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Lobelia gloria-montis

In This Issue

Wai'anae Kai Trail Plant List

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Survey Dates: September 26, 1998; November 7, 1998; September 6, 1999; February 16, 2000

Reason for Trail Selection: The Wai'anae Kai trail is well known for its largely intact native mixed mesic forest, and is an excellent hike for viewing the native plants of this vegetation zone in the Wai'anae Range. A number of rare endemic plants can be seen along this trail.

Location Reference: Bryan's Sectional Maps p. 113; USGS topographic maps: Wai'anae and Ka'ena quadrangles; trailhead global positioner reading: N 21°29.42', W 158°09.51'.

Access: Through Board of Water Supply gated trailhead area. No permit needed. Trail is described in Stuart Ball's book, *The Hiker's Guide to O'ahu.*

Elevations: Trailhead, 1,300 ft (395 m); highest elevation of survey (see Description): 2,640 ft (805 m).

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Description of Trail and Zonation: The Wai'anae Kai hike is a loop roughly in the form of a triangle, with two extensions: one heads up to Mt. Ka'ala but was not surveyed and is not described; the second goes to an area called "the Pinnacles," which was surveyed and is described. The trail is divided into six zones (see below), with separate species lists for each.

Zone 1: From trailhead to trail loop junction. Elevations: 1,300 ft (trailhead) to 1,680 ft (395–510 m). Highly disturbed dry to mesic zone, many sections dominated by strawberry guava *(Psidium cattleianum).*

Native dicots and monocots:
Peperomia blanda ('ala'ala wai nui, Syn. *P. leptostachya*)
Pipturus albidus (māmaki)
Pisonia brunoniana (pāpala kēpau)
Pisonia umbellifera (pāpala kēpau)
Psydrax odorata (alahe'e, Syn. *Canthium odoratum*)

Native ferns and fern allies:
Asplenium horridum ('alae, 'iwa)
Doodia kunthiana ('ōkupukupu)
Gonocormus saxifragoides (Syn. *G. minutus*)
Lepisorus thunbergianus (pākahakaha, Syn. *Pleopeltis thunbergiana*)
Microlepia strigosa (palapalai)
Nephrolepis exaltata subsp. *hawaiiensis* (kupukupu)
Polypodium pellucidum var. *opacum* ('ae)
Psilotum nudum (moa)
Sphenomeris chinensis (pala'ā)

Side Trails: 1,560 ft (475 m)--Side trail to right, up ridge, not taken.
Side Trails: 1,600 ft (490 m)--Side trail to left, not taken.
Side Trails: 1,640 ft (500 m)--Side trail to right, not taken.

Other Notes:
1. Alien plants seen: *Acacia confusa, Aleurites moluccana, Andropogon virginicus, Blechnum occidentale, Buddleia asiatica, Caesalpinia decapetala, Christella dentata, Christella parasitica, Clidemia hirta, Coffea arabica, Conyza bonariensis, Cordyline fruticosa, Desmodium* sp., *Dicliptera chinensis, Dovyalis hebecarpa, Fraxinus uhdei, Grevillea robusta, Lantana camara, Leucaena leucocephala, Macadamia integrifolia, Mangifera indica, Melinis minutiflora, Nephrolepis multiflora, Oplismenus hirtellus, Panicum maximum, Paspalum conjugatum, Persea americana, Phlebodium aureum, Phymatosorus grossus, Pimenta dioica, Psidium cattleianum* (both red and yellow forms), *Psidium guajava, Rivina humilis, Rubus rosifolius, Salvia coccinea, Schinus terebinthifolius, Setaria parviflora, Sporobolus* sp., *Stachys arvensis, Stachytarpheta dichotoma, S. urticifolia, Youngia japonica.*
2. *Pisonia brunoniana* with numerous sticky seedpods.

Zone 2: Beginning at Loop (triangle) junction, heading up the leg to the right, to 2,080 ft (635 m). Elevations: 1,680 ft (510 m) to 2,080 ft (635 m). This section also dominated by strawberry guava, with scattered native elements.

Native dicots and monocots:
Acacia koa (koa)
Alyxia oliviformis (maile)
Antidesma platyphyllum (hame)
Cocculus orbiculatus (huehue) (Syn. *C. trilobus*)
Coprosma foliosa (pilo)
Dianella sandwicensis ('uki'uki)
Dodonaea viscosa ('a'ali'i)
Gahnia beecheyi
Machaerina mariscoides ssp. *meyenii* ('ahaniu, 'uki)
Melicope peduncularis (alani)
Metrosideros polymorpha ('ōhi'a lehua)
Psydrax odorata (alahe'e)
Xylosma hawaiiense (maua)
Zanthoxylum kauaense (a'e)

Native ferns and fern allies:
Asplenium contiguum ('iwa lau li'i)
Asplenium horridum ('alae, 'iwa)
Asplenium normale
Cibotium chamissoi (hāpu'u)
Doodia kunthiana ('ōkupukupu)
Dryopteris fusco-atra ('i'i)
Dryopteris glabra var. *nuda* (kīlau)
Elaphoglossum paleaceum ('ēkaha)
Lepisorus thunbergianus (pākahakaha)
Microlepia strigosa (palapalai)

