RECORDS OF THE HAWAII BIOLOGICAL SURVEY FOR 1996
Part 1: Articles

Editor's Preface

We are pleased to present the third annual compilation of *Records of the Hawaii Biological Survey*. The number and diversity of taxa reported in these issues attest to the value of the *Records* as part of the ongoing effort to inventory the Hawaiian biota.

The Hawaii Biological Survey, established by the Hawaii State Legislature in 1992 as a program of the Bishop Museum, is an ongoing natural history inventory of the Hawaiian Archipelago. It was created to locate, identify, and evaluate all native and non-native species of flora and fauna within the State and 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

The discovery of a new noctuid moth from the mountains immediately behind the urban environment of Honolulu demonstrates that much remains to be learned about the native biota. At the same time, the continuing parade of new records of naturalized non-native plants and alien arthropods is alarming.

Some of the highlights of *Records of the Hawaii Biological Survey for 1996* include:

- an update of numbers of species in Hawaii, including a review of freshwater invertebrates;
- an overview of the history of spread and current status of the invasive pest weed, *Miconia calvescens*;
- new records of plants, insects, and other invertebrates resulting from field surveys and continued curation of Hawaiian collections at Bishop Museum and elsewhere;
- a summary and bibliography of a checklist of Hawaiian Foraminifera (755 species), the checklist of which will be published elsewhere;
- a catalog of the nonindigenous land and freshwater snails and slugs of Hawaii, to supplement the recently published catalog of native species.

Many of the products of Hawaii Biological Survey, including many of the databases supporting papers published here, are available on our Internet World Wide Web and gopher servers. Products currently available include taxonomic authority files (species checklists for terrestrial arthropods, flowering plants, non-marine snails, Foraminifera, and vertebrates), bibliographic databases (vascular plants, non-marine snails, and insects), specimen databases (fungi, fish, portions of the insect collection) and type specimens

(entomology; botany—including algae and fungi; and vertebrate zoology), collections data (lists of holdings for select groups of flies), detailed information and/or images (the endemic damselfly genus *Megalagrion*, the Peregrine Falcon, and others), and staff and 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 web pages where known. The Internet addresses are:

World Wide Web:
Hawaii Biological Survey Home Page
http://www.bishop.hawaii.org/bishop/HBS/

Bishop Museum Entomology Home Page
http://www.bishop.hawaii.org/bishop/ento/

Hawaii Biological Survey Databases
http://www.bishop.hawaii.org/bishop/HBS/hbsdbhome.html

"Insect and Spider Collections of the World" Home Page
http://www.bishop.hawaii.org/bishop/ento/codens-r-us.html

Hawaii Biological Survey gopher databases:
gopher.bishop.hawaii.org:70/11/BMData

The *Records of the Hawaii Biological Survey for 1996* were compiled with the assistance of Allen Allison (vertebrate zoology), George Staples (botany), Robert Cowie (malacology), Lucius Eldredge (invertebrate zoology, marine zoology), and Gordon Nishida (entomology), who assisted with editing papers in their disciplines; and was partially supported by a grant 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 U.S. Geological Survey Biological Resources Division (formerly National Biological Service), U.S. Fish and Wildlife Service, U.S. Department of Defense Legacy Program, 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 us for consideration of publication in the next *Records.* Information on submission of manuscripts and guidelines for contributors may be obtained from: Hawaii Biological Survey, Department of Natural Sciences, Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii 96817, USA; or by electronic mail: <hbs@bishop.bishop.hawaii.org>.

——*N.L. Evenhuis &*
S.E. Miller, editors

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Numbers of Hawaiian Species: Supplement 2, Including a Review of Freshwater Invertebrates[1]

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This is Supplement 2 to our earlier tabulation of species known from Hawaii (Eldredge & Miller, 1995; Miller & Eldredge, 1996; also see Mlot, 1995). The Hawaii Biological Survey continues to work on the compilation of checklists and bibliographies; some short lists of invertebrates are included in this supplement, especially for those species inhabiting freshwater. This supplement should be viewed as a further interim report subject to future change. See Eldredge & Miller (1995) for definitions and scope and see Allison *et al.* (1995) for review of marine species.

From literature and unpublished sources, 22,077 species have been recorded from the Hawaiian Islands and surrounding waters. Of these, 8,805 are endemic to the Hawaiian Islands, and 4,373 are nonindigenous species. This is an ongoing count of the biota, e.g., the completed checklist of the foraminiferans totaled 755 species, rather than the 1000+ in the original estimate. Particular interest has been paid to the freshwater animals in this supplement [see Table 2 for taxa and citations].

Hawaii Biological Survey is in the process of posting species checklists in searchable interfaces for the Hawaiian organisms on the Internet at:

http://www.bishop.hawaii.org/bishop/HBS/

More than 15,000 species are currently available (including terrestrial arthropods, native and alien land and freshwater snails, Foraminifera, flowering plants, amphibians, reptiles, birds, and mammals; with more taxa to be added).

These numbers include significant refinements from the previous compilations. Future checklists are anticipated to further refine the number, particularly for fungi and algae. For most taxa, this list does not include undescribed species (unless they have been specifically mentioned in publications).

The lists given here for freshwater microcrustaceans (Cladocera, Ostracoda, Copepoda, Amphipoda) should be seen only as rough starting points. These groups have received little serious study in the Hawaiian Islands, most records resulting from early European workers (Baird, 1962; Daday, 1906; Sars, 1904; Stingelin, 1905; Vavra, 1906). Application of modern taxonomic characters and species concepts has vastly changed the names applied in some of the these taxa (e.g., Frey, 1986) and comprehensive sampling will likely add many taxa.

Many gaps in knowledge in Hawaii's biota remain, and many species of protists, algae, fungi, worms, and arthropods need to be investigated.

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Table 1. Estimates of numbers of known species of the Hawaiian biota (based on Eldredge & Miller, 1995, Miller & Eldredge, 1996, and including this paper and other papers in *Records of the Hawaii Biological Survey for 1996*). Algae and fungi remain the same as previous editions, since the numbers are based on estimates, other categories are based on counts. The estimates for algae and fungi are for recorded species—the actual number may be much higher [see Lipscomb (1996) for discussion of microbial diversity]. Archaea and bacteria are not included.

Taxon	Total	Endemic	NIS
Algae (includes diatoms)	811	2	5?
Other protists	1106	2?	?
Fungi	1309	?	?
Lichens	723	240	?
Flowering plants	1935	850	902
Other plants	755	241	44
Cnidarians	355	75	10
Insects	7979	5246	2582
Other arthropods	811	269	473
Molluscs	1650	956	86
Annelids	307	80	30
Crustaceans	1181	55+	48
Echinoderms	278	150	0
Other invertebrates	1331	439	28+
Fish	1197	139	73
Amphibians	4	0	4
Reptiles	27	0	23
Birds	274	60	46
Mammals	44	1	19
Totals	**22077**	**8805+**	**4373+**

Archaea

Unidentified species of Archaea were reported from Pele's Vent, a deep-sea hydrothermal ecosystem near the summit of Loihi Seamount (Moyer, 1996). Archaea are microbes that, although sharing ancient metabolic genes with Bacteria, are a separate lineage more closely related to Eukaryotes (Bult *et al.*, 1996).

Marine algae

Five new species described; 2 new records from Hawaiian Islands reported; 1 new to the main Hawaiian Islands, previously reported from Kure Island (Abbott, 1996).

Table 2. Freshwater invertebrates known to occur in Hawaiian waters with major source of information. (HBS96 = papers in *Records of the Hawaii Biological Survey for 1996*).

Taxon	Species			Reference(s)/Notes
	Total	Endemic	NIS	
Sponges	1	0	?	Svihla, 1941/identification needs verification
Coelenterates	2	0	2	this paper
Platyhelminthes	2	1	1	this paper
Nemertines	1	0	1	this paper/undetermined spp.
Rotifers	31	?	?	Turner, 1996
Mollusks				
Gastropods*	32	10	22	Kay, 1979; Cowie *et al.,* 1995; Cowie, *HBS Records for 1996*
Bivalves	1	0	1	Burch, 1995
Helminth endoparasites**	12	?	?	Font, HBS96
Annelids				
Leeches	4	0	4	this paper
Polychaetes	1	0	1	Van Zwaluwenburg, 1948
Arthropods				
Insects	200+	139+	55	Howarth & Polhemus, 1991; Nishida, 1994
Branchiopods	18	0	?	this paper
Ostracods	8	?	?	this paper
Copepods	14	?	?	this paper
Amphipods***	12	9	?	this paper
Decapods***	16	9	4	this paper
Mites	2	0	2	Nishida, 1994
Tardigrades	22	?	?	Nishida, 1994
Bryozoans	2	0	2	Bailey-Brock & Hayward, 1984

* includes freshwater and brackish water species
** includes platyhelminthes (9), nematodes (2), acanthacephalans (1) that are endoparasitic in native and introduced stream fishes
*** includes anchialine species

Protozoa

Foraminifera: revised number of species is 755 (Burch & Burch, 1995, *HBS Records for 1996*); ***parasitic*** (***marine invertebrates***): 8 unidentified species of ciliates (*Chromidina* and *Opalinopsis*) parasitic in cephalopods (Hochberg, 1990); ***parasitic*** (***terrestrial vertebrates***): *Haemoproteus iwa* described from great frigatebirds at Laysan and French Frigate Shoals (Work & Rameyer, 1996); avian malaria (*Plasmodium relictum*

capistranoae) infections in Hawaiian crow (*Corvus hawaiiensis*) (Massey *et al.*, 1996); avian malaria experimentally tested in i'iwi (*Vestiaria coccinea*) and nutmeg manikins (*Lonchura punctulata*) (Atkinson *et al.*, 1995); ***other Protozoa***: *Acanthocorbis camarensis* n. sp. (Hara *et al.,* 1996).

Fungi

Three new species and 6 new records of brown-spored agarics (Horak *et al.*, 1996).

Mosses

A series of recent papers create a net loss of 5 endemic species, addition of 9 indigenous species, and addition of 1 nonindigenous species (Darigo, 1996; Frahm, 1991; Hall *et al.*, 1995; Karlin & Andrus, 1995; Lewinsky, 1993; Vitt & Hoe, 1980; Zander & Hoe, 1979).

Freshwater diatoms

Two new species described, bringing Hawaii total to 213 taxa (species and varieties), overall percentage of endemism very low (about 2%) (McMillan & Rushforth, 1987).

Ferns

Human activity has led to the naturalization of 30 species (3 more than given in Eldredge & Miller, 1995), more than 260 species in cultivation (Wilson, 1996). Medeiros *et al.* (1996) added a new endemic species of fern ally, *Phlegmariurus stemmermannii*. See Wagner *et al.* (1995) for further information on ferns enumerated in Miller & Eldredge (1996).

Cnidaria

Add hydroid *Hydrichthys pietschi* parasitic on ceratioid fish *Ceratias holboelli* (Martin, 1975); 2 freshwater cnidarians were previously noted without identification—freshwater medusa *Craspedacusta sowerbii* Lankester, 1880 [nonindigenous, first record Edmondson, 1940: 313; Matthews, 1963: 18; 1966: 246] and freshwater polyp *Calpasoma dactyloptera* (Fuhrmann, 1939) [nonindigenous, first record Matthews, 1966: 246]. Add gorgonian *Narella ornata* Bayer (n. sp.) (Bayer, 1995); previously 1 species (*Physalia physalis*) of Siphonophora was reported; through an interpretation of siphonophore distribution maps, 12 additional species should be added as possibly being found in the Hawaiian region (Alvariño, 1971).

Platyhelminthes

Parasitic: *Anonchotaenia brasiliense* Fuhrmann, 1908, recorded from native drepaniid birds (Voge & Davis, 1953); *Hymenolepis lasionycteridis* n.sp. described from bats (*Lasiurus cinereus semotus*) in Hawaii (and North America) (Rausch, 1975); 8 species (cestodes) parasitic in cephalopods (Hochberg, 1990); *Paraechinophallus hyperogliphe*, n. sp., from fish *Hyperogliphe japonica* (Tkachov, 1979); new state record of *Cylindrotaenia allisonae* Schmidt, 1980 from gecko *Lepidodactylus lugubris* (Goldberg & Bursey,); *Ascocotyle tenuicollis* is a new record from both native stream gobioid and introduced fishes (Font,).

Checklist of known species of terrestrial and freshwater turbellarians

Australopacifica subpallida (Hyman, 1939) [= *Geoplana subpallida*; endemic, terrestrial; Hyman, 1939: 119; Ogren & Kawakatsu, 1991: 56]

Bipalium kewense Moseley, 1878 [nonindigenous, terrestrial; first Hawaiian record Woodworth, 1898: 302; Winsor, 1983: 61]

Dugesia dorotocephala (Woodworth, 1987) [nonindigenous, freshwater; Kawakatsu *et al.*, 1984: 1]

Endeavouria septemlineata (Hyman, 1939) [= *Geoplana septemlineata*; endemic, terrestrial; Hyman, 1939: 116; Ogren & Kawakatsu, 1991: 69]

Oahuhawaiiana kazukolinda Kawakatsu & Mitchell, 1984 [endemic, freshwater; Kawakatsu & Mitchell, 1984: 487; see Sluys (1989) for detailed phylogenetic relationships]

Parakontikia ventrolineata (Dendy, 1892) [= *Geoplana ventrolineata*; nonindigenous, terrestrial; Waterhouse & Norris, 1987: 271; Winsor, 1991: 45]

Platydemus manokwari Beauchamp, 1963 [nonindigenous, terrestrial; Eldredge & Smith, 1994: 8]

Rhynchodemus oahuensis Hyman, 1939 [terrestrial; Hyman, 1939: 120]

Nemertinea

Specimens of *Prostoma* sp. have been reported (Weidenbach, 1995) from Hawaii; additional specimens are needed for a more definitive identification; Weidenbach reported *P. graecense* (known also as *P. rubrum*) from a single specimen [*P. rubrum* was suppressed by Gibson & Moore (1976)] (J. Norenburg, pers. comm.).

Acanthocephala

The unidentified species from freshwater fish (Font & Tate, 1994) has been identified as *Southwellina hispida* (Font,).

Nematoda

Pharyngodon lepidodactylus, n. sp. described (Bursey & Goldberg, 1996) and new state record of *Skrjabinelazia machidai* Hasegawa, 1984 (Goldberg & Bursey,) parasitic in the mourning gecko *Lepidodactylus lugubris*; 3 unidentified larvae and 2 unidentified species parasitic in cephalopods (Hochberg, 1990); 1 new record from *nene* (*Branta sandvicensis*) (Baily & Black, 1995).

Annelida: **Polychaeta**

One species considered nonindigenous freshwater *Namalycastis abiuma* (Müller *in* Grube, 1872) [= *Lycastis hawaiiensis* Johnson, 1903 (Van Zwaluwenburg, 1948; Bailey-Brock & Hartman, 1987: 297)].

Annelida: **Hirudinea**

Checklist of leech species known to occur in Hawaii

Erpobdellidae

Barbronia weberi formosana (Oka, 1929) [freshwater, nonindigenous; Moore, 1946: 173; Soós, 1966a: 154, 1966b: 383]

Gastrostomobdella quinqueannulata Moore, 1946 [endemic, predaceous, terrestrial; Moore, 1946: 177; Soós, 1966a: 155; Meyer, 1968: 24]

Glossiphoniidae

Glossiphonia weberi lata Oka, 1910 [freshwater, nonindigenous; Moore, 1946: 172]

Ozobranchidae

Ozobranchus branchiatus (Menzies, 1791) [ectoparasitic, green turtles (*Chelonia mydas*); Balazs, 1980: 20; Choy *et al.*, 1989: 89]

Ozobranchus margoi (Apathy, 1890) [ectoparasitic, green turtles (*Chelonia mydas*); Choy *et al.*, 1989: 89]

Piscicolidae

Aestabdella abditovesiculata (Moore, 1952) [= *Johanssonia abditovesiculata*; parasitic on marine fish (*Arothron hispidus*); Moore, 1952: 29; Soós, 1965: 438; Burreson, 1976: 789]

Cystobranchus sp. [parasitic on native freshwater fishes, nonindigenous; Font & Tate, 1994: 683]

Myzobdella lugubris Leidy, 1851 [parasitic on native freshwater fishes, nonindigenous; Font & Tate, 1994: 683]

Arthropoda: **Insecta**

The order Mallophaga was inadvertently omitted from Miller & Eldredge (1996), resulting in omission of 102 species, of which 5 are endemic and 44 nonindigenous. It is possible that many insect species currently considered adventive were actually introduced in early biological control programs (ca. 1890–1920). Swezey (1925: 369, 1931: 368) noted that early workers introduced "perhaps ten times as many" insects as were recorded as successful introductions up to that time, but records were not kept for most of the supposedly "failed" introductions.

Arthropoda: **Pentastomida**

The first Hawaiian record of the subphylum (phylum according to some authors) is *Raillietiella frenatus* Ali *et al.,* 1981, parasitic in lungs of mourning gecko *Lepidodactylus lugubris* (Goldberg & Bursey,).

Arthropoda: **Crustacea**: **Branchiopoda**

One species of Notostraca, not previously included—*Triops longicaudatus* (LeConte, 1846) should be added (Longhurst, 1955). Eighteen species of freshwater Cladocera (an increase from 4 in Eldredge & Miller, 1995) (Ueno, 1936; Sars, 1904; Stingelin, 1905; Brehm, 1937) are provisionally listed below. Korovchinsky (1996) provided a list

of "valid species" and "fair species" (those needing further study); only 3 of the 18 from Hawaii are listed. Twelve of the 18 names were checked against the revision of the Australian Cladocera (Smirnov & Timms, 1983). The status of the remaining species needs further investigation.

Checklist of freshwater Cladocera of Hawaii

Bosminidae

Bosmina meridionalis Sars, 1904 [= *B. hagmanni*, Makua, Oahu, and Kauai, Brehm, 1937: 335; valid species of Korovchinsky, 1996]

Chydoridae

Alona cambouei Guerne & Richard, 1893 [Molokai, Sars, 1904: 633; Lake Waiau, Hawaii, Ueno, 1936: 6; Kauai, Brehm, 1937: 335]

Alona davidi Richard, 1895 [Stingelin, 1905: 352]

Alona karua (Daday, 1898) [= *Alonella karua*, Ewa Reservoir, Oahu, Brehm, 1937: 335]

Alona sp. [Brehm, 1937: 335]

Chydorus sphaericus (Müller, 1785) [Wahiawa, Oahu, Brehm, 1937: 336; valid species but recognized as a species complex (Frey, 1986: 241)]

Camptocercus australis Sars, 1896 [Brehm, 1937: 335]

Dunhevedia crassa King, 1898 [Stingelin, 1905: 357]

Pleuroxus sp. [Wahiawa, Oahu, Brehm, 1937: 336]

Daphniidae

Ceriodaphnia dubia Richard, 1894 [Mauna Kea, Hawaii, Ueno, 1936: 4]

Ceriodaphnia cornuta Sars, 1885 [= *Ceriodaphnia rigaudi,* Stingelin, 1905: 341]

Simocephalus serrulatus (Koch, 1841) [= *Simocephalus capensis* G. O. Sars, Mauna Kea, Hawaii, Ueno, 1936: 3]

Simocephalus vetulus (Müller, 1776) var. *spinosulus* [n. var., Stingelin, 1905: 342]

Ilyocryptidae

Ilyocryptus longiremis Sars [Wahiawa, Oahu, Brehm, 1937: 335]

Macrothricidae

Macrothrix triserialis Brady, 1886 [= *Macrothrix chevreuxi* Guerne & Richard, Mauna Kea, Hawaii, Ueno, 1936: 5]

Macrothrix spinosa King, 1853 [Molokai; Sars, 1904: 633]

Moinidae

Moina micrura dubia Guerne & Richard, 1892 [Kauai, Brehm, 1937: 335]

Sididae

Latonopsis australis Sars, 1888 [Stingelin, 1905: 339; fair species]

Arthropoda: **Crustacea**: **Ostracoda**

Revised numbers total 202 species: 8 freshwater and 194 of marine origin of which 32 species are from drowned terraces around the main islands (Holden, 1967), 115 (25 new species, 10 new subspecies, 50 "sp.") taxa from Cenozoic drill holes at Midway (Holden, 1976), 15 dredged species from *Challenger* Expedition (Brady, 1880), 26 inter-

stitial species (9 n. spp.) (Hartmann, 1991), 3 benthic species (Kornicker, 1976). Additional data without specific identifications pertaining to ostracod assemblages at Maunalua Bay, Oahu (Izuka & Kaesler, 1986); zoogeography of Macrocyprididae (Maddocks, 1977).

Checklist of the freshwater ostracods known from Hawaii

Cyprididae

Chlamydotheca unispinosa (Baird, 1862) [= *Cypris unispinosa* Baird 1862: 3; Tressler, 1949: 68]

Cyprinotus cingalensis Brady, 1885 [freshwater, Vavra, 1906: 424; misidentification; see Victor & Fernando, 1980: 1292]

Heterocypris makua (Tressler, 1937) [= *Cyprinotus makua* Tressler, 1937: 192; freshwater; Victor & Fernando, 1980: 1288]

Stenocypris major (Baird, 1859) [= *Stenocypris malcolmsoni* (Brady, 1886) Tressler, 1937: 202, 1949: 73; identification may not be correct, see Victor & Fernando, 1981: 156]

Cyprinopsidae

Cypridopsis cypera Tressler, 1937 [n. sp., Tressler, 1937: 204]

Cypridopsis dentatomarginata (Daday) [Tressler, 1937: 204]

Cypridopsis vidua (Müller, 1776) [Tressler, 1937: 204]

Entocytheridae

Ankylocythere sinuosa (Rioja, 1942) [freshwater drainage ditches, host nonindigenous crayfish *Procambarus clarkii*; Hart & Hart, 1974: 29]

Arthropoda: **Crustacea**: **Copepoda**

Add 4 shallow-water marine species including 3 new species of *Leptocaris* (Kunz, 1994); no freshwater copepods were identified in Eldredge & Miller (1995).

