

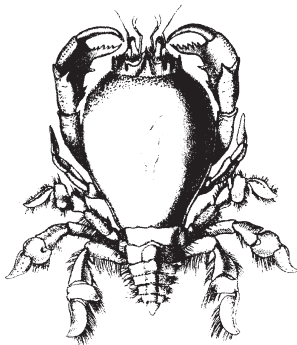
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BISHOP MUSEUM OCCASIONAL PAPERS

RECORDS OF THE
HAWAII BIOLOGICAL SURVEY
FOR 2004–2005
PART 1: ARTICLES

NEAL L. EVENHUIS
AND
LUCIUS G. ELDREDGE, EDITORS



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Cover illustration: *Notopoides latus*, a frog or spanner crab found throughout the Indo-Pacific and known from Hawaiian waters (Illustration from Henderson, 1888, *Results of the Challenger Expedition* 27: pl. 3, fig. 1).

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BISHOP MUSEUM

The State Museum of Natural and Cultural History
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**RECORDS OF THE
HAWAII BIOLOGICAL SURVEY
FOR 2004–2005
Part 1: Articles**

Editors' Preface

We are pleased to present the annual compilation of *Records of the Hawaii Biological Survey*; this year for the years 2004–2005. The number and diversity of taxa reported in these issues attest to the continuing value of the *Records* as part of the ongoing effort to inventory the Hawaiian biota accurately.

The Hawaii Biological Survey, established by the Hawaii State Legislature in 1992 as a program of Bishop Museum, is an ongoing natural history inventory of the Hawaiian Archipelago. It was created to locate, identify, and evaluate all native and nonnative species of flora and fauna within the state; and by State Law to maintain the reference collections of that flora and fauna for a wide range of uses. In coordination with related activities in other federal, state, and private agencies, the Hawaii Biological Survey gathers, analyzes, and disseminates biological information necessary for the wise stewardship of Hawaii's biological resources

Some of the highlights of *Records of the Hawaii Biological Survey for 2004–2005* include:

- a checklist of the plants of Lehua Islet;
- a checklist of the beetles of Lehua Islet;
- a new species of azooanthellate coral with an updated checklist;
- a new species of predaceous fungus gnats;
- discovery of fossil leaf gall on O'ahu;
- new records of plants, lizards, insects, and other invertebrates resulting from field surveys and continued curation of Hawaiian collections at the Bishop Museum and elsewhere.

An intensive and coordinated effort has been made by the Hawaii Biological Survey to make our products, including many of the databases supporting papers published here, available to the widest user-community possible through our web server. Products currently available include taxonomic authority files (species checklists for terrestrial arthropods, flowering plants, nonmarine snails, marine invertebrates, fossil taxa, and vertebrates), bibliographic databases (vascular plants, nonmarine snails, and insects), specimen databases (fungi, fish, invertebrates, portions of the insect collection) and type specimens (entomology; botany—including algae and fungi; and vertebrates), collections data (lists of holdings for select groups of flies as well as Cicadellidae and Pentatomidae), detailed information and/or images on endangered, threatened, and extinct plants and animals; as well as our staff publication lists. Additional reference databases include: the list of insect and spider collections of the world (based on Arnett, Samuelson & Nishida, 1993, *Insect and spider collections of the world*) with links to institutional web pages where known;

and the historical world Diptera taxonomists list with names of over 4,810 authors who have described flies.

Our Main Web Addresses:

Hawaii Biological Survey Home Page

<http://hbs.bishopmuseum.org/>

Hawaii Biological Survey Databases

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Hawaii Endangered and Threatened Species Web Site

<http://hbs.bishopmuseum.org/endangered/>

Insect and Spider Collections of the World Web Site

<http://hbs.bishopmuseum.org/codens/>

Hawaii Biological Survey's "Good Guys/Bad Guys" website

<http://hbs.bishopmuseum.org/good-bad/>

World Diptera taxonomist list

<http://hbs.bishopmuseum.org/dipterists/>

The *Records of the Hawaii Biological Survey for 2004–2005* were compiled with the assistance of George Staples and Clyde Imada (botany), Allen Allison (vertebrate zoology), and Frank Howarth and G. Allan Samuelson (entomology) who helped review papers; and was partially supported by funds from the John D. and Catherine T. MacArthur Foundation. Many of the new records reported here resulted from curatorial projects funded by the National Science Foundation and field surveys funded by the David and Lucile Packard Foundation, U.S. Geological Survey Biological Resources Division, U.S. Fish & Wildlife Service, and the Hawaii Department of Land and Natural Resources.

We encourage authors with new information concerning flora or fauna occurring in the Hawaiian Islands to submit their data to the editors listed below for consideration for publication in the next *Records*. Submission and format of papers must follow our guidelines. Information on submission of manuscripts and guidelines for contributors may be obtained on the web (via pdf format) at:

<http://hbs.bishopmuseum.org/guidelines.pdf>

or by mail from: Hawaii Biological Survey, Department of Natural Sciences, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817-2704, USA.

—N.L. Evenhuis &
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New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O‘ahu

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In 1918, the Hawaiian Sugar Planters’ Association (HSPA) established an arboretum in Mānoa Valley with the purpose of identifying promising exotic plants to reforest Hawai‘i’s denuded watersheds. Harold L. Lyon served as the Arboretum’s first director. Over a nearly 40-year period, he oversaw the transformation of the 80-hectare Mānoa property from thickets of guava (*Psidium guajava*) and California grass (*Brachiaria mutica*), and later abandoned sugar cane, into a diverse patchwork of tropical trees and other exotic plants. To this date, roughly 6000 plant species have been outplanted at Harold L. Lyon Arboretum, which is broadly divided into two regions: ‘Aihualama and Haukulu, separated by ‘Aihualama Stream. The elevation ranges from 135 m up to roughly 550 m along the upper slopes of the valley walls. The environment is mesic-wet, with an average of 400 cm of rainfall per year, well distributed throughout the year.

Excellent planting records have been maintained that tell us the date and location(s) of planting, as well as the origin of each accession. Some of the plantings failed immediately, but many were successfully established. From 1921 to 1950, Lyon and grounds manager Ed Caum produced annual reports to HSPA in which they enthusiastically noted naturalized seedlings whenever they were found. After all, the objective was to create a sustainable tropical forest that would protect the watershed. However, a few of the early plantings were soon recognized as being weedy because of their extraordinary proliferation (e.g. *Cecropia obtusifolia*, *Citharexylum caudatum*, and *Macaranga tanarius*). Lyon’s last annual report was issued in 1950, and although some recent escapes from Lyon Arboretum have been reported in the published literature (e.g., *Palisota bracteosa*; Herbst *et al.* 2004: 5), no systematic survey has been published of naturalized or naturalizing plants in and around Lyon Arboretum.

Here we report new records of naturalized and naturalizing species discovered during a systematic survey of the Arboretum grounds and forested areas of Mānoa Valley immediately bordering the Arboretum. Previous knowledge of naturalized species in Hawai‘i is based on Wagner *et al.* (1999) and information published in the Records of the Hawaii Biological Survey for 1999–2002, as well as Oppenheimer (2002) for gymnosperms. There is a continuum in plant behavior ranging from producing a few seedlings around planted specimens, to becoming widely naturalized across a large area. For the species reported as naturalized below, >100 spontaneous individuals comprising the full range of life stages were found, including at least a dozen spontaneous individuals at or near maturity. Some of the trees require a decade or more to reach full maturity, and for these species the occurrence

of at least a dozen vigorous saplings (>3 m tall) among a total of >100 spontaneous individuals was considered evidence of naturalization. The naturalized species reported here are expected to spread beyond Mānoa Valley, although this may take some time, depending on the mode of dispersal and the age at which the plant matures.

In addition to reporting species that met the above criteria for naturalization, we also report species for which seedlings were commonly found around planted specimens, but the above criteria for naturalization were not yet met. Usually, these plants were found only in the seedling stage. Sometimes this is because the Arboretum staff is deliberately killing young plants before they can establish. These species might or might not become naturalized in the future; however, because records of the early stages of naturalization are rarely available, we felt that our observations on these species would be valuable for botanists and researchers, encouraging comparative observations of behavior elsewhere as well as providing a record for future retrospective studies of the invasion process from its early stages.

Naturalized Species

Acanthaceae

Aphelandra aurantiaca (Scheidw.) Lindl.

New naturalized record

This low-growing herb is distinguished in the vegetative state by silvery white markings outlining the leaf veins. The inflorescence is a spike up to 15 cm long (Neal 1965: 784). Immature flowers are orange or yellow, turning red at maturity. It is widespread but patchily distributed at lower elevations in shaded and semi-shaded areas within the Arboretum. The plant is spreading by seeds. Isolated plants were sometimes found >100 m from established mats.

Material examined: O'AHU: Scattered plants along trail in Fern Valley, Lyon Arboretum (but many more plants in Aroid Valley), 3 Mar 2005, C. Daehler 1091 (BISH); along road makai of Dr. Lyon's memorial rock, 11 Apr 1975, R.F. Baker 1974 (BISH).

Anacardiaceae

Rhus taitensis Guillemin

New naturalized record

This medium-sized to large tree has odd-pinnate, compound leaves with 8–12 pairs of pubescent leaflets and a puberulent rachis. Leaflets are unequal at the base. The leaves are dropped on older branches, leaving distinct triangular scars on the branches. Fruits are shiny, black, flattened drupes ca. 4 mm in diameter. Saplings and seedlings are common in Haukulu, and naturalized, mature trees occur on steep, rocky outcrops outside the managed Arboretum grounds.

Material examined: O'AHU: Seedlings 0.5–1.5 m tall in *Ardisia elliptica* forest on slope above Lyon Arboretum, elev. ca. 400 m, 1 Mar 2005, C. Daehler 1072 (HLA); mature naturalized tree in Haukulu, Lyon Arboretum, fruits black and fleshy, 24 May 2005, C. Daehler 1215 (BISH); sapling 2 m tall in unmanaged thicket near Hawaiian section of Lyon Arboretum, 1 Mar 2005, C. Daehler 1073 (HAW), Lyon Arboretum (cultivated), 9 Mar 1960, D. Anderson s.n. (BISH).

Arecaceae

Archontophoenix alexandrae (F. Muell.)

New island record

H. Wendl. & Drude

Native to northern Queensland, this tall, single-trunked palm can be recognized by its lime

green crownshaft; leaflets that are pointed at the tip and ashy below; and white inflorescences that branch 3(–4) times, the long tips hanging straight down, bearing round, pea-sized, red fruits. Previously reported as naturalized on Hawai‘i (Wagner *et al.* 1999). Thickets of seedlings develop around planted specimens and mature, naturalized plants were found scattered around the Arboretum, suggesting that the seeds are being dispersed by birds. First planted in the Arboretum in 1921 and first noted as volunteering in the Lyon Arboretum 1934 annual report.

Material examined: O‘AHU: Volunteers in Aroid Valley, Lyon Arboretum, 19 Dec 1968, K. Nagata 523 (HLA).

***Arenga pinnata* (Wurmb) Merr.**

New naturalized record

Native to Southeast Asia (probably Indonesia or Malaysia), the sugar palm is a large, single-trunked palm. The leaves are large (to 9 m), dark-green above, silvery below, with the long leaflets ragged at the tips. The trunk is covered by loose, brown-black fibrous material mixed with long, stiff, spinelike fibers. At maturity this palm flowers from the top down, eventually dying. The fruits are dark red, about 2.5 cm in diameter, and are extremely irritating to the skin, containing calcium oxalate crystals. First planted in the Arboretum in 1932. Naturalized plants around the Arboretum are probably in their third generation, and they form dense stands locally.

Material examined: O‘AHU: Naturalized plant growing on ridge in upper Haukulu, Lyon Arboretum; 25 Jul 2005, C. Daehler 1318 (HAW); Lyon Arboretum (cultivated material), 25 Jul 1968, F.B. Essig 680725 (HLA).

***Caryota mitis* Lour.**

New naturalized record

Native to Southeast Asia (Myanmar to Indonesia), the dwarf fishtail palm has a clustered habit to 8 m tall. Leaves are bipinnate with leaflets wedge-shaped and ragged at the outer margin (resembling a fish tail). Inflorescences are short (usually <40 cm long), bearing dark purple to black fruits at maturity. The fruits contain calcium oxalate and are very irritating to the skin. Each stem at maturity flowers from the top down and eventually dies, but the clump continues to expand and sprout new shoots indefinitely. First planted in the Arboretum in 1932. Naturalization is mostly close to the mother plants but can become dense.

Material examined: O‘AHU: Established naturally at edge of main road leading to the waterfall, Lyon Arboretum, 24 May 2005, C. Daehler 1202 (BISH).

***Pinanga coronata* (Blume ex Mart.) Blume**

New naturalized record

This palm is native to rainforests of Java and Sumatra. The inflorescence is once-branched, with the flowers distichously arranged along the branches, which become pink with black fruits at maturity. First planted in the Arboretum in 1921 under the synonym *P. kuhlii* (which had previously been distinguished from *P. coronata* by its irregularly divided pinnae; this form is most common among the naturalized specimens). It was first noted as volunteering in the Lyon Arboretum 1934 annual report. Very dense seedling thickets are common around planted specimens. More than 50 mature, naturalized plants were seen scattered throughout the Arboretum, including in unmanaged *Ardisia elliptica* forest on the upper slopes of Mānoa Valley. Second and perhaps third-generation seedlings were also seen in the vicinity of these naturalized plants. Birds presumably disperse the seeds.

Material examined: O‘AHU: Dozens of naturalized fruiting plants and hundreds of seedlings, Aroid Valley, and widespread around Lyon Arboretum, 22 Jun 2005, C. Daehler 1305 (HAW); Lyon

Arboretum (cultivated material), 18 Jul 1968, *F.B. Essig 680718* (HLA); Waimano Stream, growing along stream, 1 Jul 2003. *R. Hauff s.n.* (BISH).

***Ptychosperma macarthurii* (H. Wendl. ex H.J. Veitch) H. Wendl. ex Hook. f. New naturalized record**

Native to New Guinea and northern Queensland, these palms are clustered, with the ends of the leaflets ragged (appearing torn off). The fruits are small, red, and irritating to the skin (containing calcium oxalate), with seeds 5-lobed in cross section. First planted in the Arboretum in 1924 and first noted as volunteering in the Lyon Arboretum 1938 annual report. Mature, naturalized plants can be found widely scattered across the Arboretum, with seedlings occurring at high densities beneath mature plants. The seeds are presumed to be bird-dispersed.

Material examined: O'AHU: Lyon Arboretum (cultivated material), 17 Jul 1968, *F.B. Essig 680719* (HLA).

***Syagrus romanzoffiana* (Cham.) Glassman New naturalized record**

Native to Brazil, the queen palm is large, single-trunked, and without a complete crown-shaft. The leaflets are held at various angles to the rachis, giving the leaf a plumose appearance. The inflorescence is enclosed in a large, woody bract, once-branched, producing yellowish fruit about 2–2.5 cm in diameter. First planted in the Arboretum in 1920 and first volunteer noted in the Lyon Arboretum 1936 annual report. This palm has only naturalized within 50 m of the mother plantings, but the naturalized plants have formed dense thickets. Because of this palm's large seeds, it may lack an effect disperser in Hawai'i.

Material examined: O'AHU: Thicket of ca. 100 saplings 1–3 m tall in vicinity of older planted specimens, Haukulu, Lyon Arboretum, 24 May 2005, *C. Daehler 1206* (HLA).

Costaceae

***Costus dubius* (Afzel.) K. Schum. New naturalized record**

This African species is one of the most aggressive recent introductions to the Arboretum. Received 8 times from European botanic gardens, under 5 different names (only one of which was *C. dubius*) from 1978 to 1992, this plant has become a major problem wherever it was planted. It produces copious quantities of seed. The leafy stems reach ca. 2 m in height, with the inflorescences borne on separate stalks arising from the rhizome. The inflorescence is rounded, with tightly fitting green bracts, out of which white flowers with a yellow-centered labellum arise. A single flower is borne in each bract. A similar species, *C. afer* Ker Gawl., usually has a pink-edged labellum (but sometimes pure white), and has 2 flowers per bract (Chelsea Specht, pers. comm.).

Material examined: O'AHU: Growing wild in *Oplismenus* grass, Haukulu, Lyon Arboretum, 1 Mar 2005, *C. Daehler 1060* (BISH, duplicate HAW); cultivated, Lyon Arboretum, 13 May 1981, *K. Nagata 2307* (HLA).

***Costus pulverulentus* C. B. Presl New island record**

Native to southern Mexico to western S. America, *C. pulverulentus* came to the Arboretum as *C. flammeus*, and was later called *C. spiralis*. It grows only 3–4 ft [0.9–1.2 m] tall, with spiral leaves, and terminal inflorescences with light greenish bracts and rose-pink flowers. This species is widespread throughout the Arboretum although it rarely dominates large areas. This species was mentioned by Wagner *et al.* (1999: 1381) as escaping from Lyon Arboretum.

Material examined: O'AHU: Growing in a shaded area with *Oplismenus* and seedlings of *Cinnamomum burmannii*, Haukulu, Lyon Arboretum, 22 Jun 2005, *C. Daehler 1308* (BISH); naturalized in many parts of Lyon Arboretum, 3 Sep 1981, *K. Nagata 2369* (HLA).

***Costus woodsonii* Maas**

New island record

Native to tropical America from lowland Nicaragua to the Pacific coast of Colombia, this species was first planted (as *C. spicatus*) in lower 'Aihualama in 1925, where it is now grows in dense stands. This species spreads locally by plantlets that develop on old inflorescences. It has also spread to other areas of the Arboretum, some quite remote from the original planting, suggesting reproduction by seeds. The leaves are spirally arranged, thick, and dark green, the bracts dark red, and the flowers red-orange. This species was mentioned by Wagner *et al.* (1999: 1381) as escaping from Lyon Arboretum.

Material examined: O'AHU: Growing in a disturbed area with *Setaria palmifolia* and other weeds, Haukulu, Lyon Arboretum, 22 Jun 2005, *C. Daehler 1307* (BISH); very common in valleys around Lyon Arboretum, 13 Jun 1968, *K. Nagata 420* (HLA).

Elaeocarpaceae

***Elaeocarpus angustifolius* Blume**

New naturalized record

This tree is native to Australia and was originally received at the Arboretum as *E. grandis* and *E. ganitrus*. It was first planted in 1924 and first reported as volunteering in the Lyon Arboretum 1938 annual report. Mature trees are easily distinguished by their blue, marble-shaped fruits (2–3 cm in diameter) and large, buttressed trunk and roots. Leaves are alternate, narrowly oblong-elliptic, 6–19 cm x 1.5–5 cm with crenulate-serrate margins (Stanley & Ross 1986: 58). Although the tree is not deciduous, aging leaves often turn red just prior to dropping, and this can be seen even in the sapling stage. Thousands of seedlings and hundreds of saplings (1–2 m tall) were seen in the vicinity of planted specimens on the managed Arboretum grounds. However, at least a dozen young trees 2–5 m tall were observed far from planted specimens in unmanaged areas around the Arboretum, including in *Cinnamomum burmannii* forest, *Ardisia elliptica* forest, and even in a dense bamboo thicket. Although these young trees in unmanaged areas have not yet flowered, their vigorous growth in unmanaged areas strongly suggest that this species is effectively naturalized. In its native range, the seeds are dispersed by fruit-eating pigeons. Such effective dispersers may not be present in Hawai'i, limiting its rate of spread. Nevertheless, the occurrence of large saplings on steep slopes away from planted specimens indicates that the seeds are, at least occasionally, dispersed by animals in Hawai'i. Rats also appear to cache the endocarps.

Material examined: O'AHU: Sapling ca. 3 m tall on ridge growing with *Cinnamomum burmannii*, *Ardisia elliptica*, and scattered large *Eucalyptus robusta* trees, 'Aihualama, above Lyon Arboretum, 1 Mar 2005, *C. Daehler 1077* (BISH), *1078* (HAW); sapling 2 m tall growing in dense bamboo forest, 'Aihualama, Lyon Arboretum, 18 Apr 2005, *C. Daehler 1105* (BISH); Lyon Arboretum (cultivated), 25 Jul 1967, *K. Nagata 279* (HLA).

Fabaceae

***Erythrina poeppigiana* (Walp.) O.F. Cook**

New naturalized record

This fast-growing tree, native to tropical America, was first planted in the Arboretum in 1929. It is characterized by compound leaves composed of 3 leaflets (7–25 cm in length) with cup-shaped stipules at the base of the 2 smaller leaflets (Nygren 1996). Racemes (10–20 cm in length) are held nearly horizontally (Little and Wadsworth 1964: 194). The

trees are at least partially deciduous in Hawai'i, with displays of orange flowers developing in winter. The saplings have thorny trunks, becoming more or less smooth with age. Seedlings and saplings were commonly seen within 100 m of planted specimens; however, spontaneous plants of all life stages, including flowering and fruiting individuals, are scattered throughout the Arboretum. A second generation of seedlings and saplings was noted around the larger spontaneous individuals. A naturalized flowering specimen was also observed in secondary forest on neighboring property belonging to Paradise Park. The 1.5 cm long, bean-type seeds of this plant are probably dispersed by wind, as the seed pod is light and papery.

Material examined: O'AHU: Unplanted 20 m tall tree with dozens of seedlings in the vicinity, near border with Paradise Park, Lyon Arboretum 24 May 2005, C. Daehler 1212 (BISH); Lyon Arboretum (cultivated), 18 Mar 1971, K. Nagata 808 (HLA).

Heliconiaceae

Heliconia latispatha Benth.

