
BISHOP MUSEUM OCCASIONAL PAPERS

RECORDS OF THE
HAWAII BIOLOGICAL SURVEY
FOR 1994
PART 1: ARTICLES

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RECORDS OF THE HAWAII BIOLOGICAL SURVEY FOR 1994 Part 1: Articles

Introduction

The Hawaii Biological Survey (HBS), 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 HBS will gather, analyze, and disseminate biological information necessary for the wise stewardship of Hawaii's biological resources.

Soon after its founding in 1889, Bishop Museum established programs to study and document the plants and animals of Hawaii and that effort has become the largest single source of information on Hawaiian organisms. Virtually all definitive published treatments and manuals of Hawaiian organisms, beginning with *Fauna Hawaiiensis* in 1890, have been produced by the Museum or in close collaboration with the Museum. There are approximately 15,000 terrestrial, 300 freshwater, and 5,500 marine species of plants and animals in Hawaii. Bishop Museum has the world's largest biological collections for Hawaii (about 4,000,000 specimens). In 1992, the Hawaii State Legislature recognized the Bishop Museum's past and current activities by designating it as the Hawaii Biological Survey.

Each year, the Bishop Museum publishes the *Records of the Hawaii Biological Survey*, which provides a medium for dissemination of short notes and records of range extensions, first state or island records, or other pertinent information on the biota of the Hawaiian Islands. The *Records* provide a venue to collect and publish significant new data on Hawaiian organisms that might otherwise not be published in any standardized, retrievable and citable manner. In addition to these shorter notes, this first volume of *Records* includes some longer papers, which contain information essential to the Hawaii Biological Survey and substantially augment our current knowledge of the status of our State's biota. The updates to the 1990 *Manual of the flowering plants of Hawai'i* are especially significant.

The *Records of the Hawaii Biological Survey for 1994* were compiled with the assistance of Allen Allison (vertebrate zoology), Walter Appleby (botany), Robert H. Cowie (malacology), Lucius G. Eldredge (invertebrate zoology, marine zoology), and Gordon

M. Nishida (entomology), who acted as editors for papers in their disciplines; and was partially supported by a grant from the John D. and Catherine T. MacArthur Foundation.

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 in writing from: Hawaii Biological Survey, Department of Natural Sciences, Bishop Museum, P.O. Box 19000A, Honolulu, Hawaii 96817-0916, USA; or by electronic mail: hbs@bishop.bishop.hawaii.org.

—Neal L. Evenhuis and
Scott E. Miller, Editors

How many species are there in Hawaii?¹

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Introduction

The Hawaiian Islands are the most isolated island group in the world. The 8 main southeastern islands, with their sequentially younger geological ages, great physiographic and climactic variation, are ideal natural laboratories for evolutionary and ecological research (see Howarth 1990, Kay 1994 for further background). Although the Hawaiian biota has been subjected to systematic study since shortly after the founding of Linnaean nomenclature, these results are scattered through publications and collections around the world. Moreover, many gaps remain in the knowledge of Hawaii's biota, especially for the smaller organisms such as viruses, bacteria, freshwater algae, protists, and soil invertebrates other than insects and mollusks. This paper is a first approximation by Bishop Museum's Hawaii Biological Survey to answer the frequently asked question: "How many species are there in Hawaii?"

In compiling this list, we have collected and assembled data and wisdom of the staff of Bishop Museum, libraries of the Bishop Museum and the University of Hawaii, and many colleagues in Hawaii and around the world. The marine portions draw heavily from the ongoing project *Reef and shore fauna of Hawaii*. The terrestrial invertebrate data derive primarily from an invertebrate survey pilot project supported by the John D. and Catherine T. MacArthur Foundation in the late 1980s. An early version of the terrestrial and freshwater portions of the list was circulated at the Hawaii Conservation Biology Initiative annual meeting in 1992. The interest of that group prompted us to continue the effort. We know that the present list is incomplete in several ways: 1) we expect that some literature has been missed; 2) we know that additional information, including unpublished new species, exist in museum collections; and 3) further fieldwork will produce additional records. The Hawaii Biological Survey is creating comprehensive databases for basic taxonomic, distributional, and biological information on all the organisms occurring in Hawaii, so we welcome additions and corrections to this list.

Classification of animals generally follows Parker (1982), with the use of kingdoms in the sense of Margulis & Schwartz (1988). Some artificial categories of convenience are used (for examples, marine mollusks). Freshwater categories generally include brackish water dwellers. Viruses and bacteria are not included because too few data are available, although the plant parasitic species were reviewed by Raabe *et al.* (1981). Human parasites are also not included. Unless noted, all numbers represent described species reported in the literature and often under-represent the eventual total which can be expected based on further exploration. On the other hand, there may be many more names in the literature for some groups because the taxa have not been reviewed or revised to eliminate the synonyms. The numbers from the *Reef and shore fauna* manuscripts include previously unpublished records.

The term endemic is problematic. In the terrestrial environment it is easy to determine the boundaries of the Hawaiian Islands, but the fact that a species is known only from Hawaii may mean only that it has not yet been reported elsewhere. This is especial-

1. Contribution No. 1995-002 to the Hawaii Biological Survey.

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ly a problem in groups that require specialized sampling techniques and that may have been better studied in Hawaii than in many other places (e.g., planktonic crustaceans, soil mites). In the marine environment this problem is worse because the ocean provides a medium for movement throughout the Indo-west Pacific. Moreover, it is difficult to determine boundaries. Thus, we expect that most of the taxa currently listed as endemic to Hawaii's marine environment will ultimately prove to be more widely distributed.

Definitions

For the marine environment "Hawaii" includes the coastal areas to the deepest waters, including all the waters surrounding all of the islands of the archipelago.

Nonindigenous species (NIS) are those species that do not naturally occur in the Hawaiian Islands and have arrived either accidentally or intentionally through biological control efforts, aquaculture imports, etc. These species have also been referred to as alien, exotic, adventive, or introduced species (Frank & McCoy 1990).

Indigenous species are those species which naturally occur in the islands but are not endemic to the islands (i.e., they also occur naturally elsewhere).

For birds, *visitors* are nonresident species; *migratory* birds follow a repeatable pattern of occurrence in the islands.

Subfossil/fossil species in Hawaii are used in the context of birds and bats that became extinct prior to the arrival of Captain Cook. Invertebrate fossils discovered through core sampling, archaeological digs, and other techniques have not been included in the data tabulated below.

Extinct species are those forms that no longer exist in their natural habitat. It is difficult at best to attempt a tabulation of how many of the species originally described from the Hawaiian Islands have become extinct through natural processes or with the advent of humans and the concomitant destruction of native habitats and associated species through time. Data on known extinct vertebrates are included in the notes, but not in Table 1.

Table 1. Estimates of Numbers of Species of the Hawaiian Biota

Taxon	Total	Endemic	NIS	Reference(s)
PROTOCTISTA				
Algae				
freshwater	120+	2	?	Vis <i>et al.</i> 1994; I.A. Abbott, pers. comm.
marine	470	?	5	I.A. Abbott, pers. comm.
Myxomycota	101	0	?	Eliasson, 1991
Protozoa				
Foraminifera	1000+	?	0	Phillips, 1977; Chave, 1987
Other protozoa	42	2?	0	Ball, 1963; Phillips, 1977; Larsen & Patterson, 1990; Boyko, 1994
FUNGI				
Fungi	1300	?	?	Baker & Goos, 1972; Goos, 1977; Kohlmeyer, 1969
Lichens	723	240	?	Smith, 1991, 1993
PLANTAE				
Bryophytes				
mosses	244	112	11	Hoe, 1979
liverworts	220	?	?	Miller & Whittier, 1990

Taxon	Total	Endemic	NIS	Reference(s)
Fern Allies	24	7	2	W.H. & F. Wagner, pers. comm.
Ferns	205	124	27	W.H. & F. Wagner, pers. comm.
Gymnosperms	10?	0	10?	W. Appleby, pers. comm.
Angiosperms	1894	850	861	Wagner <i>et al.</i> , 1990; HBS Records for 1994*
ANIMALIA				
Phagocytellozoa				
Placozoa	1	0	0	Pearse, 1989
Parazoa				
Porifera				
marine	84	24	4+	Bergquist, 1977; Chave & Jones, 1991
freshwater	1	0	1	Svihla, 1941
Eumetazoa				
Cnidaria				
Hydroida				
marine	23	4	1	Cooke, 1977
deepwater	51	31	0	Nutting, 1905
freshwater	2	0	2	Matthews, 1966
Siphonophora	1	0	0	Eldredge & Devaney, 1977
Chondrophora	2	0	0	Eldredge & Devaney, 1977
Scyphozoa	13	0	5	Devaney & Eldredge, 1977; Cooke, 1984; Burch & Burch, 1995
Octocorallia	105	17	1	Devaney, 1977b; Grigg & Bayer, 1976; Muzik, 1978; Versevelt & Bayer, 1988; Bayer, 1990; Chave & Jones, 1991
Zoantharia	23	5	1	Cutress, 1977
Zoanthiniara	7	4	0	Walsh & Bowers, 1977
Scleractinia	99	12	0	Maragos, 1977, 1995; Grigg <i>et al.</i> , 1981; Cairns, 1984
Antipatharia	15	1	0	Grigg & Opresko, 1977; Chave & Jones, 1991
Ctenophora	10	0	1	Devaney, 1977a; R. Galt, pers. comm
Platyhelminthes				
marine	41	20	0	Poulter, 1987
freshwater/terrestrial	8	4	4	Hyman, 1939; Kawakatsu & Mitchell, 1984; Kawakatsu <i>et al.</i> , 1984
parasitic	519	371+	0	Yamaguti, 1968a, 1968b, 1970; Kaneko <i>et al.</i> , 1988; Dailey <i>et al.</i> , 1992
Nemertinea				
marine	26	5?	0	Coe, 1947; Devaney & Eldredge, 1987; J. Norenburg, pers. comm.
freshwater/terrestrial	2	0	2	Howarth & Moore, 1983; J. Norenburg, pers. comm.
Gnathostomulida	8	4	0	Sterrer, 1991
Rotifera				
marine	3	0	0	Hope, 1987
freshwater	27	?	0	P.N. Turner, pers. comm
Nematoda				
marine	54	23	0	Hope, 1987
plant/soil	127	?	?	Olveira, 1940; E.M. Noffsinger & E.P. Caswell (unpubl. 1989)
zooparasitic	33+	?	?	Chapin, 1925; Deardorff <i>et al.</i> , 1982; Deardorff, 1987; McKenzie & Davidson, 1989

Taxon	Total	Endemic	NIS	Reference(s)
Priapulida	1	0	0	J. Bailey-Brock, pers. comm..
Mollusca				
Gastropoda				
marine	572	119	4	Kay, 1979; Kay & Palumbi, 1987
terrestrial	831±	759	50±	R.H. Cowie <i>et al.</i> , in press
freshwater	37±	7	30±	R.H. Cowie, pers. comm.
Bivalvia				
marine	129	66	1	Kay, 1979; Kay & Palumbi, 1987
freshwater	1	0	1	Burch, 1978; HBS Records for 1994
Polyplacophora	4	3	0	Kay, 1979
Scaphopoda	3	0	0	Kay, 1979
Cephalopoda	73	2	0	Kay, 1979; Berry, 1914; Roper & Young, 1975; Roper <i>et al.</i> , 1984; Young, 1991
Aplacophora	6	0	0	Kay, 1979
Annelida				
Oligochaeta				
marine	26	11	3?	Bailey-Brock, 1987; Erséus & Davis, 1989; Erséus, 1990
terrestrial	20	0	20	Nakamura, 1992; S.W. James, unpubl.
Archiannelida	2	0	0	Bailey-Brock, 1987
Hirudinea				
marine	3	0	0	Bailey-Brock, 1987; Choy <i>et al.</i> , 1989
terrestrial	3	0	3	Moore, 1946
Polychaeta				
marine	250+	69+	4	Pettibone, 1986; Paxton & Bailey-Brock, 1986; Bailey-Brock & Hartman, 1987; Bailey-Brock, 1990, 1991; Fauchald, 1992
freshwater	1	0	0	Van Zwaluwenburg, 1948
Pogonophora	2	2	0	Southward, 1980
Echiura	6	0	0	Edmonds, 1987
Sipuncula	14	0	0	Edmonds, 1987
Arthropoda				
Insecta (nonmarine)				
Blattaria	19	0	19	Nishida, 1994
Coleoptera	1987	1358	597	Nishida, 1994; HBS Records for 1994
Collembola	168	95	71	Nishida, 1994
Dermaptera	24	9	14	Nishida, 1994
Diptera	1426	1048	631	Nishida, 1994
Heteroptera	316	214	96	Nishida, 1994; HBS Records for 1994
Homoptera	689	385	299	Nishida, 1994; HBS Records for 1994
Hymenoptera	1283	654	605	Nishida, 1994; HBS Records for 1994
Lepidoptera	1153	950	192	Nishida, 1994; HBS Records for 1994
Mallophaga	102	5	44	Nishida, 1994
Neuroptera	60	51	8	Nishida, 1994
Odonata	41	31	8	Nishida, 1994; HBS Records for 1994
Orthoptera	290	263	26	Nishida, 1994; Otte, 1994
Psocoptera	135	89	42	Nishida, 1994
Thysanoptera	147	29	116	Nishida, 1994
Remaining orders	62	6	45	Nishida, 1994
Insecta (marine)	4	1	0	Herring, 1961, 1965; N.L. Evenhuis, pers. comm.
Araneae	108	110	71	Nishida, 1994; HBS Records for 1994
Chilopoda	24	12	12	Nishida, 1994
Diplopoda	26	16	9	Nishida, 1994
Palpigrada	1	0	1	Nishida, 1994

Taxon	Total	Endemic	NIS	Reference(s)
Paupoda	2	0	1	Nishida, 1994
Pseudoscorpionida	12	12	0	Nishida, 1994
Shizomida	1	0	1	Nishida, 1994
Scorpionida	1	0	1	Nishida, 1994
Crustacea				
Branchiopoda	4	0	0	Ueno, 1936
Ostracoda				
marine	31	?	0	J.C. Holden, MS; Kornicker, 1976; Danielopol & Hartmann, 1986; Hartmann, 1991
freshwater	1	?	?	Vávra, 1906
Copepoda	100	?	?	L.G. Eldredge, MS; Motoda, 1963; Lewis, 1966, 1967; Humes, 1976; Wells, 1986; Kunz, 1993; HBS Records for 1994
Cirripedia	58	?	0	W.A. Newman, MS; Pilsbry, 1907; Boschma, 1953
Stomatopoda	17	11	1	L.G. Eldredge, MS
Mysidacea	14	?	0	L.G. Eldredge, MS; Ortmann, 1906
Tanaidacea	8	7	0	M. Miller, MS
Isopoda				
marine	27	?	?	M. Miller, MS; Richardson, 1906
terrestrial	51	15	26	Nishida, 1994
Amphipoda				
marine	172	?	8	Barnard, 1970; Brusca, 1973, 1978
terrestrial	9	6	3	Nishida, 1994
Euphausiacea	27	?	0	Ortmann, 1906; Brinton, 1962
Decapoda				
Penaecidae	20	0	0	L.G. Eldredge, MS
Sergestidae	10	0	0	L.G. Eldredge, MS
Stenopodidea	5	4	1	L.G. Eldredge, MS
Caridea	149	?	1	L.G. Eldredge, MS
Astacidea	1	0	1	Eldredge, 1994
Thalassinidea	8	?	1	L.G. Eldredge, MS
Palinuridea	13	2	0	L.G. Eldredge, MS
Anomura	43	?	0	L.G. Eldredge, MS
Brachyura	189	?	7	L.G. Eldredge, MS; HBS Records for 1994
Acari				
marine	19	17	2	Nishida, 1994
terrestrial	517	97	337	Nishida, 1994; HBS Records for 1994
Pycnogonida	12	?	0	J.H. Stock, MS; Child, 1972
Tardigrada	22	1	19	Nishida, 1994; McInnes, 1994
Phoronida	3	0	0	Emig & Bailey-Brock, 1987
Bryozoa	150+	?	?	Soule <i>et al.</i> , 1987
Entoprocta	?	?	?	Soule <i>et al.</i> , 1987
Brachiopoda	3	0	0	Emig, 1987; B.L. Burch, pers. comm.
Chaetognatha	8	1	0	Alvarino, 1978; Pierrot-Bults & Nair, 1991
Echinodermata				
Crinoida	16	15	0	L.G. Eldredge, MS; Clark, 1949
Asteroidea	82	53	0	L.G. Eldredge, MS; Clark, 1949
Echinoidea	75	35	0	L.G. Eldredge, MS; Clark, 1949
Holothuroidea	48+	19	0	L.G. Eldredge, MS; Clark, 1949
Ophiuroidea	57	28	0	D.M. Devaney & A.N. Baker, MS; Clark, 1949
Hemichordata	4	1	0	L.G. Eldredge, MS; Hadfield & Young, 1983; 1 undescribed sp.
Chordata				
Cephalochordata	1	0	0	Eldredge, 1967

Taxon	Total	Endemic	NIS	Reference(s)
Urochordata (Tunicata)				
Thaliacea	24	0	0	Metcalf & Hopkins, 1919; Yount, 1954; Soest, 1974a, 1974b
Larvacea	2	0	0	Taguchi, 1982; Kitalong, 1986
Asciacea	45	7?	2?	D.P. Abbott, MS; Tokioka, 1967
Pisces				
marine	1150+	134+	33	Eldredge, 1994; B. Mundy, pers. comm.
freshwater	45	5	40	Eldredge, 1994; Maciolek, 1984, Devick <i>et al.</i> , 1992
Amphibia	4	0	4	Vitousek <i>et al.</i> , 1987; C. Kishinami, pers. comm.
Reptilia	18	0	18	Vitousek <i>et al.</i> , 1987; Eldredge, 1994; C. Kishinami, pers. comm.
Aves	274	60	46	R.L. Pyle, pers. comm.
Mammalia				
terrestrial	20	1	19	Tomich, 1986
marine	24	0	0	Tomich, 1986
totals	21,383	8,759	4,532	

* HBS Records for 1994 = articles in *Bishop Museum Occasional Papers* 41 and 42 of the Records of the Hawaii Biological Survey for 1994.

Notes

Algae: Marine algae numbers are from an identification manual in preparation by I.A. Abbott & W. Magruder; numbers for freshwater and terrestrial species are only estimates, except for Vis *et al.* (1994) who reported 34 species; all other existing literature is outdated and unreliable (e.g., MacCaughy 1918).

Protozoa: Chave (1987) noted more than 1000 species in Hawaiian waters; Philipps (1977) reported on more than 400 species from depths less than 100 ft; Larsen & Patterson (1990) reported 31 benthic marine flagellate species, including 2 new species.

Fungi: Baker & Goos (1972), following Parris (1940) recorded 683 species, including Myxomycota (slime molds) but not lichens; Goos (1977) recorded 900 species of Fungi Imperfecti; Baker (1977) noted 1591 species of fungi from Hawaii and the central Pacific islands. Undoubtedly, the true number is much higher because the fungi are poorly studied in Hawaii (see also Goos & Gowing 1992). Hawksworth (1994) suggested that in a given geographical area there are about 6 times as many fungi in all habitats as there are native and naturalized plant species, which suggests that there may be 12,000 species of fungi. Endemism is very low (Baker & Goos 1972, Baker 1977, Goos 1977). Kohlmeyer (1969) recorded 27 species of marine fungi including 2 nonindigenous species.

Lichens: Smith (1991) recorded 723 species, suggesting that there may be more than 800 species (his 1991 numbers include taxonomic changes published in Smith 1993). He recorded 240 species as supposedly endemic and suggested that the true number may be lower; 1 genus (*Ramalinopsis*) is endemic. See also Stenroos & Smith (1993).

Ferns (Polypodiophyta) and **fern allies** (Psilophyta and Lycophyta): Only native and naturalized (e.g., growing in the wild) species are listed; more than 200 additional species are cultivated (G. Staples, pers. comm.)

Angiosperms: Only native and naturalized species are listed; on the order of 8000 additional species are cultivated in agricultural settings and home gardens (G. Staples, pers. comm.).

Porifera: Of 80 species listed, 5 are known only from depths greater than 100 m, 5 recorded only from the Waikiki Aquarium, and 8 that might be considered doubtful species (Bergquist 1977).

Cnidaria: Octocorallia: Of 105 species listed, 4 are shallow water (Devaney 1977b),

remaining are 1 species of bamboo coral (Muzik 1978) and 101 species of deep-water gorgonians (Grigg & Bayer 1976, Versevelt & Bayer 1988, Bayer 1990).

Cnidaria: Scleractinia: Of 98 species listed, 42 found in shallow water (Maragos 1977), 49 in deeper water (Cairns 1984), 3 from northwest islands (Grigg *et al.* 1981), 5 new records in Maragos (1995); of 91 published species, 50 are exclusively ahermatypic, 37 are exclusively hermatypic, 4 are facultative species (Cairns 1984).

Platyhelminthes (Parasitic): Of 511 species listed, 147 monogenetic species including 132 species described from 121 species of Hawaiian fishes (Yamaguti 1968b). Of 357 digenetic species, 314 species including 227 species described from Hawaiian fishes. Also 30 species not cited (Yamaguti 1970), 13 from Yamaguti (1965), 7 species of cestodes (Yamaguti 1968a), and non-indigenous, marine, cage-cultured, freshwater tilapia with 1 species of marine monogean (Kaneko *et al.* 1988).

Nemertinea: Of the 28 species in the table, 6 species from Coe (1947), 7 benthic and 12 pelagic undescribed/unreported species, 2 introduced terrestrial species (J. Norenburg, pers. comm.) plus 1 parasitic (Humes 1942).

Annelida: Oligochaeta: Of 26 species listed, 23 Tubificidae (Erséus & Davis 1989); 1 new species by Erséus (1990); the other 2 are unidentified species (Bailey-Brock 1987).

Annelida: Polychaeta: Approximately 100 additional species are known, but not yet reported from Hawaiian waters (J. Bailey-Brock, pers. comm.).

Nematoda: zooparasitic: The figure given is very incomplete. Of 33 species, 22 are from intermingling herds of mammals on Molokai (McKenzie & Davidson 1989); 2 from monk seals (Chapin 1935), 8 larval forms from fishes (Deardorff *et al.* 1982), 1 parasitic record from an elasmobranch (Deardorff 1987).

Mollusca: Gastropoda: There are 763 nomenclaturally correct native land species; all endemic except 2–4 indigenous but not endemic species (Cowie *et al.*, in press), approximately 50 nonindigenous species (R.H. Cowie, pers. comm.); 7 endemic freshwater snails, approximately 30 nonindigenous species (R.H. Cowie, pers. comm.).

Mollusca: Cephalopoda: Of 73 species in the table, only 4 considered benthic (Kay 1979; Roper *et al.* 1984); for other pelagic species see Roper & Young (1975) and Young (1991).

Crustacea: Branchiopoda: Four species from Mauna Kea at elevations from 6500–13,700 ft [1980–4175 m] (Ueno 1936).

Crustacea: Ostracoda: Numerous species; J.C. Holden (MS) made identifications to only genera, he noted more than 100 fossil species; 30 benthic species (Kornicker 1976, Danielopol & Hartmann 1986, Hartmann, 1991); 1 freshwater species (Vávra 1906).

Crustacea: Copepoda: The 92 species listed include planktonic, benthic, and ectoparasitic forms; 5 interstitial species (Wells 1986).

Crustacea: Cirripedia: Of 58 species in the table, 11 are from deep water including 8 new species (Pilsbry 1907); 46 shallow-water species includes 3 acrothoracican species (W.A. Newman, MS key); 1 rhizocephalan parasite (Boschma 1953).

Crustacea: Isopoda: Of 27 marine species, 3 were collected in deep water (Richardson 1906); 6 species are parasitic epicarideans (Danforth 1970); of 51 terrestrial species 15 are endemic and 25 nonindigenous species.

Crustacea: Amphipoda: Of 172 species listed, 121 gammarideans (Barnard 1970), 4 gammarideans (Brusca 1973), 7 caprellids, 40 hyperiids (Brusca 1973, 1978).

Entoprocta: Soule *et al.* (1987) provided only unidentified generic descriptions; 55 species reported from Kaneohe Bay (Dade & Honkalehto 1986).

Chaetognatha: Seven pelagic species from distribution maps (Pierrot-Bults & Nair 1991); 1 benthic species described from Kure Atoll, Hawaii (Alvariño 1978).

Echinodermata: Crinoidea: Of 16 species listed in the table, 11 described as new species by Clark (1908); no shallow-water forms.

Echinodermata: Asteroidea: Of 82 species listed, 18 found in shallow water and 64 in deeper water; 1 species and 2 subspecies of shallow-water forms considered endemic (Devaney & Baker MS); 50 species endemic to deeper waters described as new (Fisher 1906).

Echinodermata: Echinoidea: Of 75 species, 21 found in shallow water (Eldredge MS), 53 in deeper water; *Cylpeaster eurypetalus* known only from Pearl and Hermes Reef, and Midway and Kure atolls; 35 new species described from *Albatross* material.

Echinodermata: Holothuroidea: Of 48+ species in the table, 24 found in shallow water (Eldredge, MS), 24 in deeper water; 3 shallow-water and 1 deep-water for considered endemic (Clark & Rowe 1971); Fisher (1907) described 19 new species out of 46 reported; reports (unpublished) of additional species are known.

Echinodermata: Ophiuroidea: Of 57 species, 19 found in shallow water (Devaney & Baker MS), 38 in deeper water; 6 shallow-water and 22-deep-water forms endemic.

Chordata: Urochordata: Thaliacea: 19 species of Salpidae—cosmopolitan oceanic planktonic organisms in the circumglobal warm water zone (Yount 1958); 1 species of *Pyrosoma* (Metcalf & Hopkins 1919).

Chordata: Pisces: The 1150+ marine species listed include all species from all depths to 200 miles from shore—no freshwater, no undescribed, and no doubtful species are included; 1285 species when all conditions provided (B. Mundy, pers. comm.); Randall (1992) listed 536 species of shore fishes, with 25% endemicity.

Chordata: Aves: The 274 species listed is an all-inclusive contemporary list: 60 resident native species, 46 resident nonindigenous species, 13 breeding visitor species, 155 nonbreeding visitor species. There are also 16 species extinct since Captain Cook, 35+ extinct before Captain Cook (subfossil), and 150± nonindigenous species not established bringing the total number of species known to occur or be sighted in Hawaii to 475± (R.L. Pyle, pers. comm.). [Pyle (1992) listed 131 bird species; 53 nonindigenous species.] Thirty-two fossil species have been described by Olson & James (1991) and James & Olson (1991).

Chordata: Mammalia: Of 20 species of terrestrial mammals 19 are free-ranging species (the horse is no longer feral) and 1 species of bat (an additional undescribed subfossil species of bat is known; F.G. Howarth, pers. comm.); of 24 marine species, 2 are littoral marine (seals) and 22 are pelagic (whales and dolphins) (Tomich 1986).

Summary

From literature and unpublished sources, approximately 21,383 species have been recorded from the Hawaiian Islands and surrounding waters. Of these, 8,759 are endemic to the Hawaiian Islands, and 4,532 are nonindigenous species of protists, fungi, plants, and animals. Of these approximately 15,000 species are terrestrial, 300 are found in freshwater, and 5,500 are marine-inhabiting. Endemism varies from very low (e.g., lower plants and many marine organisms) to very high (e.g., insects and snails). However, many gaps in the knowledge of Hawaii's biota (especially the smaller organisms—viruses, bacteria, protists, freshwater algae, etc.), still remain.