Checklist of freshwater copepods from the Hawaiian Islands

Order Cyclopoida

Bryocyclops anninae (Menzel, 1926) [Yeatman, 1984: 62; Evenhuis & Preston, 1995: 53]

Lernaea cyprinacea Linnaeus, 1758 [= *Lernaea carassi* Tidd, parasitic on goldfish and tadpoles, Bonnet, 1948: 7]

Macrocyclops albidus (Jurine, 1820) [= *Cyclops albidus*, Molokai, Sars, 1904: 641]

Mesocyclops aspericornis (Daday, 1906) [= *Cyclops aspericornis* n. sp., pools and ditches between Waikiki and Honolulu, Oahu, Daday, 1906: 305; = *Cyclops leuckarti* Claus, Molokai, Sars, 1904: 641; = *Mesocyclops obsoletus* (Koch), mosquito predator, Bonnet & Mukaida, 1957: 99; Kiefer, 1981: 172]

Paracyclops poppei (Rehberg, 1880) [= *Cyclops fimbriatus* var. *poppe*i, Molokai, Sars, 1904: 641]

Order Harpacticoida

Cletocamptus deitersi (Richard, 1897) [river between Waianae and Nanakuli, Oahu, Chappuis, 1934: 635]

Elaphoidella bidens (Schmeil, 1894) [= *Attheyella coronata* Sars, 1904 n. sp., Molokai, Sars, 1904: 641; = *Elaphoidella bidens coronata* (Sars), Palolo River (Kaimuki), Oahu, Chappuis, 1934: 632]

Elaphoidella dispersa Chappuis, 1934 [n. sp., river between Waianae and Nanakuli, Oahu, Chappuis, 1934: 633]

Elaphoidella grandidieri (Guerne & Richard, 1893) [= *Attheyella grandidieri*, Molokai, Sars, 1904: 639; Hawaiian Islands, Yeatman, 1984: 85]

Epactophanes richardi Mrazek, 1893 [Oahu, Evenhuis & Preston, 1995: 53]

Leptocaris brevicornis (Douwe, 1904) [euryhaline, sometimes found in inland freshwaters, Kauai, Kunz, 1994: 35]

Nitokra pietschmanni Chappuis, 1934 [n. ssp., Moanalua, Kahili River, Waimalui (Pearl Harbor), Honolulu Fishmarket, Waikiki, Waipahu, Aiea, Waianae Plantation Reservoir, Oahu, Chappuis, 1934: 634]

Nitokra spinipes Boeck, 1865 [drift in Paakea, Waiohue, Hanakapiai, Hawaii; Barnes & Shiozawa, 1985: 2119]

Phyllognathopus viguieri (Maupas, 1892) [Oahu, Yeatman, 1984: 74; Evenhuis & Preston, 1995: 53]

Arthropoda: **Crustacea**: **Cirripedia**

Three green turtle-associated barnacles—*Chelonibia testudinaria* (on carapace, plastron, head), *Platylepas hexastylos* (attached principally to skin regions), and *Stephanolepas muricata* (burrowing species)—to be added (Balazs, 1980).

Arthropoda: **Crustacea**: **Stomatopoda**

The 17 species of stomatopods are relatively well known in Hawaiian waters; however, recent generic revisions have changed many of the established names (Manning, 1995).

Checklist of stomatopod species known from Hawaiian waters (**all marine**)

Bathysquillidae

Bathysquilla microps (Manning, 1961)

Coronididae

Paravisquilla sinuosa (Edmondson, 1921) [= *Coronida sinuosa* Edmondson, 1921]

Gonodactylidae

Gonodactylaceus aloha (Manning & Reaka, 1981) [= *Gonodactlyus aloha* Manning & Reaka, 1981]

Gonodactylellus hendersoni (Manning, 1967) [= *Gonodactylus hendersoni* Manning, 1967; including Pacific records of *G. demani*]

Harpiosquillidae

Alima alba (Bigelow, 1893) [= *Squilla alba* Bigelow, 1893; *Alima hyalina* Leach, 1817]

Lysiosquillidae
Lysiosquilla sulcirostris Kemp, 1913 [not *Lysiosquilla maculata* (Fabricius, 1793)]
Lysiosquillina maculata (Fabricius, 1793) [= *Lysiosquilla maculata* (Fabricius, 1793)]
Nannosquillidae
Acanthosquilla multifasciata (Wood-Mason, 1895)
Odontodactylidae
Odontodactylus brevirostris (Miers, 1884) [= *Gonodactylus hansenii* Pocock, 1893]
Odontodactylus hawaiiensis Manning, 1967
Protosquillidae
Echinosquilla guerini (White, 1861)
Pseudosquillidae
Pseudosquilla ciliata (Fabricius, 1787)
Pseudosquillisma guttata (Manning, 1972) [= *Pseudosquilla guttata* Manning, 1972]
Pseudosquillisma oculata (Brullé, 1837) [= *Pseudosquilla oculata* (Brullé, 1837)]
Squillidae
Busquilla quadraticauda (Fukuda, 1911) [= *Squilla boops* Kemp, 1911; *Oratosquilla quadraticauda* (Fukuda, 1911)]
Oratosquilla calumnia (Townsley, 1953) [= *Squilla calumnia* Townsley, 1953; *Squilla oratoria* DeHaan, 1844]
Pontiosquilla mauiana (Bigelow, 1931) [= *Chorida mauiana* (Bigelow, 1931)]

Arthropoda: **Crustacea**: **Mysidacea**

Revised numbers total 20 species: 13 species (Ortmann, 1906), 4 species (Tattersall, 1951), 1 possible nonindigenous species (Holmquist, 1979), 2 new species (Murano, 1995); population study of *Gnathophausia longispina* (Wilson & Boehlert, 1993).

Arthropoda: **Crustacea**: **Tanaidacea**

One newly recorded species (Muir,).

Arthropoda: **Crustacea**: **Isopoda**

Taiti & Howarth (1996) reviewed the terrestrial isopods with a total of 47 species. No isopods are known from freshwater habitats in Hawaii.

Arthropoda: **Crustacea**: **Cumacea**

One unidentified newly recorded species (Muir,).

Arthropoda: **Crustacea**: **Amphiphoda**

Green turtle-associated talitroid amphiphod—*Hyachelia tortugae*—found in buccal cavity and also on neck and hind flippers in association with superficial skin lesions (Balazs, 1980); 4 new records (Muir,).

Twelve species of amphipods reported from fresh to brackish anchialine ponds (Barnard, 1977; Barnard & Barnard, 1983; Bousfield, 1990):

Checklist of Hawaiian amphipods from fresh to brackish anchialine habitats

Carnarimelita janstocki Bousfield, 1990
Gammarella amikai (Barnard, 1970) [= *Nuuanu amikai* Barnard, 1970]
Grandidierella dentimera Myers, 1970
Grandidierella koa Barnard, 1977
Grandidierella palama Barnard, 1977
Liagoceradocus lonomaka Barnard, 1977 [= *Hadzia (Liagoceradocus) lonomaka* Barnard, 1977]
Parahyale hawaiensis (Dana, 1853)
Paramoera lokowai Barnard, 1977
Paramoera paakai Barnard, 1977
Paramoera rua Barnard, 1977
Rotomelita ana Barnard, 1977
Rotomelita lokoa Barnard, 1977

Arthropoda: **Crustacea**: **Decapoda**

New species for Hawaii—*Metapenaeopsis gaillardi* Crosnier, 1991 (n. sp.); *Aniculus hopperae* McLaughlin & Hoover, 1996 (n. sp.); *Rhynchocinetes rathbunae* Okuno, 1996 (n. sp.); new family record (Anchistiodidae), juvenile *Anchistioides compressus* Paulson, deposited in Queensland Museum (A.J. Bruce, pers. comm.); *Harrovia truncata* Rathbun, 1906 is now *Cyrtocarcinus truncatus* (Rathbun, 1906) (Ng & Chia, 1994); *Pandalus brevis* Rathbun, 1906 is now *Bitias brevis* (Rathbun, 1906) (Crosnier & Fransen, 1994); 3 species of Axiidae are noted (Kensley, 1996).

Checklist of freshwater and anchialine decapod crustaceans from Hawaii

Infraorder Caridea
Alpheidae
Metabetaeus lohena Banner & Banner, 1960 [n. sp., anchialine, Banner & Banner, 1960: 299; Holthuis, 1973: 35]
Atyidae
Antecaridina lauensis (Edmondson, 1935) [first Hawaiian record, Holthuis, 1973: 19]
Atyoida bisulcata Randall, 1840 [= *Atya bisulcata* auctt., = *Ortmannia henshawi* Rathbun, 1900; Chace, 1983: 5]
Caridinia weberi deMan, 1892 [nonindigenous, established, Devick, 1991]
Halocaridina palahemo Kensley & Williams, 1986 [n. sp., anchialine and lava tubes, Kensley & Williams, 1986: 429]
Halocaridina rubra Holthuis, 1963 [n. sp., anchialine, Holthuis, 1963: 262; = *Caridina brevirostris*, Rathbun, 1906: 919 and others]
Hippolytidae
Calliasmata pholidota Holthuis, 1973 [n. sp., anchialine, Holthuis, 1973: 37]
Ligur uvae (Borradaile, 1899) [first Hawaiian record, Maciolek, 1983: 609]
Palaemonidae (Palaemoninae)
Macrobrachium grandimanus (Randall, 1840) [= *Palaemon grandimanus* and *P. gracil-*

imanus, Randall, 1840: 142, 143; freshwater, rarely anchialine, Holthuis, 1973: 23]
Macrobrachium lar (Fabricius, 1798) [nonindigenous, established, Brock, 1960]
Macrobrachium rosenbergii (deMan, 1879) [nonindigenous, probably not established, Kanayama, 1967]
Palaemon debilis Dana, 1852 [anchialine, Holthuis, 1973: 22]
Palaemonidae (Pontoniinae)
Palaemonella burnsi Holthuis, 1973 [n. sp., anchialine, Holthuis, 1973: 24]
Procarididae
Vetericaris chaceorum Kensley & Williams, 1986 [n. sp., anchialine and lava tubes, Kensley & Williams, 1986: 419]
Procaris hawaiana Holthuis, 1973 [n. sp., anchialine, Holthuis, 1973: 12]
Infraorder Astacidea: Astacidae [crayfishes]
Procambarus clarkii (Girard, 1852) [nonindigenous, established, first record, Penn, 1954]
Infraorder Brachyura
Potamonidae [freshwater crabs]
Trichodactylus punctatus Eydoux & Souleyet [Rathbun, 1906:842 "without doubt erroneously attributed to the Hawaiian Islands by those authors", members of this family have never been reported from the Hawaiian Islands]

Bryozoa and Entoprocta

The note in Eldredge & Miller (1995) for these 2 phyla was inadvertently confused. "Soule *et al*. (1987) provided only unidentified generic descriptions" was intended for Entoprocta. For Bryozoa, Soule *et al.* (1987) provided at list of some 180 species known from Hawaiian waters along with the source of the record and also included nearly 50 identified SEM photographs; for additional records see D.F. Soule *et al*. (1991); J.D. Soule *et al.* (1991), and D.F. Soule *et al.* (1992).

The 2 freshwater bryozoans are: *Hyalinella vaihiriae* Hastings, 1929 and *Plumatella repans*? (Bailey-Brock & Hayward, 1984).

Chordata

A second species—*Epigonichthys lucayanum* (Andrews, 1893)—of cephalochordate is added (Richardson & Eldredge,). Three newly recorded introduced lizards not previously included: *Anolis sagrei*, *A. equestris*, *Phelsuma guimbeaui* (Kishinami & Kishinami, 1996). Two new marine fish—*Aseraggodes borehami* Randall, 1996 and *A. therese* Randall, 1996 (Family Soleidae)—described from Hawaiian waters (Randall, 1996).

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Status, Ecology, and Management of the Invasive Plant, *Miconia calvescens* DC (Melastomataceae) in the Hawaiian Islands[1]

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Abstract

Miconia calvescens (Melastomataceae), native to montane forests of the neotropics, has now invaded wet forests of both the Society and Hawaiian Islands. This tree, which grows up to 15 m tall, is potentially the most invasive and damaging weed of rainforests of Pacific islands. In moist conditions, it grows rapidly, tolerates shade, and produces abundant seed that is effectively dispersed by birds and accumulates in a large, persistent soil seed-bank. Introduced to the Hawaiian Islands in 1961, *M. calvescens* appears to threaten much of the biological diversity in native forests receiving 1800–2000 mm or more annual precipitation. Currently, *M. calvescens* is found on 4 Hawaiian islands—Hawaii, Maui, Oahu, and Kauai. Widespread awareness of this invader began in the early 1990s. Although biological control is being pursued, conventional control techniques (mechanical and chemical) to contain and eradicate it locally are underway.

Introduction

The effects of biological invasions are increasingly being recognized for their role in degradation of biological diversity worldwide (Usher *et al*., 1988; D'Antonio & Vitousek, 1992). Native ecosystems of oceanic islands are known to be especially subject to invasion and displacement by non-native species (Loope & Mueller-Dombois, 1989; others). The Hawaiian Islands now have nearly 100 invasive plant species that threaten to seriously alter native ecosystems (Smith, 1985; Stone *et al.,* 1992).

The Melastomataceae is one of the most damaging and invasive families of weeds in Hawaii. Of the 15 melastome species naturalized in the Hawaiian Islands (Almeda, 1990), 9 have been declared Noxious Weeds, the worst being *Clidemia hirta*, *Tibouchina herbacea*, *Oxyspora paniculata*, and *Miconia calvescens*.

With approximately 1,000 species, *Miconia* is easily the largest genus in the tropical family Melastomataceae (Cronquist, 1981). *Miconia calvescens* DC is a small tree 4–15 m tall with large (to 80 cm), strongly trinerved leaves. It is native to Central and South America from southern Mexico to northern Argentina and Chile, where it is an early successional tree species of wet thickets and dense mixed forest, colonizing small light gaps (R. Burkhart, Hawaii Department of Agriculture (HDOA); F. Almeda, pers. comm.). It occupies middle elevation sites in Ecuador at 300–1830 m (Wurdach, 1980). Specimens of the bicolorous form with purple leaf undersides have been collected only from southern Mexico to Costa Rica; farther south, leaf undersides are greenish (Meyer, 1996). The bicolorous form of *M. calvescens,* known to horticulturists as "velvet tree", is valued for its attractive large leaves, velvety dark green above and purple on the underside. This bicolorous form of the species has been cultivated in greenhouses in Europe and botanical gardens in Asia since the mid-1800s (Birnbaum, 1991) and is the form established and

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invasive in the Hawaiian Islands and in French Polynesia.

Introduced to Tahiti at the Papeari Botanical Garden in 1937, it now dominates the forest over 65% of the 1045 km^2 island (Meyer, 1996). Many sites, formerly dominated by native vegetation, have become completely transformed as *M. calvescens* gained dominance, due to the creation of deep shade which few native species can tolerate (Meyer, 1994). In Tahiti, 70–100 native plant species, including 35–45 species endemic to French Polynesia, are directly threatened by invasion of *M. calvescens* into native forests (Meyer & Florence, unpublished ms.). This invader has now spread to 3 other islands of French Polynesia (Moorea, Raiatea, Tahaa). After the late Pacific botanist F.R. Fosberg saw the developing infestation of *M. calvescens* in Tahiti in 1971, he warned Hawaiian authorities that "it is the one plant that could really destroy native the Hawaiian forests" (Altonn, 1991).

Miconia calvescens was introduced to Hawaii as an ornamental in 1961. Currently found on four islands (Hawaii, Maui, Oahu, Kauai), it is generally recognized as a threat to native habitats receiving 1800–2000 mm or more of annual precipitation. This paper presents the history of *M. calvescens* in the Hawaiian Islands, its status, ecology, and prospects for management.

History and status of *Miconia calvescens* in the Hawaiian Islands

Until 1991, awareness of the threat from *M. calvescens* was not widespread in Hawaii. It was not listed as naturalized in Hawaiian plant literature of the 1960s and 1970s (e.g., Neal, 1965; St. John, 1973). The authoritative *Manual of the flowering plants of Hawai'i* (Wagner *et al*., 1990) did not include *M. calvescens* as one of the 861 naturalized species receiving treatment. The introduction to the Melastomataceae (Almeda, 1990) did mention that "In addition to the species treated here, *M. calvescens*... is sometimes cultivated, and volunteer seedlings have reportedly appeared at the Lyon Arboretum, Oahu, and on private estates near Hilo, Hawaii. It is now apparently becoming naturalized. Establishment of this species on Sri Lanka and Tahiti suggests that it will spread in our area unless cultivation is discouraged." In the 1980s, a few conservationists expressed alarm at a burgeoning population at Onomea, north of Hilo, island of Hawaii, and volunteer efforts to remove plants were mounted. This effort did not receive widespread support.

In 1991, conservation agencies on Maui became aware that *M. calvescens* was present on that island. An alarm was raised in the press (Hurley, 1991; Altonn, 1991) and by scientists (Gagné *et al.*, 1992, Medeiros & Loope, 1992). By late 1991, a colorful and factual "wanted" poster on *M. calvescens* was produced in large numbers and distributed widely, especially on windward Maui, with the aim of education and soliciting reports of *M. calvescens* locations. As of 1996, serious removal/eradication programs are progressing on Maui, Oahu, and Kauai, and the problem is being fully assessed and control efforts started on Hawaii.

Miconia calvescens on Oahu Island

Miconia calvescens was first introduced to the Hawaiian Islands in 1961 by the noted botanist and horticulturist Joseph F. Rock at Wahiawa Botanical Garden (planting records, Wahiawa), a site in central Oahu with suboptimal, seasonally dry habitat—about 1500 mm of annual rainfall. A report from a homeowner of a single sapling growing in her yard

across the street from the garden entrance led to the destruction of the original parent tree by the garden staff (W. Kobayashi, HDOA, pers. comm.) in May of 1995. A door-to-door canvassing effort in May 1996 resulted in location of only one other plant (Whitmore Village).

At Waimea Botanical Garden, northwest Oahu, *M. calvescens* was grown (1975–1983) but did not thrive in the seasonally dry climate (1500–1650 mm mean annual rainfall), before being destroyed because of its potential to spread (K. Woolliams, Waimea Botanical Garden, pers. comm.).

In 1964, a single individual of *M. calvescens* was planted at Harold L. Lyon Arboretum in Manoa Valley on the outskirts of Honolulu in the southeastern Koolau Range (planting records, Lyon Arboretum). Naturalized seedlings were first noted in 1975 and continue to be reported to the present (R. Hirano, pers. comm.). Recognizing the threat, the garden destroyed the original plant in the early 1990s (C. Lamoureux, Lyon Arboretum, pers. comm.). Although all new seedlings are promptly removed upon discovery, 5 fertile *M. calvescens* trees and numerous associated seedlings and saplings were discovered and destroyed by Sierra Club volunteers in steep, thickly vegetated, unmaintained portions of the arboretum in 1995.

Another single specimen of *M. calvescens* was planted, probably in the late 1970s or early 1980s (W. Wong, pers. comm.), at the entrance to Paradise Park, in Manoa Valley near Lyon Arboretum; the tree had produced numerous seedlings around its base, none of which had reached reproductive age by 1991 when management removed all known plants on the recommendation of conservationists (B. Gagné, pers. comm.). However, an adjacent infestation on an upland 14 ha parcel was discovered and plant removal started by HDOA and the Department of Land and Natural Resources (DLNR) in 1995. Five fertile trees and numerous saplings have been removed so far. Also, probable progeny (4 non-reproductive plants) of the original planted specimen were found on the west slope of Puu Pia in central Manoa Valley.

Miconia calvescens is now known to have naturalized at 3 locations in the southeastern Koolau Range, including Manoa, Kalihi, and Nuuanu valleys (Conant, 1996). Finally, on windward Oahu (Kahaluu), *M. calvescens* is known (A.C. Medeiros, pers. observ.) to have been grown by at least one private horticulturist (who obtained a single plant from a mainland nursery in the early 1980s) until it was destroyed in the early 1990s.

Known sites of *M. calvescens* on Oahu are mapped in Figure 1, and populations are summarized in Table 1.

Miconia calvescens *on Hawaii Island*

Miconia calvescens was first noted in the early 1960s on Hawaii island near Hilo at the Herbert Shipman estate (R. Blackshear, pers. comm.). By 1971, the species was clearly naturalized at the Hilo estate (K. Wooliams, pers. comm.). At an early date, *M. calvescens* was also introduced to Onomea, where it is now extensively naturalized and has locally developed nearly monospecific stands. Due to its sale prior to 1992, *M. calvescens* has become naturalized from numerous loci on the windward side of the island in North Hilo (Hakalau), South Hilo (Onomea, Papaikou, Hilo, Panaewa, Waiakea-uka), and Puna (Keaau, Kurtistown, Paradise Park subdivision, Orchid Land subdivision, Nanawale, Pahoa, Leilani Estates subdivision) districts. *M. calvescens* is also present less extensively in the North Kona district (Keauhou and Holualoa) and South Kona district

Table 1. Known populations of *Miconia calvescens* on Oahu, Maui, and Kauai:

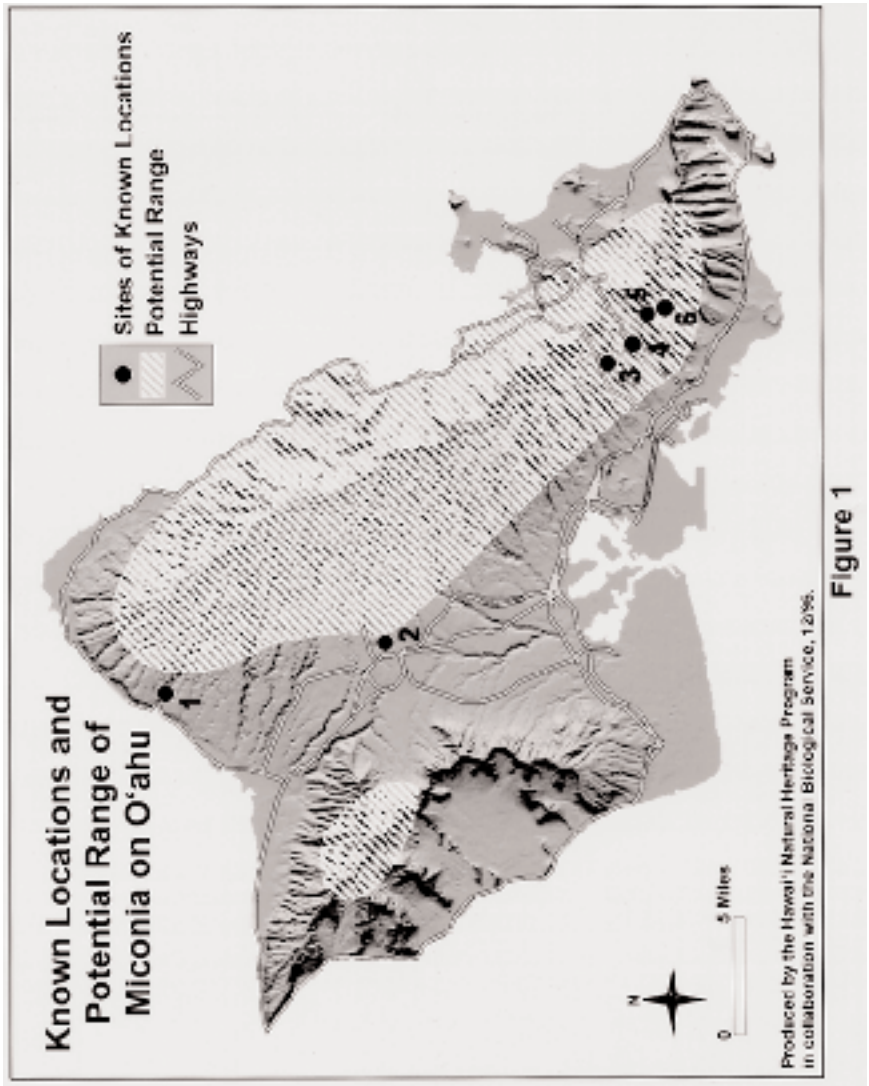
Location	Year "Discovered"	Elevation (meters)	Extent
OAHU			
Wahiawa Bot. Garden	1961	292	2 plants
Lyon Arboretum	1964	120-395	61 ha
Waimea Bot. Garden	1976	15	1 plant
Paradise Park	1978/1991	150-245	7 ha
Kalihi Valley	1994	207	6 ha
Nu‘uanu Valley	1995	200	4 ha
MAUI			
Upper Nahiku	1990	120-300	ca.80 ha
Hana/Olopawa	1991	60-370	300 ha+
Lower Nahiku	1991	20-160	ca.50 ha
Keanae	1991	50-60	ca.40 ha
Hoalua	1991	360	1 sapling
Huelo 1	1992	110	ca.7 ha
Huelo 2	1995	120	2 trees++
Peahi	1995	150	1 tree+
Upper Keanae	1995	430	1 sapling
Kaupo	1995	490	1 tree
KAUAI			
Wailua Homesteads	1995/1996	40-140	35-40 plants
Kapa‘a Homesteads 1	1995	97	1 plant
Kapa‘a Homesteads 2	1995	134	1 plant
Wailua Reservoir	1996	146	1 plant

(Hookena), western Hawaii island (W. Shishido, HDOA, pers. comm.).

