# A BEGINNER'S GUIDE TO PROPAGATING NATIVE PLANTS OF VOLCANO

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## PROPAGATING WITH SEEDS

***COLLECTING*:** Make sure you are collecting mature seed; this means you have to collect ripe fruits. Dry fruits (e.g., koa or māmane pods) will be obviously dry when mature and the seeds inside will also be hard and dry. Insects may attack older dried fruits fallen from the plant or even still attached, tunneling through the seeds or turning them to powder. Typically, fleshy fruits (e.g., pilo, kāwa`u, māmaki, etc) will turn from green to another color as they ripen and become slightly softer just before becoming fully ripe. Ripe fruit are also subtly easier to remove from the plant.

***STORING:*** For dry fruits, store in a paper bag at room temperature to prevent mold. However, be aware that insect seed predators may be present and active at room temperature so it is best to process these fruits and seeds quickly to avoid insect damage. If you are not going to clean seeds of fleshy fruits immediately, put them in a plastic bag and store them in the refrigerator (but not in the back where they can freeze; freezing typically kills native Hawaiian seeds). Storing in the refrigerator will keep the pulp from becoming dry and difficult to separate from the seed and will inhibit insect damage. I have had little success germinating seeds old fleshy fruits that are dry and clinging to the stem.

Fleshy pilo fruits massaged to liberate large seeds

***CLEANING*:** Cleaning seeds means removing the seeds from the fruit surrounding them. Collected seeds should be cleaned prior to storage or sowing in germination trays. Cleaning seeds is worth the time it takes because it demonstrably enhances germination rates, probably by removing germination inhibitors present in the fruit. Large dry seeds such as koa can usually be manually removed from the fruit. For fleshy fruits with large seeds, you can typically remove the pulp by hand or by massaging the fruit. Cleaning fleshy fruits with small seeds may require creative approaches. Try a fine mesh strainer. Work the pulp across the strainer in a bowl of water. This may separate the pulp and the seeds, with the seeds passing through the strainer and collecting in the water below; ideally, most of the pulp will remain in the strainer. Also sow the pulp because many tiny seeds remain in the pulp remains. Sometimes with slightly larger fruits you can push the pulp through the strainer and catch the seeds in the strainer. Another option with some fruits/seeds is to try leaving the fruits in a plastic bag at room temperature for a few days until the fruits get mushy (and hopefully not too moldy) and then try separating seed from fruit by massaging, smearing, or straining them. A useful technique for some fleshy fruits with tiny seeds is to let them air dry and then massage them to fragment them and release the seeds.

(*left*) Māmaki fruits in strainer, ready to have "seeds" (actually fruits) forced through sieve into water in bowl. (right) Māmaki "Seeds" (darker objects) in bottom of bowl (along with some pulp), soaking.

***SOAKING*:** Seeds should be soaked for at least 12 hours in fresh water. I have successfully germinated seeds soaking in bowls of water forgotten several days. Before soaking seeds, it is best to decant the pulpy water and pour in fresh water to remove as much of the germination inhibitor as

possible. Small seeds have thin seed coats and may require any pretreatment. Soaking overnight in warm water (cooler than bath water) would probably not hurt them. For larger seeds, germination seems to be enhanced by placing seeds in a container with hot tap water and letting them soak for 12-48 hours. Koa seeds germinate best when water is brought to a boil and turned off just before putting the seeds in for an overnight soak. This works well with `a`ali`i too and helps with māmane.

***SCARIFYING:*** Some plants with large seeds and thick seed coats may need to be scarified by rubbing a portion of the seed coat with sandpaper or nicking the edge of the seed coat with toe nail clippers. The danger with these techniques is injuring the embryo. You might first dissect a seed and find out where the embryo (looks like a curled up shoot) is located before commencing with scarification of the rest of the seeds. Soak seeds before scarifying; do not soak after scarifying. Water will be absorbed too readily in a scarified seed, killing the embryo. As you observe your container of water after seeds have been soaking at least overnight, the rule of thumb is that "sinkers" are more likely to be viable than the "floaters." The floaters float because of insect or fungal attack.

***SOWING*:** Small seeds can be placed on the surface of a dry mix and watered in naturally to the right depth with a mist spray. Medium sized seeds should be covered with a depth of potting mix the size of the seed. Take care to disperse seeds over germination tray, especially small seeds, so that they do not form dense thickets of seedlings. This can be a real challenge.

***GERMINATING:*** Consistent watering, a well-drained media, and warm temperature are the critical factors in seed germination. Misting lightly every day or more generously every other day works best. You want to keep the media moist but not water logged. My best germinating medium seems to be 1/3 Perlite, 1/3 black cinder, and 1/3 Sunshine Mix #4. Other propagators have experimented their way to the optimal media that works best for them. For example, the national park typically uses a 1:1:1 mix of vermiculite, perlite, and cinder. The more vermiculite, perlite, and cinder, the more frequently the germination trays need to be watered or misted. The essential feature of an effective germination mix is that it is well-drained and germination trays are placed in a well-lighted area with good air circulation to avoid damping-off fungal diseases. If you can achieve good air circulation and adequate lighting, then warm temperatures are a desired condition; warm temperatures reduce germination time.

***GROWING SEEDLINGS IN TRAYS:*** Patience is a virtue. Some seeds grow very slowly, especially small seeds with little endosperm to provide a nutritional jump start. You might want to try fertilizing weekly with a foliar fertilizer at half the label dosage and with micronutrients.