Nephrolepis exaltata subsp. *hawaiiensis* (kupukupu)
Psilotum nudum (moa)
Sphenomeris chinensis (pala'ā)

Side Trails: 1,900 ft (580 m)--Side trail to left, not taken
Side Trails: 1,980 ft (605 m)--Side trail to right, not taken

Other notes:
1. Alien plants seen: *Aleurites moluccana, Blechnum occidentale, Christella dentata, Christella parasitica, Clidemia hirta, Cordyline fruticosa, Grevillea robusta, Nephrolepis multiflora, Oplismenus hirtellus, Paspalum conjugatum, Persea americana, Phlebodium aureum, Psidium cattleianum, P. guajava, Schinus terebinthifolius, Setaria palmifolia.*
2. *Leucobryum albidum* (a native cushiony moss) noted.

Zone 3: Beginning of native mesic forest up to trail crest, dominated by 'öhi'a/koa overstory with uluhe understory and a rich variety of native species.
Elevations: 2,080 ft (635 m) to 2,620 ft (800 m).
Note: This section of trail ends at power lines (N 21°30.16'; W 158°9.33'). The connector trail to Mt. Ka'ala begins at the power lines at the top end of this segment.

Native dicots and monocots:
Acacia koa (koa)
Alyxia oliviformis (maile)
Antidesma platyphyllum (hame)
Bidens torta (ko'oko'olau)
Bobea elatior ('ahakea)
Canavalia galeata ('āwikiwiki)
Chamaesyce multiformis ('akoko)
Cocculus orbiculatus (huehue)
Coprosma foliosa (pilo)
Coprosma longifolia (pilo)
Dianella sandwicensis ('uki'uki)
Diospyros hillebrandii (lama)
Diospyros sandwicensis (lama)
Dodonaea viscosa ('a'ali'i)
Elaeocarpus bifidus (kalia)
Freycinetia arborea ('ie'ie)
Gahnia beecheyi
Hedyotis terminalis (manono)
Hesperomannia arbuscula
Hibiscus arnottianus (koki'o ke'oke'o)
Ilex anomala (kāwa'u)
Korthalsella complanata (hulumoa)
Labordia tinifolia (kāmakahala)
Melicope peduncularis (alani)
Melicope sp. (alani)
Metrosideros polymorpha ('ōhi'a lehua)
Metrosideros tremuloides (lehua 'āhihi)
Myrsine lessertiana (kōlea)
Panicum nephelophilum (konakona)
Pipturus albidus (māmaki)
Pittosporum confertiflorum (hō'awa)
Platydesma cornuta var. *decurrens*
Pouteria sandwicensis ('āla'a)
Psychotria hathewayi var. *hathewayi* (kōpiko)
Psychotria kaduana (kōpiko kea)
Psychotria mariniana (kōpiko)
Psydrax odorata (alahe'e)
Scaevola gaudichaudiana (naupaka kuahiwi)
Smilax melastomifolia (hoi kuahiwi)
Syzygium sandwicense ('ōhi'a hā)
Xylosma hawaiiense (maua)

Native ferns and fern allies:
Asplenium horridum ('alae, 'iwa)
Asplenium normale
Asplenium polyodon (pūnanamanu)
Cibotium chamissoi (hāpu'u)
Dicranopteris linearis f. *emarginata* (uluhe)
Dicranopteris linearis f. *linearis* (uluhe)
Doodia kunthiana ('ōkupukupu)
Dryopteris fusco-atra ('i'i)
Dryopteris glabra var. *nuda* (kīlau)
Elaphoglossum paleaceum ('ēkaha)
Lepisorus thunbergianus (pākahakaha)
Microlepia strigosa (palapalai)
Nephrolepis exaltata subsp. *hawaiiensis* (kupukupu)
Psilotum complanatum (moa)
Sadleria pallida ('ama'u)
Sadleria cyatheoides ('ama'u)
Sphenomeris chinensis (pala'ā)

Side trails: Many side trails to the left at 2,360 ft plus (720 m), causing substantial erosion and devastation of area around trail.

Other notes:
1. Alien plants seen: *Acacia mearnsii, Andropogon virginicus, Blechnum occidentale, Buddleia asiatica, Christella parasitica, Clidemia hirta,*

Conyza bonariensis, Cordyline fruticosa, Desmodium sp., *Grevillea robusta, Lantana camara, Lythrum maritimum, Nephrolepis multiflora, Paspalum conjugatum, Psidium* cattleianum (red form), *Rubus argutus, R. rosifolius, Schinus terebinthifolius, Setaria parviflora, Spathodea campanulata, Spathoglottis plicata.*

2. *Hesperomannia arbuscula* and large *Syzygium sandwicense* at 2,360 ft (720 m). *Hesperomannia* was not blooming at time of Sept. or Nov. surveys. (Apr-July flowering noted in herbarium spms.).
3. *Zanthoxylum kauaense* reported near approach to power poles, but not seen on our trip.
4. *Coprosma longifolia* heavily fruiting (orange fruits).
5. *Canavalia galeata*--a single purple bloom seen.
6. *Psychotria hathewayi* var. *hathewayi* in bloom.
7. *Psychotria greenwelliae* reported from this trail; previously known only from Kaua'i.
8. *Strongylodon ruber* reported here; not seen.