The *M. calvescens* infestation on Hawaii island is more extensive than the second largest one on Maui island. Known sites are mapped as polygons based on available information in Fig. 2, but we have not attempted to summarize populations in Table 1. Detailed mapping of invaded areas is a huge task that has only recently begun (R. Warshauer, USGS/BRD, pers. comm.). A special concern involves the existence of large tracts of fallow land resulting from recent abandonment of sugar cane cultivation. The cleared lands, lacking tree and shrub cover, may facilitate the inland spread of *M. calvescens* to extensive upland forest reserves nearby.

Miconia calvescens *on Maui Island*

On Maui, *M. calvescens* was first introduced in the early 1970s at the private nursery and botanical garden, Helani Gardens, not far from the coast at Hana on northeastern East Maui (H. Cooper, pers. comm.). By the time the potential threat was realized in 1991 (Gagné *et al.*, 1992), *M. calvescens* was naturalized and abundant throughout the 16.5 ha garden. When removed in 1991, the largest *M. calvescens* trees in the garden were over 10 m tall with basal diameters to 30 cm. Nevertheless, concerted removal effort within Helani Gardens has resulted in a manageable situation where local eradication is feasible.


Known Locations and Potential Range of Miconia on O'ahu
Sites of Known Locations
Potential Range
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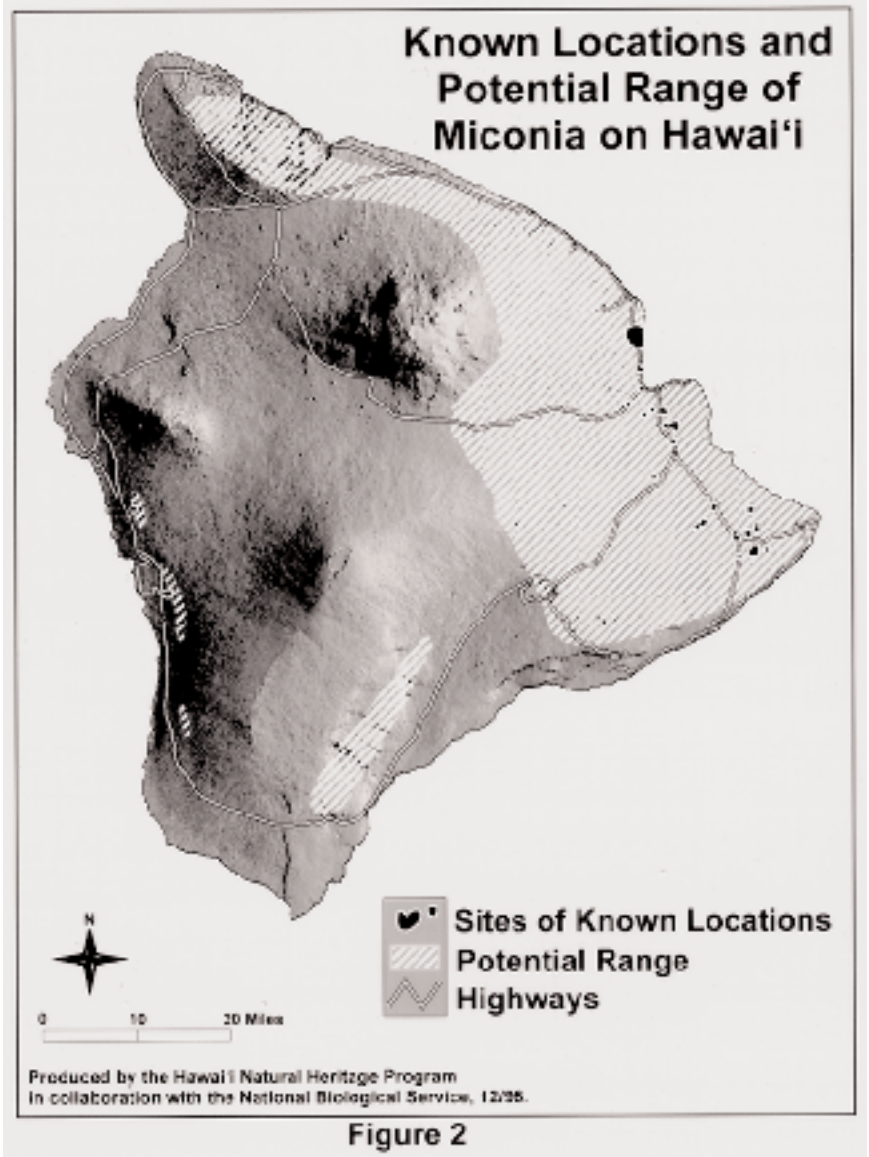
Produced by the Hawai'i Natural Heritage Program
in collaboration with the National Biological Service, 1996.

Figure 1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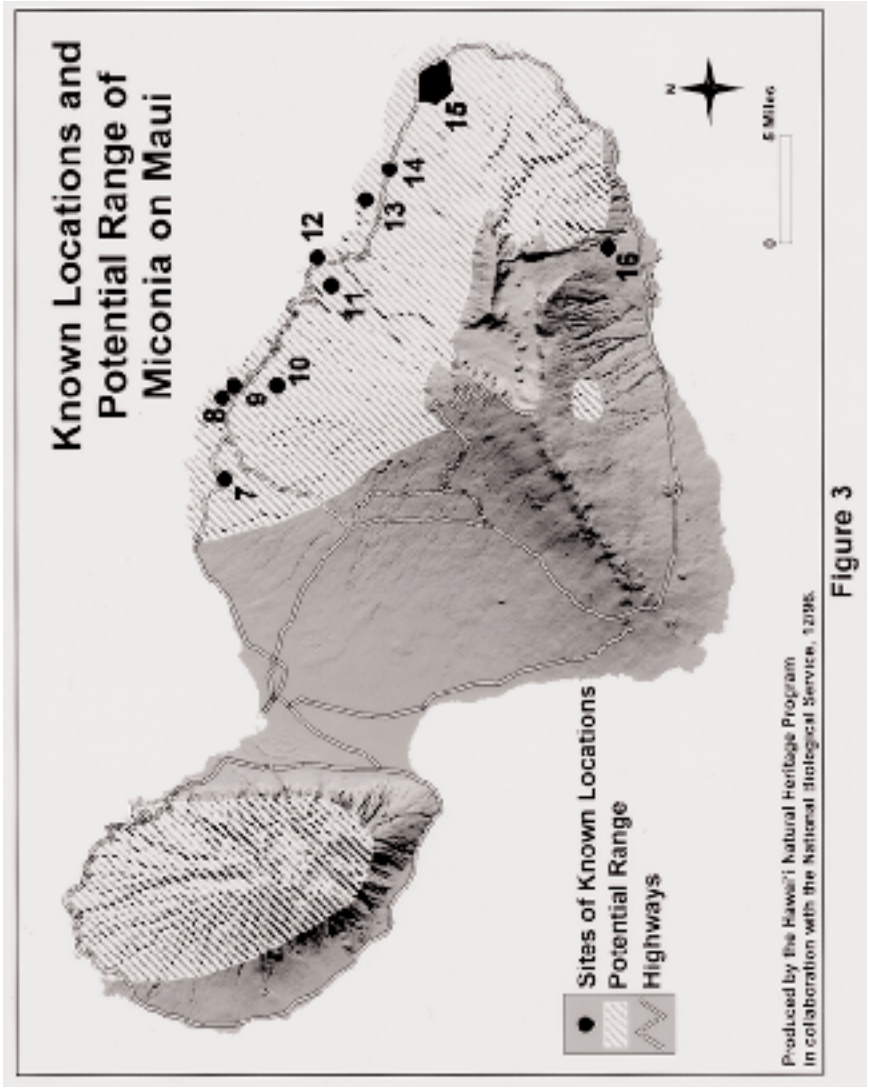
Produced by the Hawai'i Natural Heritage Program
in collaboration with the National Biological Service, 12/95.

Figure 2


Known Locations and
Potential Range of
Miconia on Maui
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Produced by the Hawai'i Natural Heritage Program
in collaboration with the National Biological Service. 1996.

Figure 3

Five additional populations were found in 1991–93 on windward East Maui and over 20,000 plants were removed. However, in September 1993, a much larger concentration of *M. calvescens* was discovered upslope above Helani Gardens and Hana, up to 370 m in elevation, stretching as far as Olopawa cinder cone. This Hana/Olopawa population is by far the largest on Maui. Four discrete dense stands of canopy-sized *M. calvescens* trees occur on a 500-year old lava flow (Crandell, 1983) in predominantly non-native forest, dominated by the introduced tree *Spathodea campanulata*, with pockets of lowland native wet forest. Numerous outliers occur within an area of over 300 ha. The original source of the dense stands may have been planted or seeds may have been dispersed from nearby (<1 km) Helani Gardens by birds.

Currently, 10 populations of *M. calvescens* are known on Maui (Fig. 3; Table 1). With the exception of a single tree in leeward Kaupo district, all other populations are located on the northern and northeastern flanks of Haleakala volcano (East Maui) from near sea level to 430 m elevation. Known populations on Maui are currently the focus of aggressive management.

Miconia calvescens *on Kauai Island*

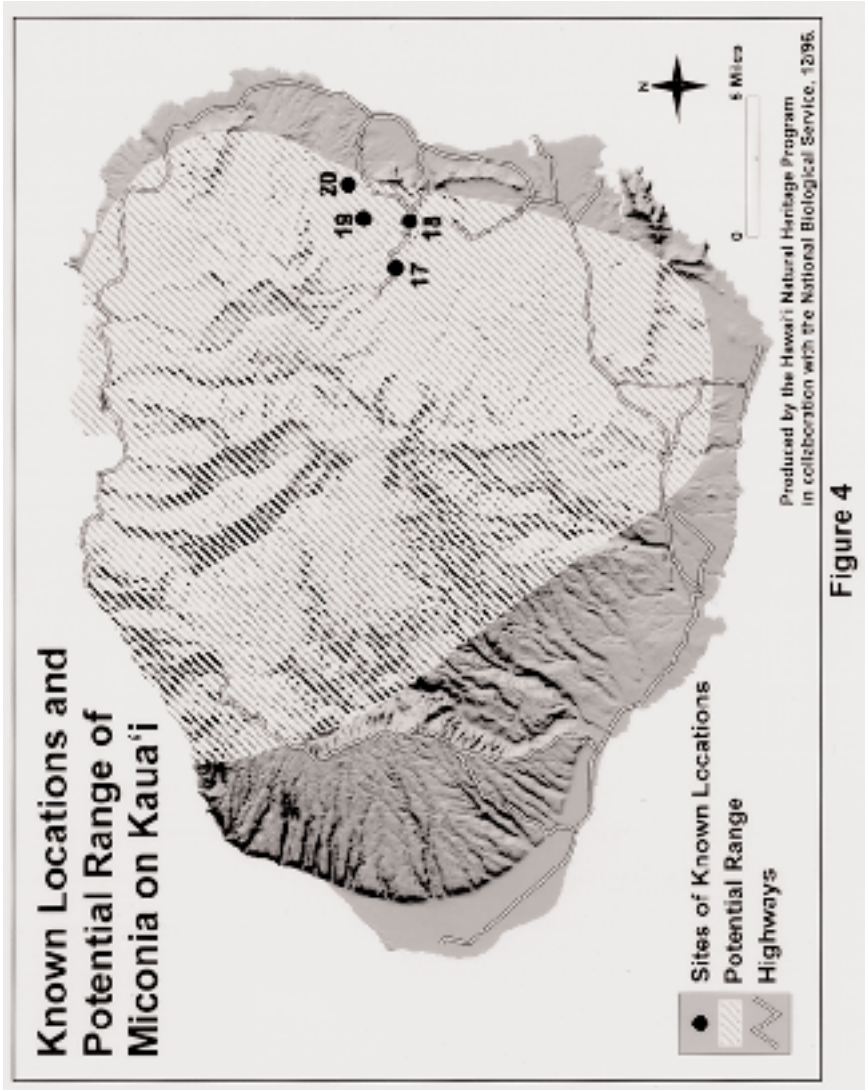
Miconia calvescens was discovered on Kauai in October 1995 in Wailua Homesteads by an HDOA employee following up a report by a local resident, who was alerted to the threat of Miconia by a public service announcement on television. The source of plants in the area was apparently a large tree (30 cm basal diameter), destroyed in 1993, grown from a seedling from Oahu given to a nursery by a friend (Conant, 1996). In 1995, approximately 20 plants were removed, and monitoring continues in an area within 0.5 km of the nursery. In December 1995, a large (7 m tall) flowering *M. calvescens* plant was found 2 km distant from the nursery with the remnants of a plastic pot attached to its roots (G. Nagai, HDOA, pers. comm.). Soon afterwards, a second large plant, also with remnants of a plastic pot, was found even further distant (4 km) from the infested nursery. An additional 15–20 plants were near the banks of the Wailua River (40 m elevation) near the infested nursery in 1996 and can probably be considered a range extension of the nursery infestation. Most recently in 1996, a single spontaneous plant has been removed adjacent to Wailua Reservoir. This is the only known "wild" plant disjunct from the nursery infestations on Kauai.

Known sites of *M. calvescens* on Kauai are mapped in Fig. 4, and populations are summarized in Table 1.

Aspects of the invasion and ecology of *Miconia calvescens*

The invasion of native ecosystems on Tahiti island has been the most important factor in the recognition in the Hawaiian Islands of *M. calvescens* as one of the most invasive and damaging of wet forest weeds. With similar volcanic origins, ages, and distance from the equator and from continents, the Society (16°40'–18°00' S lat.) and Hawaiian (19°00'–22°20' N lat.) Archipelagos have highly comparable climate, topography, and biota. Both the Society and Hawaiian Islands have relatively high endemism, rich pteridophyte, and depauperate monocot floras with many native genera in common (Florence, 1987, Wagner *et al.*, 1990, Wagner, 1992).

Native forests of the Society and Hawaiian Islands are relatively low statured, have naturally higher solar radiation levels, and fewer tree species than many other rainforests.


Known Locations and
Potential Range of
Miconia on Kaua'i
20
19
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Sites of Known Locations
Potential Range
Highways
Produced by the Hawai'i Natural Heritage Program
in collaboration with the National Biological Service, 1995.

Figure 4

These factors may act in making these forests especially vulnerable to invasion by *M. calvescens* because solar radiation levels at the forest floor are not dark enough to preclude germination and establishment of its seedlings. Relatively high intensity of solar radiation has been suggested as a factor in the vulnerability of native forests in the Seychelles to the melastome, *Clidemia hirta* (Gerlach, 1993).

Naturalized populations of *M. calvescens* in the Hawaiian and Society Islands characteristically have leaves with purple undersides. *Miconia calvescens* from the southern part of its range, South America, have older leaves that are entirely green (Wurdack, 1971). *Miconia calvescens* plants with all leaves having red to purple undersides typically originate in the northern part of the range of the species in Mexico, Guatemala, and Costa Rica (Wurdack, 1971). The original source of the *M. calvescens* introduced to Tahiti is known to be Mexico via Peradeniya Botanical Garden, Sri Lanka (Meyer, 1994). The red-purple lower leaf surface of *M. calvescens* and the fact that botanist J.F. Rock spent much time in Asia suggests that the *M. calvescens* introduced to Hawaii by Rock had a similar origin.

Phenology

Flowering and fruiting of mature trees in *M. calvescens* populations in Hawaii can occur nearly anytime of year. A single tree can flower/fruit 2–3 times in a year with flowers, mature and immature fruits often seen on the same tree. *Miconia calvescens* trees begin to flower at 4–5 years old at about 3–4 m in height. Full-sized (> 8 m) trees produce 50–200+ inflorescences, increasing with tree size and sun exposure. Each inflorescence is comprised of 1000–3000 perfect flowers with exserted styles. When fully open, the short-lived (ca. 12–24 hours) flowers, white with pink tint, are strongly sweet-scented. At Hana, Maui, nonindigenous syrphid and other unidentified small flies have been observed visiting flowers.

Ripe fruits are dark purple, average 5.9 mm (n = 250) in diameter and have a sweet taste; each fruit contains 50–200 seeds. Seeds of *M. calvescens* are tiny, about 0.5 mm in diameter. A single 10 m tree with 100 inflorescences, 300 fruits/inflorescence, and 100 seeds per fruit, will produce 3 million seeds 2 or 3 times a year.

Seed Dispersal

In the Society and Hawaiian Islands, *M. calvescens* seeds are effectively dispersed by non-native frugivorous birds. In the Society Islands, *M. calvescens* seeds are dispersed by the abundant white-eye *Zosterops lateralis* (Gaubert, 1992), and the red-vented bulbul (*Pycnonotus cafer*) (Meyer, 1994). In Hawaii, dispersal is probably by Japanese white-eye (*Zosterops japonicus*), red-billed leiothrix (*Leiothrix lutea*), and common mynah (*Acridotheres tristis*). In Hawaii, the Japanese white-eye is abundant from low elevations up to high elevation native rainforests (Scott *et al.*, 1986). The red-vented bulbul, an important disperser of *M. calvescens* seeds in the Society Islands, while established on Oahu since the 1960s (Pratt *et al.,* 1987), is not (at least not yet) established on Hawaii, Maui, or Kauai.

Seed Banks

Substantial stored seed banks can accumulate beneath dense naturalized stands of *M. calvescens*. In greenhouse trials in Tahiti, a square meter of the uppermost 2 cm of soil

from a dense *M. calvescens* stand, periodically disturbed, produced 17,808 *M. calvescens* seedlings in six months (Gaubert, 1992).

Seed banks lie largely dormant under normal shaded conditions but are stimulated by an opening in the canopy. After herbicidal defoliation of Maui's main population, *M. calvescens* seedlings appeared in great numbers, especially on preferred microsites of mineral soil, dead tree boles, and dead *Sadleria* tree fern trunks. Under normal conditions, *M. calvescens* seedlings are characteristically found clustered or scattered near, or less often at some distance from, fruiting-sized *M. calvescens* trees, sometimes in deep shade.

Meyer (1994) has verified *M. calvescens* seed life in soil samples of more than 2 years. Three years after acquisition, Maui horticulturists have found *M. calvescens* germinants in pots of *Heliconia* from *M. calvescens*-infested Helani Gardens. Indirect evidence from a long-term plot on Raiatea, Society Islands, suggests seed life of at least four years (J.-Y. Meyer, unpubl.).

Natural enemies

Herbivory by the Chinese rose beetle (*Adoretus sinicus*) on *M. calvescens* leaves is frequently observed in both the Hawaiian and Society Islands. Though this herbivory can cause up to 50% defoliation on individual leaves, it has never been widespread and has never been observed to cause mortality.

Management of the *M. calvescens* invasion

Despite many invasive plant control projects in Hawaii, *M. calvescens* is regarded as a very high priority because 1) its potential impacts on watershed lands and biological diversity appear to be much greater than those of other invasive plants, and 2) containment and/or eradication is still feasible, at least on some islands and parts of other islands, at this time.

Miconia calvescens was listed on 22 August 1992 as a Noxious Weed under Chapter 68 of the Hawaii Revised Statutes by the HDOA. This authorized (but did not fund) the HDOA to conduct control on private land. An interagency Melastome Action Committee (MAC), formed on Maui in 1991, began to convene regularly to plan strategy and solicit funding. The Melastome Action Committee (MAC) has had broad interagency representation, with at least 5 government agencies and private entities involved in control efforts on Maui. Increased awareness of the threat from *M. calvescens* on Maui has led to important efforts on other islands (Conant *et al.* in press). By 1995–96, MAC, working in cooperation with the East Maui Watershed Partnership, had developed a comprehensive plan for control of *M. calvescens* on Maui, obtained meaningful funding, and initiated aggressive control. Beginning in 1995, a Melastome Action Committee was set up on the island of Hawaii and quickly became effective in organizing mapping and control efforts and lobbying for funding. Efforts on Oahu and Kauai, where *M. calvescens* is less widespread, are being handled successfully by the combined efforts of State agencies (HDOA and the Oahu District DLNR) and volunteers.

It is clear that the relatively early stage of detection and control on Oahu and Kauai should result in substantial savings in the cost of control. Low level helicopter reconnaissance is an important tool for locating remote populations. Public education (wanted posters, newspaper stories, public service announcements) has been important in locating new *M. calvescens* populations, aided by the distinctive appearance of the plant. "Operation Miconia", a state-wide interagency public education and involvement effort in

April 1996, used hotlines, reporting forms, and agency followup for surveillance (Tanji, 1996).

Infestations of *M. calvescens* are controlled using mechanical and chemical means. Ground crews uproot smaller plants entirely or cut down larger plants and chemically treat the stumps. Herbicidal control (Garlon® 4, DowElanco, Indianapolis, Indiana) of canopy trees with a helicopter is an innovative and effective technique (Medeiros & Loope, unpubl. data). Control efforts involving volunteers must be balanced with the appreciable risk of spreading *M. calvescens* seeds in mud on boots, by equipment, etc. Because of persistent seed banks, all areas where *M. calvescens* has been found and removed must be rechecked periodically for newly germinated individuals.

Worldwide success of biological control of invasive plants has had mixed results; assessments suggest that success occurs in 20–40% of cases (Julien, 1982; Hobbs & Humphries, 1995). Despite this, initial exploration of the native range of *M. calvescens* has yielded numerous potential biocontrol agents (R. Burkhart, HDOA, pers. comm.). Of these, fungal pathogens currently appear most promising. At the end of 1996, a proposal for release of *Colletotrichum gloeosporoides* f. sp. *miconiae* was submitted to the Hawaii Department of Agriculture.

If biological control is developed successfully, substantial effects on the growth and reproduction of *M. calvescens* are at least a decade away. Pending further developments, mechanical and chemical control are the most promising methods of containing and potentially eradicating invasive populations of *M. calvescens* in the Hawaiian Islands.

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New and Noteworthy Cyperaceae from the Hawaiian Islands[1]

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Since the preparation of a treatment of the indigenous and naturalized Cyperaceae of the Hawaiian Islands by Koyama in 1987 for publication in the *Manual of the flowering plants of Hawai'i* (Koyama, 1990) a number of new distribution records as well as several additional naturalized species have been collected. Some of them were apparently inadvertently overlooked by Koyama, while others represent focused collecting efforts after publication of the *Manual* in 1990. In this paper we report on them, give descriptions, and provide couplets that can be integrated with the keys published in the *Manual.* The arrangement of the species is alphabetical within each genus. The descriptions are adapted from relevant literature cited under each species and examination of specimens.

This paper reports new archipelago and island records for the sedge family (Cyperaceae) and clarifies one taxonomic problem. We report 7 species never recorded before from the Hawaiian Islands, which were found in study of unidentified material in 2 major Hawaiian collections (BISH, US), and through field collections. They are: *Carex longii, Eleocharis olivacea, E. schaffneri, Fimbristylis ferruginea, F. miliacea, Rhynchospora radicans* subsp. *microcephala,* and *Schoenoplectus mucronatus.* We include descriptions and keys for 4 additional species. Three of these, *Cyperus confertus*, *C. cyperoides*, and *Schoenus apogon*, were previously incidentally reported as new naturalized species in the Hawaiian Islands (Herbarium Pacificum Staff, 1996). The fourth, *Cyperus prolifer*, previously know only from cultivation in the islands, is here reported as a new naturalized species on Kauai. Additional collecting since 1987 has resulted a in new island distribution record for *Cyperus rotundus*. We also report a taxonomic change in *Cyperus* and a verification of naturalized status for *Cyperus esculentus*.