***TRANSPLANTING AND POTTING MIXES:*** I wait until the seedlings have 3-4 true leaves. I use a spoon as a transplanting tool and place the transplant into a pot about 2/3 full of wet potting mix. Place the transplant in the pot upright and fill in with more potting soil up to or slightly above the soil clinging to the stem (soil will compact and sink). My standard potting mix is 1:1:1 Sunshine Mix, black cinder, and home soil (from the target planting site to reduce chances of contamination). A germinating medium with more cinder relative to potting mix, or perlite instead of cinder, may actually be more effective but does dry out faster so you have to really be on top of watering. The Sunshine Mix and black cinder provide good drainage; the soil provides nutrients and symbiotic root fungi (mycorrhizae). Good drainage is essential for plants grown in an uncovered nursery in a wet environment. Most mortality is associated with poor drainage (e.g., too much soil or Sunshine Mix). A weak, slow release fertilizer (say 8:8:8) can be added to the potting media before the plants are transplanted. Foliar fertilizing works well too. I use Miracle Grow at ½ strength. The Volcano Rare Plant Facility does foliar fertilizing weekly. One problem that often arises in transplanting from germination flats to pots results from the difficulty of dispersing seeds as you sow them into the germination trays. This may result in hard-to-separate, dense clusters of seedlings with intertwined root systems. If seedlings come up very densely in the trays you can try four approaches: 1) leave them in the trays to self-thin; 2) thin

out the germinating seeds by hand; 3) transfer and separate spoonfuls of seedlings into new trays and let these grow for a few weeks before attempting to separate these new clusters which have a higher edge of interior ratio or let them self-thin; or 4) scoop out clusters and separate the root systems in a bowl of water and then pot up the mostly bare-rooted seedlings.

***DIRECT SEEDING*:** It is possible with at least one local native plant group to bypass the germination tray, media, and pot stages and directly sow seeds into the environment with a satisfactory germination rate. A striking example is with `ōha wai (*Clermontia parviflora*), `ōha kēpau (*Clermontia hawaiiensis*), and undoubtedly other species of *Clermontia*. The soft, ripe fruits of these can be smeared on the trunks of tree ferns, inoculating this substrate with the minute seeds of these species. Mossy covered surfaces of the tree fern trunks should be used. The presence of moss is an indicator of moisture, either from rain falling through the canopy or running down the stem. Germination may take several months. These plants are frequently epiphytes on tree ferns and will grow to maturity from the germinating seeds. This technique will also work in local rain forest by smearing ripe *Clermontia* fruit in moss mats on the forest floor or on nurse logs. Direct seeding into appropriate microsites is a little explored area of plant propagation and a possible interesting experimental area for backyard plant propagationists. Smearing fruits of native rain forest plants, e.g., `ōhelo (*Vaccinium calycinum*), that grow as epiphytes, on nurse logs, or in moss mats on the forest floor seem like good candidates for direct seeding. Successful germination has been achieved with kāwa`u (Hawaian holly) (*Ilex anomala*) and kōlea (*Myrsine lessertiana*), both rain forest trees, by cutting shallow slits in a tree fern log and placing fruits (for kāwa`u ) or cleaned seeds (for kōlea). For example, try direct seeding on mossy hāpu`u nurse logs or moss mats on the forest floor. Direct seeding technique may require copious amounts of fruit or seed because germination rates may be much lower than in germination trays with deliberate cleaning of seeds, pretreatment of seeds, ideal germination media, and seeds. It therefore may not make much sense for species with limited numbers of seed; *Clermontia* is an abundant plant with abundant fruit and hundreds if not thousands of seeds per fruit.

## PROPAGATING WITH CUTTINGS AND "SNAPLINGS"

Many, if not most, native plants can be propagated vegetatively by cuttings. Seed propagation methods are fairly standardized; seeds must be cleaned and soaked. Some methods for cuttings are also fairly standard, e.g., use healthy sources plants, take cuttings in the morning while food reserves are high and use sharp, clean tools. However, selection of material for cuttings varies a great deal. Although most cuttings are taken from stems, cuttings in some cases work well from leaves, roots, tubers, rhizomes, bulbs, or corms. Furthermore, with stem cuttings, greater success may be achieved by selecting the appropriate maturation stage of the stem. For example, stem cuttings of woody plants are usually categorized as: hardwood cuttings (mature wood of trees or shrubs); semi-hardwood (recent growth of trees or shrubs); or softwood (very recent growth). Effectiveness varies with different dosages of rooting powders or solutions. These stimulate rooting and often have fungicide added. Because of these complexities, I recommend reading the introduction about cuttings in *Growing Hawai`i's Native Plants* by Kerin Lilleeng-Rosenberger, and follow the species-specific directions she provides.

Germination of seeds and germinated seedlings require only simple care. The trays can be watered deeply every other day. One of the most important factors in success of cuttings is care of the propagules after placing in the media. Chances of survival and rooting are strongly influenced by the environment, by reducing transpiration and keeping the media moist. An optimal post cutting environment is a shaded mist chamber with misters on timers. In windward Volcano, these conditions can be cheaply mimicked in part by placing the flats or pots with cuttings in a shaded environment without direct sun and counting on the natural high humidity of this location and nearly daily rains to reduce transpiration and water the media.

One method of making cuttings worth trying on native shrubs in Hawai`i is the use of "snaplings." Cuttings are taken directly from the host plant by hand and directly potted, preferably with a rooting hormone applied to the cut surface. This term was coined by a Volcano resident, Michael McKenny, who demonstrated it to me. Snaplings are short, side shoots broken off the main stems of the plant. These may have a high rate of success, maybe because they are young and actively growing. Use of a clean, sharp cutting tool may enhance the success rate but may be unnecessary and may introduce disease to the parent plant.

## PROPAGATING WITH AIR LAYERS

Air layering involves stimulating a branch or stem of a woody plant to form roots while still attached to the parent plant. This method is ideal for propagating larger plants in a short period of time. Also, the air layer is the same age as the parent plant and may flower and bear fruit, if the parent plant is mature. Roots are stimulated to develop when the cambium and phloem tissue are removed. This prevents the regrowth of the bark tissue and interrupts food transport from the leaves of the air layer to the rest of the plant. However, xylem tissue interior to the phloem is not cut so that water transport to the air layer is not interrupted. It takes 3-6 months for roots to form and can be done any time of year but the optimum time is spring. Stems up to six inches or greater can be air layered but root formation may not be adequate with larger air layers for survival as transplants into the ground or pots.

**Step 1**. With a sharp knife, girdle through the rough bark of a branch 1-2 inches in diameter above and below an area of the stem about the same distance as the diameter.

**Step 2**. Scrape the bark tissue away between the two girdle cuts all the way around the stem.

**Step 3.** With `ōhi`a, peel off the next (readily peeled) layer**. Do not go this deep with other species.**

**Step 4**. Apply rooting compound to upper end of girdled area.

**Step 5.** Cover the girdled area with wet sphagnum and wrap black plastic around the sphagnum, securing at the top and bottom with ties. You can also use two layers of metal foil instead of plastic.