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References

- Alvariño, A.** 1978. *Spadella gaetanoi*, a new benthic chaetognath from Hawaii. *Proc. Biol. Soc. Wash.* **91**(3): 650–57.
- Bailey-Brock, J.H.** 1987. Phylum Annelida, p. 213–16. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- . 1990. *Polydora nuchalis* (Polychaeta: Spionidae), a new Hawaiian record from aquaculture ponds. *Pac. Sci.* **44**(1): 81–87.
- . 1991. Tubeworms (Serpulidae, Polychaeta) collected from sewage outfalls, coral reefs and deep water off the Hawaiian Islands. *Bull. Mar. Sci.* **48**(2): 198–207.
- . & **O. Hartman.** 1987. Class Polychaeta, p. 216–454. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Baker, G.E.** 1977. The prospect for mycology in the Central Pacific. *Harold L. Lyon Arboretum Lecture* **8**, 51 p.
- . & **R.D. Goos.** 1972. Endemism and evolution in the Hawaiian biota: Fungi, p. 409–31. In E. A. Kay, ed., *A natural history of the Hawaiian Islands: selected readings*. University of Hawaii Press, Honolulu.
- Ball, C.H.** 1963. *Cephaloidophora carpilodei* n. sp. and *C. pinquis* n. sp., gregarines of a xanthid crab in Hawaii. *J. Protozool.* **10**(3): 321–27.
- Barnard, J.L.** 1970. Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. *Smithson. Contrib. Zool.* **3**, 286 p.
- Bayer, F.M.** 1990. A new isidid octocoral (Anthozoa: Gorgonacea) from New Caledonia, with descriptions of other new species from elsewhere in the Pacific Ocean. *Proc. Biol. Soc. Wash.* **103**(1): 205–28.
- Bergquist, P.R.** 1977. Porifera, p. 53–69. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Berry, S.** 1914. The Cephalopoda of the Hawaiian Islands. *Bull. Bur. Fish.* **23**: 255–362.
- Boschma, H.** 1953. The Rhizocephala of the Pacific. *Zool. Meded.* **32**(17): 185–210.
- Boyko, C.B.** 1994. Catalog of recent type specimens in the Department of Invertebrates, American Museum of Natural History. I. Micro-invertebrates (phyla Sacromastigophora, Gnathostomula, Gastrotricha, Rotifera, and Tardigrada). *Am. Mus. Novit.* **3106**, 44 p.

- Brinton, E.** 1962. The distribution of Pacific euphausiids. *Bull. Scripps Inst. Oceanogr.* **8**(2): 51–279.
- Brusca, G.J.** 1973. Pelagic Amphipoda from the waters near Oahu, Hawaii, excluding the family Scinidae. *Pac. Sci.* **27**(1): 8–27.
- . 1978. Contribution to the knowledge of hyperiid amphipods of the family Scinidae from near Hawaii, with a description of a new species, *Scina hawaiiensis*. *Pac. Sci.* **32**(3): 281–92.
- Burch, B.L.** 1978. Asian clam, *Corbicula*, threatens Hawaii. *The Nautilus* **92**(1): 54–55.
- Burch, B.L. & T.A. Burch.** 1995. New Hawaiian records for *Stephanoscyphus simplex* Kirkpatrick (Cnidaria: Scyphozoa). *Bishop Mus. Occas. Pap.* **42**: 53.
- Cairns, S.D.** 1984. New records of ahermatypic corals (Scleractinia) from the Hawaiian and Line Islands. *Occas. Pap. B. P. Bishop Mus.* **25**(10): 1–30.
- Chapin, E.A.** 1925. Descriptions of new internal parasites. *Proc. U.S. Natl. Mus.* **68**(2603): 1–4.
- Chave, E.H.** 1987. Common living benthic Foraminifera in Mamala Bay, Hawaii, with descriptions of two new species. *Bishop Mus. Occas. Pap.* **27**: 25–72.
- . & **A.T. Jones.** 1991. Deep-water megafauna of the Kohala and Haleakala slopes, Alenuihaha Channel, Hawaii. *Deep-Sea Res.* **38**(7): 781–803.
- Child, C.A.** 1972. A new species of *Anoropallene* (Pycnogonida) from the Hawaiian Islands. *Proc. Biol. Soc. Wash.* **85**(11): 147–50.
- Choy, B.K., G.H. Balazs & M. Dailey.** 1989. A new therapy for marine turtles parasitized by the piscicolid leech, *Ozobranthus brachiatus*. *Herp. Rev.* **20**(4): 89–90.
- Clark, A.H.** 1949. Ophiuroidea of the Hawaiian Islands. *B.P. Bishop Mus. Bull.* **195**, 133 p.
- Clark, A.M. & F.W.E. Rowe.** 1971. *Monograph of shallow-water Indo-west Pacific echinoderms*. British Museum (Natural History), London. 234 p.
- Coe, W.R.** 1947. Nemerteans of the Hawaiian and Marshall Islands. *Occas. Pap. B. P. Bishop Mus.* **19**(3): 101–06.
- Cooke, W.J.** 1977. Order Hydroida, p.71–104. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- . 1984. New scyphozoan records for Hawaii: *Anomalorhiza shawi* Light, 1921, and *Thysanostoma loriferum* (Ehrenberg, 1835); with notes on several other rhizotomes. *Proc. Biol. Soc. Wash.* **97**(3): 583–88.
- Cowie, R.H., N.L. Evenhuis & C.C. Christensen.** 1995. Catalog of the native land and freshwater molluscs of the Hawaiian Islands. *Bishop Mus. Bull. Zool.* **3**: in press.
- Cutress, C.E.** 1977. Orders Corallimorpharia, Actiniaria, Ceriantaria, p. 130–147. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1. Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Dade, W.B. & T. Honkalehto.** 1986. Common ectoproct bryozoans of Kaneohe Bay, p. 52–65. In: Jokiel, P.L., R.H. Richmond & R.A. Rogers, eds., *Coral reef population biology*. Hawaii Institute of Marine Biology Technical Report 37.
- Dailey, M.D., M.L. Fast & G.H. Balazs.** 1992. A survey of the Trematoda (Platyhelminthes: Digenea) parasitic in green turtles, *Chelonia mydas* (L.) from Hawaii. *Bull. South. Calif. Acad. Sci.* **91**(2): 84–91.

- Danforth, C.G.** 1970. Epicaridea (Isopoda) of Hawaii. *Bull. South. Calif. Acad. Sci.* **69**(1): 27–31.
- Danielopol, D.L. & G. Hartmann.** 1986. Ostracoda. Part 1: stygobiont Ostracoda from inland subterranean waters, p. 265–94. In: Botosaneanu, L., ed., *Stygofauna mundi*. E.J. Brill, Leiden.
- Deardorff, T.L.** 1987. Redescription of *Pulchrascaris chiloscylli* (Johnston and Mawson, 1951) (Nematoda: Anisakidae), with comments on species in *Pulchrascaris* and *Terranova*. *Proc. Helminthol. Soc. Wash.* **54**(1): 28–39.
- . **M.M. Kliks, M.E. Rosenfeld, R.A. Rychlinski & R.S. Desowitz.** 1982. Larval ascaridoid nematodes from fishes near the Hawaiian Islands, with comments on pathogenicity experiments. *Pac. Sci.* **36**(2): 187–201.
- Devaney, D.M.** 1977a. Ctenophora, p. 262–69. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- . 1977b. Subclass Octocorallia, p. 119–29. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Devaney, D.M. & L.G. Eldredge.** 1977. Class Scyphozoa, p. 108–18. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- . 1987. Phylum Nemertea (Rhynchocoela), p. 59–69. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Devick, W.S., J.M. Fitzsimons & R.T. Nishimoto.** 1992. *Conservation of Hawaiian freshwater fishes*. State of Hawaii Division of Aquatic Resources. 26 p.
- Edmonds, S.J.** 1987. Phyla Sipuncula and Echiura, p. 185–212. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Eliasson, U.H.** 1991. The myxomycete biota of the Hawaiian Islands. *Mycol. Res.* **95**: 257–67.
- Eldredge, L.G.** 1967. Record of a lancelet from Hawaii. *Pac. Sci.* **21**(4): 564.
- . 1994. *Introductions of commercially significant aquatic organisms to the Pacific islands*. South Pacific Commission, Noumea. 127 p.
- Eldredge, L.G. & D.M. Devaney.** 1977. Other hydrozoans, p. 105–07. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Emig, C.C.** 1987. Phylum Brachiopoda, p. 167–70. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- . **& J.H. Bailey-Brock.** 1987. Phylum Phoronida, p. 171–81. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Erséus, C.** 1990. Marine Oligochaeta of Hong Kong, p. 259–335. In: Morton, B., ed., *The*

- marine flora and fauna of Hong Kong and southern China* 2. Vol. 1. Introduction and taxonomy. Hong Kong University Press, Hong Kong.
- . & D. Davis. 1989. The marine Tubificidae (Oligochaeta) of Hawaii. *Asian Mar. Biol.* 6: 73–100.
- Fauchald, K.** 1992. A review of the genus *Eunice* (Polychaeta: Eunicidae) based upon type material. *Smithson. Contrib. Zool.* 523, 422 p.
- Fisher, W.K.** 1906. The starfishes of the Hawaiian Islands. *Bull. U.S. Fish Comm.* 23(3): 987–1130.
- . 1907. The holothurians of the Hawaiian Islands. *Proc. U.S. Natl. Mus.* 32(1555): 637–744.
- Frank, J.H. & E.D. McCoy.** 1990. Endemics and epidemics of shibboleths and other things causing chaos. *Fla. Entomol.* 73(1): 1–9.
- Goos, R.D.** 1977. Comparative observations of the Hyphomycetes of Hawaii and Central America. *Kavaka* 6: 31–35.
- . & D.P. Gowing. 1992. Type specimens of fungi maintained at Herbarium Pacificum, Bernice P. Bishop Museum, Honolulu. *Mycotaxon* 43: 177–98.
- Grigg, R.W. & F.M. Bayer.** 1976. Present knowledge of the systematic and zoogeography of the Order Gorgonacea in Hawaii. *Pac. Sci.* 30(2): 167–75.
- . & D. Opresko. 1977. Order Antipatharia, p. 242–61. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- . J.W. Wells & C. Wallace. 1981. *Acropora* in Hawaii. Part 1. History of the scientific record, systematics, and ecology. *Pac. Sci.* 35(1): 1–13.
- Hadfield, M.G. & R.E. Young.** 1983. *Planctosphaera* (Hemichordata: Enteropneusta) in the Pacific Ocean. *Mar. Biol.* 73(2): 151–53.
- Hartmann, G.** 1991. Ostracoden von Hawaii, insbesondere aus dem marinen Interstitial. *Helgoländ. Meeresuntersuch.* 45: 165–98.
- Hawksworth, D.L.** 1994. The tropical fungal biota: census, pertinence, prophylaxis, and prognosis, p. 265–93. In: Issac, S., J.C. Frankland, A.J. Whalley & R. Watling, eds., *Tropical mycology*. Cambridge University Press, Cambridge.
- Hering, J.L.** 1961. The genus *Halobates* (Hemiptera: Gerridae). *Pac. Insects* 3(2–3): 223–305.
- . 1965. *Hermatobates*, a new generic record for the Atlantic Ocean, with descriptions of new species (Hemiptera: Gerridae). *Proc. U.S. Natl. Mus.* 117(3510): 123–30.
- Hoe, W.J.** 1974. Annotated checklist of Hawaiian mosses. *Lyonia* 1: 1–45.
- . 1979. The phytogeographical relationships of Hawaiian mosses. Unpubl. Ph.D. Dissertation, University of Hawaii, Honolulu. 357 p.
- Hope, W.D.** 1987. The Aschelminth complex, p. 71–81. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Howarth, F.G.** 1990. Hawaiian terrestrial arthropods: an overview. *Bishop Mus. Occas. Pap.* 30: 4–26.
- . & J. Moore. 1983. The land nemertine *Argonemertes dendyi* (Dakin) in Hawaii (Nemertinea: Hoploneurinae: Prosorhochmidae). *Pac. Sci.* 37(2): 141–44.

- Humes, A.G.** 1942. The morphology, taxonomy, and bionomics of the nemertean genus *Carcinonemertes*. III. *Biol. Monogr.* **18**(4): 3–105.
- . 1976. Distribution and hosts of *Stellicola* (Copepoda, Cyclopoida) associated with *Linckia* (Asteroidea) in the Indo-west Pacific. *Beaufortia* **25**(321): 49–61.
- Hyman, L.H.** 1939. Land planarians from the Hawaiian Islands. *Arch. Zool. Exper. Gen.* **80**(3): 116–24.
- James, H.F. & S.L. Olson.** 1991. Descriptions of thirty-two species of birds from the Hawaiian Islands: Part II. Passeriformes. *Ornithol. Monogr.* **46**: 1–88.
- Kaneko, J.J., II, R. Yamada, J.A. Block & R. Nakamura.** 1988. Infection of tilapia, *Oreochromis mossambicus* (Trewavas), by a marine monogenean, *Neobenedenia melleni* (MacCallum, 1927) Yamaguti, 1963 in Kaneohe Bay, Hawaii, USA, and its treatment. *J. Fish Diseases* **11**: 295–300.
- Kawakatsu, M. & R.W. Mitchell.** 1984. *Oahuhawaiiiana kazukolinda* gen. et sp. nov. (Turbellaria, Tricladida, Maricola), a new freshwater planarian from Honolulu, Oahu Island, Hawaii, U.S.A. *Zool. Sci.* **1**(3): 487–500.
- . **R.W. Mitchell, Y. Hirao & I. Tanaka.** 1984. Occurrence of *Dugesia dorotocephala* (Woodworth, 1897) (Turbellaria, Tricladida, Paludicola) in Honolulu, Hawaii. *Biol. Mag. (Okinawa)* **22**: 1–9.
- Kay, E.A.** 1979. *Hawaiian marine shells. Reef and shore fauna of Hawaii.* Section 4: Mollusca. Bishop Museum Press, Honolulu. 652 p.
- . 1994. *A natural history of the Hawaiian islands. Selected readings II.* University of Hawaii Press, Honolulu. xi + 520 p.
- . **& S.R. Palumbi.** 1987. Endemism and evolution in Hawaiian marine invertebrates. *Trends Ecol. Evol.* **2**(7): 183–86.
- Kitalong, A.E.** 1986. A preliminary study on the emergence patterns of microfauna in Kaneohe Bay, Hawaii, p. 414–23. *In*: Jokiel, P.L., R.H. Richmond & R.A. Rogers, eds., *Coral reef population biology.* Hawaii Institute of Marine Biology Technical Report 37.
- Kohlmeier, J.** 1969. Marine fungi of Hawaii including the new genus *Helicascus*. *Canad. J. Bot.* **47**: 1469–1487.
- Kornicker, L.S.** 1976. Benthic marine Cypridinacea from Hawaii (Ostracoda). *Smithson. Contrib. Zool.* **231**, 24 p.
- Kunz, H.** 1993. Beitrag zur Kenntnis von Zwei *Psammopsyllus*-Arten (Copepoda, Harpacticoida, Cyliindropsyllidae). *Crustaceana* **64**(2): 143–54.
- Larsen, J. & D.J. Patterson.** 1990. Some flagellates (Protista) from tropical marine sediments. *J. Nat. Hist.* **24**: 801–937.
- Lewis, A.G.** 1966. Copepod crustaceans parasitic on elasmobranch fishes of the Hawaiian Islands. *Proc. U.S. Natl. Mus.* **118**(3524): 57–154.
- . 1967. Copepod crustaceans parasitic on teleost fishes of the Hawaiian Islands. *Proc. U.S. Natl. Mus.* **121**(3574): 1–204.
- MacCaughy, V.** 1918. Algae of the Hawaiian Archipelago. *Bot. Gaz.* **65**: 42–57, 121–49.
- Maciolek, J.A.** 1984. Exotic fishes in Hawaii and other islands of Oceania, p. 131–61. *In*: Courtenay, W.R., Jr. & J.R. Stauffer, eds., *Distribution, biology, and management of exotic fishes.* Johns Hopkins University Press, Baltimore.
- Maragos, J.E.** 1977. Order Scleractinia, p. 158–241. *In* Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii.* Section 1: Protozoa through Ctenophora.

Bishop Museum Press, Honolulu.

- . 1995. Revised checklist of extant shallow water stony coral species from Hawaii (Cnidaria: Anthozoa: Scleractinia). *Bishop Mus. Occas. Pap.* **42**: 53–54.
- Margulis, L. & K.V. Schwartz.** 1988. *Five kingdoms: an illustrated guide to the phyla of life on earth*. Second edition. W.H. Freeman & Co., New York. 376 p.
- Matthews, D.C.** 1966. A comparative study of *Craspedacusta sowerbyi* and *Calpasoma dactyloptera* life cycles. *Pac. Sci.* **20**(2): 246–59.
- McInnes, S.J.** 1994. Zoogeographic distribution of terrestrial/freshwater tardigrades from current literature. *J. Nat. Hist.* **28**(2): 257–352.
- McKenzie, M.E. & W.R. Davidson.** 1989. Helminth parasites of intermingling axis deer, wild swine and domestic cattle from the island of Molokai, Hawaii. *J. Wildl. Diseases* **25**(2): 252–57.
- Metcalf, M.M. & H. S. Hopkins.** 1919. *Pyrosoma*—taxonomic study based upon the collections of the United States Bureau of Fisheries and the United States National Museum. *Bull. U.S. Natl. Mus.* **100** 2(3): 195–272.
- Miller, H.A. & H. O. Whittier.** 1990. Bryophyte floras of tropical Pacific islands. *Trop. Bryol.* **2**: 167–75.
- Moore, J.P.** 1946. Leeches (Hirudinea) from the Hawaiian Islands, and two new species from the Pacific region in the Bishop Museum collection. *Occas. Pap. B. P. Bishop Mus.* **18**(11): 171–91.
- Motoda, S.** 1963. *Coryceus* and *Farranula* copepods (Cyclopoida) in Hawaiian waters. *Publ. Seto Mar. Biol. Lab.* **11**(2): 209–62.
- Muzik, K.** 1978. A bioluminescent gorgonian, *Lepidisis olapa*, new species (Coelenterata: Octocorallia), from Hawaii. *Bull. Mar. Sci.* **28**(4): 735–41.
- Nakamura, M.** 1992. An ecological study of earthworms in Papua New Guinea. *J. Chuo Univ.* **13**: 19–33.
- Nishida, G.M., ed.** 1994. Hawaiian terrestrial arthropod checklist. Second edition. *Bishop Mus. Tech. Rep.* **4**, 287 p.
- Nutting, C.C.** 1905. Hydroids of the Hawaiian Islands collected by the steamer *Albatross* in 1902. *Bull. U.S. Fish Commn.* **23**(3): 931–59.
- Oliveira, J.M.** 1940. Plant-parasitic and free-living nematodes in Hawaii. *B. P. Bishop Mus. Occas. Pap.* **15**(29): 361–73.
- Olson, S.L. & H.F. James.** 1991. Descriptions of thirty-two new species of birds from the Hawaiian Islands: Part I. Non-Passeriformes. *Ornithol. Monogr.* **45**: 1–88.
- Ortmann, A.E.** 1906. Schizopods of the Hawaiian Islands collected by the steamer *Albatross* in 1902. *Bull. U.S. Fish Commn.* **23**(3): 961–73.
- Otte, D.** 1994. *The crickets of Hawaii. Origin, systematics and evolution*. Orthopterist's Society, Philadelphia. vi + 396 p.
- Parker, S.P., ed.** 1982. *Synopsis and classification of living organisms*. 2 vols. McGraw-Hill Book Co., New York.
- Parris, G.K.** 1940. A check list of fungi, bacteria, nematodes, and viruses occurring in Hawaii, and their hosts. *Plant Disease Reporter, Supplement* **121**, 91 p.
- Paxton, H. & J.H. Bailey-Brock.** 1986. *Diopatra dexiognatha*, a new species of Onuphidae (Polychaeta) from Oahu, Hawaiian Islands. *Pac. Sci.* **40**(1-4): 16.
- Pearse, V.B.** 1989. Growth and behavior of *Trichoplax adhaerens*: first record of the phylum Placozoa in Hawaii. *Pac. Sci.* **43**(2): 117–21.

- Pettibone, M.H.** 1986. Review of the Iphioninae (Polychaeta: Polynoidae) and revision of *Iphione cimex* Quatrefages, *Gattyana deludens* Fauvel, and *Harmothoe iphioneloides* Johnson (Harmothoinae). *Smithson. Contrib. Zool.* **428**, 43 p.
- Phillips, F.J.** 1977. Protozoa, p. 12–52. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Pierrot-Bults, A. C. & V. R. Nair.** 1991. Distribution patterns in Chaetognatha, p. 86–116. In: Bone, Q., H. Kapp & A.C. Pierrot-Bults, eds., *The biology of chaetognaths*. Oxford University Press, New York.
- Pilsbry, H. A.** 1907. Hawaiian Cirripedia. *Bull. Bur. Fish.* **26**: 179–190.0
- Poulter, J.** 1987. Phylum Platyhelminthes, p. 13–58. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Pyle, R.L.** 1992. Checklist of the birds of Hawaii—1992. *'Elepaio* **42**: 43–62.
- Raabe, R.D.** 1981. *Checklist of plant diseases in Hawaii: including records of micro-organisms, principally fungi, found in the state*. Enlarged and revised by Ibra L. Conners and Albert R. Martinez. Hawaii Institute of Tropical Agriculture and Human Resources, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. 313 p.
- Randall, J.E.** 1992. Endemism of fishes in Oceania. *UNEP Regional Seas Rep. Stud.* **147**: 55–67.
- Richardson, H.** 1906. Isopods collected at the Hawaiian Islands by the U.S. Fish Commission steamer *Albatross*. *Bull. U.S. Fish Commn.* **23**(3): 819–26.
- Roper, C.F.E. & R.E. Young.** 1975. Vertical distribution of pelagic cephalopods. *Smithson. Contrib. Zool.* **209**, 51 p.
- . **M.J. Sweeney & C.E. Nauen.** 1984. FAO species catalogue. Vol. 3. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. *FAO Fish. Synop.* **125**, **3**: 1–277.
- Smith, C.W.** 1991. Lichen conservation in Hawaii, p. 35–45. In D.J. Galloway, ed., *Tropical lichens: their systematics, conservation, and ecology*. Systematics Association Special Volume 43. Clarendon Press, Oxford.
- . 1993. Notes on Hawaiian parmelioid lichens. *Bryologist* **96**: 326–32.
- Soest, R.W.M. van.** 1974a. Taxonomy of the subfamily Cyclosalpidae Yount, 1954 (Tunicata, Thaliacea), with descriptions of two new species. *Beaufortia* **22**(288): 17–55.
- . 1974b. A revision of the genera *Salpa* Forskål, 1775, *Pegea* Savigny, 1816, and *Ritteriella* Metcalf, 1919 (Tunicata, Thaliacea). *Beaufortia* **22**(293): 153–91.
- Soule, J.D., D.F. Soule & H.W. Chaney.** 1987. Phyla Entoprocta and Bryozoa (Ectoprocta), p. 83–166. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 2: Platyhelminthes through Phoronida and Section 3: Sipuncula through Annelida. Bishop Museum Press, Honolulu.
- Southward, E.C.** 1980. Two new species of Pogonophora from Hawaii. *Pac. Sci.* **34**(4): 371–78.
- Stenroos, S. & C.W. Smith.** 1993. Notes on the amphipacific relations of Hawaiian Cladoniaceae. *Trop. Biol.* **8**: 275–80.
- Sterrer, W.** 1991. Gnathostomulida from Hawaii. *Zool. Scripta* **20**(2): 129–36.
- Svihla, A.** 1941. The occurrence of freshwater sponges in the Hawaiian Islands. *Science* **94**(2438): 278–79.

- Taguchi, S.** 1982. Seasonal study of fecal pellets and discarded houses of Appendicularia in a subtropical inlet, Kaneohe Bay, Hawaii. *Estuar. Coast. Shelf Sci.* **14**: 545–55.
- Tokioka, R.** 1967. Pacific Tunicata of the United States National Museum. *U.S. Natl. Mus. Bull.* **251**, 247 p.
- Tomich, P.Q.** 1986. *Mammals in Hawaii. A synopsis and notational bibliography*. Second edition. Bishop Museum Press, Honolulu. 375 p.
- Ueno, M.** 1936. Cladocera of Mauna Kea, Hawaii. *B. P. Bishop Mus. Occas. Pap.* **12**(11): 1–9.
- Van Zwaluwenburg, R.H.** 1948. *Lacustris hawaiiensis* Johnson. *Proc. Hawaii. Entomol. Soc.* **13**(2): 210.
- Vávra, W.** 1906. Ostracoden von Sumatra, Java, Siam, den Sandwich-Inseln und Japan. *Zool. Jahrb. (Syst.)* **23**: 413–38.
- Versevelt, J. & F.M. Bayer.** 1988. Revision of the genera *Bellonella*, *Eleutherobia*, *Nidallia* and *Nidaliopsis* (Otocorallia: Alcyoniidae and Nidalliidae), with descriptions of two new genera. *Zool. Verh.* **245**: 1–131.
- Vis, M.L., R.G. Sheath, J.A. Hambrook & K.M. Cole.** 1994. Stream macroalgae of the Hawaiian Islands: a preliminary study. *Pac. Sci.* **48**: 175–87.
- Vitousek, P.M., L.L. Loope & C.P. Stone.** 1987. Introduced species in Hawaii: biological effects and opportunities for ecological research. *Trends Ecol. Evol.* **2**(7): 224–27.
- Wagner, W.L., D.R. Herbst & S.H. Sohmer.** 1990. *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu. 1853 p.
- Walsh, G.E. & R.L. Bowers.** 1977. Order Zoanthinaria, p. 148–57. In Devaney, D.M. & L.G. Eldredge, eds., *Reef and shore fauna of Hawaii*. Section 1: Protozoa through Ctenophora. Bishop Museum Press, Honolulu.
- Wells, J.B.J.** 1986. Copepoda: marine-interstitial Harpacticoida, p. 356–81. In: Botosaneanu, L., ed., *Strygofauna mundi*. E.J. Brill, Leiden.
- Yamaguti, S.** 1965. New digenetic trematodes from Hawaiian fishes, I. *Pac. Sci.* **19**(4): 458–81.
- . 1968a. Cestode parasites of Hawaiian fishes. *Pac. Sci.* **22**(1): 21–36.
- . 1968b. *Monogenetic trematodes of Hawaiian fishes*. University of Hawaii Press, Honolulu. 287 p.
- . 1970. *Digenetic trematodes of Hawaiian fishes*. Keigaku Publishing Co., Tokyo. 436 p.
- Young, R.E.** 1991. Chiroteuthid and related paralarvae from Hawaiian waters. *Bull. Mar. Sci.* **49**(1–2): 162–85.
- Yount, J.L.** 1954. The taxonomy of the Salpidae (Tunicata) of the central Pacific Ocean. *Pac. Sci.* **8**(3): 276–330.

Contributions to the Flora of Hawai'i. III. New Additions, Range Extensions, and Rediscoveries of Flowering Plants¹

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Introduction

Publication of the *Manual of the flowering plants of Hawai'i* (Wagner *et al.* 1990) has provided an accurate and up-to-date compendium of the flowering plants of the Hawaiian Islands. In addition to 956 native species (53% of the the total flowering plants), 861 naturalized species (47% of the total) occur in the Hawaiian Islands. The *Manual* therefore not only furnishes an important baseline for the taxonomy, distribution, and status of existing native species, but for naturalized taxa as well.

However, recent collecting efforts and field work by the authors and other collectors, primarily on Kauai, have yielded 40 new additions to the Hawaiian flora, the rediscovery and recollection of 17 taxa (mostly endemic) previously considered to be extinct or possibly so on Kauai, and range extensions to Kauai for 53 taxa known elsewhere in the Hawaiian Islands. In addition, we record for the first time range extensions of 3 taxa to Molokai and 1 to Maui. This is the third paper in a series dealing with contributions to the flora of Hawaii, the previous two (Wagner *et al.* 1986, 1989) being precursors to the *Manual*. This paper is intended to provide supplementary data and new records for certain taxa obtained subsequent to publication of the *Manual*.

Diagnostic characters are given for taxa representing new additions to the Hawaiian flora to distinguish them from those treated in the *Manual*. These new records are presented with specimen data, including the herbaria in which they have been deposited. Herbarium acronyms follow those in the eighth edition of *Index Herbariorum* (Holmgren *et al.* 1990). Since the majority of collections cited in this paper were made by staff of the National Tropical Botanical Garden, the first set of duplicates is deposited in this institution's herbarium (PTBG). Distributional data in the Hawaiian Islands for the species treated herein are taken from the *Manual* unless stated otherwise. Elevations are expressed in meters, although equivalents in feet are given parenthetically if label data are in feet. Approximate elevations have been added [in brackets] when such data from known sites were lacking. All identifications have been made by the authors, except for those mentioned in the acknowledgements section.

