, and to fence enclosures for healing the sick. Although lama is still much more common than many of species in this book, its range has been greatly restricted in range considering that it was once a dominant dry forest species, only 10% of which remain.

Gouania vitifolia
Buckthorn Family: Rhamnaceae

Distribution
Dry of Moderately Wet Forest, 2,000': South Kona, Ka'u.

Description
The leaves of this climbing vine-like shrub are distributed one after another on either side of the branch. The leaves are narrowly heart-shaped with teeth on the edges that point towards the leaf tip. The cuplike flowers occur in clusters on a stem up to 2¾" long with up to 2 leaves. The 5 green, triangular structures that emerge from the central disk look like petals but are actually leafy coverings called sepals. The tiny, white petals of the flower poke out between each sepal. The multipart fruits are about 3/8" long with 2 or 3 thin projections (wings) each about 1/8" across and covered in wooly hairs. When mature, the fruits separate into 3 parts and split open. The egg-shaped seeds are dark, shiny and about 1/8" across.

Comments
Threats to *Gouania vitifolia* include... [*forthcoming*]

Cyanea hamatiflora *Hāha*

Bellflower Family: Campanulaceae

Distribution
Wet Forest, 4,300'-5,600': South Kona.

Description
This branchless tree can grow over 25' tall. The stem-less leaves cluster at the top of the trunk from which they grow directly. They are narrower at the base than near the tip, have tiny teeth on the edges and hairs on the undersurface. The leaves grow up to about 30" long and 5½ " wide. Scars are visible along the trunk where old leaves have fallen off. The purple flowers occur in a dense cluster at the top of the trunk. They have 5 spreading lobes forming a pattern like the points of a star, all of which curve uniformly back around a central column. The dark red to purple berries are about 1/8" across and longer than wide.

Comments
[*Forthcoming*]

Clermontia drepanomorpha *'Ōhā wai*

Bellflower Family: *Campanulaceae*

Distribution

Wet Forest 3000'-4800':
Windward Kohala Mountain

Description

This tree may grow up to 20' tall or more from the ground or grow in other trees. The oval leaves cluster at the tips of many spreading branches. The leaves are up to 8½ long, 1¾ wide, and have edges with small rounded teeth. The dark purple flowers usually occur in pairs and can be up to 2" long. They have 5 long, spreading tips around a central column, which has a white tuft of hairs visible at the end. Two of the spreading tips point up and three point down. The round structure at the base of the flower, called the calyx, also 4 long spreading lobes (4) similar in appearance to the 5 lobes in front. The round, orange berries are about 1"across and contain tiny dark seeds.

Comments

This is one of 22 species belonging to the Hawaiian genus *Clermontia* recognized collectively in Hawaiian as *'Oha wai*. A white mass is often visible covering berries and especially branch tips (bottom right picture). This species may be a host for rare native fruit flies (*Drosophila*), which inhabit the flowers of *Clermontia* species. For example, small flies can be observed inside the flowers of *Clermontia drepanomorpha*. The species name (*drepanomorpha*) refers to the curved shape of the flower in relation to the long curved beaks of some extinct native Hawaiian honeycreepers belonging to the group *Drepanididae*. This species is very similar in appearance to *Clermontia kohalae*, which longer, narrower flowers and tends to occur at lower elevations.

Cyanea platyphylla *'Aku 'aku, Hāhā*

Bellflower Family: *Campanulaceae*

Distribution

Wet Forest 400'-3000': Windward Mauna Kea and Mauna Loa, Puna, and Waipio

Description

'Aku 'aku has a single stem up to 10' tall. Like many other *Cyanea* species this plant changes appearance as it matures. Identification is therefore difficult, and is further complicated because it can flower during its juvenile stage. Young plants have many small prickles. These juvenile plants also have short-stemmed leaves all along the main trunk. The leaves are wider near the rounded tip than at the base, up to 8" long and 3" wide with wavy edges with stems less than 2" long. Adult plants tend to have fewer prickles and leaves that are clustered near the top. Raised circular scars are easily seen along the stem where leaves have fallen off. Adult leaves can exceed 2' in length and be 8" wide on stems up to 8" long. The white and/or purple flowers about 2" long occur in clusters near the base of the leaves. They have 5 spreading tips and a long, central column with white hairs visible near the tip. The orange berries have a rounded oval profile 1/8" long and a circular width 1/4" across. Immature fruits are shown in the lower photo.