All identifications are by M. Strong except as noted. Island abbreviations found in the keys follow Wagner *et al*. (1990).

Carex

Carex longii Mackenzie **New state record**

Originally reported as *Carex ovalis* Gooden by Fosberg & Sachet (1975) based on a collection from the island of Hawai'i [Kohala Mountains, Kahua Ranch, 1000 m, 2 August 1956, *Rubtzoff 2720* (US)]. By the time the *Manual of flowering plants of Hawai'i* went to press in early 1988, this specimen could not be located to verify the identification, and no other collections from the Hawaiian Islands were then known. Thus it was included by Koyama (1990: 1387) as a short note. Since then, this collection was found in the unmounted Polynesian backlog at US, and several other specimens were found at BISH in the undetermined Cyperaceae folder which were inadvertently not examined by Koyama. A. Reznicek identified the plant as *Carex longii*, a widespread, New World

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species that is now becoming naturalized in the Pacific (Hawaiian Islands and New Zealand). *Carex longii*, now known from a number of localities in the Hawaiian Islands, has unquestionably become part of the naturalized flora. It occurs on Hawai‘i from Waimea Reservoir, South Kohala District, south to Honoaunau Forest Reserve, South Kona District, and was recently collected on East Maui.

The following couplets can be used in conjunction with the key in the *Manual* provided by Koyama (1990: 1387). Insert at couplet 4.

4(3). Perigynium (1.5–)2.5–3.5 mm long, base cordate, edges not winged; spikes spicately disposed, the lowermost remote; leaves filiform, 0.8–1(1–1.5) mm wide; K, M, H ..... **C. echinata**

4. Perigynium 3–4.5 mm long, base cuneate, wing-margined; spikes crowded at culm tips; leaves linear 1–4 mm wide (**4a**).

4a(4). Inflorescence capitate, 1–2 cm long; perigynia 1.5–1.7 mm wide, spreading; inner band of leaf sheath scarious, hyaline, obscurely veined; M, H .... **C. macloviana**

4a. Inflorescence moniliform-spicate, 3–5 cm long; perigynia 1.7–2.5 mm wide, closely appressed; inner band of leaf sheath green, herbaceous, prominently veined; EM, H ..... **C. longii**

Carex longii can be distinguished from other species of *Carex* in the Hawaiian Islands by the terminal moniliform-spicate inflorescence with ascending, closely appressed perigynia and green, herbaceous, prominently veined inner bands of the leaf sheaths. It can be characterized as follows: Densely tufted perennial, forming small to medium sized clumps; culms sharply triangular, (15–) 30–80 (–120) cm tall, scabrous on angles just below the inflorescence. Leaves linear, flat, usually shorter than the culms, 1.5–4 mm wide; sheaths pale green, closely surrounding the culm, the inner band green, herbaceous, prominently veined. Inflorescence a narrowly ovoid to oblong-ovoid, head-like cluster of (2–) 3–10 (–11) spikes, the axis usually obscured, the spikes silvery green to silvery brown, ovoid, 7–11 cm long, 5–8 mm wide, gynecandrous, sessile; bracts short; pistillate glumes pale brown or reddish brown, membranaceous, ovate, shorter and narrower than their perigynia, the apex obtuse to subacute. Perigynium membranaceous, pale brown, ascending, the beaks appressed, elliptic to rhombic, widest near the middle, 3–4.5 mm long, 1.7–2.5 mm wide, prominently several nerved, margins narrowly winged, scabrous toward the apex, the apex gradually narrowed to a beak ca. 1 mm long, the beak deeply bifid on dorsal side, shallowly 2-toothed on ventral side; stigmas 2. Achenes ovoid, lenticular, substipitate. Literature used in preparing description was Correll & Johnston (1970), Standley & Steyermark (1958), and Fernald (1950).

Carex longii is native to North America, from Canada (Great Lakes Region and the Maritime Provinces) to New England , south to Florida and Texas. Sporadic throughout Mexico, Central America, the West Indies, and Andean South America, and naturalized in the Hawaiian Islands since at least 1956 and in New Zealand since 1949 (Healy & Edgar, 1980).

Additional material examined. MAUI: East Maui, West Wailuaiki along ditch rd., 1981, *Hobdy 1094* (BISH); East Maui, Lower Kipahulu Valley, below Puu Ahuula, 1 mi NW of Kipahulu Village, 19 July 1980, *Canfield & Stemmermann 791* (MICH). HAWAI'I: Kona, July 1964, *Carlson s.n.* (BISH); Honoaunau Forest Reserve, S. of jeep rd., 1400 m. July 1970, *Herbst 1705* (BISH); muddy pasture SW of Waimea Reservoir, 9 September 1986, *Stemmermann 7106* (BISH, US); South Kona District, Kealakekua Ranch, Kealakekua ahupua'a, road to Papaloa, 1030 m, 11 March 1988, *Wagner et al. 5955, 5958* (BISH, US).

Cyperus

In the genus *Cyperus* we report 3 new state records, new island records for another 2 species, and discuss a taxonomic change for another species. We use a broad circumscription of the genus here including *Mariscus* following the recent trend among specialists in the family (e.g., Tucker, 1994). Two of the species included here, *C. confertus* and *C. cyperioides,*were mentioned as new records earlier by the Herbarium Pacificum Staff (1996), but they did not include keys or descriptions.

Cyperus confertus Swartz (syn.: *Mariscus confertus* (Swartz) C.B. Clarke)

The single collection of this species apparently was from a naturalized population, but the extent of its distribution in the Hawaiian Islands is not known. The following couplets can be used in conjunction with the key in Koyama's treatment (1990: 1415), and should be inserted in key to *Mariscus* at couplet 4:

4(2). Spikes globose-ovoid or broadly ovoid to hemispherical with an abbreviated rachis; spikelets appearing fascicled (**4a**.)

4. Spikes cylindrical to oblong-cylindrical with an elongated rachis; spikelets spicately disposed (**5**).

4a(4). Glumes ovate, 2.2–2.5 mm long, stramineous or yellowish, apex cuspidate, awned; mature achenes obovate, 1–1.2 mm long, blackish, puncticulate; H... ..... **C**. **confertus** (**M**. **confertus**)

4a. Glumes oblong-lanceolate or oblong-elliptic, 2.7–3.5 mm long, reddish brown, apex acute; mature achenes oblong-obovoid, 1.2–1.5 mm long, brown, smooth; O ..... **C**. **congestus** (**M**. **congestus**)

Cyperus confertus can be characterized as follows: Plants perennial, variable in size. Culms tufted or solitary, (2–)6–50(–65) cm tall, (0.5–)1–2(–2.5) mm wide, trigonous, smooth, forming small cormlike enlargements at base with age. Leaves 2–4, all basal or rarely 1/3 of the way up the culm; blades linear, 3–35 cm long, (0.5–)1–5(–7.5) mm wide, thinly herbaceous, soft, gradually acuminate at apex; sheaths tinged with brownish purple. Inflorescence umbelliform, simple, congested in a head in poorly developed individuals; involucral bracts 2–5, elongate, leaflike, 2–3 times as long as the inflorescence; rays 2–5, patent, 1–9(–13) cm long, slender; prophylls ca. 5 mm long, straw-colored, purplish tinged, the orifice shallowly 2-toothed. Spikes globose-ovoid, densely bearing (5–)8–20(–30) spikelets on an abbreviated axis, 10–15 mm long and 10–15 wide, straw-

colored or light stramineous-brown. Spikelets divergent, jointed at base, oblong-lanceolate, 6–10 mm long, 2.0–2.2 mm wide, compressed, straw-colored, 6- to 18-flowered; rachilla very narrowly winged; glumes ovate, 2.2–2.5 mm long, 1.8–2 mm wide, thickly membranaceous or thinly herbaceous, straw-colored or light yellowish brown, 3- or 4-nerved on both sides, gradually narrowed from above the base toward a 3-dentate apex, the costa wide, green, projected beyond the apex into a slightly excurved cusp 0.3 mm long. Stigmas 3. Achenes oblong-obovate, 3-angled, 1.0–1.2 mm long, 0.7–0.8 mm wide, blackish, puncticulate, tapering at base, contracted above to mucronulate apex. Literature used in preparing description was Koyama (1979).

Cyperus confertus is indigenous to the West Indies, Venezuela, Colombia, and Galapagos Islands.

Material examined. HAWAI'I: South Kona, Lava field inland of Kapua Bay, 7 Oct 1986, *Stemmermann 7125* (BISH).

Cyperus cyperoides (L.) O. Kuntze (syn.: *Mariscus sumatrensis* (Retz.) J. Raynal).

This species was reported by Kükenthal (1935–1936) from the Hawaiian Islands based on a specimen collected by Hillebrand. However, efforts by Scanlan (1942) to locate this specimen were unsuccessful and thus this species was not included by Koyama (1990). We recently noted a single naturalized collection made in 1936. The current status of this species is not known. The following couplets can be used in conjunction with the key in Koyama's treatment (1990: 1416) to distinguish *Cyperus cyperoides* from other species in the Hawaiian Islands. Insert in key at couplet 11:

11(6). Glumes folded, the keel acute; spikelets flattened, brown; bearing 1–2 fertile glumes; HI exc. Ka ..... **C. pheloides** (**M. pheloides**)

11. Glumes involute, embracing upper glumes, the keel rounded; spikelets filiform, green, bearing 2–3 fertile glumes (**12**)

12(11). Spikes cylindrical, on peduncles up to 6 cm long; mature spikelets spreading, at right angles to the culm or reflexed; fertile glumes 1 or at most 2; achenes linear-oblong, 0.6 mm wide; H ..... **C. cyperoides** (**M. sumatrensis**)

12. Spikes obovate, sessile or on short peduncles up to 2 cm long; mature spikelets suberect, crowded; fertile glumes at least 2; achenes oblong-ellipsoid, 0.8–0.9 mm wide; K, O, Mo ..... **C. cyperinus** (**M. cyperinus**)

Cyperus cyperoides can be characterized as follows: Perennial with very short woody rhizome clothed with brown fibers. Culms solitary or few together, erect, triquetrous, 10–75 cm tall, 1–3 mm wide, smooth, the thickened base clothed with the remains of old leaf sheaths. Leaves shorter than to equaling the culm; blades linear, 3–6 mm wide, flattish plicate, herbaceous; sheaths pale, the lower eventually becoming brownish or reddish brown. Corymbs simple, rarely compound, open, 3–8 cm wide; rays 3–7, obliquely patent, the longer ones up to 6(–10) cm long, terminated by a spike; spikes cylindrical, 1.0–2.5 cm long, 6–10 mm wide, densely bearing many spikelets, greenish; involucral bracts 3–8, the lower ones surpassing the corymb. Spikelets spreading or the

lower ones usually reflexed, linear-lanceolate, 3–5 mm long, 0.5–1 mm wide, bearing 4 or 5 glumes, 1- or 2-fruited; rachilla straight, jointed above the base, with white-hyaline, lanceolate wings; glumes oblong-lanceolate, obtuse or mucronulate at apex, 3–3.5 mm long, ca. 1 mm wide, margin inrolled, herbaceous, pale green, faintly several nerved, the keel 3-nerved, forming an obtuse back. Stigmas 3. Stamens 3. Achenes 3-angled, linear-oblong, 1.7–2.3 mm long, 0.5–0.6 mm wide, rufous to castaneous, minutely puncticulate. Literature used in preparing description was Koyama (1979) and Kern (1974).

Cyperus cyperoides is widespread from Africa to Asia, Malesia, and Australia, primarily in tropical and subtropical regions. In the New World, it has become naturalized in the West Indies.

Material examined. HAWAI'I: Kawaihae, Kohala, 1500 ft, 31 August 1936, *Hosaka 1558* (BISH).

Cyperus esculentus L. **Rediscovery**

This species was previously known from only a single collection from Onomea, Hawaii in 1956 (Koyama, 1990: 1396), and was thought to perhaps no longer persist in the Hawaiian Islands. Based on one recent collection, it is now known to be at least sparingly naturalized in the Hilo area.

Material examined. HAWAI'I: Hilo, April 1984, *Stemmermann 6889* (BISH).

Cyperus involucratus Rottb. **Nomenclatural and taxonomic change**

Baijnath (1975) has shown that there is an earlier name, *C. involucratus*, for the widely naturalized plant known as *Cyperus alternifolius* L., *C. flabelliformis* Rottb., or *C. alternifolius* subsp. *flabelliformis* Kük. He showed that there are a number of characters that separate *C. alternifolius*, which is relatively rare in Madagascar and Reunion, from *C. involucratus* Rottb. (syn. *C. flabelliformis* Rottb., nom. superfl.), which is indigenous to Africa, and widely cultivated and naturalized around the world. Kükenthal (1935–1936) intended to make a new combination based on *C. flabelliformis* Rottb., but because it is an illegitimate name based on the same type as that of *C. involucratus* he actually proposed a new name (*C. alternifolius* subsp. *flabelliformis* Kük.) with the same type as that of *C. involucratus*, which is an acceptable and legitimate name for *C. involucratus* at the subspecies level. Baijnath's study, however, suggests that because there are a number of non-overlapping morphological differences, and distinct geographical ranges for these two taxa, that they should be treated as separate species, *C. alternifolius* and *C. involucratus*.

Cyperus prolifer Lam. **New naturalized record**

This species has been cultivated in the Hawaiian Islands, and is here reported as at least sparingly naturalized on Kaua'i. The synonyms *Cyperus aequalis* Vahl, *C. isocladus* Kunth, and *Cyperus prolifer* var. *isocladus* (Kunth) Kük. have often been used for this species in the literature. The following couplets will distinguish *Cyperus prolifer* from

other *Cyperus* species in the Hawaiian Islands. Insert in key to *Cyperus* at couplet 7 (Koyama, 1990: 1394):

7(6). Leaves at culm bases reduced to bladeless sheaths (**7a**).
7. Leaves at culm bases with blades (**8**).
7a.(7). Involucral bracts exceeding the length of the rays, 10–35 cm long, 3–20 mm wide; K, Mi ..... **C. involucratus**
7a. Involucral bracts shorter than the rays, 0.5–3 cm long, 1–3 mm wide; K ... . **C. prolifer**

Cyperus prolifer can be distinguished from other species of *Cyperus* on the Hawaiian Islands by the spreading umbelliform inflorescence with approximate rays. *Cyperus prolifer* can be characterized as follows: Perennial with stout creeping rhizome, roots blackish brown or purplish. Culms crowded, erect, terete or triangular, glabrous, 25–110 cm long, 2–7 mm wide. Leaves reduced to bladeless sheaths; sheaths ferrugineous to dark purple, glabrous, the apex mucronate. Inflorescence open, umbellate, 10–20 cm in diameter with elongate rays, often forming secondary culms 8–25 cm long topped by a new smaller inflorescence, the main rays 50–100 per culm, 4–10 cm long, all of subequal length, each bearing a 5–8 mm long reddish brown prophyll at the base, the spikelets borne in digitate, sessile clusters at ray tips or in clusters on slender raylets with 1 to several sessile spikelets at base. Spikelets linear, 3–12 mm long, 1–1.4 mm wide, 7–25 flowered, reddish brown; glumes oblong-ovate, 1.2–1.5 mm long, obtuse or mucronulate at apex. Stamens 3; anthers spinescent. Achenes obovate, trigonous, 0.4–0.5 mm long, 0.3–0.4 mm wide, maturing pale brown, smooth to minutely papillose. Literature used in preparing description was Haines & Lye (1983).

Cyperus prolifer is native to southeastern Africa, ranging north along the east coast to Kenya. It primarily occurs in coastal habitats on the mainland and on offshore islands. It has been reported to have escaped cultivation in central Florida where it is now apparently recently naturalized and invasive (Carter *et al.,* 1996).

Material examined. KAUA‘I, Wahiawa Mountains, Wahiawa Bog (Kanaele Swamp), ca. 2100 ft, 7 September 1983, *Flynn 590* (BISH, US).

Cyperus rotundus L. **New island record**

This species was reported by Koyama (1990: 1399) from Kure and Midway Atolls and all of the main Hawaiian Islands except Kaho‘olawe and Moloka‘i. Here we report a naturalized record from French Frigate Shoals.

Material examined. FRENCH FRIGATE SHOALS: Tern Island, June 1988, *Herbst & Takeuchi 9053* (BISH)*, Herbst & Takeuchi 9076* (BISH).

Eleocharis

Two species, *Eleocharis olivacea* and *E. schafferii* have not been previously reported from the Hawaiian islands. The following couplets can be used in conjunction with the key provided by Koyama (1990: 1402) to distinguish them from other Hawaiian species.

Insert in key to *Eleocharis* at couplet 3:

3(1). Apex of the sheath not hyaline, firm, with oblique orifice (**4**)
3. Apex of the sheath hyaline, membranaceous or scarious (**6**)
4(3). Stolons present; spikelets lanceoloid to narrowly ovoid, acute; style base spongy; Ni, O, Ka ..... **E. calva**
4. Stolons absent; spikelets ovoid to broadly ovoid-ellipsoid, obtuse; style base not or slightly spongy (**5**).
5(4). Achenes brown at maturity; style base deltoid, nearly as wide as the achene; K, O, Mo, M, H ..... **E. obtusa**
5. Achenes black at maturity; style base depressed-conical, up to 1/3 as wide as the achene or slightly wider; K, O, Mo ..... **E. geniculata**
6(3). Spikelets ovate, subacute, 2–3 mm long; scales broadly ovate, obtuse to acute; achene olive-green, 0.7 mm long, the surface with longitudinal black striations; style base small, depressed-conical; K ..... **E. schaffneri**
6. Spikelets ellipsoid to oblong-ovoid, acute, 3–7 mm long; scales ovate; achene olive to dark brown, 0.8–1 mm long, the surface puncticulate; style base elongated, with conic-subulate center; H ..... **E. olivacea**

Eleocharis olivacea Torrey **New state record**

This species could have been introduced by migrating waterfowl, but the eastern North American indigenous distribution argues perhaps more for inadvertent introduction by humans on the muddy shores of the Wailuku River.

Eleocharis olivacea can be characterized as follows: Plants perennial. Culms tufted or scattered on filiform stolons, often decumbent, light green, compressed-filiform, soft, somewhat spongy, 0.5–4 dm long, 0.5–1 mm wide. Upper leaf sheaths hyaline, loose. Spikelets oblong-ovoid, 4–9 mm long, 1.5–2.2 mm wide, acute; glumes with brown to reddish sides and green midrib, ovate to ovate-oblong, 1.5–2.5 mm long, ca. 1 mm wide, the outer with rounded apex. Stigmas 2. Achenes olive to dark brown, lustrous, puncticulate, obovoid, biconvex, 0.8–1 mm long, the style base conical, 1/4 as wide as the achene, sometimes prolonged into a subulate beak; bristles 6–8, green or whitish, opaque or semi-translucent, exceeding the achene, retrorsely spinulose. [2n = 20.] Literature used in preparing description was Svenson (1929).

Eleocharis olivacea is native in the United States along the Atlantic Coastal Plain from Nova Scotia south to Florida, locally inland from Maine to southern Ontario and Minnesota south to Pennsylvania, Ohio, and Michigan.

Material examined. HAWAI‘I: Wailuku River, 12 mi W of Hilo, 1200 m, 8 September 1980, *Fosberg 60578* (US).

Eleocharis schaffneri Boeck. **New state record**

This species can be characterized as follows: Plants annual. Culms tufted, light green, capillary, setaceous, spreading, sulcate, 3–5 cm long, 0.6–0.8 mm wide. Apex of upper leaf sheaths hyaline. Spikelets ovate, 3–4 mm long, 2 mm wide, subacute; glumes

green, frequently with light red or bronze sides, broadly ovate, obtuse or acute, 1.5–1.7 mm long, 0.7–0.8 mm wide. Stigmas 2. Achenes olive green with longitudinal black striations, obovoid, biconvex, 0.7 mm long, the style base very small, depressed-conical, 1/4 as wide as the achene; bristles 6 or 7, white, somewhat shorter than the achene, retrorsely spinulose. Literature used in preparing description was Svenson (1929).

Eleocharis schaffneri is native to southern Mexico, Honduras, Nicaragua, and Costa Rica. It was perhaps inadvertently introduced into the Hawaiian Islands by humans; however, habitat in wetland sites visited annually by a variety of migrating birds does not rule out natural introduction.

Material examined. KAUA'I: Hanalei Dist., National Wildlife Refuge, Hanalei Valley, in taro paddies, 9 May 1989, *Texeira s.n.* (US); Hanalei National Wildlife Refuge, 10 m, growing in water of taro paddies, 11 June 1990, *Wagner & Flynn 6347* (US), 8 Oct. 1991, *Flynn et al. 4749* (US).

Fimbristylis

Fimbristylis ferruginea (L.) Vahl **New state record**

The following couplets can be used in conjunction with the key in the *Manual* provided by Koyama (1990: 1404). Insert at couplet 3:

3(1). Achenes coarsely to finely reticulate; lower bracts usually longer than the inflorescence; inflorescences simple, compound, or decompound, bearing numerous spikelets (**3a**)

3. Achenes minutely reticulate-puncticulate; lower bracts shorter to slightly longer than the inflorescence; inflorescence simple, bearing 1–5 spikelets (**4**)

3a. Scales glabrous; achenes coarsely reticulate with usually (5–)7–9(–12) rows of horizontally oriented, rectangular cells; K, O, Mo, M, H ..... **F. dichotoma**

3a. Scales with dense, silvery, short appressed hairs distally; achenes finely reticulate with usually 25–35 rows of isodiametric cells; O ..... **F. ferruginea**

Fimbristylis ferruginea can be characterized as follows: Perennial with short, stout rhizomes. Culms tufted, obscurely angled, subterete towards base, compressed near apex, to 1 m tall, 1.5–3 mm wide at base, many-ribbed, glabrous. Leaves 3–6; blades flat to involute, to 4 dm long, 1–2 mm wide, light green to brown, glabrous, scabrous on margins, abaxial side distinctly nerved, adaxial side smooth, spongy-thickened, the apex acute; sheaths prominently nerved on back, pale green, ligulate at adaxial base of blade, with a horizontal band of pale, appressed hairs, 0.3–0.4 mm wide, the wide, membranous inner band ferrugineous to reddish brown, minutely red speckled, with a U-shaped orifice, sometimes convex to truncate on upper leaves, ciliate at apex. Inflorescence a simple or rarely compound, dense or sometimes subcapitate cyme, 2–4 (–7) cm in diameter; involucral bracts (2–) 3–6, flattened to subinvolute, to 7 cm long, 0.8–1.4 mm wide, scabrous on margins, shorter than to exceeding the inflorescence; rays compressed, short, 0.6–1 mm wide, finely ribbed. Spikelets (1–) 3–12, broadly to narrowly ovate, 0.6–1.2 cm long, 3–5 mm wide. Scales ovate to oblong-ovate, boat-shaped, 3.5–4 mm long, ca. 3 mm wide, 1-nerved medially, lateral nerves indistinct, pale reddish brown except for the green or grayish green median band, with dense, silvery, short appressed hairs distally, ciliate along

upper margin, the pale, narrow midrib ending in a short cusp at the obtuse to rounded apex. Stamens 3; anthers linear, ca. 1 mm long, bluntly apiculate at apex. Styles 2-branched, the branches 1/4 to 1/3 the length of the style, the unbranched portion flattened, 0.4–0.5 mm wide, fimbriate along the margins from base to apex. Achenes biconvex, obovoid, 1.5–1.7 mm long (including stipitate base), 1.1–1.2 mm wide, obtuse to truncate at apex, bluntly apiculate, stramineous to pale brown, finely reticulate with 25–35 rows of isodiametric cells. Literature used in preparing description was Strong (1996).