The majority of these new records and range extensions for Kauai involve cultivated species that have become naturalized. In the context of this paper, naturalized is defined as "Thoroughly established and replacing itself by vegetative or sexual means, but originally coming from another area . . . [and] introduced, intentionally or unintentionally, by man or his activities" (Wagner *et al.* 1990: 1645). Many of these newly naturalized species (e.g., *Cotoneaster pannosa*, *Duranta erecta*) have the potential of becoming weedy and should be carefully monitored and eradicated if they show signs of spreading further. A lesser number of species have wide naturalized distributions outside of the Hawaiian Islands (e.g., *Spermacoce latifolia*, *Verbena bonariensis*) and were presumably introduced unintentionally, possibly as seed contaminants.

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Acanthaceae

Odontonema cuspidatum (Nees) O. Kuntze

Odontonema cuspidatum was referred to as *O. strictum* (Nees) Kuntze by Wagner *et al.* (1990: 167), who noted that "It is sometimes observed in disturbed areas that do not obviously represent cultivated plants, at least on Kauai, Oahu, and Hawaii . . ." However, they did not regard it as being naturalized in the archipelago because fruiting collections were not observed by them. Although fruiting collections of this species are rare, at least 1 of the collections examined has mature fruit (*Lorence 7442*). This species is clearly established as an adventive in secondary vegetation in a number of localities on Kauai, including Lawai Valley along the Lawai Stream and near the town of Lawai. *Odontonema cuspidatum* differs from other Acanthaceae in the Hawaiian Islands by the following characters: habit shrubby, 1–1.5 m tall, leaves short-petiolate, the blade ovate-elliptic, 9–15 x 3.5–9.7 cm, sparsely hirtellous beneath on veins and costa; inflorescence terminal, a 3–5-branched thyrsoid panicle, the partial inflorescences racemiform, 10–22 cm long, flowers in cymules of 3–5, on hirtellous pedicels 2.5–3 mm long, calyx red, the lobes 5, triangular-ovate, 1–1.5 mm long; corolla bright red, salverform, slightly zygomorphic, the tube 25–28 mm long, 3 mm wide distally, glabrous without, lobes 5, oblong, 4–5 x 2–3 mm, glabrous without, glandular puberulent within, the margins ciliate; capsule clavate, glabrous, 10 x 3 mm.

Material examined. KAUAI: Koloa District, along Koloa road between Piko road and Hailima road, 13 Aug 1986, *T. Flynn 1859* (BISH, PTBG); National Tropical Botanical Garden, Lawai Valley, along Lawai Stream below Stillwater Dam, 25–30 m, 9 Jul 1993, *D. Lorence 7442* (PTBG).

Ruellia devosiana Hort. Makoy ex E. Murr.

This is a **new naturalized record** of this Brazilian species in the Hawaiian Islands, where it occurs in *Metrosideros*/*Acacia* forest on Kauai. It can be distinguished from the other *Ruellia* species in the archipelago by: erect perennial habit; leaves with blades oblong-elliptic, 3–6 x 0.7–1.4 cm, dark green above with central portion silvery green, dark purple beneath, the base decurrent along the 0.5–1 cm long petiole, the margins ciliate; corolla 4.5–5 cm long, the tube white basally, distally lilac with purple veins; capsules clavate, ca. 1 cm long.

Material examined. KAUAI: Waimea District, Na Pali-Kona Forest Reserve, Kohua Ridge trail (Maile Flat trail) between Mohihi ditch and Mohihi stream, 1012–1060 m (3320–3480 ft), 31 Jul 1989, *T. Flynn et al. 3524* (BH, BISH, MO, NA, NY, PTBG, US).

Sanchezia speciosa J. Leonard

This tropical American species is cultivated for its attractive foliage and flowers on Kauai, Oahu, and perhaps other Hawaiian Islands. It has escaped from cultivation and is apparently spreading vegetatively in the mesic, low-elevation site at this Kauai locality. This collection represents the first record of the genus *Sanchezia* Ruiz & Pavón being naturalized in the Hawaiian Archipelago. This plant has been referred to as *S. nobilis* J. D. Hook. in the Hawaiian Islands (Neal 1965: 780) and in Fiji (Smith 1991: 127) where it is also naturalized. *Sanchezia speciosa* can be distinguished from other Acanthaceae in the Hawaiian Islands by the following characters: robust perennial herb or shrub; leaves elliptic or ovate-elliptic, 12–37 x 4–13.5 cm, green with pale yellow or white midrib and sec-

ondary veins; bracts brick red, 2.5–5.5 cm long; calyx deeply 5-parted; corolla deep yellow to orange, 4.5–5.5 cm long, tubular, corolla lobes contorted in bud, the style and stamens yellow; stamens with only 2 well-developed anthers, these 2-loculed; capsules narrowly cylindrical, usually containing 6–8 seeds.

Material examined. KAUAI: Kawaihau District, Kalihiwai Valley, S side of Kalihiwai River, first gulch mauka of ocean, 10 m, 1 Apr 1990, *D. Lorence 6430* (BISH, MO, PTBG, US).

Aloeaceae

Aloe vera (L.) Burm. f. [syn. *Aloe barbadensis* Mill.]

At the Hanapepe site this species grows on dry cliffs in secondary shrubland with naturalized succulents and *Leucaena*, where it sets fruit and also spreads from basal offshoots. At the Kekaha locality a scattered population of 50–100 plants occurs in secondary vegetation near sea level with *Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth dominant. *Aloe vera* is widely cultivated in the Hawaiian Islands as a medicinal plant whose thick sap is used to soothe burns, and this is a **new naturalized record** of this species in the archipelago. This species is readily characterized by the following: plants short-stemmed or stemless, producing basal offshoots, glabrous, leaves succulent, in dense rosette, narrowly dagger-shaped, light green, often spotted with white, filled with clear gelatinous matrix, 15–60 x 3–8 cm, base sheathing, tapering to long acute apex, cartilaginous margin bearing stout teeth 1–1.5 cm apart; inflorescences usually unbranched, axillary racemes to 1 m long, floriferous in distal half; flowers solitary, subtended by a scarious bract 4–5 mm long, pedicel 3–4 mm long, corolla tubular, light orange or yellow, tepals 6, linear-elliptic, 25–28 x 4–5 mm, connate in basal 1/3, stamens and style included, ca. 25 mm long; fruit capsular, 15–17 x 7–8 mm, trigonous, splitting into 3 segments.

Material examined. KAUAI: Waimea District, Hanapepe, along Awawa Road along Hanapepe River below Hanapepe Heights, 20–30 m, 10 Dec 1993, *D. Lorence & T. Flynn 7430* (PTBG); Waimea District, Kekaha, Parcel 10, portion of Lot C, TMK 1–2–02–32, 10 Jun 1993, *M. Chapin et al. 3* (PTBG).

Amaranthaceae

Alternanthera sessilis (L.) DC

This common weed of moist ground is also naturalized on Oahu, Molokai, Maui, and Hawaii (Wagner *et al.* 1990: 185). These collections represent a **new naturalized record** of this species on Kauai.

Material examined. KAUAI: Kawaihau District, in marshy ground behind "Donkey Beach" between Kealia and Anahola, 23 Oct 1988, *L. Hume 362* (BISH, PTBG); Koloa District, Hanapepe River at Ho Road crossing, 10 m, 5 May 1987, *D. Lorence & T. Flynn 5206* (BISH, PTBG); Lawai, 4090 Akemama Road, 1985, *W.L. Wagner 5623* (BISH, US); Lawai Kai, cleared field, 6 m (20 ft), Spring 1979, *L. Hume 7* (PTBG).

Gomphrena globosa L.

This common garden annual is widely cultivated on Kauai as well as the other main islands, but previously has been reported as being naturalized only on Oahu (Wagner *et al.* 1990: 193).

Material examined. KAUAI: Koloa District, about 1.5 miles E of Makawehi Point, Poipu, on cliffs, 25 May 1988, *L. Hume et al. 349* (PTBG).

Apiaceae

Daucus pusillus Michx.

Previously known from Oahu, Molokai, Lanai, and Hawaii, *Daucus pusillus* was collected in mixed mesophytic forest on Kauai where it is locally common on the east-facing slopes of Waimea Canyon. It is introduced or perhaps native according to Wagner *et al.* (1990: 204).

Material examined. KAUAI: Waimea District, Waimea Canyon State Park, Waimea Canyon in remnant forest on steep, dry slope at mile 11.3, Hwy 550, 1067 m (3500 ft), 21 May 1987, T. Flynn 2206 (PTBG); Na Pali-Kona Forest Reserve, ridge top at junction of Koaie and Hipalau Valleys, 853–671 m (2800–2200 ft), 25 Apr 1991, T. Flynn *et al.* 4574 (BISH, PTBG, US).

Spermolepis hawaiiensis Wolff

Historically this species is known from Kauai, Oahu, Molokai, Maui, and Hawaii. Wagner *et al.* (1990: 212) stated that the only recent collections, representing the only known extant populations, were made on Oahu in 1988. However, the U.S. Fish and Wildlife Service reported populations also exist on Molokai, Lanai, and West Maui (Canfield *et al.* 1994). The collections cited here represent a **rediscovery** of *Spermolepis hawaiiensis* on Kauai. Collectors' notes indicate the Waimea Canyon population consists of a few plants growing in mostly alien dry shrubland vegetation with *Leucaena leucocephala* (Lam.) de Wit, *Sida fallax* Walp., *Cenchrus ciliaris* L., *Grevillea*, *Lipochaeta*, and *Bidens*. The Koaie Canyon population consists of "abundant" plants growing in an area above cliffs with *Eragrostis variabilis* (Gaud.) Steud., *Bidens sandvicensis* Less., and *Schiedea spergulina* A. Gray, with *Kalanchoë pinnata* (Lam.) Pers. and goats being the major threats.

Material examined. KAUAI: [Waimea District], Waimea Canyon, below Canyon rim road around 3–4 miles up from Waimea, 366 m (1200 ft), 7 Apr 1994, S. Perlman *et al.* 14110 (PTBG, US); Waimea District, Koaie Canyon, north-facing cliffs between Hipalau and Kawaiiki Valley, great escarpment, 607–671 m (2000–2200 ft), 25 Apr 1991, K.R. Wood *et al.* 756 (PTBG).

Apocynaceae

Catharanthus roseus (L.) G. Don

This common garden ornamental has escaped from cultivation and is widely naturalized in the Hawaiian Islands; Wagner *et al.* (1990: 216) recorded it from all the main islands except Kauai and Lanai. This is a **new island record** of the Madagascar periwinkle from Kauai, where it was collected on coastal cliffs growing among native and naturalized species and in a eucalyptus grove with other naturalized herbaceous species.

Material examined. KAUAI: Koloa District, 1.5 miles E of Makawehi Point, Poipu, above cliffs, 6 m, 25 May 1988, L. Hume *et al.* 348 (PTBG); Koloa District, National Tropical Botanical Garden, S. of headquarters, naturalized on slopes in *Eucalyptus citriodora* grove, 120 m, 21 Jun 1994, D. Lorence 7465 (BISH, MO, PTBG, US).

Asteraceae

Bidens campylothea Schultz-Bip. subsp. *campylothea*

Prior to its discovery on Kauai, *Bidens campylothea* subsp. *campylothea* was known from Oahu, Lanai (where probably extinct), and Hawaii (Ganders & Nagata 1990:

273). These collections represent a range extension of this taxon to Kauai where it is scattered to locally abundant in clearings on slopes and along streams and rivers in lowland wet forest with *Metrosideros* and *Dicranopteris* dominant. Threats include invasion by alien plant species, including *Rubus rosifolius* Sm., *Paspalum conjugatum* Bergius, and *Oplismenus hirtellus* (L.) P. Beauv.

Material examined. KAUAI: Hanalei District, Waioli Valley, back of valley below Namolokama Mt, 396 m (1300 ft), 4 Nov 1992, *S. Perlman et al.* 13093 (BISH, PTBG, UBC, UC), 300–370 m, 11 Dec 1991, *K.R. Wood & S. Perlman* 1495 (BISH, PTBG, UBC, UC); headwaters of Wainiha River, NE fork, just SW of Mahinakehau Ridge, 680–825 m, 29–30 Jan 1993, *D. Lorence et al.* 7337 (BISH, PTBG, US); Kawaihau District, north-facing cliffs and forested slopes below Kekoiki, 800–850 m, 9 Feb 1993, *K.R. Wood et al.* 2358 (PTBG, UBC, US); Kawaihau and Hanalei Districts [Makaleha Mountains, Kealia Forest Reserve], 607–858 m (2000–2814 ft), 9 Feb 1993, *T. Flynn et al.* 5264 (AD, PTBG, US); [Hanalei District] Makaleha Mountains, N face below Kekoiki, 823 m (2700 ft), 9 Nov 1993, *K.R. Wood* 2358 (PTBG).

Bidens cynapiifolia Kunth

Previously known from dry areas on Oahu, Molokai, Lanai, Maui, and Hawaii (Ganders & Nagata 1990: 274), this naturalized species was found growing on Kauai in dry secondary vegetation dominated by *Leucaena* and *Bothriochloa*.

Material examined. KAUAI: Waimea District, Waimea Canyon Drive along road below Panini Heights, 91 m, 27 Jan 1988, *T. Flynn et al.* 2707 (PTBG).

Centratherum punctatum Cass. subsp. *punctatum*

Collections of *Centratherum punctatum* from Hawaii correspond to subsp. *punctatum* in Kirkman's (1981) revision of the genus. This garden escape is a **new naturalized record** of the genus in the Hawaiian Islands. Native to South America, *C. punctatum* subsp. *punctatum* is distinguished from other Asteraceae in the archipelago by the following combination of characters: branching herb 0.3–0.6 m tall, probably annual; leaves with blades obovate-spathulate, 2–4 x 1–2 cm, margins coarsely serrate-dentate, densely glandular-punctate beneath, base decurrent onto petiole; heads terminal or terminal on lateral branches, broadly discoid, 1.5–2 cm in diam., involucre bracts (phyllaries) ovate-oblong, membranaceous, green with margins and tips wine red, golden-glandular toward apex dorsally and on margins; rays absent, disc florets with corolla purple, externally glandular; achenes 1.5 mm long, longitudinally 9-ribbed, pappus whitish or pale brown, bristles linear, 3–4 mm long, antrorse setose, deciduous.

Material examined. KAUAI: Koloa District, Papalina road, Kalaheo, in pasture near National Tropical Botanical Garden headquarters, 128 m (420 ft), 16 Nov 1989, *T. Flynn & D. Lorence* 3587 (BISH, F, PTBG, US); Waimea District, Kokee State Park, Kumuwela Ridge road, 1.2 miles from junction with Mohihi Road, 1120 m (3680 ft), 6 Nov 1989, *T. Flynn et al.* 3585 (BISH, PTBG, US).

Cotula australis (Sieb. ex Spreng.) J.D. Hook.

Cotula australis is sparingly naturalized also on Oahu, East Maui, and Hawaii (Wagner *et al.* 1990: 289). On Kauai it has become established at the edge of a parking lot adjacent to a lawn area and will undoubtedly spread further.

Material examined. KAUAI: Waimea District, Kokee State Park, Kokee Lodge and Natural History Museum parking lot, along Hwy 550, 1121 m (3680 ft), 22 Feb 1991, *T. Flynn & L. Mehrhoff* 4441 (BISH, PTBG, US), 25 Mar 1991, *D. Lorence & M. Lorence* 6732 (F, MO, PTBG).

Flaveria trinervia (Spreng.) C. Mohr

Previously known only from Barber's Point to Sand Island and Koko Head on Oahu (Wagner *et al.* 1990: 317), this naturalized species was found growing near sea level on the SE coast of Kauai.

Material examined. KAUAI: Lihue District, Niumalu near old Nawiliwili Canoe Club off Hulemalu road, 1.5 m, 18 Oct 1988, T. Flynn *et al.* 3186 (BISH, F, MO, PTBG, US).

Gaillardia pulchella Foug.

Previously reported known from Kure Atoll, Oahu, and Maui (Wagner *et al.* 1990: 318), this species was commonly cultivated as an ornamental in Hawaii in the past. On Kauai it is naturalized in native shrubland dominated by *Dodonaea viscosa* Jacq. with *Sida*, *Scaevola*, *Nama*, and *Waltheria*, or secondary shrubland with *Leucaena* and *Prosopis*, usually on low sand dunes near the coast. On Molokai it is naturalized along the beach with strand vegetation on the Kalaupapa Peninsula, where it appears to have spread from plants cultivated in the Kalaupapa cemetery (D. Lorence, pers. comm.).

Material examined. KAUAI: Waimea District, U.S. Navy Pacific Missile Range Facility at Barking Sands, between Kokole Point and Navy Housing [4 m], 27 Feb 1988, T. Flynn 2786 (BISH, PTBG); Kehaka Army National Guard Rifle Range, 3 m (10 ft), 20 Feb 1992, T. Flynn 4892 (BISH, PTBG, US), 4894 (PTBG). MOLOKAI: Kalaupapa Peninsula, road from airport to Kalaupapa village, 5 m, 19 Jan 1991, D. Lorence 6680 (PTBG).

Senecio madagascariensis Poiret

On Kauai, this **new state record** was presumably introduced as a contaminant in grass seed along with *Verbena bonariensis* and *Lotus uliginosus* (see below) and has become naturalized locally. It is also naturalized on the island of Hawaii in the North Kohala District, primarily along roadsides. Because its seeds are dispersed by wind, this species already has become naturalized in Australia and New Zealand and has the potential of becoming a serious weed in the Hawaiian Islands. Harold Robinson (pers. comm., 1994) notes that *Senecio madagascariensis* may not be the correct name for this taxon. It differs from the other 2 erect herbaceous *Senecio* species naturalized in Hawaii in the following characters: parts glabrous and non-glandular; leaves sessile, blade unlobed, linear-oblong, 3–6 x 0.2–0.7 cm, base auriculate, margins minutely dentate; heads with involucre cylindrical, 5–7 mm high, principal involucre bracts 21–23, apices of bracts and bracteoles purplish with white hair tufts; ray florets 13–15, yellow, tube 3–4 mm long, limb oblong, 5–7 mm long, disc florets numerous, yellow, the tube 3–4 mm long, the lobes 0.3–0.4 mm long; achene 1.5–2 mm long, oblong-ellipsoid, brown, weakly ribbed, the ribs scabrous; pappus 3.5–4 mm long, of many fine, capillaceous white hairs.

Material examined. KAUAI: Lihue District, Hwy 50 along newly seeded road cut over Huleia Stream (Halfway Bridge), 97 m, 21 Mar 1990, L. Hume 497 (BISH, PTBG, US), 9 Jun 1990, W.L. Wagner & T. Flynn 6321 (BISH, US). HAWAII: North Kohala District, Kawaihae DHHL Survey Supp. Sta. C, Puu Honu, 1204 m (3950 ft), 18 Jul 1989, S. Perlman *et al.* 10312 (PTBG, US); Hwy 250 between Hawi and Kamuela, ca. 500 m, 29 Jun 1988, T. Flynn & D. Lorence 3080 (PTBG); Kohala Mountain Road, 914 m, roadside, growing with kikuyu grass, Jan 1991, W. Shishido *s.n.* (BISH).

Begoniaceae***Begonia cucullata* Willd.**

This is a **new naturalized record** of *Begonia cucullata* in the Hawaiian Islands, presumably as an escape from cultivation. On Kauai it was collected in predominantly secondary vegetation of *Myrica faya* Aiton, *Acacia melanoxylon* R. Br. ex Aiton, and *Eucalyptus* sp. in a mixed mesophytic forest region. On Hawaii it was growing in predominantly secondary vegetation primarily of introduced grasses. *Begonia cucullata* differs from the other 3 *Begonia* species naturalized in the archipelago by the following characters: glabrous perennial herb 2–5 dm tall, seasonal; leaves relatively few, widely spaced, blades broadly ovate or suborbicular, slightly asymmetrical, 6–11 x 4–12 cm, margins minutely crenate-serrate, ciliolate, petioles 1.5–4 cm long, stipules 2–3 cm long, ovate-oblong, margins finely denticulate-ciliolate; flowers few, erect or nodding, perianth red or white with pink tinge, staminate perianth parts 4, outer ones broadly elliptic or suborbicular, 10–15 mm long, inner ones elliptic, 0.6–1.2 cm long, the pistillate flowers with 3-winged ovary, the perianth parts 5, broadly elliptic or subcircular, 0.5–0.8 cm long; capsule 3-winged, 1.5–1.7 cm long.

Material examined. KAUAI: Waimea District, Kokee State Park, unnamed trail from Kokee-Halemanu Trail to Hwy 550, 1080–1100 m, 17 Feb 1988, *D. Lorence et al.* 5808 (BISH, MO, PTBG, US). HAWAII: South Kona District, Kealakekua Ranch, Kealakekua ahupua'a road to Papaloa, 610 m, along roadside on lava rock, 11 Mar 1988, *W.L. Wagner et al.* 5941 (BISH, PTBG, US).

***Begonia hirtella* Link**

This species is now known to be naturalized locally on Kauai, as well as on Oahu, Maui, and Hawaii from whence it was previously recorded by *Wagner et al.* (1990: 384).

Material examined. KAUAI: Kawaihau District, Kapaa Stream, ca. 0.5 miles above Hoopi'i Falls, 152 m (500 ft), 15 Oct 1989, *L. Hume & R. Levine* 427 (BISH, PTBG, US).

Boraginaceae***Carmona retusa* (Vahl) Masamune**

This species is cultivated at least on Oahu and Kauai as a hedge plant. At the Kauai locality, *Carmona retusa* was collected in secondary vegetation of *Syzygium*, *Psidium*, *Leucaena*, and *Melinis* with forestry plantings. At the Maui site, collectors' notes indicate it is densely naturalized over several acres under kiawe (*Prosopis pallida*). The 2 described species of *Carmona* have recently been considered conspecific and treated as *C. retusa* (Thulin 1987: 413–17). This species has been identified as *C. microphylla* (Lam.) Don [syn. *Ehretia microphylla* Lam.] in the archipelago (St. John 1973: 287). Its occurrence on Kauai represents a **new naturalized record** of *Carmona* Cav. in Hawaii. *Carmona* differs from *Cordia* and *Tournefortia*, the other 2 shrubby or arborescent members of Boraginaceae naturalized in the Hawaiian Islands, by the following characters: leaves in fascicle-like clusters of 3–5, blade obovate or oblanceolate, 1.5–5 x 0.8–2.5 cm, base decurrent onto petiole, coarsely 3–5-toothed towards apex, apex acute to obtuse or rounded, when young both surfaces with stiff white hairs, upper surface becoming scabrid, petiole 1–5 mm long; inflorescences 3–12-flowered scorpioid cymes, unbranched or branched once, sepals 4–5, lanceolate, 3–4 mm long; corolla white, rotate, 8–10 mm in diam., lobes 4–5, 3–4 mm long; fruits globose, 4–5 mm in diam., ripening brownish

orange, pericarp thin, pyrene white, bony.

Material examined. KAUAI: Kawaihau District, Wailua House Lots by Nonou Forest Reserve, 49–213 m (160–700 ft), 28 Jan 1991, *T. Flynn & M. Egan 4390* (BISH, PTBG). MAUI: West Maui, lee side of Waihee Dunes, growing under kiawe forest, 19 Mar 1991, *R. Hobdy 3286* (BISH, US).

Brassicaceae

Hirschfeldia incana (L.) Lagr.-Foss.

Hirschfeldia incana is native to the Old World Mediterranean region. These collections represent a **new naturalized record** of the genus *Hirschfeldia* Moench in the Hawaiian Islands. On Hawaii it is a common weed in dry, disturbed areas and along roadsides in high elevation *Sophora* dry forest. The discovery of *Hirschfeldia incana* in the Hawaiian Islands caused us to realize that several Hawaiian specimens of this species were misidentified as *Brassica nigra* (L.) W. Koch by R. Rollins and several others by Wagner and D. Herbst. In fact, 1 of these specimens, *Herbst & Ishikawa 5169* (BISH), was used for the the illustration labelled *Brassica nigra* in Wagner *et al.* (1990: 401, pl. 43). It should also be noted that the *Wagner & Warshauer 4681* collection was used for the preparation of the fruit inset of plate 43, but was inadvertently omitted from the voucher list on page 1712.

Brassica nigra is characterized by the fruiting pedicels weakly thickened, the valves in young-fruiting stage with only the midvein clearly visible, the fruit 4-angled and beaked, the beak without a basal constriction and lacking seeds, the seeds ca. 1.5 mm wide, dark reddish brown, and coarsely reticulate. By contrast, *Hirschfeldia incana* is characterized by the fruiting pedicels conspicuously swollen, clavate, 3–4 mm long, young fruiting valves clearly with 3–7 veins, the fruit erect, appressed to rachis, 1–1.5 cm long, terete and beaked, the beak 3–6 mm long, with an abrupt basal constriction and usually 1-seeded, the seeds 0.5–0.7 mm wide, yellowish brown, and minutely reticulate. *Sisymbrium officinale* is sometimes confused with *Brassica nigra* and *Hirschfeldia incana* but can be separated from them by its incumbent cotyledons, 2-lobed stigma, and fruits not beaked, whereas *Brassica* and *Hirschfeldia* have conduplicate cotyledons, entire stigmas, and beaked fruits.

Material examined. HAWAII: South Kohala District: Hawaii Belt Road (Mamalahoa Hwy), ca. 8.5 mi from Waimea, 16 Oct 1985, *T. Flynn 1289* (PTBG); along Hwy 190 at 2.6 mi N of junction of road to Waikoloa, 16 Jan 1984, *W.L. Wagner et al. 5236* (BISH); North Hilo District at border to Hamakua District, Mauna Kea, Puu Kanakaleonui area, *Sophora* alpine dry forest, common along Saddle Road, 3 Jun 1993, *K.R. Wood & S. Perlman 2604* (MO, PTBG); Hamakua District, growing along Saddle Road NW of Pohakuloa State Park, ca. 1737 m (ca. 5700 ft), 16 Jan 1975, *D. Herbst & S. Ishikawa 5169* (BISH); Saddle Rd. at Pohakuloa Training Area HQ, 17 Nov 1982, *W.L. Wagner & R. Warshauer 4681* (BISH). MAUI: East Maui, Pukalani, in vacant lots, Pukalani Terrace Estates, 366 m (1200 ft), 20 Nov 1982, *K.M. Nagata 2563* (BISH).

Lepidium oblongum Small

Also naturalized on Niihau, Oahu, Molokai, Lanai, and Kahoolawe (Wagner *et al.* 1990: 409), this species is a common lawn weed around the pier park in Hanalei. This collection is a **new naturalized record** of this species on Kauai.

Material examined. KAUAI: Hanalei District, Hanalei, Hanalei Pier Park [2 m], 27 May 1988, *T. Flynn et al. 2989* (BISH, PTBG).

Lepidium virginicum L.

This widespread weed was previously recorded as naturalized from Midway Atoll, Oahu, Molokai, Maui, and Hawaii (Wagner *et al.* 1990: 409). It is the **second naturalized record** of *Lepidium* species from Kauai.

Material examined. KAUAI: Lihue District, Hwy 51 just N of junction with Hwy 570, 45 m (150 ft), 11 Mar 1991, T. Flynn 4471 (BISH, F, MO, PTBG, US).

Lobularia maritima (L.) Desv.

The widely cultivated sweet alyssum was previously recorded as being naturalized in sandy areas on Kure and Midway atolls and Maui (Wagner *et al.* 1990: 411). On Molokai, it is locally very abundant in sandy soils from the Kalaupapa lighthouse to Kalaupapa village.

Material examined. MOLOKAI: Kalaupapa Peninsula, along road from airport to Kalaupapa village, ca. 5 m, 19 Jan 1991, D. Lorence 6679 (PTBG, US).

Rapistrum rugosum (L.) All.

This is a **new naturalized record** of the genus *Rapistrum* Krantz in the Hawaiian Islands. This species can be distinguished from other Hawaiian Brassicaceae by the following features: annual herbs, sparsely hispid in lower parts; leaves lyrate-pinnatifid, upper ones subentire; petals yellow, 6–10 mm long; siliques elongate with a transverse partition, indehiscent except by breaking into jointed segments; upper member of silique enlarged, subglobose, roughened, abruptly narrowed to a slender beak 3–4 times long than basal cylindrical segment. *Rapistrum rugosum* is native to Eurasia and naturalized elsewhere.