Comments

Hawaiians ate the cooked leaves of *'Aku'aku* during food shortages. *Campana* is the Latin word for bell. The family name *Campanulaceae* refers to the bell-shaped flowers shared in common by this family that includes all the Hawaiian lobeliads. Hawaiian lobeliads tend to be much larger and have more elongated flowers than lobeliads from other places.

Trematolobelia grandifolia *Koli‘i*

Bellflower Family: *Campanulaceae*

Distribution

Wet Forest 2000' -4900'**:** Kohala, Saddle Area, Volcano

Description

The single woody stalk of *Koli‘i* can grow up to 13’ tall. Its leaves radiate from the top of the stalk, forming a round cluster. The leaves have small teeth along the edges, a purple central rib, and are up to 17" long and 3" across. A secondary leaf cluster may grow during flowering when the leaves at the top begin to fall off (top middle photo). Up to 10 branches about 2' long, develop at the top, forming pattern similar to the spokes of a bicycle wheel. Each branch produces numerous white flowers up to 3" long. The flowers are tubular and curved at the base, splitting into three spreading tips around a central column, also up to 3" long. The two small tips at top curve back upon themselves and the larger lower tip curves broadly downward. Fine white hairs are visible at the tip of the central column. The round seed capsules are about ½ “across with 10 ribs and many holes. The capsules dry at maturity to release many tiny seeds.

Comments

The flower shape suggests co-evolution with some native Hawaiian honeycreeper birds like the extinct *Mamo* and the I‘iwi which still pollinates *Koli‘i* and other lobeliads as the birds visit different plants to sip nectar with their long, curved beaks. The seed capsules of *Koli‘i* reach maturity during dry periods when the seeds are easily dispersed by the wind. The genus name *Trematolobelia* refers to the holes (*trematos*) in the seed capsules of this Hawaiian group that is probably related to the genus *Lobelia*. Tresing?

Argyroxiphium kauense **Ka'u Silversword**

Tarweed Family: *Asteraceae*

Distribution

Wet Forest 5300'-6200': Ka'u, Hualalai?

Description:

The Ka'u Silversword develops a short w
grows. The leaves at the top of the trunk emerge as circular cluster (sea urchin? The leaves are narrowly triangular in cross section, taper to a point, have fine, silver hairs and are up to 15¾ long. It develops a flowering stem with as many as 350 flower heads. Each flower head consists of a disk surrounded by up to 11 petal-like rays that range in color from white to purple, have several lobes, and reddish filaments visible at the center. The central portion of the disk produces many tubular red and yellow flowers. Each flowering head produces many dry fruits up to \!" long.

Comments:

Out-planting efforts (right photo) are dependent on the availability of suitable habitat free of browsing pressure. *Argyroxiphium kauense* is a member of the unusual plant group referred to as the Silversword Alliance (see comments *Argyroxiphium sandwicense*).

Cyrtandra giffardii ***Ha‘iwale, Kanawao ke‘oke‘o***

Gesneriaceae: African Violet Family

Distribution

Wet Forest: 3,100'-4,900': Volcano, Hamakua.

Description

This unique (endemic) native species is a small tree up to 20' tall. It has many slender branches and its leaves cluster near the branch tips. The leaves are arranged opposite one another on the branch and tend to be wider near the tip than at the base. They may reach 5" long and 2" across at their widest point, with small teeth along the edges. The leaf veins form a characteristic netted pattern (reticulate), that helps to distinguish this species from other members of the genus *Cyrtandra*. The flowers grow on long stems in clusters of up to 5. They emerge from a tubular, leafy covering with pointed lobes called the calyx. The white flowers are about 1/2” long, are cylindrical at the base, and open into as many as 6 lobes. The round, sometimes egg-shaped, white berries are about “ across.