New island record

Previously reported from Maui, Hawai'i, and Kaua'i (Wagner *et al.* 1999; Lorence & Flynn 1997). Within the Arboretum, stands of the yellow-orange *H. latispatha* have become quite dense and are difficult to eradicate. It begins to flower in late May, and sets seed in the summer. Presumably birds spread the seeds around. Several other forms (red-and-yellow, pure red) are adventives, but they are not nearly as widespread and problematic as the large yellow-orange variety. Outside the Arboretum grounds, two isolated flowering plants were also seen in unmanaged *Ardisia elliptica* forest.

Material examined: O'AHU: Established among dense *Oplismenus* and ferns, Lyon Arboretum, 22 Jun 2005, C. Daehler 1304 (BISH); Lyon Arboretum (cultivated), 20 Dec 1984, K. Nagata 3121 (HLA).

Malpighiaceae

Hiptage benghalensis (L.) Kurz

New naturalized record

This liana, native to Indo-Asia, was first planted in 1920 under the synonymous name *Hiptage madablota* Gaertn. (Neal 1965: 494). In the 1980s, Arboretum staff noted that it was "out of control" around the original planting in Haukulu, and the plants were cut back. Nevertheless, this species has naturalized in unmanaged gullies in Haukulu, where it forms dense thickets. Although individual plants can cover very large areas by sprawling, the plant is also reproducing by seed, as evidenced by seedling around mature individuals. The seeds are wind-dispersed.

Material examined: O'AHU: Several large plants forming thickets in a steep-banked gully, Haukulu, at the border between Lyon Arboretum and former Paradise Park, 1 Mar 2005, C. Daehler 1064 (BISH), 1065 (HAW); University of Hawai'i, Mānoa campus (cultivated), 16 Oct 1967, Herbst 656 (HLA); Kea'ahala Stream, Kāne'ohe, cascading over canopy of *Ficus microcarpa* and *Syzygium cumini*, 12 Apr 2001, Imada 2001-49 (BISH).

Marantaceae

Pleiostachya pruinosa (Regel) K. Schum.

New naturalized record

This rhizomatous perennial is native to tropical America and was first planted probably in the 1950s. This species is characterized by flowers occurring on clustered spikes resembling an oversized wheat inflorescence and accounting for the common name, wheat calathea. The leaves are musoid with purple undersides. It is widespread in Haukulu, and it is presumably bird-dispersed. It is on the increase.

Material examined: O'AHU: Upper Aroid Valley, Lyon Arboretum (presumed naturalized collection), 28 Sep 1971, *K. Nagata 885* (HLA).

Stromanthe tonckat (Aubl.) Eichler

New naturalized record

This erect, rhizomatous herb, native to tropical America, was first planted in 1981. The plant sends up 1–1.2 m long internodes, which then produce several leafy branches. Mature berries are ellipsoid, somewhat pear-shaped, red then turning black at maturity. This species is common in Haukulu, where it has established along trails and in unmanaged wet areas of the Arboretum. It has definitely increased in abundance in recent years.

Material examined: O'AHU: Fruiting plants established in *Oplismenus*, beneath large *Ficus* trees, Haukulu, Lyon Arboretum, 1 Mar 2005, *C. Daehler 1076* (BISH, duplicate HAW); Lyon Arboretum (cultivated), 28 Nov 1984, *Nagata 3096* (HLA).

Meliaceae

Khaya nyasica Stapf ex Baker f.

New naturalized record

This African tree was first planted in the Arboretum in 1932. It is characterized by its compound leaves, with 3–4 pairs of ovate-obovate, thin, papery leaflets commonly 7–9 cm in length (Irvine 1961: 521). The fruit is a 4–5-valved woody capsule approaching 8 cm in diameter (Irvine 1961: 521) that opens to reveal the winged, wind-dispersed seeds. Thousands of seedlings and saplings were found throughout the Arboretum and far from planted specimens, but they are especially common in Haukulu. Seedlings were often found growing in partial shade, among basket grass (*Oplismenus hirtellus*). This plant takes many years to develop into a mature tree, which makes it relatively easy to control on managed Arboretum grounds. Another name, *Khaya anthotheca* (Welw.) C. DC., is usually considered synonymous (Schabel 2002: 532).

Material examined: O'AHU: Seedlings and saplings found growing in dense *Oplismenus*, Haukulu, Lyon Arboretum, 1 Mar 2005, *Daehler 1074* (BISH), *1075* (HAW); Lyon Arboretum (cultivated), 26 Jul 1968, *Nagata 455* (HLA).

Musaceae

Musa velutina H. Wendl. & Drude

New naturalized record

This banana is usually <2 m tall, with musoid leaves <1 m long. It produces small (5–10 cm long), fuzzy pink fruits that split open when mature to reveal seedy, white pulp that is presumably consumed by birds. More than a dozen mature, spontaneous plants were observed in Haukulu, which were likely established from seed, but naturalized plants were not seen outside Haukulu, suggesting that spread to new locations is slow. Once established, the plant spreads locally as clumps. Volunteers were first documented in the Lyon Arboretum annual report in 1941.

Material examined: O'AHU: Single plant growing in a disturbed area among *Oplismenus*, *Erechtites valerianifolia*, *Setaria palmifolia*, and other weeds, Haukulu, Lyon Arboretum 24 May 2005, *C. Daehler 1214* (BISH); Lyon Arboretum (cultivated), 12 Jun 1980, *W. Teraoka & L. Whiteaker 303* (HLA).

Myrtaceae

Syzygium grande (Wight) Wall.

New naturalized record

This tree, native to tropical Asia, was first planted in the Arboretum in 1932 under the synonym *Eugenia grandis* Wight. It is characterized by its broadly elliptical leaves (10–25 cm × 6–12 cm) with up to 20 well-spaced secondary veins in a pinnate arrangement (Lemmens *et al.* 1995: 456), the veins appearing to disappear before reaching the leaf margin.

The fruits are urn-shaped to ellipsoid berries, apparently green when ripe, 1–2 cm in length, containing a single seed ca. 5–7 mm in size. Hundreds of seedlings and saplings were seen, mostly within 100 m of the original plantings in both Haukulu and 'Aihualama. Although only four trees were recorded as planted in 'Aihualama, over a dozen mature trees >10 m tall and thickets of saplings 1–5 m tall were observed in unmanaged secondary forest. The spread of this species may have been slowed by dispersal limitation.

Material examined: O'AHU: Naturalized plants in *Ardisia elliptica* forest, Aihualama, Lyon Arboretum, 18 May 2005, Daehler 1108, (BISH); Lyon Arboretum (cultivated), 12 Oct 1967, *D. Herbst* 648 (HLA); Wahiawa Botanic Garden (cultivated), 23 Apr 1986, *J. Lau* 2294 (BISH).

***Syzygium syzygioides* (Miq.) Merr. & L.M. Perry New naturalized record**

This tree, native to tropical Asia, was first planted in 1940. It is characterized by elliptic-oblong or oblong-lanceolate leaves 4–10 cm long and 1.5–5.5 cm wide; white flowers with reddish calyces ca. 4 mm long; and globose, or depressed-globose fruit to 12 mm in diameter, dark red or purplish black when ripe (Lemmens *et al.* 1995: 471). Records indicate that six trees were planted, and several of these planted trees are known to have died. Nevertheless, dozens of large saplings and mature trees were found in Haukulu, mainly within 100 m of the original plantings. The naturalized plants are spreading into unmanaged areas consisting of *Ardisia elliptica* and *Psidium cattleianum* forest. The seeds are probably dispersed by birds, but the pattern of spread suggests that an efficient disperser is not present in Mānoa Valley.

Material examined: O'AHU: Edge of trail in *Psidium cattleianum* forest, upper Haukulu, Lyon Arboretum, 3 Mar 2005, *C. Daehler* 1089 (BISH); 5-m tall, unplanted tree in upper Haukulu growing among *Psidium cattleianum*, Mānoa Valley, 14 Jun 2005, *C. Daehler* 1312 (HAW).

Podocarpaceae

***Dacrycarpus imbricatus* (Blume) de Laub. New naturalized record**

This tree, native to Java, was first planted in the Arboretum in 1921 as *Podocarpus cupressina* and volunteers were first documented in the Lyon Arboretum 1934 annual report. It is characterized by flat, linear, dimorphic leaves 0.8–1.3 cm long or ca. 0.2 cm long, the latter appressed along young, green branches (Brandis 1906: 696). The leaf size, shape, and arrangement superficially resembles some *Cupressus* species. The seeds are attached to red, fleshy receptacles and are presumably dispersed by birds. Naturalized plants of all life stages are found widely scattered throughout unmanaged parts of the Arboretum, but they were not observed at high densities anywhere.

Material examined: O'AHU: In bamboo thicket, 'Aihualama, Lyon Arboretum, 18 Apr 2005, *C. Daehler* 1099 (BISH, duplicate HAW); Mānoa Valley (cultivated), 29 Oct 1934, *Grant* 7548 (BISH); head of Mānoa Valley, adjacent to the Lyon Arboretum property, 15 Apr 1990, *L. Pyle* sub *G.W. Staples* 582 (BISH).

Rhamnaceae

***Alphitonia excelsa* Reissek ex Endl. New naturalized record**

This tree, native to Australia and other parts of the Pacific, was first planted in the Arboretum in 1924 and was first noted as volunteering in the Lyon Arboretum 1939 annual report. It is characterized by ovate-elliptic leaves with white undersides, even in the seedling stage. Damaged young shoots emit an odor of sarsaparilla. The fruit is a bluish black drupe, ca. 1.3 cm in diameter (Anderson 1947: 249). Dozens of saplings and mature trees were found in Haukulu along with hundreds of seedlings.

Material examined: O'AHU: Edge of trail in *Psidium cattleianum* forest, upper Haukulu, Lyon Arboretum, 3 Mar 2005, *C. Daehler 1088* (BISH); Lyon Arboretum (cultivated), 16 Apr 1969, *K. Nagata 534* (BISH).

Rosaceae

Prunus grisea (Blume ex C. Muell.) Kalkman **New naturalized record**

This tropical Asian tree was first outplanted in the Arboretum in 1985 from plants obtained at Foster Botanical Garden, Honolulu. Originally, three trees were planted in close proximity. Some efforts have been made by Arboretum staff to control this species, but thousands of seedlings and dozens of 1–3 m tall saplings were found, mostly within a 400 m² area centered around the original plantings.

Material examined: O'AHU: Extensive seedling carpets (>100 m²), with scattered saplings forming thickets in vicinity of three planted trees, Haukulu, Lyon Arboretum, 3 Mar 2005, *C. Daehler 1097* (BISH), *1098* (HAW); Ho'omaluhia Botanical Garden (cultivated), 14 Apr 1997, *C. Amable 3444* (BISH); Waimea Arboretum (cultivated), 28 Oct 1992, *D. Orr 84p585* (BISH).

Rubiaceae

Randia fitzalanii F. Muell.

New naturalized record

This tree, native to tropical Asia and Australia, was first planted in the Arboretum in 1919 and first noted by Lyon as volunteering in 1943. The plant is characterized by dark green, glabrous, obovate-ovate leaves 1–20 cm long. Leaves are commonly oblanceolate in seedlings. The flowers are white and fragrant, and the fruit is yellow at maturity, ca. 8 cm in diameter, and many seeded. Thousands of seedlings and dozens of saplings were observed in 'Aihualama. Records indicate that it was planted only in the lower parts of 'Aihualama, but saplings and mature plants were found more than 300 m away in upper 'Aihualama, bordering on State of Hawai'i watershed forest.

Material examined: O'AHU: Mature naturalized tree ca. 5 m tall in Haukulu with dozens of seedlings in the vicinity, Lyon Arboretum, 14 Jun 2005 *C. Daehler 1317* (BISH); seedlings in *Ardisia elliptica* forest, 'Aihualama, Lyon Arboretum, 3 Mar 2005, *C. Daehler 1094* (HAW); Lyon Arboretum (cultivated), 22 Mar 1972, *S. Ishikawa 72* (HLA).

Verbenaceae

Clerodendrum macrostegium Schauer

New island record

This species was previously reported as naturalized from Kaua'i (Lorence & Flynn 1997). It has spread throughout the Arboretum, but it is especially common in Haukulu. It was originally accessioned in 1978 as *Dombeya* sp. and later determined to be *Clerodendrum* sp. Plants were established from seeds in 1981, and by 1983 it was noted as flowering and suckering prolifically around the middle of the Arboretum. Hundreds of mature plants and hundreds of seedlings were seen. The plant can spread prolifically by root suckers, some of which are >5 m apart. Seedlings were also abundant, and large numbers of isolated seedlings suggest that the seeds are being effectively dispersed, possibly by birds.

Material examined: O'AHU: Lyon Arboretum (cultivated), 2 Apr 1984, *K. Nagata 2876* (BISH); established on an unmanaged bank, Haukulu, Lyon Arboretum, 1 Mar 2005, *C. Daehler 1059* (BISH, duplicate HAW); Ho'omaluhia Botanical Garden, Kāne'ohe, spreading by root suckers and by seed?, 21 May 1992, *G.W. Staples 827* (BISH).

Other Notable Naturalized Records

Apocynaceae

Alstonia macrophylla Wall. ex G. Don

Previously reported as naturalized from Hawai'i (Wagner *et al.* 1997: 51), and very recently reported on O'ahu from a single naturalized plant, collected near the Likelike Hwy. (Herbst *et al.* 2004: 3). Widely scattered individuals of all life stages of *A. macrophylla* can be found throughout the Arboretum and in unmanaged *Psidium cattleianum* and *Ardisia elliptica* forest surrounding the Arboretum. Seedlings appear to be tolerant of at least semi-shade. One 4 m tall plant was observed emerging from the center of a dense, 1-m high thicket of *Dicranopteris linearis*, where no other plants had been successful. In Ceylon, this species became rapidly naturalized following its introduction for timber, and it has become one of the most prominent secondary forest species there (Dassanayake & Fosberg 1983: 42). First planted in the Arboretum in 1933.

Material examined: O'AHU: Off Likelike Hwy., growing with *Dicranopteris linearis*, *Schefflera actinophylla*, *Psidium cattleianum*, 11 Apr 2003, D. Souza s.n. (BISH); tree 5 m tall in *Psidium cattleianum* forest, along trail to second (upper) waterfall, above Lyon Arboretum, 23 Feb 2005, C. Daehler 1058 (BISH); sapling 1.5 m tall in uncleared palm thicket, 3 Mar 2005, C. Daehler 1090 (HAW).

Arecaceae

Livistona chinensis (Jacq.) R. Br.

A large, single-trunked fan palm with glossy green leaves, drooping at the tips; petioles with sharp teeth; and olive-sized and shaped, greenish blue fruit. This species was reported by Wagner *et al.* (1999) as escaping in Moanalua Valley, O'ahu. At the Arboretum, this species is found around the original plantings, with some naturalized individuals >200 m from original plantings. Groves have also been observed on the Nu'uuanu side of Konahuanui. The particular naturalized variety of *L. chinensis* came from plantings in Moanalua Gardens in 1927. It appears to be a taller, faster-growing variety than that found in landscaping around Honolulu.

Material examined: O'AHU: Immature, 3 m tall plant established at the edge of Aroid Valley, near Hawaiian Section, no planted specimens seen within 100 m, Lyon Arboretum, 22 Jun 2005, C. Daehler 1306 (HLA).

Clusiaceae

Clusia rosea Jacq.

Although this is not a new record for O'ahu, its status around Lyon Arboretum merits mention, as Wagner *et al.* (1999) indicate only that it is "becoming naturalized" on O'ahu. Naturalized *Clusia rosea* plants were found in a variety of size classes (seedlings up to 5 m tall) scattered throughout the middle and upper slopes of unmanaged parts of both Haukulu and 'Aihualama, as well as on neighboring State of Hawai'i watershed forest. In some places in the vicinity of old planted trees, there are dense sapling thickets containing hundreds of plants 0.5–2 m tall. Although this plant is known to be an epiphytic strangler, most of the naturalized seedlings were not growing epiphytically. However, one established plant was observed growing epiphytically on a *Falcataria moluccana* tree, indicating that it is definitely being dispersed by birds. It was first planted in the Arboretum in 1927, and Lyon first noted seedlings around planted specimens in his 1943 annual report.

Material examined: O'AHU: Seedlings and saplings growing in bamboo forest, 'Aihualama, Lyon Arboretum, 18 Apr 2005, Daehler 1101 (BISH), Daehler 1102 (HAW).

Species Showing Signs of Naturalization

Araceae

Anthurium pentaphyllum G. Don var. *bombacifolium* (Schott) Madison

[Syn. *A. aemulum* Schott]

Naturalized specimens of this epiphytic climber from tropical America were seen growing on dozens of tree trunks in Haukulu, especially in the vicinity of Aroid Valley. It can be recognized by its palmately compound leaves with 5–11 leaflets, 20–30 cm long and 2.5–9 cm wide. The spadix is violet-purple, 2.5–12 cm long. First planted in the Arboretum probably in the 1930s.

Material examined: O'AHU: Growing wild up a tree in Haukulu, Lyon Arboretum, 24 May 2005, C. Daehler 1211 (BISH); Lyon Arboretum (cultivated), 3 Feb 1971, K. Nagata 751 (HLA); Foster Gardens, Honolulu (cultivated), 27 Aug 1959, Potter s.n. (BISH).

Philodendron lacerum (Jacq.) Schott

This climber occurs in large patches in several places around the Arboretum. It is characterized by large (20–30 cm long), shiny leaves with 5+ paired lobes. Petioles are typically 20–40 cm long. Although this species appears to be spreading only vegetatively, it forms very dense stands that can be 1 m thick on the ground and much higher when it has climbed over other plants. In one unmanaged gulch in Haukulu, this species has spread over >400 m² with nearly 100% cover. A slightly smaller patch was also seen outside of the Arboretum property along the 'Aihualama trail. Although this species appears to depend on deliberate human plantings to get established, it is extremely vigorous once planted, and it can be expected to spread through the forest understory.

Material examined: O'AHU: Blanketing ca. 400 m² of forest floor and climbing trees on unmanaged slope, Haukulu, Lyon Arboretum, 3 Mar 2005, C. Daehler 1082 (HAW); Lyon Arboretum (cultivated), 11 Dec 1930, E. Caum s.n. (BISH).

Philodendron scandens K. Koch & Sello ssp. *scandens* f. *micans* Bunting

[Syn: *Philodendron hederaceum* var. *hederaceum* (Jacq.) Schott]

This climber and ground cover occurs in large patches in Aroid Valley, which is an unmanaged section of the Arboretum. It was also seen climbing dozens of trees in the vicinity of Aroid Valley. It is easily recognized by its cordate leaves, dark green to bronze, with a velvety upper surface in the juvenile form. Spread is probably exclusively vegetative.

Material examined: O'AHU: Vine, climbing trees and blanketing the forest floor in Aroid Valley, Haukulu, Lyon Arboretum, 22 Jun 2005, C. Daehler 1301 (BISH).

Araliaceae

Schefflera taiwaniana (Nakai) Kaneh.

This tree is native to Taiwan and was first planted in 1981. Epiphytic seedlings were found in the vicinity of the planted specimens, indicating that the species is being spread by birds, and suitable microhabitats are available for establishment. Considering the similarities with *Schefflera actinophylla*, which has become abundantly naturalized as an epiphyte, it would appear that *S. taiwaniana* has strong potential to become naturalized.

Material examined: O'AHU: Naturalized sapling 1.5 m tall growing in thicket at edge of main road leading to the waterfall, Lyon Arboretum, 24 May 2005, C. Daehler 1202(BISH).

Begoniaceae***Begonia nelumbifolia*** Schlttdl. & Cham.

This species was seen escaping from plantings mainly near the cottages and along roads. It appears to be in the process of becoming naturalized, though it is not aggressive. The first planting date is unknown.

Material examined: O'AHU: Volunteering on hillsides, 13 Jun 1967, *K. Nagata 416* (HLA); just into Aroid Valley (presumed naturalized), 11 Apr 1975, *R.F. Baker 71* (BISH).

Combretaceae***Terminalia bellirica*** (Gaertn.) Roxb.

Native to Indo-Malaysia, this tree was first planted in the Arboretum in 1931. The accession was listed as *T. bellerica*. The leaves are 10–22 cm long and fruits are ca. 2.5 cm long, velvety, yellow when ripe (Brandis 1906: 307). Seedlings are very common in the vicinity of planted specimens, but older age classes were not found because they are regularly cut down by Arboretum staff. The spread of this species is probably limited by lack of an appropriate animal disperser.

Material examined: O'AHU: University of Hawai'i at Mānoa (cultivated), 12 Aug 1967, *D. Herbst 529* (HLA).

Costaceae***Costus scaber*** Ruiz & Pav.

Stems to 3 m long. Inflorescence cigar-shaped; bracts reddish orange; flowers tubular, orange. This species seems to reproduce mostly by vegetative plantlets arising from old inflorescences. It can form dense thickets locally. Although seeds are produced, seedlings are fairly rare thus far. First planted in the in the Arboretum in the 1950s or perhaps earlier.

Material examined: O'AHU Lyon Arboretum (cultivated), 21 Jun 1982, *K. Nagata 2480* (HLA); Lyon Arboretum (cultivated), 30 Nov 1982, *K. Nagata 2743* (HLA).

Dimerocostus strobilaceus Kuntze

Stems to 6 m. Inflorescence cylindrical; bracts green; flowers with a broad, white labellum. Although *D. strobilaceus* is spreading in the Arboretum, it seems to spread mostly by vegetative means and remains locally concentrated in the vicinity of the original planting sites. First planted in the Arboretum pre-1956.

Material examined: O'AHU Lyon Arboretum (cultivated), 17 Jun 1968, *K. Nagata 427* (HLA).

Elaeocarpaceae***Elaeocarpus serratus*** L.