Material examined. KAUAI: Waimea District, Hwy 50 between Eleele and Kalaheo, ca. 2.1 mi E of Eleele Shopping Center, 134 m (440 ft), 5 May 1987, T. Flynn & D. Lorence 2182 (BISH, PTBG, US).

Cactaceae

Acanthocereus tetragonus (L.) Hummelinck

Escaped from cultivation, this night-blooming cactus is naturalized on the southern coast of Kauai in dry secondary scrubland dominated by *Leucaena leucocephala*, *Acacia farnesiana* (L.) Willd., and *Cereus uruguayanus* Ritter ex R. Kiesling. This species is also naturalized in Hanapepe along Moi Road just N of the junction with Hanapepe Road, near Hanapepe Heights (Flynn & Lorence, pers. comm. 1993). The native range of *Acanthocereus tetragonus* is circum-Caribbean, and this is a **new naturalized record** of *Acanthocereus* (Berger) Britton & Rose in Hawaii. *Acanthocereus tetragonus* can be distinguished from the other Cactaceae genera naturalized in the Hawaiian Islands by the following combination of characters: habit densely branching, stems armed, broadly 3–4-winged, arching or sprawling, usually touching the ground and rooting at the ends, reaching 1.5–2 m high, when growing near trees often climbing and reaching 5–6 m tall; areoles usually with 1 (–2) stout central spines 4.5–6.5 cm long and 3–4 radial spines 0.5–2 cm long; flowers nocturnal, white, funnellform, 24–26 cm long, areoles of tube and ovary with brown felt and a few subulate spines.

Material examined. KAUAI: Koloa District, Poipu area, along Kapili Road about 0.25 miles S of Lawai Road, 15 m, 12 Dec 1988, D. Lorence & T. Flynn 6277 (BISH, PTBG).

Harrisia bonplandii (Parmentier) Britton & Rose

This terrestrial night-blooming cactus has escaped from cultivation and become naturalized in dry secondary thicket of *Leucaena leucocephala* and *Cereus uruguayanus*. This collection is a **new naturalized record** of this species in the archipelago. A native of Argentina, Brazil, and Paraguay, *Harrisia bonplandii* is distinguished from other naturalized Cactaceae in the Hawaiian Islands by the following features: distinctive habit, with some stems erect and reaching 1–1.5 m, the others arching or trailing on the ground; stems 4-angled; areoles with 1 central spine 2.3–3 cm long and 4–6 lateral spines 0.5–2 cm long, spines black-tipped; flowers white, nocturnal, funnellform, ca. 20 cm long with green, pink-tipped outer tepals; perianth tube with persistent scales. *Harrisia bonplandii* differs from *H. martinii* (Lour.) Britton, a species also naturalized in the Poipu area (Solomon 1990: 418), by its areoles with 4–6 (not 1–3), much longer radial spines 5–20 mm long, and scales of the perianth tube wooly in the axils.

Material examined. KAUAI: Koloa District, Poipu area, along Poipu Road at intersection with Kapili Road, ca. 10–15 m, 12 Dec 1988, D. Lorence & T. Flynn 6279 (PTBG).

Hylocereus costaricensis (Weber) Britton & Rose

This is a **new naturalized record** of *Hylocereus costaricensis* in the Hawaiian Islands, although *H. undatus* (Haw.) Britton & Rose is naturalized on most of the main islands (Solomon 1990: 419). Both species are vining and produce adventitious roots along their stems as they climb on rocks and trees. *Hylocereus costaricensis* is native to Central America and the Caribbean and is naturalized in dry *Leucaena* secondary thickets on Kauai at Hanapepe, in the vicinity of Poipu, and on the slopes of the lower Lawai Valley (Lorence & Flynn, pers. comm., 1994). *Hylocereus costaricensis* differs from *H. undatus* by its bluish or grayish green colored stems (versus bright green), the stem margins straight or somewhat undulate and never horny (versus crenulate and horny), purpletinged flower buds (versus green), and outer perianth segments reddish, especially near the tips (versus yellowish green).

Material examined. KAUAI: Waimea District, Hanapepe, Moi Road just N of junction with Hanapepe Road, ca. 11–12 m (35–40 ft), 18 Oct 1989, T. Flynn & L. Hume 3571 (BISH, PTBG).

Selenicereus grandiflorus (L.) Britton & Rose

This hemiepiphytic vine with large, white nocturnal flowers spreads profusely by vegetative propagation and also sets abundant pinkish red fruit. This species is naturalized locally along the S coast of Kauai from near Spouting Horn to the lower Lawai Valley slopes in secondary vegetation with *Casuarina* sp. and *Euphorbia tirucalli* L., and also in *Leucaena* secondary shrubland near Poipu (D. Lorence, pers. comm., 1994). This is a **new naturalized record** of the genus *Selenicereus* (A. Berger) Britton & Rose in the Hawaiian Islands. This species is native to Cuba, Hispaniola, and the Caribbean coast of Mexico. The seeds of this and other naturalized Cactaceae are probably dispersed by birds. *Selenicereus grandiflorus* differs from other Cactaceae genera naturalized in the Hawaiian Islands by its hemiepiphytic vining habit, slender 4–5-ribbed stems, areoles with 3–5 short spines 1–2 mm long; white tubular nocturnal flowers 24–39 cm long, outer perianth segments linear, brown, inner segments oblanceolate, 10 cm long, white, areoles of tube and hypanthium with long, curling, reddish brown wooly spines and bristles in the scale axils;

fruit strongly tuberculate.

Material examined. KAUAI: Koloa District, W end of Lawai Road at entrance to Lawai Kai, ca. 15 m, 12 Dec 1988, *D. Lorence & T. Flynn* 6278 (PTBG).

Campanulaceae

Cyanea recta (Wawra) Hillebr.

According to Lammers (1990: 461) *Cyanea recta* was thought to be extinct and consequently was classified as a Category 3A species by the U.S. Fish and Wildlife Service (USFWS) (Smith 1990). As a result of its rediscovery in Waioli Valley (Lorence & Flynn 1993a: 13) and the Makaleha Mountains (Lorence & Flynn 1993b: 13) it is being reviewed by the USFWS for inclusion on the endangered species list (L. Mehrhoff, pers. comm., 1993). In Waioli Valley a population of at least 100 plants was observed at 410 m (1330 ft) and another of 55 plants was observed at 762–853 m (2500–2800 ft). In the Makaleha Mountains 3 populations were observed: 1 with 65 plants at 853–865 m (2800–2840 ft); 1 with 15 plants at 935 m (3070 ft); and 1 with 43 plants at 625–768 m (2060–2520 ft). This species occurs in lowland wet forest and lowland wet shrubland dominated by *Metrosideros polymorpha* Gaud. and *Dicranopteris linearis* (Burm. f.) Underwood. *Cyanea recta* often occurs in gulches where it forms populations in light to moderate shade. Threats to this species include damage by feral pigs, and invasion by alien plant species, primarily *Rubus rosifolius*.

Material examined. KAUAI: Kawaihau District, Powerline Trail, Keahua side of ridge, 454 m, 10 Aug 1980, *C. Christensen* 339 (BISH, PTBG); Hanalei District, Waioli Valley, back of valley below Namolokama, 396 m, 30 Dec 1991, *S. Perlman & K.R. Wood* 12445 (PTBG), 30 Dec 1991, *K.R. Wood & S. Perlman* 1554 (PTBG); 5 Nov 1992, *T. Flynn et al.* 5129 (PTBG), *D. Lorence et al.* 7281 (PTBG); Kawaihau District, Kealia Forest Reserve, Makaleha Mtns., W of Ke Ana Kolea heading SSW up slopes of Puu Eu, 607–701 m (2000–2300 ft), 10 Nov 1993, *D. Lorence & T. Flynn* 7427 (PTBG); Lihue District, Iliiliula Drainage, below and SE of Kawaikini, ca. 579 m (ca. 1900 ft), 26 Sep 1994, *K.R. Wood & S. Perlman* 3580 (PTBG), 3586 (PTBG), 3588 (PTBG).

Cyanea undulata C. Forbes

Cyanea undulata was considered by Lammers (1990: 467) as being possibly extinct. A recent intensive survey of the Wahiawa Drainage revealed the presence of at least 12 small, scattered populations of this species comprising 28 individuals (5 adults and 23 juveniles) (Lorence 1994: 12, Lorence & Flynn 1991: 6–7). *Cyanea undulata* occurs in the shade of lowland wet forest with *Metrosideros polymorpha*, *Antidesma platyphyllum* H. Mann var. *hillebrandii* Pax & K. Hoffm., and *Syzygium sandwicensis* (A. Gray) Nied. between about 630 and 800 m elevation where it usually grows on stream banks or steep slopes in dense shade.

Material examined. KAUAI: Koloa District, Lihue-Koloa Forest Reserve, NW of Wahiawa Bog, along tributary of Wahiawa Stream, NW of stream and SE of Hulua, 650–730 m, 10 Apr 1988, *T. Flynn et al.* 2928 (PTBG), 19 Jul 1989, *T. Flynn et al.* 3458 (PTBG); N of main Wahiawa Stream along unnamed tributary by “dam” towards ridge connecting Hulua and Kapalaoa Peaks, 630–680 m, 11 Dec 1990, *D. Lorence et al.* 6642 (PTBG); heading SE from ridge connecting Hulua and Kapalaoa Peaks (870 m) down into hanging valley (740 m) above unnamed tributary N of Wahiawa Stream, ca. 800 m, 20 May 1991, *D. Lorence et al.* 6795 (PTBG); W side of Wahiawa Drainage, gulch between “Lone Loulu” ridge and LZ1, 700–770 m, 23 Jul 1991, *K.R. Wood et al.* 1082 (PTBG).

Delissea rivularis (Rock) F. Wimmer

Delissea rivularis was considered by Lammers (1990: 469) to be extinct, as the most recent specimens available to him were collected in 1916. This species was recently collected in the "Blue Hole" where it grows in low undisturbed wet forest with stunted trees and shrubs (*Metrosideros*, *Bobea*, *Perrottetia*) and a dense ground cover of pteridophytes, *Gunnera*, *Cyrtandra*, and *Cyanea* over saturated, rocky ground. In the upper Hanakoa Valley *Delissea rivularis* grows in montane wet forest with *Metrosideros* and *Dicranopteris* dominant.

Material examined. KAUAI: boundary of Lihue and Kawaihau Districts, area called "The Blue Hole," headwaters of N fork of Wailua River, just N of Mt Kawaikini and SE of Mt Waialeale, deep narrow valley surrounded by vertical cliffs with waterfalls, 600–700 m, 10 Aug 1988, *K.R. Wood et al.* 97 (F, PTBG); Hanalei District, Hono O Na Pali Natural Area Reserve, upper Hanakoa Valley, 1067 m (3500 ft), 23 Sept 1989, *S. Perlman & R. Hill 10834* (BISH, F, PTBG, US).

Lobelia hillebrandii Rock

This endemic species was previously known only from wet forest vegetation on Maui (Lammers 1990: 477). This collection represents a **new island record** of *Lobelia hillebrandii* from Molokai.

Material examined. MOLOKAI: Waihanau Stream, above diversion dam, 732 m, 12 Nov 1989, *K. Valier s.n.* (PTBG).

Caryophyllaceae

Alsinidendron viscosum (H. Mann) Sherff

Alsinidendron viscosum was considered to be extinct, known from only 4 collections made on Kauai in the early part of this century (Wagner *et al.* 1990: 502). One population of approximately 10 plants was located along the Mohihi-Waialeale Trail growing in *Metrosideros*-dominated wet forest with *Dodonaea*, *Cheirodendron*, *Melicope*, *Vaccinium*, and *Dianella*. Heavy pig damage was obvious in the vicinity and threatens this population. Two additional populations of about 30 and 43 plants, respectively, along the Nawaimaka Stream and on the ridge between Waialeale and Nawaimaka Valleys occur in montane mesic forest of *Acacia koa* A. Gray and *Metrosideros polymorpha* associated with *Poa sandvicensis* (Reichart) Hitchc., *Bidens cosmoides* (A. Gray) Sherff, and *Panicum nephelophilum* Gaud. in the understory. These 2 populations are also threatened by feral pig and goat damage and invasion by *Psidium*, *Passiflora*, *Rubus*, and *Lantana*.

Material examined. KAUAI: Waimea District, Na Pali-Kona Forest Reserve, Mohihi-Waialeale Trail from Camp 10 Road, 960–1100 m, 5 Jun 1992, *T. Flynn et al.* 5031 (PTBG); Nawaimaka Stream, *Acacia* montane mesic forest, ca. 1000 m, 19 Mar 1993, *K.R. Wood et al.* 2438 (BISH, MO, NY, PTBG, US); Waialeale Valley, ridge between Waialeale and Nawaimaka Valleys, 950–1050 m, 16 May 1991, *K.R. Wood et al.* 842 (PTBG).

Schiedea helleri Sherff

Known previously only from the type collected at Kaholuamanu, Kauai in 1895, *Schiedea helleri* was thought to be probably extinct (Wagner *et al.* 1990: 514). A population of approximately 30 plants of this species was recently located in montane wet forest with *Metrosideros*, *Cheirodendron*, and *Dicranopteris* invaded by *Rubus argutus* Link.

Material examined. KAUAI: Waimea District, Mohihi Stream, near gaging station [1042 m], 10 May 1993, K.R. Wood & S. Perlman 2543 (PTBG).

Schiedea spergulina A. Gray var. *leiopoda* Sherff

Schiedea spergulina var. *leiopoda* was previously known from localities E of Hanapepe and a ridge W of Wahiawa and was thought to be perhaps extinct by Wagner *et al.* (1990: 520). In 1988 a population of ca. 35 plants was discovered in the National Tropical Botanical Garden growing in lowland dry cliff vegetation with *Plectranthus parviflorus* Willd., *Bidens sandvicensis* subsp. *sandvicensis*, and the alien Mauritius hemp, *Furcraea foetida* (L.) Haw.

Material examined. KAUAI: Koloa District, National Tropical Botanical Garden, Lawai Valley, cliff above medicinal plants area, 60 m (200 ft), 31 Aug 1988, Flynn 3117 (PTBG), 15 May 1989, Flynn *et al.* 3400 (PTBG), 16 Jul 1991, K.R. Wood & S. Perlman 1079 (PTBG, US).

Schiedea stellarioides H. Mann

Last collected in 1916, *Schiedea stellarioides* was considered to be extinct (Wagner *et al.* 1990: 520). A population comprising approximately 500 plants was found growing in montane mesic forest with *Acacia koa* and *Metrosideros polymorpha* dominant in association with *Poa sandvicensis*. This population is threatened by feral pigs and goats as well as invasion by alien plants, primarily *Rubus*, *Passiflora*, and *Psidium*.

Material examined. KAUAI: Waimea District, Waialae Valley, ridge between Waialae and Nawaimaka Valleys, above Waialae Falls, 950–1050 m, 26 Mar 1991, K.R. Wood *et al.* 659 (PTBG), 16 May 1991, K.R. Wood *et al.* 841 (PTBG).

Casuarinaceae

Casuarina cunninghamiana Miq. X *C. glauca* Sieb. ex Spreng.

This collection initially was distributed as *Casuarina glauca* but later was determined in duplicate as *C. cunninghamiana* X *C. glauca* by L. A. S. Johnson and K. Wilson. Wagner *et al.* (1990: 529) stated that *C. glauca* was planted by foresters on all the main islands except Niihau and also noted that it spreads extensively by root suckers only on Oahu and Lanai. Label data on the above-cited collection indicate that plants in this area are also spreading by root suckers and are therefore considered as naturalized. This collection is a **new naturalized record** of this hybrid in the Hawaiian Islands.

Material examined. KAUAI: Waimea District, Kaaweki Ridge, just NE of (above) Polihale State Park, 600 m, 9 Jun 1987, D. Lorence *et al.* 5267 (BISH, PTBG).

Chenopodiaceae

Atriplex suberecta Verdoorn

Native to Australia and South Africa, this species was previously recorded as naturalized in the Hawaiian Archipelago in French Frigate Shoals, Oahu, Molokai, Lanai, Maui, and Hawaii (Wagner *et al.* 1990: 535). These collections represent a **new naturalized record** of this species on Kauai where it was collected in secondary coastal vegetation and along a roadside.

Material examined. KAUAI: Lihue District, Niumalu Flat, Hulemalu Road near oil storage tanks by Nawiliwili Bay, ca. 4.6 m (ca. 15 ft), 3 Apr 1987, T. Flynn & D. Lorence 2141 (PTBG);

Waimea District, Waimea Canyon State Park, secondary roadside vegetation along Hwy 550 between the Kokee hunter check-in station and the Waimea Canyon Lookout, 28 Mar 1994, *T. Flynn & D. Lorence 5537* (BISH, MO, PTBG, US).

Clusiaceae

Hypericum mutilum L. subsp. **mutilum**

This North American native is naturalized and locally common on eastern Molokai, Maui, and Hawaii (Wagner *et al.* 1990: 544). It is a **new island record** for Kauai where it was found growing along a dirt road in wet soil adjacent to lowland rain forest with *Metrosideros* spp. dominant.

Material examined. KAUAI: Kawaihau-Hanalei District Boundary, along the Power Line Trail, just N of summit camp (near Mt Kualapa), 620–630 m, 4 Oct 1989, *D. Lorence et al. 6380* (BISH, MO, PTBG, US).

Convolvulaceae

Argyreia nervosa (Burm f.) Bojer

Although the genus *Argyreia* Lour. is not recorded as being naturalized in the Hawaiian Islands (Austin 1990: 549), *A. nervosa* produces abundant seed and clearly is naturalized in secondary vegetation in a number of locations on Kauai. In Hanapepe River valley it grows on trees in secondary vegetation with *Leucaena* dominant. The plants collected along Hwy 520 (Tree Tunnel Road) were climbing over *Psidium* at the edge of a cane field. Known locally as baby woodrose, *Argyreia nervosa* is easily distinguished from other native and naturalized Convolvulaceae in the archipelago by the following: vigorous perennial liana, all parts except upper leaf surface densely whitish sericeous-tomentose, leaves with lamina orbicular-ovate, 7–30 x 7–30 cm, cymes robust, 9–10-flowered, peduncle 10–14 cm long, cymules enclosed by pairs of spatheaceous ovate bracts 4–5 cm long; calyx lobes 5, 10–12 mm long, externally sericeous, corolla 5–7.5 cm long, externally sericeous and pale pink, internally glabrous and deep lavender, style 20–25 mm long, stigma very shallowly bilobed with spreading lobes; fruits with persistent calyx lobes (resembling small wood-roses), subglobose, indehiscent, hard, 10–15 mm in diam.; seeds up to 4 per fruit, brown, downy.

Material examined. KAUAI: Koloa District, Hwy 50, just E of junction with Maluhia Road (Hwy 520), 4 Sep 1985, *T. Flynn 1203* (PTBG); Waimea District, along Awawa Road along Hanapepe River below Hanapepe Heights, 20–30 m, 10 Dec 1993, *D. Lorence & T. Flynn 7432* (BISH, PTBG, US).

Crassulaceae

Crassula ovata (Mill.) Druce [syn. *Crassula argentea* Thunb.]

Native to South Africa, the commonly cultivated jade plant is naturalized locally on cliffs with other succulents in secondary *Leucaena* thicket on Kauai. This collection is a **new naturalized record** of it in the Hawaiian Islands. *Crassula ovata* is distinguished from *C. multicaeva* (the following species) and *C. sieberiana* (Schult.) Druce (naturalized on Hawaii) by the following: shrubs with larger habit, 0.5–1.5 m tall, leaves larger, subsessile, obovate or spatulate, 2–3 x 1–2 cm, apex obtuse or rounded, surfaces covered by scarios, waxy coating flaking off in scales upon drying; flowers in pedunculate corymb-

iform cymes 5–7 cm long, 3.5–5 cm wide, peduncle 3–4 cm long, pedicels 5–6 mm long; calyx lobes broadly triangular, 1 mm long; petals white with pinkish tinge, narrowly ovate or oblong, 5–6 x 2–2.5 mm, stamens 5 mm long, styles 2 mm long, carpels narrowly ovoid, 2–3 mm long.

Material examined. KAUAI: Waimea District, Hanapepe, along Awawa Road along Hanapepe River, below Hanapepe Heights, ca. 12 m (ca. 40 ft), 10 Dec 1993, *T. Flynn & D. Lorence 5489* (PTBG).

Crassula multicava Lem.

Crassula multicava is native to the Cape Province of South Africa. This is a **new naturalized record** of this species in the Hawaiian Islands. On Kauai it has spread from cultivated plants and has become naturalized locally in the Kokee region along a road through eucalyptus plantings in mesic forest where it is spreading vegetatively via plantlets produced by the fruiting inflorescences and possibly also by seed. This species is distinguished from *Crassula ovata* and *C. sieberiana* by the following: herb 15–30 cm tall, stems sprawling with ends erect, unbranched or sparsely branched, with flaking waxy epidermis; leaves short-petiolate, upper pair sessile, petioles winged, 0.5–1.5 cm long, lamina broadly elliptic to broadly ovate or subcircular, 1.8–5 x 1.5–3.8 cm, base obtuse to rounded or truncate, usually decurrent along petiole, apex obtuse to rounded, when fresh dull red-green above, dull whitish below, drying thick-chartaceous, both surfaces pitted with pellucid-punctate glands; flowers in paniculate cymes 14–16 x 4–6 cm, peduncles 7–10 cm long, branches reddish tinged; flowers on slender, minutely bracteolate pedicels 4–7 mm long; calyx lobes narrowly triangular, 0.8–1.5 x 0.8–1 mm, green; petals pale pink or white with pinkish tinge, narrowly ovate-oblong, 4–5 x 1–2 mm, stamens 3.5–4 mm long, styles 1.5 mm long, carpels 2 mm long; seeds brown, ellipsoid, 0.3–0.4 mm long; fruiting inflorescences proliferous, producing plantlets in axils of bracteoles.

Material examined. KAUAI: Waimea District, Waimea Canyon State Park, Puu Ka Pele Forest Reserve, near turnoff for Boy Scout Camp, ca. 1036 m (ca. 3400 ft), 28 Mar 1994, *T. Flynn & D. Lorence 5535* (PTBG), 7 Apr 1994, *K.R. Wood 3097* (PTBG).

Kalanchoë daigremontiana Raymond-Hamet & H. Perrier

This species is locally naturalized on Kauai where it occurs on cliffs in dry *Leucaena* secondary vegetation with other naturalized succulents. This native of Madagascar is cultivated in gardens, but this collection is a **new naturalized record** of this species in the archipelago. *Kalanchoë daigremontiana* is distinguished from other members of the genus naturalized in the Hawaiian Islands (*K. fedtschenkoi*, *K. pinnata* (Lam.) Pers., and *K. tubiflora*) by the following characters: herb with stem unbranched, erect, 25–40 cm tall; leaves opposite, petiole 3–4.5 cm long, lamina narrowly triangular-hastate, 15–20 x 3.5–6 cm, dark green above and with purple markings beneath, the base subcordate or auriculate, margin coarsely serrate with teeth 5–10 mm apart, serrations producing plantlets; flowers said to be rose-colored (Neal 1965: 377). A hybrid between *K. daigremontiana* [as *Bryophyllum daigremontiana* (Raymond-Hamet & H. Perrier) Berger] and *K. tubiflora* (Harv.) Raymond-Hamet, characterized by intermediate leaf morphology, is also cultivated in the archipelago (D. Lorence, pers. comm., 1994).

Material examined. KAUAI: Waimea District, Hanapepe, along Awawa Road along Hanapepe River, below Hanapepe Heights, 20–30 m, 10 Dec 1993, *D. Lorence & T. Flynn 7431* (PTBG).

Kalanchoë fedtschenkoi Raymond-Hamet & H. Perrier

Native to Zimbabwe in southern Africa, *Kalanchoë fedtschenkoi* is widely cultivated in the Hawaiian Islands but was not previously recorded as being naturalized (Wagner *et al.* 1990: 567). It is distinguished from other members of the genus naturalized in the archipelago by the following: plant 30–60 cm tall, often covered by a glaucous bloom, stems wiry, sprawling with ends erect or arching, leaves opposite or ternate, sometimes overlapping on short stems and appearing subdistichous, petioles 2–5 mm long, lamina obovate or subcircular, 2.5–5 x 2–4 cm, pinkish or purplish green to lavender in color (a form with variegated yellow and green leaves also is cultivated), margin with 1–5 pairs of shallow serrations, usually distally; inflorescences terminal, pendulous, cymose-corymbiform, 5–6 x 6–8 cm; flowers subtended by leafy bracts, on pedicels 1.5–2 cm long, nodding, calyx reddish pink, limb 11–12 mm long, tubular, lobes 5–6 mm long, corolla 18–20 mm long, pale salmon, lobes rounded or obtuse, stamens and style included.

Material examined. KAUAI: Waimea District, Hanapepe, along Awawa Road along Hanapepe River, below Hanapepe heights, 12 m (40 ft), 10 Dec 1993, *T. Flynn & D. Lorence 5490* (PTBG).

Cyperaceae

Gahnia aspera Spreng. subsp. *globosa* (H. Mann) J. Kern

This endemic subspecies of the indigenous *Gahnia aspera* was previously recorded only from Oahu (Koyama 1990: 1409). This is a **new island record** of this species from Kauai, where it occurs as an understory sedge in secondary lowland mesic forest with indigenous remnants (Nonou Mountain), and in diverse mesic forest (at Hipalau and Haelele Valleys). Threats in these areas are invasion by alien plant species, primarily *Lantana camara* L., *Rubus argutus*, *Psidium cattleianum* Sabine, and *Triumfetta semitriloba* Jacq., and damage by feral pigs and deer.

Material examined. KAUAI: Kawaihau District, Wailua, W slope of Nonou Mountain, ca. 1/4 way down from summit on trail to Queen's Acres, Wailua Homestead, 26 Nov 1987, *L. Hume 279* (PTBG); Nonou Mountain, Nonou Forest Reserve, along trail to summit through secondary forest, 274–304 m (900–1000 ft), 26 Feb 1988, *T. Flynn & D. Lorence 2781* (BISH, F, MO, PTBG, RSA), *T. Flynn & D. Lorence 2782* (BISH, MO, PTBG, US); W side of Nonou, wooded slope, 304 m (1000 ft), 31 Dec 1952, *H. St. John 24922* (BISH); Lihue District, W of Keopaweo, Nawiliwili, dryish forest, 366 m (1200 ft), 5 Jan 1953, *H. St. John 21533* (BISH, 2 sheets); Waimea District, Hipalau Valley, below north-facing cliffs, 530–770 m, 6 Jun 1992, *K.R. Wood & J. Lau 1952* (BISH, PTBG, US); Haelele Valley, 865 m (2,480 ft), 26 Aug 1994, *K.R. Wood 3460* (PTBG).

Morelotia gahniaeformis Gaud.

The genus *Morelotia* Gaud. is indigenous to both New Zealand and the Hawaiian Islands. This species is endemic to the Hawaiian Islands (St. John 1958: 334–38) and was treated as *Gahnia gahniiformis* (Gaud.) A. Heller by Koyama (1990: 1409). It represents a **new island record** for Kauai and also occurs on Molokai, Lanai, Maui, and Hawaii (Koyama 1990: 1410).

Material examined. KAUAI: Koloa District, Lihue-Koloa Forest Reserve, NW of Wahiawa Bog in stunted, bog-like vegetation on ridge above stream, 750 m, 12 Apr 1988, *T. Flynn et al. 2933* (BISH, MO, PTBG); same locality, along windswept crest of ridge parallel to Wahiawa Stream and leading to Kapalaoa peak, 700–780 m, 18 Dec 1990, *T. Flynn et al. 4322* (AD, CHR, BISH, PTBG, US), 685 m, 26 Mar 1993, *K.R. Wood 2467* (PTBG).

Euphorbiaceae

Breynia disticha J. R. & G. Forst. cv. Roseo-picta

This ornamental shrub native to New Caledonia and the New Hebrides is widely cultivated as a hedge plant in the Hawaiian Islands. It has become naturalized by spreading vegetatively via root suckers where formerly planted around abandoned homesites on Maui and Kauai (T. Flynn, pers. comm. 1994). This is the first record of the genus *Breynia* J. R. & G. Forst. being naturalized in the Hawaiian Islands. *Breynia disticha* is usually found near villages and towns and is distinguished from other Euphorbiaceae in the archipelago by: shrubby habit, 2–2.5 m tall, spreading by root suckers; absence of latex; leaves petiolate, when young the blades mottled with green, white, pink, and burgundy; staminate calyx greenish yellow, pistillate calyx white with green markings; filament column white, the anthers pale yellow.