Comments

The genus *Cyrtandra* is highly variable in appearance and has over 50 recognized Hawaiian species that the Hawaiians recognized collectively as *Ha‘iwale* or *Kanawao ke‘oke‘o*. The Hawaiian name, *Kanawao ke‘oke‘o* means “white *kanawao*” in reference to the plant’s white flowers and its likeness to *Kanawao*(*Broussasia arguta*). Plants of different *Cyrtandra* species may be found in the same area and often hybridize to produce offspring that may exhibit characteristics of both parents.

Sicyos alba *‘Anunu*

Gourd Family: *Cucurbitaceae*

Distribution

Wet Forest 3300'-5200': Windward Mauna. Kea, Mauna Loa, Kilauea

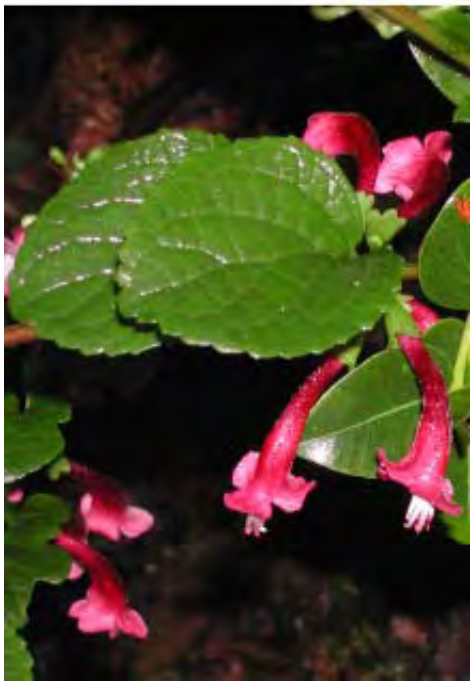
Description

‘Anunu is a climbing vine up 65’ long. The leaves are heart-shaped, about 4" across with up to 5 curving lobes, pointed tips, and small teeth along the edges. The white flowers occur in clusters. Each flower has a stem about 1" long on a branching structure. The flowers occur separately as male and female. The male flowers have five pointed tips. Both types of flowers are found on the same plant. The green to white fruits are about 1" long and ½“ thick with a single ½ “ long seed.

Comments

Sicyos alba is one of 7 native species in the genus *Sicyos* found on the island of Hawai‘i that the Hawaiians referred to collectively as ‘*Anunu*. This *‘Anunu is* the only Hawaiian species of *Sicyos* with white fruits. The genus name *Sicyos* means cucumber, which in the same family (*Cucurbitaceae*), as well as the introduced gourd (*Lagenaria sicer*aria), or *ipu*, traditionally used by Hawaiians.

Stenogyne calaminthoides
Mint Family: *Lamiaceae*



Distribution
Moderately Wet Wet Forest: 2400'-5100' Islandwide?
Description
This vine climbs other vegetation or sprawls on the ground. Oval leaves up to 2" long and 1½“ wide. The tubular flowers up to ___ long are purple to white in color. Fruits
Comments

Clermontia montis loa ***Oha wai***

Bellflower Family: *Campanulaceae*

Distribution:
Wet Forest: 3,500'-5600'Saddle Area, Puna, Ka'u
Description:
This branching tree can grow up to 16' tall. Its leaves are wider near the tip than at the base and can reach 7½ "long and
Comments:

Cyanea Stictophylla

Distribution:
Wet Forest
Description:
Comments:

Argyroxiphium sandwicense *'Ahinahina*, *Mauna Kea Silversword*

Tarweed Family: *Asteraceae*

Distribution

Subalpine-Alpine, 8800'-12300', Mauna Kea.