This tree is native to Indo-Asia and was first planted in the Arboretum in 1936. This species is easily distinguished from *E. angustifolius* by its shorter, wider leaves and its orange-brown fruits. Numerous seedlings and a few small saplings were seen in the vicinity of planted specimens; however, unlike *E. angustifolius*, larger saplings were not found outside of managed areas. This plant may lack an appropriate disperser in Hawai'i. The fruit and seeds are both larger than in *E. angustifolius*, so a very large bird would be required to ingest the seeds and carry them long distances.

Material examined: O'AHU: Lyon Arboretum (cultivated), 6 Apr 1967, *K. Nagata 215* (HLA); Lyon Arboretum (cultivated), 10 Oct 1967, *D. Herbst 640* (BISH).

Euphorbiaceae

Mallotus philippensis (Lam.) Müll. Arg.

Reported by Wagner *et al.* (1999) only from the Naval Magazine, Lualualei, Wai'anae Mountains, O'ahu. At the Arboretum, roughly a dozen seedlings 0.3–1.0 m in height were observed growing in thickets within 100 m of planted specimens. Larger plants also exist, but they are rare. Given that this plant has become locally common at another site on O'ahu, it seems to have potential to become naturalized in Mānoa Valley. First planted in the Arboretum in 1921.

Material examined: O'AHU: Naval Magazine, Lualualei, Wai'anae Mountains, 23 Oct 1984, K. Nagata 3074 (HLA); Naval Magazine, Lualualei, 17 May 1994, K.R. Wood 3189 (BISH).

Flacourtiaceae

Caloncoba echinata (Oliver) Gilg

[Syn. *Oncoba echinata* Oliv.]

This tree has ovate, acuminate-tipped leaves, the upper surface often appearing crinkled around the leaf veins. The flowers are white, ca. 1 cm in diameter, developing in the leaf axils. The immature fruit is covered with soft spines that develop into a mat of tangled yellow hairs at maturity. Dozens of small seedlings were seen in the immediate vicinity of planted specimens. The Arboretum staff regularly uses herbicide to kill seedlings of this plant, and this practice has prevented saplings from establishing. This species probably lacks an effective disperser on O'ahu.

Material examined: O'AHU: Cultivated specimen, Haukulu, Lyon Arboretum, 14 Jun 2005, C. Daehler 1314 (HAW); Lyon Arboretum (cultivated), 18 Mar 1971, D. Anderson 71812 (HLA); Tantalus, near hogback, 15 Jan 1943, McGuire *s.n.* (BISH).

Leeaceae

Leea indica (Burm. f.) Merr.

This sprawling shrub from tropical Indo-Asia was first planted in 1931 under the synonym *L. sambucina*. Seedlings were first noted around planted specimens in the Lyon Arboretum 1943 annual report. In our current survey, roughly a dozen seedlings were seen within 100 m of planted specimens. It is surprising that this species has not spread further given that its small berries appear to be attractive to birds.

Material examined: O'AHU: Mature, unplanted shrub ca. 3 m tall, growing ca. 10 m off side of road leading to the waterfall, Lyon Arboretum, C. Daehler 1203 (BISH); UH campus Magoon greenhouse facility (cultivated), 16 Oct 1985, J. Lau 1529 (BISH).

Magnoliaceae

Michelia champaca L.

This medium-sized tree, native to Indo-Asia, was first planted in the Arboretum in 1922. It is best known for its perfumy flowers. Several medium-sized seedlings (0.2–0.5 m tall) were observed in shady areas within 100 m of planted specimens. This species may have limited dispersal ability.

Material examined: O'AHU: Lyon Arboretum (cultivated), 3 Oct 1968, K. Nagata 223.

Melastomataceae

Medinilla cumingii Naudin

Medinilla magnifica Lindl.

More than a dozen naturalized plants of both species were observed growing epiphytically on mossy logs and occasionally on trees scattered throughout the Arboretum. When

flowering, *M. magnifica* has large pink bracts at the base of the inflorescence, while these are absent or very small in *M. cumingii*. The leaves of the two species also differ, the shape being ovate-elongate in *M. magnifica* and ovate-rotund in *M. cumingii*. The latter species also has shinier leaves. These *Medinilla* species both appear to require a specific, mossy microhabitat for germination and/or survival, and the relative rarity of this microhabitat in the young forests around the Arboretum may have limited the success of these species so far. Nevertheless, the seeds are dispersed by birds, and there is potential for these species to be carried to older forests where appropriate microhabitats may be more abundant. Oppenheimer (2004: 13) recently reported *M. cumingii* as naturalized near Hāna Hwy on Maui.

Material examined: O'AHU: Plants established from seed on rocks densely covered by moss, no known seed source within 100 meters, Lyon Arboretum, *M. cumingii*, 14 Jun 2005, C. Daehler 1309 (HAW); Lyon Arboretum (cultivated) *M. cumingii*, August 1976, Spence 392 (HLA); Lyon Arboretum (cultivated) *M. magnifica*, 6 Jun 1967, K. Nagata 216 (HLA).

Moraceae

Antiaris toxicaria Lesch.

This tree, which occurs in tropical rainforests throughout the Old World tropics, was first planted in the Arboretum in 1929. Lyon noted seedlings of this plant in 1946. In our current survey, roughly a dozen seedlings were seen within 100 m of planted specimens. This species may lack an effective disperser in Hawai'i. The drupes are fairly large (2 cm in diameter), and a large bird or bat would be required to transport the seeds. Nevertheless, the plant appears to be locally reproducing.

Material examined: O'AHU: Lyon Arboretum (cultivated), 6 Aug 1964, G. Gillett 1592 (HLA).

Myrsinaceae

Ardisia virens Kurz

Four *A. virens* seedlings were planted in Haukulu in 1979. By 1981, seedlings were abundant in the vicinity of the planted specimens, and in summer 1982, all of the planted specimens were cut down and killed because staff were worried that this species would become a pest. Seedlings are still relatively common around Haukulu, and one fruiting shrub was found growing in a thicket ca. 100 m from the original plantings. The seedlings are easily distinguished from those of *A. elliptica* by their glaucous leaves and crenate leaf margins.

Material examined: O'AHU: Mature plants ca. 3 m tall with dozens of seedlings in the vicinity, Haukulu, Lyon Arboretum; 24 May 2005, C. Daehler 1205 (BISH); Lyon Arboretum (cultivated), 22 Oct 1980, K. Nagata 2199 (HLA).

Ardisia sieboldii Miq.

Four *A. sieboldii* were planted near the *A. virens* in Haukulu in 1979. They have yet to be eliminated. Seedlings occur in the vicinity of the plantings, but they do not seem to be spreading nearly as aggressively as *A. virens*. *Ardisia sieboldii*, from Japan, can become a small tree. The leaves are dark green with a lighter midrib and no marginal crenulations. The new growth is green (whereas the new growth of *A. elliptica* is reddish).

Material examined: O'AHU: Cultivated with seedlings nearby, Haukulu, Lyon Arboretum 24 May 2005, C. Daehler 1210 (HAW).

Oleaceae

Noronhia emarginata (Lam.) Thouars

This species was recently reported as naturalized on Maui and Kaua‘i (Flynn & Lorence 2002; Starr *et al.* 2003). Seedling carpets were observed in the immediate vicinity of planted specimens. Arboretum staff periodically uses herbicide to kill the seedlings, and this probably has prevented saplings from establishing. This species may lack an appropriate animal disperser in the Arboretum.

Material examined: O‘AHU: Hundreds of seedlings seen in the vicinity of a planted specimen, 14 Jun 2005, 14 Jun 2005, *C. Daehler 1316* (HAW); Kahana Valley, along highway with *Leucaena leucocephala* (and other weeds, presumed escape from cultivation), 4 Dec 1972, *G. Spence 127* (HLA).

Orchidaceae

Vanilla planifolia Andrews

First planted in the Arboretum in 1921 under the synonym *V. fragrans* Ames. This sprawling orchid vine, native to tropical America, occurs occasionally as an escape in the upper region of ‘Aihualama. Large, dense patches (>10 m across) were observed in scattered areas among *Dicranopteris linearis*, *Citharexylum caudatum*, and *Ardisia elliptica*. Patches of this plant are probably being established by wind or gravity dispersal of vegetative fragments.

Material examined: O‘AHU: Lyon Arboretum (cultivated), 31 May 1968, *K. Nagata 378* (HLA).

Podocarpaceae

Afrocarpus mannii (Hook.) C.N. Page

[Syn: *Nageia mannii* (Hook.) Kuntze]

This tree was first planted in the Arboretum in 1939. Planted specimens at the Arboretum were observed in three separate locations, and in all cases seedlings and saplings were observed in the immediate vicinity. Leaves are opposite, linear, 7–15 cm long and ca. 1 cm wide. Receptacles (“fruits”) are fleshy, green, pear-shaped, 4–5 cm long. The spread of this species may be limited by lack of an efficient animal disperser.

Material examined: O‘AHU: Growing wild among *Ardisia elliptica* and ginger, on steep slope, Haukulu, Lyon Arboretum, 14 Jun 2005, *C. Daehler 1313* (BISH); labeled as *P. usambarensis*, Lyon Arboretum (cultivated), 3 Jan 1974, *S. Ishikawa 368* (HLA).

Tiliaceae

Trichospermum richii (A. Gray) Seem.

This tree is native to the South Pacific and was first planted in the Arboretum in 1971 from seeds collected in Fiji. It is characterized by ovate, alternate leaves 10–30 cm long, with serrate margins. In young plants the leaves are cordate, with the upper leaf surface having a crinkled appearance; and the upper leaf veins sometimes red or pink. The flowers are monoecious and dimorphic. The females are yellowish green and occur in pendant clusters in the leaf axils. The males occur singly, and have white petals offset from the sepals, which have a white inner surface and a reddish pink, pubescent outer surface. The fruit is a bivalved capsule. Roughly a dozen seedlings and saplings were observed around planted specimens. Naturalization seems likely, considering the rapid growth rate of this species, its many small, dispersible seeds, and the observed successful establishment of seedlings.

Material examined: O'AHU: cultivated tree with seedlings and saplings nearby, Lyon Arboretum, 24 May 2005, C. Daehler 1208 (HAW); Lyon Arboretum (cultivated), 5 Dec 1986, K. Nagata 3573 (BISH).

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An Annotated Checklist and New Island Records of Flowering Plants From Lehua Islet, Ni‘ihau, Hawai‘i

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Lehua bears a structural relationship to Ni‘ihau as a secondary tuff crater (Palmer, 1937) and lies 1.2 km to its north. Lehua is uninhabited and has an area of 1.1 km² and a maximum elevation is 213 m. The flora of Lehua is composed of some 60 taxa of vascular plants from 26 families. Of these species two are pteridophytes; 40 are dicotyledons; and 18 are monocotyledons. Eleven species are native endemics to Hawai‘i; 14 are indigenous; 34 are nonnative naturalized species; and one is thought to be a Polynesian introduction. Twelve of the following taxa represent new islands records previously unrecorded for Ni‘ihau. Edward L. Caum (1936) was the first to conduct a floral survey of Lehua in 1931–1932 and references are made to his research. The only other known plant surveys include a day trip conducted by the National Tropical Botanical Garden (NTBG) on 10 January 1992 (Flynn 1992), in addition to the more recent botanical inventories conducted by the authors under the auspices of the Offshore Islet Restoration Committee (OIRC) from 2001–2005. If known, we use the Ni‘ihau plant name in each account.

Aizoaceae

Sesuvium portulacastrum (L.) L.

‘Akulikuli is an indigenous mat forming perennial herb with long creeping stems and succulent leaves. It was observed as locally common by Caum. We also find it common around the weathered shelves above the sea near the southwestern leeward side, in addition to a few patches on the crest of the west horn.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, Flynn *et al.* 4847 (BISH, PTBG); 19 Feb 2002, K.R. Wood *et al.* 9305 (BISH, PTBG, US).

Asclepiadaceae

Asclepias curassavica L.

Laulele is a nonnative, naturalized, erect perennial herb. Caum reported this species as being rare along the southern slopes just east of the sea-caves, yet we made no observations of it.

Calotropis procera (Aiton) W. T. Aiton

New island record

Previously recorded from only the Big Island, this is the first record of the small crown-flower naturalized on Ni‘ihau or Lehua Islet. We observed two plants, one along Lehua’s steep lower central inner crescent at 82 m elev., and another on the outer central crescent at 100 m elev.

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Material examined. NI'ĪHAU: Lehua Islet, inner crescent, 14 May 2005, K.R. Wood 11345 (BISH, PTBG, US); outer crescent, 6 Oct 2005, K.R. Wood 11533 (BISH, PTBG).

Asteraceae

Ageratum conyzoides L.

Maile hohono is a nonnative, naturalized, malodorous annual herb that was considered uncommon by Caum. Our surveys found that it becomes a dominant species after rains in the flatter zones throughout Lehua.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4860 (BISH, PTBG).

Artemisia australis Less.

'*Ahinahina* is an endemic shrub with aromatic leaves that shimmer with silvery hairs. Although it was not observed by Caum, we found a small localized population centrally located along the upper inner crescent. Unfortunately, during our research over the last four years, this small population has died off, most likely the result of continued herbivory by rabbits.

Material examined. NI'ĪHAU: Lehua Islet; 20 Dec 2001, K.R. Wood et al. 9221 (BISH, PTBG, US); 10 Jan 1992, Perlman et al. 12486 (BISH, PTBG).

Cirsium vulgare (Savi) Ten.

The bull thistle is a nonnative, naturalized sub-shrub with a purple corolla and bristles on its stems and leaves. Caum made no report of this species, and we observed only a single dried-up plant on the central inner crescent.

Conyza bonariensis (L.) Cronq.

Lani wela is a nonnative, naturalized, densely pubescent herbaceous species. It was not observed by Caum, yet we observed this species randomly in small numbers after rains.

Gamochaeta purpurea (L.) Cabr

New island record

The purple cudweed is a nonnative, naturalized herbaceous species of around 25 cm, erect with moderately woolly leaves. Caum did not report this species. Previously unrecorded from Ni'ihau and Lehua Islet, we found this species to occur in small numbers throughout the islet after rains and report it here as a new island record.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4852 (BISH, PTBG).

Hypochoeris radicata L.

New island record

The hairy cat's-ear is a nonnative perennial herb with a long taproot and yellow florets. Previously unrecorded from Ni'ihau and Lehua Islet, this species was occasionally observed along the inner crescent of the islet and the following collection represents a new island record.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4859 (BISH, PTBG).

Pluchea carolinensis (Mill.) Gillis

The sourbush is a nonnative, naturalized shrub of 1.0–1.5 m height with aromatic leaves. It was not observed by Caum but is currently occasional throughout Lehua's inner and outer crescent. This sturdy shrub species, along with *P. indica* and *P. xfosbergii*, has become a preferred nesting site for the Red-footed Booby.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4858 (BISH, PTBG); 6 Oct 2005, K.R. Wood 11546 (BISH, PTBG, US).

***Plucheia indica* (L.) Less.**

The Indian fleabane is a nonnative, naturalized shrub of 1.0–1.5 m height with coarsely dentate leaves. It was not observed by Caum but is by far the most common dominant shrub species throughout Lehua’s inner and outer crescent.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, *Lorence et al.* 7129 (AD, PTBG, SING); 6 Oct 2005, *K.R. Wood 11545* (BISH, PTBG, US).

Plucheia xfosbergii* Cooperr. & Galang*New island record**

This taxon represents a nonnative hybrid between *P. indica* & *P. carolinensis*. It was not noted by Caum. Previously unrecorded from Ni‘ihau and Lehua Islet, this species occurs around the southern slopes of Lehua’s outer crescent and represents a new island record.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, *Lorence et al.* 7128 (AD, BISH, PTBG, US); 6 Oct 2005, *K.R. Wood 11547* (BISH, PTBG, US); 18 Nov 2005, *K. R Wood 11617* (AD, BISH, PTBG, US).

***Sonchus oleraceus* L.**

Pualele is a nonnative, naturalized annual herb that was observed by Caum. During this current study, *pualele* was seen occasionally throughout the islet.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, *Flynn et al.* 4861 (PTBG).

***Verbesina encelioides* (Cav.) Benth. & Hook.** **New island record**

The golden crown-beard is a nonnative, naturalized herb that was not observed on the islet by Caum. Previously unrecorded from Ni‘ihau and Lehua Islet, we located a few plants on the eastern face below the east horn, and report it here as a new island record.

Material examined. NI‘IHAU: Lehua Islet; 6 Jul 2002, *K. R Wood & VanderWerf 9878* (BISH, PTBG).

***Xanthium strumarium* L.**

Kikānia is a nonnative, naturalized, erect annual herb with ovoid burs that are armed with hooked prickles. We observed only a few plants around the western outer crescent where radial drainages are known to have seeps during winter rains. Caum did not report this plant.

Boraginaceae***Heliotropium anomalum* Hook. & Arnott var. *argenteum* A. Gray**

Nohonohopu‘uone is an endemic, prostrate subshrub that sometimes forms mats with whorled succulent leaves that are covered in soft, silky gray hairs. Caum reported this species to be “restricted to the inner side of the crest ranging between the base of the east horn and westward to about the median line on the rocks of the pre-summit series” where it formed an almost pure stand. He stated that further west toward the base of west horn it grew sparingly. We were unable to re-locate this species during our surveys.

Material examined. NI‘IHAU: Lehua Islet; 4 Dec 1931, *E.L. Caum 16* (BISH, PTBG).

***Heliotropium curassavicum* L.**

Lau po‘opo‘ohina is an indigenous, perennial herb with prostrate stems that was reported by Caum to be growing in a few places on the southern cliffs and in the neighborhood of the landing just above the water. We saw many plants of this species in the area of the landing, and found several larger populations in association with *Sesuvium portulacastrum* (‘ākulikuli) growing around the shelves of tuff above the sea on the southwestern leeward side of the islet.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, *Perlman et al.* 12491 (BISH, PTBG).

Cactaceae***Opuntia ficus-indica* (L.) Mill.**

Pānini is a nonnative cactus that was considered common by Caum and occurred on the southern and eastern faces of the islet with a few scattered clumps on the inner side of the crescent near the base of the west horn. We did not observe this species and suspect that the population has died out as the result of a bio-control introduced in Hawai'i several decades ago.

Chenopodiaceae***Chenopodium carinatum* R.Br.**

Goosefoot is a nonnative naturalized annual herb with prostrate stems. This species was not observed by Caum, yet can be quite common after spring rains along the inner-crescent slopes.

Material examined. NI'ĪHAU: Lehua Islet; 20 Dec 2001, *K.R. Wood et al.* 9225 (BISH, PTBG, US); 19 Feb 2002, *K.R. Wood et al.* 9300 (BISH, PTBG, US); *K.R. Wood & VanderWerf* 9874 (BISH, PTBG).

***Chenopodium murale* L.**

Āheahea is a nonnative, naturalized annual herb with erect stems of around 10–20 cm. It was not observed by Caum but is currently densely distributed throughout the islet after rains.

Material examined. NI'ĪHAU: Lehua Islet; 14 May 2005, *K.R. Wood et al.* 11346 (BISH, PTBG, US); 10 Jan 1992, *Lorence et al.* 7127 (BISH, PTBG, US); 20 Dec 2001, *K.R. Wood et al.* 9224 (BISH, PTBG).

Convolvulaceae***Ipomoea pes-caprae* (L.) R. Br. subsp. *brasiliensis* (L.) Ooststr.**

Pohuehue is an indigenous vine with long trailing stems that occasionally root at the node. Caum considered it rare on Lehua because he found only one small patch on the lower inner side of west horn, about 70 m below the summit. We did not find any plants of this species.

***Jacquemontia ovalifolia* (Choisy) H. Hallier**

subsp. *sandwicensis* (A. Gray) K.R. obertson

Pā'ūohi'iaka is an endemic subspecies of vine with long, prostrate trailing stems up to 3 m in length. Caum called it the prevalent plant, common in all parts of the island except the tip of the west horn. We also found it to be the most abundant species. It appears that rabbits avoid eating this plant and during dry periods where most of the grasses and herbaceous plants die back, this species still remains green and thrives.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, *Lorence et al.* 7126 (AD, BISH, PTBG, US)

Cucurbitaceae***Sicyos maximowiczii* Cogn.**

Puaokama is an endemic annual vine with trailing stems up to 10 m long. Caum considered it rare and found it only in one location at the foot of a radial valley just to the west of the tank houses. The tank houses were just above and to the west of the sea-caves. Caum remarked that rabbits had eaten the base of the singular plant and killed it. We observed several large 10 m diameter patches in the same general region as Caum, but also observed several dozen patches along the inner crescent region. Seeds were collected for restoration.

Material examined. NI‘IHAU: Lehua Islet; 6 Mar 2004, K.R. Wood & M. Ono 10592 (BISH, PTBG); 10 Jan 1992, Perlman et al. 12487 (PTBG, US); 10 Jan 1992, Lorence et al. 7130 (AD, BISH, MO, PTBG, US); 19 Feb 2002, K.R. Wood et al. 9297 (BISH, PTBG, US); 6 Jul 2002, K.R. Wood & VanderWerf 9878 (BISH, PTBG, US).

Cyperaceae

Cyperus javanicus Hoult.

'Ahu'awa is an indigenous, 1-m tall perennial sedge with glaucous blue-green leaves and flattened brown-gold spiklets. It prefers sites with water seepage. Caum observed it in several locations, including the base of the east horn just below the crest; in the radial valleys of the southern slope near the cliffs; and just behind the bench to the west of the gas tank houses (i.e., west of the sea-caves). We observed several populations, including one in a natural seep on a shelf just above the southeastern cliffs (UTM 387386–2435789); in addition to several small patches around the seeps just above the sea-caves. Seeds were collected for restoration.

