

## Conservation Status and Research on the Fabulous Green Sphinx of Kaua'i, *Tinostoma smaragditis* (Lepidoptera: Sphingidae), Including Checklists of the Vascular Plants of the Diverse Mesic Forests of Kaua'i, Hawai'i<sup>1</sup>

M. L. HEDDLE,<sup>2</sup> K. R. WOOD,<sup>3</sup> A. ASQUITH,<sup>4</sup> AND R. G. GILLESPIE<sup>2</sup>

**ABSTRACT:** In 1895, a moth was captured in a mountain home in Makaweli, Kaua'i, that would captivate and elude entomologists for the next century. *Tinostoma smaragditis* (Meyrick), aptly nicknamed the "Fabulous Green Sphinx of Kaua'i" is a stunningly beautiful moth with green wings and thorax, pale brown hind wings, and orange antennae. Eighteen individuals are known to have been collected on Kaua'i. However, despite extensive searches in areas around Kōke'e, all the specimens discovered until the 1990s were incidental catches, and the natural habitat and host plant of the moth remained unknown. This study describes the results of extensive searches of the diverse mesic forests with the aim of establishing range, habitat, and host-plant associations of the Fabulous Green Sphinx. In February 1998 a male *T. smaragditis* was attracted to a mercury vapor light set up in the diverse mesic forest. Subsequently, one other specimen was collected in a similar habitat type on another part of the island. However, the host plant of the moth remains unknown. In this paper we provide a history of collections, a summary of known biology, and a guide to potential host plants, including checklists of vascular plants found in the diverse mesic forests of two locations where *T. smaragditis* was found, Kalalau and Mahanaloa Valleys on Kaua'i.

THE "FABULOUS GREEN SPHINX of Kaua'i," *Tinostoma smaragditis* (Meyrick), is an exquisite moth with brightly colored green wings and thorax, pale brown hind wings, and orange antennae. There are several distinct differences in morphology between the sexes: The male has a black spot on the forewing behind the second median line and a black band on the thorax behind the head. Both these markings are absent in the female. The underside of the female's fore and hind wings are a pale green, whereas those of the male are pinkish brown. The male antennae

are bipectinate; those of the female are filiform.

The first specimen of *T. smaragditis* collected was an adult male from Makaweli, Kaua'i, at 610 m and was given to R. C. L. Perkins for identification in 1895 (Meyrick 1899) (Figure 1). Despite searches for the moth and its larva (Zimmerman 1958), it was not until 1961 that a second adult specimen was discovered "resting on the lid of a garbage can" (Bryan 1962) on Kōke'e Road, Kaua'i. The third specimen, discovered at nearby Kalalau Lookout in 1969, marked the beginning of a series of collections as moths were drawn from the surrounding forest, attracted to the bright lights of the Air Force Tracking Station (1200 m) situated above the mesic forests of the Kōke'e region. The Bishop Museum now has six specimens from the area: Kalalau Lookout (1972), Kōke'e Air National Guard Station (1974, 1983 [2], and 1984), and Mahanaloa Valley (1998).

<sup>1</sup> This work was funded by a contract to the University of Hawai'i by the U.S. Fish and Wildlife Service. Manuscript accepted 3 May 1999.

<sup>2</sup> Center for Conservation Research and Training, and Department of Zoology, University of Hawai'i, Honolulu, Hawai'i 96822.

<sup>3</sup> National Tropical Botanical Garden, P.O. Box 340, Lāwa'i, Kaua'i, Hawai'i 96765.

<sup>4</sup> Kaua'i National Wildlife Refuge Complex, P.O. Box 87, Kīlauea, Kaua'i, Hawai'i 96754.

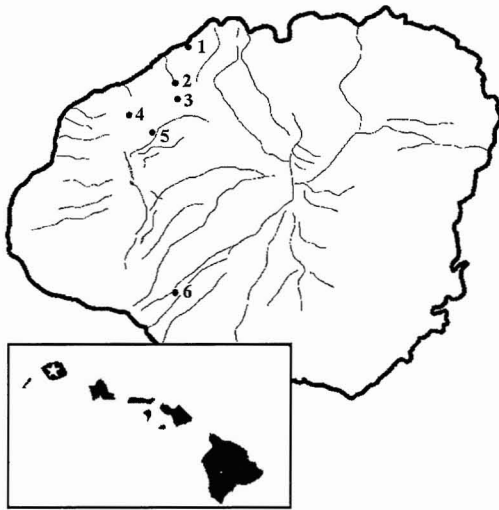


FIGURE 1. Main map: Island of Kaua'i showing distribution for collections of *Tinostoma smaragditis*. 1, Ho'olulu Valley, 1992; 2, Kalalau Valley, 1998; 3, Kalalau Lookout (tracking station), 1969 to present (10 specimens); 4, Mahanaloa Valley, 1998; 5, Halemanu, 1961; 6, Makaweli, 1895. Inset: Main chain of Hawaiian Islands. Star indicates island of Kaua'i.