Material examined. MAUI: Hana District, coastal pasture lands SE of Hamoa to Waioka, Makaalae, at edge of *Terminalia/Syzygium* grove near old homesites, 30 m, 27 Oct 1987, T. Flynn & Sidler 2573 (BISH, PTBG).

Chamaesyce thymifolia (L.) Millsp.

This species was previously recorded as being naturalized on Oahu and Hawaii in low elevation dry, disturbed sites (Koutnik & Huft 1990: 617). It was collected in similar habitats on Kauai and Maui. *Chamaesyce thymifolia* is native from Mexico to Argentina, the West Indies, and the Paleotropics.

Material examined. KAUAI: Koloa District, Poipu, in and around parking lot at Sheraton Poipu, 1.5 m (5 ft), 2 Oct 1990, T. Flynn 4258a (PTBG). MAUI: Hana District, Kalahu Point, NTBG Kahanu Garden, in cultivated area from entrance along edge of forest, 15 m (50 ft), 30 Oct 1987, T. Flynn 2584 (BISH, PTBG).

Euphorbia peplus L.

This species was previously recorded from Midway Atoll, Maui, and Hawaii (Huft 1990: 620). Indigenous in Europe, it is now a cosmopolitan weed. This is a **new island record** of this species from Kauai, where it was collected as a garden weed.

Material examined. KAUAI: Waimea District, Kokee State Park, Mohihi Road ca. 1 mile of Hwy 550, cabin of John Plews, 1100 m, 13 Feb 1988, D. Lorence et al. 5796 (PTBG, US).

Euphorbia tirucalli L.

Euphorbia tirucalli is indigenous to tropical Africa and Madagascar and now widely cultivated in tropical areas. Various known as milk bush, pencil plant, pencil tree, or tirucalli, this species is occasionally cultivated as a curiosity, at least on Kauai. Collector's notes indicate that although the observed plants were sterile, the species appears to be sparingly naturalized locally as it forms dense thickets along Lawai Road where it is propagating vegetatively. *Euphorbia tirucalli* is easily distinguished from the Kauai endemic *E. haeleleana* and the introduced cultivated *E. lactea* Haw., the only other arborescent members of the genus in the archipelago, by the following characters: branches slender, pencil-like, smooth, green, 2–4 mm in diam.; leaves linear-oblong, 5–10 x 1–1.5 mm, soon deciduous; flowers and fruits rarely produced.

Material examined. KAUAI: Koloa District, Poipu, Lawai Road, in pasture N of road from Spouting Horn to the Allerton Estate, 6 m (ca. 20 ft), 12 Oct 1988, *T. Flynn 3133* (PTBG).

Fabaceae

Acacia melanoxylon R. Br. ex Aiton

The blackwood acacia or Australian blackwood from SE Australia was introduced into the Hawaiian Islands as a forestry tree and ornamental, and since 1960 over 17,000 trees have been planted in forestry reserves, at least on Kauai, Oahu, Molokai, and Maui (Little & Skolmen 1989:134). The species is now naturalized throughout the Kokee State Park region of Kauai. In a note, Geesink *et al.* (1990: 640) stated "During the final stages of preparation of this manuscript it was learned that this species has definitely become naturalized at least on East Maui, and may become a pest." Nevertheless, the collections cited here are the first documented record of it being naturalized in the archipelago. *Acacia melanoxylon* is distinguished from other native and naturalized *Acacia* species in the archipelago by the following characters: tree 8–12 m tall; leaves phyllodial, glabrous, straight or only slightly curved, 5–13 x 0.8–2.2 cm, apex acute, obtuse or rounded, tip mucronate; flower heads in axillary and terminal racemes of 3–5; flowers light yellow; pods narrowly oblong, 7.5–13 x 1 cm, reddish brown, coiled; seeds 6–10 per pod, ellipsoid, 5 mm long, shiny black.

Material examined. KAUAI: Waimea District, Kokee State Park, Halemanu Trail, from Camp Sloggett to Halemanu Valley, 1100–1150 m, 17 Feb 1988, *D. Lorence et al. 5806* (PTBG, US); Kokee State Park, along road near mile 16.5 marker, 1219 m (4000 ft), 4 Dec 1986, *T. Flynn 1988* (PTBG); along trail from Camp 10 road to Kilohana across NE edge of Alakai swamp, 5 Dec 1978, *T. Croat 44962* (MO, PTBG).

Albizia saponaria (Lour.) Blume ex Miq.

This native of the Malay Peninsula, Borneo, Celebes, Moluccas, Sula Archipelago, and the Philippines furnishes a fine timber for house construction and furniture. According to Rock (1920: 18) it was introduced into Oahu by W. Hillebrand, and a few specimens were cultivated in Honolulu at that time. On Kauai it has become naturalized near the Grove Farm Homestead in Lihue and spread over several acres with a population of ca. 100 plants (K.R. Wood, pers. comm., 1994). These collections represent a **new naturalized record** of this species in the Hawaiian Islands. *Albizia saponaria* differs from 2 other species of *Albizia* Durazz. naturalized in the archipelago, *A. chinensis* (Osbeck) Merr. and *A. lebeck* (L.) Benth., by the following characters: tree 5–10 m high, leaves 28–40 cm long, bipinnate, pinnae 2 pairs, 10–20 cm long, the distal pair larger than the basal pair, leaflets usually 2–3 pairs per pinna, 3.5–12 x 2.5–7 cm, ovate to elliptic, sides of base equal to unequal, apex obtuse or abruptly short-acuminate, adaxially sparsely puberulent, abaxially puberulent; inflorescence a terminal panicle of heads, 15–33 x 9–20 cm, the axes densely brown-hirtellous; heads 1–2 cm in diam., 6–12-flowered, flowers white; calyx 2 mm long, strigillose, the lobes 0.3–0.6 mm long, acute; corolla 3–4 mm long, the lobes 1.5 mm long; stamens 12–15 mm long; pods 7–18 x 2.5–3.2 cm, thin, flat, brown, margin raised, 5–12-seeded; seeds 6 x 3 mm, elliptic, flat, dark brown.

Material examined. KAUAI: Lihue District, Grove Farm Homestead, 4050 Nawiliwili Road, historical plantings by G. N. Wilcox, 29 Apr 1993, *K.R. Wood & R. Schleck 2522* (BISH, NY, PTBG, US), 24 Feb 1994, *K.R. Wood & R. Schleck 3002* (BISH, PTBG, US).

Lotus uliginosus Schkuhr

Previously recorded as naturalized on Molokai, Maui, and Hawaii (Geesink *et al.* 1990: 681), this is a **new naturalized record** of this species on Kauai.

Material examined. KAUAI: Lihue District, Hwy 50 along newly seeded road cut over Huleia Stream (Halfway Bridge), 97 m, 19 Jun 1994, W.L. Wagner & T. Flynn 6319 (US).

Medicago lupulina L.

This species is very common locally along the roadside and is easily recognizable because of its bright yellow flowers on erect branch tips. Previously recorded as naturalized on Midway Atoll, Oahu, Maui, and Hawaii (Geesink *et al.* 1990: 684), this collection is a **new naturalized record** of this species on Kauai.

Material examined. KAUAI: Lihue District, along Hulemalu Road between Nawiliwili and Puhi, ca. 61 m, 25 Mar 1991, T. Flynn & W. Flynn 4485 (BISH, MO, PTBG, US).

Flemingia strobilifera (L.) Ait. f. [syn. *Moghania strobilifera* (L.) St. Hil. ex Kuntze]

This species is native to Indomalaysia and is naturalized at least in the West Indies (Adams 1972: 355, Howard 1988: 492). This is a **new naturalized record** of *Flemingia* Roxb. ex Ait. f. in the Hawaiian Islands. It is easily distinguished from other genera in the subfamily Papilionoideae (= Faboideae) in the archipelago by the following combination of characters: habit a small shrub 1–1.5 m, leaves unifoliate, leaflets ovate to elliptic, gland-dotted abaxially; stipules striate; inflorescence paniculate, 10–20 cm long, peduncle zig-zag, branches strobiliform, with whitish green flowers and pale green fruits enclosed by pale green, persistent bracts that turn a golden brown color upon drying.

Material examined. MAUI: Hana District, on the lower flanks of Ka-iwi-o-pele, 12 m (40 ft), 5 Nov 1987, T. Flynn *et al.* 2591 (PTBG), 7 Mar 1988, T. Flynn *et al.* 2716 (BISH, BM, F, K, MEXU, MO, PTBG, RSA, US).

Samanea saman (Jacq.) Merr.

The monkeypod is native to tropical America and widely cultivated in the Hawaiian Islands. Geesink *et al.* (1990: 696) noted that this species is probably naturalized on all the main islands but has been documented only from Oahu and Hawaii. This collection confirms the naturalized status of *Samanea saman* on Kauai.

Material examined. KAUAI: Koloa District, National Tropical Botanical Garden, Lawai Valley, E side of valley in secondary vegetation with *Syzygium cumini* (L.) Skeels and *Cascabela thevetia* (L.) Lippold, ca. 35–40 m, 5 Dec 1994, D. Lorence 7612 (PTBG).

Trifolium dubium Sibth.

Native to Europe, this naturalized species was previously known in the Hawaiian Islands only from East Maui and Hawaii (Geesink *et al.* 1990: 712).

Material examined. KAUAI: Hanalei District, Kokee State Park, Hwy 550 at mile 18.4, 1219 m (4000 ft), 4 May 1990, T. Flynn & S. Perlman 3899 (BISH, PTBG, US); Waimea District, Kokee State Park, Hwy 550 between Hawaii Air National Guard Station and Kalalau lookout, 1256 m (4120 ft), 2 Jan 1989, T. Flynn *et al.* 3259 (PTBG).

Gesneriaceae

Cyrtandra cyaneoides Rock

Known only from the type collected at Waialae Valley, Kauai and another old col-

lection without label data, *Cyrtandra cyaneoides* was considered as possibly extinct by Wagner *et al.* (1990: 753). Recent field work has revealed populations of *Cyrtandra cyaneoides* at 4 additional localities on Kauai. Populations of this species occur in gullies on steep slopes and cliff faces below the western and southwestern rim of Namolokama Mtn. growing with ferns and *Gunnera kauaiensis* Rock. Two populations of *C. cyaneoides* were observed growing on the banks of the Wainiha River in lowland *Metrosideros polymorpha* wet forest associated with *Syzygium*, *Antidesma*, *Broussaisia*, *Boehmeria*, and *Perrottetia*. Here large, unbranched plants reached a maximum size of 4–5 m tall (D. Lorence, pers. comm., 1994, and 35 mm slides). In addition, single sterile plants were sighted (but vouchers not made) at 2 other localities: upper Waioli Valley near the main waterfall in *Metrosideros* lowland wet forest at 747 m (Lorence & Flynn 1993a: 24); and Makaleha Mountains on the NE sector of the Makaleha Plateau SE of Makaleha Peak at 859 m in *Metrosideros/Cheirodendron* lowland wet forest (Lorence & Flynn 1993b: 23).

Material examined. KAUAI: Hanalei District, Halalea Forest Reserve, summit of Namolokama Mt, along western (leeward) rim of plateau, 1250–1347 m (4100–4420 ft), 18 Jun 1988, *T. Flynn et al.* 3046 (PTBG), 1200–1350 m, 9 Sep 1988, *K.R. Wood et al.* 171 (BISH, PTBG, US), 172 (PTBG), 173 (PTBG, US), on SW face rappel, 1100–1280 m, 18 Jun 1991, *K.R. Wood et al.* 919 (PTBG); Hanalei District, Wainiha Valley, Hinalale Falls, 650 m, 9 Jan 1993, *K.R. Wood et al.* 2243 (PTBG).

Haloragaceae

Gonocarpus chinensis (Lour.) Orch. subsp. *verrucosus* (Maiden & E. Betcke) Orch.

This species was previously recorded as being sparingly naturalized in wet forest only at Hawaii Volcanoes National Park on Hawaii (Wagner *et al.* 1990: 792). It is a small decumbent herb rooting at the lower stem nodes.

Material examined. KAUAI: Kawaihau District, mauka of Kilauea town in large bog area, 137 m (450 ft), 10 Apr 1988, *L. Hume & R. Levine* 323 (PTBG).

Hydrangeaceae

Philadelphus karwinskianus Koehne

This is a **new naturalized record** of *Philadelphus* L. in the Hawaiian Islands. A native of Mexico, *Philadelphus karwinskianus* has been cultivated on Oahu since 1944 and was originally planted on Kauai as an ornamental at cabins in Kokee State Park where it has subsequently spread extensively. Although it does not appear to set fruit, it spreads vegetatively, blanketing large areas on slopes along streams in koa forest. Currently infestations occur in at least 3 areas: along the Noe Stream adjacent to Mohihi Road; along and above the Elekeninui Stream facing Mohihi Road; and between the S end of the Kokee-Halemanu Trail and Hwy 550. This species also appears to be naturalized on Maui in the vicinity of Kula. *Philadelphus karwinskianus* can be distinguished from the endemic *Broussaisia arguta* Gaud., the only other member of Hydrangeaceae in the archipelago, by the following characters: sarmentose shrub with vining stems 5–6 m long, often climbing up to 4 m in trees; leaves opposite, petioles slender, 4–10 mm long, blades ovate to ovate-elliptic, 3–7 x 1.5–2.8 mm, adaxially sparsely strigose, abaxially strigose-sericeous, base obtuse or rounded, apex acuminate, margins with 3–6 pairs of small teeth; inflorescences terminal, cymose-paniculate with 3–4 pairs of lateral branches each with 1–3 flowers, bracts leafy; flowers 4-merous, hermaphroditic, fragrant; hypanthium turbinate, 5–6

mm long, sericeous, sepals green, triangular-ovate, 6–8 x 4–5 mm, sericeous, petals white, subcircular, 10–15 x 10–15 mm, stamens ca. 50, filaments white, anthers yellow; stigma lobes 4, style villous basally, disc villous.

Material examined. KAUAI: Waimea District, Kokee State Park, unnamed trail from Kokee-Halemanu Trail to Hwy 550, 1100–1150 m, 17 Feb 1988, *D. Lorence et al.* 5811 (PTBG, US); Kokee State Park, below J.H.R. Plews' cabin along Mohihi Road, 5 Aug 1983, *T. Flynn* 519 (PTBG), 21 Aug 1985, *R. Howard* 20217 (A, PTBG). MAUI: Kula District, common in Kula along Kula Hwy, ca. 1219 m (ca. 4000 ft), 13 Jun 1984, *K. M. Nagata* 2461 (BISH).

Iridaceae

Watsonia borbonica (Pourr.) Goldblatt

Commonly cultivated in the Kokee region, this attractive species sets seed and has become naturalized locally in several areas. It was previously recorded as being naturalized only on East Maui (Goldblatt & Henrich 1990: 1449) and is native to South Africa.

Material examined. KAUAI: Waimea District, Puu Ka Pele Forest Reserve, Puu Lua Reservoir, 1100 m, 27 Jan 1988, *D. Lorence et al.* 5746 (BISH, PTBG).

Lamiaceae

Ocimum gratissimum L.

This species was previously known from dry, disturbed areas on Niihau, Oahu, Molokai, Maui, and Hawaii (Wagner *et al.* 1990: 808). It is naturalized and locally common in grazed shrubland dominated by *Lantana* and *Bothriochloa*, and in *Prosopis* thickets on western Kauai. *Ocimum gratissimum* is currently pantropical, although its native origin is unknown.

Material examined. KAUAI: Waimea District, Kekaha Road along Pokii Ridge through Waipao Valley, 91 m (300 ft), 4 Dec 1986, *T. Flynn* 1990 (BISH, MO, PTBG); U.S. Navy Pacific Missile Range Facility at Barking Sands, E of Navy Housing, 3 m (10 ft), 18 Jan 1988, *T. Flynn* 2705 (BISH, F, MO, PTBG).

Phyllostegia knudsenii Hillebr.

Phyllostegia knudsenii was known only from the type collection from the woods of Waimea on Kauai and was considered extinct by Wagner *et al.* (1990: 819). A population of 3 plants of this species was located in the Koaie Canyon growing in diverse mesic forest with *Metrosideros*, *Cryptocarya*, *Dodonaea*, *Dicranopteris*, *Elaeocarpus*, *Melicope*, *Pleomele*, *Bobea*, *Freyinetia*, *Diplazium*, and other native taxa. Threats at this site include feral goats and invasion by *Erigeron karvinskianus* DC.

Material examined. KAUAI: Waimea District, Koaie Canyon, upper canyon, in forest 21 m (70 ft) above stream, north-facing slope, 692 m (2270 ft), 31 Aug 1994, *S. Perlman & K.R. Wood* 14365 (PTBG), 24 May 1993, *K.R. Wood & S. Perlman* 2583 (PTBG).

Phyllostegia wawrana Sherff

Considered extinct by Wagner *et al.* (1990: 826), this Kauai endemic species was known only from 4 collections from Hanalei, Kokee Stream, and the Kokee area, and was last collected in 1926. At the Makaleha Plateau site a population of ca. 12 plants of *Phyllostegia wawrana* occurs in *Metrosideros-Cheirodendron* lowland wet forest, with

major threats being the alien plant species *Rubus rosifolius*, *Paspalum conjugatum*, *Pluchea carolinensis* (Jacq.) G. Don, *Melastoma candidum* D. Don, and *Erechtites valerianifolia* (Wolf) DC. At the upper Hanakoa Drainage a population of 3 plants was sighted in *Metrosideros-Cheirodendron* montane wet forest with riparian vegetation, major threats being feral pigs and the alien plant species *Rubus argutus* and *Mariscus meyenianus* (Kunth) Nees. At the Honopu site a few plants of *Phyllostegia wawrana* grow along a stream bed in *Metrosideros-Dicranopteris* montane wet forest, with major threats being feral pigs, goats, and the alien plant species *Rubus rosifolius*, *R. argutus*, *Passiflora mollissima* (Kunth) L.H. Bailey, and *Lantana camara*.

Material examined. KAUAI: Hanalei District, upper Hanakoa Drainage, 1073 m (3520 ft), 31 Jan 1994, K.R. Wood 2969 (PTBG); Honopu Valley, back of valley near stream bottom, 692 m (3920 ft), 17 Aug 1993, S. Perlman & K.R. Wood 13734 (PTBG, US), K.R. Wood & S. Perlman 2704 (PTBG); Kawaihau District, Makaleha Mountains, transect 3, on north-facing slope of Makaleha Plateau, N of Makaleha Stream, 780–816 m (2560–2680 ft), 2 Jul 1993, S. Perlman & K.R. Wood 13690 (PTBG); Makaleha Plateau N of Makaleha Stream, forested slopes and drainage ESE of Makaleha Peak, 800–830 m, 1 Jul 1993, K.R. Wood et al. 2651 (PTBG), 2652 (PTBG).

Salvia coccinea Juss. ex J. A. Murray

This species is known to be naturalized on Oahu, Molokai, Lanai, Maui, and Hawaii (Wagner et al. 1990: 829). On Kauai it is naturalized in relatively dry secondary forest dominated by *Syzygium*, *Schinus*, *Chrysophyllum*, and *Psydrax*. *Salvia coccinea* is native from the southeastern U.S.A. to South America.

Material examined. KAUAI: Lihue District, Niumalu, Hoary Head Mtn. Range below Keopaweo, 137 m (450 ft), 14 Oct 1988, T. Flynn et al. 3176 (PTBG).

Liliaceae

Asparagus setaceus (Kunth) Jessop

Native to southern Africa, the so-called asparagus fern is commonly cultivated as an ornamental in the Hawaiian Islands, but has not been recorded previously as being naturalized here. At the Kalaheo site *Asparagus setaceus* is naturalized locally in the shade of secondary vegetation of *Ficus microcarpa* L. f., *Psidium*, and *Schinus*. It may be distinguished from other native and naturalized Liliaceae in the archipelago by the following: stems climbing, green, armed with thorns towards base, branches horizontal, forming flat sprays, cladophylls 3–5 mm long, filiform, in clusters of 10–25, subtended by scarious, ovate true leaves 0.5–1 mm long; flowers usually solitary on branches, on pedicels 1–2 mm long, tepals 6, greenish white, elliptic, 2–2.5 x 1–1.5 mm, stamens 1.5 mm long, ovary ellipsoid, 1 mm long, style short with 3-lobed stigma; fruit globose-depressed, 6 mm diam., ripening red then black; seeds 4 mm diam., flattened, black.

Material examined. KAUAI: Koloa District, Kalaheo, Kalawai Park, ca. 230 m, 26 Sep 1987, D. Lorence 5569 (BISH, PTBG).

Zephyranthes citrina Baker

The zephyr or yellow rain lily is frequently cultivated in Hawaiian gardens. These collections represent a **new naturalized record** of the genus in the Hawaiian Islands, although plants are often adventive in lawns (G. Staples & D. Herbst, in preparation). The zephyr lily may be more widely naturalized than suspected but has been overlooked due

to its rather short flowering period, after which it dies back to underground bulbs. *Hippeastrum puniceum* (Lam.) Voss is the only other bulb-forming, geophytic Liliaceae with an inferior ovary naturalized in the Hawaiian Islands. *Zephyranthes citrina* can be distinguished from the former species by these characters: smaller bulbs 2.5–3 cm in diam.; narrower linear leaves 2–3 mm wide; 1-flowered inflorescences; smaller flowers with a bright yellow perianth 4–5 cm long.

Material examined. KAUAI: Koloa District, Maluhia Road across from Ann Knudsen Park, 4 Sep 1985, *T. Flynn 1197* (BISH, PTBG); along Hwy 53 between Koloa and Lawai, ca. 1 mile from Lawai, roadside, 126–134 m (420–440 ft), 16 Sep 1990, *M. Kiehn MK-900916-1/1* (PTBG).

Malvaceae

Sida cordifolia L.

This naturalized species was known previously from dry areas in Kaupo on Maui and near Kona on Hawaii (Bates 1990: 897). On Kauai a localized population was found in secondary forest dominated by *Acacia koa*, *Grevillea robusta* A. Cunn. ex R. Br., *Lantana camara*, and *Stachytarpheta urticifolia* (Salisb.) Sims.

Material examined. KAUAI: Waimea District, along Mokihana Ridge, Puu Ki-Waiialae Trail, 570 m, 20 Feb 1991, *T. Flynn et al. 4436* (BISH, PTBG, US).

Moraceae

Ficus microcarpa L. f.

The Chinese or Malayan banyan is native from Ceylon and India through southern China, Australia, and New Caledonia. Widely cultivated in the Hawaiian Islands, Wagner *et al.* (1990: 926) noted that this species is probably naturalized on all of the main islands, but has been recorded only from Oahu, Maui, and Hawaii. Nevertheless, *Ficus microcarpa* is widespread and abundantly naturalized on Kauai. At the Lawai Valley site, large trees are abundant in secondary forest of *Leucaena leucocephala* and *Syzygium cumini* (L.) Skeels on rocky slopes.

Material examined. KAUAI: Koloa District, Lawai Valley, National Tropical Botanical Garden, E of Bamboo Bridge crossover, 25–30 m, 9 Dec 1994, *D. Lorence 7613* (BISH, PTBG, US).

Myrsinaceae

Myrsine fosbergii Hosaka

Previously known from the Koolau Mts of Oahu (Wagner *et al.* 1990), this is a **new island record** of *Myrsine fosbergii* from Kauai. This species was collected in lowland and montane wet forest dominated by *Metrosideros*, and in lowland mesic forest dominated by *Metrosideros* and *Acacia*. The Kauai collections differ in having 2–3 flowers per fascicle (compared with 4–8 for Oahu), but otherwise correspond with material of *M. fosbergii* from Oahu and key out to this species in Wagner *et al.* (1990: 940).

Material examined. KAUAI: Hanalei District, Na Pali Coast State Park, survey transect 9, Kalalau Valley, along main stream on steep bank, 396 m (1300 ft), 13 Jun 1989, *S. Perlman et al. 10367* (BISH, PTBG, US); Hanalei District, Namolokama, on summit plateau on E side rim, 1311 m (4300 ft), 18 Jun 1991, *S. Perlman et al. 12004* (PTBG, US); Koloa District, Lihue-Koloa Forest Reserve, Wahiawa Bog, 640 m (2100 ft), 4 Apr 1991, *T. Flynn et al. 4510* (BISH, PTBG, US); Koloa District, Lihue-Koloa Forest Reserve, along ridge ESE of Puu Kolo, 518 m (1700 ft), 21 Sep 1988,

T. Flynn et al. 3147 (PTBG); Kalalau District, Kalalau near back of valley, 488 m (1600 ft.), 6 Sep 1986, *Hobdy* 2625 (BISH); Waimea District, Kawaiula Valley, S side, 762 m (2500 ft.), in *Metrosideros* mixed forest with *Xylosma*, *Pelea*, *Claoxylon*, *Planchonella*, 3 July 1987, *Lau* 3089 (BISH).

Myrsine mezii Hosaka

Considered extinct by Wagner *et al.* (1990: 943), this species was previously known only from 2 collections made in 1895 on the W ridge of Hanapepe River. *Myrsine mezii* was recently collected in the Nawaimaka drainage E of Waialae ridge, central Kauai, where 2 or 3 plants were observed in *Acacia koa* and *Metrosideros polymorpha* mixed mesic forest. Threats in this area are feral pigs and the alien plants *Psidium cattleianum* and *Lantana camara*.

Material examined. KAUAI: Waimea District, Na Pali-Kona Forest Reserve, along Nawaimaka Stream, 969–975 m (3180–3200 ft), 19 Mar 1993, *T. Flynn et al.* 5307 (BISH, MO, PTBG, US); Nawaimaka Stream, drainage to E of Waialae, *Metrosideros-Acacia* mixed mesic forest with riparian communities, 2 trees seen, 1000 m, 9 Nov 1993, *K.R. Wood & S. Perlman* 2844 (PTBG).

Myrtaceae

Pimenta dioica (L.) Merrill

The allspice tree is naturalized in the hills above Kalaheo below (SW of) the Alexander Reservoir, in secondary forest and mixed forestry plantings. This is a **new naturalized record** of this species in the Hawaiian Islands. *Pimenta dioica* is easily distinguished from all other Myrtaceae occurring in the Hawaiian Islands by the following characters: small tree 8–10 m tall with smooth, peeling bark; twigs flattened, often with low wings or ridges; leaves opposite, petiolate, blades narrowly elliptic or oblong, pinnately veined, with abundant oil glands and strong, spicy odor when crushed; plants dioecious; flowers in pilosulous axillary panicles, small, 3–4 mm in diam., sepals distinct in bud, petals and stamens white; fresh fruits 7–8 mm in diam., green, ripening purple-black; seeds 2, brown, 3–4 mm in diam., suborbicular, flattened unilaterally.

Material examined. KAUAI: Koloa District, Lihue-Koloa forest reserve, along jeep track to Alexander Reservoir and Mt Kahili, ca. 366 m (ca. 1200 ft), 7 Apr 1988, *D. Lorence et al.* 5939 (PTBG), 7 Sep 1983, *T. Flynn* 580 (PTBG).

Oleaceae

Olea europaea L. subsp. *africana* (Mill.) P. Green

Wagner *et al.* (1990: 992) recorded *Olea europaea* subsp. *africana* as being “naturalized and becoming a serious pest” at a single locality on Hawaii Island. This collection represents a **new island record** from Kauai, where *Olea europaea* subsp. *africana* has become abundantly naturalized from planted trees in secondary forest of *Psidium cattleianum*, *Grevillea robusta*, *Eriobotrya japonica* (Thunb.) Lindl., *Eucalyptus robusta* Sm., and occasional *Acacia koa*.

Material examined. KAUAI: Waimea District, Papaalae Ridge road, 1 mile W of Hwy 550 and due E of Contour road, 957 m, 16 Nov 1994, *D. Lorence & T. Flynn* 7604 (PTBG); Puu Ka Pele Forest Reserve, along forestry management contour road between Papaalae Ridge and Haelele Ridge, naturalizing on Kauai, ca. 914 m (ca. 3000 ft.), 15 Nov 1989, *T. Flynn & Kawakami* 3536 (BISH, PTBG).