Fimbristylis ferruginea has a Pantropical distribution.

Material examined. O'AHU: Kahuku, near Kuilima, (Puna Ho'olopo Marsh), N edge of marsh, 1 October 1984, *Whistler s.n.* (BISH); James Campbell National Wildlife Refuge, Kahuku, in vicinity of bird-viewing gazebo, ca. 10 ft., 5 April 1992, *Imada et al. 92–27* (BISH); Kahuku, Punahoolapa Marsh, growing in wetland, 11 June 1992, *Engilis & Reid 92–24* (BISH, US).

Fimbristylis miliacea (L.) Vahl **New state record**

This species has not been reported previously in the Hawaiian Islands and was apparently overlooked by Koyama (1990) when he prepared his treatment of Hawaiian Cyperaceae. *Fimbristylis miliacea* was perhaps inadvertently introduced by humans; however, habitat in wetland sites visited annually by a variety of migrating birds does not rule out natural introduction. It appears to be well established on Kaua'i.

The following couplets can be used in conjunction with the key in the *Manual* provided by Koyama (1990: 1404). Insert at couplet 1:

1. Styles not or scarcely flattened, the margins glabrous or ciliolate, not fimbriate; spikelets 2–6 mm long (**1a**)
1. Styles strongly flattened, the margins conspicuously fimbriate; spikelets 4–14 mm long (**3**)
1a(1). Upper leaves at base of culm reduced to bladeless sheaths; leaves laterally compressed; spikelets subglobose; K ..... **F. miliacea**
1a. Upper leaves at base of culm with blades; leaves not laterally compressed; spikelets ovoid, oblong-ovoid, ovoid-ellipsoid or cylindrical (**2**)

Fimbristylis miliacea can be characterized as follows: Plants annual. Culms densely tufted, 10–60 (–80) cm tall, 1–3 mm wide below, slender, rigid, flattened, or somewhat 4-angled toward base, often with a double margin along each edge, light green, glabrous, clothed at base with 2 or 3 bladeless sheaths. Leaves of sterile leaf shoots equitant, distichous; blades laterally compressed in transverse section, linear, rigid, glabrous, smooth except on spinulose scabrous upper margins, tapering evenly from wide, clasping sheaths to subacute apex; basal sheaths laterally flattened with a sharp dorsal edge. Infloresence compound or decompound, composed of dense to loose system of cymes bearing many spikelets; involucral bracts 2 to 4, setaceous, 1/2 to 1/3 the length of the rays; rays 3 to 7, unequal, patent, 1–5 cm long, scabrous; spikelets solitary, ovoid-globular to globular, 1.5–3(–5) mm long, 1.5–3 mm wide, both ends rounded; glumes pale to reddish brown, membranaceous, ovate, broadly white hyaline on the margins, the midrib green or yellowish, rarely excurrent. Style slender, not fimbriate, 0.5–0.7 mm long, pyramidal at base;

stigmas 3. Achenes pale brown or cream-yellow, obovoid, trigonous, rounded to an apiculate apex, 0.6–0.8 mm long, 0.35–0.5 mm wide, conspicuously cancellate with 5–7 rows of fine, transversely linear-oblong cells, the longitudinal ribs frequently prominent and sparsely verruculose, the base cuneate. Literature used in preparing description was Kral (1971).

Fimbristylis miliacea occurs in both the New and Old World. In the New World, it occurs from the eastern and southern United States west along the Gulf into Texas, south throughout the West Indies, Central America, and South America. In the Old World it occurs from Asia eastwards through Malesia and many Pacific Islands.

Material examined. KAUA'I: Hanalei District, U.S. Fish and Wildlife Reservation, Hanalei Valley, in and around taro patches, 3 m, 18 July 1977, *Herbst 5952* (BISH, US); Mauka Reservoir, W of tree tunnel on Maluhia Rd., in mud flats at NE end of reservoir, 26 September 1985, *Flynn 1237* (BISH, PTBG, US); Waimea District, Hanapepe Valley, Hanapepe River at cement crossing between Ko and Awawa Roads, 5 May 1987, *Flynn & Lorence 2183* (BISH, PTBG, US); Hanalei Bridge, taro field along rd., near sea level, 31 March 1988, *Wagner & Lorence 5998* (BISH, US); National Wildlife Refuge, Hanalei Valley, in taro paddies, 9 May 1989, *Texeira s.n.* (US).

Rhynchospora

Rhynchospora radicans (S. & C.) Pfeiff. subsp. ***microcephala*** (Bertero ex Spreng.) W. Thomas **New state record**

This taxon has not been reported previously from the Hawaiian Islands. It appears to be at least sparingly naturalized in cultivated lands in Puna District, Hawai'i. It was initially described as a species of *Dichromena* (*D. microcephala* Bertero ex Spreng.). Citing close similarities to *Rhynchospora* in characters of the stigma and style, Thomas (1984) showed that *Dichromena* Michx. is better placed under *Rhynchospora* as a section. In his monograph of *Rhynchospora* sect. *Dichromena*, he treated *Dichromena microcephala* as a subspecies of *Rhynchospora radicans* (S. & C.) Pfeiff., arguing that "both geographically and morphologically, these two taxa seem to form two ends of one cline." Not only is this record a new one for the Hawaiian Islands, it also represents the first record of this species occurring outside its indigenous range. Because of its occurrence in agricultural land rather than near areas visited by migrating waterfowl this species was probably introduced to the Hawaiian Islands inadvertently by humans. The following couplet can be used in conjunction with the key provided by Koyama (1990: 1428). Insert at couplet 1:

1. Inflorescence a single head of 3–6 spikelets at apex of the culm; H ..... **R. radicans** subsp. **microcephala**

1. Inflorescence bearing 1–9 simple, compound, or decompound partial panicles (**1a**).

1a.(1). Inflorescence bearing 5–9 large, decompound partial panicles; leaves (5–) 7–18 mm wide; HI exc. Ni & Ka ..... **R. sclerioides**

1a. Inflorescence bearing 1–5 small, simple to compound or decompound, corymbiform partial panicles; leaves 1.5–6 mm wide (**2**).

Rhynchospora radicans subsp. *microcephala* can be characterized as follows: Annual or short lived perennial, primarily glabrous; culms caespitose, arching to erect, 10–60 cm tall, 1–2 mm in diameter, triquetrous to obtusely so. Leaves (2–) 3–4 (–5), primarily cauline or from sterile shoots, a few basal; blades herbaceous, linear, 1.4–5 mm wide, to 30 cm long, flat to slightly involute, nerved, especially abaxially, often ciliate marginally at base, the basal leaves when present usually with reduced blades or bladeless sheaths, occasionally with blades to 10 cm long and 3 mm wide; inner band of leaf sheath herbaceous with concave orifice, hyaline only at apex. Inflorescence a conical to hemispherical head of 3–6 spikelets, 1–1.5 cm in diameter, the central spikelet largest; involucral bracts (3–) 4–5, leaflike, spreading to reflexed, exceeding the inflorescence, ciliate basally along margins, the basal bract longest, 4–15 cm long, 1.5–4.5 mm wide; spikelets 7–12 mm long, 2–4.3 mm wide; scales ca. 20–30, ferrugineous, ovate, 4.2–5.2 mm long, 1.8–3.6 mm wide, boat-shaped, weakly carinate distally; stamens 3; perianth bristles absent; style 2-cleft to about the middle, the base very shallowly triangular to shallowly lunate, 0.1–0.4 mm high, 0.6–1.2 mm wide, brownish to stramineous or greenish. Achene stramineous to brownish orange or bony white, very widely obovate, 0.9–1.2 mm long, 0.8–1.4 mm wide, biconvex, bilaterally symmetrical, transversely rugulose on both sides. Literature used in preparing description was Thomas (1984).

Rhynchospora radicans subsp. *microcephala* is indigenous to the West Indies, Central America, western South America, and sporadically to the Guianas and Amapá, Brazil.

Material examined. HAWAI'I: Puna Dist., 0.4 mi. NW of Lava Tree State Monument, edge of abandoned cane field, ca. 180 m, 19 August 1992, *Wagner 6761* (US), *Kiehn & Luegmayr 920819-2/1* (BISH, PTBG, WU).

Schoenoplectus

Schoenoplectus mucronatus (L.) Pallas **New state record**

This species has not been reported previously from the Hawaiian Islands. Based on its occurrence in old agricultural land this species is presumably a recent inadvertent introduction by humans. The following couplets can be used in conjunction with the key provided by Koyama (1990: 1431) to distinguish this species from other Hawaiian species of the genus.

1. Inflorescence a head without elongate rays; culms 15–100 cm tall (**3**)
1. Inflorescence with elongate rays; culms usually 70–380 cm tall (**2**)
3(1). Culms 3-angled with plane or concave sides, stout, (2–)3–10 mm wide; H ..... **S. mucronatus**
3. Culms subterete or rarely obtusely angled, slender, 1–4 mm wide; K, H ..... **S. juncoides**

Schoenoplectus mucronatus can be characterized as follows: Plants perennial with short rhizomes. Culms tufted, rather stout, stiff, erect, sharply 3-angled, the sides usually concave, smooth, 0.5–1.0 m tall, (2–)3–8 mm wide. Leaves reduced to 1–2 bladeless sheaths, membranaceous, pale green to brownish, up to 7–20 cm long, often septate-nodu-

lose, the lowest somewhat scalelike. Inflorescence pseudolateral, consisting of a single capitate cluster of (2–)4–25 spikelets, up to 4 cm across; involucral bracts 3-angled, erect in anthesis, becoming divergent to reflexed with age, 1–10 cm long. Spikelets stramineous to brownish, sessile, 10–20 mm long, 4–6 mm wide, densely many flowered, base rounded, apex acute; glumes yellowish brown, ovate to ovate-orbicular, membranaceous, tightly appressed, 2.8–4 mm long, 2–3 mm wide, minutely ciliolate along the upper margin, midrib prominent, sides many-nerved, apex acute, short-mucronulate. Stigmas 3, but often 2 in some flowers. Stamens 3; anthers linear, cuspidate, 1–1.8 mm long. Achenes at maturity blackish brown to black, glossy, broadly obovate, plano-convex or subtrigonous, dorsoventrally compressed, 2–2.2 mm long, 1.8–2 mm wide, appearing smooth, but obscurely transversely wrinkled, apex mucronate; bristles 5–6, stout, unequal, slightly surpassing to distinctly longer than the achene, retrorsely scabrous. Literature used in preparing description was Kern (1974).

Schoenoplectus mucronatus is indigenous to tropical Africa, southern Europe to southern Asia, Japan, Malesia, Philippine Islands, and Australia; and naturalized in the United States.

Material examined. HAWAI'I: muddy area just SW of Waimea Reservoir, September 1986, *Stemmermann & Jacobsen 7105* (BISH, US).

Schoenus

Schoenus apogon Roem. & Schult.

We have seen a single Hawaiian collection representing the first record of this genus from the Hawaiian Islands, and almost certainly an inadvertent introduction by humans, judging from the habitat of the single locality. The following couplet can be used in conjunction with the generic key provided by Koyama (1990: 1383) to distinguish it from other genera occurring in the Hawaiian Islands. This species was mentioned as a new record previously by the Herbarium Pacificum Staff (1996), but they did not include keys or descriptions.

12(11). Styles distinctly jointed at base, the style base conical or subulate, persistent on achene; stigmas 2 or almost undivided ..... **Rhynchospora**

12. Styles continuous with achene, not forming a distinctive style base; stigmas 2–3 or more (**12a**).

12a(12). Length of the lower internodes of the rachilla very short between the empty glumes, the upper ones elongated and zigzag between the flower-bearing glumes ..... **Schoenus**

12a. Length of the lower internodes of the rachilla not conspicuously different than those of the upper ones (**13**).

Schoenus apogon can be characterized as follows: Tufted perennial, slender. Culms filiform, 5–25 cm long, ribbed, 1–3 nodose below the inflorescence. Leaves primarily basal, few cauline, linear-setaceous, canaliculate, shorter than the culms, 2–10(–15) cm long, 0.5–0.8 mm wide; sheaths of the cauline leaves narrowly tubular, unbearded at apex,

entirely purplish or purplish at base only, 1–2 cm long. Inflorescence dense, subcapitate, consisting of 2–5 loose or dense sessile or pedunculate fascicles of spikelets, both terminal and lateral from the upper leaf sheaths, aggregated or distant; involucral bracts similar to the leaves, the lowest one longer than the inflorescence, sheathing at the base; spikelets brown to purplish black, weakly compressed, lanceolate to oblong-lanceolate, acute, 4–7 mm long, 1–1.2 mm wide, subsessile to short-pedicellate, 2–3-flowered, the internodes at base of spikelet shorter in length than the zigzagging upper ones; glumes 6–8, the middle 2 or 3 flower-bearing, the lower 3 empty, oblong-lanceolate, distichous, glabrous, 3–4.5 mm long, somewhat spinulose-scabrous on the keel near tip, purplish black except for the narrow whitish hyaline margin and brownish keel. Stigmas 3. Stamens 3. Achenes white, subglobose, obtusely trigonous, 1 mm long, 0.8 mm wide, reticulate, with three longitudinal ribs ending in the apiculate tip; bristles 6, antrorsely scabrous, ferrugineous, from a little shorter than to slightly overtopping the achene, not falling with the achene. Literature used in preparing description was Kern (1974), Jessop & Weber (1986), and Moore & Edgar (1970).

Schoenus apogon is indigenous to Australia, New Zealand, and Japan, including the Ryukyu Islands.

Material examined. HAWAI'I: "near 3500 ft" road sign, Volcano, among moss on roadside, 4 August 1976, *Degener 35812* (BISH, US).

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Contributions to the Flora of the Hawai‘i. VI[1]

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As discussed in previous papers published in the *Records of the Hawaii Biological Survey* (Wagner & Herbst, 1995; Lorence *et al.*, 1995; Herbst & Wagner, 1996; Shannon & Wagner, 1996), recent collecting efforts, continued curation of collections at Bishop Museum and the National Museum of Natural History (including processing of backlogs), and review of relevant literature all continue to add to our knowledge about the Hawaiian flora. When published, this information supplements and updates the treatments in the *Manual of the flowering plants of Hawai‘i* (Wagner *et al.*, 1990). In just the last 2 years, in the *Records of the Hawaii Biological Survey* alone, new records for 265 taxa of flowering plants have been reported from the Hawaiian Islands. In this paper we report an additional 13 new state records (from Kaua‘i, O‘ahu, Moloka‘i, and Hawai‘i), 14 new island records (from Midway Atoll, Kaua‘i, O‘ahu, Maui, Lana‘i, Kaho‘olawe, and Hawai‘i), 8 taxonomic changes, and 2 corrections of identification. All specimens are determined by the authors except as indicated.

Amaranthaceae

Amaranthus retroflexus L. **New state record**

This coarse, villous, monoecious herb 5–30 dm tall apparently was naturalized in the Hawaiian Islands 20 years ago, but its current status is not known. The following diagnostic characters are adapted from Webb *et al.* (1988) and Reed (1970). *Amaranthus retroflexus* is distinguished from other species of *Amaranthus* in the Hawaiian Islands by leaf blades 2–10 cm long, 1–4.5 cm wide, narrowly ovate, the petioles up to 5 cm long; flowers in dense spike-like clusters in stout paniculate inflorescences 5–20 cm long, the staminate tepals 4–5, 2–3 mm long, the pistillate ones similar in number and size, but the apex rounded to truncate, the bracteoles 4–5 mm long, lanceolate, awn-tipped; and fruit ca. 1.5 mm long, circumscissile near the middle, the lid smooth or rugulose near the line of dehiscence.

Amaranthus retroflexus is native from southern Canada through much of the United States and northern Mexico; it is widely naturalized around the world.

Material examined. HAWAI‘I: Ka‘ohe, Pohakuloa State Park, 6500 ft., 7 July 1977, *Herbst 5907* (US). Specimen det. by F. R. Fosberg and S. Mosyakin.

Apocynaceae

Alstonia macrophylla Wall. ex G. Don **New state record**

This species was cultivated in the Hawaiian Islands prior to 1949. There are collections at BISH from Lawa‘i Kai, Kaua‘i; the Waimea Arboretum and Botanical Gardens, O‘ahu; and the Shipman estate, Kea‘au, Hawai‘i (the label on this specimen, collected by

1. Contribution No. 1997-005 to the Hawaii Biological Survey.
2. Research Associate in Botany, Department of Natural Sciences, Bishop Museum, Honolulu, Hawaii.
3. Honorary Associate in Botany, Department of Natural Sciences, Bishop Museum, Honolulu, Hawaii.

L.W. Bryan, 2 Aug. 1949, states that, "this tree came from nursery at Foster Gardens many years ago"). It has recently become naturalized on Hawai'i. Specimens det. by A.J.M. Leeuwenberg.

Material examined. HAWAI'I: Pepe'ekeo, mauka of Highway 19, directly across from Hilo Processing Co. quarry site, near entrance to D. Carlsmith estate, in pasture with exotics such as guava and rose apple, ca. 550 ft., 25 Feb. 1991, *Takiue s.n.* (BISH); Hilo, invasive weed tree on various substrates, 76 m, March 1993, *Paul s.n.* (BISH); South Hilo Dist., Waiakea, Keaukaha Military Reservation, along jeep road through mixed native/alien forest, occasional, 60 ft., 5 July 1996, *Herbst & Hopper 9783a* (BISH).

Asteraceae

Cyanthillium cinereum (L.) H. Rob. **Taxonomic change**

The species treated as *Vernonia cinerea* (L.) Less. in Wagner *et al.* (1990: 373) has recently been recognized as belonging to the segregate genus *Cyanthillium*. Robinson (1990) provided the new combination. Though no recent monograph exists, *Cyanthillium* is thought to be a genus of about 25 species, and, except for the pantropical *C. cinereum* which occurs in the Hawaiian Islands, is restricted to Africa, Madagascar, and Asia (Bremer, 1994).

Emilia sonchifolia (L.) DC. var. ***javanica*** **New island record**
(N. Burm.) Mattfeld

Reported by Wagner *et al.* (1990: 312) as occurring only on Kaua'i and O'ahu, *E. sonchifolia* var. *javanica* is now known to be naturalized on East Maui as well, along with *E. sonchifolia* var. *sonchifolia* and *E. fosbergii* Nicolson.

Material examined. MAUI: East Maui, Maliko Bay off Hwy. 36, beach front, 5 August 1993, *McKinnon et al. 510* (US).

Gnaphalieae

Delimiting the large and heterogeneous taxa *Helichrysum* and *Gnaphalium* and the numerous related genera has been a significant problem in generic classification in the Asteraceae. Recently the tribe Inuleae has been revised at the generic level (for summary see Anderberg, 1994). In that revision the Inuleae was split into 3 tribes. One of them, comprising the everlastings and cudweeds (represented in the Hawaiian Islands by *Gnaphalium, Filago,* and *Helichrysum*; Wagner *et al.*, 1990) were removed to the tribe Gnaphalieae and generic circumscriptions were revised (Anderberg, 1991). The revision of the Gnaphalieae included the description of a number of new genera and resurrection of several others. Considerable progress in delimiting more natural groupings in this difficult tribe has been made through these studies, but some difficult problems remain, especially in and surrounding the large genus *Helichrysum*.

Many of the revisions suggested or supported by Anderberg are being widely adopted. When they are adopted for the taxa in the Hawaiian flora, a number of changes are necessary. In the revised scheme *Gnaphalium* in the Hawaiian Islands has been replaced

by the 3 genera *Euchiton*, *Gamochaeta,* and *Psuedognaphalium*, and each of the 3 *Gnaphalium* species treated by Wagner *et al.* (1986, 1990: 320) is placed in a different genus. The species key provided in Wagner *et al.* summarizes some of the diagnostic characters of the these genera, but a more detailed key to these genera, adapted from Drury (1971) and Anderberg (1991), is presented below.

We also report that the species long known in the Hawaiian islands as *Gnaphalium japonicum* Thunb. has been misidentified and is actually *Euchiton sphaericus* (Willd.) A. Anderb. (syn. *G. sphaericum* Willd.). We conclude by reporting the true *E. japonicus* (Thunb.) A. Anderb. (syn. *G. japonicum* Thunb.) as a new state naturalized record.

Several papers by Drury on the New Zealand Gnaphalieae (1970, 1971, 1972) are helpful, although he treats the taxa considered genera by Anderberg (1991, 1994) at the sectional level in the genus *Gnaphalium*. It now appears to be generally accepted that the old broad circumscription of *Gnaphalium* is polyphyletic. In fact the species included in *Pseudognaphalium* are considered to be more closely related to and perhaps congeneric with *Helichrysum* (Hilliard & Burtt, 1981; Anderberg, 1991). The following key separates the 3 genera occurring in the Hawaiian Islands formerly treated as *Gnaphalium*.

1. Leaves usually weakly clasping the stem and sometimes slightly decurrent; capitulescences in corymbose or subglobose clusters; involucral bracts opaque-white or -yellowish white, conspicuously shiny; corollas pale yellow; pappus hairs deciduous individually or held together in small clusters by basal cilia; achene epidermis with often overlapping papillae; achene sparsely covered with short, clavate myxogenic hairs, the hairs producing exudate in water ..... ***Pseudognaphalium***
1. Leaves not clasping the stem, not decurrent; capitulescences usually crowded into terminal clusters enveloped by leafy involucral bracts or into terminal and axillary clusters coalescing into spiciform inflorescences; corollas purple at least toward the lobes; pappus hairs deciduous in small groups held together by basal cilia or connate and deciduous as a unit; achene epidermis smooth or with paired papillae; achene with globose or short clavate myxogenic hairs, the hairs producing exudate or not (**2**).
2. Leaves flat and straight; achene epidermis microscopically papillose, the papillae paired; achenial hairs clavate, usually 4 × as long as wide, not readily emitting mucilage in water; capitula usually crowded into terminal clusters enveloped by a leafy involucre or with a smaller bracteate cluster immediately below; pappus hairs usually deciduous in small groups held together by basal cilia, not connate basally ..... ***Euchiton***
2. Leaves often folded or sickle-shaped; achene epidermis smooth, without microscopic papillae; achenial hairs globose, producing exudate in water; capitula crowded into terminal and axillary clusters, the clusters usually coalescing into spiciform inflorescences; pappus hairs connate basally into a ring, deciduous as a unit ..... ***Gamochaeta***

In the following synopsis of *Pseudognaphalium* only the necessary nomenclature and types needed to validate new combinations are provided. A full listing of the taxonomic synonyms for these taxa is given by Wagner *et al.* (1986).

Euchiton

There are 2 species of *Euchiton* in the Hawaiian Islands. *Euchiton sphaericus* has been consistently misidentified (as *Gnaphalium japonicum*), and *E. japonicus* is reported here for the first time.