Information on the larva of *T. smaragditis* comes largely from an adult female captured in 1992 in Ho'olulu Valley at 122 m elevation, which laid eggs in the container in which it was held. The larva, which averages 3.9 mm in length, has a reddish caudal horn about 2 mm long (Cambell and Ishii 1993). Larvae were also collected before the Cambell and Ishii (1993) study, although the observations were not published. The first instars and infertile eggs from this earlier collection were deposited at the Bishop Museum; the notes attached to the vial of larvae indicate that only 15 eggs were laid, and of these, only 5 were fertile. The eggs took 9 days to hatch, which concurs with the findings of Cambell and Ishii (1993).

The host plant of *T. smaragditis* remains unknown. Cambell and Ishii (1993) conducted extensive host-plant testing, but could not induce the first instars to feed on any of the native plants offered, nor on an artificial diet (Cambell and Ishii 1993).

Our study was initiated in November 1997 to determine the range, habitat, and host-

plant associations of the Fabulous Green Sphinx, focusing on the diverse mesic forests to the west of Kōke'e State Park. In our current survey we have investigated three regions of Kaua'i: Mahanaloa, Kalalau, and Waimea.

#### MATERIALS AND METHODS

A mercury vapor light powered by a generator (Honda EX350) was used to attract any moths present in the mesic forest. This light was run from dusk until around 2200 hours. Plants were searched for larvae by shaking vegetation onto a white sheet. In addition, the canopy was searched visually using binoculars.

#### RESULTS AND DISCUSSION

The first specimen captured in our study was deposited at Bernice P. Bishop Museum. The second specimen was photographed, and its proboscis was unrolled and measured. It was then released after being marked on its thorax with a yellow dye.

#### Distribution

Moths were captured in the Mahanaloa and Kalalau areas only (Figure 1). In February 1998 one of us (A.A.) was successful in attracting a male specimen to a mercury vapor light while collecting in Mahanaloa Valley (670 m). In October 1998 two of us (M.L.H. and K.R.W.) observed another male specimen that was attracted to light at an elevation of 640 m in the diverse mesic forest of Kalalau Valley. No larvae were observed.

#### Response to Light

On both occasions that *T. smaragditis* was caught at light in the current study, it was observed to fly directly toward the light. Although some Lepidoptera have been perceived as rare because they do not respond to lights, both male and female *T. smaragditis*

have been collected at lights on several occasions. If its native habitat is the low, diverse mesic forests, as we hypothesize, it is likely that a strong response to light takes it far up to the tracking station near Kalalau Lookout at Kōke'e State Park.

#### *Host Plants*

Both locations at which *T. smaragdita* was found, Mahanaloa and Kalalau, represent a globally imperiled plant community known as Diverse Mesic Forest (Wagner et al. 1990). This natural community is endemic to Kaua'i and is characterized by its rich diversity of native tree species along with the absence of a consistent set of dominant species. Common tree genera in both these regions include *Acacia*, *Alphitonia*, *Antidesma*, *Bobea*, *Charpentiera*, *Cheirodendron*, *Coprosma*, *Diospyros*, *Elaeocarpus*, *Hedyotis*, *Melicope*, *Metrosideros*, *Myrsine*, *Nestegis*, *Pipturus*, *Pisonia*, *Pleomele*, *Pouteria*, *Psychotria*, *Santalum*, *Syzygium*, and *Xylosma*. Other occasional components shared between these two Kaua'i Diverse Mesic Forest communities include *Claoxylon*, *Cryptocarya*, *Flueggea*, *Hibiscus*, *Morinda*, *Nerudia*, *Perrottetia*, *Pittosporum*, *Pteralyxia*, *Rauvolfia*, *Tetraplasandra*, *Wikstroemia*, and *Zanthoxylum*.

Regional checklists of vascular plants observed within *T. smaragdita* habitat for both Mahanaloa and Kalalau Valleys are provided in Appendix 2 and Appendix 3 of this paper. Because this project is ongoing, future observations, inventories, and comparison studies are planned for other site locations where *T. smaragdita* has been documented (e.g., 1992 sighting in Ho'olulu Valley). In addition, other relictual patches of lowland Diverse Mesic Forest communities on Kaua'i need more investigation, such as Pōhakuo Valley (upper hanging valley on the Nāpali coast) and the Koai'e Canyon region (including Hipalau and Kawaiiiki Valleys). To help ascertain the still unknown host plant for this distinctive and extremely rare moth, and in the likely event that the host plant will be a species restricted to Kaua'i and/or the Hawaiian Islands, also included is a list of

native Hawaiian vascular plant endemics that both sites have in common (Appendix 1).

At the time of writing of this paper, the host plant of *T. smaragdita* is still unknown. However, various entomologists have made several suggestions and observations with regard to possible hosts. The most extensive effort to establish the host plant was made by Cambell and Ishii (1993). The female moth discovered in 1992 was found on the endemic tree *Charpentiera densiflora*. At the time of collection, the tree was not searched for larvae or eggs (Gaden Kamakau, pers. comm.). The resultant larvae were not observed to feed on any of the 130 native plants offered to them, and Cambell and Ishii concluded that plant species used in their study are improbable candidates as host plants for *T. smaragdita*. However, several plants were offered to the larvae for 5 min only, including *Charpentiera densiflora*, the plant on which the female was resting. Because many species of Lepidoptera can take several hours to initiate feeding in captivity (M.L.H., pers. obs.), the plants listed in the Cambell and Ishii (1993) publication should not be excluded given the data available.