Description

'Ahinahina forms a spiky silver ball with thick leaves up to 15¾ " long. The leaves are triangular in cross section, taper to a point, and are covered with fine, silver hairs. The plant flowers once in its life, usually between November and January. It develops a flowering column up to 10' tall with as many as 600 flower heads. Each flower head consists of a disk surrounded by up to 20 petal-like rays that range in color from light pink to purple-red, have several lobes, and red filaments visible at the center. The central portion of the disk produces many yellow, columnar flowers. Each flowering head produces many dry fruits up to ½ " long.

Comments

'Ahinahina is part of an unusual group of plants referred to as the Silversword Alliance. Plants in this group exhibit a wide variety of forms, growing as shrubs and vines (*Dubautia*), or trees (*Wilkesia*). Although their genetic make-up differs widely, plants in the Silversword Alliance are capable of interbreeding. Interbreeding produces hybrids with some characteristics of both parent plants. The genus name (*Argyroxiphium*) describes the leaves, translating to "silver-sword". The Hawai'ian name (*'Ahinahina*) is a reference to Hina, a Hawaiian goddess believed to inhabit the moon.

Big Island Management Areas

Conservation on Public Lands

More than one million acres on the Island of Hawai‘i (see next page) are held in some form of *public trust* under County, State, or Federal. The use and management of these public lands are frequently involved in controversy as competing groups promote their specific interests. These include native Hawaiian land rights, hunting rights, commercial and agricultural leases, watershed protection, and native ecosystem conservation.

The concept of “multiple use” in public land management is widely applied on the mainland U.S., and often applied in Hawai‘i as a possible “political” solution in user conflicts over public lands management. Because many of Hawai‘i’s unique, native plant and animal species are protected by both federal and state endangered species legislation, recent decades have seen successful conservationist-driven lawsuits. This has forced both state and federal authorities to shift priorities from incompatible “multiple-uses” toward an emphasis on preservation and restoration of threatened native species and ecosystems on public lands. This hunting (or other public recreational uses) and native ecosystem protection cannot co-exist on the island.

There are many thousands of acres of public land where human land use has largely eliminated native ecosystems (see “Ecosystem Today” map on page #). In these areas, current landscapes are now dominated by alien species compatible with long-term, sustainable hunting of feral game animals. Because of the diverse environments found on the Island of Hawai`i, the public lands in different geographical areas have their own unique plant species and specific management issues.

Windward Kohala

The Kohala Mountains serve as a critical watershed area for surrounding urban and agricultural communities, and the coastal tourism industry in nearby South Kohala. Annual rainfall exceeds 200 inches in the windward forests of Kohala. In addition, frequent, wind-driven, cloud water (fog) is intercepted by the forest canopy and adds to the overall available water. This unique, moss and fern covered "cloud forest" in Kohala contains many rare Hawaiian plants adapted to the wet, bog-like conditions. The state forests of Kohala are divided into three management units: The Kohala Forest Reserve, including the Pololu and Waimanu section; The Kohala Watershed Forest Reserve, directly above Waimea; and the Pu`u O Umi Natural Area Reserve. Invasive ginger is a spreading problem and feral Pigs are a major threat to this fragile, cloud forest ecosystem and public hunting is encouraged year-round. Hunting and hiking access is by DLNR permit only.

Leeward Kohala and North Kona

The dry, leeward slopes of Kohala, Mauna Kea and Hualalai once supported vast areas of native dry forest, coastal grassland and shrubland. Over the past two centuries this area has been heavily impacted by timber extraction (sandalwood), increases fire frequency, and over grazing by both cattle ranching and feral game animals. Invasive alien plants, such as fountain grass, cactus, lantana, koa haole, and kiawe) have now largely replaced the native dry forest in much of this area, leading to the currently endangered status for some of the few remaining native plant populations.

The Pu‘u Anahulu Game Management area and adjacent Pu‘u Wa‘awa‘a Cooperative Game Management Area includes more than 100,000 acres of state land, currently managed for sustainable (seasonal) public hunting of goat, sheep, pig, and selected game birds. Adjacent to these areas, in the saddle between Mauna Kea and Mauna Loa, are additional State and Federal lands available for public hunting and recreational use (DLNR permit required).