Zone 4: Ridge crest saddle trail from trail crest to connector at base of Pinnacles. Slope falls away steeply on both Wai'anae and Mākaha sides. Again, native mixed mesic forest.

This section begins at N 21°30.16'; W 158°9.33' (power lines) and ends at N 21°30.14'; W 158°09.81'.

Elevations: From power lines at 2,620 ft (800 m), to 2,460 ft (750 m).

Native dicots and monocots:
Acacia koa (koa)
Alyxia oliviformis (maile)
Antidesma platyphyllum (hame)
Bidens torta (ko'oko'olau)
Bobea elatior ('ahakea)
Canavalia galeata ('āwikiwiki)
Cenchrus agrimonioides (kāmanomano)
Chamaesyce multiformis ('akoko)
Clermontia kakeana (hāhā)
Cocculus orbiculatus (huehue)
Coprosma foliosa (pilo)
Coprosma longifolia (pilo)
Cyanea angustifolia (hāhā)
Cyanea longiflora (hāhā, Syn. *Rollandia longiflora*)
Dianella sandwicensis ('uki'uki)
Dodonaea viscosa ('a'ali'i)
Elaeocarpus bifidus (kalia)
Eragrostis variabilis (kāwelu, 'emoloa)
Gahnia beecheyi
Hedyotis terminalis (manono)
Ilex anomala (kāwa'u)
Korthalsella complanata (hulumoa) (seen on *Bobea*)
Labordia tinifolia (kāmakahala)
Melicope clusiifolia (alani)
Melicope makahae (alani)
Melicope oahuensis (alani)
Melicope peduncularis (alani)
Metrosideros polymorpha ('ōhi'a lehua)
Myrsine lanaiensis (kōlea)
Myrsine lessertiana (kōlea)
Nestegis sandwicensis (olopua)
Pipturus albidus (māmaki)
Platydesma cornuta var. *decurrens*
Psychotria mariniana (kōpiko)
Psydrax odorata (alahe'e)
Scaevola gaudichaudiana (naupaka kuahiwi)
Smilax melastomifolia (hoi kuahiwi)
Stenogyne kaalae
Styphelia tameiameiae (pūkiawe)
Syzygium sandwicense ('ōhi'a hā)
Vaccinium calycinum ('ōhelo)
Viola chamissoniana ssp. *tracheliifolia* (pāmakani, 'olopū)
Wikstroemia oahuensis ('ākia)
Zanthoxylum kauaense (a'e)

Native ferns and fern allies:
Asplenium contiguum ('iwa lau li'i)
Asplenium nidus ('ēkaha)
Asplenium normale
Cibotium chamissoi (hāpu'u)
Dicranopteris linearis f. *emarginata* (uluhe)
Dicranopteris linearis f. *linearis* (uluhe)
Doodia kunthiana ('ōkupukupu)
Dryopteris glabra var. *nuda* (kīlau)
Dryopteris sandwicensis
Elaphoglossum aemulum ('ēkaha)
Elaphoglossum crassifolium (hoe a Māui)
Elaphoglossum paleaceum ('ēkaha)
Grammitis tenella (kolokolo)
Lepisorus thunbergianus (pākahakaha)
Nephrolepis exaltata subsp. *hawaiiensis* (kupukupu)
Psilotum complanatum (moa)
Psilotum nudum (moa)
Pteridium aquilinum var. *decompositum* (kilau)
Sphenomeris chinensis (pala'ā)

Other Notes:
1. Alien plants seen: *Acacia mearnsii, Ageratina riparia, Andropogon virginicus, Blechnum occidentale, Christella dentata, Christella parasitica, Clidemia hirta, Conyza bonariensis, Cordyline fruticosa, Coffea arabica, Epidendrum* x *obrienianum, Grevillea robusta, Lantana camara, Melinis minutiflora, Nephrolepis multiflora, Paspalum conjugatum, Psidium cattleianum, P. guajava, Rubus rosifolius, Schinus terebinthifolius, Setaria parviflora, Spathodea campanulata, Trema orientalis, Triumfetta* sp., *Verbena litoralis.*
2. At 2,400 ft (730 m). Side trail to right--area ravaged. Many small trails, erosional and environmental damage apparent.
3. *Clermontia kakeana:* large tree, heavily fruiting, but plant appears to be in decline compared with past visits, with some branches dying back. [In Sept. 1999 the plant was dead but still standing]
4. *Cyanea angustifolia:* flowering and fruiting.
5. *Cyanea longiflora:* heavily fruiting.
6. *Viola chamissoniana* ssp. *tracheliifolia* flowering and seeding.
7. *Hedyotis degeneri* var. *coprosmifolia, Melicope elliptica* reported here; not seen.

Zone 5: From base area below Pinnacles (2,460 ft) to Pinnacles.
Elevations: begins at 2,460 ft (750 m); positioner N 21°30.14'; W 158°09.81'.