*Claoxylon sandwicense* was suggested as a host plant for *T. smaragdita* by Bianchi (1986) after he observed substantial herbivory on the plant in the vicinity of the tracking station where the moth had been collected. However, he searched the plants in the surrounding area and found no larvae.

In our surveys of the diverse mesic forests, we have observed extensive herbivory on *Nestegis sandwicensis*, *Pisonia sandwicensis*, *Pouteria sandwicensis*, and *Charpentiera densiflora*. The herbivore was not observed, but it is possible that it could have been *T. smaragdita*.

#### CONCLUSIONS

The Fabulous Green Sphinx of Kaua'i is not only a beautiful species, worthy of protection and study in its own right, but also provides us with an impressive means for attracting attention to the plight of the diverse

mesic forests of the Hawaiian Islands. It is our hope that, by learning more about the biology of this moth, particularly its feeding habits, we can learn more about effective management of its habitat and therefore protect from endangerment and extinction the birds, plants, and other insects that constitute the biotic community of the diverse mesic forest of Kaua'i.

#### ACKNOWLEDGMENTS

This study was supported by grants from the U.S. Fish and Wildlife Service, and the Ecology, Evolution, and Conservation Biology Graduate Program at the University of Hawai'i. Dean Jamieson, Gaden Kamakau, and J. C. E. Riotte all contributed valuable information on their observations of this rare moth. We thank Edwin Pettys, Wayne Sousa, and Victor Tanimoto for their help in obtaining access to the areas in which we needed to collect. We also thank the pilots and employees of Inter Island Helicopters.

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#### APPENDIX 1

CHECKLIST OF ENDEMIC HAWAIIAN PLANTS COMMON TO MAHANALOA VALLEY AND KALALAU VALLEY DIVERSE MESIC FORESTS (SPECIES ENDEMIC TO KAUA'I DENOTED BY AN ASTERISK\*)

##### Ferns and Fern Allies

###### Blechnaceae

- Doodia kunthiana* Gaud.  
*Sadleria pallida* Hook. & Arnott

###### Cyatheaceae

- Cibotium glaucum* (Sm.) Hook. & Arnott

###### Dennstaedtiaceae

- Pteridium decompositum* Gaud.

###### Dryopteridaceae

- Diplazium sandwichianum* (Presl) Diels  
*Dryopteris glabra* (Brack.) Kuntze  
*Dryopteris unidentata* (Hook. & Arnott) C. Chr.  
*Nephrolepis exaltata* (L.) Schott  
subsp. *hawaiiensis* W. H. Wagner  
*Tectaria cicutaria* (L.) Copel.  
subsp. *gaudichaudii* (Mett.) W. H. Wagner

###### Grammitidaceae

- Grammitis tenella* Kaulf.

###### Pteridaceae

- Coniogramme pilosa* (Brack.) Hieron.  
*Doryopteris decipiens* (Sm.) Hook.

###### Selaginellaceae

- Selaginella arbuscula* (Kaulf.) Spring

##### Monocots

###### Agavaceae

- \**Pleomele aurea* (H. Mann) N. E. Brown

###### Cyperaceae

- Carex wahuensis* C. A. Mey.  
subsp. *wahuensis*

- Gahnia beecheyi* H. Mann

- Mariscus phleoides* Nees ex Kunth  
subsp. *phleoides*

###### Juncaceae

- Luzula hawaiiensis* Buchenau  
var. *hawaiiensis*

###### Poaceae

- Eragrostis variabilis* (Gaud.) Steud.

###### Smilacaceae

- Smilax melastomifolia* Sm.

##### Dicots

###### Amaranthaceae

- \**Charpentiera elliptica* (Hillebr.) A. Heller  
*Nototrichium sandwicense* (A. Gray) Hillebr.

###### Apocynaceae

- Alyxia oliviformis* Gaud.  
\**Pteralyxia kauaiensis* Caum  
*Rauwolfia sandwicensis* A. DC

###### Araliaceae

- \**Cheirodendron trigynum* (Gaud.) A. Heller  
subsp. *helleri* (Sherff) Lowry  
*Tetraplasandra kavaiensis* (H. Mann) Sherff  
\**Tetraplasandra waimeae* Wawra

###### Asteraceae

- Artemisia australis* Less.  
*Bidens sandwicensis* Less.  
subsp. *sandwicensis*  
\**Wilkesia gymnoxiphium* A. Gray