Aerial roots developed after 3-6 months. Step 6 is to cut off the stem at the lower girdle or below without cutting the aerial roots and pot it up to further grow the root system or transplant it directly into the soil.

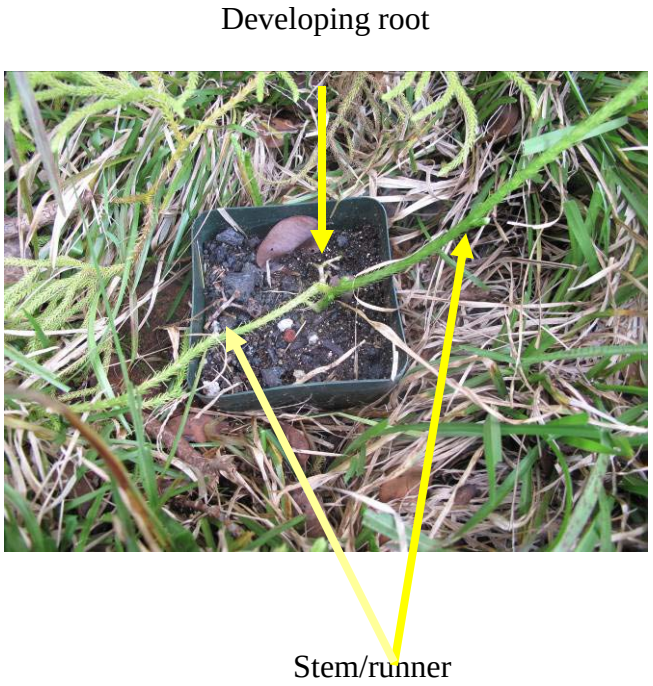
## PROPAGATING WITH "SNATCHLINGS"

Dense stand of small tree ferns. Most of these individuals will die as this stand self-thins. Instead of allow the stand to self-thin, some individuals may be removed and placed in pots to be eventually planted elsewhere.

Often native plants will establish in dense clusters after removal of invasive plants. These seedlings and saplings will compete with each other and naturally self-thin as they grow larger. You can remove some individuals, pot them up for planting later or transplant them to other areas. The advantage of potting them up is that you are more likely to attend to their needs if they are in your plant nursery rather than in the ground.

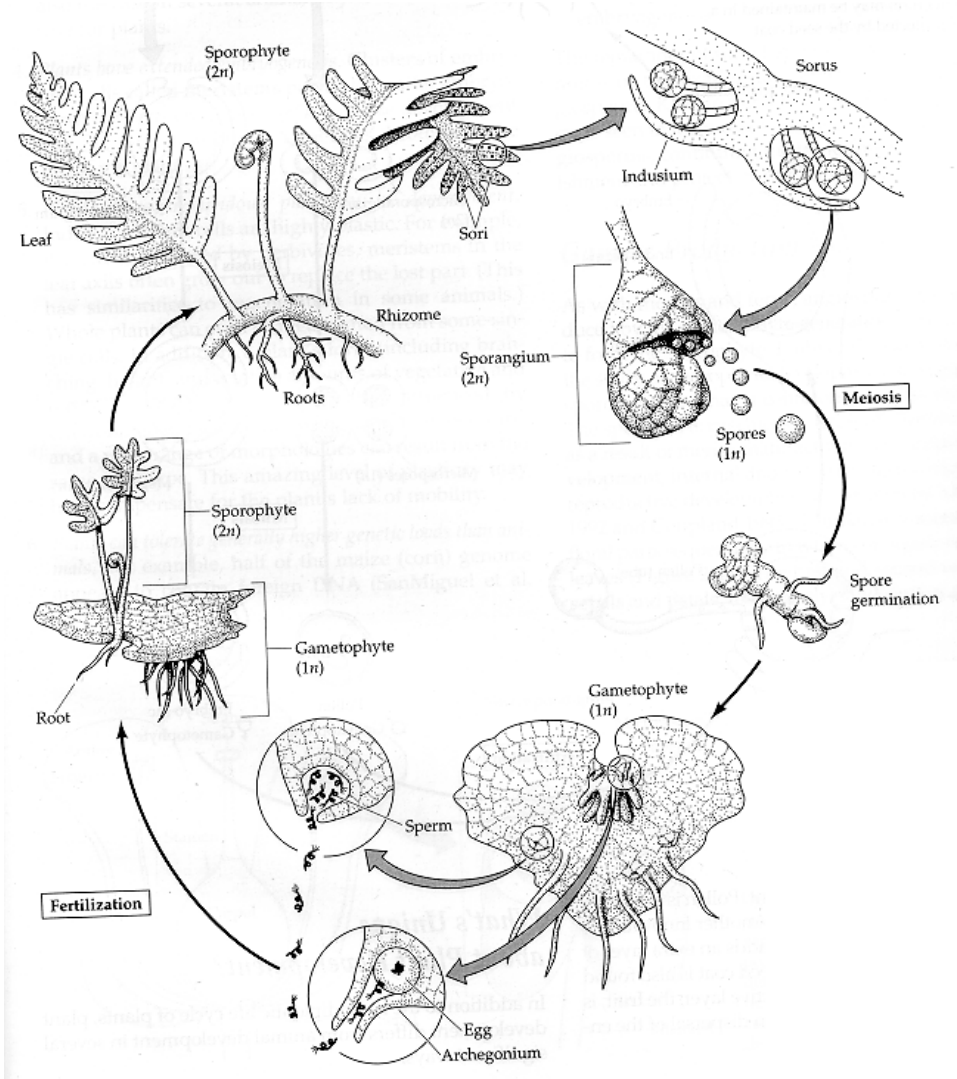
## PROPAGATING WITH “ROOTLINGS”

This backyard technique takes advantage of the rooting tendency of plants with above-ground runners such as wāwaeiʻole (*Lycopodiella cernua*). Pots with media are placed under the runners. Roots may develop and penetrate the media. When these are relatively established, then the connection to the main plant can be cut or both ends of the runner can be cut, leaving a rooted plant of wāwaeiʻole in the pot. You can sometime find incipient roots on the runners and these stems are ideal for placing on the media. You can propagate with “rootlings” in the wild by placing pots with media under runners where they lie or from potted plants in your nursery by strategic placement of your pots around pots that contain the plant providing runners.