Euchiton japonicus (Thunb.) A. Anderb. **New state record**

The following collection was originally identified by Wagner as *Gnaphalium purpureum* L., but a specialist on this group, M. Dillon, provided the correct identification in 1994. It is easily distinguished from *Euchiton sphaericus*, which is an annual herb, by its stoloniferous perennial habit, and from *Gamochaeta* by the characters given in the key.

Material examined. HAWAI'I: Upper Waiakea Forest Reserve, along Disappointment Trail (Pu'u Maka'ala access rd.) of Stainback Hwy., in *Metrosideros* rainforest, ca. 1100 m, 26 July 1983, *Wagner et al. 4842* (BISH, US).

Euchiton sphaericus (Willd.) A. Anderb. **Corrected identification**

This species has been consistently misidentified in the Hawaiian Islands as *Gnaphalium japonicum* since its introduction in the early part of this century.

Gamochaeta purpurea (L.) Cabr. **Taxonomic change**

The plant treated by Wagner *et al.* (1990: 321) as *Gnaphalium purpureum* is transferred to *Gamochaeta* in the classification of Anderberg (1991).

Logfia gallica (L.) Coss. & Germ. **Taxonomic change**

In the classification of Anderberg (1991) this is the correct name for the naturalized species referred to *Filago gallica* L. by Wagner *et al.* (1990: 315).

Pseudognaphalium sandwicensium (Gaudich.) A. Anderb. **Taxonomic changes**

Pseudognaphalium sandwicensium var. *sandwicensium*

Pseudognaphalium sandwicensium var. *hawaiiense* (O. Degener & Sherff) W.L. Wagner, comb. et stat. nov. [based on *Gnaphalium hawaiiense* O. Degener & Sherff *in* Sherff, *Am. J. Bot*. 36: 507. 1949. TYPE: Hawaiian Islands: Hawai'i: Kilauea, 9 April 1930, *O. Degener 18462b* (NY, holotype, photo F)].

Pseudognaphalium sandwicensium var. *kilaueanum* (O. Degener & Sherff) W.L. Wagner, comb. nov. [based on *Gnaphalium sandwicensium* var. *kilaueanum* O. Degener & Sherff *in* Sherff, *Am. J. Bot*. 36: 505. 1949. TYPE: Hawaiian Islands: Hawai'i: Kilauea, dryish barren roadside, 9 April 1930, *O. Degener 18462a* (NY, holotype, photo F)].

Pseudognaphalium sandwicensium var. *molokaiense* (O. Degener & Sherff) W.L. Wagner, comb. nov. [based on *Gnaphalium sandwicensium* var. *molokaiense* O. Degener & Sherff *in* Sherff, *Lloydia* 11: 309. 1948. TYPE: Hawaiian Islands: Moloka'i: west

Moloka‘i, near Waiahewahewa Gulch, rather localized on arid hot coastal dunes, 19 April 1928, *O. Degener 18302* (NY, holotype; BISH, NY[3], US!, isotypes)].

The plants referred to as intermediates between *P. sandwicensium* var. *sandwicensium* and *P. sandwicensium* var. *molokaiense* by Wagner *et al.* (1986, 1990: 322) from coastal strand and dune habitats are here considered better referred to *P. sandwicensium* var. *molokaiense*. They are a close match morphologically, and probably represent past direct connections among the islands of the Maui complex (Maui Nui) and the thin land connection between O‘ahu and Moloka‘i discussed by Carson & Clague (1995).

Sphagneticola trilobata (L.) Pruski **Taxonomic change**

In his monograph of Ecliptinae, Strother (1991) transferred the species treated as *Wedelia trilobata* (L.) Hitchc. by Wagner *et al.* (1990) to the new genus *Complaya*. Robinson and Cuatrecasas (1992) pointed out that the group had already been named *Thelechitonia* Cuat. Now Pruski (1996) has found that *Sphagneticola* is an even earlier name for this group of 4 species, and has made the new combination. For a detailed discussion of the nomenclature of this species the reader is referred to Pruski (1996); publication of the combination was effected in Funk & Pruski (1996).

Chenopodiaceae

Atriplex maximowicziana Makino **New state record**

This species has been known to be naturalized in the Hawaiian Islands for over 20 years but was not treated by Wagner *et al.* (1990) because it remained unidentified until recently when S.L. Welsh examined several of the specimens cited here. The following description is modified from the *Flora of Taiwan* (Liu, 1996).

Monoecious, suffrutescent, perennial herbs; stems up to 10 dm tall, procumbent to erect, densely farinose. Leaves alternate or the lowermost subopposite, ovate to trullate, 1–4 cm long, 0.7–1.8 cm wide, margin entire, apex obtuse to muncronulate, base cuneate. Staminate flowers in terminal, dense spikes, ca. 1 cm long; pistillate flowers in small paniculate clusters of spikes. Fruiting bracts compressed, trullate-rhombic, 6–9 mm long, coarsely toothed in the lower half, connate at base. *Atriplex maximowicziana* is native to southeastern China, Taiwan, and Japan (Ryukyu Islands).

Material examined. HAWAI‘I: Hawaii Volcanoes National Park, Puukohola Heiau historic site, April 1975, *J. D. MacNeil s.n.* (US [2 sheets]); South Kohala Dist., Kawaihae Ahupua‘a, Kawaihae Harbor, on dredged coral substrate, 21 June 1987, *Stemmermann & Luce 7151* (US); South Kohala Dist., Kawaihae Ahupua‘a, Kawaihae Harbor, on limestone, 6 September 1987, *Stemmermann & Luce 7195* (US); South Kohala Dist., Kawaihae Ahupua‘a, Kawaihae Harbor, open, dry, exposed areas, 2 Aug. 1996, *Herbst 9796* (BISH); South Kohala Dist., Kawaihae Ahupua‘a, Kawaihae Harbor, in disturbed area by harbor, 27 April 1975, *Herbst 9714* (BISH). Specimens det. by S.L. Welsh.

Salsola tragus L. **Taxonomic change**

The genus *Salsola* has long been taxonomically difficult with a number of different interpretations adopted at various times, especially for the widely naturalized species

often treated as *S. kali* L. The correct name for the single species naturalized in the Hawaiian Islands (a widely naturalized species worldwide, treated as *S. kali* by Wagner *et al.*, 1990: 540) is *S. tragus* (S. Mosyakin, pers. comm.; Wilken, 1993). *Salsola tragus* is native to Eurasia. Other names that have been associated with this widely naturalized species of *Salsola* have been misapplied.

Cyperaceae

Rhyncospora caduca Elliott **New island record**

Previously reported from the islands of Maui and Hawai‘i by Koyama (1990: 1428), this species now occurs on O‘ahu as well.

Material examined. O‘AHU: Kahana Valley, 200 ft., Sept. 1992, *Takeuchi 8516* (BISH).

Euphorbiaceae

Chamaesyce serpens (Kunth) Small **New state record**

Chamaesyce serpens, a New World native, was formerly confused with *C. albomarginata* (Torr. & A. Gray) Small by experts on Hawaiian botany (Koutnik & Huft, 1990: 604). In the Hawaiian Islands it is known only from Kaua‘i, whereas *C. albomarginata* is known only from O‘ahu. These 2 species can be separated by the following key adopted from the descriptions in the *Flora of Texas* (Correll & Johnston, 1970).

1. Plants perennial; staminate flowers 15–30 per cyathia; leaves 3–8 mm long, orbicular to oblong, apex rounded, occasionally emarginate or apiculate; base strongly inequilateral; stipules united into a membranous scale 1–2 mm long, white; involucre ca. 1 mm long; capsules 1.3–2 mm long ..... ***C. albomarginata***
1. Plants annual; staminate flowers 3–8(–10) per cyathia; leaves 2.5–2.8 mm long, oblong to orbicular, apex rounded; base weakly inequilateral; stipules united into a membranous scale 0.2–1.2 mm long, white to pink; involucre ca. 0.7 mm long; capsules 1–1.2 mm long ..... ***C. serpens***

Material examined. KAUA‘I: Hanama‘ulu Bay, naturalized around abandoned wharf, 17 March 1961, *Degener & Degener 27481* (US); Maha‘ulepu, between Ha‘ula and Po‘ipu, lithified dunes, 27 May 1984, *Wagner et al. 5373* (BISH); near Waita Reservoir, below Koloa and Poipu, along dirt road in sugar cane fields, 8 April 1988, *Wagner et al. 6024* (BISH, US); Koloa Dist., Maha‘ulepu, littoral vegetation in sand pockets over lithified dunes, 15 ft., 28 September 1990, *Flynn et al. 4253* (BISH, US).

Fabaceae

Crotalaria juncea L. **New state record**

This species has not previously been reported as naturalized in the Hawaiian Islands, but it has been cultivated (Neal, 1965). It can be distinguished from the other naturalized Hawaiian species of the genus by the following characters adopted from the treatment by Rudd (1991). It is an annual herb up to 2.5 m tall; stems erect, ribbed, subappressed pubescent; leaves simple, oblong to oblanceolate, apex acute to obtuse, stipules filiform, ca. 2 mm long; flowers 15–20 mm long, in terminal inflorescences 10–25 cm long, bracts nar-

rowly lanceolate, 3–5 mm long, calyx 15–20 mm long, weakly bilabiate, the lobes 3–4 times as long as the tube, velutinous; petals 15–25 mm long, bright yellow, with dark red or brown streaks, the standard to 25 mm long, the keel to 20 mm long, with a twisted beak, the wings shorter than the keel; pods cylindrical, 2.5–3.5(–5.5) cm long, velutinous, sessile; seeds 6–15 per pod, cordiform, 4–6 mm long, light brown to black. *Crotalaria juncea* is native to India, but is widely cultivated as a cover crop and for fiber. In the Hawaiian Islands it was cultivated by the Hawaiian Sugar Planters' Association as early as 1918 (*Rock s.n.*, BISH) and is apparently known as sunhemp and grown for its nitrogen fixation properties (L. Stemmermann, pers. comm.). It has become widely naturalized and now has a pantropical distribution.

Material examined. O'AHU: Honolulu, Kalakaua Ave., 9 Sept. 1962, *Sasakawa s.n.* (BISH); det. by R. Barneby. HAWAI'I: Ka'u Dist., along Ka'alu'alu-Wai'ohinu rd., cleared field in subdivision, 230 m, 19 June 1990, *Wagner et al. 6392* (US); det. by D. Windler.

Medicago sativa L. **New island record**

Formerly known to occur on Midway Atoll, Kaua'i, O'ahu, Lana'i, and Hawai'i (Geesink *et al.*, 1990: 686), *Medicago sativa* is now known to occur on Maui as well.

Material examined. MAUI: [East Maui?], roadside *hale*, 2160 m, 30 Oct. 1982, *Medeiros 295* (BISH); East Maui, Baldwin Ave. near Hali'i Maile Rd. jct, weed on road shoulder, 17 June 1991, *Hobdy et al. 3381* (BISH).

Senna gaudichaudii (Hook. & Arn.) **New island record**
H. Irwin & Barneby

At the time of publication of the *Manual of the Flowering Plants of Hawai'i*, *Senna gaudichaudii* had been documented from all of the main islands except Ni'ihau and Kaho'olawe (Geesink *et al.*, 1990: 699). Its occurrence on Kaho'olawe has now been documented as well.

Material examined. KAHO'OLAWE: Makawao Dist., 'Ale'ale stack, near Pu'u Koa'e, 10–90 m, 18 March 1992, *Wood et al. 1729* (BISH).

Lauraceae

Cinnamomum burmani (Nees) Blume **New island record**

This species has been cultivated on O'ahu for most of this century and is naturalized there (Werff, 1990: 846). It was recently reported as naturalized on East Maui (Wagner & Herbst, 1995), and is here reported as naturalized on Hawai'i.

Material examined. HAWAI'I: Hamakua Dist., Nienie Ahupua'a, in patch of exotic trees near irrigation reservoir, trees of various sizes and many seedlings observed, ca. 1000 ft, 12 July 1996, *Herbst 9787* (BISH).

Lemnaceae

In the *Manual of the flowering plants of Hawai'i*, Wagner *et al.* (1990) treated only 2 species of Lemnaceae. There are now known to be 5 species of Lemnaceae in the Hawaiian Islands. In addition to reporting 3 new state records (*Lemna obscura* (Austin)

Daubs, *Spirodela punctata* (G. Mey.) C.H. Thomps., and *Wolffia globosa* (Roxb.) Hartog & Plas), we also report one taxonomic change (*Lemna aequinoctialis* Welw.) and 3 new island records (for *Lemna aequinoctialis* and *Spirodela polyrhiza* (L.) Schleid.).

For keys, descriptions, and distribution records for all taxa in the Lemnaceae, the reader is referred to Landolt (1980, 1986) and Landolt & Urbanska-Worytkiewicz (1980); a key to genera occurring in the Hawaiian Islands and key characters for the *Lemna* and *Spirodela* species occurring in the Hawaiian Islands are given below (from Landolt, 1980, 1986). Determinations were kindly provided by E. Landolt (excluding US sheet of *S. punctata*).

The 2 species of Lemnaceae treated by Wagner *et al.* (1990) were considered by them to be possibly naturalized, but they may represent natural introductions by migrating waterfowl. The colonization sources of the others reported here are similarly ambiguous.

Key to genera of Lemnaceae in the Hawaiian Islands:

1. Fronds with 1–20 roots (2).
1. Fronds rootless ..... ***Wolffia***
2. Fronds with 1 root and 1–5 (–7) nerves ..... ***Lemna***
2. Fronds with (1–)2–20 roots and (3–)5–16 nerves ..... ***Spirodela***

Key to *Lemna* in the Hawaiian Islands:

1. Root sheath winged at base; root tip sharply pointed; roots not longer than 3 cm; no red color present on fronds ..... ***L. aequinoctialis***
1. Root sheath not winged; root tip mostly rounded; roots often longer than 3 cm; fronds often red colored on lower surface or with red spots on either surface ..... ***L. obscura***

Lemna aequinoctialis Welw. **Taxonomic change and new island record**

Wagner *et al.* (1990) reported the *Lemna* occurring in the Hawaiian Islands as *L. perpusilla* Torr. According to Landolt (1980, 1986; see also Landolt & Urbanska-Worytkiewicz, 1980), *L. perpusilla* is restricted in distribution to eastern North America, and the plants in the Hawaiian Islands previously referred to *L. perpusilla* actually represent *L. aequinoctialis* Welw., a pantropical species which is very similar to *L. perpusilla*. The observation of this species on the island of Hawai‘i reported in Wagner *et al*. (1990) is documented by the following collection.

Material examined. HAWAI‘I: Hilo, Wailoa Estuary, floating, 25 July 1987, *Stemmermann & Luce 7184* (mixed collection with *Spirodela polyrhiza*) (BISH).

Lemna obscura (Austin) Daubs **New state record**

Aside from the 3 documented collections from the Hawaiian Islands, *L. obscura* occurs only in southeastern North America.

Reported by Landolt (1986) from O‘ahu, Pearl City, 2 collections by D. Herbst, ETH culture numbers 7325 and 7471 (vouchers at ZT).

Material examined. HAWAI'I: Hilo, Lokaka Pond, floating, 20 Aug. 1987, *Stemmermann & Warshauer* 7188 (BISH).

Key to *Spirodela* in the Hawaiian Islands:

1. Fronds 1–1 1/2 times as long as wide, with 7–16 (–21) nerves; roots 7–21, up to 4 cm long ..... ***S. polyrhiza***
1. Fronds 1 1/2–2 times as long as wide, with (3–) 5–7 nerves; roots (1–) 2–7 (–12), up to 7 cm long ..... ***S. punctata***

Spirodela polyrhiza (L.) Schleid. **New island records**

Previously known only from O'ahu (Wagner *et al.*, 1990: 1458), the following collections document the occurrence of *Spirodela polyrhiza* on Maui and Hawai'i.

Material examined. MAUI: *s.l.*, 5 Aug. 1927, *Degener 8934* (collected by D.L. Topping; mixed collection with *Lemna aequinoctialis*) (US). HAWAI'I: Hilo, Wailoa Estuary, floating, 25 July 1987, *Stemmermann & Luce 7184* (mixed collection with *Lemna aequinoctialis*) (BISH).

Spirodela punctata (G. Mey.) C.H. Thomps. **New state record**

Material examined. O'AHU: near Kailua levee, floating in standing water in *Scirpus* stands, 30 July 1976, *Smith 150* (BISH, US [2 sheets]); US sheets det. by F.R. Fosberg. HAWAI'I: Punalu'u, Ninole Pond, floating, 4 Sept. 1987, *Stemmermann 7194* (BISH); Hilo, Waioloa Estuary, 25 July 1987, *Stemmermann & Luce* 7182 (BISH).

Wolffia globosa (Roxb.) Hartog & Plas **New state record**

Other than the 2 collections cited here from the Hawaiian Islands, *W. globosa* is known to occur in California, eastern and southern Asia, and southern and eastern Africa (Landolt, 1986). Reported by Landolt (1986) from O'ahu, Pearl City, D. Herbst, ETH culture number 7470 (voucher at ZT).

Material examined. MOLOKA'I: Puko'o, along shore, 11 Oct. 1916, *Hitchcock 15116* (US).

Malvaceae

Sida ciliaris L. **New state record**

There are 4 conspicuous differences (2 of them vegetative) between *Sida ciliaris* and the 7 naturalized or indigenous species of *Sida* reported for the Hawaiian Islands by Bates (1990). *Sida ciliaris* is the only species in the Hawaiian Islands that is a procumbent herb; it has much smaller leaf blades than any of the other species, with a length of only 1–2 cm; the petals are often rose colored, although they are sometimes red-orange or yellowish; and the schizocarps are muricate (Fryxell, 1988). Other characters described by Fryxell include leaf blades narrowly elliptic, few-toothed apically, and glabrous above; stipules linear to oblanceolate; flowers subsessile in dense terminal clusters; calyx lobes divided in apical half; schizocarp conical; and mericarps 5–8. A plant of disturbed, often arid habitats, *S. ciliaris* was previously known from southern North America, South America, and the West Indies (Fryxell, 1988) and is now also known from several localities on O'ahu.

Material examined. O‘AHU: Ke‘ehi Lagoon Park, in lawns, 5 May 1987, *Whistler s.n.* (BISH); Makakilo, lowland dry grassland and forest W of Makakilo town and below paved road leading toward Camp Timberline access road, growing along road with other alien species, uncommon, 22 Oct. 1990, *Imada & Char s.n.* (BISH); Pearl Harbor, Pearl City Peninsula, near Surtass Bldg., 13 Aug. 1991, *E. Funk s.n.* (BISH); Honolulu Dist., Camp Catlin area, at edge of parking lot, locally common, ca. 10 ft., 15 March 1991, *Herbst 9373* (BISH); ‘Ewa Dist., Barbers Point Naval Air Station, naturalized in lawn in front of terminal, ca. 1.5 m, 7 Sept. 1992, *Nagata 4250* (BISH). *Whistler s.n.* and *E. Funk s.n.* det. by D. Bates.

Passifloraceae

Passiflora suberosa L. **New island record**

Passiflora suberosa was previously known only from the islands of O‘ahu, Maui, and Hawai‘i (Escobar, 1990: 1014). Its occurrence on Lana‘i is reported here.

Material examined. LANA‘I: Kanepu‘u dry forest, opening in the Olopua forest of Lapaiki Road, inside the *Gardenia brighamii* exclosure, 518 m, 11 May 1991, *Hobdy 3293* (BISH).

Poaceae

Dactyloctenium aegyptium (L.) Willd. **New island record**

This record from Midway Atoll represents the first known collection of *Dactyloctenium aegyptium* from the Northwestern Hawaiian Islands. It had previously been documented on O‘ahu, Moloka‘i, Maui, Kaho‘olawe, and Hawai‘i (O’Connor, 1990: 1522).

Material examined. MIDWAY ATOLL: W end of Sand Island, Frigate Point, in sand, 16 Dec. 1991, *Flint s.n.* (BISH).

Festuca

Two species of *Festuca*, both previously known to be naturalized on Hawai‘i, one *(F. rubra*) of which is also reported from Maui (O’Connor, 1990: 1547, 1548), are here reported as naturalized on Kaua‘i. Specimens det. by D. Clayton.

Festuca arundinacea Schreb. **New island record**

Material examined. KAUA‘I: Makaha roadside, tall clump grass to nearly 1.3 m tall, 23 March 1993, *Hobdy 3586* (BISH); Waimea Dist., Pu‘u Ka Pele Forest Reserve, Makaha Ridge Road, 0.8 miles W of jct. with Hwy. 550, ca. 3000 ft., 31 May 1992, *Flynn et al. 3976* (BISH).

Festuca rubra L. **New island record**

Material examined. KAUA‘I: Hanalei Dist., Kalalau Rim, Kalahu side below and W of first Kalalau Lookout, 790 m, 13 March 1992, *Wood & Perlman 1701* (US), *Wood & Perlman 1704* (BISH); Pohakuao, hanging valley between Kalalau and Hanakoa, 400–600 m, 1 April 1992, *Wood et al. 1761* (BISH, US); Waimea Dist., Awa‘awapuhi Valley, N facing slopes above stream, 0.5 miles in along trail, 3300–3500 ft., 18 May 1994, *Wood et al. 3193* (BISH).

Polygonaceae

Rumex conglomeratus Murr. **New state record**

This species has been naturalized in the Hawaiian Islands on the island of Kaua‘i

since at least the 1980s. The collections listed below were misidentified as *R. crispus* or not identified. Characters that separate *R. conglomeratus* from other Hawaiian species of *Rumex* are adopted from several regional treatments (S. Mosyakin, unpubl.; Webb *et al.* 1988; Hickman, 1993). *Rumex conglomeratus* can be distinguished from other species of *Rumex* in the Hawaiian Islands by its distinctly interrupted inflorescence, the whorls of flowers widely spaced; fruiting inner tepals oblong and each with a tubercle, these subequal or equal, 1/2–3/4 the tepal width, and tepal margins entire. The most useful characters for distinguishing *R. conglomeratus* from *R. crispus* are the whorls of flowers widely spaced vs. nearly continuous and the tubercles > 1/2 the tepal width vs. < 1/2 the tepal width. *Rumex conglomeratus* is native to Europe, western and southwestern Asia, and northern Africa; widely naturalized in other parts of the Pacific basin and North America. Specimens det. by S. Mosyakin.

Material examined. KAUA‘I: Hanalei Dist., Koke‘e State Park, Mohihi Rd., near Camp Sloggett, disturbed roadside, 1100 m, 26 May 1984, *Wagner et al. 5370* (BISH, US); upper slopes of Kalalau Valley between Kalalau and Pu‘u O Kila lookouts, diverse forest, 3660 ft., 23 September 1986, *Flynn & Koob 1902* (US).

Rubiaceae

Serissa japonica (Thunb.) Thunb. **New state record**

This species is a cultivated ornamental that now appears to have become naturalized on Hawai‘i.

Material examined. HAWAI‘I: Hamakua Dist., Nienie Ahupua‘a, sparingly naturalized at the edge of a macadamia nut orchard, ca. 1000 ft., 2 July 1996, *Herbst 9788* (BISH).