Brassicaceae  
 \**Lepidium serra* H. Mann  
 Campanulaceae  
 \**Cyanea sylvestris* A. Heller  
*Lobelia hypoleuca* Hillebr.  
 Caryophyllaceae  
 \**Schiedea kauaiensis* St. John  
 Celastraceae  
*Perrottetia sandwicensis* A. Gray  
 Ebenaceae  
*Diospyros hillebrandii* (Seem.) Fosb.  
*Diospyros sandwicensis* (A. DC) Fosb.  
 Elaeocarpaceae  
*Elaeocarpus bifidus* Hook. & Arnott  
 Ericaceae  
*Vaccinium dentatum* Sm.  
 Euphorbiaceae  
 \**Antidesma platyphyllum* H. Mann  
 var. *hillebrandii* Pax & K. Hoffm.  
*Claoxylon sandwicense* Mull. Arg.  
 \**Chamaesyce atrococca* (A. Heller) Croizat & Degener  
 \**Chamaesyce celastroides* (Boiss.) Croizat & Degener  
 var. *hanapensis* (Sherff) Degener & I. Degener  
*Euphorbia haeleleana* Herbst  
*Flueggea neowawraea* W. Hayden  
 Fabaceae  
*Acacia koa* A. Gray  
 Flacourtiaceae  
*Xylosma hawaiiensis* Seem.  
 Goodeniaceae  
*Scaevola procera* Hillebr.  
 Hydrangeaceae  
*Broussaisia arguta* Gaud.  
 Lauraceae  
*Cryptocarya mannii* Hillebr.  
 Myrsinaceae  
*Myrsine lanaiensis* Hillebr.  
 Myrtaceae  
*Metrosideros polymorpha* Gaud.  
 var. *glaberrima* (H. Lév.) St. John  
*Syzygium sandwicensis* (A. Gray) Nied.  
 Nyctaginaceae  
*Pisonia sandwicensis* Hillebr.  
 Oleaceae  
*Nestegis sandwicensis* (A. Gray) Degener, I. Degener & L. Johnson  
 Piperaceae  
*Peperomia latifolia* Miq.  
 Pittosporaceae  
*Pittosporum glabrum* Hook. & Arnott  
 \**Pittosporum kauaiense* Hillebr.  
 Rhamnaceae  
*Alphitonia ponderosa* Hillebr.  
 Rubiaceae  
*Bobea brevipes* A. Gray  
*Coprosma foliosa* A. Gray  
 \**Coprosma waimeae* Wawra  
*Hedyotis terminalis* (Hook. & Arnott) W. L. Wagner & Herbst  
*Morinda trimeria* Hillebr.

\**Psychotria greenwelliae* Fosb.  
 \**Psychotria hobbyi* Sohmer  
*Psychotria mariniana* (Cham. & Schlechtend.) Fosb.  
 Rutaceae  
 \**Melicope anisata* (H. Mann) T. Hartley & B. Stone  
*Zanthoxylum dipetalum* H. Mann  
 var. *dipetalum*  
 Santalaceae  
 \**Santalum freycinetianum* Gaud.  
 var. *pyrularium* (A. Gray) Stemmermann  
 Sapotaceae  
*Pouteria sandwicensis* (A. Gray) Baehni & Degener  
 Thymeliaceae  
*Wikstroemia oahuensis* (A. Gray) Rock  
 Urticaceae  
*Boehmeria grandis* (Hook. & Arnott) A. Heller  
*Neraudia melastomifolia* Gaud.  
*Pipturus albidus* (Hook. & Arnott) A. Gray  
 \**Pipturus kauaiensis* A. Heller

## APPENDIX 2

CHECKLIST OF VASCULAR PLANTS OF MAHANALOA VALLEY, KAUA'I, HAWAII (1600–2400 FT [490–730 M] ELEVATION) (NAMES FOR FLOWERING PLANTS FOLLOW WAGNER ET AL. [1990]; NAMES FOR PTERIDOPHYTES FOLLOW UNPUBLISHED CHECKLIST BY W. H. & F. WAGNER)

## Ferns and Fern Allies

Aspleniaceae  
*Asplenium cookii* Copel.  
*Asplenium excisum* Presl  
*Asplenium kaulfussii* Schlechtend.  
*Asplenium nidus* L.  
*Diellia pallida* W. H. Wagner  
 Blechnaceae  
*Blechnum occidentale* L.  
*Doodia kunthiana* Gaud.  
*Sadleria pallida* Hook. & Arnott  
 Cyatheaceae  
*Cibotium glaucum* (Sm.) Hook. & Arnott  
 Dennstaedtiaceae  
*Microlepia speluncae* W. H. Wagner  
*Microlepia strigosa* (Thunb.) Presl  
*Pteridium decompositum* Gaud.  
 Dryopteridaceae  
*Cyrtomium caryotideum* Presl  
*Deparia petersenii* (Kunze) M. Kato  
*Diplazium sandwichianum* (Presl) Diels  
*Dryopteris fusco-atra* (Hillebr.) Robinson  
*Dryopteris glabra* (Brack.) Kuntze  
*Dryopteris unidentata* (Hook. & Arnott) C. Chr.  
*Elaphoglossum paleaceum* (Hook. & Arnott) Sledge  
*Nephrolepis exaltata* (L.) Schott  
 subsp. *hawaiiensis* W. H. Wagner  
*Tectaria cicutaria* (L.) Copel.  
 subsp. *gaudichaudii* (Mett.) W. H. Wagner  
 Gleicheniaceae  
*Dicranopteris linearis* (N. L. Burm.) Underw.  
*Diplopterygium pinnatum* (Kunze) Nakai