Hamakua

The windward slopes of Mauna Kea, extending from Honoka‘a to Hilo, include a patch-work of State forest reserve lands that generally lie between 2,000 ft and 5,000 ft in elevation. Below 2,000 ft, most lands on the Hamakua Coast were cleared in the 19th century for sugar cane plantations. State reserve lands include: the Hamakua Forest Reserve (8 separate forest parcels extending from Kea‘a to Hoea Ka`ao); the Hilo Forest Reserve (7 separate parcels extending from Manowaiale`e to Kaiwiki); and the large Hilo Watershed Forest Reserve, which lies adjectent to the saddle road above Hilo and protects the Wailuku River watershed. These mid-slope, wet forests can receive annual rainfall in excess of 300 inches. Native *‘Ohi‘a* forest with *hapu`u* understory dominates at lower elevations, grading in to mixed *koa* and *‘Ohi‘a* forest above the 4,000 ft level. Other important protected areas along this coast include the Laupahoehoe Natural Area Reserve and the Hakalau Forest National Wildlife Refuge. Several Endangered Hawaiian forest birds and plants inhabit this wet forest ecosystem.

The historic Humu‘ula Trail, which is 5.3 miles long, starting above O‘okala and ending at Keanakolu along the Mana Road, traverses wet, windward Mauna Kea.

Mauna Kea

The Mauna Kea Forest Reserve and Game Management Area encompasses most of the dry, ‘7,000 ft level. The *mamane-naio* subalpine forest and higher elevation native shrubland was heavely impacted by feral sheep, goat, and cattle grazing during the 19th and 20th centuries. Successful lawsuits in the 1970s, aimed at protection of the endangered *palila* bird, lead to dramatic reductions in feral sheep, feral goat, and mouflon numbers over the past 30 years. This has resulted in some recovery of the native ecosystems and successful restoration effort for endangered plant species such as the Mauna Kea Silversword (*ahinahina*).

Mamane tree (left) on Mauna Kea shows characteristic absence of foilage below the height at which animals can reach to browse. *Pukiawe* bushes naturally have an irregular, spiky profile. Those at right have been pruned to a semi-circular profile by browsing activity. Grass survives beneath the tree canopy, benefiting from its shade and moisture “stripped” from passing clouds.

Puna and Volcano

The windward Puna district includes some of the last remaining areas of undisturbed, lowland and coastal, native wet forest in the Hawaiian Islands. Soils are poorly developed in much of this area because of the young volcanic rocks. Consequently, very little of Puna was converted to plantation agriculture. The Nanawale, Malama Ki, and Keauohana Forest Reserves have easily accessible fragments of native, lowland wet forest (including coastal *hala* forest (*Pandanus tectorius*), and also recent lava flow areas undergoing colonization by native plant species. Hawai‘i Volcanoes National Park includes land extending from the coast of Puna to the summit of Mauna Loa, and now down into Ka‘u, including many of the distinctive ecosystem types found on the Island. There are also extensive areas of upland wet forest in the Waiakea, Upper Waiakea, and Ola`a forest reserves, as well as the Pu‘u Maka`ala Natural Area Reserve(below) which protects many rare native species and once common species, including *Pritchardia* palms (below).

South Kona and Ka‘u

Public lands in South Kona and Ka‘u lie mostly below the active south–west rift zone of Mauna Loa. Recently, 116,000 acres of Kahuku Ranch (above), that include the rift zone, have been aquired as an addition to Hawai‘i Volcanoes National Park. Historic lava flows (19th and 20th Centuries) have covered large areas in these districts. Past sugar cane plantations and cattle ranching in Ka‘u have eliminated much native forest from elevations below 2,500 ft. The Ka‘u Forest Reserve, and the much smaller South Kona Forest Reserve, allow public access into native wet and moderately wet forest ecosystems. In addition, the Manuka and Kipahoehoe Natural Area Reserves are also available in South Kona for limited public recreational use. The winter-dry, wet forests of South Kona comprise the last remaining habitat for the rarest native bird on Hawai’i Island, the *Alala* (Hawaiian crow).