# PROPAGATING FERNS FROM SPORES

**FERN LIFE CYCLE**




**Introduction.** Propagating ferns from spores takes patience in monitoring for ripe spores, waiting for gametophytes to produce young sporophytes, and waiting out the early slow growing stage of the sporophytes. It is also possible to propagate some fern species by dividing the plants vertically, slicing through the rhizome, but it may be difficult to find source material for this kind of propagation. Spores are much more readily available and may yield hundreds of young ferns for outplanting (eventually).

**HERE ARE THE STEPS:**

**1. Collect fern spores when they are ripe.** Ripe spores may be present only during a fairly short window in the life of the frond. You will probably have to closely monitor the fern you want to propagate to catch it at the right stage. First, some terms (see illustration): *spores,* which are microscopic, are produced in roundish *sporangia* that you can distinguish with a hand lens. The sporangia collectively make up the *sori* or bodies on the underside of the fern frond. The sori may be round to linear and be located in the central part of the frond or on the edge of the frond. The sori may have a covering called an *indusium* or have no covering. Usually the sori start as light green in color (the indusium may be tan) when the sori contain immature spores. Typically the sori will be dark brown when ripe and ready for collecting (in some cases the mature spores will color the sori black, red, or yellow). After the spores are shed, the sori usually become lighter brown and appear depleted as the sporangia lose their content and detach from the sori.

**2. Cut the fertile frond and place over white paper, spore-side down.** Collect on standard 8 1/2 X 11 computer or copy paper (recycled of course) and cover with another sheet of paper. For smaller fronds you can fold the paper and put the fronds inside. Put some books on top to hold the paper and fronds flat or place inside a good sized book. Some propagationists place the books vertically. The spores will fall onto the paper and appear as a brownish or colored dust after a few days. Wait a couple of week to harvest all the spores. Some fern propagators put the cut frond into a

paper bag to collect spores. On the paper as the frond dies you will find small capsules, probably brown in color and visible to the naked eye. These are the sporangia that have fallen from the frond. There is also a much finer dust made up of spores. You will need at least a dissecting scope to see these as distinct grains.

**3. Prepare the (mostly) sterile germinating media**. Peat pellets (peat organized into cylindrical shape), available from some garden stores, are a good medium. Sunshine Mix (mostly peat, perlite, and limestone) also works. In fact, lots of media work, according to the literature, such as sand or moist, porous bricks. Pour boiling water over the media and pour off the excess water. Some propagators place the media in a microwave for 2-3 minutes to sterilize rather than using boiling water. I think the biggest source of contamination in growing ferns from spores is contamination by other ferns or mossses, rather than by fungi or bacteria, so it is annoying rather than lethal to your ferns.

**4**. **Sow the spores on to the medium**. Try to sow the spores lightly (perhaps an impossible feat). You might transfer the spores to a clean sheet of paper first or use the old paper. Tilt the paper at 45 degrees above the media and flick the underside with a finger or pencil to get the spores to fall on the medium below.

**5. Place the media in your creative growth chamber.** The growth chamber should keep the media and germinating spores at 100% relative humidity but not water logged. Plastic containers with lids that snap into place, e.g. fancy lettuce containers, Taco-Bell salad containers, Café 100 sandwich containers, make excellent growth chambers for germinating spores and growing gametophytes. It is advisable to sterilize these containers first in a 10% solution of bleach but I have found this optional. Sanitation is overrated. Then place these in a cool environment out of direct sunlight.

**6. Be patient.** The spores should germinate within a few weeks and you will see a green, mossy-appearing mat growing on top of the media. These are the gametophyte prothalli (see diagram of life cycle). Soon this develops into a mass of tiny, heart-shaped gametophyte plants usually less than 1/4 inch across. You may need a hand lens to confirm that you have gametophytes because they will be growing very densely. The gametophyte is the alternate stage in the life cycle of the fern from the spore-producing fern frond or sporophyte. The gametophyte produces sperm and eggs. After fertilization, the sporophyte frond will develop on the gametophyte. It may take many months to see your first fronds emerge, depending on the species. Keep the gametophytes at very high humidity but without soggy media.

**7. Transplant plugs of gametophytes/young sporophytes to a new media and continue to be patient.** Transplanting will give the soon-to-emerge sporophytes more room to grow. 1:1 Sunshine Mix/black cinder makes a good media because of the perlite that will help keep the peat from getting waterlogged. The media can be spread out on the bottom of the same kinds of enclosed growth chambers such as “humidomes” or salad boxes. Make sure humidity stays high because the sperm need a film of moisture to swim to the eggs.

**8. Harden off the young sporophytes before transplanting to separate pots outside the growth chamber.** Once the sporophytes are about 1 inch tall, poke holes in the growth chamber or prop open the lids to reduce the humidity and get your young fern sporophytes get used to life outside the cushy growth chambers.

**9. Transplant the young sporophytes.** Place them into uncovered, two inch pots with Sunshine Mix/black cinder, in a very shady location. Keep them moist but not waterlogged and transplant into larger pots as they grow.

## PROPAGATING AND PLANTING TIPS FOR SELECTED NATIVE VOLCANO PLANTS

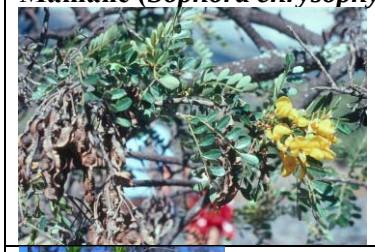
**(Suggestions below based on author's personal experience except for those marked ***)**