Native dicots and monocots:
Acacia koa (koa)
Alyxia oliviformis (maile)
Antidesma platyphyllum (hame)
Bidens torta (ko'oko'olau)
Bobea elatior ('ahakea)
Canavalia galeata ('āwikiwiki)
Chamaesyce multiformis ('akoko)
Cocculus orbiculatus (huehue)
Coprosma foliosa (pilo)
Dianella sandwicensis ('uki'uki)
Diospyros hillebrandii (lama)
Diospyros sandwicensis (lama)
Dodonaea viscosa ('a'ali'i)
Dubautia sherffiana (kūpaoa)
Elaeocarpus bifidus (kalia)
Gahnia beecheyi
Hedyotis acuminata (au, pilo)
Hedyotis degeneri
Hibiscus arnottianus (koki'o ke'oke'o)
Ilex anomala (kāwa'u)
Melicope makahae (alani)
Melicope peduncularis (alani)
Metrosideros polymorpha ('ōhi'a lehua)
Metrosideros tremuloides (lehua 'āhihi)
Myrsine lessertiana (kōlea)
Osteomeles anthyllidifolia ('ūlei, u'ulei)
Panicum nephelophilum
Peperomia tetraphylla ('ala'ala wai nui)
Plectranthus parviflorus ('ala'ala wai nui)
Pleomele forbesii (hala pepe, le'ie)
Psychotria hathewayi var. *hathewayi* (kōpiko)
Psychotria kaduana (kōpiko kea)
Psydrax odorata (alahe'e)
Rumex albescens (hu'ahu'akō)
Santalum freycinetianum ('iliahi)
Scaevola gaudichaudiana (naupaka kuahiwi)
Schiedea mannii
Senna gaudichaudii (kolomona)
Sida fallax ('ilima)
Stenogyne kaalae
Styphelia tameiameiae (pūkiawe)
Vaccinium sp. ('ōhelo)
Viola chamissoniana ssp. *tracheliifolia* (pāmakani, 'olopū)

Native ferns and fern allies:
Asplenium aethiopicum ('iwa'iwa a Kāne)
Asplenium horridum ('alae, 'iwa)
Doodia kunthiana ('ōkupukupu)
Doryopteris decipiens (kumuniu)
Doryopteris subdecipiens (kumuniu)
Dryopteris glabra var. *nuda* (kīlau)
Dryopteris sandwicensis
Elaphoglossum paleaceum ('ēkaha)
Lepisorus thunbergianus (pākahakaha)
Nephrolepis exaltata subsp. *hawaiiensis* (kupukupu)
Sphenomeris chinensis (pala'ā)

Side trails: Vague side trails to north in Pinnacles area.

Other notes:
1. Alien plants seen: *Ageratina riparia, Andropogon virginicus, Blechnum occidentale, Conyza bonariensis, Cordyline terminalis, Grevillea robusta, Kalanchoe pinnata, Melinis minutiflora, Nephrolepis multiflora, Paspalum conjugatum, Psidium cattleianum, Rubus argutus, Schinus terebinthifolius, Setaria parviflora, Sida* sp., *Triumfetta* sp., *Verbena litoralis.*

2. Two *Senna gaudichaudii* plants seen here on trail.
3. *Gouania meyenii, Lysimachia hillebrandii, Schiedea hookeri, Dissochondrus biflorus* seen in the past here, not seen on this trip.
4. Much evidence of pig damage on and around trail.

Zone 6: From base at makai end of ridge crest saddle trail (where the Pinnacles trail joins) back to trail loop junction. This return loop is more disturbed vegetationally than the uphill leg.

Elevations: The turn to reconnect with lower junction is at 2,460 ft (750 m), position is: N 21°30.14', W 158°90.81'.

Native dicots and monocots:
Acacia koa (koa)
Alyxia oliviformis (maile)
Antidesma platyphyllum (hame)
Bidens torta (ko'oko'olau)
Bobea elatior ('ahakea)
Carex meyenii
Cenchrus agrimonioides (kāmanomano)
Chamaesyce multiformis ('akoko)
Charpentiera tomentosa (pāpala)
Coprosma foliosa (pilo)
Cyperus sp.
Dianella sandwicensis ('uki'uki)
Diospyros hillebrandii (lama)
Dodonaea viscosa ('a'ali'i)
Elaeocarpus bifidus (kalia)
Eragrostis sp.
Gahnia beecheyi
Freycinetia arborea ('ie'ie)
Hedyotis terminalis (manono)
Melicope peduncularis (alani)
Metrosideros polymorpha ('ōhi'a lehua)
Myrsine lessertiana (kōlea)
Nestegis sandwicensis (olopua)
Panicum nephelophilum
Pisonia umbellifera (pāpala kēpau)
Pittosporum glabrum (hō'awa)
Pouteria sandwicensis ('āla'a)
Psychotria mariniana (kōpiko)
Psydrax odorata (alahe'e)
Rauvolfia sandwicensis (hao)
Santalum ellipticum ('iliahi)
Smilax melastomifolia (hoi kuahiwi)
Streblus pendulinus (a'ia'i)
Xylosma hawaiiense (maua)

Native ferns and fern allies:
Asplenium contiguum ('iwa lau li'i)
Asplenium horridum ('alae, 'iwa)
Doodia kunthiana ('ōkupukupu)
Microlepia speluncae
Microlepia strigosa (palapalai)
Psilotum nudum (moa)
Sphenomeris chinensis (pala'ā)

Other Notes:
1. Alien plants seen: *Acacia mearnsii, Aleurites moluccana, Blechnum occidentale, Canna indica, Clidemia hirta, Coffea arabica, Cordyline fruticosa, Fraxinus uhdei, Grevillea robusta, Lantana camara, Nephrolepis multiflora, Oplismenus hirtellus, Paspalum conjugatum, Persea americana, Phlebodium aureum, Phymatosorus grossus, Psidium cattleianum, Psidium guajava, Rubus argutus, Rubus rosifolius, Schinus terebinthifolius, Toona ciliata, Zingiber zerumbet.*
2. *Achatinella mustelina* found in some numbers in this zone.
3. *Joinvillea ascendens, Pneumatopteris sandwicensis* reported here; not seen.