Papaveraceae

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

Wagner *et al.* (1990: 115) stated that a specimen of *Argemone glauca* was gathered at Waimea, Kauai by William Anderson during Captain Cook's *Resolution* Voyage in 1778, making it likely the first herbarium specimen ever collected in the archipelago. As no recent collections were available for study, Wagner *et al.* (1990: 1005) erroneously stated this species occurred on all the main islands except Kauai. A recent collection, representing its **rediscovery** on Kauai, is now available from pastureland near Waimea, and it has been sighted in Kalalau Valley growing in secondary or disturbed vegetation (K.R. Wood, pers. comm. 1994).

Material examined. KAUAI: Waimea District, Waimea, middle of cow pasture, 91–152 m, 4 Aug 1992, J.H.R. Plews s.n. (BISH).

Passifloraceae

Passiflora maliformis L.

This species is sparingly naturalized locally on Kauai near the Halfway Bridge in secondary vegetation with forestry plantings of *Casuarina* sp. and *Adenantha pavonina* L. *Passiflora maliformis* is also sparingly naturalized in the Cook Islands (Whistler 1990: 388) and Fiji (Smith 1981: 669), but was not previously recorded as being naturalized in the Hawaiian Islands. *Passiflora maliformis* is distinguished from other members of the genus naturalized in the archipelago by the following characters: leaves with blades entire, ovate, 13–17 x 6.5–9.5 cm, base rounded or subcordate, apex short acuminate, petioles 3–4 cm long with 1–2 pairs of sessile glands; stipules deciduous; floral bracts large, 3-parted, nearly enclosing the mature fruits; fruits spheroidal, 3.5–4 cm in diam., fruit wall yellowish green, hard and woody, 5 mm thick; seed arils translucent white, grape-flavored.

Material examined. KAUAI: Lihue District, near Hwy 50 just E of Halfway Bridge, along turnoff into canefield just N of Hwy 50, ca. 100 m, 29 Dec 1989, D. Lorence 6417 (BISH, F, MO, PTBG, US).

Passiflora suberosa L.

This naturalized species has been previously recorded from Oahu, Maui, and Hawaii (Wagner *et al.* 1990: 1014). On Kauai *Passiflora suberosa* was collected in secondary forest dominated by *Syzygium cumini*, *Chrysophyllum oliviforme* L., *Schinus terebinthifolius* Raddi, and *Psydrax odorata* (Forst. f.) A.C. Sm. & S. Darwin.

Material examined. KAUAI: Lihue District, Hoary Head Mtn. range, E slope of Kalanipuu, above Nawiliwili, 91 m (300 ft), 15 Feb 1988, L. Hume 304 (PTBG); Hoary Head Mtn. Range, below Keopaweo, 12–137 m (40–450 ft), T. Flynn *et al.* 3173 (PTBG).

Piperaceae

Peperomia hirtipetiola C. DC

Previously known from Maui and Lanai (Wagner *et al.* 1990: 1026), these collections represent a **new island record** for this species on Kauai. It is a terrestrial herb with erect stems 0.3–0.8 m tall that occurs as scattered individuals or small populations in low-

land rain forest usually dominated by *Metrosideros polymorpha* Gaud. In collections of *Peperomia hirtipetiola* from Kauai pubescence of the adaxial leaf surface ranges from glabrate or sparsely hirtellous-villosulous (Wood *et al.* 2647, Lorence *et al.* 7342) to moderately hirtellous-villosulous (Lorence *et al.* 7305).

Material examined. KAUAI: Hanalei District, upper Waioli Valley, in hanging valley above "mist waterfall" N of Kaliko Peak, 762–853 m, 21 Jan 1993, D. Lorence *et al.* 7305 (BISH, PTBG); Hanalei District, headwaters of NE fork of Wainiha River just SW of Mahinakehau Ridge, 680–825 m, 29–30 Jan 1993, D. Lorence *et al.* 7342 (BISH, PTBG, US); Hanalei District, Makaleha Mountains, forested slopes and drainage ESE of Makaleha Peak, 800–830 m, 1 Jul 1993, K.R. Wood *et al.* 2647 (PTBG); Lihue District, headwaters of N fork of Wailua River, area called "The Blue Hole" or "The Crater", just E of Mt Waialeale and Kawaikini, 650–680 m, 13 Jun 1990, W.L. Wagner *et al.* 6357 (US).

Poaceae

Anthoxanthum odoratum L.

Previously known from Molokai, Maui, and Hawaii (O'Connor 1990: 1498), this is the first record of the sweet vernalgrass being naturalized on Kauai where it was collected in *Metrosideros* wet forest along a trail with other naturalized species.

Material examined. KAUAI: Waimea District, Kokee State Park, Kalua Pui trail, *Metrosideros*-dominated forest, 1256 m (4120 ft), 4 May 1987, T. Flynn 2179 (BISH, PTBG).

Brachiaria subquadripa (Trin.) Hitchc.

This species was cited as *Brachiaria distachya* by O'Connor (1990: 1503). The single Kauai collection lacks locality and habitat information (*Au s.n.*, BISH). However, this collection and Lorence & Flynn 6726 were subsequently identified as *B. subquadripa* by W.D. Clayton in 1994. As noted by O'Connor (1990: 1503), *Brachiaria subquadripa* also occurs on Oahu, Maui, and Molokai where it is naturalized along roadsides and in pastures. This species is common as a weed in coffee fields and lawns at Kalaheo, thus clearly establishing its status as naturalized in the Hawaiian Islands and extending its range to Kauai.

Material examined. KAUAI: Koloa District, Kalaheo, Pacific Tropical Botanical Garden, new headquarters, [120 m], 10 Nov 1983, T. Flynn 644 (PTBG); Kalaheo, new coffee plantation on McBryde land, at S end of Papalina Road and W edge of NTBG, 120 m, 14 Feb 1991, D. Lorence & T. Flynn 6726 (BISH, MO, PTBG, US); Kauai, without locality, 1 Apr 1964, S. *Au s.n.* (BISH).

Cenchrus tribuloides L.

This is a **new state record** for the dune sandbur. The native range of this species is the Atlantic coasts of North America and Gulf coasts of Mexico and Central America. Collectors' notes indicate *Cenchrus tribuloides* was confined to an area of ca. 3 square m near the Navy base [where it presumably was introduced via military equipment or vehicles], and along the road from the military housing facility to the dump. All plants were eradicated from both populations and no other plants were observed on the island (S. Perlman and K.R. Wood, pers. comm.).

Material examined. KAHOOLAWA: Makawao District, SW coast near Hanakanaea, *Prosopis-Cenchrus [ciliaris]* lowland dry forest, 40 m, 23 Feb 1992, K.R. Wood & S. Gon 1644 (PTBG, US); Hanakanaea, near "Smugglers Cove," near road to dump from housing facility, mostly alien vegetation with *Prosopis pallida* and *Cenchrus ciliaris*, 7 m, 24 Feb 1992, S. Perlman *et al.* 12607 (PTBG).

Ehrharta stipoides Labill.

The meadow ricegrass was previously recorded as being naturalized on Oahu, Maui, and Hawaii (O'Connor 1990: 1536). On Kauai it is naturalized at higher elevations in disturbed areas of native *Metrosideros* and *Acacia* forest and as a lawn weed.

Material examined. KAUAI: Waimea District, Kokee State Park, Mohihi Road ca. 1 mile E of Hwy 550, cabin of Frank Hay, 1 Nov 1983, *T. Flynn 683* (PTBG); Kokee State Park, on Canyon Trail to Waipoo Falls, 885–1098 m, 26 Aug 1983, *W.L. Wagner et al. 4944* (BISH, US); Kumuwela Road ca. 1.6 miles past junction with Mohihi Road, 10 May 1985, *T. Flynn 1093* (BISH, PTBG).

Eragrostis amabilis (L.) Wight & Arnott

Eragrostis amabilis was formerly known as *E. tenella* (L.) P. Beauv. ex Roem. & Schult. in the Hawaiian Islands (O'Connor 1990: 1545). This small, delicate species was previously recorded as being naturalized on Midway Atoll, Niihau, Oahu, Maui, Kahoolawe, and Hawaii and reported from Molokai (Hughes, 1995: 8–9). On Kauai it usually occurs in disturbed sites, lawns, and secondary vegetation at low elevations.

Material examined. KAUAI: Koloa District, lower reaches of Lawai Valley, in Lawai Kai (Allerton Gardens), 1–10 m, 29 Jan 1988, *D. Lorence & P. O'Connor 5762* (BISH, PTBG); Lihue District, Lihue airport, lawn adjacent to rental car agencies, ca. 36 m, 26 Sep 1990, *D. Lorence & H. Iltis 6612* (PTBG); Waimea District, U.S. Navy Pacific Missile Range Facility at Barking Sands, between Kokole Point and Navy Housing in *Dodonaea* shrubland, 3 m (10 ft), 15 Jan 1988, *T. Flynn et al. 2694* (BISH, PTBG).

Eragrostis elongata (Willd.) Jacq.

Eragrostis elongata was reported as adventive on Kauai and Hawaii and was first collected on Kauai in 1966 (O'Connor 1990: 1538). This species is definitely naturalized on Kauai where it occurs along roadsides, in canefields, and in other weedy areas.

Material examined. KAUAI: Waimea District, Waimea Canyon State Park, Hwy 550 near hunter check-in station, at ca. mile 7.2, 762 m (2500 ft), 27 Jan 1988, *T. Flynn & P. O'Connor 2718* (BISH, PTBG), 23 Jan 1984, *T. Flynn 745* (BISH, PTBG); Kokee State Park, Mohihi Road along Waikeke Swamp, 1097 m (3600 ft), 28 Jan 1988, *T. Flynn et al. 2724* (PTBG); Kokee State Park, Kaluapuhi Trail, 20 Dec 1983, *W.L. Wagner et al. 5133* (BISH); Kokee State Park, near Berry Flats Trail, along side of jeep trail in wet shaded forest, 16 Dec 1966, *D. Herbst 285* (BISH).

Eragrostis pectinacea (Michx.) Nees

The Carolina lovegrass is also recorded as being naturalized on Oahu, Lanai, Maui, and Hawaii (O'Connor 1990: 1545). On Kauai it is naturalized in lowland dry secondary shrubland near Waimea.

Material examined. KAUAI: Waimea District, Russian Fort Elizabeth State Historical Park, Waimea, 6 m (20 ft), 7 Mar 1989, *T. Flynn et al. 3287* (BISH, BM, F, K, MO, PTBG, US).

Eragrostis pilosa (L.) P. Beauv.

This species was reported as adventive on Molokai, Maui, and Hawaii, where it was first collected in 1911 (O'Connor 1990: 1538). These collections represent a **new naturalized record** of *Eragrostis pilosa* on Kauai.

Material examined. KAUAI: Koloa District, Lawai, Pacific Tropical Botanical Garden parking lot, [120 m], 31 Oct 1983, *T. Flynn 630* (BISH, PTBG); Pacific Tropical Botanical Garden, lower

Lawai Valley (Allerton Gardens), W side of Lawai Stream, 10 m, 29 Jan 1988, D. Lorence & P. O'Connor 5761 (BISH, PTBG).

Ischaemum byrone (Trin.) Hitchc.

This Hawaiian endemic species was previously recorded from Molokai, Maui, and Hawaii (O'Connor 1990: 1557). On Kauai it was collected from a population growing on dripping wet coastal cliff faces with *Bacopa monnieri* (L.) Wettst., *Lythrum maritimum* Kunth, and *Mariscus javanicus* (Houtt.) Merr. & Metcalfe. *Ischaemum byrone* has been listed as an endangered species by the U.S. Fish and Wildlife Service (Mehrhoff 1994).

Material examined. KAUAI: Hanalei District, Kauapea Beach (Secret Beach) between Kilauea Point and Niu [1.5 m], 25 May 1989, T. Flynn & B. Schaeffer 3429 (BISH, PTBG, US), 30 Jul 1993, S. Perlman & K.R. Wood 13723 (PTBG).

Panicum konaense Whitney & Hosaka

This small, delicate annual grass occurs on Kauai (**new island record**) in rather dry, disturbed areas dominated by alien vegetation and seems to appear only after periods of prolonged winter rains. This endemic Hawaiian endemic species was previously recorded from Molokai, Maui, and Hawaii (Davidse 1990: 1569).

Material examined. KAUAI: Waimea District, Waimea Canyon Drive, ca. 3.3 mi from Waimea town, edge of Waimea Canyon, 369 m (1210 ft), 7 Feb 1985, T. Flynn 995 (PTBG); Puu Ka Pele Forest Reserve, Kaaweke Ridge, N side of ridge in shaded, moist soil pockets of rock outcrop, 335 m (1100 ft), 2 Jan 1989, T. Flynn et al. 3253 (PTBG).

Panicum niihauense St. John

This endemic Hawaiian species was previously known only from the island of Niihau, where it is rare in sand dunes or rocky outcrops (Davidse 1990: 1570). The Kauai population (**new island record**) was estimated to consist of about 20 plants in 1992 and seems to have survived Hurricane Iniki relatively unscathed. The plants grow in an area between coral sand dunes with native shrubland and the edge of secondary *Prosopis pallida* forest.

Material examined. KAUAI: Waimea District, Polihale State Park, in dunes behind Queen's Pond [15 m], 24 Feb 1985, T. Flynn 1011 (PTBG), 5 June 1992, S. Perlman et al. 12799 (PTBG), 14 Jan 1993, S. Perlman & K.R. Wood 13236 (PTBG).

Poa mannii Munro ex Hillebr.

In his treatment of Poaceae for Hawaii, O'Connor (1990: 1584) considered *Poa mannii* to be possibly extinct, as it was last collected from Olokele Gulch and "Waimea", Kauai in 1916. Recent collecting efforts have revealed populations growing in at least 7 localities on Kauai. *Poa mannii* is usually restricted to moist vertical cliff faces and rock ledges, or dripping, wet rock walls, often on northern exposures in partial shade, where it is rare and scattered to locally frequent. This species is frequently associated with diverse mixed mesic forest of *Acacia koa*, *Metrosideros polymorpha*, *Alectryon*, *Diospyros*, *Antidesma*, and *Myrsine*, or dry shrubland with *Styphelia*, *Dodonaea*, *Wilkesia*, and *Eragrostis variabilis*. Threats to *Poa mannii* include browsing by goats and invasion by alien plants including *Erigeron karvinskianus*, *Pluchea carolinensis*, *Lantana camara*, *Rubus rosifolius*, and *Psidium guajava* L. Two of the collections cited below (Flynn 1026 and Lorence et al. 5955) were determined, we believe in error, as *Poa annua* L. by W.D.

Clayton in 1994. Unlike *P. annua*, which has leaf sheaths open for about half their length, these 2 collections have completely closed sheaths and correspond with *P. mannii* in all other essential characters.

Material examined. KAUAI: Waimea District, Waimea Canyon State Park, Kukui Trail, ca. 50 yds. past its junction with Iliau Loop, 19 Mar 1985, *T. Flynn 1026* (BISH, PTBG); Waimea Canyon State Park, Iliau Loop Trail, common along trail below check-in station, 877 m (2880 ft), 17 Apr 1991, *T. Flynn et al. 4552* (BISH, PTBG, US); Kauhau Ridge, near gauging station and ditch, north-facing mesic forest, 926 m (3040 ft), 25 Mar 1991, *K.R. Wood et al. 655* (PTBG); Puu Ka Pele Forest Reserve, Makaha Valley, 3 mi W of intersection with Hwy 550 along Makaha Ridge road, steep narrow canyon with seasonal stream, 460 m, 11 Apr 1988, *D. Lorence et al. 5955* (BISH, PTBG); Makaha Ridge and Valley, N rim just before facility, 549 m (1800 ft), 2 Jan 1993, *K.R. Wood et al. 2228* (MO, PTBG); Waimea Canyon along Koaie River 1–2 km upstream from Lonomea Shelter, on SE side of river, 540–560 m, 16 Apr 1991, *D. Lorence et al. 6773* (PTBG, US); Waialae Valley, ridge between Waialae and Nawaimaka Valleys, above Waialae Falls, 950–1050 m, 16 May 1991, *K.R. Wood et al. 847* (PTBG); Hanalei District, Kalalau Valley, north Kalalau rim, below Puu o Kila, 950–1150 m, 6 Jul 1991, *K.R. Wood 1034-A* (BISH, PTBG); Kalalau rim, Kalahu side below first Kalalau lookout, 1100–1150 m, 15 Aug 1991, *K.R. Wood 1148* (PTBG), *1149* (BISH, MO, PTBG, US); Kalalau rim, Kalahu side below and W of first Kalalau lookout, 900–1000 m, 20 Aug 1991, *K.R. Wood 1157* (PTBG), 700–800 m, 22 Nov 1991, *K.R. Wood 1425* (PTBG); Kalahu side, isolated hanging valley below and W of first Kalalau lookout, 550–670 m, 4 Dec 1991, *K.R. Wood 1468* (PTBG); Kalalau rim, below and E of first Kalalau lookout, 1000–1100 m, 15 Sep 1991, *K.R. Wood 1255* (PTBG); Awaawapuhi Valley, on north-facing slopes, 1067 m (3500 ft), 18 May 1994, *S. Perlman & K.R. Wood 14202* (MO, PTBG).

Schizachyrium condensatum (Kunth) Nees

Schizachyrium condensatum, native to tropical and subtropical America, was previously recorded as being naturalized in the Hawaiian Archipelago only on Hawaii Island, primarily in Hawaii Volcanoes National Park (O'Connor 1990: 1590). However, it has become widely naturalized on Kauai also. In addition to the collections cited below, this species is also naturalized in the Hanalei District in Waioli Valley and the Makaleha Mountains (Lorence & Flynn 1993a: 19, 1993b: 19), and along the coastal Hwy 56 (D. Lorence, pers. comm., 1994). It is becoming a major threat to native vegetation in these regions, as it is one of the first plants to colonize landslides and areas disturbed by Hurricane Iniki in 1992.

Material examined. KAUAI: Lihue District, summit of Mauna Kapu, Kalepa Ridge, 207 m (680 ft), 19 Aug 1989, *L. Hume & R. Levine 411* (PTBG, US); border of Hanalei and Kawaihau Districts, Forest Reserve lands, 655 m (2150 ft), 3 Oct 1989, *T. Flynn et al. 3547* (BISH, F, MO, MU, NY, OS, PTBG, US); Waimea District, Waimea Canyon State Park, Hwy 550 near hunter check-in station, ca. mile 7.2, ca. 762 m (ca. 2500 ft), 27 Jan 1988, *T. Flynn et al. 2717* (PTBG); Hanalei District, Hanalei, National Wildlife Refuge, ca. 0.5 mi above primary taro fields on slopes, *W.L. Wagner & R. Hanford 6278* (US); Limahuli Valley, W side of ridge separating Limahuli and Hanakapiai valleys, above waterfall, in almost undisturbed low elevation rain forest, 488–625 m (1600–2060 ft), 10 Dec 1987, *T. Flynn et al. 2679* (PTBG).

Schizachyrium scoparium (Michx.) Nash

Native to southern Canada and most of the United States, the prairie beardgrass or little bluestem was recorded as being present in the Hawaiian Islands as early as 1922 (Rotar 1968: 330). Nevertheless, this Kauai collection, determined by W.D. Clayton in 1994, represents a **new naturalized record** of this species in the Hawaiian Islands. *Schizachyrium scoparium* may be distinguished from *S. condensatum* by the following characters: culms densely tufted, 50–150 cm tall, erect, often glaucous, branching distally, sheaths and blades glabrous or blades long pilose towards base, blades 9–20 x 3–4 mm;

inflorescence with racemes 3–6 cm long, mostly curved, the peduncles filiform, mostly included in the sheaths, often spreading, the rachis slender, flexuose, pilose; sessile spikelet 6–8 mm long, scabrous, the awn 8–15 mm long, twisted, minutely scabrid; pedicellate spikelet reduced, short-awned, spreading, the pedicel pilose.

Material examined. KAUAI: Hanalei District, Waipa ahupua'a SW of Waipa Stream, pasture land and secondary forest giving way to *Metrosideros*-dominated forest near base of ridge that forms natural boundary of area, 45–292 m (150–960 ft), 2 Dec 1988, T. Flynn & L. Hume 3220 (BISH, PTBG).

Polygalaceae

Polygala paniculata L.

Collectors' notes indicate this herbaceous species is common in disturbed land and along roadsides on Kauai. *Polygala paniculata* was previously recorded as naturalized on Oahu, East Maui, and Hawaii (Wagner *et al.* 1990: 1058).

Material examined. KAUAI: Kawaihau/Lihue District boundary, upper Wailua River area, in open wet roadside on unpaved road leading to "Blue Hole" [ca. 250–300 m], 6 Aug 1989, L. Hume & R. Levine 399 (BISH, MO, PTBG, US); Kawaihau District, above Keahua Arboretum, Wailua, on roadside, 4 Mar 1993, L. Hume & J. Spinnler 515 (BISH, PTBG, US).

Rhamnaceae

Gouania meyenii Steud.

Gouania meyenii was previously considered endemic to Oahu, where only 3 populations are currently known from the Waianae Mountains (Wagner *et al.* 1990: 1095). Its occurrence on Kauai represents a **new island record**. On Kauai this species is restricted to a few remnants of lowland diverse mesic forest restricted to cliffs and in hanging valleys inaccessible to feral goats. Associated taxa include *Metrosideros*, *Melicope*, *Dubautia*, *Hibiscus*, *Zanthoxylum*, *Santalum*, *Hedyotis*, *Chamaesyce*, and *Nototrichium*. The Kalalau Valley population consists of approximately 22 plants, whereas only a single plant was observed in Hipalau Valley. Serious threats to this species on Kauai are feral goats, invasion by alien plant species, and landslides (Wood & Perlman 1992: 12; K.R. Wood, pers. comm., 1993).

The Kauai populations of this species exhibit some differences from those in the Waianae Mountains on Oahu. The isolated populations on these 2 islands apparently have become fixed for some characters, including peduncle length, number of fruit wings, and leaf pubescence. Peduncles of the Kauai plants are 7–21 mm long, whereas in the Oahu populations the peduncles are (20–) 25–60 mm long. Fruits of the Kalalau, Kauai population are 3-winged, sometimes 2-winged, whereas fruits of the Oahu populations are 2-winged or occasionally 3-winged. Finally, the Hipalau Valley specimen has completely glabrous leaves while the Kalalau population has the leaves sparsely appressed pilose on the lower leaf surface, as do the Oahu plants.

Material examined. KAUAI: Waimea District, Waimea Canyon drainage, Koaie Canyon, at back of Hipalau Valley, on north-facing cliff, 21 Oct 1992, S. Perlman & K.R. Wood 13060 (PTBG, US); Hanalei District, Kalalau Rim, Kalahu side below and W of first Kalalau lookout, 790 m, 20 Nov 1991, K.R. Wood 1393 (BISH, PTBG), 22 Nov 1991, K.R. Wood 1424 (BISH, PTBG, US), 13 Mar 1992, K.R. Wood & S. Perlman 1707 (PTBG), 1708 (PTBG, US); Kalalau Valley, back of valley on cliffs below Puu o Kila, 725 (2380 ft), 10 Jun 1992, S. Perlman *et al.* 12805 (PTBG, US).

Rosaceae

Cotoneaster pannosus Franch.

This is a **new naturalized record** of the genus *Cotoneaster* Medikus in the Hawaiian Islands. Wagner *et al.* (1990: 1100) noted that on Maui and Hawaii *C. pannosus* persists in the vicinity of cultivated plants although it has not spread, but they added "However, it could easily become a pest because of its attractive, presumably bird-dispersed fruit." On Kauai this shrub has escaped from cultivated plants in forestry plantings and around cabins in the Kokee area and on Makaha Ridge. This species has become naturalized in diverse mesic forest of *Acacia koa*, *Metrosideros polymorpha*, alien species, and forestry plantations in Waimea Canyon State Park, Kokee State Park, and Puu Ka Pele Forest Reserve at ca. 1000–1300 m elevation. *Cotoneaster pannosus* is distinguished from all other Rosaceae in the archipelago by the following characters: shrub 2–5 m tall; leaves simple, blades elliptic, 1.5–3 x 0.8–1.6 cm, glabrous above, whitish tomentose beneath, apex mucronulate, petiole 5–8 mm; flowers in terminal corymbs, petals white; fruit a bright red pome, subglobose to ellipsoid, 5–7 mm in diam.; seeds 2–5, 4–5 mm long. Another species, *C. microphyllus* Wall. ex Lindl., which differs from *C. pannosus* in its low habit up to 1 m tall, leaf blades up to 0.8 cm long, and the lower surface white-gray pilose-strigose, later glabrate, has been cultivated on the island of Hawaii and may be naturalized there (Herbst, pers. comm.).

Material examined. KAUAI: Waimea District, Puu Ka Pele Forest Reserve, 13 mile marker from Waimea along Hwy 550, near turnoff to Methodist and Boy Scout camps, 1006 m (3300 ft), 2 Dec 1993, K.R. Wood & S. Perlman 2878 (PTBG), along road from Hwy 550 to Boy Scout Camp, 1036 m, 16 Nov 1994, Lorence & Flynn 7603 (PTBG).

Eriobotrya japonica (Thunb.) Lindl.

The loquat is frequently cultivated as a fruit tree in the Hawaiian Islands. Wagner *et al.* (1990: 1100) noted that it occasionally escapes from cultivation in Hawaii Volcanoes National Park. On Kauai this species clearly has become naturalized locally in mixed mesic *Acacia/Metrosideros* forest and along roadsides in the Kokee State Park region. This is a **new naturalized record** of it in the Hawaiian Islands. *Eriobotrya japonica* is distinguished from all other Rosaceae in the archipelago by: tree to 4 m tall; stipules brownish tomentose, 5–8 mm long, persistent; leaves with blade obovate-elliptic or oblanceolate, 10–30 x 3.5–9.5 cm, glabrous above, pale brownish tomentulose beneath, margins serrate-dentate distally; flowers in terminal panicles, externally brown-tomentulose; fruits obovoid-ellipsoid, 2–2.5 x 1.5–2 cm, yellow, juicy, tomentulose when young, usually 2-seeded; seeds ellipsoid, plano-convex, 1.5 cm long, brown.

Material examined. KAUAI: Waimea District, Puu Ka Pele Forest Reserve, Kauhao Ridge Road leading from Hwy 550 W towards Methodist and Boy Scout camps, 1006–1036 m, 25 Mar 1991, D. Lorence *et al.* 6731 (BISH, MO, PTBG, US).

Rubiaceae

Bohea timonioides (J.D. Hook.) Hillebr.

According to Wagner *et al.* (1990: 1118), *Bohea timonioides* is known definitely from Maui and Hawaii only; a few atypical collections from Oahu and Kauai possibly belonging to this species are known, but differ by their exceptionally long peduncles and calyx limbs. However, the collections cited below correspond very well with typical material of *Bohea timonioides* from Maui and Hawaii and definitely confirm its presence on

Kauai. In the Waimea Canyon complex this species was collected in diverse mesic forest associated with *Diospyros*, *Psydrax*, *Erythrina*, *Hibiscadelphus*, *Tetraplasandra*, and *Flueggea*, severely degraded by goats and invaded by *Aleurites*, *Lantana*, *Melia*, and *Psidium*. In Makaha Valley *Bobea tinonioides* was collected in diverse mesic forest with *Nestegis*, *Pteralyxia*, *Euphorbia*, *Diospyros*, *Nototrichium*, and *Dodonaea*, with major threats being *Lantana camara* and feral deer and goats.

Material examined. KAUAI: Waimea District, Koaie Canyon, from Lonomea Camp, E along Koaie Stream, 640 m, 30 Mar 1990, K.R. Wood *et al.* 273 (MO, PTBG, US); Koaie Canyon, Koaie Stream, heading SW to S fork of Kawaiiki Stream, 730 m, 3 Mar 1990, K.R. Wood *et al.* 291 (AD, MU, PTBG), J. Lau 2203 (BISH), 548 m (1800 ft), 31 Jan 1990, T. Flynn *et al.* 3754 (PTBG, US); Waimea District, Hipalau Valley, 530–770 m, 6 Jun 1992, K.R. Wood & J. Lau 1957 (AD, BISH, F, MO, PTBG, US); Waimea Canyon drainage, Poomau Canyon, S side of stream, 473 m (1550 ft), 27 Nov 1987, S. Perlman & J. Lau 7016 (MO, P, PTBG); Makaha Valley, north aspect, 683 m (2240 ft), 16 Jun 1993, K.R. Wood & S. Perlman 2609 (PTBG).