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
|  **`A`ali`i (*Dodonaea viscosa*)** | Grows naturally in leeward Volcano in `ōhi`a woodland and `ōhi`a/koa forest. Tree form grows naturally very near Volcano Golf and Country Club (VGCC). | Cuttings taken from the base of the plant are supposed to work best.*** | Separate the tiny black seeds from winged dry fruits. This can be done manually or place fruits in a plastic bag and bang on a hard surface. Drop seeds in scalding water and let soak in the cooling water for 24 hours. Germinate in 2-4 weeks and grow fast. | Place in open areas with minimal or no shading. Can be force-fit into rainy environments if kept in open and soil well drained. |
|  **(*pictured*) `Ākia (*Wikstroemia phillyreifolia)* (Also *W. sandwicensis)*** | *Wikstroemia phillyreifolia* grows in dry `ōhi`a woodland in VGCC or very rarely on south facing cut banks on roads in windward Volcano. (*W. sandwicensis* is very scattered in Volcano wet forest). | Have not tried this since propagation from seed so successful. See Lilleeng-Rosenberger. | The large seeds can be readily squeezed by hand from pulp. High germination rates. | *W. phyllyreifolia*) grows well in open sites in Golf Course and open to partly shady areas in wet forest. (*W. sandwicensis* will grow in partial shade in wet forest.) |
|  **`Ama`uma`u fern (*Sadleria cyatheoides)*** | Grows on edge of forest or out in open areas in both windward and leeward Volcano. Establishes well in disturbed soil. | Use same techniques as for *Cibotium* tree ferns. `Ama`u may be small enough to dig up entire plant, including intact fronds and some of root mass. Expect about 50% or higher mortality. | Have not tried propagation from spores and no information available from standard sources. | *S. cyatheoides* transplants fairly readily when using small, recently established plants. For transplanting larger plants, lay trunk flat on ground rather than upright. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
| **Hāpu`u (*Cibotium glaucum)***  | Will grow in open to deeply shady conditions. Probably grows fastest in partial sun or partial shade. Will grow in VGCC under shady conditions but persists on the edge of its ecological range. | Transplants readily as small ferns. With larger plants, cut off fronds and cut through trunk at base and place in hole in ground or lie on forest floor to also serve as a nurse log. Transplant in February or March just before new fronds emerge so plants do not eat up starch reserves while waiting for fronds to develop. | Can be grown from spores: http://www2.hawaii.edu/~eherring/hawnprop/cib-glau.htm | This information also applies to hāpu`u `i`i (*Cibotium menziesii*) and meu (*Cibotium* chamiisoi), more uncommon species in Volcano. Expect high survival but low vigor for 3-4 years after transplanting. |
|  **`Ie`ie (*Freycinetia arborea*)** | In a few lightly disturbed locations in windward Volcano. | Make cutting of stems with side roots (aerial roots) and plant in media.*** My success rate is low for this method recommended by L-R. See comments for method that works for me. | Fruits rare but will germinate and can be grown from seed.*** | Cut several foot length of `ie`ie "rope." Lay on soil with leaves upright at one or both ends and portion of stem with aerial roots on ground. Cover with humus and litter. |
| **`Iliahi (*Santalum paniculatum*)**  | Only naturally occurring in VGCC and vicinity in dry `ōhi`a woodland. | Not reported in standard sources. | Fruits are ripe when purplish. Let seeds dry for a few days after cleaning. Break seed coat gently with hammer, best cracking along seem. Soak for three days. *** | Semi-parasite. Do not need to plant a host woody plant in the pot with iliahi; they will find host after outplanting. |
| **Kanawao (*Broussaisia arguta*)**  | Common shrub in understory of wet forests of Volcano. | Air layers and short "snaplings" have high rate of success. Cuttings should be made from the top of the plant in spring prior to flowering when wood is soft.*** | Seeds tiny. Try sieve method. Another alternative for folks with good near vision or a dissecting microscope is to try to tease out seeds from the pulp with a probe. Another method with lower success rate is to keep fruits in a plastic bag at room temperature until soft (several days) and then try to massage seeds into a bowl of water. | Transplants poorly because of extensive underground root systems from which most upright shoots arise. Removing a large root ball will enhance chances of survival. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
|  **Kāwa`u (*Ilex anomala*)**(pic taken in water; note reticulate vein pattern) | Common in wet forests of Volcano and the most moist woodland sites of VGCC | See Lilleng-Rosenberger*** | Clean and no pretreatment needed. Fairly low germination rate. An alternative method is to place whole fruit in slits cut in tree fern log; close slits.*** | |
| **Koa (*Acacia koa*)**  | Naturally occurring and planted in VGCC and formerly occurring in scattered stands in Volcano Village and now planted widely. Did not occur naturally in Volcano west of Highway 11 | No information available. | Boil water, turn off heat, and toss in seeds. Wait 24 hours. Plant in sun well away from structures and facilities | Easy to grow from seed but roots can do a lot of damage and subject to falling West of Highway 11, does much better in deeper pockets of soil. |
|  **Kōlea (*Myrsine lessertiana*)** | Common in wet forests and in the most moist forest sites in VGCC. | None reported in standard sources | Clean and sow in common flat. An alternative is to remove pulp and place in slit cut in tree fern log and close slit.*** | Transplants successfully at lower rates than other wet forest trees. Do not transplant seedling taller than 4 inches.*** |
| **Ko`oko`olau (*Bidens hawaiiensis*)**  | The open areas of the VGCC are on the eastern, wetter end of the range of this species in the Volcano area. | The most direct means is to cut the stems, even up to two feet long, and insert them in the soil, no rooting powders needed. Snaplings work with modest rates of success. An alternative is to try three inch tip cuttings.*** | Seeds (actually fruits) are brownish-black at maturity. Remove chaff and sow (no presoaking needed). | Ko`oko`olau can be force-fit grown in open areas of windward Volcano. It may be more short-lived in windward Volcano. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
| **Kūkaenēnē (*Coprosma ernodioides*)**  | Common in dry `ōhi`a woodlands of VGCC and occasionally in wet forests of Volcano, usually in open, exposed areas. | Not reported in available sources | Clean and soak seeds. | In windward Volcano plant in full sun, preferably on south facing bank. |
| **Manono (*Kadua affinis*)**  | Found scattered in wet forest and into the most moist forest sites in VGCC. | Stem cuttings have high success rate*** | Remove pulp from bluish black fruits, soak. Good germination rates. | Fast growing shrub/small viney tree. |
| **Ma`o Hau Hele (*Hibiscus brackenridgei)***  | Not known to be naturally occurring in Volcano but that may be due to loss from parts of its original range in Hawai`i. Could have been formerly in VGCC area before becoming rare? | Can make large cuttings up to two feet long and place in soil without rooting compound. Also, can make stem cuttings with 2-3 nodes each. | Have not tried this since cuttings work so well. | Grows luxuriantly in VGCC. Can thrive also in windward Volcano if planted in open areas. May do best when partly protected from full rain such as under eaves on south side of house. |
| **Maile (*Alyxia oliviformis*)**  | Uncommon to rare in Volcano community. Found from sea level to 7,000 ft elevation from wet to dry plant communities. Will grow in full sun to fairly shady conditions. Probably grows best in partial shade to full sun. | There is a relatively new technique form making cuttings. I have not tried this: http://www2.hawaii.edu/~eherring/hawnprop/aly-oliv.htm | The fruits are uncommon but germination rates are high if you clean the pulp off manually and soak in warm water for 24 hours. | Highly variable species. Grow your own maile and save the ones in the wild. When you place your plants into ground, more success if plants 12 inches tall with host plant to lean on. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
| **Māmaki (*Pipturus albidus)***  | Common in windward Volcano in open areas or partial shade. Occasional in VGCC in moist sites. | Some propagationists have been successful with 4-6 inch cuttings; others have reported no success. With excellent germination from seed, no need to deal with cuttings. Small seedlings transplant successfully and are found in recently disturbed, open areas. | Use only most succulent fruits; massage, dry, or force through fine sieve to separate seeds | Germinates naturally in disturbed soil. Your planted māmaki will make excellent shade "structures" in in 2-4 years. |
| **Māmane (*Sophora chrysophylla*)**  | Small tree in VGCC area but can be grown in open areas of windward Volcano too | Not reported in literature. | Remove seeds from dry pods. One trick is to place pods in an old pillow case and hit against a hard surface. The seeds need scarification. You might get some germination by dropping seeds into scalding water, letting cool, and soaking for 24 hours. | Best methods of seed scarification are to soak for 30 min in concentrated sulfuric acid. Can also cut off small ends of seeds with nail clippers or sand with file. |
|  **Na`ena`e/ Kupaoa (*Dubautia ciliolata)*** | *Dubautia ciliolata* is found in dry `ōhi`a woodlands of VGCC. | Tip cutting, 3-5 inches long*** | Fruits have plumose hairs at top like dandelion. Remove hairs and sow seeds or surface of medium without soaking or treatment. | Plant in open among native shrubs. |
| **Na`ena`e/Kupaoa (*Dubautia scabra)***  | *Dubautia scabra* is found sparingly in open areas or disturbed sites of wet forest in windward Volcano. | Have not tried this. | Same as above | Plant in open at edge of forest or gaps. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
| **Naupaka kuahiwi (*Scaevola chamissoniana*)**  | Grows in open areas of wet forest above 1,000 foot elevation, often establishing after disturbance. | Have not tried this | Squeeze seeds from fruit; soak. Germinates eventually and plant grows fast. Likes wet, cool, and open areas. | Fast growing plant for open areas with lots of sun. Have not tried placing seeds in scalding hot water to enhance germination rate. |
| **Naio (*Myoporum sandwicensis*)**  | Very scattered trees or tall shrubs in VGCC and scattered trees in wet forest near Volcano Village, especially on older soils. | Reports of success are mixed.*** One technique that worked was cutting off half of leaves, scraping basal bark for about ½ inch, dipping in rootone, and putting cuttings in cinder/compost/local soil and maybe most importantly, putting cutting in shady rain forest environment. | Clean pulp and soak seeds. Fairly slow germination and rates low too. | This species highly impacted by a newly introduced insect. |
| **`Ōha wai (*Clermontia parviflora*)**  | Common shrub in wet forests of Volcano and other areas of windward Hawai`i Island | Have not tried this but second hand reports suggest low success rate.*** | Clean seed through a fine mesh strainer into a bowl of water. Direct seeding works well on mossy tree fern trunks by smearing fruit on to this substrate or mossy sites on forest floor. | These methods apply to other *Clermontia* species and *Cyanea*, |
| **`Ōhelo kau lā`au (*Vaccinium calycinum*)**  | Understory in wet forest in Volcano, often as an epiphyte but also growing from the soil. | Use pencil sized stem segments with at least three nodes and use rooting hormone.*** | Clean seeds with strainer technique as above. Or try letting fruits dry so that pulp can be massaged away. My experience is that seeds germinate but grow extremely slowly so try very dilute foliar fertilizer with micronutrients added to germinated seedlings in trays. | Try direct seeding technique on mossy sites on trees, tree ferns, or nurse logs.*** |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
|  **`Ōhelo (*Vaccinium reticulatum*)** | Found in leeward Volcano in open dry `ōhi`a woodland areas of VGCC. | Try as above | Tiny seeds so try strainer technique as per *Clermontia parviflora*. | Cuttings may be more successful than propagation by seed. |
| **`Ōhi`a (*Metrosideros polymorpha*)**  | Light-loving species, all environments throughout Volcano. | Ōhi`a transplants readily, up to head-height or taller saplings, especially if growing in deep soil. Cuttings fairly successful; leave 2-4 leaves. Air layers successful if cut deeply and remove outer layer of yellowish wood that tends to peel off stems readily. | Tiny seeds available almost any time of year as flowering trickles through out the year with peaks in March-June and November-January (Volcano area). Sprinkle on top of trays or pots and keep moist. In an `ōhi`a rich site, leave unsown pots out and windblown seeds will find them and germinate. | `Ōhi`a is notoriously slow growing. However, the oval hairy leaf, variety (most common variety at Kīlauea summit) grows fastest. `Ōhi`a responds well to fertilizer. |
| `  **`Ōlapa (*Cheirodendron trigynum*)** | Common in wet forests in windward Volcano and the most moist forested areas of VGCC. | Seedlings abundant, especially on nurse logs, as epiphytes, or in `ōhi`a tree leaf litter. Mixed results with cuttings.*** | I have had any success germinating seeds. More patient folks have been able to germinate seeds but germination occurs very slowly. Seeds may require after ripening, i.e., seeds reach viable stage well after fruit appears ripe. | Even small trees up to 1 inch in diameter and 8 feet tall transplant readily. Grows faster than many other rain forest trees except koa. |
| **Olomea (*Perrotettia sandwicensis*)**  | Small, deciduous tree in wet forests of Volcano. Uncommon except for Wright Road and vicinity. | No methods reported in standard sources. | Collect fruits when bright red. Let fruits soften in plastic bag and try to separate per instructions for kanawao above. Pulp is slimy. | Fruits available in summer along Wright Road in state highway right-of-way just outside national park's `Ōla`a Forest. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
|  **Pa`iniu (*Astelia menziesiana*)** | Wet forests of Volcano, from soil or on nurse logs or as an epiphyte. | Not mentioned by Lilleeng-Rosenberger but success reported with divisions by making sure the division has some rootlets exposed. | Orange fruits ripen late winter to late spring. Small black seeds can be teased from the fleshy pulp with a probe or fine tweezers. | When outplanting, dig a very shallow hole and cover base of rooting areas with leaf litter and humus; Do not bury roots in soil. |
| **Pala`ā (*Sphenomeris chinensis*)**  | Common in disturbed open areas in windward Volcano and moister sites in VGCC. | Use rhizome cuttings. Dig up rhizome and cut so that 3-4 fronds are in the cutting. Or keep root mass intact and make division per palapalai. Cut down into root mass. Divisions should be at least 4 inches across. | Have not heard of any successful attempts to do this. | Transplants work fairly well. This fern gets established on its own in disturbed areas. Transplant small plants into pots or directly translocate to a new site. Some mortality. |
| **Palapalai (*Microlepia strigosa)***  | Found scattered in gaps in rain forest in some parts of Volcano and in moist, shady areas in VGCC. Does best in partial shade. | Propagates well from divisions. Remove large plant and root mass from pot. Use machete, cane knife, or saw to cut down from the base of the plant to the bottom of the root mass to make smaller divisions. Repot each division. | Can be propagated but slowly from spores. See methods below in handout. | Plant in gaps or edge of forest. |
| **Peperomia (`Ala`ala wai nui) (*Peperomia hypoleuca)***  | In forest understory in wet forests of Volcano and in moist, shady sites of VGCC. | Idiot-proof. Stem cuttings with two or more nodes. Probably do not need rooting powder. Even works by just laying cutting on surface of media. | Fruits are tiny, dark, and sticky dots on long inflorescenses. Massage over germination tray to shake fruits loose on surface of media | Prescriptions apply to all Peperomia species. Use *Peperomia cookiana* in VGCC in moist, shady areas. Use *P. hypoleuca* and *P. macreana* in wet forest. In the latter, do not plant where lots of tree fern litter. |