Material examined. NI‘IHAU: Lehua Islet; 4 Jun 1931, E. L. Caum 5 (BISH, PTBG); 14 May 2005, K.R. Wood et al. 11348 (BISH, PTBG); 6 Jul 2002, K.R. Wood & VanderWerf 9873 (BISH, PTBG).

Cyperus polystachyos Rottb.

This species is a small indigenous sedge with stiff culms. The form observed by Caum was described as tiny compared to the normal form which ranges between 20–30 cm. Caum observed a population near the base of the east horn, on the outer side just below the crest. Currently, plants are uncommon and scattered around the north side of the island.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4867 (PTBG).

Fimbristylis cymosa R. Br. subsp. *umbellato-capitata* (Hillebr.)

T. Koyama

Mau'u 'aki'aki is an indigenous perennial sedge, usually around 10 cm tall, with short rhizomes and stiff erect leaves and culms. Caum noted that it was rare in 1931, growing sparingly along the crest of the southwest ridge, where it formed mats in tiny rock pockets. In addition, he noted a single, small but fully mature clump on the crest of the west horn, well out toward the tip. Early in our surveys we only observed a few scattered clumps clinging just below and east of the lower southwest ridge (UTM 386003–2435260). This region has a steep 45° slope with scattered chunks of slate-like tuff. Subsequently, this population has died off, and we are unaware of any living plants remaining on the islet.

Material examined. NI‘IHAU: Lehua Islet; 6 Jul 2002, K.R. Wood & VanderWerf 9869 (PTBG).

Euphorbiaceae

Chamaesyce hirta (L.) Millsp.

Koko kahiki is a nonnative, naturalized herbaceous annual herb that was reported by Caum as not uncommon, scattered along the crest of the island and sparingly elsewhere. We observed it throughout the islet after rains and found it to be moderately common.

Material examined. NI‘IHAU: Lehua Islet; 6 Oct 2005, K.R. Wood 11539 (BISH, PTBG); 19 Nov 2005, K.R. Wood 11618 (PTBG).

Fabaceae

Prosopis pallida (Humb. & Bonpl. ex Willd.) **New island record**

Kunth

Kiawe is a nonnative, naturalized hardwood tree that was not observed by Caum. A single tree of this species is reported here, and it occurs at the lower end of one of the radial

drainages on the east central leeward side of the outer crescent. This single tree is used by nesting red-footed boobies. It is also interesting to note that around five dead red-footed boobies were observed in this tree. Some had apparently died sometime ago as the only evidence of their presence was their feet still left clinging to the roosting branch. Dozens of invasive cattle egrets (*Bubulcus ibis*) have also been observed nesting in this tree and pose a serious threat to the native boobies that need shrubs or trees to raise their young. Previously unrecorded from Ni'ihau and Lehua Islet, this collection constitutes a new island record.

Material examined. NI'IIHAU: Lehua Islet; 20 Dec 2001, K.R. Wood et al. 9218 (BISH, PTBG); 19 Nov 2005, K.R. Wood 11616 (PTBG).

Malvaceae

Abutilon grandifolium (Willd.) Sweet

The hairy abutilon or *ma'o* is a nonnative, naturalized shrub, about two meters tall. It was not observed by Caum but is currently common in crevices on the less steep lower and central slopes of the outer crescent. This shrub is used by red-footed boobies for nesting and perching.

Material examined. NI'IIHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4849 (BISH, PTBG).

Sida fallax Walp.

Ilima is an indigenous, prostrate or sub-erect shrub of around 25 cm in height. Caum recorded this species as rare with only two plants seen near the tip of the east horn on the inner crescent side and a few seedlings on the crest of the west horn. We report this plant occurring only on the crest and inner crescent side of the west horn. It is immediately observable after crossing over the west horns natural arch.

Material examined. NI'IIHAU: Lehua Islet; 6 Oct 2005, K.R. Wood 11537 (BISH, PTBG).

Nephrolepidaceae

Nephrolepis multiflora (Roxb.) F.M. Jarrett **New island record** ex C.V. Morton

This sword-fern is a nonnative, naturalized species, 30–50 cm tall, with fronds clustered on short decumbent to sub-erect rhizomes. Caum did not record this species. Our survey showed this species to be rare with just a few plants observed above the southern landing in loose sandy seeps, in addition to a few plants emerging out of the fissures of tuff along the inner crescent shelves with *Doryopteris decipiens*. This collection represents a new island record.

Material examined. NI'IIHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4855 (PTBG, US).

Nyctaginaceae

Boerhavia repens L.

Anena is an indigenous perennial herb with prostrate stems. Caum reported this species as very rare because he found only three seedlings along the flats above the sea-caves. Our surveys revealed this species as occasional to common throughout the islet.

Material examined. NI'IIHAU: Lehua Islet; 14 May 2005, K.R. Wood et al. 11344 (BISH, PTBG, US); 20 Dec 2001, K.R. Wood et al. 9219 (BISH, PTBG).

Oxalidaceae

Oxalis corniculata L.

'Thi 'ai is an indigenous perennial herb 5–10 cm in height with trifoliate leaves. Caum made no observations of this species, yet we saw it occasionally throughout the islet after rains.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4866 (PTBG, US)

Papaveraceae

Argemone glauca (Nutt. ex Prain) Pope var. *glauca*

Pua kala is an endemic perennial herb with glaucous blue-green stems and leaves, yellow latex, and white flowers. Caum reported this species as being rare in 1931 with two plants in a pocket just behind the cliffs on the south side and two more in a deep gully on the northern side of the southwest ridge. We noted this species as occasional on the western slopes of the southwest ridge, in addition to being occasional on the inner crescent slopes.

Material examined. NI‘IHAU: Lehua Islet; 19 Feb 2002, K.R. Wood et al. 9298 (BISH, PTBG); 19 Feb 2002, K.R. Wood et al. 9306 (BISH, PTBG, US).

Passifloraceae

Passiflora foetida L.

Lani wai is a nonnative vine with glandular pubescence on its petioles that give the plant a foetid odor. It was not observed by Caum, yet has been documented on Ni‘ihau. We observed three plants of this species along the southern slope just west of camp.

Material examined. NI‘IHAU: Lehua Islet; 30 May 2003, K.R. Wood et al. 10190 (BISH, PTBG, US)

Poaceae

Cenchrus ciliaris L.

New island record

Buffelgrass is a nonnative, naturalized, perennial species of grass that forms mats or tussocks. Caum did not report this species. Currently it is the most common grass on the islet. It thickly covers the flatter regions around the inner and outer crescent and dies back during dry periods. We have observed wedge-tailed shearwaters nesting below the tussocks of this grass. This species has not been recorded on Ni‘ihau or Lehua Islet and represents an island record.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4848 (BISH, PTBG, US).

Cenchrus echinatus L.

‘Ume‘alu is a nonnative, naturalized annual species of grass with decumbent culms and burs with sharp bristles. Caum did not find this species. Currently it is occasional throughout the islet with a greater density around the western end of the outer crescent.

Material examined. NI‘IHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4854 (PTBG, US); 20 Dec 2001, K.R. Wood et al. 9223 (BISH, PTBG).

Chloris barbata (L.) Sw.

Swollen fingergrass is a nonnative, naturalized annual grass not documented by Caum yet is currently common on islet.

Material examined. NI‘IHAU: Lehua Islet; 14 May 2005, K.R. Wood et al. 11350 (BISH, PTBG, US); 20 Dec 2001, K.R. Wood et al. 9222 (BISH, PTBG).

Chloris radiata (L.) Sw.

Radiate fingergrass is a nonnative, naturalized annual grass. Caum made no note of this species. Currently it is occasional to locally common throughout the islet.

Chloris virgata Sw.

New island record

Feather fingergrass is a nonnative, naturalized annual grass with digitate feathery spikes. Caum made no note of this species. Currently it is occasional to locally common throughout the islet.

Material examined. NI'ĪHAU: Lehua Islet; 6 Oct 2005, K.R. Wood 11538 (PTBG).

Digitaria ciliaris (Retz.) Koeler

Kūkaepua'a is a nonnative, naturalized annual grass with decumbent stems. Caum found a number of dead plants in a small patch near the middle of the west horn, and a single dead plant was on the crest of the southwest ridge. We found this species throughout the islet especially after rains.

Material examined. NI'ĪHAU: Lehua Islet; 6 Jul 2002, K.R. Wood & VanderWerf 9876 (BISH, PTBG, US); 14 May 2005, K.R. Wood et al. 11343 (BISH, PTBG, US); 6 Oct 2005, K.R. Wood 11535 (PTBG).

Digitaria insularis (L.) Mex ex Ekman

New island record

Sourgrass is a nonnative, naturalized and densely tufted perennial with erect culms of 1 m. Caum did not report this species. Sourgrass is previously unrecorded from Ni'īhau and Lehua Islet and the following collection represents an island record. We noted a single clump along the eastern slopes of the islet.

Material examined. NI'ĪHAU: Lehua Islet; 6 Jul 2002, K.R. Wood & VanderWerf 9875 (BISH, PTBG, US).

Eragrostis amabilis (L.) Wight & Arnott

Lovegrass is a nonnative, naturalized annual grass with erect slender culms of 10–20 cm. Caum made no note of this species. We found this species throughout the islet especially around the flatter regions during the wet season.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn et al. 4853 (PTBG, US).

Eragrostis variabilis (Gaud.) Steud.

Kawelu is an endemic perennial with tufted culms of around 50 cm that can be common on islets. Caum made no observations of this species, and we made only one observation of a dried up plant in one of the radial drainages along the outer crescent just to the east of the sea-caves.

Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.

Pili is an indigenous perennial with erect tufted culms of around 50 cm and flowers that have twisted or contorted awns. In 1931 Caum reported this species as common, on the outer side of east horn, and scattered over the eastern half of the southern slope. He also noted that it grew very sparingly west of the median line. We found this species to be occasional on the eastern slopes of the islet and note that it is locally common along the upper southern slopes of the outer crescent where it reaches its greatest density.

Material examined. NI'ĪHAU: Lehua Islet; 4 Dec 1931, E.L. Caum 8 (BISH, PTBG); 6 Jul 2002, K.R. Wood & VanderWerf 9872 (BISH, PTBG, US).

Lepturus repens (G. Forster) R. Br.

This indigenous perennial grass has erect or spreading stems of around 30 cm. Caum makes no reference to this species. We observed a few dried and dead individuals along the central eastern slopes of the islet and along the west horn. Subsequently, we have been unable to relocate any living individuals for documentation.

Panicum fauriei Hitchc. var. *latius*

New island record

(St. John) Davidse

This species is an endemic, decumbent annual grass which has low diffuse stems that can spread out for 10–25 cm. Caum makes no reference to this species, yet we found it to be

common along the upper southwest ridge up to the summit, and along the western inner crescent where it reaches its greatest density. It is also occasional around the east horn. This species is previously unrecorded from Ni'ihau and Lehua Islet and the following collections constitute an island record.

Material examined. NI'IIHAU: Lehua Islet; 19 Feb 2002, K.R. Wood *et al.* 9296 (BISH, PTBG, US); 19 Feb 2002, K.R. Wood *et al.* 9307 (BISH, PTBG, US).

***Panicum pellitum* Trin.**

Kāi'oi'o is an endemic, decumbent annual grass spreading out 10–25 cm. Caum stated that it was common in 1931 along the crest of the southwest ridge and at the tip of west horn, and we also found it to be common along the summit of the southwest ridge and occasional along the western inner crescent. There were also a few plants at the tip of the west horn.

Material examined. NI'IIHAU: Lehua Islet; 19 Feb 2002, K.R. Wood *et al.* 9295 (BISH, PTBG, US); 19 Feb 2002, K.R. Wood *et al.* 9302 (BISH, PTBG, US).

***Panicum torridum* Gaud.**

Kākonakona is an endemic grass of around 10 to 50 cm tall with velvety puberulent leaves. Caum did not report this species, but we found it to be a dominant species along the summit ridge. *Kākonakona* reaches its greatest density within the upper inner crescent after rains.

Material examined. NI'IIHAU: Lehua Islet; 10 Jan 1992, Flynn *et al.* 4862 (BISH, PTBG); 10 Jan 1992, Flynn *et al.* 4857 (PTBG, SING, US); 19 Feb 2002, K.R. Wood *et al.* 9294 (BISH, PTBG, US).

***Setaria verticillata* (L.) P. Beauv.**

Mau'u pilipili is a nonnative, naturalized tufted annual grass of approximately 25–50 cm tall. Caum reported this species as very rare in 1931 with one clump observed on a tiny ledge near the southern landing. We found this species to be very common on the islet. During the latter summer period, this species seems to completely dry up.

Material examined. NI'IIHAU: Lehua Islet; 14 May 2005, K.R. Wood *et al.* 11349 (BISH, PTBG).

Portulacaceae

***Portulaca oleracea* L.**

Ākulikuli kula is a nonnative, naturalized, annual herb with succulent decumbent or suberect stems and small yellow flowers. Caum reported this plant as being uncommon, although scattered along the length of the crest from about the middle of the southwest ridge to near the tip of the east horn. We found this species to be one of the most common throughout the islet. This species appears to be desirable to rodents as the authors have observed extensive herbivory on the leaves and stems.

Material examined. NI'IIHAU: Lehua Islet; 10 Jan 1992, Flynn *et al.* 4856 (BISH, PTBG, US).

***Portulaca pilosa* L.**

Ākulikuli is a nonnative, naturalized, perennial herb with purple-red stems and magenta flowers. It was not observed by Caum but we found it occasionally throughout the islet and sometimes locally common along the inner crescent.

***Portulaca villosa* Cham.**

Ihi is an endemic perennial herb with decumbent stems and white or pink-white flowers. Caum reported this species as rare with only one small stand on the crest of the west horn, near the tip. The plants were all small and in poor condition. We did not see this species.

Primulaceae***Anagallis arvensis* L.**

The scarlet pimpernel is a nonnative, naturalized, short-lived herb around 10 cm tall with a salmon colored corolla. This species was not observed by Caum, but we recorded it as being occasional along the flatter inner and outer crescent regions after rains.

Material examined. NI'ĪHAU: Lehua Islet; 6 Jul 2002, K.R. Wood & VanderWerf 9871 (BISH, PTBG, US).

Pteridaceae***Doryopteris decipiens* (J. Sm.) Hook.**

Kumuniu is an endemic fern with small triangular fronds of around 5–10 cm long. Caum noted that there were only a few clumps on the inner slope near the peak, just below the crest of the ridge. We report this species as occasional in the same general region noted by Caum.

Material examined. NI'ĪHAU: Lehua Islet; 6 Mar 2004, K.R. Wood & M. Ono 10591 (BISH, PTBG, US); 10 Jan 1992, Flynn *et al.* 4865 (PTBG, US); 20 Dec 2001, K.R. Wood *et al.* 9220 (BISH, PTBG).

Solanaceae***Solanum americanum* Mill.**

Po'polohua is an indigenous, short-lived perennial herb of around 50 cm in height with white or purple tinged corolla and glossy black berries. This species was not observed by Caum and is reported here as being rare on the flats above and west of the sea-caves; and occasional along the flatter zones of the inner crescent especially after rains.

Material examined. NI'ĪHAU: Lehua Islet; 19 Feb 2002, K.R. Wood *et al.* 9301 (BISH, PTBG, US); 6 Jul 2002, K.R. Wood & VanderWerf 9870 (BISH, PTBG, US).

Sterculiaceae***Waltheria indica* L.**

'Uhaloa is an indigenous sub-shrub with prostrate to ascending branches; velvety gray-green leaves; and yellow flowers. Caum reported this species to be very common in all parts of the islet with the exception of the tip of the west horn where it occurred very sparingly. He further stated that with the exception of *Jacquemontia*, it was the most common plant species on the island. We found *'uhaloa* to be common throughout the islet but not as dominant as *Cenchrus ciliaris*, *Portulaca oleracea*, *Ageratum conyzoides*, and *Chenopodium murale*. *'Uhaloa* is able to survive during drought periods when the aforementioned herbs sometimes die back.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Flynn *et al.* 4851 (BISH, PTBG, US); 6 Oct 2005, K.R. Wood 11544 (BISH, PTBG, US).

Urticaceae***Pilea peplodes* (Gaud.) Hook. & Arnott****New island record**

Pilea is a low spreading indigenous succulent perennial herb in the nettle family. Caum did not record this species, yet we noted it to be occurring in a small localized population along the inner crescent and growing in moist crevices. This species was previously unrecorded from Ni'ihau and Lehua Islet and the following collection constitutes an island record.

Material examined. NI'ĪHAU: Lehua Islet; 10 Jan 1992, Lorence *et al.* 7136 (BISH, PTBG).

Verbenaceae***Lantana camara* L.**

Lanakana is a nonnative, naturalized shrub around 1–2 m tall, with stout recurved prickles. Caum reported only one plant in a soil pocket on the edge of the southern cliffs. He noted that the plant was destroyed after the specimen was taken and that Mr. Aubrey Robinson, the owner of the island of Ni‘ihau, has for a number of years, conducted a systematic campaign to exterminate *lanakana* on Lehua, to prevent the spread of the plant to Ni‘ihau. We did not observe this species.

Zygophyllaceae***Tribulus cistoides* L.**

Nohu is an indigenous perennial herb with creeping decumbent stems and compound leaves that are densely covered in silvery strigose hairs. Caum did not observe this species, but we recorded 15 plants along the ridge and scattered around the inner crescent side of the west horn.

Material examined. NI‘IHAU: Lehua Islet; 19 Feb 2002, *K.R. Wood et al.* 9304 (BISH, PTBG, US); 6 Oct 2005, *K.R. Wood* 11536 (BISH, PTBG, US).

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New Plant Records from the Hawaiian Archipelago

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The following contributions of plants collected before 2006 include 50 new records of plants located on the islands of Moloka'i, Lāna'i, Kaho'olawe, Maui, and Hawai'i. The records are comprised of 2 new state records, 5 new naturalized records, 38 new island records, and 5 range extensions. 12 of the records are from Moloka'i, 4 are from Lāna'i, 15 are from Kaho'olawe, 17 are from Maui, and 2 are from Hawai'i. All but 3 of the records are for nonnatives. Images of most of the material examined can be seen at <http://www.hear.org/starr/>. Voucher specimens are housed in the Bishop Museum's *Herbarium Pacificum* (BISH), Honolulu, Hawai'i.

Acanthaceae

Barleria cristata L.

New island record

Barleria cristata (Philippine violet) was previously reported from Kaua'i, O'ahu, Maui, and Hawai'i (Wagner *et al.*, 1999; Oppenheimer & Bartlett, 2002). This sprawling shrub is now also known from Moloka'i, where large patches can be found in the understory of kiawe (*Prosopis pallida*) along the road to the East end of Moloka'i.

Material examined. **MOLOKA'I:** East Moloka'i, Kalua'aha, filling understory in many spots along Kamehameha Hwy., in association with *Prosopis pallida*, 10 ft [3 m], 17 May 2005, Starr & Starr 050517-5.

Thunbergia fragrans Roxb.

New island record

Thunbergia fragrans (white thunbergia) was reported from Kaua'i, O'ahu, Maui, and Hawai'i, and is noted to probably be on all of the main islands (Wagner *et al.*, 1999). This twining vine with white flowers is now also known from Moloka'i, where is a volunteer in yards in Kualapu'u.

Material examined. **MOLOKA'I:** Central Moloka'i, Naiwi, Kualapu'u, volunteering in yards, in association with *Ochna* and *Carmona retusa*, 850 ft [260 m], 18 May 2005, Starr, Starr, Buchanan, & Hart 050518-3.

Thunbergia laurifolia Lindl.

New island record

Thunbergia laurifolia (blue trumpet vine) was previously known from Kaua'i, O'ahu, and Maui (Starr *et al.*, 1999; Oppenheimer, 2003). This sprawling vine is now also known from Lāna'i, where it can be found in Kapano Gulch.

Material examined. **LĀNA'I:** Lāna'i City, Kapano Gulch, 600 ft [182 m], 23 Jun 2005, Starr, Starr, Anderson, & Anderson 050623-4.

Aizoaceae

Tetragonia tetragonioides (Pall.) Kuntze

New island record

Tetragonia tetragonioides (New Zealand spinach) was previously known from Midway, Nihoa, Kaua'i, O'ahu, Maui, and Hawai'i (Wagner *et al.*, 1999; Oppenheimer *et al.*, 1999;

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Starr & Martz, 2000; Starr *et al.*, 2003). This succulent herb is now also known from Moloka'i, where it grows near the coast at Hālawā Valley.

Material examined. **MOLOKA'I:** East Moloka'i, Hālawā, Hālawā Valley, near coast, in association with *Sesuvium portulacastrum*, *Vigna marina*, and *Tournefortia argentea*, 5 ft [2 m], 17 May 2005, Starr & Starr 050517-13.

Amaranthaceae

Amaranthus dubius Mart. ex Thell.

New island record

Amaranthus dubius (spleen amaranth) was previously reported from Kaua'i, O'ahu, Lāna'i, and Hawai'i (Wagner *et al.*, 1999). This weedy herb is now also known from Maui, where it can be found scattered about Pu'u o Kali.

Material examined. **MAUI:** East Maui, Kīhei, Pu'u o Kali, growing in *a'a* lava in association with *Amaranthus hybridus*, *Sida fallax*, *Cenchrus ciliaris*, and *Prosopis pallida*, 1000 ft [305 m], 27 May 2004, Starr; Starr, Medeiros, & vonAllmen 040527-1.

Asteraceae

Centratherum punctatum Cass.

New island record

subsp. *punctatum*

Centratherum punctatum subsp. *punctatum* (larkdaisy) was previously reported from Kaua'i, Maui, and Hawai'i (Lorence *et al.*, 1995; Oppenheimer, 2003; Starr *et al.*, 2004). This weedy purple herb is now also known from Moloka'i, where it is scattered along Kamehameha Hwy on the East end of Moloka'i.