Two public hiking trails in this region of the island allow access to a range of native ecosystems. The Kaheawai trail (12 mile round trip) descends from the 1,900 ft elevation (Mamalahoa Highway) to the coast within the Manuka Natural Area Reserve. It crosses areas of relatively intact, native, dry forest. The Ainapo jeep road/trail, located a few miles south of the Hawai‘i Volcanoes National Park Boundary in Ka`u, includes an 8 mile jeep road through the Kapapala Forest Reserve to a trail head at 5,650 ft. From here there is a challenging, (10 mile) hiking trail to the summit of Mauna Loa. This trail crosses through three of the major upland ecosystems of the island (mountain dry and moderately dry forest; subalpine forest and shrubland and alpine desert). Access by permit is neccessary from DLNR and National Park.

Landscape Transformation

Background: Smoke from a raging wildfire rises thousands of feet.

Feral sheep and fountain grass return quickly after a fire in a rare plant habitat on Mauna Kea.

Thousands of domestic sheep and wild cattle once grazed Mauna Kea's slopes. Domestic cattle, feral goats, and pigs continue to roam the area.

Fountain grass is an invasive species adapted to frequent fires and provides the fuel for wildland fires to spread.

Mullein is an alien plant and has the greatest elevational range of any plant in Hawai`i.

Myrica faya is spreading in Volcano and Ka'u. It changes nutrient availability in native forest areas.

Strawberry guava forms dense thickets in the wet forestareas of Hamakua.

Ginger patches are replacing native dwarf cloud forest in Kohala.

MALAMA KA ‘AINA: WHAT YOU CAN DO

- **Act responsibly to prevent fires and littering on public lands.**
- **Report downed or damaged fences protecting native ecosystems.**
- **Report poaching or unauthorized collecting and cutting of plants and animals.**
- **If you find rare or unusual native plants in previously unknown areas, where conservation action may be required, report this information to appropriate State or Federal authorities.**
- **Volunteer for group conservation activities sponsored by community and governmental agencies, such as tree planting, alien plant removal, and fire break construction.**
- **Clean boots and clothing between trips to the field to insure alien plant seeds are not accidentally transported to new areas.**
- **Share your knowledge of Hawaiian plants and their environments with others.**

This means you, as pig hunters, hikers, land and resource managers, and other dedicated people can help by recognizing our rare and endangered plant species, taking note of their location, condition, and possible threats from natural or other causes and report your observations. Aloha ‘aina.

Websites and Books about Hawaiian Plants

Websites

Hawaiian Native Plants, University of Hawaii Botany
http://www.botany.hawaii.edu/faculty/carr/natives.htm

Alien Plants in Hawaii, UH Botany-
http://www.botany.hawaii.edu/faculty/carr/aliens.htm

Flora of the Hawaiian Islands / Systematic Biology-Botany, National Museum of Natural History, Smithsonian Institution
http://rathbun.si.edu/botany/pacificislandbiodiersity/hawaiianflora/index.htm

United States Geological Survey: Hawaiian Ecosystems At Risk Project (HEAR)
http://hear.org

United States Fish and Wildlife Service Pacific Islands Web Site Index
http://pacificislands.fws.gov/webmap.html

Hawaii Department of Land and Natural Resources: Division of Forestry and Wildlife
www.dofaw.net

Bishop Museum Homepage has links to Searchable Botany and Ethnobotany Database
http://www.bishopmuseum.org

Books

Wagner, Warren L., Herbst, Derral R. Manual of the Flowering Plants of Hawaii

Remains of a Rainbow: Rare Plants and Animals of Hawaii

Plants in Hawaiian Culture

Hawaii: A Natural History

Hawaiian Forest Plants

Zeigler, Alan. 2002. Natural History of Hawaii, University of Hawaii Press.

Lā au Hawaii: Traditional Uses of Hawaiian Plants

The Atlas of Hawaii

Vegetation of Pacific Islands