Hedyotis corymbosa (L.) Lam.

This species is an herb with matted or trailing stems occurring as a weed in lawns, along roadsides and paths, and in vacant lots. It has tiny seeds that can be transported easily by mud sticking to shoes, etc. *Hedyotis corymbosa* is native to Africa and now widely naturalized in many tropical regions. This collection establishes its naturalized status on Kauai. *Hedyotis corymbosa* is also naturalized on Oahu, East Maui, and Hawaii (Wagner *et al.* 1990: 1141).

Material examined. KAUAI: Lihue District, Lihue Airport, lawn adjacent to car rental agencies, ca. 36 m, 26 Sep 1990, D. Lorence & H. Iltis 6611 (BISH, MO, PTBG, US).

Morinda trimera Hillebr.

St. John (1979: 378) reported a single sterile collection of this species from Kauai, although the specimen was not located by Wagner *et al.* (1990: 1158). Previously known from Oahu, Lanai, and Maui, the occurrence of *Morinda trimera* on Kauai is now definitely established. This species was collected in lowland diverse mesic forest with *Diospyros* and *Metrosideros* in Kalalau Valley, and in disturbed mixed mesophytic forest with *Acacia koa*, kukui, guava, and *Hibiscus waimeae* A. Heller subsp. *waimeae* in Mahanaloa Valley (K.R. Wood, pers. comm.).

Material examined. KAUAI: Hanalei District, Kalalau Valley, back of valley at 594 m (1950 ft), 10 Jun 1992, S. Perlman *et al.* 12806 (BISH, PTBG, US), base camp in back of valley, diverse mesic and *Metrosideros/Diospyros* forest, 580 m, single tree, threats from goats, landslides, *Rubus argutus*, *Erigeron*, *Kalanchoe*, *Lantana*, *Psidium guajava*, *Pluchea*, 10 Jun 1992, K.R. Wood *et al.* 1964 (BISH, F, MO, PTBG, US).

Richardia scabra L.

Lewis & Oliver (1974: 282) recorded *Richardia scabra* as being native to tropical America and elsewhere adventive in the continental U.S.A. (Indiana) and Africa. This is a **new state record** and, indeed, the first record of it on any Pacific island. On Kauai it was found growing in a sugarcane field, suggesting it was introduced as a weed. *Richardia brasiliensis* Gomes, also naturalized in the Hawaiian archipelago, has mericarps that are adaxially broadly and openly concave with a slim median keel, whereas those of *R. scabra* are adaxially closed to a narrow groove or sulcus. These 2 species are

otherwise similar in morphology.

Material examined. KAUAI: Lihue District, sugar cane road E of Omoe (Hoary Head Mtn. Range), 158–170 m (520–560 ft), 20 Sep 1990, *M. Kiehn & T. Flynn* MK-900920-1/1 (PTBG, US, WU), MK-900917-2/1 (PTBG, WU); Lihue District, Hulemalu Road near junction with Halehaka Road, along cane ditch [ca. 67 m], 3 Oct 1985, *T. Flynn* 1245 (PTBG).

Spermacoce

Only 2 species of *Spermacoce* L. were recorded by Wagner *et al.* (1990: 1173) as being naturalized in the Hawaiian Islands: *S. assurgens* Ruiz & Pavón and *S. mauritiana* Gideon (here considered a synonym of *S. exilis* (L. O. Williams) C. Adams). Two additional species are recorded here for the first time as being naturalized in the archipelago: *S. latifolia* Aubl. on Kauai and *S. ovalifolia* (M. Martens & Galeotti) Hemsl. on the island of Hawaii. We have adopted the species concepts of Burger & Taylor (1993: 313–320) in their treatment of the *Spermacoce* for *Flora Costaricensis*. The 4 *Spermacoce* species naturalized in Hawaii can be separated by characters given in the following key.

Key to *Spermacoce* in the Hawaiian Islands

1. Stems (9–)20–90 cm long; leaves (15–)25–60 mm long, at least the lower ones distinctly petiolate with petioles 5–10 mm long. (2).
1. Stems 6–20 cm long; leaves 5–20 mm long, sessile or the lower ones with petioles only 1–2 mm long. (3).
- 2 (1). Stems terete, unwinged or with 4 low ridges to 0.1 mm wide; corolla tube ca. 0.5–1 mm long; hypanthium 2–3 mm long; seeds dark reddish brown, 1.5–1.7 mm long, the surface foveolate and transversely deeply grooved. *S. assurgens*
2. Stems tetragonal, 4-winged, the wings 0.5 mm wide; corolla tube ca. 4–5 mm long; hypanthium 1–1.5 mm long; seeds light brown, 2–2.6 mm long, the surface foveolate, not transversely grooved. *S. latifolia*
- 3(1). Stems usually procumbent, the stem wings often long ciliolate; calyx lobes 2; hypanthium ca. 0.5 mm long; seeds yellowish brown with shallow, transversely elongate pitting. *S. exilis*
3. Stems usually erect, the stem wings glabrous; calyx lobes 4; hypanthium ca. 1 mm long; seeds reddish brown with deep, isodiametrical or slightly transversely elongate pitting. *S. ovalifolia*

Spermacoce exilis (L. O. Williams) C. Adams

This species was previously recorded by Wagner *et al.* (1990: 1173), under the name *Spermacoce mauritiana*, as being naturalized on Maui and Hawaii. These additional cited collections suggest this species is becoming more widespread, at least on Hawaii island.

Material examined. HAWAII: Puna District, Lava Tree State Monument, along Hwy 132 just E of Kanihiku Village, ca. 190 m, 17 Jun 1990, *D. Lorence et al.* 6571 (PTBG), ca. 190 m, 7 Jan 1991, *D. Lorence & T. Flynn* 6665A (PTBG), on park roads and paths, 18 Jun 1990, *W.L. Wagner & S. Mill Arey* 6429 (US); South Hilo District, Hilo, vacant lot along Keawe St., 10 m, 20 Jun 1990, *D. Lorence et al.* 6575 (PTBG).

Spermacoce latifolia Aubl.

Spermacoce latifolia is here recorded from the Hawaiian Islands for the first time. It is native to tropical South America and the West Indies and is now common as a weed in

many tropical regions including Africa, India, Ceylon, Malesia, Australia, and Fiji (Smith 1988: 374). Because of its localized distribution in a sugarcane field on southern Kauai, *Spermacoce latifolia* is presumably of recent introduction in the Hawaiian Islands, possibly as a seed contaminant. However, the other 2 species of *Spermacoce* recorded by Wagner *et al.* (1990: 1173) as being naturalized in the archipelago (*S. assurgens* and *S. mauritiana* [= *S. exilis*]) are becoming or have already become widespread weeds, and *S. latifolia* also can be expected to spread.

Material examined. KAUAI: Lihue District, sugar cane road E of Omoe (Hoary Head Mtn. Range), ca. 158–170 m (520–560 ft), ruderal, 17 Sep 1990, *M. Kiehn & T. Flynn* MK-900917–2/3 (PTBG, WU, US), MK-900917–2/4 (BISH, PTBG, WU), 20 Sep 1990, MK-900920–1/2 (PTBG, WU), MK-900920–1/3 (PTBG, WU, US).

Spermacoce ovalifolia (M. Martens & Galeotti) Hemsl.

Wagner *et al.* (1990: 1173) mentioned that *Spermacoce prostrata* Aubl. may have been collected once in Hilo, although they were not able to locate the voucher specimen collected by D. Herbst and determined by F. R. Fosberg. The below cited specimens correspond well with Mexican and Central American material of *Spermacoce ovalifolia*, a species resembling *S. prostrata* but differing in having glabrous, tetragonal ribbed stems, narrowly elongate-deltate (or inrolled and subulate), persistent calyx lobes, and reddish brown seeds with numerous pits in the testa. It is likely that the specimen referred to as *S. prostrata* by Wagner *et al.* (1990: 1173) actually represents *S. ovalifolia*. This species was collected in secondary vegetation in *Metrosideros* wet forest at the dump site, and in *Metrosideros* shrubland with *Nephrolepis* and *Stereocaulon* over a'a lava. These collections definitely establish the identity of this species in the Hawaiian Islands.

Material examined. HAWAII: Puna District, mile 16 of Hwy 130, ca. 304 m (ca. 1000 ft), 26 May 1990, *T. Flynn et al.* 3910 (PTBG, US); Volcano Refuge Transfer Station, along Hwy 11 between Glenwood and Volcano, 930 m, 7 Jan 1991, *D. Lorence & T. Flynn* 6673 (PTBG), 960 m, 13 Mar 1988, *W.L. Wagner et al.* 5976 (BISH, PTBG); along Pahoia-Pohoiki Road 0.5 mi E of junction with Hwy 132, roadsides, common, 180 m, 18 Jun 1990, *W.L. Wagner & S. Mill Aray* 6390 (US).

Rutaceae

Melicope pallida (Hillebr.) T. Hartley & B. Stone

In their treatment of *Melicope* Forst. & Forst. f. in the Hawaiian Islands, Stone *et al.* (1990: 1198) noted that *M. pallida* was possibly extinct as it was last collected on Oahu in 1970. The last collection on Kauai prior to the one by J. Lau was made in 1952 (*Degener & Greenwell* 21556, BISH), on the rim of Kalalau Valley. Recent botanical survey work in Kalalau Valley (Wood & Perlman 1993: Appendix C) has revealed *M. pallida* to be widespread locally in diverse lowland mesic forest with *Metrosideros*, *Acacia*, *Diospyros*, *Nototrichium*, *Pittosporum*, *Tetraplasandra*, *Psychotria*, *Psydrax*, *Alyxia*, *Hedyotis*, *Nestegis*, and *Dicranopteris*, and cliff vegetation with native grasses, sedges, and *Artemisia*. Threats to *M. pallida* include feral goats and pigs, falling rocks and landslides caused by feral animal activities, and invasive alien plant species, primarily *Lantana camara* L., *Psidium guajava*, *Erigeron karvinskianus*, and *Kalanchoë pinnata* (Lam.) Pers. *Melicope pallida* also occurs in Honopu Valley and Awaawapuhi Valley in *Acacia-Metrosideros* mixed mesic forest. In Koaie Canyon the species was observed growing in *Metrosideros-Dicranopteris* wet forest, with *Erigeron karvinskianus*, *Lantana*

camara, and goats as major threats. One sterile plant was observed in upper Limahuli Valley on the NE side of the ridge above Limahuli waterfall at ca. 607 m (ca. 2000 ft) growing in *Metrosideros* and *Dicranopteris* wet forest vegetation (K.R. Wood, pers. comm. 1994).

Material examined. KAUAI: Hanalei District, Napali area, Hanakapiai Valley, 610 m, 1 Apr 1986, *Lau 2207* (BISH); Kalalau Valley, at mile 18.4, 1219 m (4000 ft), 4 May 1990, *T. Flynn & S. Perlman 3889* (PTBG); Kalalau rim, N of Kahuamaa Flat, 990–1020 m, 3 Mar 1991, *K.R. Wood et al. 628* (PTBG), 800 m, 4 Jul 1991, *K.R. Wood & M. Query 1017* (PTBG), NE rim below Puu o Kila, and down to “Peach Tree” ridge, 1100–1200 m, 9 May 1991, *K.R. Wood et al. 808* (PTBG), north rim below Puu o Kila, 500 m, 5 Aug 1991, *K.R. Wood et al. 1096* (PTBG), Kalahu side below and W of first Kalalau lookout, 900–1000 m, 20 Aug 1991, *K.R. Wood 1159* (BISH, PTBG, US), below and E of first Kalalau lookout, 1000–1100 m, 15 Sep 1991, *K.R. Wood et al. 1229* (BISH, PTBG), base camp in back of valley, 750–800 m, 11 Jun 1992, *K.R. Wood et al. 1967* (PTBG), below Alealau, on cliffs, 945 m (3100 ft), 17 Feb 1993, *S. Perlman 13349* (PTBG); Honopu Valley rim, 500 m W of easternmost rim, 750–850 m, 5 Sep 1991, *K.R. Wood et al. 1191* (PTBG), *1201* (MO, PTBG, US), *1201A* (PTBG), 853 m (2800 ft), 6 Nov 1993, *K.R. Wood 2834* (PTBG); Awaawapuhi Valley, along trail to 1075 m then N down ridge, 1000–1050 m, 17 Apr 1992, *K.R. Wood & M. Query 1801* (PTBG, US); Pohakua, hanging valley between Kalalau and Hanakoa, 400–500 m, 2 Apr 1992, *K.R. Wood et al. 1774* (PTBG, SING); Waimea District, Koae Canyon, 823 m (2700 ft), 24 May 1993, *K.R. Wood & S. Perlman 2586* (PTBG).

Melicope paniculata (St. John) T. Hartley & B. Stone

Melicope paniculata was previously known from only 3 collections, all from Kauai (Stone *et al.* 1990: 1199): the type from the upper Lihue Ditch Trail (875 m), and 2 collections from Wahiawa Bog (ca. 580 m). At the Wailua River site, this species is very rare with only a single individual observed, while on Namolokama collector’s notes indicate it is occasional. These collections represent a **rediscovery** of this species. The crushed parts emit a strong anise odor (*Lorence & Flynn 7110*).

Material examined. KAUAI: Kawaihau District, SE of Mt Pohakupele, along N. fork of Wailua River, N of ditch intake up unnamed tributary E. of main river, lowland forest of *Metrosideros*, *Antidesma*, and *Pisonia* dominant, invaded by *Psidium*, *Rubus*, and *Lantana*, 366–580 m, slender tree 5 m tall, with strong anise odor, leaves with revolute margins, 1 individual seen, 4 Nov 1991, *D. Lorence & T. Flynn 7110* (PTBG, US); Hanalei District, Namolokama Mt, Halelea Forest Reserve, *Metrosideros montana* wet mixed community with sedges, grasses, and bryophytes, 1100–1280 m, 2 m tall tree, 18 Jun 1991, *K.R. Wood et al. 924* (BISH, PTBG, US), 19 Jun 1991, *K.R. Wood et al. 946* (BISH, PTBG, US).

Melicope quadrangularis (St. John & E. Hume) T. Hartley & B. Stone

Previously known only from the type collected in the vicinity of Wahiawa Bog in 1919, *Melicope quadrangularis* was presumed extinct by Stone *et al.* (1990: 1202). However, a population of approximately 13 individuals of this species was recently observed in the Wahiawa Mountains growing in lowland wet forest and wet shrubland with *Metrosideros* spp. and *Syzygium sandwicensis* between 810 and 860 m (*Lorence & Flynn 1991: 12*). This collection represents a **rediscovery** of this species.

Material examined. KAUAI: Koloa District, Lihue-Koloa Forest Reserve, Wahiawa drainage, SW of Kapalaoa in diverse forest of *Metrosideros*, *Antidesma*, *Syzygium* invaded by *Psidium catlettianum* and *Rubus rostrifolius*, 850 m, 20 May 1991, *K.R. Wood et al. 858* (PTBG).

Zanthoxylum hawaiiense Hillebr.

Zanthoxylum hawaiiense was collected on Kauai in degraded mesic to dry forest in the Waimea Canyon complex, where collectors' notes indicate it is rare. This endemic species was previously known from Molokai, Lanai, Maui, and Hawaii (Stone *et al.* 1990: 1214).

Material examined. KAUAI: Waimea District, Na Pali-Kona Forest Reserve, Koaie Canyon, Koaie Stream to S fork of Kawai Iki Stream, 755 m, 31 Mar 1990, K.R. Wood *et al.* 289 (AD, BISH, MO, PTBG, US), J. Lau 2204.0 (BISH).

Sapotaceae

Chrysophyllum oliviforme L.

Chrysophyllum oliviforme, a common ornamental tree in the Hawaiian Islands, has been collected on Niihau, Kauai, Oahu, and Maui in non-urban areas where it may have escaped (Pennington 1990: 1231). Pennington stated "There is no evidence that it has yet become truly naturalized, although game birds could easily disperse the fleshy fruit." On Kauai this species clearly has become naturalized in a number of sites in secondary forest, secondary thicket, and among *Eucalyptus* forestry plantings. *Chrysophyllum oliviforme* is easily distinguished from the other 2 genera of Sapotaceae in the Hawaiian archipelago (*Nesoluma* Baill. and *Pouteria* Aubl., both indigenous) by the following characters: small tree 5–7 m tall; young twigs, lower leaf surface, and flower buds densely golden-brown or rusty-brown with silky sericeous pubescence; apex of lamina abruptly short acuminate; flowers 5-merous, in axillary fascicles; fruits ellipsoid (olive-shaped), 2–2.5 x 1 cm, 1-seeded, fleshy, ripening purple, edible.

Material examined. KAUAI: Lihue District, along Hwy 50 just E of Puhi, across from Kauai Community College [ca. 100 m], 10 Dec 1987, D. Lorence *et al.* 5727 (PTBG); Niumalu, Hoary Head mountain range below Keopaweo, 12–137 m (40–450 ft), 14 Oct 1988, T. Flynn *et al.* 3180 (PTBG); Lihue District, Waikoko Management area, ca. 250 m, 2 Nov 1974, J. Fay *et al.* 240 (PTBG).

Scrophulariaceae

Lindernia procumbens (Knock.) Philcox

This herbaceous species, found growing in mud flats in a reservoir on Kauai, is a **new state record**. Two other members of the genus *Lindernia* All. are naturalized in the archipelago: *L. antipoda* (L.) Alston and *L. crustacea* (L.) F. v. Muell. (Wagner *et al.* 1990: 1242). *Lindernia procumbens* (specimen determined by D. Philcox), resembles *L. antipoda* in habit but differs by its shorter corolla 4–4.5 mm long with tube 3.5–4 mm long and lobes 0.5–1 mm long, and shorter capsules 3–4 mm long. In both the latter species the calyx is cleft nearly to the base in contrast to *L. crustacea*, which has the calyx cleft to about the middle.

Material examined. KAUAI: Koloa District, Waita Reservoir, erect herb in mud flats at N end of reservoir [ca. 85 m], corolla bluish, 26 Sep 1985, T. Flynn 1239 (PTBG).

Veronica peregrina L. subsp. *xalapensis* (Kunth) Pennell

This taxon was encountered as a weed near a water fountain growing with other naturalized herbs at a lookout much frequented by visitors, who may have introduced it unintentionally by seeds clinging to mud on their shoes. This collection definitely establishes

the presence of *Veronica peregrina* subsp. *xalapensis* on Kauai. It is also sparingly naturalized in Hawaii Volcanoes National Park on Hawaii where it is apparently a recent introduction (Wagner *et al.* 1990: 1250).

Material examined. KAUAI: Hanalei District, Kokee State Park, Puu o Kila lookout, 1250 m (4140 ft), 24 Mar 1987, T. Flynn 2131 (PTBG).

Verbenaceae

Duranta erecta L.

Both collections of *Duranta erecta* (syn. *D. repens* L.) are from secondary vegetation, the first being shrubland dominated by *Leucaena leucocephala*, and the second being forestry plantings with *Melinis minutiflora* P. Beauv. Although *Duranta erecta* is commonly cultivated in the Hawaiian Archipelago, this is a **new naturalized record** of the genus there. *Duranta erecta* is distinguished from other naturalized and native Verbenaceae in the Hawaiian Islands by: habit a shrub 2–3 m, branches often armed with spines 1.5–2.5 cm long; leaves scentless, shortly petiolate, lamina simple, ovate-elliptic or obovate-elliptic, 1.5–6 x 0.8–3 cm, minutely puberulent, margin entire or sparsely crenate distally; inflorescences axillary and terminal racemes, rachis slender, simple or rarely branched; flowers on slender pedicels 2–3 mm long; calyx tubular, 4–5 mm long, externally strigulose, minutely 5-toothed; corolla zygomorphic, 10–12 mm long, blue-violet with white center and 2 dark purple veins on lip, densely hirtellous within and without; fruiting calyx fleshy, orange, flask-shaped, 5–7 mm in diam. enclosing the fruit; fruit separating into 4 pyrenes, each 2-loculed.

Material examined. KAUAI: Lihue District, between Lihue and Nawiliwili along Hwy 501, ca. 0.5 miles W of ocean, opposite Kauai High School, 36 m, 20 Oct 1990, D. Lorence 6624 (BISH, PTBG); Waimea District, Puu Ka Pele Forest Reserve, Kaaweki Ridge, 738 m (2420 ft), 16 Dec 1986, T. Flynn & D. Harter 2018 (PTBG).

Lantana montevidensis (Spreng.) Briq.

This species is commonly cultivated in the Hawaiian Islands and has become naturalized around Lanai City, Lanai (Wagner *et al.* 1990: 1230). On Kauai it is adventive locally, probably spreading from seeds dispersed by birds or from yard clippings dumped into the pasture from adjacent housing areas. This is a **new naturalized record** of this species on Kauai.

Material examined. KAUAI: Koloa District, Poipu, in pasture N of Lawai Road, secondary vegetation dominated by *Leucaena* and *Digitaria*, 6 m, 12 Nov 1988, T. Flynn & D. Lorence 3132 (PTBG).

Verbena bonariensis L.

Verbena bonariensis, along with *Senecio madagascariensis* and *Lotus uliginosus*, was collected on Kauai (**new island record**) on a newly grassed area where it presumably was introduced as a grass seed contaminant and is now spreading. This species is also naturalized on Maui and Lanai (Wagner *et al.* 1990: 1325).

Material examined. KAUAI: Lihue District, along newly grassed road cut at Halfway Bridge on Hwy 50, 122 m, 9 Jun 1990, T. Flynn & W.L. Wagner 3980 (BISH, MO, PTBG, US), 7 Jun 1994, W.L. Wagner & T. Flynn 6757 (BISH, PTBG, US; additional duplicates to be distributed).

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References

- Adams, C.D.** 1972. *Flowering plants of Jamaica*. University of the West Indies. Mona, Jamaica. 848 p.
- Austin, D.F.** 1990. Convolvulaceae, p. 548–564. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Bates, D.M.** 1990. Malvaceae, p. 868–903. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Burger, W. & C.M. Taylor.** 1993. Family # 202 Rubiaceae. In: W. Burger, ed., *Flora costaricensis*. Fieldiana: Botany (n.s.) **33**: 1–333.
- Canfield, J.E., D.R. Herbst & A. Asquith.** 1994. Department of the Interior, Fish and Wildlife Service. 50 CFR Part 17. Endangered and threatened wildlife and plants; endangered status for 12 plants from the Hawaiian Islands. *Federal Register* **59**(217): 56333–56351.
- Davidse, G.** 1990. *Panicum* (Poaceae), p. 1565–1574. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Ganders, F. & K. Nagata.** 1990. *Bidens*, p. 267–83. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Geesink, R., W.L. Wagner, & D.R. Herbst.** 1990. Fabaceae, p. 629–721. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Goldblatt, P. & Henrich, J. E.** 1990. Iridaceae, p. 1444–1449. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawaii'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Holmgren, P.K., N.H. Holmgren & L.C. Barnett, eds.** 1990. *Index herbariorum. Part*

- I: The herbaria of the world*. Regnum Vegetabile 120. New York Botanical Garden. 693 p.
- Howard, R.A.** 1988. *Flora of the Lesser Antilles, Leeward and Windward Islands*. Vol. 4. Arnold Arboretum, Harvard University. Jamaica Plain, Massachusetts. 673 p.
- Huft, M.J.** 1990. *Euphorbia*, p. 618–20. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Hughes, G.D.** 1995. New Hawaiian plant records. II. *Bishop Mus. Occas. Pap.* 42: 2–10.
- Kirkman, L.K.** 1981. Taxonomic revision of *Centratherum* and *Phyllocephalum* (Compositae: Vernoniaeae). *Rhodora* **83** (833): 1–24.
- Koutnik, D.L. & M.J. Huft.** 1990. *Chamaesyce*, p. 602–17. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Koyama, T.** 1990. Cyperaceae, p. 1381–1436. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Lammers, T.G.** 1990. Campanulaceae, p. 420–489. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Lewis, W.H. & R.L. Oliver.** 1974. Revision of *Richardia* (Rubiaceae). *Brittonia* **26**: 271–301.
- Little, E.L., Jr. & R.G. Skolmen.** 1989. *Common forest trees of Hawaii (native and introduced)*. U.S. Dep. Agric., *Agric. Handb.* **679**, v + 321 p.
- Lorence, D.H.** 1994. Recovery plan for the Wahiawa plant cluster: *Cyanea undulata*, *Dubautia pauciflora*, *Hesperomannia lydgatei*, *Labordia lydgatei*, and *Viola heleanae*. U.S. Fish and Wildlife Service, Portland.
- . & **T.W. Flynn.** 1991. Botanical survey of the Wahiawa Drainage, Kauai. Final report, submitted to the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 78 p.
- . & **T.W. Flynn.** 1993a. Botanical survey of the upper Wai'oli Valley, Kauai. Final report, submitted to the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 27 p., maps.
- . & **T.W. Flynn.** 1993b. Botanical survey of the Makaleha Mountains, Kauai. Final report, submitted to the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife. 25 p., maps.
- Mehrhoff, L.** 1994. Department of the Interior, Fish and Wildlife Service. 50 CFR Part 17. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 21 plants from the Island of Hawaii, State of Hawaii. *Federal Register* **59**(43): 10305–10323.
- Neal, M.C.** 1965. *In gardens of Hawaii*. Revised edition. Bishop Museum Press, Honolulu. 924 p.
- O'Connor, P.J.** 1990. Poaceae (excluding *Panicum*), p. 1481–1604. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Pennington, T.D.** 1990. Sapotaceae, p. 1231–1234. In: Wagner, W.L., D.R. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press

ly with apices of ridges dark fuscous. Antenna yellow to brown; first segment with longitudinal black stripes on anterior surface. Metapleura always dark fuscous, often outlined in white, remaining pleurae yellowish brown to fuscous. Sternum yellowish white. Legs yellow, with longitudinal black stripes on tibiae and femora; coxae often translucent white; tarsi variably infuscated. Median carinae of nota always pale. Tegmina highly variable from translucent pale yellow to strongly infuscated, imparting an opaque, smoky appearance; an elongate, dark fuscous mark present along distal claval margin and another smaller mark at apex of costal vein; small fuscous marks present at apices of all costal cells; proximal half of posterior costal vein always paler than remainder; bases of all setae along veins fuscous. Abdomen yellow to brown, posterolateral area of each segment fuscous. FEMALE: Length 5.57–6.0 mm. Cephalic horn with ventral margin straight to weakly and evenly concave; dorsal margin weakly sinuous. Remainder of appearance as in male except for an orange to red coloration of abdominal dorsum.

Type material. Holotype M, KAUAI: Haupu saddle road, 250 m, 13.III.93, ex. *Chamaesyce* sp., (A. Asquith), (BPBM 15532); 5M, 4F paratypes, same data as holotype (BPBM).

Other specimens examined. KAUAI: 4F, Hoary Head Mts, 24.VII.1970, *Euphorbia* (W.C. Gagné) (BPBM).

Distribution: Known only from the Haupu mountain range of southeast Kauai.

Kau'i Subspecies of *Dictyophorodelphax zwaluwenburgi*

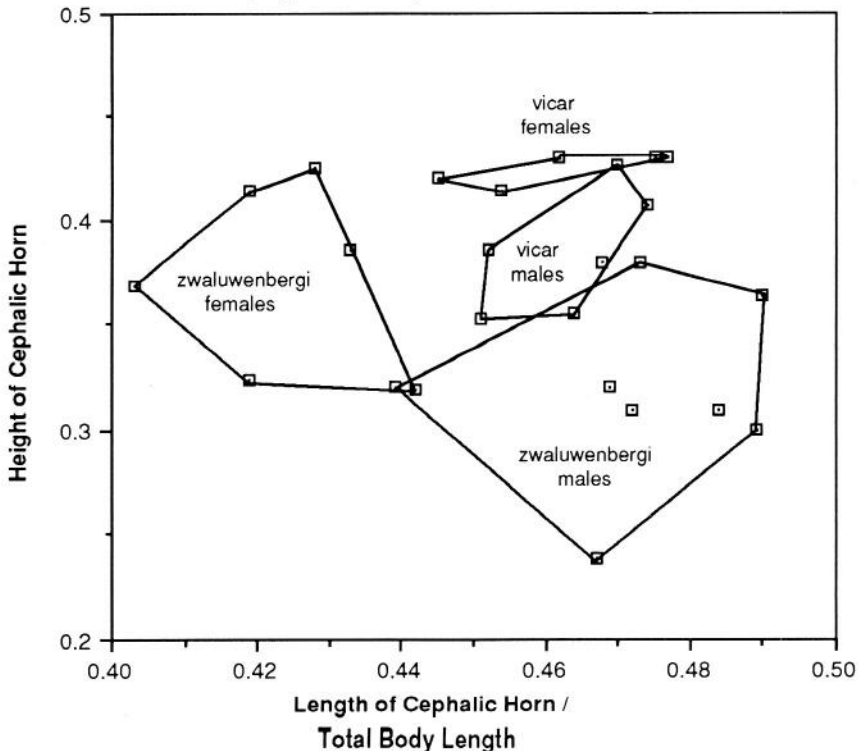


Fig. 1. Relationships between the height of the cephalic horn and cephalic horn/total body length ratio in sexes and subspecies of *Dictyophorodelphax zwaluwenburgi*.