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Breaking Seed Dormancy in Hawaiian *Santalum* Species with Gibberellic Acid

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It started as a rather straightforward project for the Nature Conservancy of Hawai'i – develop a reliable means of germinating *Santalum freycinetianum* var. *lanaiense* seeds. I had repeatedly germinated *S. ellipticum* seeds in a tray of clean vermiculite after first scarifying the apex of the fruit's endocarp and then soaking the endocarp (containing the seed) in tap water for one to two days. These seeds usually took five to eight weeds to sprout and germination percentages were nearly always 80% or better. However, after more than 200 seeds and seven months with a variety of pretreatments including scarifying the endocarp, cracking the endocarp, removing the endocarp and soaking from one day to two weeks in tap water, I still had less than a handful of *S. freycinetianum* var. *lanaiense* seeds that had germinated. Of these few, none had survived and grown into healthy seedlings. Frustrated, I turned to the literature for help. In the USDA Forest Service General Technical Report PSW-122. 1990 (Sandalwood in the Pacific: A State of Knowledge Synthesis and Summary from the April 1990 Symposium), the Centre Technique Forestier Tropical (CTFT) in New Caledonia reported a "very efficient technique" they developed "which involves pre-soaking with GA..." The report did not state which *Santalum* species the CTFT tested with this technique. However, the non-Hawaiian species, *S. album, S. austrocaledonicum* and *S. spicatum* are referred to in connection with other research conducted by the CTFT.

The gibberellic acid worked. Not only did gibberellic acid prompt the germination of *S. freycinetianum* var. *lanaiense* seeds but it dramatically sped up the germination of *S. ellipticum* seeds as well. (I have not tested *S. paniculatum*). Gibberellic acid can be purchased from a biological supply company such as Carolina Biological Supply, Inc. Unfortunately, the small amounts needed require a sensitive scale for weighing but resourceful growers should be able to overcome this inconvenience.

Begin by extracting the endocarp (containing a seed) from a ripe fruit and cleaning it by hand underwater. Let the endocarp-seed air dry for approximately one week. Then, using forceps or medium sandpaper, remove a small portion of the endocarp at its pointed end (apex) so that the embryo inside is visible; do not damage the embryo. Soak the endocarp-seed in a shallow container of 0.05% gibberellic acid for five days, changing the solution daily. Afterward, remove the endocarp-seed from the gibberellic acid solution and dust it with a 1:1 mixture of powdered sulfur and captan®. This will inhibit fungus from infecting the seed. Sow the endocarp-seed in a covered tray on new moist vermiculite.

Seeds begin sprouting in about one week and continue to germinate for another two to three weeks. Watch for a crack to develop in the thick endocarp. The crack's interior, the embryo, looks white against the dark endocarp. As the crack widens, the root emerges from the embryo's apex. After good root development (an additional one to two weeks), transfer the seedlings to individual containers containing a 1:1 mix of fine cinder (not black sand) and vermiculite. Using a peat-based medium caused some seed and seedling death by fungal infection. Germination using this method is over 90% successful for the two species tested. Even endocarp-seeds as old as seven months responded to the above treatment and sprouted at a high percentage.

Biocontrol of Yellow Himalayan Raspberry: Exploration in China

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ABSTRACT: **Yellow Himalayan raspberry (YHR) (*Rubus ellipticus* var. *obcordatus*) is a noxious bramble in Hawai'i targeted for biocontrol research. Earlier literature searches were focused on the occurrence of natural enemies in its putative native habitats: the Himalayan foothills of northern India. Facilitated by a cooperative agreement with Chinese scientists, we have undertaken recent field surveys in provinces of southern and central China, also part of YHR's range. YHR was found at several sites, representing diverse habitats, in Yunnan and Sichuan Provinces. Notwithstanding its apparent wide geographical distribution, YHR was neither locally common nor appeared as vigorous in growth as in Hawai'i. Numerous insects and a rust fungus, but few other pathogens were associated with YHR. Work is underway in China to determine which of the insects are sufficiently host specific for further testing in Hawai'i.**

Rubus ellipticus Sm., which is widely grown as an ornamental in warm regions, is classified in series *Elliptici*, section *Idaeanthi*, subgenus *Idaeobatus* (Focke, 1910). Two varieties of *R. ellipticus*, distinguished by their leaf shape, are recognized: *R. ellipticus* var. *ellipticus* and *R. ellipticus* var. *obcordatus*, the variety known in Hawai'i as yellow Himalayan raspberry (YHR). YHR was introduced, presumably for use in plant breeding programs, to the Volcano Agricultural Experiment Station and has since spread from this site. It was first collected as an escapee from cultivation in 1961, and has become naturalized locally in the Volcano, and regions similar habitat on the island of Hawai'i in mid-elevation forests (1,060-1,220 m elevation) (Jacobi and Warshauer, 1992; Stratton, 1996; Wagner et al., 1990).

