

EDWARD Y. HOSAKA and ALAN THISTLE

NOXIOUS PLANTS of the Hawaiian Ranges

RANGES

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PREFACE

Ranchers and farmers face the constant menace of noxious plants appearing in their vicinity. Some of these pests have in the past rendered thousands of acres useless as pastures. A heavy expenditure of time and money has been necessary to reclaim such lands. New pests are bound to appear from time to time, accidentally introduced with imported seed and ornamental plants.

Some of the noxious plants already established are localized on one island. Once a free-seeding noxious weed is well established in a given locality, it is practically impossible to eradicate it. The best that can be done is to attempt control. If a new infestation is noted in the very early stages, it can often be eradicated. The late Mr. A. W. Carter successfully eradicated piripiri (*Acaena sanguisorbae*), a very serious pest in the sheep raising regions of New Zealand, that was discovered on the Waimea-Keanakolu road. Never did the old adage, "A stitch in time saves nine," better apply.

No one individual can cover the Territory with sufficient frequency to note all new infestations of noxious weeds. Therefore, the most effective procedure is to acquaint ranchers, farmers, county agents, rangers, and civic-minded individuals with the major plant pests which now have localized distribution but which may some day spread to other communities. When any suspected plant is found by such an individual, he should have it positively identified through his county Extension agent or forester. Pests may be eradicated and spread prevented by warning neighbors and destroying such pests in the early stages of growth.

Obviously this is a community enterprise. One individual can infest the whole community by allowing the pest to develop on his farm. Eradication of new noxious weeds could well become a community enterprise for any or all local civic or rancher organizations. Many states have laws which permit the establishment of "weed-free areas." Hawaii has no such laws. The only procedure now possible is the enlightened and aroused voluntary support of each community.

The method of eradication depends somewhat on the nature of the plant. It is important to know whether the plant is an annual (short-lived) or a perennial (long-lived), whether it spreads by seed, stolons, or rhizomes, and other such features. In the tropics, plants grow the year a round, and their growth is largely influenced by rainfall. Therefore, some species are seen in the various stages of development in going from the dry to the moist sections. Nearly all the worst local pests are perennials and nearly all produce viable seed. In general, eradication of a local infestation requires that the entire plant should be dug out — not just cut off at the ground level. Furthermore, the entire plant should be burned so that the seeds as well as the plant will be destroyed. Digging out the plant and burying it may simply serve to give the seed a favorable medium for germination. Any focus of infestation should be visited from time to time over a period of several years to destroy all new seedlings. Obviously such a method is not feasible for large infestations. Chemical poisons can sometimes be used. Parasitic insects, fungi, and bacteria have been successful in a few instances but are limited in their use. In cultivated lands it is possible by frequent plowing and discing and the use of cover crops to starve and choke out noxious weeds. Considerable experimentation is necessary to develop specific methods for each type of plant. Such information is not available for all plant pests in Hawaii. Hence, the only safe method for some is to dig and burn.

GENERAL RECOMMENDATIONS

The outstanding weed-control development in recent years was the discovery that certain growth-regulating substances or hormones, such as 2,4-dichlorophenoxyacetic acid (2,4-D) and other related hormones, in certain concentrations, are highly effective as selective herbicides.

These chemicals are marketed under numerous trade names in various forms, concentrations, and combinations. Generally speaking, they are usually more effective when used on plants which are making vigorous growth. Because these herbicides do not affect desirable grasses and are nonpoisonous to livestock in the concentration necessary to control weeds, they are particularly well suited for use on pasture land. However, in many instances they have had a detrimental effect on some of the desirable legumes.

Because of the fact that dosage requirements of these herbicides as foliage sprays on the same plant pests differ from place to place and from season to season, no specific pounds per acre are recommended in this bulletin. Good control of some species has been obtained with as little as 1 pound of concentrate diluted in sufficient water to uniformly cover an acre. In other instances, 4 and even 6 pounds may be required.

In the case of bark treatments, the dilution remains constant at about 1:25 (or about 4 pounds active material per 25 gallons oil) whereas the gallons per acre of final spray will vary depending on the number and size of plants that are found in the area. From this it can be seen that it is impossible to give any definite figure on the amount of active material required per acre for bark treatment—the only set figure that can be given is the most effective rate of dilution. Good results have been obtained when bark treatments were made with ester in oil. Amine forms of 2,4-D and 2,4,5-T in water do not work as well as the ester forms for bark treatments. Where regrowth occurs, repeat applications will be necessary. For hard-to-kill trees or trees with thick bark it may be of help to score or girdle the trunk and apply on the cut surface. The most effective method is to cut down the tree and treat the stump immediately after cutting.

When guava, lantana, and other shrubs or trees are defoliated, other undesirable and possibly harder-to-kill plants may replace them very rapidly. To help prevent this, seeds of vigorous pasture grasses or other desirable forage plants should be sown as soon as possible after treatment.

Because many economic crops are susceptible to damage by 2,4-D and 2,4,5-T, the user must be extremely careful in the application, transportation, and storage of these hormone herbicides.

Unlike hormone-type herbicides, sodium TCA (sodium trichloroacetate) is an effective grass killer. This herbicide may be used most advantageously for eradication when noxious grasses are not fully established and when present in small patches. If the noxious grass is fully established, it is usually not economically feasible to use this herbicide. Its use is much more effective than digging as a means of eradicating grass pests with deep underground stolons or rhizomes. For shallow-rooted grasses the aromatic oils fortified with pentachlorophenol have shown considerable promise.

At this writing very little is known of the herbicidal effect of CMU (chlorophenyl dimethylurea) on the noxious plants of the Hawaiian ranges. CMU has shown good pre-emergency control of some weeds. This herbicide shows indications of being less injurious to many economic crops than the hormone-type weed killers.

Because of almost constant development and improvement in the field of chemical weed control, it is recommended that persons desiring to use such methods consult their local agricultural authorities, who should have definite information for particular local conditions.

In the past, hand grubbing was one of the chief methods of eliminating plant pests. Today, hand grubbing of noxious plants has its place, but the new herbicides already have had an effect on weed control in Hawaii, and with the rapid advancement that is now taking place it is expected that the immediate future will see still greater changes.

The following is a brief description of herbicidal chemicals recommended or suggested in this publication.

The *2,4-D acid* itself is a crystalline organic compound made up principally of chlorine, phenol, and acetic acid. It has a low solubility in water. The acid, when mixed with sodium carbonate or sodium bicarbonate, is soluble in water. The acid is the cheapest form of 2,4-D. It is noninflammable, noncorrosive, and relatively nonpoisonous to man and animal.

The *sodium* and *ammonium salts of 2,4-D* are the results of reaction of the acid with sodium and ammonium salts. These are known to be the least effective forms on woody plants.

The *amine forms of 2,4-D* are concentrated liquid salts. The 2,4-D acid is placed in reaction with the liquid triethanolamine or triethylamine. This form is quite popular in Hawaii and is known to be more effective on woody plants than the sodium or ammonium salts of 2,4-D. This is the form generally used in low gallonage application because of its higher solubility than the other salt forms.

The *esters of 2,4-D* are made by placing the 2,4-D acid in reaction with various alcohols. There is a wide range of volatility in this form of 2,4-D. Esters of the lower-series alcohols such as isopropyl and ethyl alcohols are highly volatile and therefore should not be used near sensitive crops. The heavier esters are relatively low in volatility; however, more caution should be exercised when using the heavy esters of 2,4-D than when using the nonvolatile or very low volatile acid, salt, and amine forms of 2,4-D. The esters have proved to be the most effective form of 2,4-D in controlling hard-to-kill herbaceous and woody plants.

The compound *2,4,5-T (2,4,5-trichlorophenoxyacetic acid)* is a closely related substance to 2,4-D. Various formulations of this compound are prepared in a manner similar to 2,4-D. Combinations of 2,4-D and 2,4,5-T are available. The various formulations of 2,4,5-T and combinations of 2,4-D and 2,4,5-T are particularly useful in the control of many 2,4-D resistant herbaceous and woody plants. In using 2,4,5-T formulations, caution must be exercised as in the use of 2,4-D in preventing spray mist from drifting onto sensitive crops. The volatile forms should be used in isolated or nonhazardous areas and never near sensitive crops.

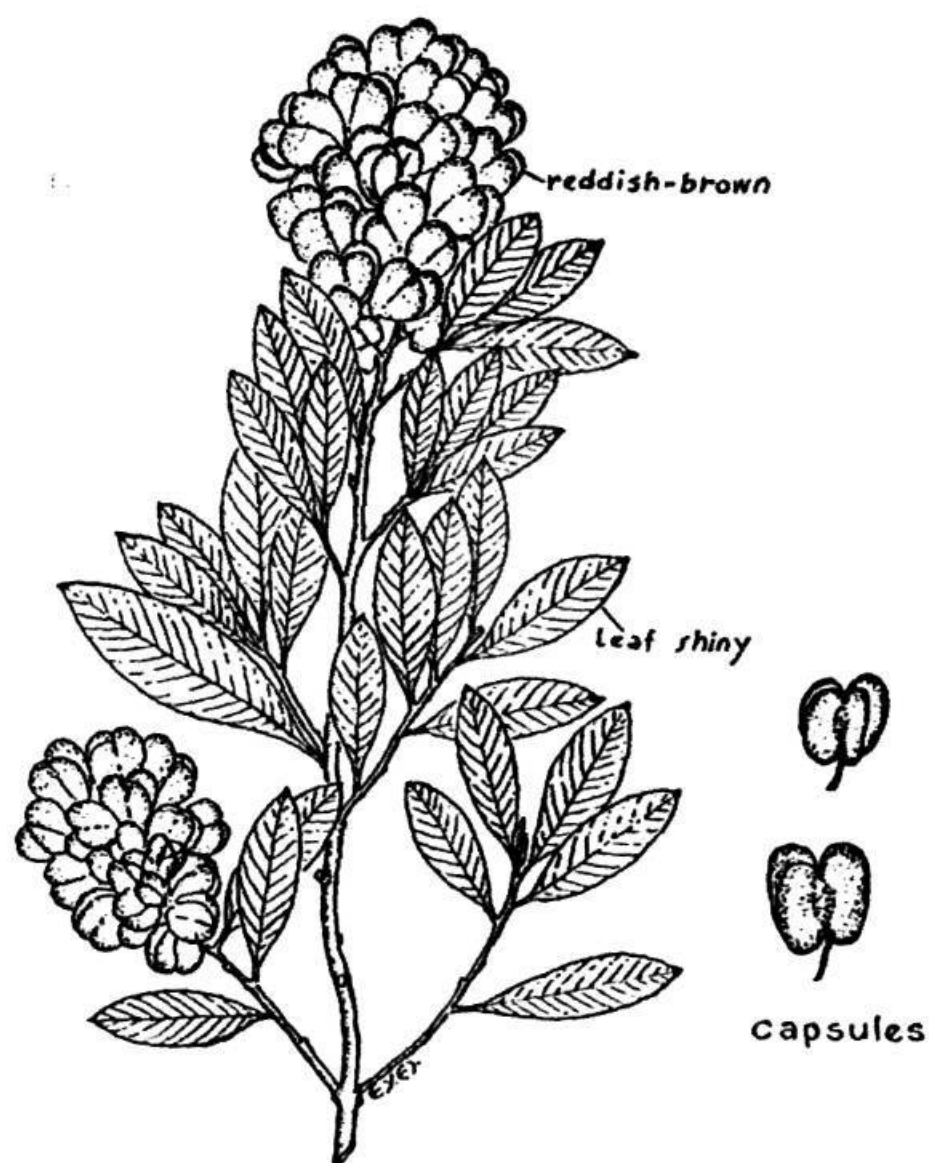
TCA (Trichloroacetate) is generally available on the market in white powder form as the sodium salt of trichloroacetic acid. It is readily soluble in water and relatively nonpoisonous to animals. It causes corrosion of metal spray equipment, which should be thoroughly washed after using this herbicide. TCA is primarily a grass killer; it acts principally through the root system, hence it can kill grass pests with deep underground stems. This herbicide is valuable for spot treatment of noxious grass pests in pastures.

CMU (Chlorophenyl dimethylurea) is a promising new product on the market. Its solubility is relatively low in either oil or water. In the concentrations necessary to control plants, CMU is considered relatively safe to use on pasture land and has shown excellent results as a pre-emergence spray for weed control. At present its use is still in the experimental stage.

The distribution of noxious plants described in this bulletin has been reported according to the climatic zone system developed by Ripperton and Hosaka (see map, page 20). One or more zones have been indicated as offering the best environmental condition for the development and spread of each weed listed (table 1). It is important, then, that land areas which are not known to be infested but which are located in zones where certain noxious plants thrive should be carefully watched for evidences of infestation.

NOXIOUS PLANTS

AALII, *Dodonaea eriocarpa* Sm.



Why a pest: Aalii is a persistent shrub of no forage value. It is taking up some good pasture lands.

General Characters: A branching shrub, 8 to 20 feet tall. Leaves papery, longer than wide, 2½ to 4 inches long. Flowers clustered at the ends of branches. Capsule conspicuously winged, brownish to reddish brown.

Dissemination: This is a slow-spreading plant. It disseminates only by seed; the bark is thin, and the brittle stems and branches do not take root.

Distribution: Found on all the islands in zones B, C₁, C₂, and E. It is most abundant at middle elevations between 2,500 to 6,000 feet.

Control: It is easily killed by a brush cutter, a chain-drag, or by bulldozing.

History: Cosmopolitan, found in all tropical countries including Australia, New Zealand, tropical America, Africa, and probably all islands in the Pacific.

AIR PLANT, *Bryophyllum pinnatum*
Kurz

Why a pest: Air plant competes with forage grasses and often crowds out desirable pasture plants. It has no forage value.

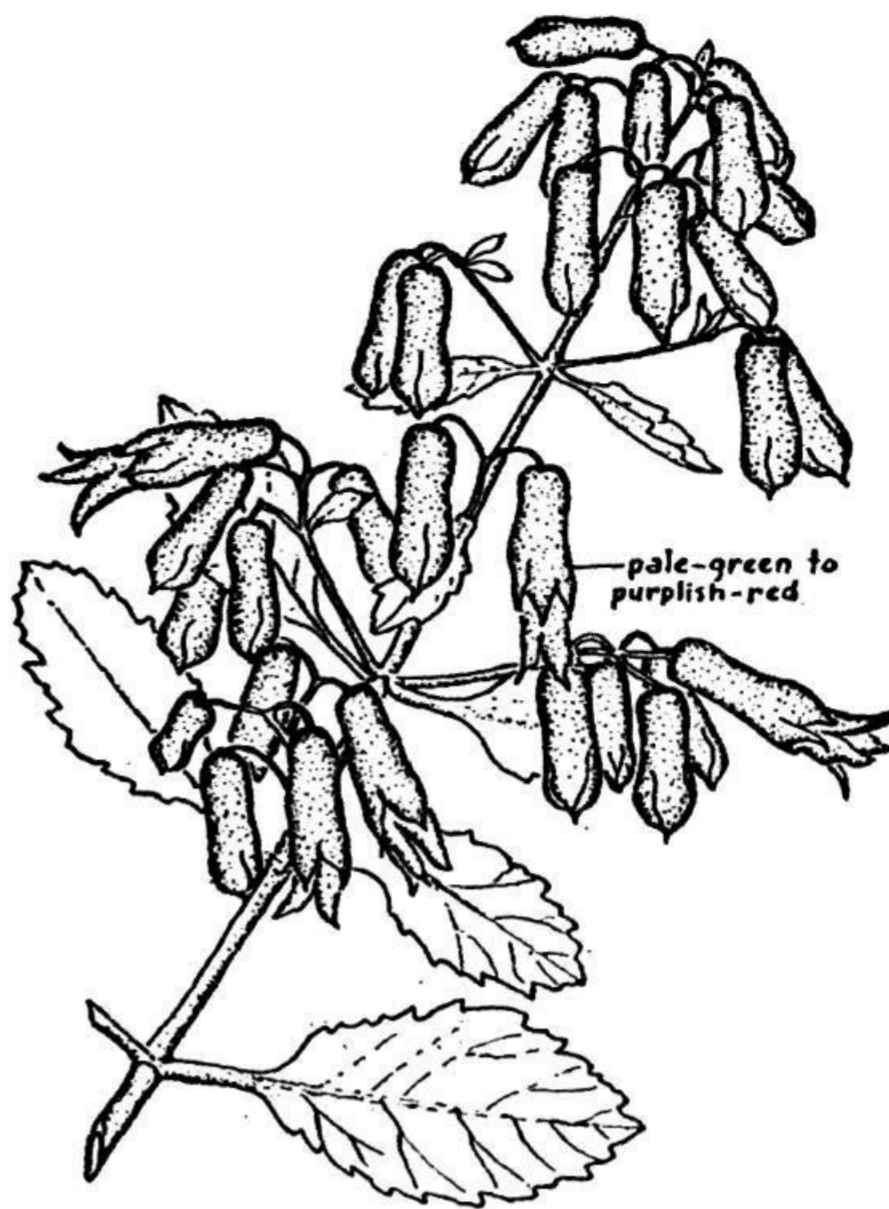
General Characters: A succulent herb, 2 to 3 feet tall. Leaves fleshy. Flowers purplish green, bell-shaped.