Material examined. **MOLOKA'I:** East Moloka'i, Moakea, Kukumamalu Gulch, near Kuala, growing along side of Kamehameha Hwy., in association with *Hypparhenia* sp., 600 ft [182 m], 17 May 2005, Starr & Starr 050517-8.

Conyza canadensis (L.) Cronq.

New island record

var. *pusilla* (Nutt.) Cronq.

Conyza canadensis (horseweed) was previously reported from all the main islands except Kaho'olawe (Wagner *et al.*, 1999). This diminutive herb is now also known from Kaho'olawe, where it is locally common near the summit.

Material examined. **KAHO'OLAWA:** Pu'u Moaulanui, on West rim of Lua Makika, in experimental planting area, in association with *Eragrostis curvula*, *Pluchea* spp., and *Leucaena leucocephala*, 1400 ft [425 m], 8 Feb 2005, Starr; Starr; Higashino, Bruch, & Bryce 050208-2.

Dyssodia tenuiloba (DC.) B.L. Rob.

New island records

Dyssodia tenuiloba (dog weed, Dahlberg daisy) was previously reported from the islands of Maui and O'ahu (Starr *et al.*, 2002), and is now known from Moloka'i and Kaho'olawe. On Kaho'olawe this quickly spreading bedding plant with small yellow flowers and highly dissected leaves has been found in two widely separated high traffic locations. On Moloka'i this bedding plant has escaped from plantings near the Hotel Moloka'i. *Dyssodia tenuiloba* should also be looked for on other Hawaiian Islands, such as Kaua'i, where it was collected (Flynn 6747 BISH) in Lihue at the Wal-Mart Garden Center for \$0.77 per 4-inch pot and labeled as "Zinnia 'Dreamland mix' F1 hybrids".

Material examined. **KAHO'OLAWA:** Honokanaia, on side of path from helicopter LZ to bunkhouse, 15 ft [5 m], 30 Mar 2004, Starr; Starr; Higashino, & Abbott 040330-1; Moaulanui, near water catchment building, 1300 ft [400 m], 7 Jun 2004, Starr; Starr; Higashino, & Bruch 040607-2. **MOLOKA'I:** Kaunakakai, 'Ōhai Ali'i Rd., on side of road, spreading from nearby plantings, 25 ft [8 m], 17 May 2005, Starr & Starr 050517-14.

Lactuca sativa* L.*New island record**[Syn. *Lactuca serriola* L.]

Previously known from all the main islands except Ni'ihau and Kaho'olawe (Wagner & Herbst, 1995; Wagner *et al.*, 1999; Oppenheimer, 2003), *Lactuca sativa* (prickly lettuce) is now also known from Kaho'olawe, where this prickly herb is occasionally found along roadsides on the summit plateau.

Material examined. **KAHO'OLAWA:** North trail from Lua Makika to Hakioawa, 1150 ft [350 m], 30 Mar 2004, *Starr, Starr; & Tokishi 040330-6*; Pu'u Moaulaiki, along road to pu'u, 1350 ft [411 m], 30 Mar 2004, *Starr, Starr; & Tokishi 040330-7*.

Pluchea xfosbergii* Cooperr. & Galang*New island record**

Previously known from Midway Atoll, Kaua'i, O'ahu, Moloka'i, and Maui (Wagner *et al.*, 1999), *Pluchea xfosbergii*, a spontaneous hybrid, is now also known from Kaho'olawe, where it can be found growing on the summit in association with *Pluchea carolinensis* and *Pluchea indica*.

Material examined. **KAHO'OLAWA:** Moaulanui, north rim, sprawling patches, 1450 ft [441 m], 27 Aug 2003, *Starr, Starr; & Abbott 030827-2*; N side of Lua Makika, 1444 ft [440 m], 18 Nov 2004, *Oppenheimer H110406*.

Senecio madagascariensis* Poirlet*New island records**

Senecio madagascariensis (fireweed) was previously documented from Kaua'i, O'ahu, Maui, and Hawai'i (Lorence *et al.*, 1995; Starr *et al.*, 1999; Oppenheimer & Bartlett, 2002; Herbst *et al.*, 2004), and is now established on Lāna'i and Kaho'olawe. On Lāna'i this weedy little Asteraceae is found at the Koele golf course. On Kaho'olawe *S. madagascariensis* is found as single plants in widely separated locations.

Material examined. **LĀNA'I:** Koele, Koele golf course, 600 ft [182 m], 23 June 2005, *Starr, Starr; Anderson, & Anderson 050623-2*. **KAHO'OLAWA:** North trail from Lua Makika to Hakioawa, 1150 ft [350 m], 30 Mar 2004, *Starr, Starr; & Tokishi 040330-3*; Moaulanui, near summit, 1480 ft [450 m], 11 May 2004, *Starr, Starr; & Higashino 040511-1*.

Boraginaceae***Carmona retusa* Poirlet****New island record**

Carmona retusa (scorpion bush, Philippine tea) was previously known from Kaua'i and Maui (Lorence *et al.*, 1995; Starr *et al.*, 2003). This prolific shrub is now also known from Moloka'i, where it is widely naturalized in and near Kaunakakai.

Material examined. **MOLOKA'I:** Kaunakakai, Moloka'i Shores, volunteering in hard-to-reach places, widely cultivated and naturalized in this area, in association with *Schefflera actinophylla* and *Washingtonia* sp., 15 ft [5 m], 16 May 2005, *Starr & Starr 050516-5*.

Brassicaceae***Lepidium oblongum* Small****New island record**

Lepidium oblongum (pepperwort) was previously known from all the main islands except Maui and Hawai'i (Lorence *et al.*, 1995; Wagner *et al.*, 1999). This diminutive herb is now also known from Maui, where it was found scattered about Pu'u o Kali.

Material examined. **MAUI:** East Maui, Kihei, Pu'u o Kali, growing in *a'a* lava in association with *Sida fallax* and *Erythrina sandwicensis*, 1000 ft [305 m], 28 Jan 2004, *Starr, Starr; Medeiros, & vonAllmen 040128-2*.

Chenopodiaceae***Chenopodium oahuense* (Meyen) Aellen** **New island record**

Chenopodium oahuense ('aweoweo) was previously known from Lisianski, Laysan, French Frigate Shoals, Necker, Nihoa, and all the main islands except Kaho'olawe (Wagner *et al.*, 1999). This hardy native is now also known from Kaho'olawe where it was widely planted and sown as seed in restoration efforts on the island, and has now spread far beyond those plantings, from sea level to the summit. The original stock is believed to have come from Maui.

Material examined. **KAHO'OLAWA:** Honokanaia, near base camp, in coastal wetland on the makai side of the old coastal road, in association with *Cenchrus ciliaris*, *Prosopis pallida*, *Sida fallax*, and *Abutilon incanum*, 10 ft [3 m], 8 Feb 2005, Starr, Starr, Higashino, Abbott, & Bryce 050208-1.

Salsola tragus* L.*New island record**

Salsola tragus (prickly Russian thistle) was previously known from O'ahu, Kaho'olawe, Maui, and Hawai'i (Wagner *et al.*, 1997; Wagner *et al.* 1999; Herbst & Wagner, 1999; Oppenheimer & Bartlett, 2002; Herbst *et al.*, 2004). This spiny dryland plant is now also known from Moloka'i where it can be found near the dump. The Moloka'i Invasive Species Committee is planning to control the plants at this site.

Material examined. **MOLOKA'I:** Na'iwa, Moloka'i dump, near Manawainui Gulch, scattered plants growing in industrial area hard pan and nearby scrub, in association with *Leucaena leucocephala*, 275 ft [84 m], 16 May 2005, Starr & Starr 050516-3.

Convolvulaceae***Ipomoea cairica* (L.) Sweet****Range extension**

Ipomoea cairica (koali 'ai, ivy-leaved morning glory) was previously reported from all the main islands except Maui (Wagner *et al.*, 1999). This palmately lobed vine with purple flowers was then documented from West Maui by Oppenheimer & Bartlett (2000) and is here reported as a range extension to East Maui, where it was sprawling and rooting at the nodes in a gulch in Kula.

Material examined. **MAUI:** East Maui, Kula, filling gulch on mauka side of Haleakalā Hwy. near residential area, 3000 ft [914 m], 27 Mar 2004, Starr, Starr, & Bryce 040327-1.

Crassulaceae***Kalanchoe daigremontiana*****New island record**

Raymond-Hamet & H. Perrier

Kalanchoe daigremontiana (mother of millions, devil's backbone) was previously reported as a new naturalized record from Kaua'i (Lorence *et al.*, 1995) where it was locally naturalized on cliffs in dry *Leucaena* secondary vegetation. This large succulent with showy flowers is now also known from Maui, where it is common in pastures around Pu'u Pimoe.

Material examined. **MAUI:** East Maui, Kanaio, Pu'u Pimoe, growing in dry scrub and pastures in association with *Prosopis pallida* and *Amaranthus spinosus*, 1500 ft [457 m], 31 Mar 2004, Starr, Starr, & Wysong 040331-3.

Cyperaceae***Cyperus cyperinus* (Retz.) Suringar****New island record**

[Syn. *Mariscus cyperinus* (Retz.) Vahl]

Cyperus cyperinus was previously known from Kaua'i, O'ahu, and Moloka'i (Wagner *et al.*, 1999). This collection represents a new island record from Maui where a lone clump of this native sedge was found on a dry lava field in an enclosure in lower Kanaio.

Material examined. **MAUI:** East Maui, Kanaio National Guard enclosure, on a'a lava in sparse *Dodonaea* shrubland, 400 ft [121 m], 31 Mar 2004, Starr, Starr, & Wysong 040331-1.

Cyperus difformis* L.*Range extension**

Cyperus difformis was previously known from Kauaʻi, Oʻahu, and West Maui (Wagner *et al.*, 1999; Starr *et al.*, 2002). The following collection represents a range extension to East Maui where this sedge can be found as a roadside weed on the Hana Hwy.

Material examined. MAUI: East Maui, Huelo, Hāna Hwy, growing in a puddle and locally common in area of lowland, disturbed, wet roadside, 600 ft [182 m], 7 Aug 2003, Starr & Starr 030807-3.

Fabaceae***Acacia mearnsii* De Wild.****New island record**

Acacia mearnsii (black wattle) was previously known from all the main islands except Niʻihau and Kahoʻolawe (Hughes, 1995; Wagner *et al.*, 1999). This aggressive tree is now also known from Kahoʻolawe where it was used in planting trials (KIRC, 1998) and has since been found beyond those plantings as a volunteer.

Material examined. KAHŌʻOLAWĒ: Kanapou, Native Hawaiian Plant Society restoration site along K2, in association with *Dodonaea viscosa* and *Salsola tragus*, 1150 ft [350 m], 27 Dec 2004, Starr, Starr, Higashino, & Price 041227-2.

Caesalpinia decapetala* (Roth) Alston*New island record**

Caesalpinia decapetala (cat's claw) was previously known from Niʻihau, Kauaʻi, Oʻahu, East Maui, and Hawaiʻi (Wagner *et al.*, 1999). This spiny sprawling plant is now also known from Lānaʻi where it can be found through much of Kapano Gulch. This plant still needs to be collected from Molokaʻi, where it is well established in Waiakalae Gulch.

Material examined. LĀNAʻI: Lānaʻi City, Kapano Gulch, 600 ft [182 m], 23 Jun 2005, Starr, Starr, Anderson, & Anderson 050623-1.

Crotalaria assamica* Benth.*New island record**

Crotalaria assamica (rattle pod) was previously known from Oʻahu, Maui, and Hawaiʻi (Wagner *et al.*, 1999; Starr *et al.*, 2002). This simple leaved rattle pod is now also known from Molokaʻi where it is locally common on the side of dirt roads in Hoʻolehua.

Material examined. MOLOKAʻI: Hoʻolehua, side of dirt road, in association with *Leucaena leucocephala*, 550 ft [168 m], 18 May 2005, Starr, Starr, Buchanan, & Hart 050518-5.

Crotalaria trichotoma* Bojer*New state record**

Native to Mozambique and Tanzania (PIER, 2005; GRIN, 2005), and previously not known from Hawaiʻi, *C. trichotoma* (curara-pea) was collected in Haʻiku, Maui, in low elevation, moist, disturbed roadside vegetation. The identification was determined by R.M. Polhill, Royal Botanical Gardens (RBG), Kew. This species can be distinguished by the following characteristics. "Erect herb, sts. streaked, pubescent; lfts. 3, elliptic to 2.25 in [1 cm] long; racemes loose, many-fl'd., to 10 in. long; calyx glabrous, petals yellow, standard streaked; fr. oblong-cylindrical, pubescent" (L.H. Bailey Hortorium, 1976). This species is considered invasive in Papua New Guinea and northern Queensland, Australia (PIER, 2005). This collection represents a new state record for Hawaiʻi.

Material examined. MAUI: East Maui, Haʻiku, West Kuiaha Rd, in association with *Citharexylum caudatum* and *Psidium guajava*, 700 ft [213 m], 29 Nov 2000, Starr & Martz 001129-4.

Zornia* cf. *reticulata* J.E. Smith*New state record**

Native from New Mexico (United States) to Brazil, the West Indies, and Australia (FAO, 2005), *Zornia* cf. *reticulata* (*zornia*), was found on Maui in an empty lot by pastures on

West Kuiaha Rd, Ha'iku. The area is mesic to wet lowland rural residential. *Zornia* cf. *reticulata* can be distinguished by the following: "A diffuse annual with two ovate-lanceolate pointed leaflets, flowers distant in peduncled spikes, pod joints two to seven, roundish, convex or reticuled on sides, flowers yellow concealed in the stipular bracts" (FAO, 2005). The plant was determined to genus level by Gwilym Lews of the RBG, Kew, using relevant taxonomic revision by Mohlenbrock (1961). The species was tentatively determined by George Staples and Derral Herbst of Bishop Museum who report that specimens from Guam appear to be the same species. This collection represents a new state record for Hawai'i.

Material examined. MAUI: East Maui, Ha'iku, scattered in empty lot by pastures on West Kuiaha Rd, in association with *Andropogon virginicus* and *Acacia koa*, 900 ft [274 m], 29 Nov 2000, Starr & Martz 001129-1.

Lamiaceae

Hyptis suaveolens (L.) Poir.

New island record

Previously reported as sparingly naturalized in relatively dry, disturbed sites, at least on O'ahu and Hawai'i (Wagner & Herbst, 1995; Wagner *et al.*, 1999), *H. suaveolens* is now also known from Maui in similar dry disturbed habitat. The identification was made by Alan Paton, RGB, Kew. This collection represents a new island record for Maui.

Material examined. MAUI: East Maui, Kaupo, scattered plants in Hawelewele Gulch, 40 ft [12 m], 26 Jul 2001, Starr & Martz 010726-1.

Liliaceae

Asparagus plumosus J. G. Baker

New island record

Asparagus plumosus (asparagus fern) was previously known from Kaua'i, O'ahu, Maui, Hawai'i (Lorence *et al.*, 1995; Imada *et al.*, 2000; Oppenheimer & Bartlett, 2000; Starr *et al.*, 2002; Oppenheimer & Bartlett, 2002). This twining vine is now also known from Moloka'i where it is found wild along Kamehameha Hwy near 'Ōhi'a bridge.

Material examined. MOLOKA'I: 'Ōhi'a, 'Ōhi'a bridge, side of Kamehameha Hwy, climbing up into *Syzygium cumini* trees, 10 ft [3 m], 17 May 2005, Starr & Starr 050517-3.

Linaceae

Linum bienne Mill.

New island record

Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner *et al.*, 1999). It was then also reported from Kaua'i (Oppenheimer, 2004). It is now also known from Hawai'i, scattered in subalpine pasture and mamane (*Sophora chrysophylla*) shrubland on the north slope of Mauna Kea in the vicinity of Pu'u Mali.

Material examined. HAWAII'I: Mauna Kea, Pu'u Mali, in association with *Pennisetum clandestinum* and *Sophora Chrysophyllum*, 6600 ft [2000 m], 23 Jul 2004, Starr, Starr, & Crummer 040723-4.

Malvaceae

Sida ciliaris L.

New island record

Sida ciliaris (red flowered sida) was previously known from Kaua'i, O'ahu, and Maui (Wagner *et al.*, 1997; Oppenheimer & Bartlett, 2000; Staples *et al.*, 2003, Starr *et al.*, 2004). This prostrate shrub is now also known from Kaho'olawe where it is found in the "lawn" at base camp.

Material examined. KAHŌ'OLAWĒ: Honokanaia, growing in disturbed lawn at base camp near the galley, in association with *Indigofera spicata* and *Cenchrus ciliaris*, 20 ft [6 m], 13 Oct 2004, Starr, Starr, Higashino, & Abbott 041013-1.

Meliaceae***Cedrela odorata* L.****New naturalized record**

Cedrela odorata (West Indian cedar) is a tall, nearly smooth, unpleasant smelling tree native from the West Indies south to the Amazon regions (Neal, 1965). This species is similar in appearance to *Toona* in Hawai'i and can be distinguished by having seeds winged in the lower part only, yellowish flowers with the ovary raised on a cylindrical disk, leaves with 10 to 20 pairs of narrow-oblong leaflets 5–7 in [2–3 cm] long, reaching heights of 100 ft [33 m] and diameters of 3–6 ft [1–2 m] above the buttresses at the base, and unbranched to about half way up (Neal, 1965). This large tree is commonly planted in forestry plantations and the timber is said to be aromatic, light weight, and strong (Neal, 1965). In the state of Hawai'i, over 26,000 *C. odorata* trees were planted from 1910–1960 (Skolmen, 1960). About 9,000 of these were planted on the island of Maui in the vicinities of Hana, Ko'olau, and Makawao (Skolmen, 1960). *Cedrela odorata* is now naturalized in these areas and is spreading from forestry plantations into nearby lowland disturbed wet forest. This collection documents this species on Maui and represents a new naturalized record for the state of Hawai'i. *Cedrela odorata* was also planted in mass on Kaua'i, O'ahu, Moloka'i, and Hawai'i, and should be investigated on those islands to determine if similar spread from plantations is occurring.

Material examined. MAUI: East Maui, Nua'ailua, Hāna Hwy, near Keanae in small gulch east of Nua'ailua bay, established in the area, numerous seedlings, saplings, and large adult trees observed, 200 ft [60 m], 29 Nov 2000, *Starr & Starr 030807-1*.

Myrtaceae***Angophora costata* (Gaertn.) Britten****New naturalized record**

[Syn. *Angophora lanceolata* Cav.]

Angophora costata (gum myrtle, lanceleaf gum myrtle), native to Queensland and New South Wales, Australia, is previously known in Hawai'i from forestry plantings, primarily on O'ahu (10,336 trees) and Maui (over 7,700 trees), with lesser plantings on Kaua'i (558 trees) and Hawai'i (989 trees) (Little & Skolmen, 1989; Skolmen, 1960). On O'ahu, trees can be observed on the Mānoa Cliffs Trail, Tantalus Mountain and there extensive plantings in Waiawa and Waiiau above Pacific Pallasades and Waimano Home (Little & Skolmen, 1989). On Maui, it was planted in Ko'olau, Kula, Makawao, and Waihou Springs forest reserves and was "growing well" in the Borge Ridge area of the Makawao Forest Reserve (Little & Skolmen, 1989). This large tree is now known to be naturalized on Maui, in the Olinda area. *Angophora costata* is similar in appearance to *Eucalyptus*, but differs in having opposite paired leaves and flowers with 5 separate white petals (Little & Skolmen, 1989). It is a tall tree, to 80 ft [24 m] in height; bark is smooth, flaking off and becoming mottled and gray brown; leaves are lanceolate, to 5 in [2 cm] long, and short petioled; flowers are white, in clusters, to 1 in. across, with short panicles, and many white thread like stamens; fruit cuplike, rounded, about 1/2 in [0.5 cm]. long, with 10 long ridges, blackish, hard, thick walled, opening like a lid, 3 celled (L.H. Bailey Hortorium, 1976; Little & Skomen, 1989).

Material examined. MAUI: East Maui, Kalialinui, Olinda, Kahakapao Gulch, widely planted as a forestry tree along the mauka boundary of the Forest Reserve, seedlings and saplings spreading from plantings into nearby pasture and gulches, in association with *Eucalyptus* sp., *Metrosideros polymorpha*, and *Vaccinium* sp., 3800 ft [1158 m], 18 Aug 2005, *Starr & Starr 050818-2*.

Ochnaceae***Ochna thomasi* Engler & Gilg****New island record**

Ochna thomasi (Mickey Mouse plant) was previously known from O'ahu and Maui

(Herbarium Pacificum Staff, 1998; Imada *et al.*, 2000; Oppenheimer, 2003; Starr *et al.* 2004). This colorful shrub is now also known from Lānaʻi where it is found in Kapano Gulch.

Material examined. **LĀNAʻI:** Lānaʻi City, Kapano Gulch, 600 ft [182 m], 23 Jun 2005, *Starr, Starr, Anderson, & Anderson 050623-3.*

Passifloraceae

Passiflora suberosa L.

Range extension

Passiflora suberosa (*huehue haole*) was previously known from Kauaʻi, Oʻahu, Lānaʻi, Maui, and Hawaiʻi (Lorence *et al.*, 1995; Wagner *et al.*, 1997; Wagner *et al.*, 1999). On Maui, this passion vine was previously only known from West Maui, and is now known from East Maui, where it is established in Piʻiholo. The Piʻiholo Agricultural Experiment Station on East Maui was at one time growing many different species of *Passiflora*. Ed Tamura with the Hawaii Department of Agriculture asked them to stop the experimental plantings, for fear of these new *Passiflora* species spreading from the station. However, the plea was too late, and *P. suberosa* is now one of a handful of species of *Passiflora* that were able to escape beyond the experimental plantings at Piʻiholo before the plantings were destroyed. The following collection represents a range extension to East Maui, where this passion vine with small blue fruits can be found twining under *Eucalyptus*.