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|---|---|---|---|---|
| **Pilo (*Coprosma ochracea, rhynchocarpa, pubens*, etc).**  | *C. ochracea* is the common pilo in windward Volcano; *C. rhynchocarpa* is in VGCC, and *C. pubens* occurs in windward Volcano out Wright Road and vicinity. | Small seedlings transplant well and may be abundant under some trees. | Germinates well from seed. Easy to clean pulp away from the two big seeds. Soak for a day or two in tap water. | Pilo in wet forest grows in deep shade to open sunny areas. Grows very rapidly but short-lived. Excellent plant for restoration from scratch. |
| **Pūkiawe (*Leptechophylla tameiameiae*).**  | Abundant in dry `ōhi`a woodland in VGCC. Rare in wet forest in Volcano and there found in a few locations in open areas such as south facing road cut banks. | Not reported in standard sources. | ******* Hard to germinate. Keep in plastic bag until fruit is mushy. Then clean seeds and soak in hot water to 2 days; then soak in vinegar for 15 minutes. | Try collecting large volumes of seed and try direct seeding in disturbed soil or bare areas.*** |
|  **`Uki (*Machaerina angustifolia*)** | In open areas of wet forest; does well in disturbed soil and early successional habitats. In more moist sites in VGCC. | Dig up root mass to expose underground root mass. Cut into sections and cut back leaves. Pot up and mist frequently. *** | Cut seed heads and place them in newspaper or paper bag to dry. Seeds with some attached parts will fall out and can be collected and sorted out. Soak and sow. Seeds germinate but grow very slowly. Try dilute foliar fertilizer.*** | Does not transplant well with more than two leaves. Small plants transplant fairly well. |
|  **`Uki`uki (*Dianella sandwicensis*)** | In dry ōhi`a woodland of VGCC. Have not observed in wet forests of Volcano but occurs on East Rift of Kīlauea so might be in lower subdivisions of Volcano. | Have not tried this and can find no information in the literature. | Fruits and seeds mature when fruit is dark blue. Squeeze out seeds by hand and soak in water. Germinates readily. | Plant under `ōhi`a and among native shrubs. |