YHR has been designated a noxious weed by the state of Hawai'i. In infested lands, it forms impenetrable thickets of heavily armed growth, to 4 or more meters high. At present, the greatest infestation is locally centered in the Volcano community adjacent to Hawai'i Volcanoes National Park (HAVO), but spread is thought to be inevitable. In contrast with Hawai'i's several other introduced bramble species, *R. ellipticus* is relatively shade tolerant and has the ability to invade and become established in undisturbed forest under stories. In such sites where it has become established, little other vegetation has been observed growing under or near *R. ellipticus* (Stratton, 1996). Whether this is due to the increased shading or whether *R. ellipticus* has allelopathic qualities has not been conclusively determined.

The fleshy fruit of *R. ellipticus* is readily consumed by birds, which in turn distribute the seeds. There is generally little doubt that, in time, *R. ellipticus* has the ability to become widely established throughout the islands (Gerrish et al., 1992). Resource managers and landowners consider mechanical or chemical means of control

of *R. ellipticus* no longer adequate to address the problem. On the other hand, *R. ellipticus* is still sufficiently concentrated in range that biological control is considered feasible if suitable agents can be found.

Whereas Hawai'i has no commercial production of raspberry or blackberry that might otherwise be threatened by introduction of natural enemies of *Rubus* spp., two endemic members of this genus, occur in Hawai'i whose protection from attack by any introduced biocontrol agents is necessary. Focke (1910) classified both of Hawai'i's native species together in section *Spectabiles* of subgenus *Idaeobatus*. However, in revisiting the taxonomic placement of the two native species through DNA analysis, Howarth et al. (1997) and Alice and Campbell (1999) determined that *R. hawaiensis* and *R. macraei* are of different origins from one another, suggesting that Focke's earlier classification should be reconsidered.

Literature Search

Becking (1979) reported: "*Rubus ellipticus* occurs naturally in continental Asia and some adjacent islands, such as Sri Lanka and Luzon in the Philippines. It was introduced into Java and is established to some extent in the surroundings of the Cibodas Mountain Gardens." He further stated: "...the species, at least for a period, was grown as a crop plant in Florida and California under the name of Golden Evergreen raspberry."

Medical research attention has been given *R. ellipticus* as a potential producer of anti-fertility pharmaceuticals (Bhakuni et al., 1987; Sharma et al., 1981; 1983a; 1983b). The ability of *R. ellipticus* to fix nitrogen, noteworthy for a non-leguminous plant, has also been reported (Becking, 1979; 1984). However, these reports were not confirmed and called into question in a survey of non-leguminous plants of Pakistan for nitrogen fixing ability, in which no root nodules were found on *R. ellipticus* (Chaudhary et al., 1981).

Because of its putative origins in the Himalayan foothills of northern India, my earlier literature searches and correspondence with local scientists for information on potential biocontrol agents were directed to this region, where YHR was reported to have some value for its edible fruit, but its aggressive, weedy nature also was recognized. Therefore, YHR is considered among the pest plants targeted for control in India (Misra and Singh, 1972, Misra and Sharma, 1970). YHR also was introduced to Malawi, Africa, where it threatens natural forest succession (Edwards, 1985). Notwithstanding its recognized noxious characteristics and attempts to control YHR through conventional methods in other regions, biocontrol approaches appear to be limited to our own work in Hawai'i.

Literature searches for reports of insects and diseases of *R. ellipticus* have yielded raspberry ringspot (Dhingra and Niazi, 1972), and *Rubus* yellow net and *Rubus* mosaic virus diseases (Pandey and Tripathi, 1973) in India. Incidence of each of the two latter diseases was reported to reach 50% in some regions. A leaf fungus, *Cercoseptoria heteromalla*, was reported on living leaves of *R. ellipticus* in India (Kamal et al., 1986), although the severity of the disease it caused was not described. Other fungi, such as *Helotium lividofuscum*, also occur on dead leaves of *R. ellipticus* (Thind and Saini, 1967), the usefulness of such fungi in a biocontrol program is questionable, however. Khadka and Shah (1967) provided a list of plant diseases in Nepal and included three diseases on *Rubus* spp. caused by fungi of the genera *Alternaria, Cladosporium,* and *Uredo. Rubus ellipticus* was not mentioned specifically as a host, however. Fewer references to insects harmful to *R. ellipticus* are available, possibly indicating that insects exert less impact on this host than do diseases caused by fungi and viruses.

Personal correspondents in India reported several insects and diseases associated with the genus *Rubus* in general, but little information relative to host range (i.e., specificity) and/or severity of damage to the host was available. The usefulness of these agents for biocontrol of *R. ellipticus* in Hawai'i therefore cannot be predicted from field observations in the native habitats. In this regard, even the above-listed viruses and fungi reported to occur on *R. ellipticus* in India may not be limited in host range to this species. As stated above, the ability of any potential agent to attack either or both of the endemic Hawaiian species of *Rubus* must be carefully ascertained before the agent can be considered for field release.