Dissemination: Hundreds of small seeds are produced and carried by rain water. The fleshy leaves stay alive for a long time when detached from the plant and produce new plants at the notches along the margin.

Distribution: Air plant is found on all islands in local patches in B, C₁, and D₁ zones. It seems to prefer shallow soil, rocky ledges, rock piles, and stone walls.

Control: Air plant is sensitive to weed-killing chemicals, and easily controlled with hormone herbicides and with oil spray. The amine form of 2,4-D has given good control.

History: Native of the East Indies and widely distributed throughout the tropics. First reported on the lava flows of Kau, Hawaii, in 1888 as "of recent introduction."



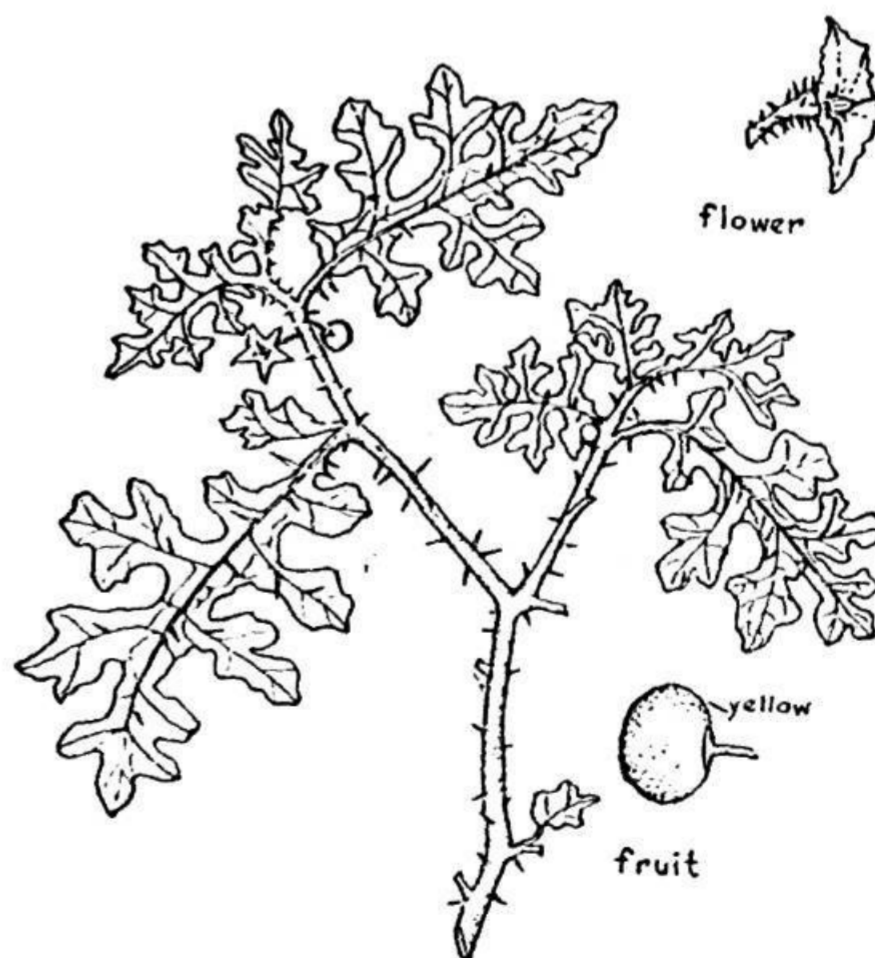
APPLE OF SODOM, *Solanum sodomium*
L.

Why a pest: The sharp spines on the leaves and stems of this pest discourage animals from grazing in its vicinity. Scattered plants quickly close in with their broad leaves and shade out desirable plants. It has no forage value and is known to be poisonous.

General Characters: A broad shrub, 2 to 3 feet tall, with sharp thorns on the leaves and stems. Flower pale violet. Fruit 1¼ to 1½ inches in diameter, yellowish when ripe, smooth and roundish.

Dissemination: Some ranchers have claimed that during drought the animals eat the fruit and scatter the seeds in the droppings.

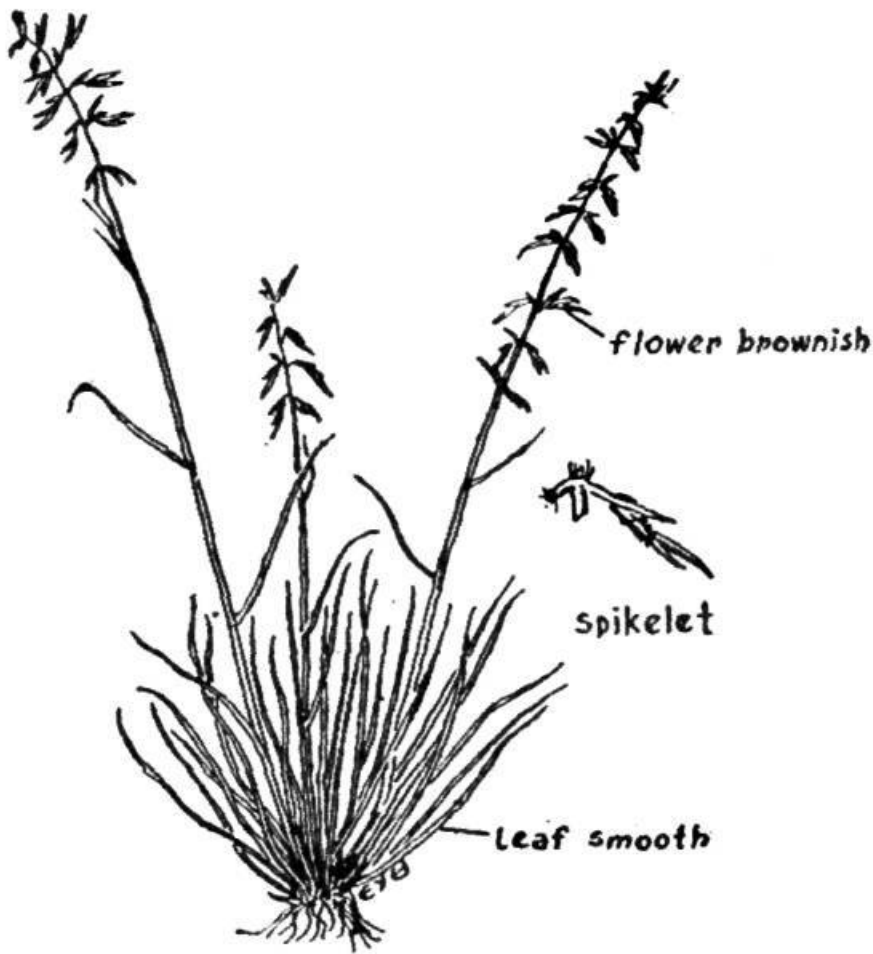
Distribution: It has restricted distribution on all the islands in A, B, C₁, C₂, and D₁ zones. There is another plant with scarlet fruit that closely resembles



this plant. This red-fruited plant is rare, but when found it should be treated like the apple of Sodom.

Control: A partial to a complete kill has been obtained by using 2,4-D-2,4,5-T combinations in oil spread over the entire plant.

History: This plant was accidentally introduced. First reported by Heller in 1897 as well established in the vicinity of Honolulu. The native habitat is North Africa.



BARBWIRE GRASS, *Cymbopogon refractus* (R. Br.) A. Camus

Why a pest: Barbwire grass is worthless for forage and is spreading on good pasture lands. Its narrow, tough, wiry leaves have a disagreeable soapy taste and are seldom eaten by cattle.

General Characters: A bunchy perennial grass, 1 to 3 feet tall, with tough stems and a dense mass of narrow, harsh, wiry leaves at the base. The individual plant increases into a large clump by producing new shoots around the base. The flowers twist at an angle from the stem, resembling the prongs of barbwire, hence

its name.

Dissemination: It produces a large amount of viable seed which drops to the ground, causing a gradual expansion of the infestation. The seed tends to cling to the hair of animals, and new infestations thus develop in widely separated places. In Kau, Hawaii, the wild goats passing through a stand of barbwire grass, in going from one grazing area to another, carry the seeds on their bodies.

Distribution: At present it is confined to certain areas on Kauai, Lanai, Molokai, Maui, and Hawaii in dry to semidry locations at elevations of about 300 to 3,500 feet in zones B and C₁. Barbwire grass has so far never been found in wet areas. In 1945 the localized areas covered by this pest were small, but in the last 8 years these areas have increased to several hundred acres. In the Kau section this pest has taken complete possession of over 400 acres and has turned the pastures into worthless land. The infested areas on Kauai, Lanai, and Oahu are less than 1 acre; on Molokai and Maui, 5-10 acres; on Hawaii, over 700 acres.

Control: In small infestations the plants should be dug up and burned. Indications are that eradication may be obtained by the use of sodium TCA. In dry pastures stargrass (*Cynodon plectostachyum*) and molasses grass have been fairly successful in competing with this pest. In semimoist locations, fast-growing, mat-forming grasses such as kikuyu and pangola might be used.

History: Native of Australia. First reported by Hosaka in 1936 from Kahuku, Kau, Hawaii.

BLACKBERRY, *Rubus penetrans* Bailey

Why a pest: Blackberry is aggressive and competes with cultivated forage plants. Hundreds of acres of good seeded pasture have been made useless by the encroachment of this pest. The trailing branches make an effective covering of the ground and their sharp spines discourage the animals from trespassing.

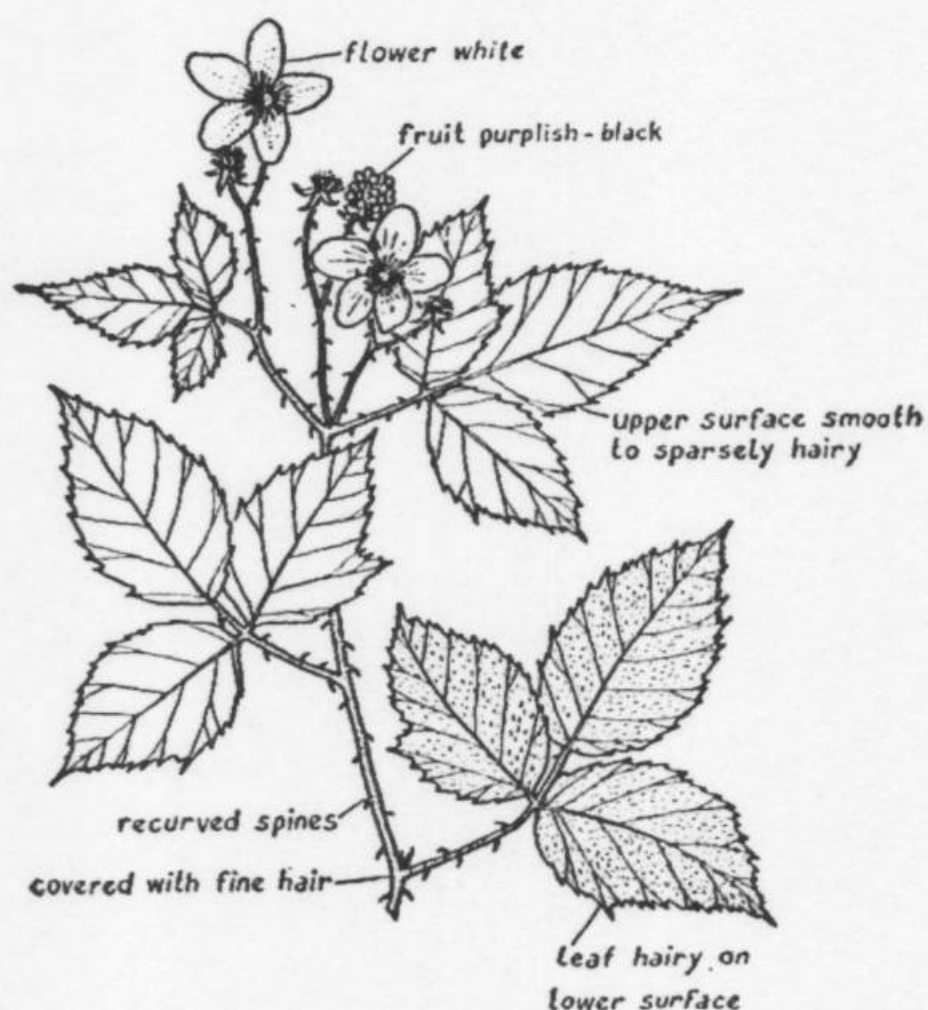
General Characters: A semiwoody, long, trailing decumbent shrub, with strong recurved spines on the stems. Leaves consisting of three leaflets. Flowers white. Fruit somewhat globose, black when ripe, edible.

Dissemination: Fruits are eaten by birds and the seeds dispersed. Animals grazing around blackberry patches often pick up broken branches with ripe fruit and transport them some distance away.

Distribution: Found on Hawaii, Maui, Kauai, and Oahu in C₂, D₂, and D₃ zones.

Control: Herbicides containing 2,4,5-T have been successfully used in controlling blackberry.

History: Introduced from continental America prior to 1900; escaped from cultivation.