- Grammitidaceae  
*Adenophorus tamariscinus* (Kaulf.) Hook. & Grev.  
*Grammitis tenella* Kaulf.
- Lindsaeaceae  
*Odontosoria chinensis* (L.) J. Sm.
- Polypodiaceae  
*Lepisorus thunbergianus* (Kaulf.) Ching  
*Polypodium helleri* Underw.
- Psilotaceae  
*Psilotum nudum* (L.) Beauv.
- Pteridaceae  
*Adiantum hispidulum* Sw.  
*Adiantum raddianum* Presl  
*Coniogramme pilosa* (Brack.) Hieron.  
*Doryopteris decipiens* (Sm.) Hook.  
*Pityrogramma austroamericana* Domin  
*Pteris excelsa* Gaud.  
*Pteris [x] hillebrandii* Copel.  
*Pteris irregularis* Kaulf.  
*Pteris cretica* L.
- Selaginellaceae  
*Selaginella arbuscula* (Kaulf.) Spring
- Thelypteridaceae  
*Thelypteris dentata* (Forsk.) E. St. John  
*Thelypteris parisitica* (L.) Fosb.
- Monocots
- Agavaceae  
*Cordylone fruticosa* (L.) A. Chev.  
*Pleomele aurea* (H. Mann) N. E. Brown
- Cyperaceae  
*Carex meyenii* Nees  
*Carex wahuensis* C. A. Mey.  
subsp. *wahuensis*  
*Gahnia beecheyi* H. Mann  
*Mariscus hillebrandii* (Boeck.) T. Koyama  
subsp. *decipiens* (Hillebr.) T. Koyama  
*Mariscus meyenianus* (Kunth) Nees  
*Mariscus phleoides* Nees ex Kunth  
subsp. *phleoides*
- Juncaceae  
*Luzula hawaiiensis* Buchenau  
var. *hawaiiensis*
- Liliaceae  
*Dianella sandwicensis* Hook. & Arnott
- Menispermaceae  
*Cocculus trilobus* (Thunb.) DC
- Pandanaceae  
*Freycinetia arborea* Gaud.
- Passifloraceae  
*Passiflora ligularis* Juss.
- Poaceae  
*Agrostis avenacea* J. G. Gmelin  
*Bromus mollis* L.  
*Bromus rigidus* Roth  
*Digitaria setigera* Roth  
*Eragrostis grandis* Hillebr.  
*Eragrostis variabilis* (Gaud.) Steud.  
*Holcus lanatus* L.  
*Oplismenus hirtellus* (L.) P. Beauv.  
*Panicum nephelophilum* Gaud.  
*Paspalum urvillei* Steud.
- Poa mannii* Munro ex Hillebr.  
*Schizachyrium condensatum* (Kunth) Nees  
*Setaria gracilis* Kunth  
*Vulpia bromoides* (L.) S. F. Gray
- Smilacaceae  
*Smilax melastomifolia* Sm.
- Zingiberaceae  
*Hedychium gardnerianum* Ker-Gawl.
- Dicots
- Amaranthaceae  
*Charpentiera elliptica* (Hillebr.) A. Heller  
*Nototrichium sandwicense* (A. Gray) Hillebr.
- Apocynaceae  
*Alyxia oliviformis* Gaud.  
*Pteralyxia kauaiensis* Caum  
*Rauwolfia sandwicensis* A. DC
- Araliaceae  
*Cheirodendron trigynum* (Gaud.) A. Heller  
subsp. *helleri* (Sherff) Lowry  
*Tetraplasandra kauaiensis* (H. Mann) Sherff  
*Tetraplasandra waimeae* Wawra
- Asteraceae  
*Ageratum conyzoides* L.  
*Artemisia australis* Less.  
*Bidens sandwicensis* Less.  
subsp. *sandwicensis*  
*Conyza bonariensis* (L.) Cronq.  
*Dubautia laevigata* A. Gray  
*Elephantopus mollis* Kunth  
*Emelia fosbergii* Nicolson  
*Erechtites valerianifolia* (Wolf) DC  
*Erigeron karvinskianus* DC  
*Lipochaeta fauriei* H. Lev.  
*Pluchea symphytifolia* (Mill.) Gillis  
*Remya kauaiensis* Hillebr.  
*Sonchus oleraceus* L.  
*Wilkesia gymnoxiphium* A. Gray  
*Youngia japonica* (L.) DC
- Brassicaceae  
*Lepidium serra* H. Mann
- Campanulaceae  
*Cyanea hirtella* (H. Mann) Hillebr.  
*Cyanea sylvestris* A. Heller  
*Delissea rhytidosperra* H. Mann  
*Delissea undulata* Gaud.  
subsp. *kauaiensis* Lammers  
*Lobelia hypoleuca* Hillebr.  
*Lobelia yuccoides* Hillebr.
- Caryophyllaceae  
*Schiedea kauaiensis* St. John  
*Schiedea membranacea* St. John
- Celastraceae  
*Perrottetia sandwicensis* A. Gray
- Convolvulaceae  
*Ipomoea cairica* (L.) Sweet
- Crassulaceae  
*Kalanchoë pinnata* (Lam.) Pers.
- Ebenaceae  
*Diospyros hillebrandii* (Seem.) Fosb.  
*Diospyros sandwicensis* (A. DC) Fosb.
- Elaeocarpaceae





PLATE 1. An adult male *Tinostoma smaragditis*, captured in Mahanaloa Valley, Kaua'i, in January 1999. Photo credit: M. L. Hedde and David Preston.



PLATE 2. An adult male *Tinostoma smaragditiis*, captured in Mahanaloa Valley, Kaua'i, in January 1999. Photo credit: M. L. Hedde and David Preston.