Spermacoce capitata Ruiz & Pav. **New state record**

The sole specimen known to document the occurrence of this species in the Hawaiian Islands was found at US recently while curating the entire Hawaiian collection. The large capitate inflorescences are the most striking feature of *Spermacoce capitata*, as indicated by the specific epithet. The habit and size of this coarse, erect, perennial herb are also unique among *Spermacoce* species occurring in the Hawaiian Islands; *Spermacoce capitata* reaches a height of 1 m, and has sessile leaves that are 3–10 cm long. Other diagnostic characters (from MacBride, 1936; Steyermark, 1974) include inflorescences terminal or axillary, subhemispherical, 8–16 mm in diameter; calyx lobes 4–5; corolla tube 2–4 mm long; seeds 1.2–1.6 mm long, the surface foveolate and transversely deeply grooved.

Material examined. HAWAI‘I: Honounau, Kona, in field, 1000 ft., 18 August 1979, *Kami s.n.* (US). Specimen det. by F.R. Fosberg.

Spermacoce ovalifolia (M. Martens & Galeotti) Hemsl. **New island record**

Lorence *et al.* (1995) reported *Spermacoce ovalifolia* from Hawai‘i, the first documented occurrence of this species in the Hawaiian Islands. It is now known to occur on O‘ahu also.

Material examined. O‘AHU: N Halawa Valley, wet soil in grass-covered hill, 2 February 1994, *Imada et al. 94-5* (BISH, US).

Sapotaceae

Chrysophyllum oliviforme L. **New island record**

A common ornamental tree in the Hawaiian Islands, *C. oliviforme* was reported as naturalized on Kaua‘i by Lorence *et al.* (1995). It is now clearly naturalized on 2 other islands as well, O‘ahu and Hawai‘i.

Material examined. O‘AHU: ‘Ewa Dist., along Panakauahi Gulch, at the edge of an old pineapple field, very common along gulch sides with *Eucalyptus, Albizzia*, and silk oak, 600 ft., 8 Feb. 1996, *E. Funk s.n.* (BISH). HAWAI‘I: Hamakua Dist., Kapulena Ahupua‘a, Kapulena Gulch, sparingly naturalized along sides of gulch forested with alien species of trees, ca. 1000 ft., 2 Aug. 1996, *Herbst 9797* (BISH).

Solanaceae

Two changes to the treatment of *Lycopersicon* by Symon (1990) in the *Manual of the Flowering Plants of Hawai‘i* are reported here. The first involves placement of the genus *Lycopersicon.* Spooner *et al.* (1993) present data from morphological and cpDNA phylogenetic analyses that strongly support the sister relationship of potatoes and tomatoes, and treat *Lycopersicon* as a subsection within *Solanum* sect. *Potatoe*; based on their analyses, *Lycopersicon* species are now treated as species of *Solanum*. Readers are referred to their paper for details of this long-contentious situation.

Symon (1990) treated 2 species of naturalized *Lycopersicon*, *L. esculentum* Mill. and *L. pimpinellifolium* (Jusl.) Mill. The second change concerns the identification of the naturalized plants referred by Symon (1990: 1259) to *L. pimpinellifolium* (= *Solanum pimpinellifolium* Jusl.). These actually represent feral forms of *L. esculentum* Mill. (= *Solanum lycopersicum* L.), as *S. pimpinellifolium* does not occur in the Hawaiian Islands. Apparently the incorrect identification traces to Neal (1965 or earlier editions). A.A. Heller was the first to collect the wild-growing plants in the Hawaiian Islands in 1895, and he correctly identified them in his report (Heller, 1897). Muller (1940) likewise cited Hawaiian collections (including Heller’s) under *L. esculentum* in his monograph of the genus. O. Degener *et al.* (1967) treated the naturalized plants as *L. galenii* Mill., a name that has been considered by others (including Muller) to be a taxonomic synonym of *L. esculentum* Mill. The description given by Symon (1990) does reflect characteristics of *S. pimpinellifolium*; however, close study of plants naturalized in the Hawaiian Islands shows them to have the less deeply divided corollas, shorter inflorescences, coarser habit, and slightly larger fruits of the wild-reverted forms of the cultivated tomato. In summary, the 2 taxa of *Lycopersicon* reported by Symon (1990) are both *S. lycopersicum*, one a long-naturalized wild-reverted form and the other primarily represented by repeatedly escaped cultivated tomatoes.

Solanum lycopersicum L. var. ***cerasiforme*** (Dunal) Spooner, Anderson & Jansen **Taxonomic change and corrected identification**

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The Genus *Sigmatineurum* Parent in Hawaii (Diptera: Dolichopodidae), with a Revised Key to Species[1]

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Introduction

Collections since the recent review of *Sigmatineurum* (Evenhuis & Polhemus, 1994) have added new species and a re-examination of currently known species and comparisons with other hydrophorine species have better defined the taxonomic limits of this endemic Hawaiian genus. As a result of these investigations, three new species, *S. nigrum* (East Maui), *S. parenti* (East Maui), and *S. meaohi* (Hawaii Island), are described and illustrated and *Eurynogaster binodata* Parent from Oahu is newly transferred to *Sigmatineurum*. Also, a male of *S. iao*, one of only two specimens of this species to have been collected from Iao Valley on West Maui since the 1930s, has its male abdomen described for the first time. As a result of these new additions to the genus, a revised key to the species of Hawaiian *Sigmatineurum* is presented.

Materials and Methods

Specimens examined in this study derived from The Natural History Museum, London (BMNH), Bishop Museum (BPBM), Hawaii State Department of Agriculture, Honolulu (HDOA), and the University of Hawaii at Manoa (UHM). Terminology follows Bickel (1991) with the addition of the abbreviation tr = trochanter.

Systematics

Sigmatineurum iao Evenhuis Fig. 7

Sigmatineurum iao Evenhuis *in* Evenhuis & Polhemus, 1994: 8–9.

The original description of this species was based on two specimens, one each collected in 1915 and 1931. Recent collection of a single male and female allow examination and description of the abdomen (broken off in the type specimen) and male hypopygium for the first time. Otherwise, characters given in Evenhuis & Polhemus (1994) for this species remain the same.

Abdomen. Brown with emerald green and magenta reflections, long dark setae posterolaterally on tergite I, thinner hairs posterolaterally on tergites IV and V; sternal 4 process (Fig. 7) dark brown to black, triangular in shape, long, thin, in lateral view. Hypopygium dark brown.

Material examined. MAUI: West Maui: 1 male, 1 female, Iao Valley, Poohahoahoa Stream, 2000 ft. [610 m], 6.v.1994, D.A. Polhemus [preserved in alcohol] (BPBM).

Sigmatineurum omega Evenhuis Fig. 1

Sigmatineurum omega Evenhuis *in* Evenhuis & Polhemus, 1994: 8–9.

The original illustration of the male leg in Evenhuis & Polhemus (1994: fig. 17) was inaccurately drawn, however the description is correct. A corrected figure is given here (Fig. 1).

1. Contribution No. 1997-006 to the Hawaii Biological Survey.

Sigmatineurum binodatum (Parent), **new combination** Figs. 2, 6, 8

Eurynogaster binodata Parent, 1939: 241.

Diagnosis. Keys to *S. mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but is easily distinguished by the foliate sternal 4 process (Fig. 8), which is thick in lateral view; the small pointed process on the the mid trochanter; the lack of strong bristles on the ventral surface of FII (Fig. 2); and the setal characters of TII.

Types: Holotype and two male paratypes from: Hawaiian Islands: Oahu, Kaluanui Stream, 2000 ft [610 m], 18.x.1936, F.X. Williams in BMNH, examined. A female paratype of *binodata* so labeled in BMNH from Mt. Kaala, Oahu, September 1936, F.X.Williams, is probably a specimen of *Eurynogaster minor* Parent and may have been mislabeled.

Other material examined. Hawaiian Islands: OAHU: [Koolau Mountains:] Kaluanui Stream, 2000 ft. [610 m], 3.iv.1938, 14.v.1946, 18.x.1936, 22.xi.1936, all F.X. Williams (HDOA).

Habitat. Williams (1939) gave a detailed description of the general habitat and biology of this species as well as observations on its behavior (some of this information was presented in Evenhuis & Polhemus, 1994).

Sigmatineurum nigrum Evenhuis, **new species** Figs. 3, 8

Diagnosis. Keys to *mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but differs from that species by the distinct triangular process on the ventral surface of the mid femur, the pointed process on the trochanter, the long, thin sternite 4 process, its larger size, and its dark body coloration.

Male. Body length: 6.5 mm. Wing length: 5.5 mm. Head. Front, face, and vertex dark brown with blue-green reflections, clypeus pale brownish pruinose, with darker anterior tentorial pits and light blue-green highlights; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis brown; antenna with arista length slightly less than head height.

Thorax. Mesoscutum and scutellum brown with magenta and green reflections; notopleural area shining magenta; anepisternum with brassy green (below) and magenta (above) reflections; remainder of pleura brown; thoracic setae black to dark chocolate brown: 5 *dc*; 2 + 1 *np*; 1 *ph*; 1 *pa*; 1 + 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few hairs ventrally at apex; TI (Fig. 3a) slightly sinuous with long, dense hairs along ventral surface (MSSC), single strong seta on anterior surface near middle. It1 long, 6 times length of It2, with long, dense setae on ventral surface (MSSC). It3-5 unmodified. IItr with distinct thorn-like process apically. FII (Fig. 3b) with distinct triangular process ventrally at apical one-fourth (MSSC); with strong, thorn-like apicalmost seta, small, short, peg-like setae covering apex of triangular process, and scattered fine hairs and setae from middle of segment to thorn-like apical seta (MSSC). TII sinuous, with subbasal notch and slightly swollen area at apical 1/3; strong hairs and setae along ventral surface, longest at basal one-third and near apical swollen area; strong spur at swollen area, slightly sorter than longest hairs there. IIt1 slightly bowed, with patch of dense setae basally. IIt2-5 unmodified. Right midleg broken off and missing beyond basal one-third of tibia. Leg III unmodified.

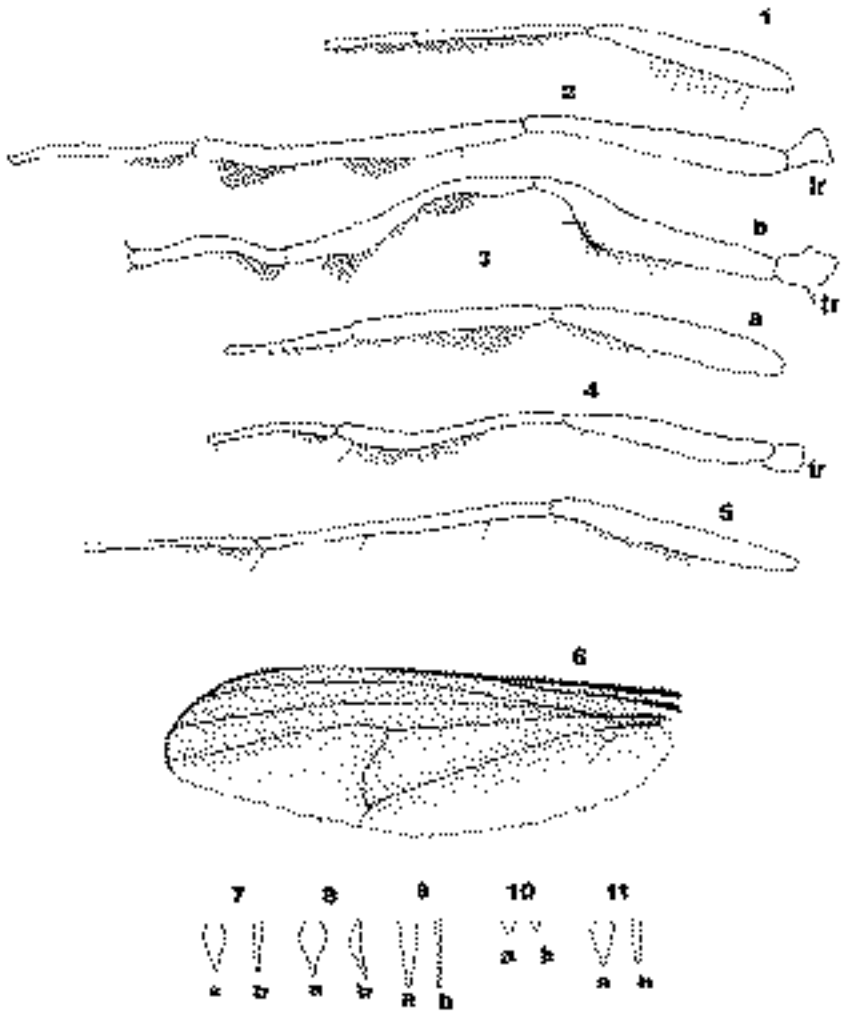
I—5.0;5.0;3.0/0.5/0.5/0.5/0.5

II—8.0;6.8;3.5/3.3/3.0/2.0/1.5

III—8.0;9.5;5.0/3.5/2.5/1.4/1.3

Wing. Subhyaline throughout, brown color densest basally and along anterior margin to apex of R2+3; crossvein m-cu bent slightly at middle, not S-shaped; slight brown tinting on M1 slightly beyond crossvein m-cu (MSSC); CuA1 almost reaching wing margin; CuAx 4.5; halter dark brown.

Abdomen. Dark brown with green reflections dorsally, reflections brassy green and magenta laterally; black hairs posterolaterally on tergite I, thinner denser patch of hairs at posterolateral angle of tergite V; sternite 4 process (Fig. 9) rather large, foliate, thin in lateral view. Hypopygium light brown with brown cerci.



Figs. 1-5. *Sigmatineurum* legs (femur to tarsus 1). **1**, *S. omega* midleg. **2**, *S. binodatum* midleg. **3**, *S. nigrum* legs; **a**, foreleg; **b**, midleg. **4**, *S. parenti* midleg. **5**, *S. meaohi* midleg. **Fig. 6**. *Sigmatineurum meaohi,* male wing. **Figs. 7-11**, *Sigmatineurum* sternite 4 processes (a, caudal view; b, lateral view). **7**, *S. iao*. **8**, *S. binodatum.* **9**, *S. nigrum.* **10**, *S. parenti.* **11**, *S. meaohi.* tr = trochanter.

Female. As in male except for lack of MSSC; legs normal, without modifications.

Types. Holotype male (BPBM 15,853) and paratype female from Hawaiian Islands: MAUI: East Maui: Maunawainui Stream, 1800 ft. [550 m], 8.ix.1994, D.A. Polhemus.

Habitat. Only a single male of this species were collected in association with *S. parenti* on rocks in the splash zone along the Maunawainui Stream.

Etymology: This species is named for the characteristic black coloration of the body.

Sigmatineurum parenti Evenhuis, **new species** Figs. 4, 10

Diagnosis. Keys to *S. mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but *parenti* is easily distinguished from *mnemogagne* by the characters of the male postabdomen: sternite 4 process is very small, peg-like (this process much larger in *mnemogagne*).

Male. Body length: 3.5–4.9 mm. Wing length: 3.5–4.8 mm. Head. Front, face, and vertex dark brown with dark blue-green reflections, clypeus slightly gray-brown pruinose, with darker anterior tentorial pits; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis pale brown; antenna with arista length two-thirds head height.

Thorax. Mesoscutum and scutellum brown with brownish gray pruinosity, blue green reflections dorsally; pleura with magenta and brassy green reflections, otherwise pleura brown; thoracic setae black to dark chocolate brown: 4 + 1 *dc*; 2 *np*; 1 *ph*; 1 *pa*; 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few stiff hairs ventrally near middle; TI with long hairs along ventral margin (MSSC), longest near middle; remainder of leg I unmodified. FII (Fig 4) with very small, black, stubby bristles along ventral margin (MSSC), bristles absent at base, thinning out apically to subapical seta; TII (Fig. xx) slightly distorted with long, black ventral hairs (MSSC) on apical half, spur undifferentiated from other ventral setae; IIt1 slightly bowed with small dense patch of short subbasal setae (MSSC); IIt2-5 unmodified. Leg III unmodified.

I—5.5;4.7;2.0/0.7/0.7/0.3/0.3

II—6.0;6.0;4.0/2.5/1.2/0.6/0.6

III—4.0;8.5;4.5/3.0/1.5/1.0/1.0

Wing . Hyaline, brown infuscation only at extreme anterior margin along costal vein; crossvein m-cu bent slightly at middle, not S-shaped; no thickening of veins R2+3, R4+5, or M1; CuA1 reaching or almost reaching wing margin; CuAx 2.0; halter white.

Abdomen. Dark brown with green reflections dorsally, reflections green and brassy green laterally; black hairs posterolaterally on tergite I; sternite 4 process (Fig. 10) very small, peg-like, thick in lateral view. Hypopygium brown.

Female. As in male except for lack of MSSC; legs normal, without modifications.

Types. Holotype male (BPBM 15,854) and 22 paratypes from Hawaiian Islands: MAUI: East Maui: Maunawainui Stream, 1800 ft. [550 m], 8.x.1994, D.A. Polhemus.

Habitat. This species was collected from rocks in the splash zone of the Maunawainui Stream.

Etymology: This species is named in memory of abbé Octave Parent, in honor of his foundational work with Hawaiian dolichopodids and for describing the genus *Sigmatineurum*.

Sigmatineurum meaohi Evenhuis, **new species** Figs. 5, 6, 11

Diagnosis. Keys to *S. omega* using the key to species in Evenhuis & Polhemus (1994), but differs from that species based on the much longer and denser setae on TII and by its larger size and darker body coloration.

Male. Body length: 4.4–4.8 mm. Wing length: 4.2–4.4 mm. Head. Front, face, and vertex dark brown with dark blue-green reflections, clypeus dark brown, with black anterior tentorial pits and some light blue-green highlights; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis dark brown; antenna with arista length slightly less than head height.

Thorax. Mesoscutum and scutellum dark brown, some blue green reflections; notopleural area shining blue-green; anepisternum with greenish reflections; remainder of pleura brown; thoracic setae black to dark chocolate brown: 5 *dc*; 2 *np*; 1 *ph*; 1 *pa*; 1 + 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few hairs ventrally at apex; remainder of leg I unmodified. FII (Fig 5) with strong stubby bristles along

ventral margin, densest and strongest from basal one-third to subapically; base and apex bare. TII slightly distorted, with fine hairs along most of ventral margin, dorsal surface with 2 strong black setae. IIt1 as in *parenti*, n. sp.; IIt2–5 unmodified. Leg III unmodified.

I—6.0;5.0;2.0/0.5/0.5/0.5/0.5
II—6.0;7.3;4.0/2.5/1.8/1.0/0.7
III—8.5;10.0;4.8/3.2/2.0/1.5/1.3

Wing (Fig. 8) Infuscated pale brown except in the middle of cells bm + dm and m and in middle of anal lobe, pale brown clouding covering most veins; crossvein m-cu S-shaped, without small spur vein; slight thickening of veins R2+3, R4+5, and M1 at level just beyond m-cu, with brown tinting surrounding thickening, thickest on M1 (MSSC); CuA1 reaching wing margin; CuAx 5.0; halter dark brown, knob brown along edges, white in middle.

Abdomen. Dark brown with blue-green and green reflections dorsally, reflections brassy green laterally; black hairs posterolaterally on tergite I, thinner denser patch of hairs at posterolateral angle of tergite V; sternite 4 process (Fig. 11) rather large, foliate, thin in lateral view. Hypopygium dark brown.

Female. As in male except for lack of MSSC; m-cu not S-shaped, but with slight bend in middle; infuscation on wing lighter throughout; legs normal, without modifications.

Types. Holotype male (BPBM 15,855) and 6 paratypes from Hawaiian Islands: HAWAII: Upper Waipio Valley, Alakahi Stream, 1050 ft. [305 m], 3.x.1996, R. Englund, R. Filbert, riffle habitat above diversion (all in BPBM).

Habitat. This species was swept from the rocks in the swift flowing waters of the Alakahi Stream, a tributary of the Waipio River in Upper Waipio Valley.

Etymology: The specific name is Hawaiian for "collector" and is named in honor of its intrepid collectors, Ron Englund and Randall Filbert, who surveyed and collected the biota of the virtually inaccessible tributaries of the Waipio River complex.

Revised Key to Hawaiian *Sigmatineurum* Parent Based Upon Males

1. Crossvein m-cu straight or with with slight bend near middle, not distinctly S-shaped; FII with only short weak bristles or bristles absent, replaced by fine hairs (*mnemogagne* species complex) 2
-. Crossvein m-cu strongly sinuate to S-shaped (Fig. 6), with or without spur veins; FII with long strong bristles on basal 1/2 (except in *omega*). 5
2. Sternal process 4 thickened in cross section (Fig. 8); tr with small pointed process; FII without black bristles, bristles replaced by fine hairs (Oahu) . . . . . **binodata** (Parent)
-. Sternal 4 process thin in cross section (Fig. 10); tr with or without pointed process; FII with black bristles ventrally 3

3. Sternal process 4 long, thin in cross section; FII with bulge subapically on ventral surface 4
-. Sternal process 4 short, peg-like in cross section (Fig. 10); FII without bulge ventrally (East Maui) . . . . . **parenti** Evenhuis, **n**. **sp**.

4. Body color black; tr with pointed process; FII with distinct triangular shaped bulge (Fig. 3b); sternal 4 process not flared laterally (East Maui) . . . . . **nigrum** Evenhuis, **n**. **sp**.
-. Body color brown, paler than above; tr without pointed process; FII with much reduced bulge subapically; sternal 4 process flared apically (East Maui) . . . . . **mnemogagne** Evenhuis

5. Crossvein m-cu without spur veins 6
-. Crossvein m-cu with spur veins 7

6. Sternal 4 process long, thin, capitate in cross section (Fig. 11); FII with bristles in middle ventrally, bare apically and basally (Hawaii—Kohalas) . . . . . **meaohi** Evenhuis, **n. sp**.
-. Sternal 4 process not capitate in cross section; FII with bristles along ventral surface from subbasally to apex (Molokai) . . . . . **chalybeum** Parent

7. TII with distinct bulge subapically; FII with ventral row of short bristles in middle, bare at base and at apex (Hawaii—Mauna Kea) . . . . . **omega** Evenhuis
-. TII without distinct bulge subapically; FII with ventral bristles much longer . . . 8

8. Wing infumate basally, anteriorly, and along most veins; veins R4+5, M1, and crossvein m-cu thickened and darkly tinted; TII without MSSC; sternite 4 process small, pointed, thick in lateral view (Kauai) . . **napali** Evenhuis
-. Wing weakly infuscate basally and anteriorly; crossvein m-cu without thickening and dark tinting; TII with strong bristles and preapical spur (West Maui) . . . . . **iao** Evenhuis

Discussion

The species composition of *Sigmatineurum* based on the specimens examined in this study and the revision by Evenhuis & Polhemus (1994) shows a high correlation of one species per volcano throughout the main Hawaiian Islands (with the exception of the three species found on East Maui). Based upon the knowledge of their restricted aquatic habitat, it can be hypothesized that there is a potential of at least one species for every volcano in Hawaii that has swift running streams. The current species composition and island distribution in Hawaii is as follows:

Species	**Island**	**Volcano**
binodatum	Oahu	Koolau
chalybeum	Molokai	East Molokai
iao	Maui	West Maui
meaohi	Hawaii	Kohala
mnemogagne	Maui	Haleakala
napali	Kauai	Kauai
nigrum	Maui	Haleakala
omega	Hawaii	Mauna Kea
parenti	Maui	Haleakala

Thus, the volcanos remaining with no recorded *Sigmatineurum* species that have swift running streams, and that should predictably support species of this genus are as follows:

Oahu	Waianae
Lanai	Lanai
Hawaii	Mauna Loa (Ninole)

Subfamilial Limits of Hydrophorinae

A comprehensive review of the world genera is badly needed in order to fully understand the subfamilial limits of members of the Dolichopodidae. However, few have attempted such a monumental investigation. Robinson (1970) is currently the only worker to have provided a careful analysis of genera within subfamilies and attempted to define subfamilial limits. Unfortunately, his work was limited to New World taxa. Taxa from particular subfamilies in the Old World tropics and native dolichopodids from Oceanic Islands are a very complex group with characters occupying a dizzying variety and that possess character states that often overlap with character states that are typical of other subfamilies. Despite these potential problems, Robinson's work still remains a paradigm and it has been used here as a basis for study for the Hawaiian genera of Dolichopodidae. The following definition of Hydrophorinae is taken from Robinson (1970):

> "Arista dorsal or apical; third antennal segment often elongate or lobed; head rounded posteriorly or slightly depressed behind vertex; epipharyngeal armature with two to four short or long lobed often separated at the base, smooth or slightly to seriately denticulate; labellae sometimes highly sclerotized and mandibuliform, pseudotracheae geminately to massively sclerotized, sometimes the sixth panel unsclerotized, sensory papillae often located on or attached to bases of the pseudotracheae. Thorax rather narrow, acrostichals biseriate to lacking, four to ten pairs of often reduced dorsocentrals; slightly to strongly convex, sometimes flattened posteriorly; proepisternum bare in upper part, often heavily pubescent below; fourth with vein not branched, last of fifth vein often shorter than the posterior crossvein. Femora with poorly differentiated preapicals often remote from the tips of the femora, anterior femora often thickened at the base and bearing distinctive setae. Abdomen sometimes flattened above; hypopygium relatively small or somewhat enlarged but usually enclosed in the tip of the preabdomen; female genitalia with a crest of dornen above. Larvae with obvious lobes posteriorly (7 lobes in *Aphrosylus*)."