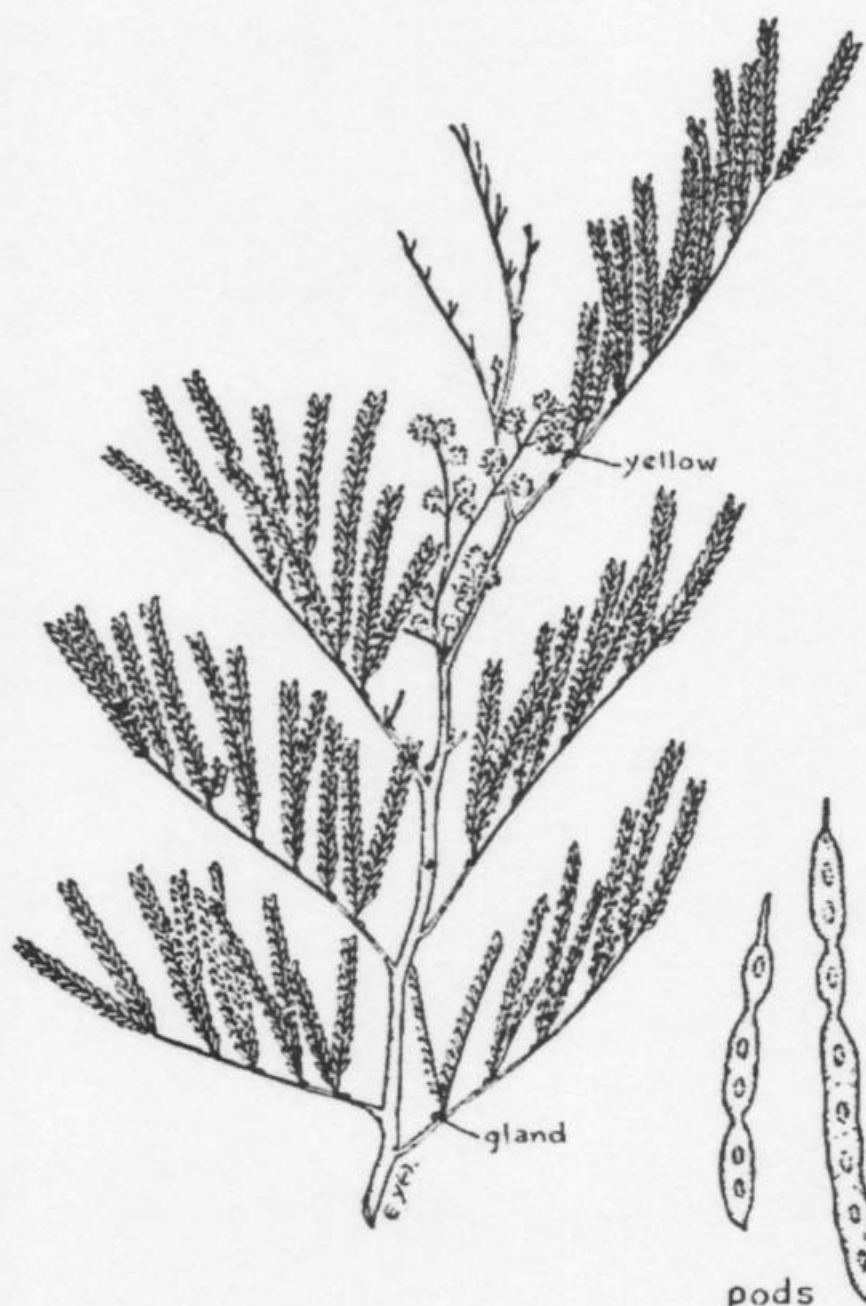
BLACK WATTLE, *Acacia decurrens* Willd.

Why a pest: A fast-growing and fast-spreading tree. From a single clump, it encroaches upon new grounds with a solid front in all directions. The stand is usually too dense for any grass to grow in association. It has no forage value.

General Characters: Black wattle is a freely branching tree, 25 to 35 feet tall. Leaves divided, small. Flowers in a cluster, yellow. Seed pods 2½ to 4 inches long and about ¼ inch wide, slightly pinched between individual seeds in the pod.

Dissemination: Abundant seeds are produced on a single tree. The pods split open with a force in drying and throw the seeds for a considerable distance.

Distribution: Found on all the islands in localized areas of zones C₁ and C₂.



Control: Herbicides have been successfully used on black wattle. Recommended treatments are: Foliar application on small plants using herbicide containing 2,4,5-T dissolved in oil in the ratio of 1:20; for large trees, stump treatments using the above formulation; for small trees, basal treatment applied completely around the trunk about a foot above the ground. Dense stands of large trees are easily cleared with a bulldozer.

History: Native of Australia. Purposely introduced for its tanning bark. A wattle trial area was planted on the slopes of Tantalus shortly after 1890. During the period from 1888 to 1893 there was considerable interest in wattle planting in Hawaii because of the high price of tanning bark. During this period considerable numbers of seeds were distributed throughout the islands.



BRACKEN FERN, *Pteridium aquilinum* var. *decompositum* (Gaud.) Tryon

Why a pest: During the spring months bracken fern makes tremendous growth and competes with planted forage grasses and legumes. Then during the fall it dies and exposes the bare ground to erosion and undesirable plants. It has been reported to be poisonous to animals. It has no forage value.

General Characters: An upright, short-lived fern, 1 to 2½ feet long, with leaves divided into many small leaflets. Fruiting bodies under the down-rolled edges of the leaflets.

Dissemination: The creeping underground rootstalks branch freely and produce many sucker shoots. In this way a single plant covers from a few to many square feet of ground area in a short

time. Wild pigs dig up the rootstalks for food and disperse the growing shoots.

Distribution: Bracken fern is found on all the islands in zones B, C₁, C₂, D₁, D₃, E₁, and E₂, but the most extensive stands are found in C₂, D₃, and E₁.

Control: Control may be obtained by planting some aggressive, sod-forming grasses.

History: This pest is believed to be native to Hawaii. It is also found in other tropical countries.

**BULL THISTLE, *Cirsium vulgare* (Savi)
Tenore (*C. lanceolatum*)**

Why a pest: Bull thistle has no forage value. It competes with palatable grasses and crowds them out by using up the plant food in the soils. The thorny leaves make this plant undesirable.

General Characters: An erect leafy plant 2 to 4 feet tall, with a long tap root. Leaves are armored with long sharp spines, the margin deeply cut, dark green. Flower single on a stem, dark purple.

Dissemination: The seeds have fluffy bristles on the end which help in dispersal.

Distribution: It is found on all the islands in zones C₁, C₂, D₃, and E₁.

Control: The larvae of a moth feed on the young leaves and weaken the plants. It is important that the plants are destroyed before they produce flowers. The amine form of 2,4-D has given good control.

History: Native of Europe and Asia, now spread to many parts of the world. This species is believed to be of recent introduction to Hawaii.



CACTUS: PANINI, *Opuntia megacantha* Salm-Dyck

Why a pest: This fast-growing, spiny plant crowds out palatable forage plants. Stands of cacti make animal run-up very difficult. Some good guinea-ekoa and Bermuda grass pastures are overrun by this pest. The red-fruited cactus is not regarded as a pest by many ranchers, but the white-fruited cactus, which has more and longer spines on the flat pods, is disliked by all.

General Characters: A fleshy, succulent, wide-spreading plant, 5 to 12 feet tall.

Dissemination: Cattle, horses, pigs, and birds eat the juicy fruit and scatter the seeds in their droppings. The pods are also knocked down by animals and kicked around, thus starting a new infestation.

Distribution: Found in the dry lowlands on all the islands. It is commonly found in zones B and C₁ and occasionally in zones A and C₂.

Control: Herbicides containing 2,4,5-T have been successfully used by some ranchers. Knocking the clumps of cacti and piling them in windrows with bulldozers have been extensively used by certain ranchers. Chain-drag has been used also with much success. This plant pest offers excellent possibilities of biological control.

History: Native of the drier parts of tropical America. It is believed that Don Marin introduced this plant to Hawaii from Mexico about 1809.

CASTOR BEAN, *Ricinus communis* L.

Why a pest: A persistent, fast-growing shrub of no forage value. The seed coat contains a poisonous principal. The death of some animals in the Territory has been associated with this plant.

General Characters: A freely branching shrub, 8 to 15 feet tall. The large leaves are lobed. Fruit is a spiny capsule with usually three seeds.

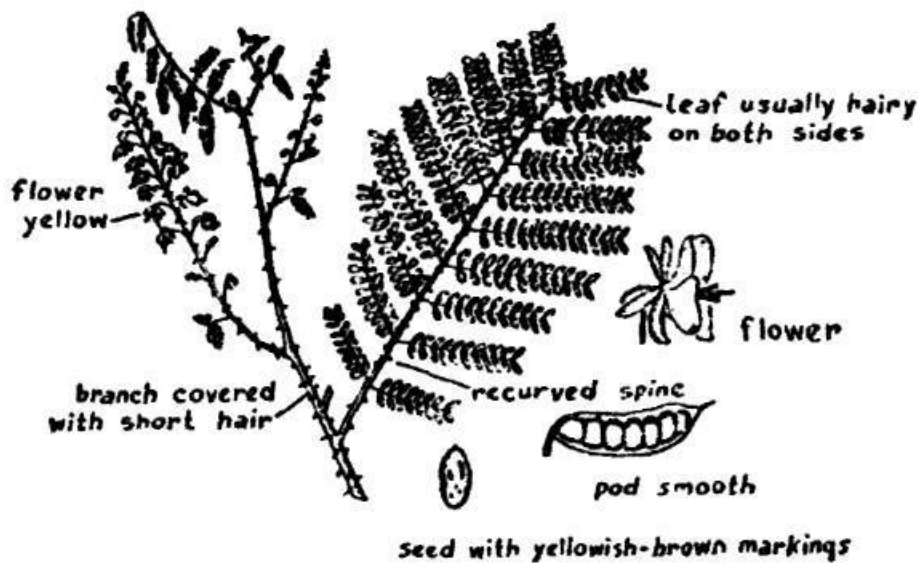
Dissemination: The capsules on ripening pop open with a force and throw the seeds 25 feet or more. The spiny seed pods are often caught in the fur of animals and carried long distances.

Distribution: Castor bean is a common lowland plant on all the islands. It is found in B, C₁, and C₂ zones.

Control: The amine forms of 2,4-D in water applied as a foliage spray have been effective in controlling this plant. The larvae of a moth defoliate this plant occasionally.

History: Probably a native of Africa but has been widely spread to all tropical regions. It is believed to be an early introduction to Hawaii.

CAT'S CLAW, *Caesalpinia sepiaria* Roxb.



Why a pest: Cat's claw forms dense, impenetrable tangles completely covering the ground and smothering out other shrubbery and small trees. The sharp, recurved spines on the stems make it particularly obnoxious.

General Characters: A freely branching, fast-growing, vine-like shrub with branches 8 to 15 feet long. The branches

and leaf stalks are covered with straight to recurved spines.

Dissemination: The seeds fall to the ground and new plants develop. Along depressions and stream beds, the seed is spread considerable distances by running water. Wherever the vine-like stems touch moist ground they take root and form new plants. Even old trunks, cut and used for fence posts, will take root and grow.

Distribution: This species is usually found along stream beds in moist regions. It is found on all the islands in zones C₁ and D₁, but the distribution is only occasional.

Control: Every effort should be made to eliminate plants when they are small, as the spiny branches make the large plants very difficult to handle. As the seeds are not windborne or carried by birds, it should be feasible to prevent encroachment of this plant onto open areas by periodic mowing and occasional grubbing out of new plants. Applications of 2,4-D-2,4,5-T in oil diluted 1:25, spread around the bases of the plants, have given good control.

History: Native of southeast Asia. Introduced and established in many tropical areas. Believed to be of recent introduction to Hawaii.

CHRISTMAS BERRY, *Schinus terebinthifolius* Raddi

Why a pest: This is an aggressive, fast spreading shrub of no forage value. It makes dense canopy and shades out grasses.

General Characters: A bushy, spreading shrub, 10 to 15 feet tall; the leathery leaves are dark green on the upper surface and light colored on the underside. Flowers small, yellowish. Fruit round, about 3/16 inch in diameter, bright red, shiny.

Dissemination: People use the bright red berries for decoration, and this helps to scatter the seeds. Light fruits are also carried by water. Birds are the most active carriers of the fruits.

Distribution: It is widely distributed over the islands in the lowlands where the annual rainfall is 20 to 45 inches. It is commonly associated with lantana and guava in zones B and C₁.

Control: Small shrubs 3 to 4 inches in diameter are killed with 2,4,5-T in oil, sprayed or brushed completely around the trunks at the base.

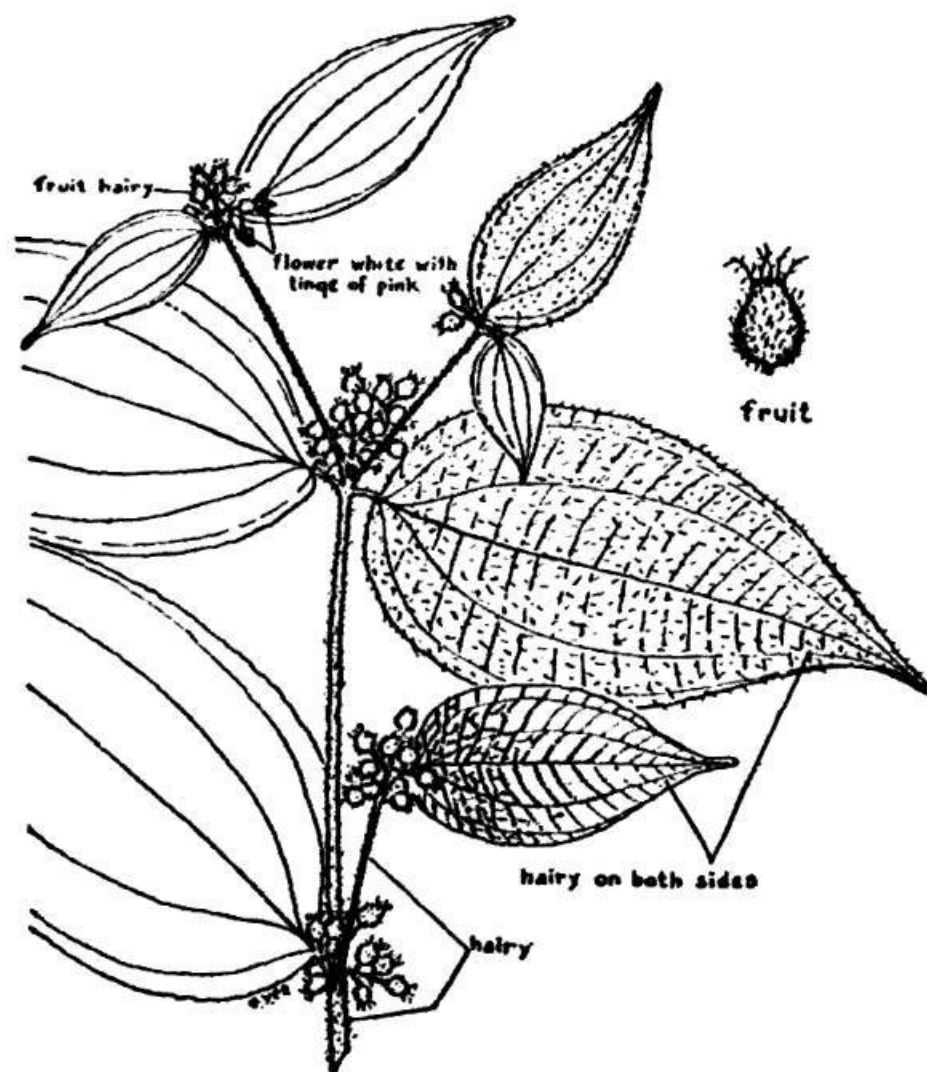
History: Native of Brazil. It is believed to have been introduced to Hawaii as an ornamental.



CLIDEMIA, *Clidemia hirta* (L.) D. Don

Why a pest: This is a very fast-growing shrub of no forage value. It competes strongly with other plants and quickly takes over an area. It was one of the most serious pests in Fiji until a thrip was introduced to control the plant. It is potentially a very serious pest.

General Characters: Clidemia is a branching shrub, 5 to 10 feet tall; the branches are hairy. The papery leaves are hairy on both sides. Flowers are clustered in the upper axils of the leaves; flower small, white, with a pink tinge. Fruit globular, fleshy, about 1/4 inch in diameter, hairy, deep purple when ripe.