- Elaeocarpus bifidus* Hook. & Arnott
- Epacridaceae  
*Styphelia tameiameia* (Cham. & Schlechtend.) F. v. Muell.
- Ericaceae  
*Vaccinium dentatum* Sm.
- Euphorbiaceae  
*Aleurites moluccana* (L.) Willd.  
*Antidesma platyphyllum* H. Mann  
var. *hillebrandii* Pax & K. Hoffm.  
*Claoxylon sandwicense* Mull. Arg.  
*Chamaesyce atrocoeca* (A. Heller) Croizat & Degener  
*Chamaesyce celastroides* (Boiss.) Croizat & Degener  
var. *hanapepensis* (Sherff) Degener & I. Degener  
*Chamaesyce halemanui* (Sherff) Croizat & Degener  
*Euphorbia haeleleana* Herbst  
*Flueggea neowawraea* W. Hayden
- Fabaceae  
*Acacia koa* A. Gray  
*Canavalia kauaiensis* J. Sauer  
*Sophora chrysophylla* (Salisb.) Seem.
- Flacourtiaceae  
*Xylosma hawaiiensis* Seem.
- Goodeniaceae  
*Scaevola gaudichaudii* Hook. & Arnott  
*Scaevola procera* Hillebr.
- Hydrangeaceae  
*Broussaisia arguta* Gaud.
- Lauraceae  
*Cryptocarya mannii* Hillebr.
- Loganiaceae  
*Labordia degeneri* Sherff
- Malvaceae  
*Abutilon grandifolium* (Willd.) Sweet  
*Hibiscus waimeae* A. Heller  
subsp. *waimeae*  
*Kokia kauaiensis* (Rock) Degener & Duvel  
*Sida fallax* Walp.
- Moraceae  
*Strebilus pendulinus* (Endl.) F. v. Muell.
- Myrsinaceae  
*Embelia pacifica* Hillebr.  
*Myrsine lanaiensis* Hillebr.
- Myrtaceae  
*Metrosideros polymorpha* Gaud.  
var. *glaberrima* (H. Lév.) St. John  
*Psidium cattleianum* Sabine  
*Psidium guajava* L.  
*Syzygium sandwicense* (A. Gray) Nied.
- Nyctaginaceae  
*Pisonia sandwicensis* Hillebr.
- Oleaceae  
*Nestegis sandwicensis* (A. Gray) Degener, I. Degener & L. Johnson
- Oxalidaceae  
*Oxalis corniculata* L.
- Phytolaccaceae  
*Phytolacca octandra* L.
- Piperaceae  
*Peperomia cookiana* C. DC
- Peperomia kokeana* Yuncker  
*Peperomia latifolia* Miq.  
*Peperomia tetraphylla* (G. Forster) Hook. & Arnott
- Pittosporaceae  
*Pittosporum glabrum* Hook. & Arnott  
*Pittosporum kauaiense* Hillebr.
- Primulaceae  
*Lysimachia kalalauensis* Skottsb.
- Proteaceae  
*Grevillea robusta* A. Cunn ex R. Br.
- Rhamnaceae  
*Alphitonia ponderosa* Hillebr.
- Rosaceae  
*Rubus rosifolius* Sm.
- Rubiaceae  
*Bobeia brevipes* A. Gray  
*Canthium odoratum* (G. Forster) Seem.  
*Coprosma foliosa* A. Gray  
*Coprosma waimeae* Wawra  
*Hedyotis knudsenii* (Hillebr.) Fosb.  
*Hedyotis schlechtendahliana* Steud.  
var. *schlechtendahliana*  
*Hedyotis terminalis* (Hook. & Arnott) W. L. Wagner & Herbst  
*Morinda trimera* Hillebr.  
*Psychotria greenwelliae* Fosb.  
*Psychotria hobdyi* Sohmer  
*Psychotria mariniana* (Cham. & Schlechtend.) Fosb.
- Rutaceae  
*Melicope anisata* (H. Mann) T. Hartley & B. Stone  
*Melicope barbigeria* A. Gray  
*Melicope ovata* (St. John & E. Hume) T. Hartley & B. Stone  
*Zanthoxylum dipetalum* H. Mann  
var. *dipetalum*
- Santalaceae  
*Santalum freycinetianum* Gaud.  
var. *pyrularium* (A. Gray) Stemmermann
- Sapindaceae  
*Dodonaea viscosa* Jacq.
- Sapotaceae  
*Pouteria sandwicensis* (A. Gray) Baehni & Degener
- Solanaceae  
*Solanum americanum* Mill.
- Thymeliaceae  
*Wikstroemia furcata* (Hillebr.) Rock  
*Wikstroemia oahuensis* (A. Gray) Rock
- Urticaceae  
*Boehmeria grandis* (Hook. & Arnott) A. Heller  
*Neraudia melastomifolia* Gaud.  
*Pipturus albidus* (Hook. & Arnott) A. Gray  
*Pipturus kauaiensis* A. Heller  
*Touchardia latifolia* Gaud.
- Verbenaceae  
*Lantana camara* L.  
*Verbena litoralis* Kunth
- Violaceae  
*Isodendron laurifolium* A. Gray
- Viscaceae  
*Korthalsella complanata* (Tiegh.) Engl.