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|---|---|---|---|---|
| **`Ūlei *(Osteomeles anthyllidifolia)***  | In dry ōhi`a woodland of VGCC. Have not observed in wet forests of Volcano. | See Lilleeng-Rosenberg and http://www2.hawaii.edu/~eherring/hawnprop/ost-anth.htm*** | Germinates readily and seedlings grow fast. Remove pulp first and then soak 24 hours. | There is a prostrate coastal form and an upland shrubby form. |
| **Uluhe (*Dicranopteris linearis)***  | Grows best in partial shade. Most abundant in wet forest or wetter sites in dry `ōhi`a woodlands such as cracks. | Very difficult to transplant or air layer larger plants**.** | For growing uluhe from spores see htttp://ipps.org/WesternNA/WR2005/Presentations/Romanchak.pdf for directions on how to grow uluhe from spores*** | Small plants, developed from spores and recently established often in disturbed areas, can be transplanted. Low success rate transplanting big plants |
|  **Ti (*Cordyline fruticosa*)** | Planted and naturalized in a wide range of habitats; does not do well in deep shade. | Best method of propagation. Cut stems into 4-6 inch pieces and place on medium in a pot. Idiot-proof. | Seeds not that commonly seen. | The naturalized variety and probably the traditional variety is the green one. |
|  **Wāwae`iole *(Lycopodiella cernua)*** | Grows in open, often disturbed areas of wet forests of Volcano and in dry `ōhi`a woodland, particularly in moist sites, in VGCC. | Propagate by "rootlings." Place running stem in contact with medium in a pot. Let roots develop and spread downward into medium. Cut stem and continue to grow rooted stem tip in pot until ready to outplant. Look for incipient roots along an above ground runner. These are ideal for placing on media. | I doubt it but should try it to test my skepticism. | Hard to transplant except when very small and rhizome is confined. Then need to remove it with as much rooting soil as practicable. |