Material examined. **MAUI:** East Maui, Piʻiholo, sprawling in understory of *Eucalyptus* sp. and *Acacia mearnsii* at old agricultural experiment station, 3400 ft [1036 m], 16 Jan 2004, *Starr & Starr 040116-1.*

Pittosporaceae

Pittosporum undulatum Venten.

New island record

Pittosporum undulatum (Victorian box, mock orange) was previously known from Lānaʻi and Hawaiʻi (Wagner *et al.*, 1999). This aggressive yet sweet smelling tree is now also known from Maui where it is sparingly naturalized in Kula.

Material examined. **MAUI:** East Maui, Lower Kimo Rd, Kula, hedge of dozens of trees surrounding property, in association with *Macadamia ternifolia*, 3000 ft [305 m], 27 Aug 2004, *Starr & Starr 040827-1*; East Maui, Pulehu Iki, Kula, several large cultivated trees with seedlings and saplings in nearby gulch and across road, in association with *Acacia mearnsii* and *Pinus* sp., 3700 ft [1127 m], 16 Feb 2005, *Starr & Starr 050216-1.*

Poaceae

Bothriochloa barbinodis (Lag.) Herter

New island record

Bothriochloa barbinodis (fuzzy top) was previously known from the islands of Niʻihau, Oʻahu, Molokaʻi, and Maui (Wagner *et al.*, 1999). It is now also known from the island of Hawaiʻi.

Material examined. **HAWAII:** Mauna Kea / Kohala, Waimea, on the side of the road between town and the airport, in association with *Pennisetum clandestinum*, 2600 ft [792 m], 23 Jul 2004, *Starr & Starr 040723-6.*

Bothriochloa bladhii (Retz.) S.T. Blake

New island record

Bothriochloa bladhii (airport grass) was previously known from Molokaʻi, Maui, and Hawaiʻi (Herbarium Pacificum Staff, 1997; Wagner *et al.*, 1999). This collection represents a new island record for Kahoʻolawe where this grass is established, though not common, on the summit.

Material examined. **KAHOʻOLAWE:** Moaulanui, north rim, in hardpan on side of road, windswept shrub/grassland, 1450 ft [441 m], 30 Jul 2003, *Starr, Starr, Abbott, & Mar 030730-1.*

***Brachiaria brizantha* (Hoch. ex Rich.) Stapf New naturalized record**

Native to tropical Africa (PIER, 2005), *Brachiaria brizantha* (beardgrass) was previously known from experimental stations on O‘ahu (*Hosaka* 2553 BISH) and Moloka‘i (*Joy HA-5222* BISH). On Kaho‘olawe, *B. brizantha* was found in a small dense clump on the side of the road near the summit. The species can be distinguished by the following characteristics. “Culms erect, 60–120 cm high; leaf blades smooth, markedly nerved, 20–30 cm long, 6–18 mm broad; flowering culms bearing up to 4 racemes, these ascending, recurved, the rachis strong and narrow, usually deep purple in color; spikelets large, purple-tinged on margins, 4–6 mm long, the lower glume purple-tinged, less than half length of spikelet and clasping base of spikelet, the upper glume as long as spikelet, sparsely hairy toward apex” (Smith, 1979). This collection represents a new naturalized record for the state of Hawai‘i.

Material examined. **KAHO‘OLAWE:** Moaulanui, near K1 where it heads into Lua Makika crater, about 5 m from side of road, occurring in an open dry disturbed area with *Dodonaea viscosa* and *Neonotonia wightii*, 1300 ft [396 m], 07 Jun 2004, *Starr & Starr 040607-4*.

***Pennisetum setaceum* (Forssk.) Chiov. New island records**

Pennisetum setaceum (fountain grass) is considered a serious pest in dry areas of Hawai‘i, and has been previously recorded from Kaua‘i, O‘ahu, Lāna‘i, and Hawai‘i (Wagner *et al.*, 1999). The following collections represent new island records for the islands of Maui and Kaho‘olawe. Infestations on both islands are still relatively localized. On Maui, *P. setaceum* was known to be present since the 1970s (Robert Hobdy, pers. comm.). There have been off and on efforts to remove fountain grass from Maui. Today, *P. setaceum* is a MISC target, with small populations of this tenacious grass persisting in Wailuku, Waihe‘e, Kahakuloa, and Kula. Other sites on Maui where *P. setaceum* was previously known from but was removed and/or no longer exists include Makena, Kanaio, and Waikapu. On Kaho‘olawe, *P. setaceum* was first observed by Lloyd Loope in 1996. All the known plants on Kaho‘olawe have since been removed, and the lone known population persists through a seed bank, with new plants being pulled by Kaho‘olawe Island Reserve Commission (KIRC) staff and volunteers.

Material examined. **KAHO‘OLAWE:** Lua Kealialalo, on east side, in relatively open area, about 20 large fruiting plants scattered with *Cenchrus ciliaris*, all plants pulled and bagged, 1000 ft [305 m], 16 Feb 2004, *Starr, Starr, Higashino, & Andrade 040216-1*. **MAUI:** East Maui, Wailuku, Maui Lani Parkway, large patch and scattered plants on sandy hillside in disturbed dry scrub along with *Leucaena leucocephala*, *Prosopis pallida* and *Cenchrus ciliaris*, 200 ft [60 m], 21 Nov 2001, *Starr & Martz 011121-1*; East Maui, Kula, Waipoli Rd., coming up in recently cleared area of mesic woodland in association with *Acacia mearnsii* and *Ehrharta erecta*, collection made by MISC crew, 3400 ft [1036 m], 6 Jan 2004, *Starr, Starr, & MISC 040106-1*.

***Sorghum bicolor* (L.) Moench Range extension**

Sorghum bicolor (sorghum) was previously known from Kaua‘i, O‘ahu, and Hawai‘i (Wagner *et al.*, 1999) and was recently reported from West Maui (Oppenheimer, 2003). The following collections represent a range extension to East Maui, where scattered individuals were found in widely separated sites.

Material examined. **MAUI:** East Maui, Kanahā Beach, Ka‘a Pt., few plants in association with *Prosopis pallida* and *Cenchrus ciliaris*, 15 ft [5 m], 01 May 2004, *Starr & Starr 040501-1*; Kihei, Kihei Community and Aquatic Center, few plants scattered in lawn and scrub areas by *Acacia confusa* plantings, 80 ft [24 m], 5 May 2004, *Starr, Starr, & Fukada 040505-2*.

***Sporobolus pyramidatus* (Lam.) Hitchc. New island record**

Sporobolus pyramidatus (whorled dropseed) was previously known from Kure, Laysan, French Frigate Shoals, and O'ahu (Wagner & Herbst, 1995; Wagner *et al.*, 1999). This coastal grass is now also known from Moloka'i where it is locally abundant near the coast on the East end of the island.

Material examined. **MOLOKA'I:** East Moloka'i, Puniu'ohua, Waialua, locally abundant along Kamehameha Hwy., overlooking coast, in association with *Prosopis pallida* and *Paspalum vaginatum*, 15 ft [5 m], 17 May 2005, *Starr & Starr 050517-6*.

Polygonaceae***Antigonon leptopus* W.J. Hooker & Arnott New island record**

Antigonon leptopus (Mexican creeper) was previously known from Midway, Kaua'i, O'ahu, Lāna'i, and Hawai'i (Bruegmann, 1998; Wagner *et al.*, 1999; Starr *et al.*, 2002). This vine with pink flowers is now also known from Moloka'i where it is found here and there along the coast and in waste areas along Kamehameha Hwy near Kakahaia.

Material examined. **MOLOKA'I:** Makolelau, near Kakahaia National Wildlife Refuge Kamehameha Hwy., here and there along coast and in waste areas, in association with *Syzygium cumini*, 10 ft [3 m], 17 May 2005, *Starr & Starr 050517-1*.

Proteaceae***Banksia integrifolia* L.f. New naturalized record**

Banksia integrifolia (coastal banksia), native to Queensland and New South Wales, Australia, was previously known from cultivation on Maui. This tree can now be found in the wild on Maui where it is sparingly naturalized in wide ranging localities on Haleakalā Ranch and other properties near Crater Rd. *Banksia integrifolia* can be distinguished by the following characteristics: "Tree, to 30 ft., leaves scattered, oblong to lanceolate, to 8 in. long and 1 in. wide, entire or sometimes toothed, white tomentose beneath; spikes to 6 in. long; flowers yellowish" (L.H. Bailey Hortorium, 1976).

Material examined. **MAUI:** East Maui, Kalialinui, one plant on sheer wall overhanging Crater Rd., in association with *Sadleria* sp. and *Dryopteris wallichiana*, 5800 ft [1767 m], 19 Jul 2005, *Starr & Starr 050719-1*; East Maui, Kamehameiki Gulch, tree with seedlings nearby, 4500 ft [1372 m], 17 Aug 2005, *Starr, Starr, & Bio 050817-3*.

***Grevillea robusta* A. Cunn. ex R. Br. New island record**

Grevillea robusta (silky oak) was extensively planted in forestry efforts in Hawai'i from 1919–1959, with over 2 million trees planted on all the main islands except Kaho'olawe (Wagner *et al.*, 1999). Naturalized specimens were known from the islands of Kaua'i, O'ahu, Maui, and Hawai'i (Wagner *et al.*, 1999) and have also now been reported from Lāna'i and Moloka'i (Herbarium Pacificum Staff, 1999; Oppenheimer, 2003). Recently, a seedling was collected on Kaho'olawe near the summit. No plantings of *G. robusta* are currently known from Kaho'olawe.

Material examined. **KAHO'OLAWA:** Moaulanui, west side of crater rim, single seedling seen and pulled, in association with *Heteropogon contortus* and *Neonotonia wightii*, 1400 ft [427 m], 07 Jun 2004, *Starr, Starr, Higashino, & Bruch 040607-1*.

Rubiaceae***Hedyotis corymbosa* (L.) Lam. New island record**

Hedyotis corymbosa (hedyotis) was previously reported from Kaua'i, O'ahu, Maui, and Hawai'i (Wagner *et al.*, 1999; Oppenheimer & Bartlett, 2002; Starr *et al.*, 2002). This small herb is now also known from Kaho'olawe where it was found in a high-traffic area near the summit. This collection represents a new island record for Kaho'olawe.

Material examined. **KAHO‘OLAWE:** Moaulanui, near summit, next to experimental pili grass bale planting, in association with *Heteropogon contortus* and *Chenopodium oahuense*, 1480 ft [450 m], 30 Apr 2004, *Starr, Starr, Higashino & Abbott 040330-2*.

Sapindaceae

Dodonaea viscosa Jacq.

New island record

Dodonaea viscosa (‘a‘ali‘i) was previously known from all the main islands except Kaho‘olawe (Wagner *et al.* 1999). This hardy indigenous species is now also known from Kaho‘olawe, where it has been planted and sown as seed during restoration efforts over the past couple decades and is now spreading well beyond those plantings.

Material examined. **KAHO‘OLAWE:** Moaulanui, near summit, D4 restoration area, very windswept, old plantings present with many seedlings and saplings in area, in association with *Melinis repens*, *Achyranthes splendens*, and *Casuarina equisetifolia*, 1400 ft [425 m], 27 Dec 2004, *Starr, Starr, Higashino & Price 041227-1*.

Scrophulariaceae

Antirrhinum orontium L.

Range extension

Antirrhinum orontium (lesser snapdragon), was first collected in 2000 by Z.E. Ellshoff who noted, “from the area around Lae o Hikiula (Kuheia), more prevalent further inland” (Staples *et al.*, 2002).

Material examined. **KAHO‘OLAWE:** Pu‘u Moaulaiki, 1300 ft [396 m], 30 Mar 2004, *Starr, Starr, & Tokishi 040330-5*.

Verbenaceae

Citharexylum spinosum L.

New island record

Citharexylum spinosum (fiddlewood) was previously known from O‘ahu and Maui (Herbarium Pacificum Staff, 1998; Starr *et al.*, 2002). This common street tree with foliage that turns orange in summer is now known from Moloka‘i where it is widely cultivated and naturalized, especially in Kaunakakai, Ma‘alehu, and Kaluako‘i.

Material examined. **MOLOKA‘I:** West Moloka‘i, Kaluako‘i, Kaka‘ako Gulch, widely cultivated and naturalized in this area, in association with *Schefflera actinophylla*, *Cenchrus ciliaris*, and *Ficus microcarpa*, 65 ft [20 m], 16 May 2005, *Starr & Starr 050516-1*.

Clerodendrum buchananii var. *fallax*
(Lindl.) Bakh.

New naturalized record

[Syn. *Clerodendrum speciosissimum* van Geert]

Native to Malaysia and Indonesia, *Clerodendrum buchananii* var. *fallax* (java glorybower, pagoda flower) is an erect woody, evergreen shrub that is cultivated as an ornamental plant for its showy red flowers and shiny black fruit (Clay & Hubbard, 1977). In Hawai‘i, it was previously mentioned by Wagner *et al.* (1999) as a garden escape on O‘ahu. On Maui, this charismatic species was collected near Hamoa (*Flynn 257 BISH*) in 1987, and more recently was collected in the Kīpahulu vicinity, where it was spreading in disturbed, wet, lowland forests, in pastures, and along fencelines. This species is also spreading from cultivation via bird dispersed fruits on other Pacific Islands (PIER, 2005). *Clerodendrum buchananii* var. *fallax* can be distinguished by its scarlet flowers which are not fragrant and downy leaves that are round heart-shaped to 1 ft long (Neal, 1965). This collection represents a new naturalized record for the state of Hawai‘i.

Material examined. **MAUI:** East Maui, Kīpahulu, in pasture and along fenceline, on young *a‘a* in association with *Mangifera indica* and *Clerodendrum chinensis*, 125 ft [38 m], 18 May 2004, *Starr & Starr 040518-1*.

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New Records of Azooxanthellate Scleractinia from the Hawaiian Islands

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Introduction

This paper is essentially an updating of the checklist of azooxanthellate corals I published slightly over 20 years ago (Cairns, 1984). It is published for three reasons: 1) to correct misidentifications and changes in classification from the earlier paper, 2) to acknowledge new records for the Hawaiian fauna, some through previously published literature and 4 as the result of this paper, including one new species, and 3) to support the hypothesis suggested in 1984 that the better known a (deep-water) fauna becomes, the more widespread and less endemic it is perceived.

Since 1984 there have been 11 papers that have had a bearing on Hawaiian azooxanthellate corals and one that was overlooked by me in 1984 (i.e., Wells, 1982). As a result of those papers: 9 species have been reidentified (resulting in the loss of one fungiid species from the list), 6 species have been added, and 6 others have been placed in different genera (see annotated checklist). Four species are added to the list herein, resulting in a net gain of 9 species, increasing the known number of azooxanthellates from 54 to 63 species.

A short post-1982 history of the fauna follows. Wells (1982) described *Balanophyllia eguchii* (= *Cladopsammia eguchii*) from many Pacific localities, including Kāneʻohe Bay, Oʻahu, a location overlooked by Cairns (1984). In a series of at least 3 papers from 1985–1993 (see below), Fitzhardinge reported the incidental occurrence of an unidentified *Culicia* from shallow water, herein described as *C. rachelfitzhardingeae*. Hoeksema (1989) re-identified the 3 facultative fungiid species reported by Cairns (1984) resulting in a net loss of one species to the list. Although primarily about the New Zealand fauna, Cairns (1995) reidentified several Hawaiian records, such as *Balanophyllia hawaiiensis* (= *B. gigas*), *Eguchipsammia oahensis* (= *E. fistula*), and *Paracyathus tenuicalyx* (= *Trochocyathus rhombocolumna*), and noted range extensions for species previously thought to be endemic to Hawaiʻi. Cairns & Zibrowius (1997) also reported range extensions of “Hawaiian” species in the Indonesian region, as did Cairns (1998) for Western Australia. Although the subject was the various types of deep-water corals attached to the *Xenophora* carrier shell, Feinstein & Cairns (1998) reported 5 species from the Hawaiian Islands, including 2 new records: *Anthemiphyllia macrolobata* (previously reported as *A. dentata* by Cairns, 1984 and later officially described by Cairns, 1999), and *Placotrochides* n. sp. (herein identified as *P. minuta* Cairns, 2004b). In a paper about the corals of Vanuatu, Cairns (1999) reported *Trochocyathus patelliformis* and *Anthemiphyllia macrolobata* from Hawaiʻi. Finally, in a field guide to the corals of Hawaii, Fenner (2005) reported four new records of shallow-water azooxanthellates (*Madracis pharensis*, *Tethocyathus minor*, *Rhizopsammia verrilli*, and *Tubastraea diaphana*), illustrating them *in situ* and in color, along with several other shallow-water azooxanthellate species.

Table 1. Number of Hawaiian azooxanthellate species and percentage faunal composition found in extralimital regions. EP = number of species also found in eastern Pacific.

	Cairns, 1984 (54 species)	Current (63 species)
Endemic (E)	26 (48.1%)	13 (20.6%)
Central-West Pacific (CWP)	9 (16.7%)	18 (28.5%)
Indo-West Pacific (IWP and IP)	8 (14.8%), 1 EP	19 (30.2%), 3 EP
Cosmopolitan (C)	9 (16.7%), 4 EP	11 (17.4%), 5 EP
Uncertain	2 (3.7%)	2 (3.2%)
TOTAL	54 (100%)	63 (99.9%)

It is generally agreed that the Hawaiian deep-sea coral fauna is an impoverished, or attenuated, Indo-Pacific fauna, with some endemic and cosmopolitan components but little connection to the eastern Pacific (Vaughan, 1907; Vaughan & Wells, 1943; Cairns, 1984). Vaughan & Wells (1943) reported a 70% endemism component whereas Cairns (1984) calculated that component to be 48% and predicted that as the Pacific fauna becomes better known the perceived endemic percentage would continue to fall. This indeed has been the case (Table 1), the endemic percentage decreasing from 48% to 21% as various deep-water species have been found throughout the Pacific and Indian Oceans. Also, the number of species held in common with the eastern Pacific has increased from 5 to 8 (Table 1).

Abbreviations used in the text include: CD = Calicular Diameter; GCD = Greater Calicular Diameter; NMNH = National Museum of Natural History, Smithsonian Institution, Washinton, D.C.; $S_x > S_y$ = in the context of a septal formula, septa of cycle x are wider than those of cycle y; USNM = United States National Museum.

Annotated Checklist

Recent azooxanthellate Scleractinia from the Hawaiian Islands (Distribution patterns: E = endemic, C = cosmopolitan, IWP = Indo-West Pacific, IP = Indo-Pacific, CWP = central and west Pacific, a = no pattern; * may be zooxanthellate in shallow water, i.e., facultative, + = new record for Hawaiian Islands.