## APPENDIX 3

CHECKLIST OF VASCULAR PLANTS OF KALALAU VALLEY, KAUA'I, HAWAII (BELOW PIHEA, 2000–2600 FT [610–790 M] ELEVATION) (NAMES FOR FLOWERING PLANTS FOLLOW WAGNER ET AL. [1990]; NAMES FOR PTERIDOPHYTES FOLLOW UNPUBLISHED CHECKLIST BY W. H. & F. WAGNER)

## Ferns and Fern Allies

- Aspleniaceae  
*Asplenium nidus* L.
- Blechnaceae  
*Blechnum occidentale* L.  
*Doodia kunthiana* Gaud.  
*Sadleria pallida* Hook. & Arnott
- Cyatheaceae  
*Cibotium glaucum* (Sm.) Hook. & Arnott  
*Cibotium nealiae* Degener
- Dennstaedtiaceae  
*Microlepia speluncae* W. H. Wagner  
*Microlepia strigosa* (Thunb.) Presl  
*Peridium decompositum* Gaud.
- Dryopteridaceae  
*Deparia petersenii* (Kunze) M. Kato  
*Diplazium sandwichianum* (Presl) Diels  
*Dryopteris glabra* (Brack.) Kuntze  
*Dryopteris unidentata* (Hook. & Arnott) C. Chr.  
*Nephrolepis exaltata* (L.) Schott  
 subsp. *hawaiiensis* W. H. Wagner  
*Tectaria cicutaria* (L.) Copel.  
 subsp. *gaudichaudii* (Mett.) W. H. Wagner
- Gleicheniaceae  
*Dicranopteris linearis* (N. L. Burm.) Underw.  
*Diplopterygium pinnatum* (Kunze) Nakai
- Grammitidaceae  
*Grammitis tenella* Kaulf.
- Lindsaeaceae  
*Odontosoria chinensis* (L.) J. Sm.
- Polypodiaceae  
*Lepisorus thunbergianus* (Kaulf.) Ching
- Psilotaceae  
*Psilotum nudum* (L.) Beauv.
- Pteridaceae  
*Adiantum hispidulum* Sw.  
*Adiantum raddianum* Presl  
*Coniogramme pilosa* (Brack.) Hieron.  
*Doryopteris decipiens* (Sm.) Hook.  
*Pityrogramma austroamericana* Domin  
*Pteris excelsa* Gaud.
- Selaginellaceae  
*Selaginella arbuscula* (Kaulf.) Spring
- Thelypteridaceae  
*Pseudophegopteris keraudreniana* (Gaud.) Holttum  
*Thelypteris dentata* (Forsk.) E. St. John  
*Thelypteris stegnogrammoides* (Baker) Fosb.
- Monocots
- Agavaceae  
*Cordyline fruticosa* (L.) A. Chev.  
*Pleomele aurea* (H. Mann) N. E. Brown
- Areaceae  
*Pritchardia minor* Becc.

## Cyperaceae

- Carex meyenii* Nees  
*Carex wahuensis* C. A. Mey.  
 subsp. *wahuensis*  
*Gahnia beecheyi* H. Mann  
*Kyllinga brevifolia* Rottb.  
*Mariscus meyenianus* (Kunth) Nees  
*Mariscus phleoides* Nees ex Kunth  
 subsp. *phleoides*
- Juncaceae  
*Luzula hawaiiensis* Buchenau  
 var. *hawaiiensis*
- Liliaceae  
*Dianella sandwicensis* Hook. & Arnott
- Pandanaceae  
*Freycinetia arborea* Gaud.
- Poaceae  
*Eragrostis variabilis* (Gaud.) Steud.  
*Oplismenus hirtellus* (L.) P. Beauv.  
*Panicum lineale* St. John  
*Paspalum urvillei* Steud.  
*Sacciolepis indica* (L.) Chase  
*Schizachyrium condensatum* (Kunth) Nees  
*Setaria gracilis* Kunth  
*Vulpia bromoides* (L.) S. F. Gray

## Smilacaceae

- Smilax melastomifolia* Sm.

## Dicots

- Amaranthaceae  
*Charpentiera densiflora* Sohmer  
*Charpentiera elliptica* (Hillebr.) A. Heller  
*Nototrichium divaricatum* Lorence  
*Nototrichium sandwicense* (A. Gray) Hillebr.
- Apocynaceae  
*Alyxia oliviformis* Gaud.  
*Pteralyxia kauaiensis* Caum  
*Rauvolfia sandwicensis* A. DC
- Aquifoliaceae  
*Ilex anomala* Hook. & Arnott
- Araliaceae  
*Cheirodendron trigynum* (Gaud.) A. Heller  
 subsp. *helleri* (Sherff) Lowry  
*Tetraplasandra kawaiensis* (H. Mann) Sherff  
*Tetraplasandra waimeae* Wawra
- Asteraceae  
*Artemisia australis* Less.  
*Bidens sandwicensis* Less.  
 subsp. *sandwicensis*  
*Conyza bonariensis* (L.) Cronq.  
*Dubautia microcephala* Skottsbo.  
*Elephantopus mollis* Kunth  
*Erigeron karvinskianus* DC  
*Pluchea symphytifolia* (Mill.) Gillis  
*Wilkesia gymnoxiphium* A. Gray
- Brassicaceae  
*Lepidium serra* H. Mann
- Campanulaceae  
*Cyanea sylvestris* A. Heller  
*Lobelia hypoleuca* Hillebr.  
*Lobelia niihauensis* St. John
- Caryophyllaceae  
*Schiedea kauaiensis* St. John