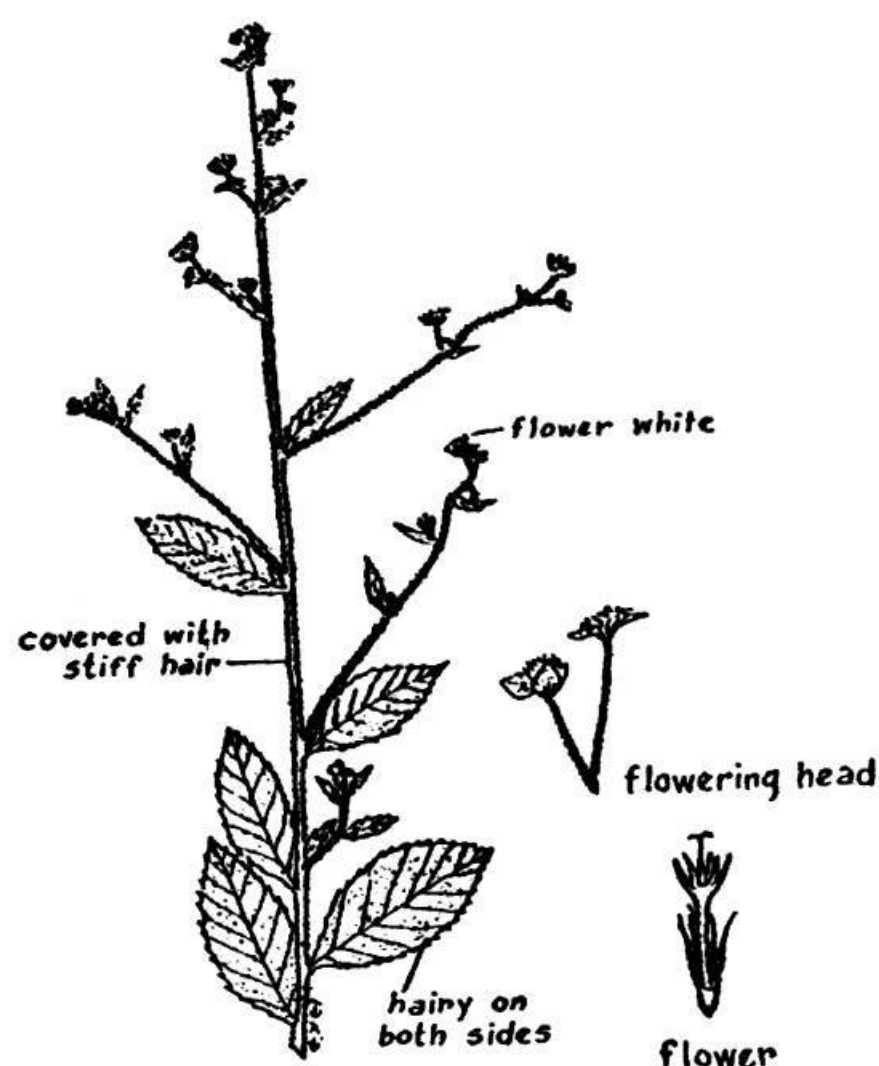


Dissemination: The plant is spread by birds that feed eagerly on the sweet, juicy berries which contain hundreds of tiny seeds.

Distribution: At the present time it is confined to a local area in the forest reserve above Wahiawa, Oahu, in zones D₁ and D₂.

Control: It is believed that applications of 2,4,5-T in oil will kill this plant. It also offers good possibilities of biological control through the introduction of its natural enemies.

History: Native of tropical America; now established in some tropical regions. It is of recent introduction to Hawaii.



ELEPHANTOPUS, *Elephantopus mollis* HBK.

Why a pest: The long, stiff hairs with which elephantopus is covered cause an itching of the skin when a person brushes against them. The plant rapidly covers valuable lands. In the islands of southeastern Polynesia it has become a very serious pest. With mosquitoes and rats, it is one of the three curses of Raratonga.

General Characters: A fast-growing, slender, upright plant that attains a height of 7 feet in 4 to 6 weeks if supplied with sufficient moisture.

Dissemination: Abundant seeds are produced by a single plant, and the seeds are carried on the fur of animals for long distances.

Distribution: At the present time elephantopus is found on Kauai and in a localized area in Kealahou, Kona, Hawaii. It is a plant of moderate to high rainfall areas, zones B, C₁, and D₁. Although first noted on Kauai about 1931, this plant has become alarmingly abundant in certain localized areas, from Lihue to Wailua to Kapaa. Elephantopus was found in Kona about 6 years ago, and in this short period it has become a permanent part of some pastures at 1,200–2,000 feet elevation. A few ranchers on Kauai have kept this pest in check by periodic mowing before seeding.

Control: Elephantopus has been found practically impossible to eradicate after it has gained a firm foothold. Every effort should be made to prevent its spread to islands free of this serious pest. The amine form of 2,4-D in water offers possibilities of control.

History: Native of tropical America. Now established in many tropical regions. It is of recent introduction to Hawaii.

EMEX. *Emex spinosa* Campd.

Why a pest: Emex grows rapidly and crowds out forage grasses and clovers. It has no forage value, and the spiny burs are a nuisance. A cultivated field infested with emex is almost useless for most vegetables or low-growing crops.

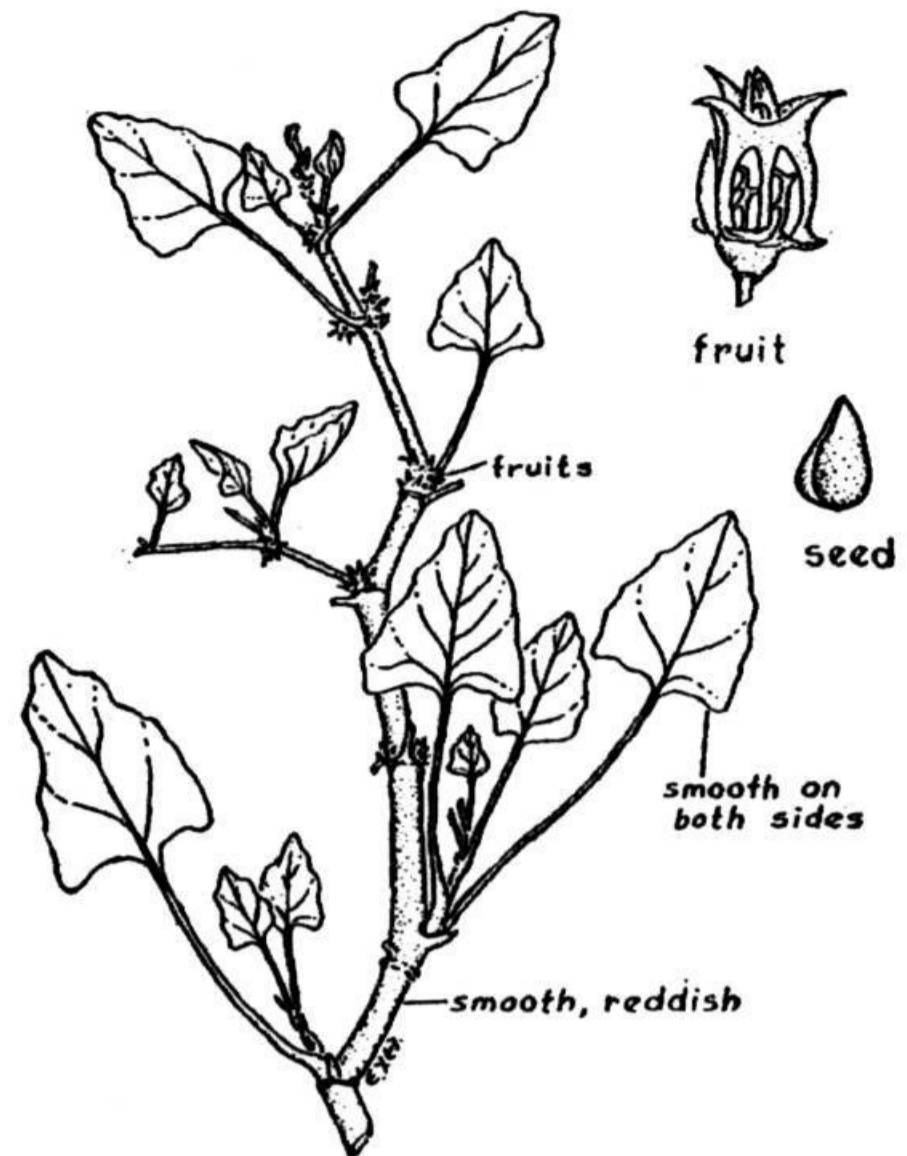
General Characters: A freely branching, low-growing, prostrate to ascending annual or short-lived perennial herb, 1 to 1½ feet high. The reddish stem is thick and somewhat fleshy. The fruit is a bur with three spines at the top.

Dissemination: Emex seeds profusely and spreads rapidly. The fruiting body is provided with hard, sharp spines which cling to grazing animals and automobile tires and is thereby carried to new localities.

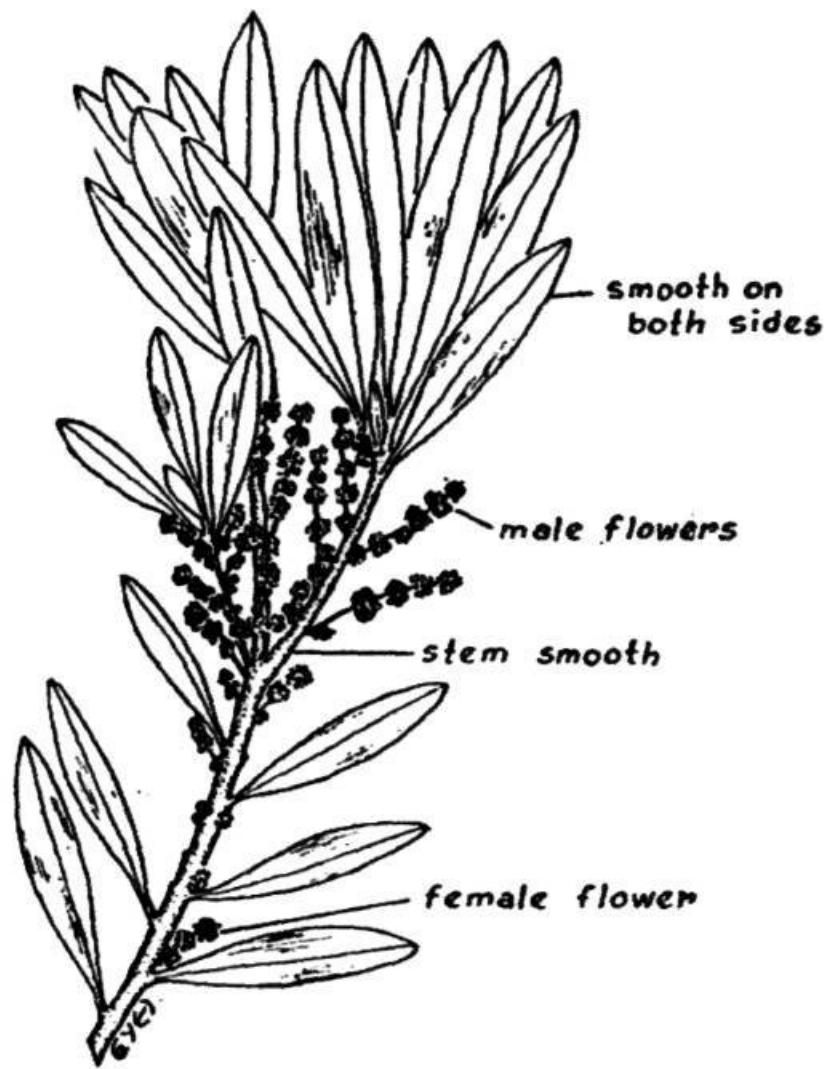
Distribution: Emex is reported on Oahu, Molokai, Lanai, Maui, and Hawaii in zones A, B, C₁, C₂, and E₁. Infested areas on Oahu and Lanai cover less than 10 acres, but on Molokai, Maui, and Hawaii emex covers a hundred acres or more. In the last 10 years it has spread over extensive areas, and the rate of increase is alarming. It grows strongly in the dry zones during the rainy seasons but dries up quickly. The fleshy taproot makes it possible for the plant to complete its life cycle by absorbing and storing moisture for its development. In areas like Waimea, Hawaii, where there is adequate moisture for 5 to 7 months, an emex plant attains large size, often 3 feet or more across.

Control: Emex is a difficult plant to eradicate because of the many seeds it leaves in the soil. A small infestation can best be eradicated by digging and removing all plants before they seed. Practices developed elsewhere for similar plants consist of repeated plowings to destroy all new plants before they seed. Kikuyu and molasses grass have been successful in keeping emex under control. Recently 2,4-D has been found to kill emex to some extent, but CMU has proved more effective in experiments.

History: This is a native of the Mediterranean region. It is of recent introduction in Hawaii.



FIREBUSH, *Myrica faya* Ait.



Why a pest: Firebush spreads rapidly and covers the land with a growth so dense that valuable pastures become useless in a relatively short time. Eradication of such a stand is a costly and time-consuming operation. It has no forage value.

General Characters: A rather handsome, thick-growing, and freely branching shrub or small tree, up to 30 feet tall. It has shiny dark-green leaves. Small red fruits are borne in clusters among the leaves.

Dissemination: The juicy red fruits are eaten by birds and the seed scattered in the droppings. Cutting the plant at the

base does not kill it but encourages the development of many young shoots from the stump.

Distribution: This plant is reported from Maui, Kauai, Oahu, and Hawaii. One of the largest stands covers many acres in the forest reserve above Paaulio on Hawaii, and it is spreading into the adjacent cleared pasture lands. It thrives normally in localities where the rainfall is 35 inches or more a year in zones C₁, C₂, D₁, and D₂.

Control: It has been found that 2,4-D and 2,4,5-T will kill small seedlings and regrowth from old stumps. Large stands are probably more economically controlled by mechanical means. Sodium chlorate has been successfully used in killing large trees by placing several spoonfuls of the powder in cuts made at the base of the trunks or on the stumps. Occasional plants in open pastures should be dug out and destroyed while still small. This tree should not be allowed to grow in a yard simply because it is attractive.

History: Native of the Azores and the Canary Islands. Introduced by immigrants from these regions about 1900 and planted in the Paaulio, Hamakua, Hawaii area. It was purposely spread as a forest tree to many of the islands.

FOUNTAIN GRASS. *Pennisetum ruppelii* Steud.

Why a pest: Fountain grass tends to form dense stands. If it were to become established in good pasture lands, it would greatly reduce their grazing value, but it is believed to have possibilities as a pioneer grass on lava flows. The harsh, wiry leaves are occasionally eaten by cattle when feed is scarce.

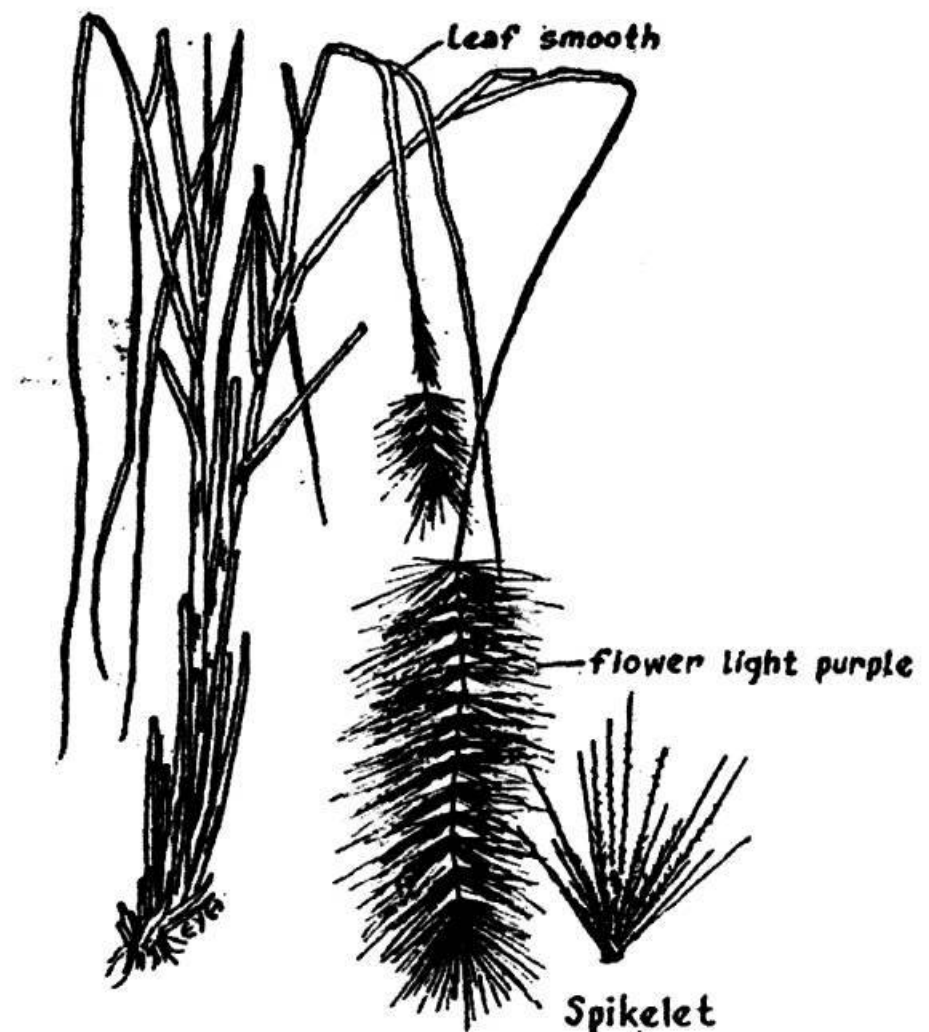
General Characters: A bunchy, erect perennial grass, 2 to 4 feet tall, with stems somewhat woody near the base; leaves are rather coarse. The erect flowering stems, each with a long cluster of pink or purplish flowers, are quite showy. Fountain grass grows well in rocky, shallow soil and stands prolonged drought remarkably well. It is a true pioneer grass.