	Distribution Pattern
Suborder Astrocoeniina	
Family Pocilloporidae	
1. <i>Madracis kauaiensis</i> Vaughan, 1907	CWP
2. <i>M.</i> sp. cf. <i>M. pharensis</i> (Heller, 1868)	C
Suborder Fungiina	
Family Fungiidae	
*3. <i>Fungia (Cycloseris) sinensis</i> Milne Edwards & Haime, 1851 = <i>Diaseris fragilis</i> sensu Cairns, 1984	IWP
*4. <i>Fungia (Cycloseris) vaughani</i> Boschma, 1923 = <i>Diaseris distorta</i> and <i>C. tenuis</i> sensu Cairns, 1984	IWP

Family Micrabaciidae

5. *Letepsammia formosissima* (Moseley, 1876) IWP

Family Fungiacyathidae

6. *Fungiacyathus fissilis* Cairns, 1984 E

7. *F. fragilis* Sars, 1872 C
= *F. hawaiiensis* Vaughan, 1907

Suborder Faviina

Family Anthemiphylliidae

8. *Anthemiphyllia macrolobata* Cairns, 1999 CWP
= *A. dentata* sensu Cairns, 1984

9. *A. pacifica* Vaughan, 1907 CWP

Family Faviidae

*10. *Leptoseria hawaiiensis* Vaughan, 1907 CWP

Family Oculinidae

11. *Madrepora kauaiensis* Vaughan, 1907 E

12. *M. oculata* Linnaeus, 1758 C

Family Rhizangiidae

+13. *Culicia rachelfitzhardingae*, n. sp. E
= *Culicia* sp. cf. *C. tenella* sensu Fitzhardinge, 1985-93

Suborder Caryophylliina

Family Caryophylliidae

14. *Anomocora* sp. cf. *A. fecunda* (Pourtalès, 1871) a

15. *Bourneotrochus stellulatus* (Cairns, 1984) CWP
= *Deltocyathus stellulatus* Cairns, 1984

16. *Caryophyllia atlantica* (Duncan, 1873) a
= *C. alcocki* Vaughan, 1907

17. *C. hawaiiensis* Vaughan, 1907 CWP

18. *C. marmorea* Cairns, 1984 CWP

19. *C. octopali* Vaughan, 1907 E

20. *C. rugosa* Moseley, 1881 IWP

21. *C.* sp. cf. *C. ambrosia* Alcock, 1898 (sensu Cairns, 1984) C

22. “*Ceratotrochus*” *laxus* Vaughan, 1907 E

23. *Coenosmilia inordinata* Cairns, 1984 E

24. *Conotrochus funiculumna* (Alcock, 1902) IWP

25. *Crispatotrochus rubescens* Moseley, 1881 CWP

= *Cyathoceras diomedae* Vaughan, 1907

= *Cyathoceras rubescens* sensu Cairns, 1984

26. *Deltocyathus* sp. cf. *D. andamanicus* Alcock, 1898 (sensu Cairns, 1984) IWP

27. *Desmophyllum dianthus* (Esper, 1794) C
= *Desmophyllum cristagalli* sensu Cairns, 1984

28. “*Paracyathus*” *molokensis* Vaughan, 1907 E

29. *Tethocyathus minor* Gardiner, 1899 IWP

30. *Trochocyathus aithoseptatus* Cairns, 1984 CWP

31. *T. burchae* (Cairns, 1984) CWP

= *Premocyathus burchae* Cairns, 1984

32. *T. gardineri* (Vaughan, 1907) CWP

33. *T. mauiensis* (Vaughan, 1907) E

34. *T. oahensis* Vaughan, 1907 E
 35. *T. patelliformis* Cairns, 1999 CWP
 36. *T. rhombocolumna* Alcock, 1902 IWP
 = *Paracyathus tenuicalyx* Vaughan, 1907
- Family Turbinoliidae
 37. *Deltocyathoides orientalis* (Duncan, 1876) IWP
 = *Peponocyathus orientalis* sensu Cairns, 1984
- Family Flabellidae
 38. *Flabellum marcus* Keller, 1974 CWP
 = *F. deludens* sensu Vaughan, 1907
 39. *F. pavoninum* Lesson, 1831 IWP
 = *Flabellum pavoninum* var. *latum* and *distinctum* Vaughan, 1907
 40. *F. vaughani* Cairns, 1984 E
 = *F. pavoninum* var. *paripavoninum* sensu Vaughan, 1907
 +41. *Javania exserta* Cairns, 1999 CWP
 42. *J. fuscus* (Vaughan, 1907) CWP
 = *Placotrochus fuscus* Vaughan, 1907
 43. *J. insignis* Duncan, 1876 IWP
 44. *J. lamprotichum* (Moseley, 1880) IWP
 +45. *Polymyces wellsi* Cairns, 1991 C
 +46. *Placotrochides minuta* Cairns, 2004 CWP
 = *Placotrochides* n. sp. sensu Feinstein & Cairns, 1998
- Family Guyniidae
 47. *Guynia annulata* Duncan, 1872 C
- Family Stenocyathidae
 48. *Stenocyathus vermiformis* (Pourtalès, 1868) C
- Family Gardineriidae
 49. *Gardineria hawaiiensis* Vaughan, 1907 IWP
- Suborder Dendrophylliina**
- Family Dendrophylliidae
 50. *Balanophyllia desmophyllioides* Vaughan, 1907 CWP
 = *B.* sp. sensu Maragos, 1977
 51. *B. diomedea* Vaughan, 1907 E
 = *B. diomedea* var. *mauiensis* Vaughan, 1907
 52. *B. gigas* Moseley, 1881 IWP
 = *B. hawaiiensis* Vaughan, 1907
 = *B. cornu* sensu Cairns, 1984
 53. *B. laysanensis* Vaughan, 1907 CWP
 54. *Cladopsammia echinata* Cairns, 1984 E
 55. *C. eguchii* Wells, 1982 IWP
 56. *Eguchipsammia gaditana* (Duncan, 1873) C
 = *Dendrophyllia gaditana* sensu Cairns, 1984
 57. *E. fistula* (Alcock, 1902) IWP
 = *Dendrophyllia oahensis* Vaughan, 1907
 58. *E. serpentina* (Vaughan, 1907) E
 = *Dendrophyllia serpentina* sensu Cairns, 1984
 59. *Enallopsammia rostrata* (Pourtalès, 1878) C
 = *Anisopsammia amphelioides* sensu Vaughan, 1907
 = *Dendrophyllia amphelioides* var. *cucullata* Vaughan, 1907

- | | |
|---|-----|
| 60. <i>Endopachys grayi</i> Milne Edwards & Haime, 1848
= <i>E. oahense</i> Vaughan, 1907 | IP |
| 61. <i>Rhizopsammia verrilli</i> van der Horst, 1922 | IP |
| 62. <i>Tubastraea coccinea</i> Lesson, 1831
= <i>Dendrophyllia manni</i> sensu Vaughan, 1907 | C |
| 63. <i>T. diaphana</i> (Dana, 1846) | IWP |

New Records

Culicia rachelfitzhardingeae Cairns, new species

(Figs. 1A–B, 2 A–D)

Culicia sp. Fitzhardinge, 1985: 374, 376.

Culicia cf. *tenella*.—Fitzhardinge & Bailey-Brock, 1989: 570, 571.—Fitzhardinge, 1993: 35, 98–110, pl. 2, figs. A–C.

Records/Types.—Holotype: one corallite from Lilipuna Pier, Kāneʻohe Bay, Oʻahu, Hawaiʻi, 2 m, 12 April 1987, SEM stub 1096, USNM 78497. Paratypes: from same locality as holotype, about 84 corallites attached to four fragments of dead *Porites* and SEM stubs 1097–8, USNM 1073265; Kaunakaki Dock, Molokaʻi, 30 Jan 2003, 1 corallite, USNM 1073266; Port Allen small boat harbor, Kauaʻi, 13 Nov 2002, 3 corallites, USNM 1073267.

Description.—Corallites occur singly, probably the result of planulation, or as small clusters of 2–6 corallites, the latter the result of distomodaeal (Fig. 2A), or more rarely polystomodaeal, intratentacular budding, after which corallites lose their lamellar linkage but remain connected by a common basal coenosteum (Fig. 1B). Thus, there are no stolons linking corallites. Corallites cylindrical, tympanoid in shape, up to 4.1 mm in diameter, but rarely over 1.5 mm in height. Sometimes in juvenile coralla a kind of polycyclic development is seen, the first thecal ring developing at a CD of about 0.5 mm, the second at 1.1 mm, and the third and last at about 2.0 mm. Epitheca smooth, noncostate, bearing fine transverse ridges. Corallum white.

Septa hexamerally arranged in up to three and one half cycles (36 septa) according to formula: $S1 > S2 \geq S3 > S4$. Juvenile corallites of 0.5–1.0 GCD have 12 septa, those between 2.0–2.5 mm have 24 septa, and those over 2.7 mm in GCD have up to 36 septa, increasing in septal number in direct relation to calicular diameter. S1 about 0.8 mm wide, reach only about 1/3 distance to center of calice, and have an entire, highly sinuous axial margin (Fig. 2C). S2 about 0.5 mm wide but otherwise similar to the S1. Both S1 and S2 bear large blunt granules on their septal faces, the granules up to 0.16 mm in height and 0.13 mm in diameter. In small corallites, S3 are rudimentary, having an irregular axial margin, but in larger corallites some S3 are flanked by a pair of rudimentary S4, in which case the flanked S3 becomes almost as large as the S2. The upper outer edges of all septa join the theca slightly below the calicular edge producing a slight calicular rim, although the distal edges of the septa rise above the calicular edge. Small (0.20 mm in diameter), cylindrical (non-lamellar), highly granular paliform lobes occur before S1, S2 and those S3 flanked by S4, forming an elliptical palar ring surrounding the columella. P1 slightly smaller and positioned closer to columella than P2 and P3. Columella papillose, consisting of 15–10 cylindrical elements each about 0.12 mm in diameter, their upper edges slightly below that of the paliform lobes. In general the fossa is shallow.

Discussion.—This species is distinguished from the other 12–13 species of Recent *Culicia* (see Cairns, *et al.*, 1999, Cairns, 2004b; Cairns, Häussermann & Försterra, 2005) by having highly sinuous, vertical, entire axial edges of the S1–2, all other species having straight, lobate to lacinate axial septal edges. Also, the palar crown is much better developed than in any other species, and stolons are rarely if ever present.

Etymology.—This species is named in honor of Rachel Fitzhardinge, who first noted the presence of this species in the Hawaiian Islands and provided specimens to the NMNH.

Distribution.—Kauaʻi, Oʻahu, and Molokaʻi, 2 m.

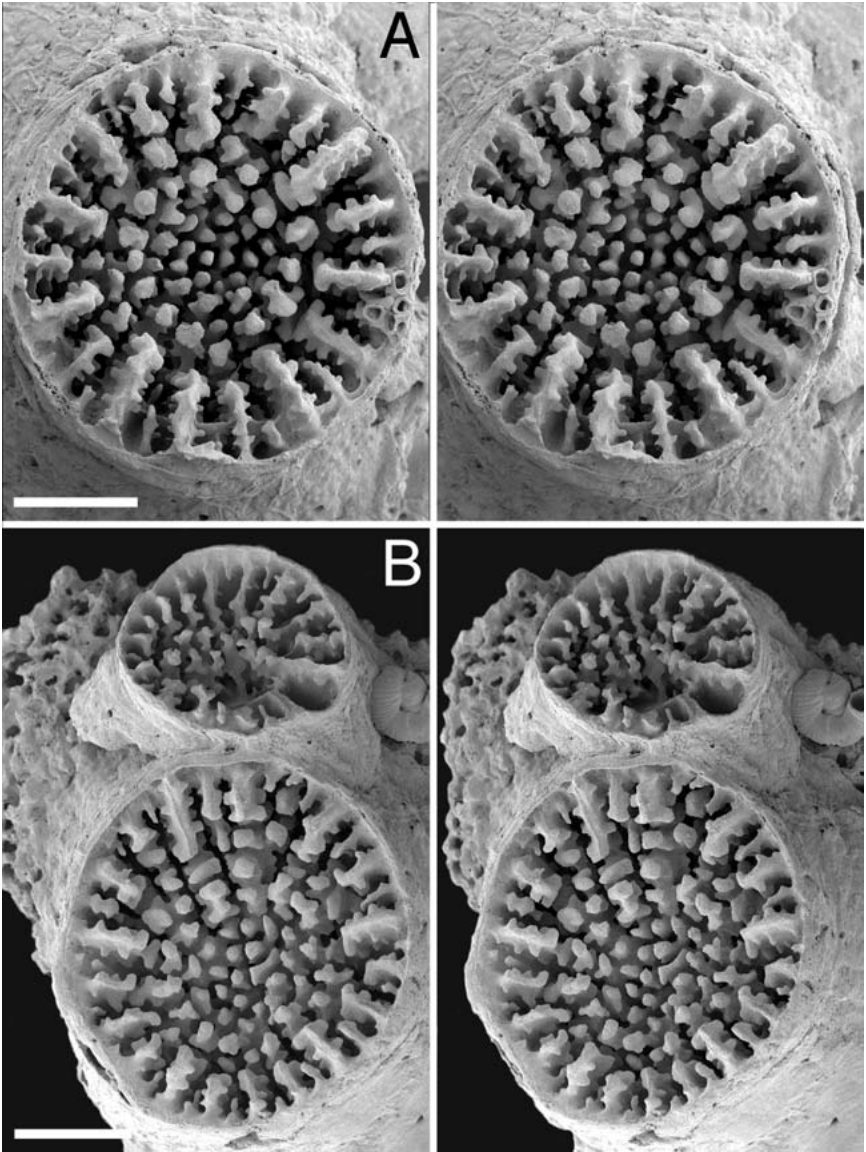


Figure 1. *Culicia rachelfithardingee*: **A**, stereo calicular view of holotype; **B**, stereo pair of parent and recently budded corallite from a topotypic paratype (USNM 1073265). Scale bars = 1 mm.

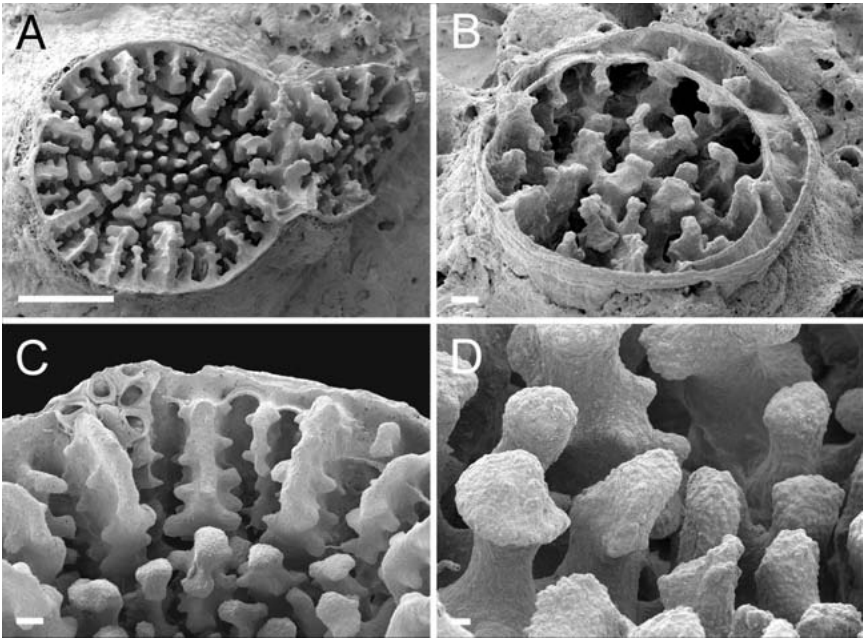


Figure 2. *Culicia rachelfitzhardingee*, topotypic paratypes (USNM 1073265): **A**, intratentacular budding in progress; **B**, juvenile corallum showing concentric thecal rings; **C**, view of inside of calice edge showing septal granulation and some pali; **D**, view of some palmar and columella elements. Scale bars: A = 1 mm, B–C = 0.1 mm, D = 0.05 mm.

***Javania exserta* Cairns**

New island record

Javania exserta Cairns, 1999: 126–127, figs. 21 g–i.

Records.—*Pisces* 5-594, 19°47'53"N, 156°08'51"W (off Keahole Point, Hawai'i), 400 m, 16 Oct 2004, 1 corallum, USNM 1071216.

Discussion.—This species is known from throughout the western Pacific from Vanuatu to the Marshall Islands at depths of 91–455 m, thus its presence in Hawai'i is not unexpected. It is distinguished from other congeners by having only 4 cycles of septa, the S1 larger than the S2, and the S3–4 being rudimentary. The species of this genus are keyed by Cairns (2004a). The specimen reported herein is small, measuring only 6.7 mm in GCD and 16.1 mm in height.

***Polymyces wellsi* Cairns**

New island Record

Polymyces wellsi Cairns, 1991: 22, pl. 8, figs. f, i, pl. 9, figs. a–b; 2000: 7, figs. 174–175; 2004b: 308 (synonymy).

Records.—*Pisces* 5-527-8, 25°48.813'N, 173°29.802'W (seamount near Pioneer Bank), 927 m, 1 corallum, USNM 1072331; *Pisces* 5-587-6, 18°43'59"N, 158°15'44"W (Cross Seamount), 440 m, 8 Oct 2004, 1 corallum, USNM 1071236.

Discussion.—This is thought to be a cosmopolitan bathyal (355–1682 m) species, pre-

viously known from western Australia, Queensland, New Zealand, Indonesia, Vanuatu, the Philippines, the Galápagos, the western Atlantic (Cairns, 2004b), and now from the Hawaiian Islands. It is distinctive in having asymmetrically developed, contiguous basal rootlets that reinforce the pedicel, and reddish-brown color of the corallum. Both specimens reported herein were badly damaged in collection, but the salient characters are observable.

***Placotrochides minima* Cairns**

Placotrochides n. sp. Feinstein & Cairns, 1998: 81, 83, fig. 10.

Placotrochides minima Cairns, 2004b: 305–306, figs. 10E–H.

Discussion.—This species was previously known from Hawai‘i only as 4 specimens that had been attached to *Xenophora* shells, collected at depths of 119–291 m off southwestern O‘ahu and Pailolo Channel between the islands of Moloka‘i, Lāna‘i and Maui (Feinstein & Cairns, 1998). No additional specimens are reported herein. It is also known from the Banda Sea and off northeastern Queensland (Cairns, 2004b), although these specimens are free living (i.e., not attached to *Xenophora* shells).

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Nonnative Occurrence of *Anguilla marmorata* in Hawai‘i: Identification Using Morphological and Molecular Characters¹

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Introduction

Anguilla eels (Pisces: Anguilliformes: Anguillidae) are found throughout the Asia-Pacific Rim and South Pacific, as well as western Europe and the American East Coast. Some species are highly prized as food; most are considered nuisances in the freshwater rivers they inhabit, feeding on a variety of fishes and shrimps. All *Anguilla* species are typically catadromous, i.e., the adults leave their freshwater rivers and streams and migrate upwards of thousands of kilometers to marine breeding areas (Aoyama *et al.* 2001). Larval eels passively make their way back to source rivers by subtropical currents to complete their life cycle. While adults leaving the streams may be relatively few in number, offspring may number in the thousands upon their return. Considered top carnivores, Anguilla eels pose a potentially serious threat to freshwater native stream animals in Hawai‘i. It is highly likely that Hawaiian stream organisms would have little defense against predation by an individual eel, or worse, a population of these eels. Anguilla eels can cross dry land to travel from pond to pond, either in search of additional food or more favorable water conditions.

A freshwater eel of a species previously unrecorded from the wild in the Hawaiian Islands was captured on Maui during the summer of 2002. The specimen was identified using morphological characteristics, with DNA analysis of two mitochondrial genes being employed to confirm identification.

Materials and Methods

Specimen collection

On 23 June 2002, Maui resident Patrick Domen speared a 1.02-m, 3.2-kg eel in a large freshwater pond in south Maui. The eel was frozen and delivered to Skippy Hau, Hawaii State Department of Land and Natural Resources-Division of Aquatic Resources-Maui, who transported it to Honolulu, 19 July 2002, to the Bishop Museum for identification. After a tissue sample was removed for DNA analysis, the specimen was fixed in 10% formalin and preserved in 75% ethanol, and cataloged in the fish collection of the Bernice Pauahi Bishop Museum (BPBM), with permission of the collector, as BPBM 39092.

DNA analysis

Genomic DNA was extracted from muscle of the unidentified eel specimen using the protocol of Sambrook and Russell (2001). Voucher DNA is held at the Pacific Center for Molecular Biodiversity, Bishop Museum (Accession No. PCMB B177). Polymerase chain reaction

1. Contribution 2006-013 to the Hawaii Biological Survey.

(PCR) amplifications were performed in 50 μ L of a solution containing approximately 10 ng of genomic DNA, 400 μ M of each dNTP, 1.5 unit Taq Polymerase (Promega), 2 μ M $MgCl_2$, each primer at 1 mM, and buffer. Primer sequences for the mitochondrial genes were taken from Palumbi (1996), as follows (5'-3'): 12S forward, AAA CTG GGA TTA GAT ACC CCA CTA T; 12S reverse, GAG GGT GAC GGG CGG GCG GTG TGT; 16S forward, CGC CTG TTT ATC AAA AAC AT; 16S reverse, CCG GTC TGA ACT CAG ATC ACG T. PCR cycling parameters (PTC 100, MJ Research Watertown, Massachusetts) for the initial double-stranded amplification were 94 °C for 1 min, 50 °C for 1 min, and 72 °C for 1 min, repeated for 45 cycles, with final extension of 72 °C for 5 min. The PCR product was gel extracted using QIAQuick Gel Extraction Kit (Qiagen Inc., California), and quantified on a 1.5% agarose gel using ethidium bromide. Cycle sequencing of 15–45 ng of the double-stranded PCR product was carried out with each primer and BigDye terminators (v. 3.1, ABI Biosystems) diluted to half concentration using 2.5x buffer. Sequences were determined by the Brigham Young University Sequencing Center on an automated sequencer. Both sequences have been submitted to GenBank (Accession Nos. AY207028 and AY207029).

Nucleotide sequences were aligned using ClustalX (default parameter settings; Thompson *et al.* 1997) then by eye. A nucleotide-nucleotide BLAST search (Altschul *et al.* 1990) was performed for the eel 12S and 16S rRNA sequences using GenBank (Benson *et al.* 2002). The most closely related sequences were downloaded, and a consensus of the 279 (12S) and 56 (16S) most parsimonious trees was constructed using PAUP version 4.0b10 (Swofford 2002) using *Stemonidium hypomelas* (Gilbert) as an outgroup. Trees were produced to clearly indicate the identification of the Maui eel, rather than to suggest the phylogeny of the genus *Anguilla*. Such studies have already been completed (Aoyama *et al.* 2001, Lin *et al.* 2001, Bastrop *et al.* 2000).

Results

Visual examination of the eel revealed it to be a male of advanced age (5+ years). Herald (1975) suggested *Anguilla anguilla* (Linnaeus), the European Anguilla eel, may attain a length of 1.5 m (5 ft) in 12 years for females, or 0.5 m (20 in) in 4–8 years for males. The gut was mostly vacant except for a bolus of greenish gray sludge near the vent, containing the remains of at least one small crustacean, *Macrobrachium lar* (Fabricius) (pincer length, 14 mm), and an otolith-like piece suggesting fish as a diet item. The eel possessed characters consistent with *Anguilla marmorata*, the Giant Mottled Eel, as diagnosed in Smith (1999): slightly projecting lower jaw; scales present (embedded in the skin); dorsal fin origin nearer gill opening than vent; dark brown mottled with lighter brown, with a yellowish-white belly. In Hawai'i, the only fish that could possibly be confused with the Maui eel would be a large individual of the family Congridae (conger eels). Both families attain a large size (to 1.5 m) and have very prominent pectoral fins. *Conger* differs from *Anguilla* in possessing a slightly inferior lower jaw and lacking scales entirely, and is typically a uniform gray color with white ventrally, or irregularly-banded with white and dark brown (this latter pattern more frequently exhibited at night). Due to the unexpected nature of this occurrence of *Anguilla* in Hawai'i, and to eliminate any possibility of misidentification of an aberrant specimen of *Conger*, DNA analysis seemed appropriate to ensure a positive identification.

Comparison with sequences published in GenBank (Table 1) resulted in the 427 base-pairs of the 12S and 628 base-pairs of the 16S mitochondrial rRNA sequences of the eel matching exactly with sequences of *Anguilla marmorata*, confirming the visual identification of the eel (Figures 1, 2). Although there were single nucleotide differences between some of the *Anguilla marmorata* GenBank accessions, the source location of the Maui eel was not able to be identified with certainty (Table 1, Figures 1, 2).