- Celastraceae  
*Perrottetia sandwicensis* A. Gray
- Convolvulaceae  
*Bonamia menziesii* A. Gray  
*Ipomoea tuboides* Degener & Ooststr.
- Crassulaceae  
*Kalanchoë pinnata* (Lam.) Pers.
- Ebenaceae  
*Diospyros hillebrandii* (Seem.) Fosb.  
*Diospyros sandwicensis* (A. DC) Fosb.
- Elaeocarpaceae  
*Elaeocarpus bifidus* Hook. & Arnott
- Epacridaceae  
*Styphelia tameiameia* (Cham. & Schlechtend.) F. v. Muell.
- Ericaceae  
*Vaccinium dentatum* Sm.
- Euphorbiaceae  
*Aleurites moluccana* (L.) Willd.  
*Antidesma platyphyllum* H. Mann  
 var. *hillebrandii* Pax & K. Hoffm.  
*Claoxylon sandwicense* Mull. Arg.  
*Chamaesyce atrococca* (A. Heller) Croizat & Degener  
*Chamaesyce celastroides* (Boiss.) Croizat & Degener  
 var. *hanapepensis* (Sherff) Degener & I. Degener  
*Euphorbia haeleleana* Herbst  
*Flueggea neowawraea* W. Hayden
- Fabaceae  
*Acacia koa* A. Gray  
*Leucaena leucocephala* (Lam.) de Wit
- Flacourtiaceae  
*Xylosma hawaiiensis* Seem.
- Goodeniaceae  
*Scaevola procera* Hillebr.
- Hydrangeaceae  
*Broussaisia arguta* Gaud.
- Lauraceae  
*Cryptocarya mannii* Hillebr.
- Malvaceae  
*Abutilon grandifolium* (Willd.) Sweet  
*Hibiscus kokio* Hillebr. ex Wawra  
 subsp. *saintjohnianus* (M. Roe) D. Bates  
*Sida fallax* Walp.
- Moraceae  
*Streblus pendulinus* (Endl.) F. v. Muell.
- Myrsinaceae  
*Myrsine lanaiensis* Hillebr.
- Myrtaceae  
*Metrosideros polymorpha* Gaud.  
 var. *glaberrima* (H. Lév.) St. John  
*Psidium guajava* L.  
*Syzygium sandwicensis* (A. Gray) Nied.
- Nyctaginaceae  
*Pisonia sandwicensis* Hillebr.
- Oleaceae  
*Nestegis sandwicensis* (A. Gray) Degener, I. Degener & L. Johnson
- Piperaceae  
*Peperomia latifolia* Miq.  
*Peperomia tetraphylla* (G. Forster) Hook. & Arnott
- Pittosporaceae  
*Pittosporum glabrum* Hook. & Arnott  
*Pittosporum kauaiense* Hillebr.  
*Pittosporum napaliense* Sherff
- Primulaceae  
*Lysimachia glutinosa* Rock
- Rhamnaceae  
*Alphitonia ponderosa* Hillebr.  
*Gouania meyenii* Steud.
- Rosaceae  
*Rubus rosifolius* Sm.
- Rubiaceae  
*Bobea brevipes* A. Gray  
*Bobea elatior* Gaud.  
*Bobea timoniodes* (J. D. Hook.) Hillebr.  
*Canthium odoratum* (G. Forster) Seem.  
*Coprosma foliosa* A. Gray  
*Coprosma waimeae* Wawra  
*Gardenia remyi* H. Mann  
*Hedyotis terminalis* (Hook. & Arnott) W. L. Wagner & Herbst  
*Morinda trimera* Hillebr.  
*Psychotria greenwelliae* Fosb.  
*Psychotria hobdyi* Sohmer  
*Psychotria mariniana* (Cham. & Schlechtend.) Fosb.
- Rutaceae  
*Melicope anisata* (H. Mann) T. Hartley & B. Stone  
*Melicope pallida* (Hillebr.) T. Hartley & B. Stone  
*Zanthoxylum dipetalum* H. Mann  
 var. *dipetalum*  
*Zanthoxylum kauaense* A. Gray
- Santalaceae  
*Santalum freycinetianum* Gaud.  
 var. *pyrularium* (A. Gray) Stemmermann
- Sapindaceae  
*Dodonaea viscosa* Jacq.
- Sapotaceae  
*Pouteria sandwicensis* (A. Gray) Baehni & Degener
- Thymeliaceae  
*Wikstroemia oahuensis* (A. Gray) Rock
- Urticaceae  
*Boehmeria grandis* (Hook. & Arnott) A. Heller  
*Neraudia melastomifolia* Gaud.  
*Pipturus albidus* (Hook. & Arnott) A. Gray  
*Pipturus kauaiensis* A. Heller
- Verbenaceae  
*Lantana camara* L.
- Viscaceae  
*Korthalsella platycaula* (Tiegh.) Engl.