Dissemination: Seeds profusely, and the light seeds are carried long distances by the wind. This plant spreads rapidly in a suitable habitat and forms nearly pure stands.

Distribution: At Puuwaawaa, Hawaii, fountain grass covers an extensive tract of relatively unweathered lava lands. At Kalaheo, Kauai, it has small localized distribution. Fountain grass is a plant of the dry regions in zones B and C₁.

Control: Any suspected plant should be identified and, if found to be fountain grass, should be dug out and burned. Surrounding areas should be watched closely for the development of new seedlings. Guinea grass has been observed to crowd out fountain grass.

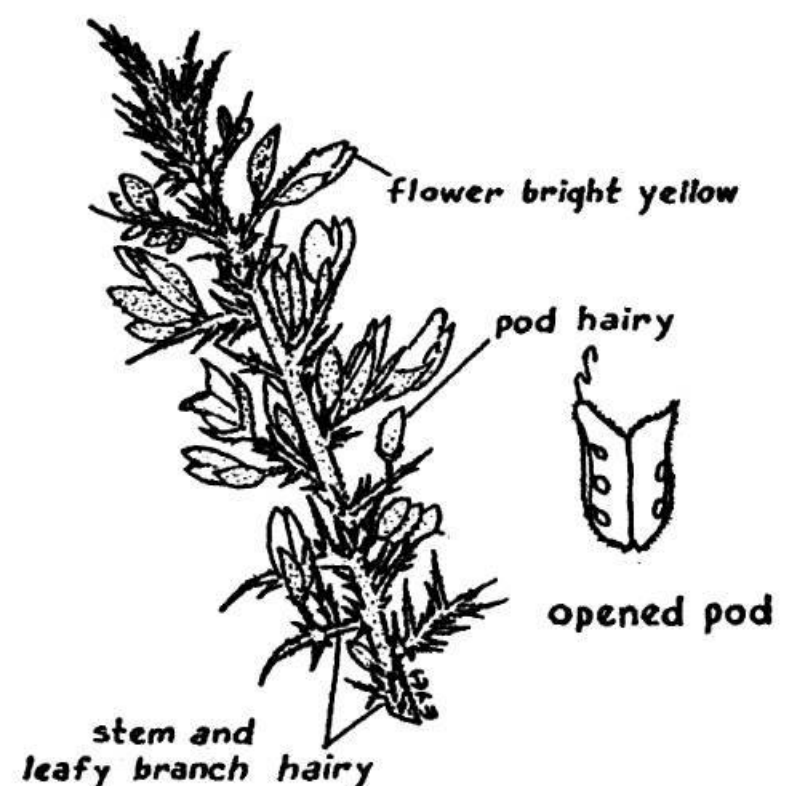
History: Native of Africa. Introduced as an ornamental to many tropical regions.



GORSE. *Ulex europaeus* L.

Why a pest: Where gorse is unchecked the stand become impenetrable and the pasture worthless. The sharp thorns penetrate clothing, snap off in the flesh, and produce burning, painful sores.

General Characters: A compact shrub, 3 to 5 feet tall, bearing many branches that have been modified into sharp spines. The bright-yellow flowers, borne on short branches, are showy and can be seen from a distance.



Dissemination: The short branches bearing the seed pods become entangled in the tails of animals and are carried long distances. The mature pod splits open with a sudden twist and throws the small seeds some distance away from the parent plant.

Distribution: At present, gorse is found in the vicinity of Olinda, Maui, and Humuula, Hawaii, in zones C₂, D₃, and E₁.

Control: Government agencies and ranchers have fought this weed for the past 30 years or longer on Maui. Although it had not been completely eradicated, it was kept under control until recently. However, in the last few years it has suddenly spread over large areas. Small gorse plants have been killed by 2,4-D and 2,4,5-T. Heavy stands present a more serious problem. In 1949 the Board of Agriculture and Forestry introduced a weevil from New Zealand to help inhibit the spread of this pest. This insect lays its eggs in the flower, and the young larvae feed on the seeds.

History: Native of England and parts of Europe. Purposely introduced to Hawaii as a living fence plant for sheep.

GUAVA, *Psidium guajava* L.

Why a pest: This is one of the most serious pests of grazing lands in the moist regions. It is a fast-growing shrub often becoming tree-like in growth. It shades and crowds out forage plants. It has no forage value.

General Characters: A shrub or a tree, 8 to 25 feet tall, with spreading branches. Leaves 3 to 6 inches long, slightly hairy on the undersurface, smooth on the upper surface. Flowers white, about 1 inch across, with many fine stamens. Fruit oval, yellowish when ripe; flesh pinkish, with many hard seeds.

Dissemination: This pest spreads by seed and by rootstalks. A small piece of root left in moist ground immediately sends out new shoots that develop into a large plant in a few months. The ripe fruits are eaten by birds, cattle, horses, and wild pigs, and the seeds spread in their droppings.

Distribution: Guava is widely distributed on all the islands in zones B, C₁, D₁, and D₂.

Control: Discing several times with a heavy disc has been quite successful in destroying a thick stand of guava up to about 5 feet high. The most economical and effective method is to treat the plants with 2,4-D dissolved in light oil. For large trees, bark treatment is best. For small plants, foliage applications of 2,4-D in water have been successful in killing top growth.

History: Native of tropical America. It is believed that Don Marin introduced this plant to Hawaii in the early 1800's.

HAIRY FLEABANE, *Pluchea odorata*
(L.) Cass.

Why a pest: A fast-growing shrub of no forage value. It is an invader of newly cleared land in the semidry to moist locations. The tremendous quantity of viable seeds produced throughout the year gives this plant great advantage in its dispersal and distribution. It competes strongly with established plants and shades out grasses and other desirable plants.

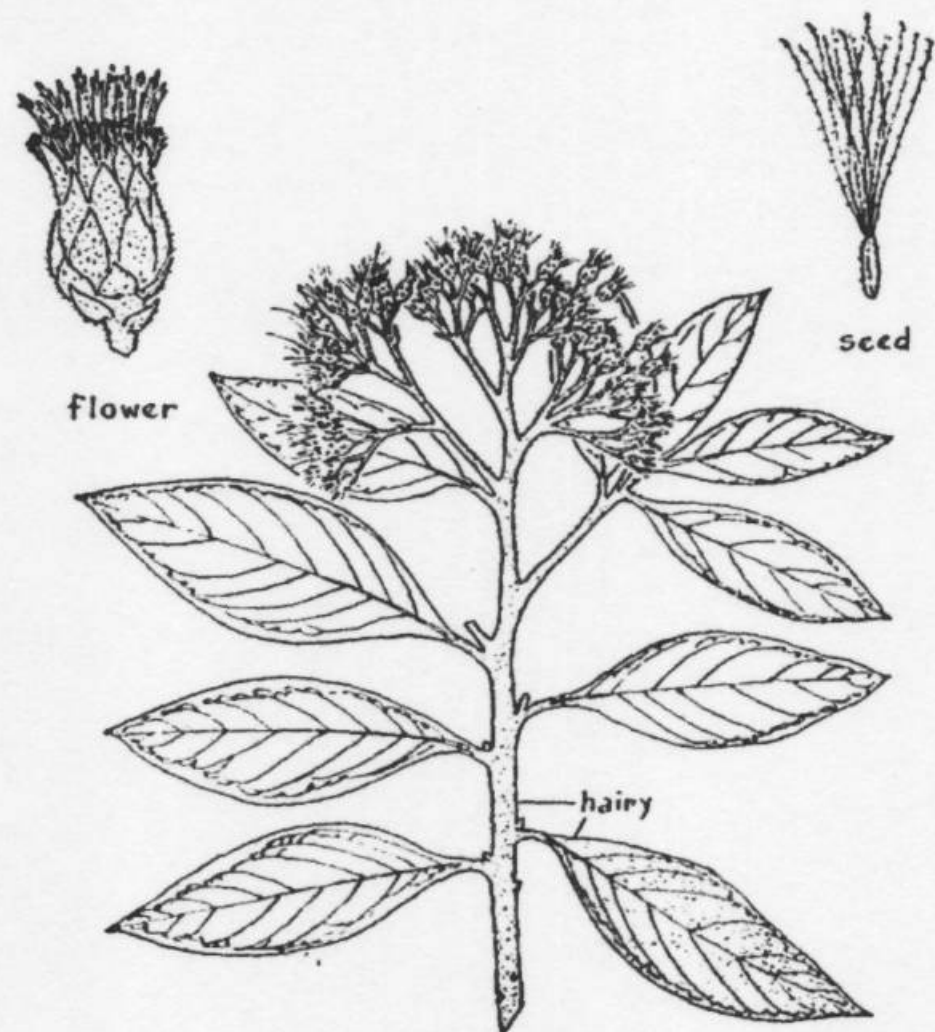
General Characters: A freely branching shrub, 3 to 12 feet tall. The leaves and branches are covered with short brownish hair. It stools from the base when cut close to the ground. It grows into a thick, many-branched shrub with stem $\frac{3}{4}$ inch or more across at base. The branches entwine, forming a mat which makes penetration very difficult.

Dissemination: Abundant flowers are produced in a head, and each seed is equipped with a $\frac{1}{4}$ -inch-long hair-like appendage that helps the seed to float in the air and be carried long distances. The viable seeds germinate readily and grow into mature plants in a short period.

Distribution: Hairy fleabane has a wide range of adaptability from the semidry to wet locations in zones B, C₁, C₂, D₁, and D₂. It grows well in saline and nonsaline soils and in marshes. In the last few years it has found its way to all the islands.

Control: Herbicide containing 2,4,5-T is quite effective on the plant. Bark application has been found to be more effective than foliage spray.

History: Native of tropical America. It is of recent accidental introduction to Hawaii, first reported from the vicinity of Honolulu in 1931.

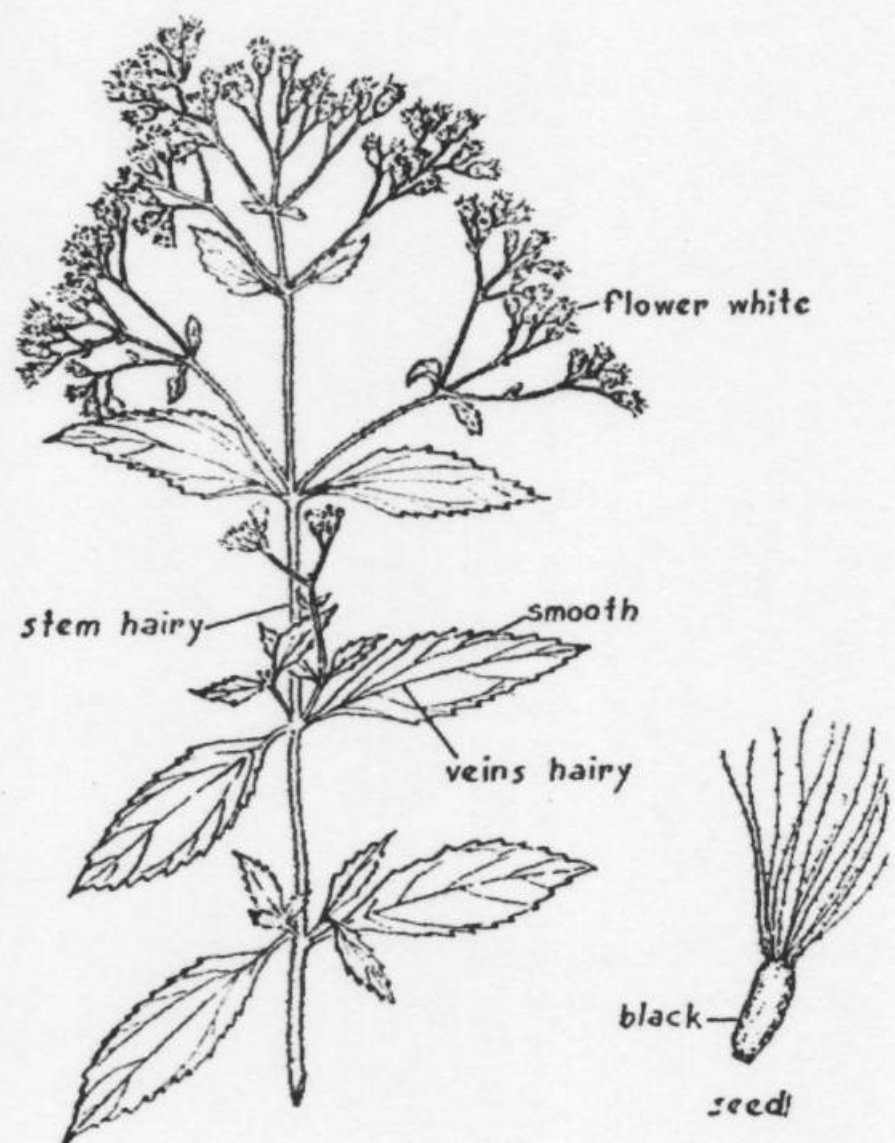


HAMAKUA PAMAKANI, *Eupatorium riparium*
Regel

Why a pest: This is an aggressive, fast-spreading shrub of no forage value. It invades a new area and in a few years dominates all other vegetation.

General Characters: A freely branching shrub, 3 to 5 feet tall; the reddish stems are covered with fine hairs. Leaves are opposite and saw-tooth on the margin. Flowers small, white, in clusters at ends of branches.

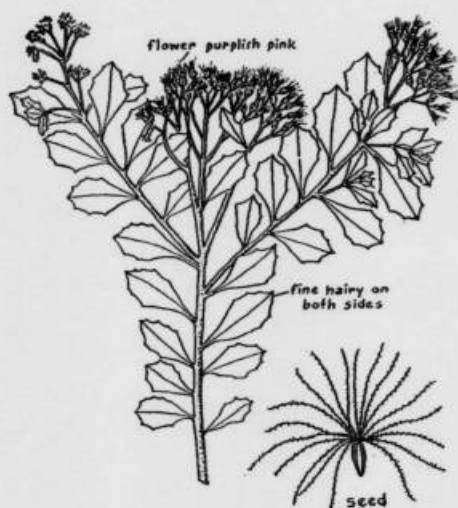
Dissemination: This plant is a prolific seeder, and each seed has long, silky hairs that help it to float long distances. Wild ducks have been reported to carry the seeds.