| Species | Range in Volcano | Vegetative Propagation | Propagation from Seed/Spores | Comments |
|---|---|---|---|---|
| ***Phyllostegia* spp. (no Hawaiian name)**  | Rare, some species in this genus in park. Some are wet forest species; other species are adapted to dry or mesic environments. | Make cutting with three or four nodes. However, keep in mind that *Phyllostegia* spp. are short-lived perennials, and that the cuttings are the same age as the parent plant. | Let fruits air dry. The four "nutlets" separate fairly easily with "massaging." Each nutlet contains a single seed. Very difficult to remove pulp but high germination without this step. Soak and sow on media. | Best to propagate by seed. |
| ***Stenogyne calaminthoides* (no Hawaiian name)**  | Crawling, climbing vine in undisturbed rain forest. | Cuttings with two or three or more nodes. This is a longer lived perennial so plants propagated from cuttings will be longer lived. | Same as above; good luck finding seeds. | You can also place a pot with media under a spreading vine, and you may get rooting in the pot (especially if the media reaches the lip of the pot). After it roots in the strategically placed pot, you can cut the shoots at either end to end up with a nicely rooted potted vine. |

## MY FAVORITE SOURCES FOR PROPAGATION SUPPLIES

**Nursery Things.** 626 Kealakai Street, Hilo. (Take Stainback Road—Panaewa Zoo Road; second left prior to Zoo; Nursery Things on right). Wide variety of propagation supplies, sold in bulk only.

**Farm Supply Cooperative,** 60 Holomua Street, Hilo. Have humidomes, very useful for seed germination.

## SOURCES FOR NATIVE PLANT STARTS

**1. Commercial sources are limited**. Most commercial nurseries focus on non-native ornamental plants. They may have a few common species or lowland natives.

**2. There are two native plant nurseries in Puna.** **1**) Lehua Lena, in Kea`au and owned by Allie Atkins (leave message at .966-7975); 2) Big Island Plants. Kim Dillman, Big Island Plants (By appointment, 985-8596 (ph/fax) kim@bigislandplants.com.

**3. Amy Greenwell Ethnobotanical Garden** in Captain Cook, Kona has native and Polynesian plants, for sale M-F including many lowland species. You can see what plants may be available by looking at their website: http://bishop.hawaii.org/exhibits/greenwell/plantsales.html.

**4. State and county road right of ways**. There is often a fringe of native vegetation between the road shoulders and adjacent county, state, federal, or private land. Calls to state and county agencies inquiring about permits or restrictions indicated that there are no restrictions and no permits required. It would be neighborly just to take fruits or small cuttings, rather than whole plants. Be cautious about collecting along highways bordering state forest reserves because of the confusion that might result from the need to have a permit for collecting in the forest reserve. You can get a permit from the Hawai`i Division of Forestry and Wildlife for collecting.

**5. A number of the most species rich sites are explicitly off-limits. These include the national parks, federal wildlife refuges, state forest reserves and natural area reserves, and the Nature Conservancy preserves.** (Permits are available from the National Parks and state forest reserves in some cases).

## LOTS OF INFORMATIVE REFERENCES

**Propagation:**
http://www.ctahr.hawaii.edu/hawnprop/botlist.htm

Lilleeng-Rosenberger, Kerin. 2005. *Growing Hawai`i's Native Plants: A Simple Step-by Step for Every Species.* The most comprehensive guide and single best reference on native Hawaiian plant propagation. Includes a summary of propagation practices and then species-by-species accounts.

J.L. Culliney and B.P. Koebele. 1999. *A Native Hawaiian Garden.* Strong point is dry, lowland species.

Bornhorst, H. 2005. *Growing Native Hawaiian Plants*, highly readable and focus on lowland species; revised edition

http://www.taunton.com/store/pages/fg_toc_071.asp. Article from *Fine Gardening* on propagation of ferns from spores.

http://aggie-horticulture.tamu.edu/extension/ornamentals/airlayer/airlayer.html. Good web site on air layering techniques.

http://www.ctahr.hawaii.edu/hawnprop/. This is a rich University of Hawaii website with many species accounts and links to a plant identification site and other propagation, gardening sites.

**Lei Making Plants, Traditional and Contemporary:**
*Ka Lei*, Marie McDonald, 1985.

*Na Lei, Makamae*, Marie McDonald and Paul Weissich, 2003. Comprehensive and great illustrations; includes brief information on propagation.

*La`au Hawai`i Traditional Hawaiian Uses of Plants*. Isabella Aiona Abbott. Bishop Museum Press. 1992.

*Growing Plants for Hawaiian Lei: 85 Plants for Gardens, Conservation, and Business.* College of Tropical Agriculture and Human Resources, University of Hawai`i at Manoa. 2002. Information on propagation included.

http://www2.bishopmuseum.org/ethnobotanydb/index.asp. Bishop Museum website on Ethnobotany.

**Native Plant Identification:**
Lamoureux, C.H. 2001. *Trailside Plants of Hawai`i's National Parks*. Hawai`i Natural History Association. Best beginning book for Kīlauea summit area. Excellent photos and descriptions.

Palmer, Daniel D. 2003. *Hawai`i's Ferns and Fern Allies*. 2003. Finally, a definitive guide to the Hawaiian fern flora! Includes fern allies, the moa's, quillworts, spike mosses, whisk ferns, and club mosses. This is a technical guide relying on dichotomous keys and takes patience and practice to use. Excellent drawings.

Valier, Kathy. 1995. *Ferns of Hawai'i.* Honolulu: University of Hawai'i Press. Nice book covering many ferns species. Photographs. Nomenclature not consistent with the more recent, technical coverage in *Hawai`i's Ferns and Fern Allies*

Wagner, Warren L., Darrel R. Herbst, and S. H. Sohmer. 1990. *Manual of the Flowering Plants of Hawai'i.* 2 vols, *Bishop Museum Special Publication 83*. Honolulu: University of Hawaii Press and Bishop Museum Press. p.1094. This is the taxonomic bible for flowering plants for Hawai`i. It is technical and relies on dichotomous keys. Some species partially illustrated.

*http://www.botany.hawaii.edu/faculty/carr/natives.htm*. University of Hawai`i website with photos and descriptions of many native plants.

*http://hear.org/*. Excellent photos of many alien plant species in Hawai`i (and some native species) and links to information about other non-native species. Web site of the Hawai`i Ecosystems at Risk program.