Work in China

During 1994-1995 I sponsored a visiting plant pathologist, Mr. Chen Wan-Quan, from the

Institute of Plant Protection of the People's Republic of China, Beijing, to the University of Hawai'i. Mr. Chen informed Dr. Clifford Smith, then Cooperative Park Studies Unit (CPSU) leader, and me that he was familiar with YHR, the range of which extended to parts of China. This led to the establishment of a cooperative agreement between Mr. Chen's research agency and the CPSU (now Pacific Cooperative Studies Unit) for YHR biocontrol research in China. Under this agreement I traveled to China to conducted field exploration in China for YHR in the company of Mr. Chen and his colleagues in June – July, 1999.

Prior to my arrival in China, Mr. Chen conducted literature searches and contacted professional colleagues in various southern locations of China where YHR was thought to occur. Through these leads, he suggested an itinerary for our travel to these sites, and also arranged with the local agricultural agency at each site for ground transportation, including a car and a driver, to the sometimes remote field areas. (Such assistance with ground transportation was essential; I saw no evidence of a car rental industry in China). Mr. Chen, Dr. Duan Xiayu, an expert in powdery mildews, and I traveled from Beijing to the southern tip of China in Yunnan Province near the Vietnamese and Laotian borders, where we searched for YHR in rural areas between the towns of Jinghong and Menghai and to the west of Menghai. My Chinese colleagues showed photographs of the plant to local farmers and other residents to solicit their help in pinpointing stands of this species. We received cooperation, sometimes enthusiastically, from almost everyone approached for assistance. Such local assistance was especially helpful in concentrating our efforts and greatly facilitated our time efficiency. Although we were successful in finding YHR at many of the locations we searched, it was rarely found in great abundance at any given site, usually being limited to one to several scattered plants. Local farmers told us that YHR had no use, and that they chopped it out as a weed where it occurred in agricultural lands. This information seemed to vary somewhat from literature reports from India describing YHR fruit as being of some value for human consumption.

Notwithstanding its lack of local abundance at the Jinghong and Menghai sites, evidence of insect activity was readily apparent as leaf feeding, leaf binding, bud feeding and shoot tip boring. A number of beetle and lepidopterous species were associated with this damage. This contrasted with a relative lack of diseases on YHR. For the most part we found only infrequent, individually occurring fungal leaf spots that appeared to be of little consequence.

Other sites visited in Yunnan Province included the "Rock Forest," a preserved national park-like area featuring eroded rock formations near Lunan to the southeast of the principal city of Kunming in the central eastern area of the province. Mature plants of YHR were scattered individually among other shrubby vegetation types. In addition to the leaf feeders, leaf binders and tip borers that we had found at the southern Yunnan sites, we found exit holes of a stem borer on dead or dying stems at the Rock Forest. Individual plants of YHR were also found along the road sides and on the edges of rice fields between Kunming and Lunan, most of which exhibited evidence of leaf feeding and leaf binding as their most prominent damage. Diseases were again much less in evidence and appeared of no effect to plant health.

As a note of interest, while in Kunming we found *R. ellipticus* var. *obcordatus*, labeled as such, in the "Medicinal Plant" section of a botanical garden. Purported uses were for ailments such as stomachache and digestive problems.

We visited Sichuan Province, north of Yunnan Province, traveling down the Yangtze River from the major city of Chongqing to Fengdu, a hilly area with which Mr. Chen was personally familiar. At sites in terraced farmland and steep rocky slopes near the town of Shuren, several kilometers to the west of Fengdu, we again found individually scattered YHR with much of the previously seen insect fauna, although we were not able to find evidence of the stem borers we had seen near Lunan. In the Fengdu area we found a leaf rust fungus, *Hamaspora rubi-sieboldii*, a fungus recorded from other *Rubus* hosts in Southeast Asia (Monoson, 1969).

Herbarium records at Southwest Agricultural University at Bei Bei, west of Chongqing, indicated that a number of *Rubus* species, including *R. ellipticus*, had in the past been collected in the nearby Jinyun Mountain area. Based on these collections, we searched for YHR at this site, but were unsuccessful in finding the plant.

In September of 1999, following my visit, Mr. Qin Qingming, a research colleague of Mr. Chen of the Chinese Academy of Agricultural Sciences, Beijing, made a separate visit to Yunnan Province in behalf of the YHR biocontrol project. He carried out fieldwork at sites that we had not visited and collected additional beetles species in addition to those Mr. Chen, Dr. Duan, and I had found.

DISCUSSION

Of the insects and disease agents found in literature reviews of YHR from the Himalayan region of northern India, fungal pathogens appear to be the most prominent. Of these, some well-known groups of significant agricultural pathogens are represented, and host specificity cannot be fully ascertained until specific isolates are host range-tested. Thus, whereas the current field studies were conducted in China, other areas of the apparently extensive range of YHR should not be overlooked. Among the disease agents mentioned from India, however, viruses are generally considered the least desirable to work with as biocontrol agents because of the frequent requirement for specific arthropod vectors and because of their submicroscopic, obligate-parasitic nature. Quarantine facilities in Hawai'i are not currently equipped to support studies of this complexity.