The genera found in Hawaii that are currently treated within Hydrophorinae are: *Hydrophorus* Fallén (2 species), *Sigmatineurum* Parent (9 species), *Paraliancalus* Parent (1 species), *Thinophilus* Wahlberg (1 species) (Grootaert & Evenhuis, 1997), and *Thambemyia* Oldroyd (= *Conchopus* of authors) (1 species[2]). I have examined various Hawaiian taxa, compared them with the characters used by Robinson, and concur that the genera listed above are hydrophorine (*sensu* Robinson). This re-examination prompted the transfer of *Eurynogaster binodata* to *Sigmatineurum*. Re-examination of all known species of *Eurynogaster* is currently underway, which will no doubt result in further transfers of species to Hydrophorinae and clarification of generic limits of that genus.

Acknowledgments

The following curators at the institutions are thanked for generously allowing access to specimens: HDOA (Bernarr Kumashiro), BMNH (Brian Pitkin and John Chainey), UHM (M. Lee Goff). I am obliged to Patrick Grootaert and Dan Bickel for informative discussions on the systematics of the Dolichopodidae and characteristics of Hydrophorinae.

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A New Species of *Thinophilus* (Diptera: Dolichopodidae) from the Hawaiian Islands[1]

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Until now the genus *Thinophilus* was not known from the Hawaiian Archipelago. Other hydrophorine genera and species that have been known previously from the islands are: the marine genus *Thambemyia* Oldroyd with *T. acrosticalis* Parent as the only species thus far recognized from Hawaii; the largest Hawaiian dolichopodid, *Paraliancalus* Parent, with *P. metallicus* (Grimshaw) found along streams in mountains; the genus *Sigmatineurum* Parent with 9 species found in the splash zone along mountain streams [see Evenhuis & Polhemus (1994) and Evenhuis (1997) for recent revisions], and *Hydrophorus* Fallén, represented by 2 species: the widespread *H. pacificus* Van Duzee and *H. williamsi* Parent, both species occurring on tidal mud flats and marshes affected by high tide. The new *Thinophilus* species described here is found in a rather similar habitat. We suppose that it is not a recent introduction, but that due to its small size it was overlooked until now. Terminology and setal abbreviations follow Bickel (1991).

Thinophilus hardyi Grootaert & Evenhuis, **new species** Figs. 1–4

Diagnosis. Small, metallic green species. Palpus yellow. Antenna yellow, but segments 2 and 3 darkened dorsally . Tip of first flagellomere truncate. Mesonotum with 5 *dc*. Legs, including tips of fore coxae, yellow. Mid femur with a strong anterior preapical; hind femur with a strong anterodorsal preapical bristle. Wing without cloudings. Abdomen ventrally with minute white hairs. Tergum 4 in female with long black bristles apically.

Male. Body length 2.4 mm; wing length 2.3 mm. *Head*. Frons with dark metallic greenish-blue ground color. Frons and face densely covered with brownish dusting. Narrowest point of face at upper apical 1/3, as wide as ocellar callus. Clypeus not delineated, distinct as a slight bulge; about 1/4 the length of the face. Palpus large, yellow, with scattered short brownish hairs. Rostrum brownish black. Occiput brownish dusted. Two long, black ocellars, pointing upward, diverging; 2 shorter verticals, pointing forward, converging; a pair of short black postocellars; 2 short postverticals, not in row with postoculars. Upper postoculars uniseriate, short, black; lateral and lower postoculars pluriseriate, longer, whitish. Antenna (Fig. 2) short, yellow, but pedicel and first flagellomere dark brown dorsally. Pedicel overlapping first flagellomere partly on upper side, bearing tiny marginal bristlets. First flagellomere subrounded, although tip truncate, longer than broad. Arista dorsal, practically bare, about 2.5 × length of antenna; apical 1/4 whitish; basal aristal segment very short.

Thorax and scutellum dark metallic green, covered with a brownish-gray dust. No dull black spots on mesoscutum. All bristles black. No *ac*; 5 *dc*, all long, gently increasing in length to the rear; anterior bristle 3/4 length of posteriormost. One each of long humeral, posthumeral, presutural, postsutural, long notopleural, supraalar, and long postalar setae. Scutellum with 2 large marginals. Upper propleura with bundle of white hairs, lower part with a few (4) longer white hairs. Prothoracic collar with row of short white bristles.

Legs. Fore coxae with basal half black; mid and hind coxae black, with yellow tips. Fore and mid tarsi darkened from base of fourth segment onwards. Hind tarsi darkened from tip of second segment onwards; otherwise legs yellow.

Fore leg: Coxa anteriorly with white hairs; at apex a row of 5 thin black bristles. Femur ven-

1. Contribution No. 1997-007 to the Hawaii Biological Survey.

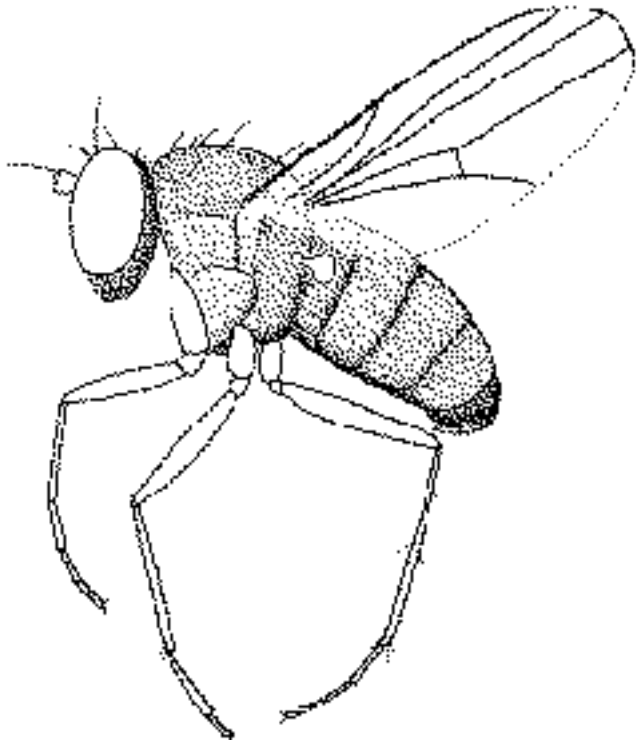

Fig. **1**. *Thinophilus hardyi*, n. sp. male habitus.

trally without bristles; posteroventrally on apical third a row of 4–5 very short bristles; a black anterior preapical. Tibia about as long as femur; 2 dorsals and a short ventral on basal third. First tarsal segment spinulose ventrally ; tarsal segments 1–4 each with 2 apicoventral spinules. Length of tibia and tarsal segments (in mm): 0.7 : 0.3 : 0.13 : 0.1 : 0.08 : 0.1.

Mid leg: Coxa with a fine black exterior bristle. Trochanter with a black ventral spot at tip. Femur with a double row of minute brown bristles ventrally; a strong, black anterior preapical bristle as long as femur is broad and a shorter posteroventral preapical. Tibia about as long as femur; 2 ad and 2 pd (or dorsals), forming pairs near base and at middle of tibia, all as long as or slightly longer than tibia is broad; a ventral and a circlet of apicals, including a rather strong ventral bristle. Tarsal segments 1–4 each with 2 apicoventral spinules. Length of tibia and tarsal segments (in mm): 0.83 : 0.34 : 0.15 : 0.13 : 0.1 : 0.13.

Hind leg. Coxa with a feeble, black exterior bristle. Trochanter with a black spot ventrally, with

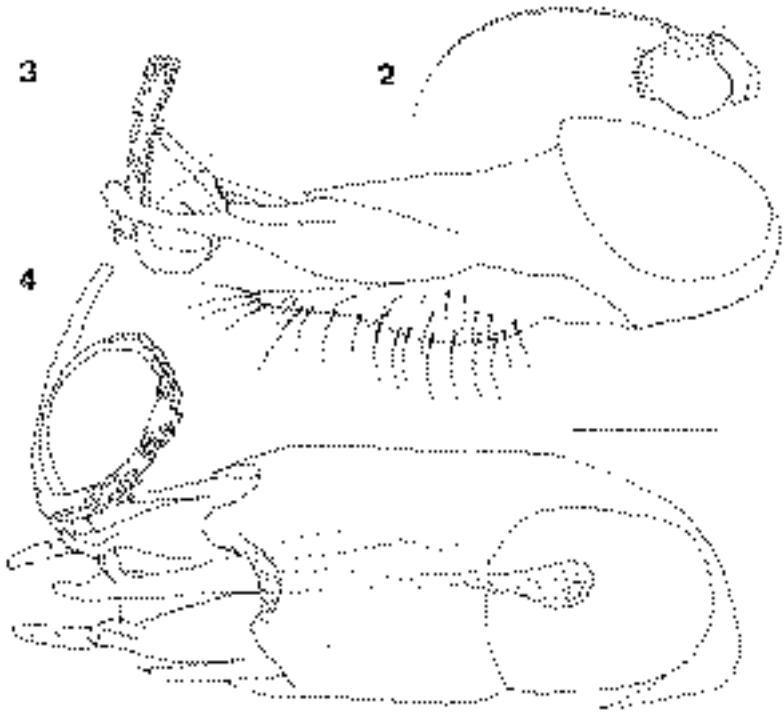

Fig. **2-4**. *Thinophilus hardyi*, n. sp. paratype male.**2**, antennae, lateral view. **3**, genitalia: lateral view. **4**, genitalia ventral view. Scale 0.1 mm.

a ventral bristle and a few hairs. Femur with a row of very short bristles ventrally; dorsally near base some of the hairs are bristle-like; a short preapical ad. Tibia about as long as femur; 3 ad, 2 pd, all short; 4 apicals (dorsal very long); at anteroventral apical rim a short brownish fringe. Tarsal segments 1–4 each with 2 apicoventral spinules. Length of tibia and tarsal segments (in mm): 0.93 : 0.23 : 0.25 : 0.18 : 0.1: 0.1.

Wing hyaline, feebly grayish-brown tinged, without clouding. Apical part of M_{1+2} gently curved (wing boss) before its middle, apically parallel to R_{4+5}. Apical part of M_{3+4} nearly 3 × longer than tp. Anal vein present. Halter pale yellow. Squama pale yellow, with short white cilia.

Abdomen dark metallic green in ground color; gray dusted. Hairs and marginal bristles on terga very short, black. Venter with minute white hairs. Hypopygium (Figs. 3, 4) with brown surstyli. Cerci yellow, 3/4 as long as surstyli. Aedeagus strap shaped, yellow.

Female. Body length: 2.38 mm; wing length: 2.43 mm. As in male except as follows: Face wider than in male; parallel-sided throughout. A row of distinct anterior bristles on hind femora. Apical bristles on terga longer than in male especially those on tergum 4.

Types. Holotype male (BPBM 15,830), allotype, and 10 paratypes (3 males, 2 females in alcohol; 1 male, 4 females on pin) from: Hawaiian Islands: OAHU: Pupukea Beach (Shark's Cove), 19.x.1996, P. Grootaert & N.L. Evenhuis (all in Bishop Museum, except 3 paratypes: 1 male, 1

female on pin and 1 male in alcohol in Royal Belgian Institute of Natural Sciences, Brussels).

Etymology. The species is named for Prof. D. Elmo Hardy who was a pioneer of the study of the dolichopodids in the Hawaiian Islands.

Discussion. Currently, 3 subgenera are recognized in the genus *Thinophilus*: *Schoenophilus* Mik, which has only 4 nearly equally long dorsocentrals (Grootaert & Meuffels, 1984); *Parathinophilus* Parent, which is characterized by the possession of small acrostichals and *Thinophilus* s.str., which has 5 or more dorsocentrals and no acrostichals.

Thinophilus hardyi, n. sp. can be distinguished from many congeners by its rather small size, the absence of a distinct bristling on the legs, the absence of dull black spots on the thorax and the unclouded veins. Also this new species does not correspond to the description of the almost cosmopolitan species *T. indigenus* Becker, 1902, which has 7 black dots on the thorax, 6 dorsocentrals, cerci with a broad tip, and black cloudings around tp and a boss on vein M_{1+2}.

Thinophilus hardyi was found on a marshy sandplate on top of a porous lava bench protected by a rocky shore from the sea. The sand was covered with brown patches of diatomaea. Sea water welled up through the lava bench from time to time. The *Thinophilus* were mainly active on the wet sand around the upwelling sea water.

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The First Endemic Hawaiian *Heliothis* (Lepidoptera: Noctuidae): *H. melanoleuca*, a New Species from Riparian Forest

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While there are 5 species of *Helicoverpa* Hardwick (1965) known from Hawaii, including 4 endemics, *Heliothis s.s*. was previously represented here only by the introduced tobacco budworm, *H. virescens*. An endemic Hawaiian species, *Heliothis melanoleuca*, is described in this paper from 9 specimens collected on Oahu. This new species has distinctive black and white vestiture (Fig. 1) sometimes tinged with yellow and/or green, which is quite unlike any other heliothine noctuid. However, examination of the genitalia of both sexes, and other characters, betrays an affinity with "typical" *Heliothis* species, as defined by Matthews (1991).

The unusual patterning of the wings is suggestive of lichen-like cryptic coloration, and it is possible that the adults may rest during the day on lichen-covered substrates. Indeed, exposed rocks partially covered with mosses and lichens are common in the type locality: wet, riparian forest on Mt. Tantalus, Oahu, elevation 550m (1,800 ft). The only other heliothines which occur naturally in the wetter parts of the tropics are the species of the *H. virescens*-group (Matthews, 1991). However, *H. melanoleuca* possesses none of the synapomorphies of the latter group listed in Poole *et al.* (1993), and its phylogenetic affinities within the genus remain undetermined.

Description of the adult (the only life history stage known to date) is based on the holotype with variation among the paratypes noted in parentheses. The single female paratype has lost much vestiture from the wings, therefore appearing lighter than the males, but since it is not otherwise much different, it is not described separately. Insect collection abbreviations are from Arnett & Samuelson (1986).

Heliothis melanoleuca Mitchell, **new species** Figs. 1–7

Expanse: 32 mm (range = 28–32 mm, mean = 30.3 mm, n = 9).

Head: Eyes well developed. First 2 palpal segments predominantly dark gray with some white distally; third palpal segment with short appressed setae, gray dorsally and white ventrally (white dorsally and ventrally in some paratypes). Frons with even short black and white scales mixed together, appearing gray to the naked eye. Vertex with longer uneven scales of the same colors. Scape of antenna bearing distinct white scales; flagellum dorsally clothed in short black appressed scales, bare ventrally; each flagellomere with a pair of lateral setae longer than flagellomere.

Thorax: Forewing dorsally mottled, ranging from pure creamy white (yellowy white tinged with green in 2 paratypes from type locality; yellowy white tinged with amber in 2 paratypes from North Halawa Valley) to dirty gray to black. Proximal half of basal area gray. Basal line black, well developed. Distal half of basal area predominantly whitish anteriorly, with 2 central gray patches;

Fig. 1. Holotype (male), habitus. **Figs. 2–6.** Male genitalia and associated sclerites. **2,** = valvae; **3,** = juxta; **4,** = aedeagus; **5,** = eighth tergite. **6,** = eighth sternite. **Fig. 7.** Female genitalia. Scale bar = 2 mm for Figs. 2-3 and 1 mm for Figs. 4-7.


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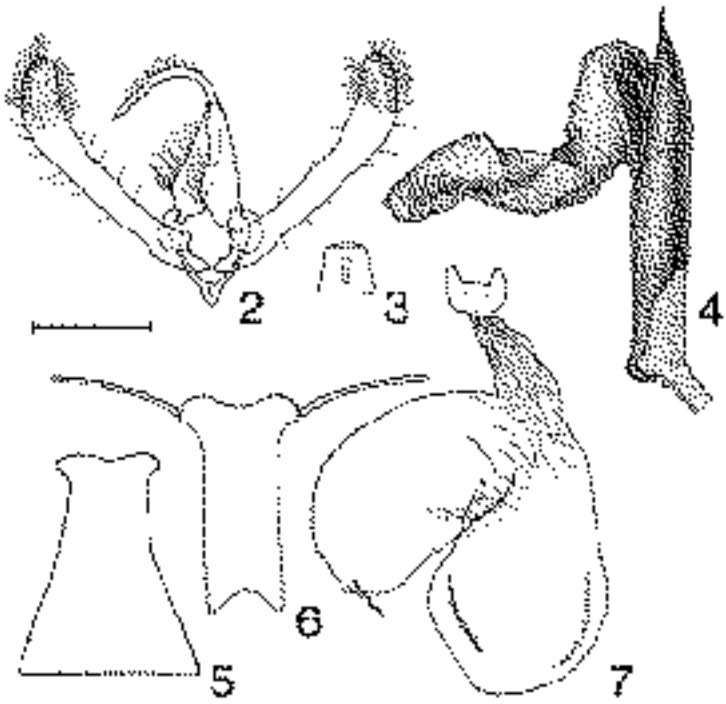
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predominantly gray posteriorly but with thin white band before antemedial line. Dentate antemedial line black, greatly thickened anteriorly. Basal half of median area mottled white and gray to black. Orbicular spot with black oval border surrounding white interior. Claviform spot squarish, overlying antemedial line basally. Medial line poorly defined, broken posterior to reniform spot, expanded into large more or less rectangular black patch on anterior wing margin, and into similar smaller patch on posterior margin. Reniform spot open anteriorly; interior dark gray with 3 white patches posteriorly. Subreniform spot poorly defined, indistinguishable from surrounding area but for black outline. Postmedial line scalloped, strongly curved towards base anteriorly, broken periodically by irregular white line on outer margin. Subterminal area black from costa through radial sector, with three white spots along costal margin; black patch surrounding diffuse white dot in cubital region and on posterior wing margin, the black patches delimiting subterminal line at outer margin; otherwise predominantly white. Terminal area predominantly gray (grayish brown in some paratypes). Adterminal line of distinct black patches. Long apical fringe of alternating gray and white. Forewing ventrally white with reniform spot showing through as gray patch. Basal half of hindwing dorsally even fawny gray, with outer half somewhat lighter. Hindwing ventrally even whitish gray with somewhat darker postmedian line and diffuse discal spot. Vestiture black on anterior face of prothorax, immediately posterior to eye. Thorax dorsally with long black and white setae intermixed, appearing gray to the naked eye (white in 5 paratypes), setae about twice as long those on vertex. Transverse, more or less straight, black band anteriorly on mesothorax, about half as wide as mesothorax. Weaker, posteriorly concave black band near posterior margin of mesothorax, and posteriorly convex black band on posterior margin of metathorax, laterally contiguous with first band, together enclosing light oval area. Longitudinal black band laterally above wing bases. Thorax laterally and ventrally covered by long white vestiture, mixed with gray from below head to between forelegs. Legs black with white patches around joints; single strong spine sometimes present on outer margin of prothoracic tibia, at half length of tibia, about half as long as outer protibial spur (visible in 3 of 7 male paratypes, and in the single female paratype).

Abdomen: First 4 segments whitish dorsally, with black patch mesally on first segment. Rest of abdomen same color as hindwings.

Male genitalia: Paratypes: Valves long and strap-like, distally recurved, 20–28 stout spines forming corona apically (Fig. 2). Surface of cucullus with mat of fine long setae, produced over dorsal margin of cucullus and dorsal to corona. Tegumen with posteroventral angle sclerotized, bearing brush of long fine setae. Uncus curved, the angle of curvature weakening distally towards flattened apex; bearing brush of setae dorsally, longest near midpoint of uncus. Juxta as long as wide (Fig. 3). Scobinate bar loosely attached to aedeagus basally otherwise positioned at base of vesica (Fig. 4). Vesica short, twisted through one complete spiral turn, with band consisting of lightly sclerotized transverse ridges extending longitudinally from base to tip. A single rounded basal diverticulum on vesica. Eighth tergite with anterior arms reduced and rounded (Fig. 5). Eighth sternite with sides parallel, proximal apodemes at least 0.6 × as long as sternite (Fig. 6).

Female genitalia: Ductus bursae approximately twice as long as wide, weakly sclerotized over most of length (Fig. 7). Appendix bursae saccate, subequal to corpus bursae.

Type material. Holotype, male (BPBM 15,880): "Hawaiian Is: Oahu I. Mt. Tantalus El. 1800 ft. Fluor. light. 13-x-1992. W. D. Perreira collector"; additional label reads "M & K Tauber also collectors." Paratypes, 3 males (1 in HDOA, 2 in BMNH) and 1 female (BPBM): same collection data as the holotype; one male (USNM): "Hawaiian Is: Oahu I. Mt. Tantalus El. 1800 ft. UV light. 19-viii-1985. W.D. Perreira collector." Genitalia slides made by R.W. Poole (USNM 46080, USNM 45895 and USNM 45896, female) and P. Gentili (USNM 46070). 3 males (2 in BPBM, 1 in USNM) "Hawaiian Is: Oahu I: North Halawa Valley El. 1000 ft. Malaise trap. 11-i-1996, 18-xi-1996, 1-xii-1996, D.J. Preston collector".

Etymology. The specific epithet *melanoleuca* is derived from the Greek words for black (melanos) and white (leukos), in reference to the unusual vestiture of this species.

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Taxonomic Changes Published in This Volume

INSECTA:
Diptera: **Dolichopodidae**
Sigmatineurum binodatum (Parent), **new combination**, transferred from *Eurynogaster.*
Sigmatineurum nigrum Evenhuis, **new species**
Sigmatineurum parenti Evenhuis, **new species**
Sigmatineurum meaohi Evenhuis, **new species**
Thinophilus hardyi Grootaert & Evenhuis, **new species**

Lepidoptera: **Noctuidae**
Heliothis melanoleuca Mitchell, **new species**