TABLE 1. Closest sequence matches to the 12S and 16S rRNA eel sequences using the GenBank nucleotide-nucleotide BLAST search

Species	GenBank accession	Collection location	Number of bp different	Reference
12S 427 base pairs				
<i>Anguilla marmorata</i>	AB021890	Indonesia	0	Aoyama pers. comm.
	AF266485	S Africa	0	Lin <i>et al.</i> 2001
	AF266484	Taiwan	1	Lin <i>et al.</i> 2001
	AF417308	not available	1	unpublished
<i>Anguilla interioris</i>	AB021886	New Guinea	1	Aoyama pers. comm.
<i>Anguilla malgumora</i>	AF266499	Philippines	2	Lin <i>et al.</i> 2001
	AF266498	Philippines	2	Lin <i>et al.</i> 2001
<i>Anguilla reinhardtii</i>	AF266487	Australia	4	Lin <i>et al.</i> 2001
16S 628 base pairs				
<i>Anguilla marmorata</i>	AJ244817	Taiwan	0	Bastrop <i>et al.</i> 2000
	AJ244816	Taiwan	1	Bastrop <i>et al.</i> 2000
	AJ244818	Taiwan	1	Bastrop <i>et al.</i> 2000
	AB021760	Indonesia	1	Aoyama <i>et al.</i> 2001
	AJ244819	Taiwan	3	Bastrop <i>et al.</i> 2000
<i>Anguilla obscura</i>	AB021762	Fiji	8	Aoyama <i>et al.</i> 2001
<i>Anguilla bicolor</i>	AB021757	Philippines	9	Aoyama <i>et al.</i> 2001

Discussion

Anguilla marmorata Quoy & Gaimard is a tropical freshwater eel, found between 24°N and 33°S. *Anguilla marmorata* is distributed throughout the Indo-Pacific, from East Africa and India to French Polynesia, north to southern Japan (Smith, 1999), east to the Galápagos (McCosker *et al.*, 2003). It is recorded as being native to French Polynesia (notably Tahiti), Fiji, and Samoa. It is not indigenous to the Hawaiian Islands. Long-time aquarists in Honolulu can remember when *Anguilla* spp. were imported into Hawai'i, primarily as live food items with a few as part of the aquarium trade (1950s–1960s), prior to the eels being prohibited for import in 1974 (HRS 150A-6; Hawaii Administrative Rules, 1995, Chapter 4-71). While most were believed to have been consumed, some were kept as display animals in koi (carp) ponds. Escapes have never been documented and until now *Anguilla* have not been reported from any Hawaiian stream.

Although larvae of freshwater *Anguilla* species are distributed by oceanic currents, it is unlikely that this individual found on Maui arrived without human intervention. Ziegler (2002) commented that the nonoccurrence of Anguillidae in the Hawaiian Islands is somewhat surprising given its widespread nature elsewhere in the western Pacific. The isolation of the Hawaiian Islands, both geographically and in terms of oceanic current flow, plus factors of deep-ocean salinity, have been, and continue to be, sufficient barriers preventing this family from reaching the Hawaiian Islands. Although *Anguilla* has been confirmed from the Galápagos (McCosker *et al.*, 2003) and Palmyra Atoll in 2003 (Handler & James, 2006) it is still unlikely that this eel could naturally find its way to the Hawaiian Islands.

The western Pacific region (Japan, the Philippines, to Indonesia), from which the Maui eel originated given the sequences available in GenBank, is inhabited by a single genetic population of *Anguilla marmorata* (J. Aoyama, pers. comm. 2002). As a result, the exact locality within the western Pacific region cannot be confirmed, particularly as the 12S and 16S rRNA regions of *Anguilla marmorata* are not sufficiently sensitive for such a determination.

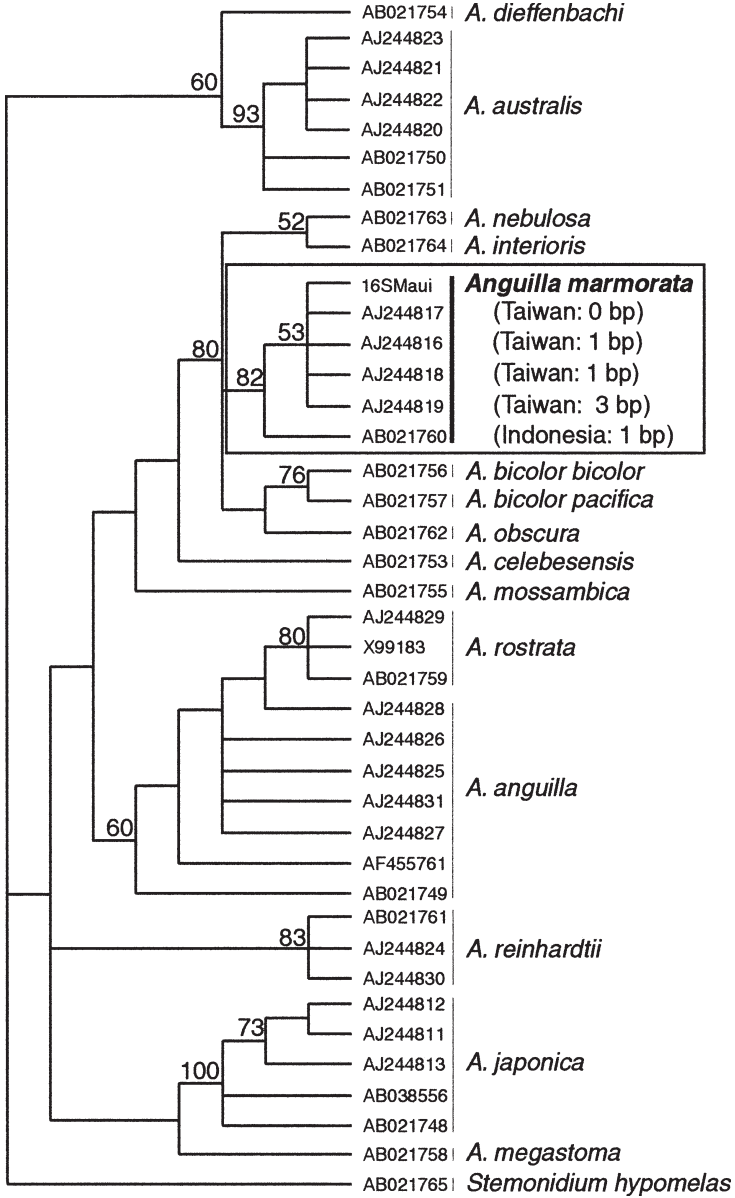


Figure 1. Consensus of 279 most parsimonious trees for 12S rRNA mitochondrial gene sequences closely matching that of the Maui eel. Base-pair (bp) differences from the Maui specimen have been indicated. Parsimony bootstrap values above 50% are shown.

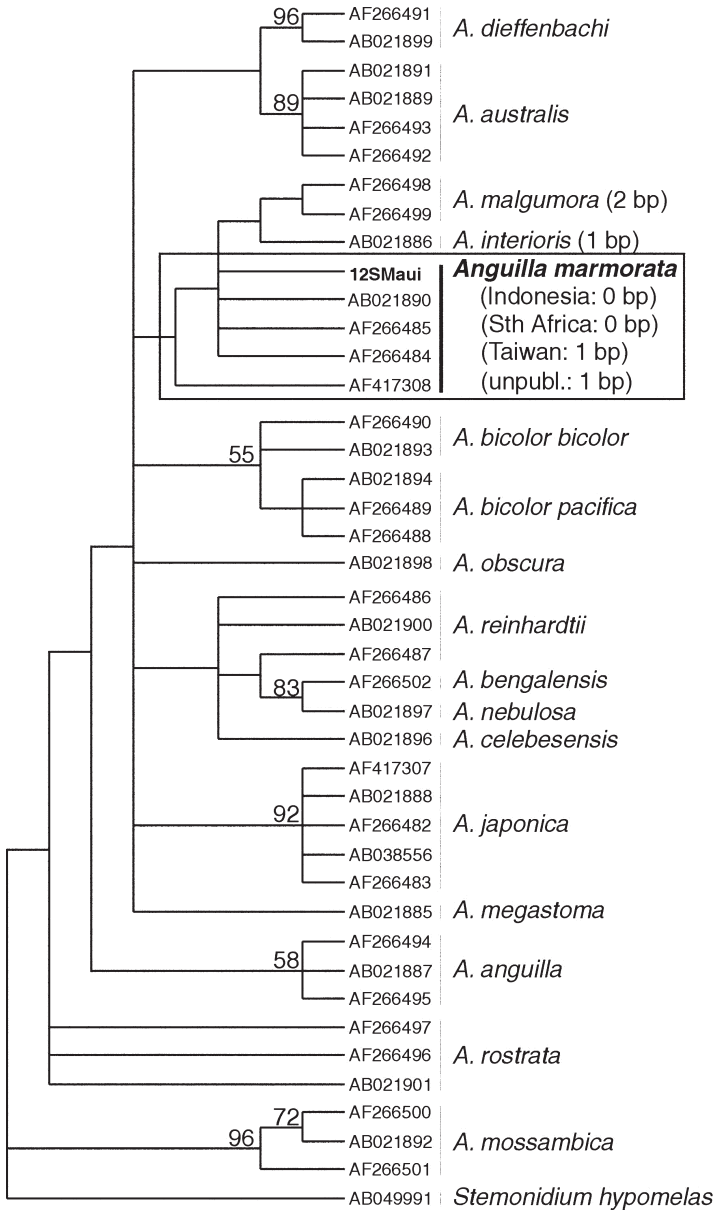


Figure 2. Consensus of 56 most parsimonious trees for 16S rRNA mitochondrial gene sequences closely matching that of the Maui eel. Base-pair (bp) differences from the Maui specimen have been indicated. Parsimony bootstrap values above 50% are shown. The Maui eel falls within the monophyletic group of *Anguilla marmorata*.

There is immediate concern regarding the discovery of *Anguilla marmorata* in a Hawaiian stream, as the species is active at night and feeds on a wide variety of prey, including arthropods (crustaceans and insects), amphibians, and fishes. Continued survey and monitoring of alien introductions, and the maintenance of education programs for Hawai'i residents and visitors which emphasize the importance of not introducing non-native species into native ecosystems, are essential for keeping the Hawaiian environment in balance. In this regard, DNA analysis can play a significant role in species identification and in elucidating the potential origin of undesirable organisms.

Acknowledgments

We thank Patrick Domen and the Domen family; Skippy Hau and Mike N. Yamamoto, Hawaii State DLNR-DAR; John E. Randall, Richard L. Pyle, and Loreen R. O'Hara, Bishop Museum; Glenn Y. Takeshita, aquarist; Domingo Cravalho, Plant Quarantine Branch, Hawaii State Department of Agriculture; and John E. McCosker, California Academy of Sciences.

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A New Species of the Hawaiian Endemic Predaceous Fungus Gnat Genus *Trigemma* Hardy (Diptera: Keroplatidae) from Hawai‘i Island¹

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Introduction

Keroplatids are represented in Hawai‘i by two endemic genera: *Tylparua* Edwards and *Trigemma* Hardy. *Trigemma* was erected as a new subgenus of *Orfelia* Costa by Hardy (1960) to take the single new species *Orfelia (Trigemma) infurcata*. Matile (1989) elevated the subgenus *Trigemma* to generic status.

Trigemma infurcata was originally described from Moloka‘i, with additional paratype specimens listed from Kaua‘i and Maui. Specimens collected by the U.S. International Biological Program (IBP) in the 1970s in the Kilauea Forest of the Big Island of the Hawaiian Islands [see Mueller-Dombois *et al.* (1981) for further details of the transects used and ecosystem analysis] reveal a new species closely related to *T. infurcata*, described below. This is only the second species known in the genus, which is endemic to the Hawaiian Islands.

Materials and Methods

The material examined in this study derives from the collection of the Bishop Museum, Honolulu (BPBM) and the University of Hawai‘i at Manoa (UHM). Descriptive terminology follows Sølvi *et al.* (2000).

Systematics

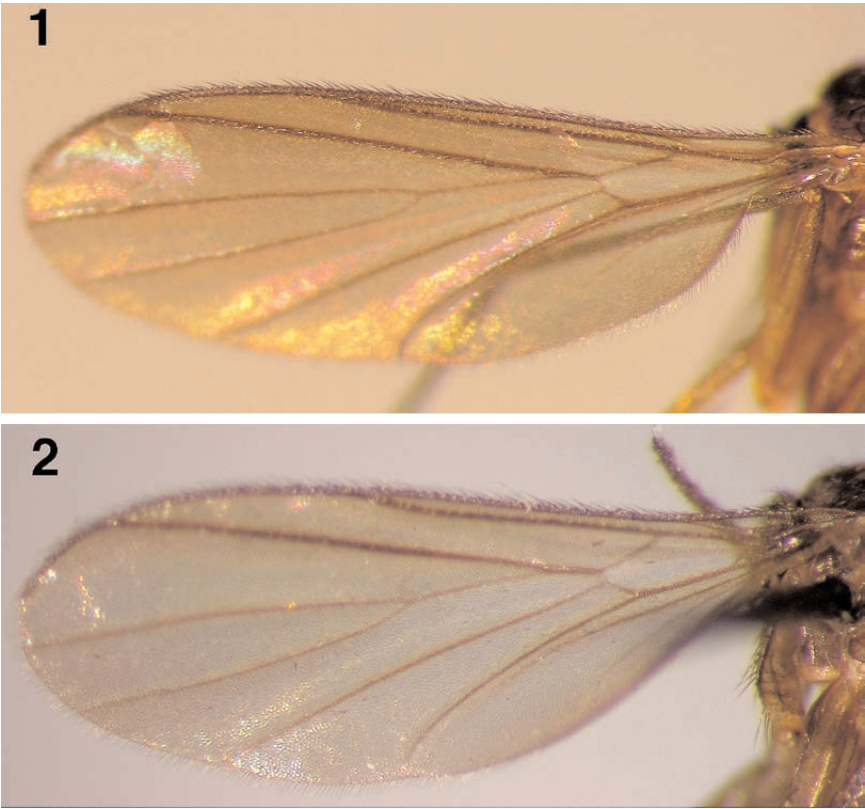
KEY TO THE SPECIES OF *TRIGEMMA* HARDY

1. Wing with Sc ending in costa before origin of Rs (Figs. 2, 3b); male hypandrium shorter than gonocoxites; gonostyle bifid (Fig. 4) **infurcata** Hardy
- . Wing with Sc ending in C at or beyond origin of Rs (Figs. 1, 3a); male hypandrium longer than gonocoxites; gonostyle flared, with one apical prong (Fig. 5) **kilauea** Evenhuis, **n. sp.**

Trigemma kilauea Evenhuis, **new species** (Figs. 1, 3a, 5)

Diagnosis: *Trigemma kilauea* can be separated from the only other known species in the genus by the vein Sc ending in the costa at or beyond the origin of the Rs vein (this vein ending well before the costa in *T. infurcata*), the hypandrium being longer than the gonocoxites (hypandrium shorter in *T. infurcata*), and the single-pronged and flared gonostyle

1. Contribution 2006-014 to the Hawaii Biological Survey.



Figures 1–2. *Trigemma* wings. 1. *T. kilauea*, n. sp. 2. *T. infurcata* Hardy.

(bifid and rounded in *T. infurcata*). In addition, its generally dark body color will separate most specimens, however, some teneral specimens will appear tawny as in *T. infurcata*.

Description: Lengths: Body: 4.2–4.8 mm; wing: 3.0–3.5 mm. **Male. Head.** Occiput brown to black. Three ocelli near middle of frons, outer pair large, medial punctiform. Ocellar callus black. Frons dark brown. Antennae: scape and pedicel yellow. Flagellum: segment 1 longer than wide; segments 2–14 squarish, each successive segment reduced in width apically as antennae slightly tapers to rounded apex. Flagellomeres brown except flagellomere 1 yellow at extreme base. Face dark brown, palpi brown to black.

Thorax. Mesonotum and scutellum shining brown to dark brown with scattered black setulae dorsally, bare strips admedially on scutum. Pleurae brown to reddish brown, anepisternum with patch of small fine yellowish to brownish hairs. Mediotergite with patch of erect brown posterodorsal setae. Laterotergite bare. Halter stem yellow, knob brown with minute black setae.

Legs. Yellowish brown to brown with black spines and hairs normally distributed. Mid and hind tibia with single spur, fore tibia without spur. Claws minute

Wing (Figs. 1, 3a). Grayish yellow hyaline with densely distributed microtrichiae. Veins C and R_{2+3} with dense hairs; remainder of veins bare. Tip of vein Sc effaced but ending in C at origin of Rs (Fig. 3a).

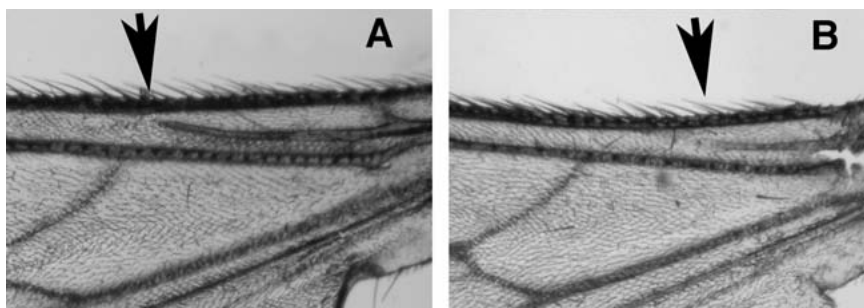


Figure 3. Detail of base of wing showing insertion of Sc at costa (arrow). **A.** *T. kilauea*, n. sp. **B.** *T. infurcata* Hardy.

Abdomen. Generally brownish with black setulae distributed evenly on dorsum; tergites I–VI shining brown; tergites VII–VIII dark brown to black. Sternites with same pattern as tergites.

Hypopygium (Fig. 5). Dark brown to black. Hypandrium longer than gonocoxites, subconical. Gonocoxites tapering toward apex, long setulose laterally, dense fine hairs medially. Gonostyle flared apically with single pronglike projection apically, densely haired.

Female. As in male except: abdomen flattened dorsoventrally and expanded at level of tergites V–VII.

Types. Holotype ♂ (BPBM 16,625) and paratype ♂ from HAWAIIAN IS: **HAWAI'I I:** Kīlauea Forest Reserve, IBP Study Site, 1586 m, 16–23 Aug 1971, Malaise trap, W.A. Steffan. **Other paratypes:** 3 ♂, 2 ♀, same data except: 19 Jul 1971, 26 Jul 1971, 31 May–7 Jun 1971, 28 Jun–5 Jul 1971, L. Goff & W.A. Steffan (BPBM); 1 ♂, Ola'a, 36.0 ft [sic!], 30 Jul 1918 W.M. Giffard (BPBM). 1 ♂, Mt. House Road above Na'alehu, 3000 ft [ca. 915 m], 15 Jul 1965, D.E. Hardy (UHM).

Etymology. Named for the type locality of Kīlauea. The name means “spewing, or much spreading” in Hawaiian, referring to the frequent volcanic eruptions in this area. The name is treated as a noun in apposition.

Trigemma infurcata (Hardy)

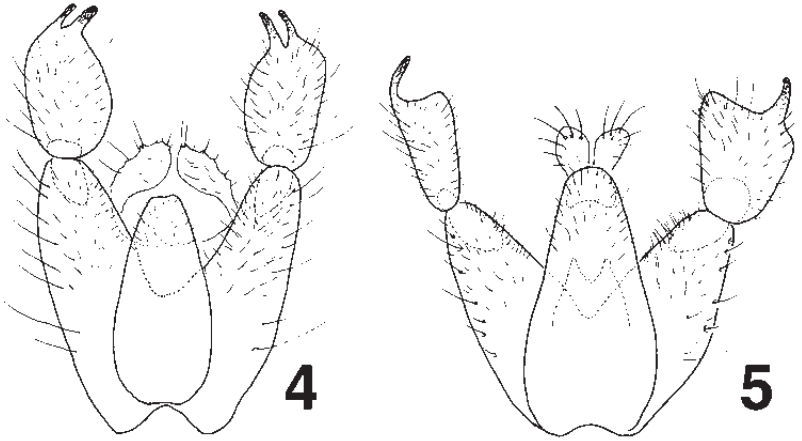
(Figs. 2, 3b, 4)

Orfelia (*Trigemma*) *infurcata* Hardy, 1960: 201.

Trigemma infurcata (Hardy). Matile, 1989: 133.

The description given by Hardy (1960) contains all the salient characters and need not be repeated here. To better identify the species of the genus in Hawai'i the wing and male terminalia are illustrated again with the gonostyle shown also in a lateral view to compare directly with the gonostyle in lateral view of *T. kilauea*, n. sp.

Material examined: HAWAIIAN IS: **MAUI:** 1 ♂ [paratype], Honomau, 23 Jun 1920, E.H. Bryan, Jr. (UHM); 1 ♂, Kula Pipe Line, 4200 ft [ca. 1280 m], Jul 1956, D.E. Hardy (UHM). **MOLOKA'I:** 2 ♂, 1 ♀ [paratypes], Pu'u Kolekole, 3600 ft [ca. 1100 m], Jul 1953, D.E. Hardy (BPBM); 1 ♂, Pēpē'ōpae, 4000 ft [1220 m], Jul 1959, D.E. Hardy (BPBM); 1 ♀ same data except: 25 Aug 1949 (UHM).



Figures 4–5. *Trigemma* male genitalia, ventral view, gonostyle slightly twisted to show lateral view. 4. *T. infurcata* Hardy. 5. *T. kilauea*, n. sp.

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