From our observations thus far, it is evident that YHR occupies a wide variety of habitats in China. Near Jinghong we found it was growing among a number of other under story species in a rubber plantation on an otherwise forested hillside. Near Menghai it occupied a wet habitat on the low dikes of fishponds, but also occurred in nearby drier waste places. At the Rock Forest site it was found in dry rocky soil, but also occurred on a pond bank. At the Shuren site near Fengdu we found it on steep, open or heavily wooded mountain slopes and terraced agricultural lands that appeared to receive considerable rainfall. On the other hand, it occurred in dry, rocky mountainous habitats and on the borders of terraced agricultural plots. Geographically, it appears that YHR is widespread throughout southern and central China, probably occupying a latitude range from the southernmost extent of the country (about the 22nd latitude) north to the 30th latitude or beyond. Furthermore, its range probably occurs as a continuous band extending westward into southern Tibet and Burma to the Himalayan region of Northern India.

Despite its purported medicinal uses, none of the local farmers we spoke with indicated that it had any value, whether as a food source or for healing purposes. Based on these contacts, whatever cultural or medicinal uses YHR might have in northern India and elsewhere, as noted above, do not seem to have universal application throughout the Chinese range of this species.

Notwithstanding the wide geographic distribution of the species, YHR occurred as scattered individual plants, usually not more than 2 meters tall, wherever we found it, and the species could not be considered common at most sites visited. Thus, in contrast to its invasive nature in Hawai'i, we never found YHR in China forming tall, robust thickets and obviously colonizing habitats. Such lack of aggressiveness of invasive weeds in Hawai'i when observed in their native habitats has been noted in other biocontrol programs (Lutzow-Felling et al., 1995; Ellshoff et al., 1995). Aside from the obvious effects of removal by local farmers, factors accounting for this difference are not readily apparent. Even taking into account the number of insects attacking YHR in China that are not present in Hawai'i, this predation alone did not seem to fully account for its relative lack of aggressiveness in areas where it had not been physically controlled.

As noted above, Hawai'i has no commercial blackberry or raspberry production, and all introduced species of *Rubus* are weedy. Host specificity testing must focus on Hawai'i's two endemic species of 'akala, *R. hawaiensis* and *R. macraei* (the latter a "Species of Concern"), thereby insuring protection from any adverse effects of introduced biocontrol agents. Under the cooperative agreement, identification and initial host specificity screening is to be carried in China, reducing the pressure on the permitting process and the quarantine facilities in Hawai'i.

Although rust fungi have proven to be effective biocontrol agents for other weeds, including species of *Rubus* (e.g., *Phragmidium violaceum* on *R. fruticosus* in Australia [Bruzzese and Hasan, 1986]), *H. rubi-sieboldii* unfortunately did not systemically infect YHR and the local leaf lesions appeared to have minimal impact on plant health. It is possible that the rust may be capable of more severe infection under other environmental

conditions. However, based on current observations, the most promise for YHR biocontrol seems to reside with insect agents. I therefore recommend that entomologists from Hawai'i take an active future role in the YHR biocontrol program.

Many of the more prominent leaf feeding insects will undoubtedly be found to be generalist feeders, and therefore not suitable for further consideration. For testing in China, *R. hawaiensis* stem cuttings, both rooted and non-rooted, have been sent to the Institute of Plant Protection to establish a test plant population at that facility. Previous attempts at cultivating both species of '*akala* in other *Rubus* biocontrol programs have shown these species difficult to maintain in a greenhouse, however (Gardner et al., 1997). Cuttings, rather than seedlings, were preferred to facilitate more rapid establishment of mature plants. To avoid unnecessary impact on *R. macraei* populations, our strategy was to screen agents first against the more common species, using the more rare plant only when an agent does not attack *R. hawaiensis*.

Further survey work in China for YHR and its natural enemies is planned for other sites in Yunnan and Sichuan Provinces not previously visited, specifically near the communities to the east of Jinghong in Yunnan, and in the Emei Mountains southwest of Chengdu in Sichuan. Sites near the city of Guiyang in Guizhou Province have also been identified as having YHR. The species has also been reported from the mountains of Tibet. Future surveys may take place during other seasons, particularly in September or October, in an attempt to observe as wide a variety of natural enemies as possible.

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David Webb's Website

We call attention to Dr. David Webb's new website, accessible via the UH Botany Department's Home Page or at **http://www.botany.hawaii.edu/faculty/webb/default.htm**. The site includes tutorials and graphic presentations in support of the Botany 201 and 410 Courses, but also of interest to anyone with botanical inclinations.

Subjects include, but are not limited to: microscopy, including photomicroscopy, macrophotography of botanical subjects, scientific writing, labeling with PowerPoint, use of the Department's HP photoscanner, photoediting, and similar skills and procedures. The website is colorful, attractive, and well designed.

Editor's Note: Call for Contributions to the Newsletter of the Hawaiian Botanical Society

To all Bot. Soc. Members: We need your input to keep the Newsletter a viable publication. We know that there is a wealth of botanical and conservation-related information, knowledge and experience out there that should be published. Please contribute your articles, notes, and observations to the Newsletter!

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