Distribution: This plant was originally found only on Hawaii but is now established on Maui, Molokai, Lanai, and Oahu in zones C₁, C₂, D₁, D₂, D₃, and E₁.

Control: Plants found in small patches can be easily grubbed out, but extensive stands should be destroyed mechanically. Chemicals such as 2,4-D and 2,4,5-T have been only partially effective.

History: Native of Mexico.



INDIAN FLEABANE, *Pluchea indica*
(L.) Less.

Why a pest: A fast-growing shrub of no forage value. It is an invader of marsh lands and coral fills along the coast.

General Characters: A much-branched shrub, 3 to 5 feet tall. The older branches are smooth and dark brown, whereas the young branches are covered with short hair. The flowers are formed in a head and purplish pink in color. Each slender seed is longitudinally ridged and tufted with a long, hair-like structure.

Dissemination: The light, freely floating seeds are carried long distances by the wind.

Distribution: Indian fleabane is found in the coastal coral fills and coastal marshes in zones A, B, and C₁ of all the islands.

Control: Herbicides containing 2,4-D-2,4,5-T combinations applied to the trunks of older trees and sprayed over the foliage of younger plants is suggested.

History: Native of southeast Asia. It is believed to be of recent accidental introduction.

JAMAICA VERVAIN, *Stachytarpheta jamaicensis* (L.) Vahl

Why a pest: This is a hardy weed and often makes a solid stand on denuded shallow soils. In such locations it chokes out all desirable grasses. It has no forage value.

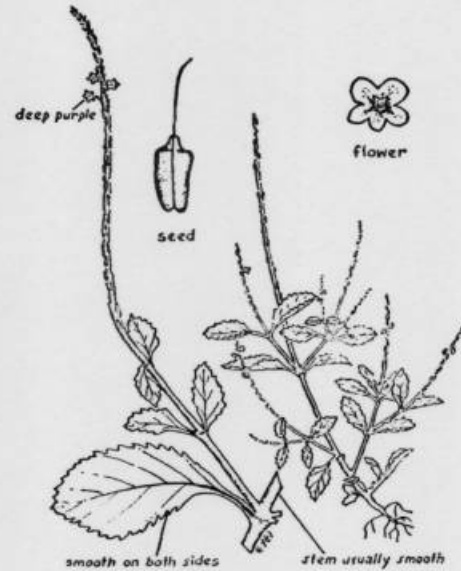
General Characters: A low woody shrub, 1 to 2 feet tall, with spreading branches. Leaves 2 to 4 inches long, with winged leafstalks, smooth on both surfaces. Flowers produced on long flowering stalks; color, deep purple.

Dissemination: Many seeds are produced on a single flowering stalk. These fall to the ground at maturity and germinate into new plants.

Distribution: It is commonly found in the semidry to wet regions on all the islands in zones B, C₁, and D₁.

Control: The amine forms of 2,4-D have given good control.

History: Native of tropical America. Now widely established throughout the tropics. Accidentally introduced to Hawaii.



JAVA PLUM, *Eugenia cumini* (L.) Druce

Why a pest: Java plum is a fast-growing tree that shades out good forage plants. It has taken over some good pasture lands.

General Characters: A branching tree, 20 to 30 feet tall, with white, smooth bark. Leaves lance-shaped, smooth. Flowers white, clustered. Fruit oblong, about 1/2 inch in diameter, violet or black, edible.

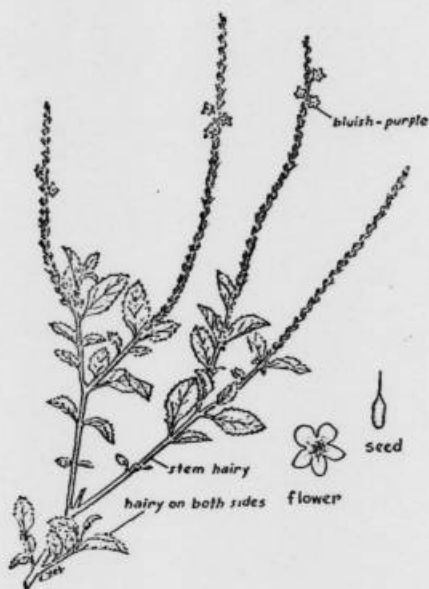
Dissemination: Birds carry the fruit long distances and feed on the juicy flesh. Children gather the fruits and transport them.

Distribution: Java plum is found on all the islands, principally in the wet to semimoist regions below 2,000 feet in zones B, C₁, and D₁. At higher elevations it does not fruit.



Control: Herbicide containing 2,4,5-T mixed with oil in a proportion of 1 part herbicide to 19 parts oil has been successfully used on the bark to kill java plum.

History: Native of tropical Africa. It was purposely introduced for the fruit.



JOEE: FALSE VERVAIN, *Stachytarpheta cayannensis* (Rich.) Vahl

Why a pest: This is a fast-spreading small shrub that forms dense thickets in pastures and crowds out desirable forage species. It grows equally well in shade under tall trees (semiwooded pastures) and in open ranges. It has no forage value.

General Characters: A freely branching woody shrub, 2 to 5 feet tall. Leaves 2 to 3 inches long, hairy on both sides. Flowers produced on a long stalk, pale bluish purple in color.

Dissemination: A single plant produces abundant seeds that fall off on ripening and produce new plants soon after a rain.

Distribution: Joee is found on all the islands in semimoist to moist regions of zones B, C₁, C₂, D₁, and D₂.

Control: Treatment with 2,4-D in water at the rate of 1:300 has been very effective in controlling this pest.

History: Native of tropical America.



KALAMONA, *Cassia laevigata* Willd.

Why a pest: This is a fast-growing shrub. It competes with forage plants and shades them out by forming a thick cover.

General Characters: An erect glabrous plant, 5 to 10 feet tall. Leaves in 3 to 4 pairs of leaflets, smooth, dark green. Flowers yellow, in a cluster at the end of branches. Pods 2 to 3 inches long, roundish.

Dissemination: Kalamona seeds are small and are easily carried on hoofs of animals. Hundreds of small seeds in the pods are also carried by water during storms.

Distribution: It is found on all the islands but makes its best growth in zones C₁, D₁, and D₂.

Control: Herbicide containing 2,4,5-T mixed with oil has been successfully used in killing this shrub.

History: This plant has a wide distribution in tropical regions.

KIAWE: ALGARROBA, *Prosopis chilensis* (Mol.) Stuntz

Why a pest: Kiawe produces edible pods for livestock, provides shade in the dryland pastures, and protects the soil, but when it forms dense thickets and interferes with good pasture management it becomes a pest. Along the coastal flats and on the adjacent lowland slopes kiawe has often become a pest rather than an asset by its aggressive habit and abundance.

General Characters: A tall, spreading tree, 24 to 50 feet tall. Leaves are small. Flowers are many, yellowish, clustered on a flowering branch 2 to 4 inches long. Seed pod flat, slender, slightly curved, 4 to 8 inches long, smooth.

Dissemination: Animals feed on the beans and scatter the seeds in the droppings.

Distribution: Kiawe is found on all the islands in A and B zones.

Control: Many ranchers are thinning out thick stands of kiawe with bulldozers in their pasture management program. Young plants and seedlings are easily killed with herbicide containing 2,4,5-T.

History: Native of tropical America. First planted by Father Bachelot in the Catholic Mission grounds on Fort Street, Honolulu, Hawaii, in 1828.

KLU, *Acacia farnesiana* (L.) Willd.

Why a pest: Klu is a pest in pastures because of its long needle-like thorns. Even the animals avoid this plant. It is only slightly grazed if at all.

General Characters: A much-branching shrub, 5 to 7 feet tall. Leaves small, several times divided. Flower bright yellow, in a roundish head of about $\frac{3}{8}$ inch in diameter. Seed pod about $2\frac{1}{2}$ inches long, cylindrical, slightly curved.

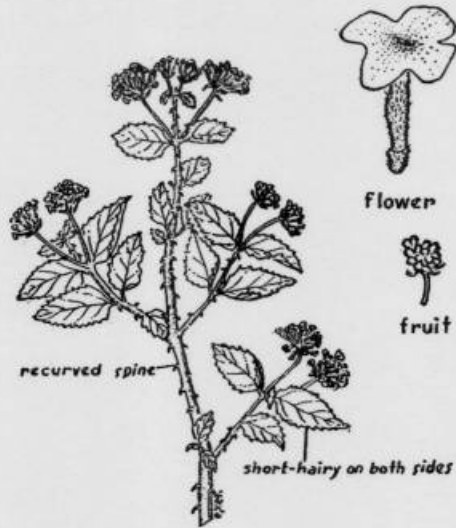
Dissemination: Klu is a slow-spreading pest.

Distribution: Found on all the islands in the dry lowland pastures of A and B zones.

Control: Herbicides containing 2,4-D-2,4,5-T combinations have been successful in killing this woody pest.



History: Native of tropical America. Now widely established in the tropical regions. This plant was probably purposely introduced to Hawaii in the early 1900's to extract the perfume principal from the flowers.



LANTANA, *Lantana camara* L.

Why a pest: Lantana grows rather rapidly and in a short time takes over a pasture and reduces the carrying capacity. It has no forage value. In Australia, it is believed to be poisonous to stock.

General Characters: A freely branching woody shrub, 3 to 7 feet tall. Leaves oval to egg-shaped, 1 to 2 inches long, covered with short stiff hairs, rough and wrinkled. Flowers of many colors, orange, and purple to red, clustered in a head. Fruits black to bluish black, juicy, sweet.

Dissemination: The juicy fruits are eaten by birds, and seeds are dispersed in

their droppings. Short joints of the roots develop into new plants.

Distribution: Lantana is commonly found on all the islands in zones A, B, C₁, D₁, and D₂.

Control: Lantana is under fair to good biological control by natural enemies introduced from Mexico in 1902. Herbicide containing 2,4,5-T has been effective when sprayed on the stems.

History: Native of tropical America. Now widely distributed throughout the tropical Pacific. It was purposely introduced to Hawaii as an ornamental by Hillebrand in 1858.



LONG-BEAKED RATTLE POD, *Crotalaria longirostrata* H. and A.

Why a pest: This plant is rarely eaten by animals and tends to form thick stands, shading out palatable grasses.

General Characters: A branching, upright plant, 2 to 3 feet tall. Leaves trifoliate, with the central one a little larger than the two side ones. Flower yellow, about 1/2 inch long, many on a stem. Seed pod about 3/4 inch long, covered with short hairs.

Dissemination: The pods on drying split open into two sections, and the force

throws the seeds some distance away from the parent plant.

Distribution: It is found only on the island of Maui in C₁ and C₂ zones.

Control: Foliage spray of 2,4-D-2,4,5-T combination in water has been quite effective in controlling this pest. Young plants are easily killed by discing.

History Native of tropical America. Believed to be an early introduction to Hawaii.

MAO. *Abutilon molle* Sweet

Why a pest: Mao is a vigorous, fast-growing shrub that forms a thicket and prevents the growth of forage species. Favorable locations in depressions and gullies are quickly taken over if not controlled. It has no forage value.

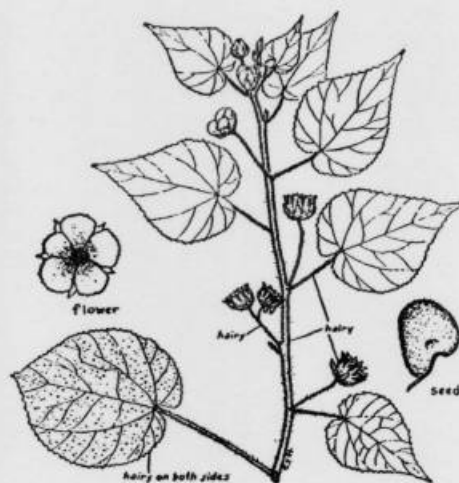
General Characters: A freely branching shrub, 5 to 10 feet tall. The heart-shaped leaves are usually spotted with black fungus infections. The orange flowers are $\frac{3}{4}$ to 1 inch across. Fruit is a capsule.

Dissemination: The capsule on drying splits open and throws out the black seeds, away from the plant, thereby helping the dispersal.

Distribution: Mao is commonly found in the semimoist locations below about 3,500 feet on all the islands. It is found in B, C₁, and C₂ zones and occasionally in the drier sections of D₁ zone.

Control: Applications of 2,4-D-2,4,5-T combinations in Diesel oil have given good control in many instances.

History: Native of South America and believed to be of recent introduction to Hawaii.



MELASTOMA. *Melastoma malabathricum* L.

Why a pest: Melastoma is an aggressive shrub that forms dense thickets and crowds out other plants. It has no forage value.

General Characters: A freely branching shrub, 8 to 15 feet tall. The fairly large pinkish-lavender flowers are rather attractive. The whole plant is covered with appressed hairs.



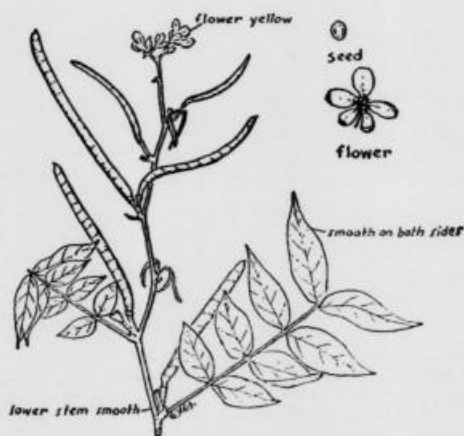
Dissemination: Neither the fruits nor the seeds are equipped with special appendages for dissemination. For this reason it spreads normally only by occupying the adjacent land year after year, but during heavy rains the small seeds may be carried downhill to start a new colony some distance away.

Distribution: This plant is reported from locations on Kauai and Hawaii where the rainfall is 50 inches or more. On Kauai it is known from Lihue to Hanalei, and on Hawaii in the Kaumana district and along the saddle road in zones D₁ and D₂.

Control: Because of the rather slow method of dispersal it should be possible to prevent its spread to other localities and to other islands. People should not collect seeds for planting in their backyards. Chemical herbicides have not been effective.

History: Introduced in 1916 to Kauai as an ornamental from Florida.

MIKI PALAOA, *Cassia occidentalis* L.



Why a pest: A persistent low shrub of no forage value. It is regarded as a poisonous plant. It competes strongly with forage plants and often crowds them out.

General Characters: A much-branched low shrub, 2 to 4 feet tall. Leaves are about 6 inches long with about eight leaflets. Flowers yellow. Pods two-valved, flattish, 4 to 6 inches long and about 1/4 inch wide.

Dissemination: The seed pod on drying snaps open and throws the small seeds a few feet away from the parent plant, thereby helping the dispersal. Animals often help disperse the plant by dragging broken branches with mature seed pods.

Distribution: It is found in the moist lowlands on all the islands. Commonly found in C₁ and D₁ zones but occasionally in the moister areas of zone B.

Control: Herbicides containing 2,4-D and 2,4,5-T have been only partially effective, and small patches should be grubbed out.

History: Native of tropical America. Now established in other tropical regions.

OX-EYE DAISY, *Chrysanthemum leucanthemum* var. *pinnatifidum* Lecoq and Lamotte

Why a pest: This daisy is a fast spreader. It persists in a pasture and competes with forage plants for space, moisture, and soil nutrients. It is not eaten by animals because of its bitter taste.

General Characters: It is a small plant of $\frac{1}{2}$ to $1\frac{1}{2}$ feet high. Leaves are smooth and dark green. Flowers are white with yellow center and borne on long slender stalks.

Dissemination: Hundreds of viable seeds are produced, and these are easily scattered. Branches with mature seeds are caught on animal hoofs and dispersed.

Distribution: Ox-eye daisy is found in the upper pastures in zones D₃ and E₁ of Hawaii.

Control: Some ranchers have used 2,4-D successfully.

History: Native of Europe. Escaped from cultivation not too long ago.



OPIUMA, *Pithecellobium dulce* (Roxb.) Benth.

Why a pest: Opiuma grows into tall, spreading trees and forms dense forest. It shades out good forage plants. Animals are said to eat the leaves, but generally it is not regarded as a forage plant. The thorns on the stems also make this tree undesirable.

General Characters: A fast-growing and freely branching tree, 25 to 50 feet tall. Leaves twice divided, smooth. Flowers white, in a cluster of about 20. Fruit about 4 inches long, spirally twisted.

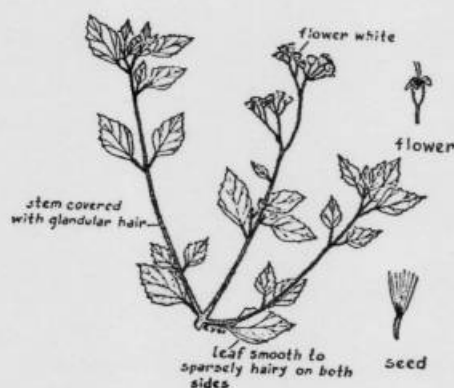


Dissemination: The mynah birds feed on the fruit and scatter the seeds.

Distribution: It is found on all the islands in zones B and C₁.

Control: Herbicides containing 2,4-D-2,4,5-T combinations have been successfully used in killing this pest.

History: Native of tropical America. Now established in many tropical countries. Introduced to Hawaii about 1870.



PAMAKANI, *Eupatorium adenophorum* Spreng.

Why a pest: Pamakani spreads to distant areas by its buoyant seeds. The fast-growing plants form almost impenetrable thickets and prevent the growth of forage species. It has no forage value.

General Characters: Pamakani makes dense thickets up to 10 feet tall and usually sends out many branches near the top. The white flowers are borne in clusters at the ends of these branches.

Dissemination: A single plant produces thousands of viable seeds. These are provided with a parachute-like structure and so are well adapted to wind dispersal. Many straight, cane-like shoots arise from a thick, gnarled, much-branched rhizome, which usually becomes separated into several parts as it gets larger. A new plant develops from each separated portion of the rhizome.

Distribution: Reported from all the islands except Kauai. It grows from sea level to about 7,000-foot altitudes in fairly moist to wet situations in C₁, C₂, D₁, D₂, D₃, and E₁ zones.

Control: Because of its wide distribution it is not possible to eradicate this species. However, it can be kept under control in arable lands by plowing under the old growth and planting aggressive grasses. Kikuyu grass reduces the vigor of new seedlings and thus contributes to rather effective control. In 1945 a gall fly was introduced from Mexico; in a few years this parasite increased in large numbers and gave effective control of pamakani. The female insect lays her eggs in the tender, growing shoots, and the stems swell into a gall. This weakens the branch and causes poor flowering. Dozens of galls are formed on a single plant, and growth is retarded.

History: Native of tropical America. Introduced to Hawaii about 1900, presumably for medicinal purposes.

PITTOSPORUM. *Pittosporum undulatum* Vent

Why a pest: This is a fast-spreading and fast-growing tree. It has no forage value and is encroaching onto wet to moist range lands.

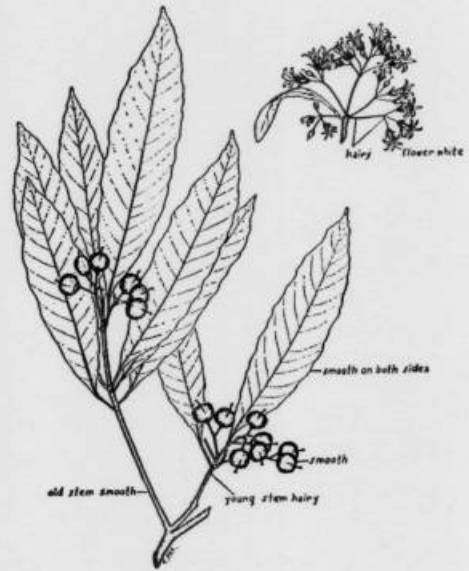
General Characters: Loosely branching shrub or small tree, 15 to 25 feet tall, young stems fine, hairy. Leaves crowded at ends of branches, lance-shaped, on leaf stalks $\frac{1}{2}$ inch long, smooth; margin of leaf wavy. Flowers clustered at end of branches, white, fragrant. Fruit oval, about $\frac{1}{2}$ inch long, surface rough, splitting into two equal halves when ripe and exposing dark-brown, shiny, angular seeds.

Dissemination: The shiny seeds are often scattered by birds.

Distribution: This plant is found only in the forest and range lands in the moist to wet Pauhau-Honokaa region. Found in C₂, D₁, and D₂ zones.

Control: Pittosporum is a weak plant and is easily killed with 2,4-D-2,4,5-T herbicides.

History: It was originally introduced from California about 1875 as an ornamental plant but did not spread widely until about 10 years ago, when it started to extend its range.



PUAKEAWE. *Styphelia tameiameia* (Cham.) Muell.

Why a pest: Uncleared range lands of extensive acreage are covered with this shrub. It is occupying some good pasture land. It has no forage value.

General Characters: A branching shrub, 3 to 8 feet tall. Leaves are small and leathery. Flower whitish, clustered. Fruit globular, about $\frac{1}{4}$ inch in diameter, red, pinkish, or white in color, mealy.

Dissemination: Birds feed on the fruit and disperse the seeds. The hard, brittle stems do not sprout.



Distribution: Found on all the islands in zones C₁, C₂, E₁, and E₂.

Control: Brush cutter, disc, or chain-drag are effective in destroying pua-keawe.

History: Native of Hawaii. Also found in Australia and other tropical areas of the Pacific.

REDLEG GRASS, *Bothriochloa ambigua* Blake



Why a pest: A fast-growing, freely flowering grass of low palatability. Animals usually avoid this grass because of its bitter taste. It has the tendency to form a dense tuft in a short period and crowd out all good grasses. Because this grass is very difficult to distinguish from another grass called *Andropogon pertusus* of India which is slightly better than the redleg grass, it is advisable to treat the two alike, and every effort should be made to eradicate either whenever they are discovered in a pasture. Thousands of acres of good pasture land in Australia have been made useless by the spread of this grass.

General Characters: A bunch grass, 1 to 3 feet tall, red colored, stems smooth. Leaves narrow, somewhat hairy, flowering heads with 2 to 4 short, rather hairy branches arranged on a short axis.

Dissemination: A free seeder and a rapid spreader.

Distribution: Found on all the islands in localized areas of A, B, and C₁ zones.

Control: Small patches should be grubbed out. Eradication can be accomplished by cultivation. Sodium chlorate has been found to be effective in killing small local patches in rock piles.

History: Native of the tropical regions of the Old World. First recorded in Hawaii in 1916.

RHODOMYRTUS, *Rhodomyrtus tomentosa* Wight

Why a pest: Rhodomyrtus forms solid thickets that are almost impossible to pass through. It has no forage value. This is a relatively recent accidental introduction but has spread rapidly; it has taken over extensive areas on Kauai.

General Characters: A shrub, 5 to 15 feet tall. The branches are covered with fine hair. The purplish-lavender flower is very attractive. The fruit is an edible purple berry which makes good jam.

Dissemination: The fruit contains many small seeds that fall near the parent and start new plants. The fruit is eaten by birds and the seeds are disseminated in their droppings.

Distribution: This plant is reported from Kauai and Hawaii in zones D₁ and D₂. It grows luxuriantly at about 1,000 feet elevation where the rainfall is 50 inches or more. On Hawaii it is found in the Hilo district.

Control: The plant is probably beyond economical control on Kauai, but careful watch should be maintained to prevent its spread to the other islands.

History: Native of southeast Asia. Widespread in the tropical and subtropical regions of the world. Accidentally introduced to Kauai about 1920.



SACRAMENTO BUR, *Triumfetta semitriloba* L.

Why a pest: Sacramento bur spreads rapidly by seed and forms such dense stands that few other plants survive in association with it. It has little forage value.

General Characters: An open-branched, perennial shrub, 5 to 10 feet tall. The round burs containing the seed have long spines and are borne in clusters near the ends of the branches.

Dissemination: The hooked spines of the burs cling to the hair on animals, and the seeds are carried to new locations.

Distribution: Sacramento bur is restricted to Maui and to a localized area in central Kona, Hawaii. The largest area of occurrence is from Kula to Ulupalakua. It is best adapted to elevations of from sea level to 3,500 feet and rainfall of from 30 to 60 inches in B, C₁, C₂, and D₁ zones.

Control: The plant itself is not difficult to kill by uprooting or plowing. A preliminary harrowing to knock down the dense growth, followed by burning during a dry period, will destroy most of the plants. New seedlings develop in



a short time, however. Planting with aggressive short grasses such as kikuyu and pangola, followed by periodic mowing, keeps the Sacramento bur under effective control. Amine forms of 2,4-D applied as a foliage spray have given good results.

History: Native of tropical parts of the Eastern Hemisphere. Widespread over many other tropical regions.



SILVER OAK, *Grevillea robusta* A. Cunn.

Why a pest: Silver oak is a rather fast-spreading tree. In certain areas it takes over the pasture and becomes a pest.

General Characters: A rather fast-growing tree, 60 or more feet tall. Leaves are divided several times. Flowers are showy, with red and yellow colors. Fruit is a brown leathery capsule with a long, twisted, extended appendage.

Dissemination: The winged seeds are scattered by the winds.

Distribution: It is widely scattered in certain localized areas over the Territory, in semiarid to moist regions of zones B, C₁, D₁, and D₂.

Control: Bulldozers have been effectively used in clearing pasture lands overrun with silver oak. Small trees are easily destroyed by chain drag.

History: Native of Australia. It was purposely introduced to Hawaii as a forest tree.



SOUR GRASS, *Trichachne insularis* (L.) Nees

Why a pest: When once established, sour grass spreads rapidly and forms almost solid stands. It looks like good forage, but under most conditions it is untouched by cattle. Many a good pasture has been ruined by this plant.

General Characters: A strong bunch-grass, 3 to 5 feet tall. It can be easily identified by the numerous silken flowering branches at the end of a long stalk. These characteristically bend to one side of the stem, resembling a banner. Young seedlings and mature plants have a bulbous base.

Dissemination: The plant produces large quantities of viable, hairy seeds which are carried by the wind for considerable distance. Individual plants increase in diameter by stooling at the base.

Distribution: Sour grass has become especially abundant in the lower altitudes of Oahu in the relatively dry zones of 20 to 30 inches of rainfall. It is spreading gradually up the slopes into the moister zones. Recently it has been found in local areas on Kauai, Molokai, Maui, and Hawaii. Sour grass is found in A, B, and C₁ zones.

Control: If a small center of infestation in a new locality can be located before the seed has been dispersed to any extent, it is possible to eliminate the plant. Ranchers have achieved some degree of success in fighting this pest by planting such hardy plants as Guinea grass and koa haole in the stands of sour grass. Sour grass is crowded out by Guinea grass. This process takes place faster in shade.

Sodium TCA, applied to the basal area of sour grass at the rate of 50 pounds dissolved in 150 gallons of water, has been successful in killing the grass in some instances.

History: Native of tropical and subtropical America. It was accidentally introduced to Hawaii from Puerto Rico.

SPINY AMARANTH. *Amaranthus spinosus* L.

Why a pest: This is one of the most serious pests in holding pastures adjacent to dairy barns. The long, sharp spines at the base of each leaf, where the leaf joins the stem, are irritating. Animals avoid this plant, and in time the plant crowds out the forage grass.

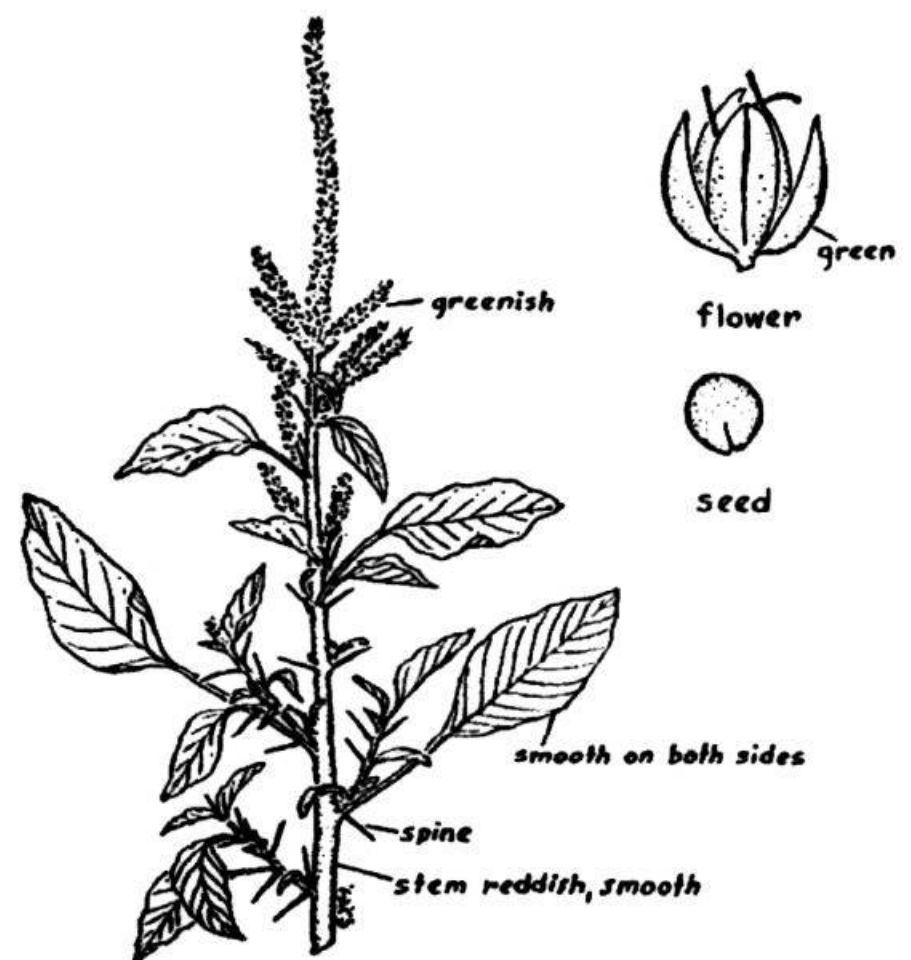
General Characters: An erect, much-branching plant, 2 to 3 feet tall, with sharp spines $\frac{1}{4}$ to $\frac{1}{2}$ inch long at the base of the leaf-stalk. Leaves $1\frac{1}{2}$ to 3 inches long, smooth on both sides. Flowers small, green, clustered on long stalks.

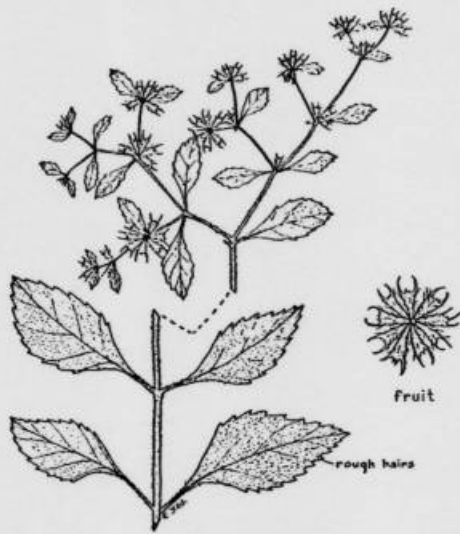
Dissemination: Hundreds of seeds are produced on the flowering stalks. The ripe seeds fall to the ground and start new plants soon after a good rain.

Distribution: Found in dry to moderately moist regions on all the islands in zones B, C₁, and D₁.

Control: Various formulations of 2,4-D dissolved in water have given good control.

History: Native of tropical America. Now widespread throughout many tropical and temperate regions. Accidentally introduced to Hawaii about 1900.





STAR BURR. *Acanthospermum hispidum* DC.

Why a pest: This fast-growing short-lived plant has no forage value. Although it is known to be nonpoisonous, the $\frac{1}{4}$ -inch-long hooked spines are troublesome.

General Characters: This is a branching annual of $1\frac{1}{2}$ to $2\frac{1}{2}$ feet in height. The flowers are borne in the axils of the leaves. The mature fruits are arranged in groups of 5 to 10 and fan-out outwards like a star.

Dissemination: The hooked spines catch on to the animals and are carried long distances and scattered. It also can be transported easily by attaching itself

to clothing and automobile tires.

Distribution: At the present time it is confined to the coastal flat in the west end of Molokai in zone A and probably B. In Queensland it is regarded as the worst plant pest.

Control: Star burr can be eradicated by discing at the early stages of growth before the seeds form. The amine form of 2,4-D in water has given good control.

History: Native of tropical America. Widely spread in the tropical and subtropical regions of the world. Accidentally introduced into Hawaii.

STRAWBERRY GUAVA, WAIAWL *Psidium cattleianum* Sabine

Why a pest: It forms dense, solid stands and crowds out all other plants.

General Characters: A small tree, 5 to 15 feet high, with smooth bark. Leaves egg-shaped, $1\frac{1}{2}$ to $3\frac{1}{2}$ inches long, 1 to $1\frac{1}{2}$ inches wide, smooth on both sides, shiny and dark green. Flowers are about $\frac{3}{4}$ inch across, white, with many stamens. Fruit oval, about $\frac{3}{4}$ inch in diameter, purplish red when ripe. Seeds are many, hard.

Dissemination: The fruits are eaten by wild pigs and birds and the seeds scattered.

Distribution: Strawberry guava is found in local clumps on all the islands in moist to wet range lands of C₁ and D₁ zones.

Control: It can be controlled with 2,4-D herbicide.

History: Native of Brazil.

YELLOW WAIAWI, *Psidium cattleianum* var. *lucidum* Hort.

Yellow waiawi has a general character of the strawberry guava, but the plant grows into a much larger tree of 20 to 35 feet in height. The slightly larger fruits are yellow.

It is found on all the islands in B, C₁, and D₁ zones and in some localities it is a serious pest.

Herbicide containing 2,4,5-T mixed with oil has been successfully used in killing this pest.



THIMBLEBERRY, *Rubus rosaeifolius* Smith

Why a pest: Thimbleberry is a persistent low shrub in pastures and competes with all forage plants for space and soil nutrient. The spines on the branches also make this plant undesirable. It has no forage value.

General Characters: A branching-shrub, 2 to 4 feet tall. Stems with recurved spines. Leaves divided into five to seven leaflets. Flowers white, clustered. Fruit roundish, $\frac{3}{4}$ to 1 inch across, bright red, many seeded.

Dissemination: Birds, especially pheasants, eat the fruits and scatter the seeds in the droppings. The underground shoots also help in spreading.

Distribution: Thimbleberry is found on all the islands in moist locations in C₁, C₂, D₁, D₂, and D₃ zones.

Control: Herbicide containing 2,4,5-T has been used successfully on this pest.

History: Native of Southeast Asia. Now widely spread to many tropical regions. An early introduction to Hawaii.





TREE MARIGOLD. *Tithonia diversifolia* (Hensl.) Gray

Why a pest: A fast-growing tall shrub that forms large clumps in a short period. It is aggressive and competes with many other plants. Next to lantana, it is said to be the most common weed in Ceylon. The leaves are bitter, and the animals avoid them.

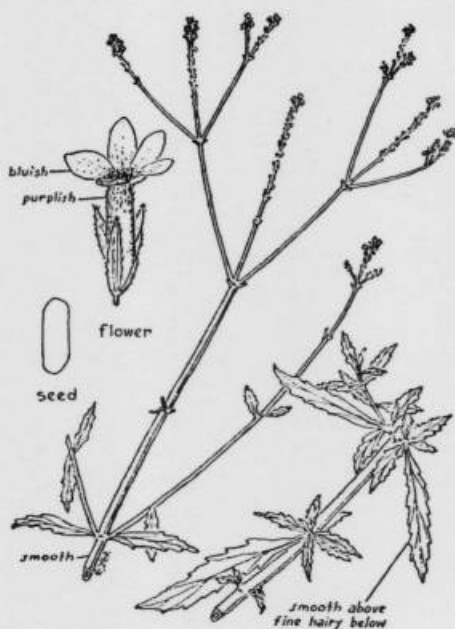
General Characters: A slender shrub, 5 to 10 feet tall. Leaves attached alternately on stem, 3- to 5-lobed. Flowers bright yellow, 4 to 5 inches across.

Dissemination: Abundant viable seeds are produced.

Distribution: Tree marigold is found on all the islands in the semimoist to moist zones of C₁ and D₁.

Control: Small clumps can be grubbed out easily. The amine form of 2,4-D in water as a foliage spray has given good results.

History: Native of tropical America. Purposely introduced to Hawaii as an ornamental. This plant is also becoming a pest in many other tropical regions.



VERBENA: OL *Verbena litoralis* H.B.K.

Why a pest: This is a moderately fast-growing plant that becomes troublesome in some regions, especially in the middle elevations. Heavy stands of verbena occupy space that should be in grass. Young shoots are often eaten by stock, especially horses, but the palatability is low.

General Characters: It is a slender, freely branching plant, 2 to 3 feet tall, stems angular. Leaves narrow, 1½ to 2½ inches long. Flowers bluish, borne on branching flower stalks.

Dissemination: Many seeds are produced. These when ripe fall to the ground and produce new plants.

Distribution: Verbena is found on all the islands. The most troublesome zones are C₂ and E₁, although it is found in C₁, D₁, and D₃ zones.

Control: The herbicide 2,4-D has been effectively used on this plant. Two or three repeated discings also destroy verbena.

History: Native of tropical America. An early introduction to Hawaii.

WILD MARIGOLD, *Tagetes minuta* L.

Why a pest: Wild marigold is a fast-growing herb of no forage value. The unpleasant odor is obnoxious and has some irritating properties to eyes and skin.

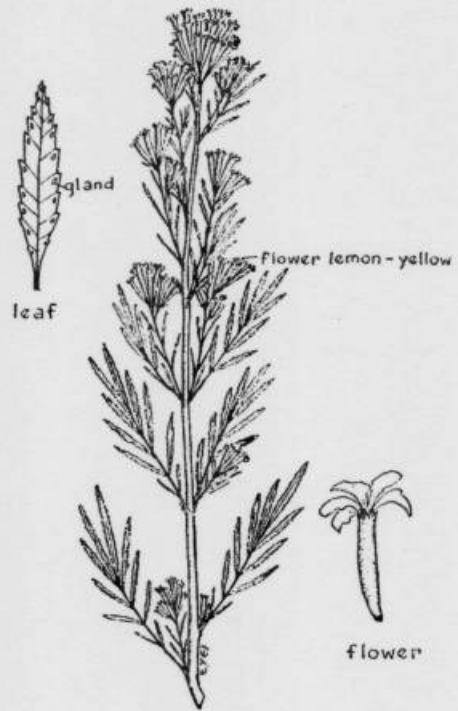
General Characters: Wild marigold is a tall, slender herb, 2 to 5 feet tall. Leaves are divided, with glands near the margin. Flower heads clustered on a stalk, lemon yellow.

Dissemination: Seeds are carried by the winds.

Distribution: At the present time it is known only from Waikii to Pohakuloa and the adjacent region, but it is spreading quite rapidly into new territories. Wild marigold is apparently adapted to semidry regions at high altitudes in zones C₂, E₁, and E₂.

Control: It is easily controlled by hoeing or disking if done before the plants produce seeds. The amine form of 2,4-D is also effective on this pest.

History: Native of Africa. A recent accidental introduction. First recorded from the island of Hawaii.



YELLOW FOXTAIL, *Setaria geniculata* (Lam.) Beauv.

Why a pest: Yellow foxtail is a very aggressive grass that chokes out other more palatable grasses. It is troublesome in the wet regions. It comes to seed very quickly, and the long bristles often collect in the pocket of the lower jaw of grazing animals, causing irritation and swelling.

General Characters: A tufted, erect plant, 1 to 2 feet tall. Each flower with a cluster of bristles. Leaves 4 to 6 inches long, slender, smooth on both surfaces.

Dissemination: Many viable seeds are produced, and these are often carried on the fur of animals.

Distribution: It is found in the wet regions of all the islands in zones C₁, C₂, D₁, D₂, and E₁.

Control: Aggressive grasses such as kikuyu, pangola, and molasses grass have been successfully used in crowding out this poor forage grass.

History: Native of tropical America. Now widespread in many tropical and subtropical regions of the world.

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TABLE 1. VEGETATION ZONES, THEIR ALTITUDE AND ANNUAL RAINFALL LIMITS

ZONE	PHASE	MAP COLOR	APPROXIMATE ALTITUDE LIMITS	APPROXIMATE TOTAL RAINFALL LIMITS	NATURAL COVER
A		Yellow	<i>feet</i> Less than 1,000	<i>inches/year</i> 20 or less	Xerophytic shrub with coastal fringe of trees
B		Orange	Less than 3,000	20-40	Xerophytic shrub with some trees in upper part
C	1-low	Green-dark	Less than 2,500	40-60*	Mixed open forest and shrubs
	2-high	Green-light	2,500-4,000		Mixed open forest
D	1-low	Pink-medium	Less than 1,500†	60 or more*	Shrub and closed forest
	2-medium	Pink-dark	Variable		Closed forest
	3-high	Pink-light	4,000 to less than 7,000		Open forest
E	1-low	Blue-medium	4,000-7,000	50 or less	Open forest and shrub
	2-medium	Blue-dark	7,000-10,000		Mainly upland open shrub
	3-high	Blue-light	Over 10,000		No seed-bearing plants

* Minimum rainfall is less than 60 inches at higher levels.

† The boundary between D₁ and D₂ varies with location and present utilization. In general, it represents the highest point of satisfactory utilization for most crops, as adjudged by climate, soil type, and present crops growing.

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COMMON NAME	SCIENTIFIC NAME	TYPE	CLIMATIC ZONES
Aalii	<i>Dodonaea eriocarpa</i>	shrub	B, C ₁ , C ₂ , E ₁ , E ₂
Air plant	<i>Bryophyllum pinnatum</i>	herb	B, C ₁ , D ₁
Apple of Sodom	<i>Solanum sodomaeum</i>	shrub	A, B, C ₁ , C ₂ , D ₁
Barbwire grass	<i>Cymbopogon refractus</i>	grass	B, C ₁
Blackberry	<i>Rubus penetrans</i>	shrub	C ₂ , D ₂ , D ₃
Black wattle	<i>Acacia decurrens</i>	tree	C ₁ , C ₂
Bracken fern	<i>Pteridium aquilinum</i> var. <i>decompositum</i>	fern	B, C ₁ , C ₂ , D ₁ , D ₃ , E ₁ , E ₂
Bull thistle	<i>Cirsium vulgare</i>	herb	C ₁ , C ₂ , D ₃ , E ₁
Cactus, Panini	<i>Opuntia megacantha</i>	shrub	A, B, C ₁ , C ₂
Castor bean	<i>Ricinus communis</i>	shrub	B, C ₁ , C ₂
Cat's claw	<i>Caesalpinia sepiaria</i>	shrub	C ₁ , D ₁
Christmas berry	<i>Schinus terebinthifolius</i>	shrub	B, C ₁
Clidemia	<i>Clidemia hirta</i>	shrub	D ₁ , D ₂
Elephantopus	<i>Elephantopus mollis</i>	herb	B, C ₁ , D ₁
Emex	<i>Emex spinosa</i>	herb	A, B, C ₁ , C ₂ , E ₁
Firebush	<i>Myrica faya</i>	tree	C ₁ , C ₂ , D ₁ , D ₂
Fountain grass	<i>Pennisetum ruppelii</i>	grass	B, C ₁
Gorse	<i>Ulex europaeus</i>	shrub	C ₂ , D ₃ , E ₁
Guava	<i>Psidium guajava</i>	shrub	B, C ₁ , D ₁ , D ₂
Hairy fleabane	<i>Pluchea odorata</i>	shrub	B, C ₁ , C ₂ , D ₁ , D ₂
Hamakua pamakani	<i>Eupatorium riparium</i>	shrub	C ₁ , C ₂ , D ₁ , D ₂ , D ₃ , E ₁
Indian fleabane	<i>Pluchea indica</i>	shrub	A, B, C ₁
Jamaica vervain	<i>Stachytarpheta jamaicensis</i>	shrub	B, C ₁ , D ₁
Java plum	<i>Eugenia cumini</i>	tree	B, C ₁ , D ₁
Joe	<i>Stachytarpheta cayannensis</i>	shrub	B, C ₁ , C ₂ , D ₁ , D ₂
Kalamona	<i>Cassia laevigata</i>	shrub	C ₁ , D ₁ , D ₂
Kiawe	<i>Prosopis chilensis</i>	tree	A, B
Klu	<i>Acacia farnesiana</i>	shrub	A, B
Lantana	<i>Lantana camara</i>	shrub	A, B, C ₁ , D ₁ , D ₂
Long-beaked rattle pod	<i>Crotalaria longirostrata</i>	shrub	C ₁ , C ₂
Mao	<i>Abutilon molle</i>	shrub	B, C ₁ , C ₂ , D ₁
Melastoma	<i>Melastoma malabathricum</i>	shrub	D ₁ , D ₂
Miki palaoa	<i>Cassia occidentalis</i>	shrub	B, C ₁ , D ₁
Opiuma	<i>Pithecellobium dulce</i>	tree	B, C ₁
Ox-eye daisy	<i>Chrysanthemum leucanthemum</i> var. <i>pinnatifidum</i>	herb	D ₃ , E ₁
Pamakani	<i>Eupatorium adenophorum</i>	shrub	C ₁ , C ₂ , D ₁ , D ₂ , D ₃ , E ₁
Pittosporum	<i>Pittosporum undulatum</i>	tree	C ₂ , D ₁ , D ₂
Puakeawe	<i>Styphelia tameiameia</i>	shrub	C ₁ , C ₂ , E ₁ , E ₂
Redleg grass	<i>Bothriochloa ambigua</i>	grass	A, B, C ₁
Rhodomyrtus	<i>Rhodomyrtus tomentosa</i>	shrub	D ₁ , D ₂
Sacramento bur	<i>Triumfetta semitriloba</i>	shrub	B, C ₁ , C ₂ , D ₁
Silver oak	<i>Grevillea robusta</i>	tree	B, C ₁ , D ₁ , D ₂
Sour grass	<i>Trichachne insularis</i>	grass	A, B, C ₁
Spiny amaranth	<i>Amaranthus spinosus</i>	herb	B, C ₁ , D ₁
Star burr	<i>Acanthospermum hispidum</i>	herb	A, B
Strawberry guava	<i>Psidium cattleianum</i>	tree	C ₁ , D ₁
Thimble berry	<i>Rubus rosaefolius</i>	shrub	C ₁ , C ₂ , D ₁ , D ₂ , D ₃
Tree marigold	<i>Tithonia diversifolia</i>	shrub	C ₁ , D ₁
Verbena	<i>Verbena litoralis</i>	shrub	C ₁ , C ₂ , D ₁ , D ₃ , E ₁
Wild marigold	<i>Tagetes minuta</i>	herb	C ₂ , E ₁ , E ₂
Yellow foxtail	<i>Setaria geniculata</i>	grass	C ₁ , C ₂ , D ₁ , D ₂ , E ₁
Yellow waiawi	<i>Psidium cattleianum</i> var. <i>lucidum</i>	tree	B, C ₁ , D ₁

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