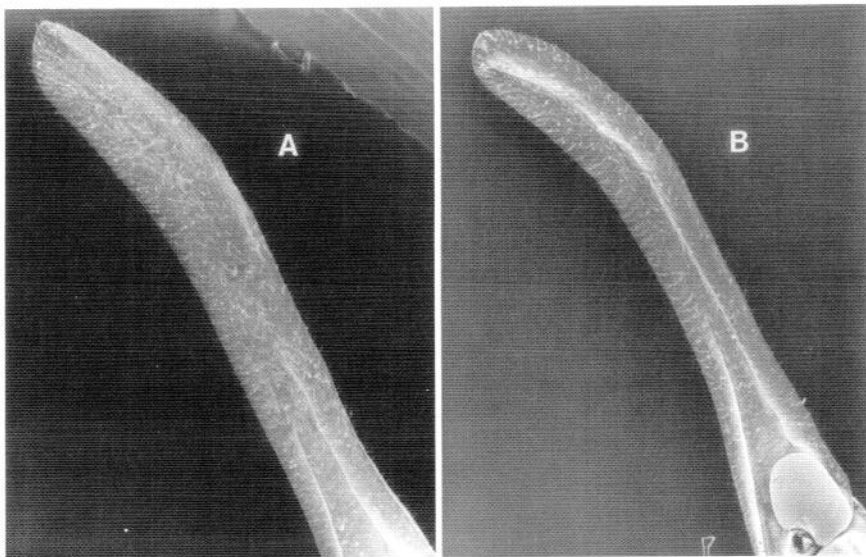


Fig. 2. Male cephalic horns of *Dictyophorodelphax*. a, *D. zwaluwenburgi* vicar. b, *D. z. zwaluwenburgi*.

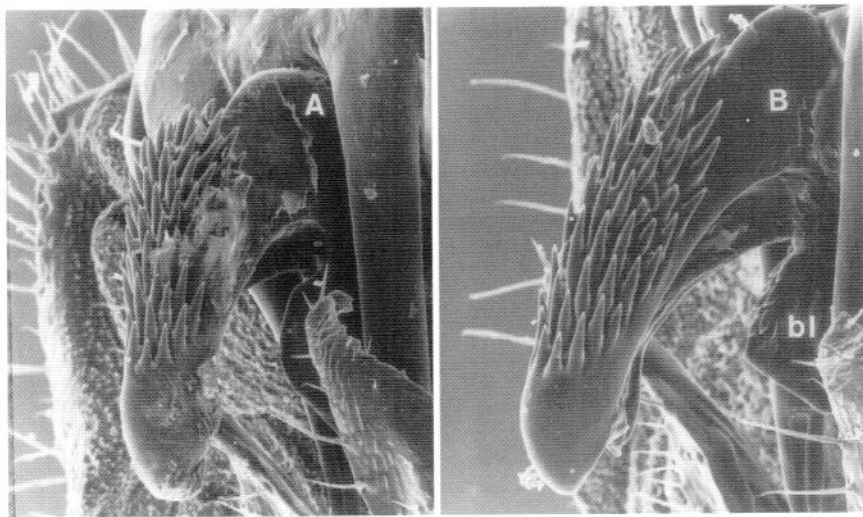


Fig. 3. Male aedeagi of *Dictyophorodelphax*. a, *D. zwaluwenburgi* vicar. b, *D. z. zwaluwenburgi*.

Discussion

In addition to *Dictyophorodelphax zwaluwenburgi*, 4 other species of *Dictyophorodelphax* have been described: *mirabilis* Swezey and *swezeyi* Bridwell from Oahu, *praedicta* Bridwell from Maui, and *usingeri* Swezey from Lanai. All species differ significantly in length and shape of the cephalic horn (Zimmerman 1948b, Beardsley 1956) and in the structure of the male aedeagus (Bridwell 1918, 1919) (males of *usingeri* have not been examined). All species are restricted to *Chamaesyce* as a host and are found in similar habitats, thus there has been little ecological shift coincident with species formation.

My interpretation of the Haupu populations as a subspecies rather than a full species is based on 1) the smaller degree of difference in the cephalic horn and aedeagus between the Alakai and Haupu populations when compared to differences among other species, 2) the distribution pattern fits the classical concept of a subspecies as a distinct geographic race (Mayr 1969), and 3) the proposed phylogenetic affinity between the Alakai and Haupu populations (Fig. 4A).

The hypothesis of the sister group relationship between the 2 subspecies (Fig. 4A), while likely, cannot be substantiated without a phylogenetic analysis of the genus. For example, the aedeagi of the 2 taxa are extremely similar, sharing the characters of 1) consistent width throughout the length, 2) strongly recurved shape, and 3) a single, contiguous patch of spines on the dorsal surface only. However, if the Kauai taxa are the most primitive (as in many Hawaiian groups), then these characters are probably plesiomorphic and cannot be used to argue for sister group status. It is possible therefore, that the founders of the species on Oahu and the younger islands (if that were the direction of colonization) originated from one of the 2 Kauai populations after they diverged from each other (Fig. 4B-C). Such a pattern could arise if the relative magnitude of the founder event (and genetic restructuring) involved in cladogenesis is more important in producing morphological apomorphies than just the sequence of cladogenesis. Thus, the lack of morphological synapomorphies may not preclude a sister-group relationship if apomorphies do not always arise at cladogenesis. Given the complex ecological, behavioral and geographic factors involved in the speciation of Hawaiian insects, this pattern should be considered in the phylogenetic studies of other taxa.

Dictyophorodelphax z. zwaluwenburgi is found in dry, open areas from 150-1100 m elevation and has been collected only on *Chamaesyce celastroides* (Boiss.) Croizat & Degener. It has been collected from the western ridges of Kokee such as Haelele and Milolii, the east, north and west rims of Waimea Canyon, Kalalau Valley, and the Napali Coast Trail between Hanakapiai and Hanakoa Valleys. It probably also occurs in suitable areas on southern ridges such as those between Olokele and Hanapepe valleys. The type series of *D. z. vicar* was taken in a similar habitat consisting of a steep, dry, sunny slope at ca 250 m. *Dictyophorodelphax* was not found among the extensive growth of *Chamaesyce celastroides* along the summit of Nounou Ridge on eastern Kauai, also at 250 m.

No individual of any *Dictyophorodelphax* species I examined displays any development of the metathoracic flight wings. Even if some winged individuals are occasionally produced they must be rare, giving these insects very poor dispersal abilities. This trait means that the rare colonization of an isolated area or the vicariance of a once contiguous area would largely restrict gene flow of the separated populations, even if the distance is not great. Therefore, while the dry slopes of the Haupu Range are only 10-20 km from

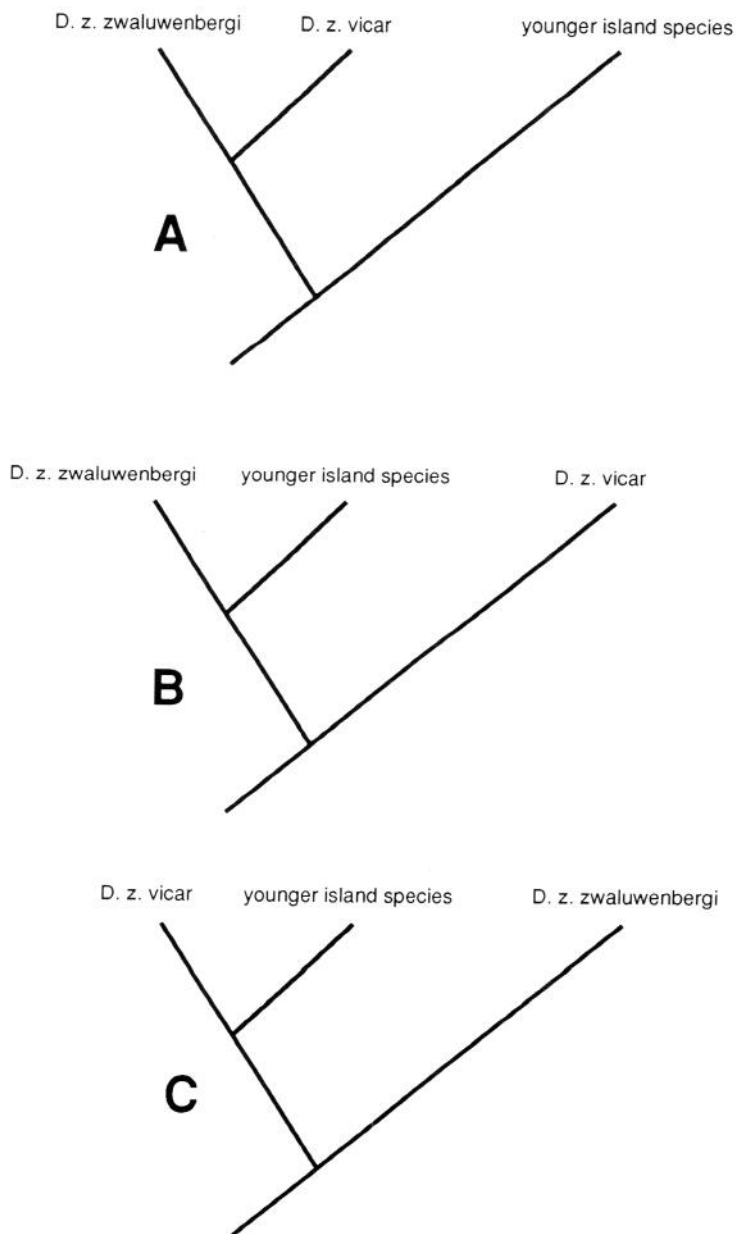


Fig. 4. Proposed (A) and alternative (B–C) relationships between *Dictyophorodelphax z. zwaluwenbergi*, *D. z. vicar*, and species on younger Hawaiian islands.

similar habitats on the southern ridges of the Alakai massif, this distance could strongly limit the exchange of individuals between the two areas.

Separation Model

The main volcano of Kauai was active for roughly 2 million years from 5.5–3.5 million years ago (ma). The Haupu Range (up to 700 m) was formed as a side vent of the original volcano and therefore roughly the same age as the slopes of the Alakai massif (Stearns 1985). The present geography of eastern Kauai is probably not indicative of past habitat separations. For example, after the cessation of the main volcano, erosion created deep valleys on the east side of Kauai, including such areas as Weoweopilau or Knudsen's Gap, which separates the Haupu Range from Mt Kahili and the Wahiawa Range of the Alakai massif. From 1.4–0.6 ma, these eroded areas were repeatedly covered with lavas from the Koloa volcanic series. In addition, rainfall was greater during glacial periods in the last 0.5 million years causing dry and mesic adapted plants to become more restricted (Gavenda 1992), which probably also decreased the availability of dry ridge habitats for *Dictyophorodelphax*. Thus, once the soft lavas of the Na Pali formation began to erode and separate Haupu from the Alakai massif 2–3 ma, the intervening area was probably a significant barrier for nonvagile taxa such as *Dictyophorodelphax*. However, the present distribution of such allopatric taxa could have resulted from either true biological vicariance of a once contiguous population or by the colonization of one area by founders after the geographic vicariance of the areas.

Comparison with other taxa

Dictyophorodelphax z. vicar represents one of the few formally recognized arthropod taxa restricted to the Haupu Range, but several undescribed species of crickets and *Rhyncogonus* weevils may also be Haupu endemics (R. Rice, pers. comm.). Otte (1994) clearly documented Haupu as an area of endemism for crickets, with 4 species of *Prognathogryllus* and 2 species of *Trigonidium* found only in this mountain range. Haupu is also clearly an area of endemism for the nonvagile land mollusks. *Carelia tenebrosa* Cooke is known only from the Haupu Range, and Cooke (1931) hypothesized that *C. tenebrosa* is most closely related to *C. olivacea*, a species found predominantly in the Makaleha Mountains. *Orobophana baldwini* Ancey, *Tornatellides productus* Ancey, *Hiona kipui* Baker, and *Godwinia haupuensis* Cooke all appear to be Haupu endemics, with the caveat that the distribution of land mollusks on Kauai is even more poorly understood than that of arthropods (Cowie *et al.* 1995). Plants on the other hand, with their greater dispersal abilities, do not appear to have responded as strongly to the Haupu-Alakai vicariance, with only one taxon, *Lipochaeta micrantha* (Nutt.) A. Gray var. *exigua* (Degener & Sherff) Gardner restricted to the Haupu Range. Clearly, an intensive arthropod survey of the Haupu mountains, particularly of nonvolant groups in mesic forest habitats, should reveal additional endemics reflecting the Haupu-Alakai vicariance.

Additional areas of endemism on Kauai

Attempting to identify within-island areas of endemism for insects is difficult because of our limited knowledge of their distributions. While this is partly due to habi-

tat loss and extinctions, more importantly is a lack of adequate sampling for most groups. For example, the majority of the Kauai insect fauna was described in the *Fauna Hawaiiensis* series (Sharp 1899–1913) and came from only a handful of localities, including: Makaweli (2000 ft), Halemanu, on Waialeale (3000 ft), mountains behind Waimea, and Kaholuamano (4000 ft). Virtually all these localities are at middle to high elevations on the western slopes of the Alakai massif. Later collectors, including O.H. Swezey, R.L. Usinger, and E.C. Zimmerman, also restricted their collecting to the western Alakai massif between 600–1200 m.

Some of the locality labels of Reverend Thomas Blackburn refer to “in mountains behind Lihue (3000 ft),” and apparently Otto Swezey did make some collections from Olokele Canyon in 1920. However, it has only been in the last 40 years that insects have been collected from a diversity of areas on Kauai. Several Collembola, for example, have been described from lowland areas on Kauai (e.g., *Aethiopella kuolo* Christiansen & Bellinger from the Hanalei River Valley) but these and many other insects have been so poorly collected that it is impossible to generalize their distributions.

However, despite these limitations I have attempted to identify the distribution patterns of Kauai insects based on a review of the literature, specimens in the collections of the Bishop Museum and University of Hawaii, and extensive field collecting for 3 years. I have also compared plant (Wagner *et al.* 1990; D. Lorence & T. Flynn, pers. comm.) and land mollusk (Cowie *et al.* 1995 and references therein) distributions to search for congruent patterns.

It appears that the distributions of most insects on Kauai are defined by host plant or habitat rather than geography *per se*, and many are, or were, widespread. In fact, the perception of precinctiveness in many Hawaiian insects (Howarth 1990, Howarth & Ramsay 1991) is probably derived from our limited knowledge rather than their limited ranges. *Idiomyia crucigera* (Grimshaw) and *Drosophila villosipedis* Hardy, for example, can be found breeding in the rotting bark of both native and introduced plants from Kokee to Alexander Dam, Kilohana Crater, Nounou Ridge, and Hanakapiai Valley at sea level (Carson *et al.* 1970, Montgomery 1975, A. Asquith, unpubl. data). *Scaptomyza (Bunostoma) anomala* Hardy occurs in wet forest at 1200 m to the dry windrows of macadamia nut orchards at 160 m (Asquith 1995b). Several species of *Oliarus* leafhoppers were described from “Lihue, lower forest zone, 800 feet elevation,” but have also been collected in Kokee (Giffard 1925).

Elevation, rather than horizontal geography seems to have more strongly structured insect distributions. Certain aquatic stream or riparian insects are restricted to the low to mid elevation reaches of streams (Asquith & Messing 1993) and several species of *Odynerus* wasps (Perkins 1913), *Omiodes* (formerly *Hedylepta*) moths (Zimmerman 1958), and *Nysius* seed bugs (Usinger 1942) are or were exclusively lowland inhabitants. At least 1 species of native Psocoptera (*Ptycta aaroni* Thornton) is exclusively a lowland inhabitant on Oahu and Maui; and Kauai probably had an equivalent species (Thornton 1984). Other species of *Ptycta* exhibit elevational zonation on Kauai (Thornton 1984). Entire plant communities restricted to low elevation are detailed in Wagner *et al.* (1990), and 2 of the larger Kauai land snail genera *Carelia* and *Orobophana* were exclusively or predominantly lowland taxa (Cowie *et al.* 1995).

Likewise, many insects are restricted to wet forest habitats at middle to higher elevations. This is true for both phytophagous species dependent on certain host plants, and

scavengers or predators that have particular substrate, humidity or temperature requirements. However, many phytophagous species may have more restricted distributions than their host plants [most *Metrosideros polymorpha* specialists for example (Gagné 1979)] or alternatively may feed on several related species so their distribution is greater than any one of their individual hosts (many of the orsilline Lygaeidae (Usinger 1942)).

Therefore, only a small portion of the Kauai insect fauna displays well delimited endemism, and many areas of endemism are as much ecologically as geographically defined. For example, the northeast Kauai-southern Kauai parapatry is a common pattern in plants, often with the sister taxa sympatric in the Wahiawa Mountains but occurring at different elevations (Wagner *et al.* 1990). In these cases, the different areas probably represent ecological conditions to which the endemic plant taxa have adapted (higher vs. lower rainfall), but there are no examples of this pattern in insects. In contrast, *Dictyophorodelphax* in Haupu and *Nesiomiris* plants bugs in the Makaleha Mountains are groups in which the ecology of the sister taxa are identical, and they likely diverged through geographic segregation only. However, with perhaps one exception, plants do not display this pattern. This suggests that the origins of many species in plants and insects on Kauai have been fundamentally different.

Waialeale Summit

This is a unique *Metrosideros/Dubautia/Oreobolus* bog at the summit region of Mt Waialeale (Gagné & Cuddihy 1990).

Plants: *Lysimachia venosa* (Wawra) St. John, *Dubautia waialealae* Rock, *Cheirodendron dominii* Kraj., and *Dubautia imbricata* St. John & G. Carr subsp. *acronaea* G. Carr.

I can find no example of any insect restricted to the summit of Waialeale because this area has unfortunately not received any insect collection efforts. However, several species are known only from the open boggy areas of the Alakai Swamp including *Drosophila apodasta* Hardy, *D. capitata* Hardy, *D. fuscoapex* Hardy, *Mestolobes quadrifascia* (Swezey), *Nysius hardyi* Ashlock, and *Limonia sabroskyana* Byers.

Wahiawa and Alakai Swamps

This area represents the split distribution of several species that are found only in the bogs and surrounding wet forests of both Wahiawa and Alakai swamps.

Plants: *Myrsine helleri* (Degener & I. Degener) St. John, *Lysimachia daphnoides* (A. Gray) Hillebr., *Melicope feddei* (H. Lévl.) T. Hartley & B. Stone, *Melicope waialealae* (Wawra) T. Hartley & B. Stone, *Lobelia kauaensis* (A. Gray) A. Heller.

The only documented insect that displays this pattern is the damselfly *Megalagrion paludicola* Maciolek & Howarth. This species breeds in small pools of water in the swampy ohia forest around the Wahiawa and Alakai swamps (Maciolek & Howarth 1979).

West-Southwest mesic forest

This is an area of mesic forest extending roughly from the southern rim of Kalalau Valley to Haelele Ridge.

Plants: *Psychotria hobdyi* Sohmer, *Hibiscus kokio* Hillebr. & Wawra subsp. *saintjohnianus* (M. Roe) D. Bates, *Hibiscus waimeae* A. Keller subsp. *waimeae*, *Kokia*

kauaiensis (Rock) Degener & Duvel, *Canavalia kauaiensis* J. Sauer, *Schiedea membranacea* St. John, *Delissea rhytidosperra* H. Mann, *Labordia helleri* Sherff, *Nothoecstrum peltatum* Skottsbo.

This region has been extensively collected entomologically in the last several decades and numerous new species have been described from this area. Both the delphacid leafhopper *Nesothoe magnacornis* Beardsley (Beardsley 1960) and the plant bug *Sarona laka* Asquith (Asquith 1994) breed only on *Claoxylon sandwicense* Muell.-Arg. Both of these species have been collected only from the western mesic forest, although I have searched on *Claoxylon* extensively in other areas. The psyllid *Hemischizocranium aloha* (Caldwell) develops only on *Zanthoxylum dipetalum* H. Mann and has also been collected only from western ridges (Uchida & Beardsley 1992). Many other species have been described from collections along Awaawapuhi or Nualolo trails which also probably represent this distribution, such as *Prognathogryllus hypomacron* Otte (Otte 1994).

Na Pali Coast

An area consisting of coastal cliffs and valley floors from Hanakapiai to the Mana Plain.

Plants: *Panicum lineale* St. John, *Pritchardia napaliensis* St. John, *Pittosporum napaliense* Sherff, *Hedyotis st-johnii* B. Stone & Lane, *Charpentiera densiflora* Sohmer, *Canavalia napaliensis* St. John, *Schiedea apokremnos* St. John.

One species of dolichopodid fly (*Sigmatineurum napali* Evenhuis) is restricted to water drainages in this area (Evenhuis & Polhemus 1994). Additional research may show other Dolichopodidae that are restricted to the Na Pali valleys or even display individual valley endemism as apparently do some varieties of snails such as *Hiona exaequata* (Gould) (Cowie *et al.* 1995).

East-Northeast Kauai

This is the area extending from the Wahiawa Mountains to Wainiha Valley. The northwestern limit of this area is variable, as a few taxa are also found in the mesic valleys further west including Limahuli, Hanakapiai and Waiahuakua. Many of the species restricted to this area are apparently extinct or known only from the original collections. Thus, it is difficult to assess the original extent of the distribution of many of the representative taxa or if some actually had more restricted distributions.

Plants: *Pisonia wagneriana* Fosb., *Pritchardia hardyi* Rock, *Pritchardia viscosa* Rock, *Pritchardia waialealeana* Read, *Psychotria wawrae* Sohmer, *Myrsine fernseei* (Mez) Hosaka, *Cyrtandra limahuliensis* St. John, *Cyrtandra pickeringii* A. Gray, *Cyanea asarifolia* St. John, *Cyanea fissa* (H. Mann) Hillebr. subsp. *fissa*, *Cyanea recta* (Wawra) Hillebr., *Cheirodendron forbesii* (Sherff) Lowry, *Bidens forbesii* Sherff subsp. *forbesii* (excluding the Wahiawa drainage), *Wikstroemia hanalei* Wawra and *Hibiscus clayi* Degener & I. Degener, *Labordia lydgatei* C. Forbes, *Hesperomannia lydgatei* C. Forbes, *Cyanea linearifolia* Rock.

Crickets probably provide the best example of this pattern among insects, with 3 species of *Prognathogryllus*, 7 species of *Trigonidium*, and at least 1 species of *Laupala* displaying this distribution (Otte 1994). *Megatrioza kauaiensis* Uchida & Beardsley is known only from *Pritchardia hardyi* along the Powerline trail (Uchida & Beardsley 1988). In what is probably the best example available of geographic endemism on Kauai,

Gagné (1995) identified 2 species of *Nesiomiris* plant bugs endemic to the Makaleha Mountains, each with its respective sister taxon in the main Alakai massif. *Euryzogaster mediocris* Tenorio was also described and is known only from Waipahee, a stream draining the Makaleha range (Tenorio 1969). As discussed earlier, this Makaleha endemism for insects undoubtedly represents a different process than that giving rise to the general Northeast Kauai pattern in plants, even though some of the plant species are also found in the Makaleha Mountains.

The snail genus *Georissa* Blanchard is also known only from collections along the Powerline trail (Cowie *et al.* 1995). Many other snail species are known only from eastern or northeastern Kauai (e.g. *Endodonta laminata* (Pease) occurs from Kalihiwai to Haena), but in general they have very restricted distributions and do not display the same pattern of endemism as do the plants and insects.

South Kauai

This area extends from the Wahiawa mountains to Waimea Canyon, often including the Haupu range. It is the most poorly documented area of endemism on Kauai, largely because the land from the Wahiawa Mountains to Kapukapaia Ridge is inaccessible private property.

Plants: *Myrsine mezii* Hosaka, *Cyanea fissa* (H. Mann) Hillebr. subsp. *gayana* (Rock) Lammers, *Lipochaeta micrantha* (Nutt.) A. Gray var. *micrantha*, *Schiedea spergulina* A. Gray var. *spergulina*.

Some insects described from early collections at Kaholuamano and Makaweli might represent species restricted to the southern ridges or valleys, but this will remain obscure until better collections are available. Even *Dictyophorodelphax* z. *zwaluwenburgi* has not been collected south or east of Waimea Canyon, and it is not known whether there is an endemic insect fauna of the southern slopes of Alakai massif that also occurs in the Haupu Range, as is the pattern for several plants.

Wahiawa Mountains

The area of the Wahiawa Mountains includes both the bog and the surrounding ridges. It is an area of exceedingly high floristic endemism with at least 12 species and several newly discovered undescribed taxa (Lorence & Flynn 1991).

Plants: *Melicope paniculata* (St. John) T. Hartley & B. Stone, *Melicope quadrangularis* (St. John) T. Hartley & B. Stone, *Dubautia pauciflorula* St. John & G. Carr, *Dubautia imbricata* St. John & G. Carr subsp. *imbricata*, *Cyrtandra olona* C. Forbes, *Labordia tinifolia* var. *wahiawaensis* St. John, *Cyanea undulata* C. Forbes, *Cyanea spathulata* (Hillebr.) A. Heller subsp. *longipetiolata* Lammers, *Chamaesyce sparsiflora* (A. Heller) Koutnik, *Bidens forbesii* Sherff subsp. *kahiliensis* Ganders & Nagata, *Viola helenae* C. Forbes & Lydgate, *Viola kauaensis* A. Gray var. *wahiawaensis* C. Forbes.

Hiona wahiawae Baker is the only mollusk recognized as endemic to this region (Cowie *et al.* 1995).

This area was apparently not accessed by early entomological collectors and even in recent years has received little attention. Here again crickets represent the best example of Wahiawa endemism, with 3 species of *Prognathogryllus*, *Laupala kanaele* Otte and *Laupala pseudonoe* Otte all restricted to this area (Otte 1994). The few other species that have been described from this area are also found elsewhere on Kauai. For example, *Drosophila ornata* Hardy & Kaneshiro was described from Wahiawa Bog but is now also

known from Pouli Stream in Hanalei, the Hono O Na Pali NARS area at 1050 m and the Kokee region. Given the botanic and physiographic uniqueness of this area (the only lowland bog in Hawaii), it would be surprising if the Wahiawa drainage does not harbor additional endemic arthropods.

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References

- Asquith, A.** 1994. Revision of the endemic Hawaiian genus *Sarona* Kirkaldy (Heteroptera: Miridae: Orthotylinae). *Bishop Mus. Occas. Pap.* **40**, 81 p.
- _____. 1995a. Evolution of the endemic Hawaiian genus *Sarona* (Heteroptera: Miridae): Speciation on geographical and ecological islands. In: Wagner, W.L. & V. Funk, eds., *Patterns of speciation and biogeography of the Hawaiian biota*. Smithsonian Institution Press, Washington, D.C.: in press.
- _____. 1995b. Distribution, abundance and phenology of *Scaptomyza* (*Bunostoma*) *anomala* Hardy (Diptera: Drosophilidae): a proposed endemic indicator species for protein bait sprays in Hawaii. *Proc. Hawaii. Entomol. Soc.* **32**: in press.
- _____. & **R.L. Messing**. 1993. Contemporary Hawaiian insect fauna of a lowland agricultural area on Kauai: Implications for local and island-wide fruit fly eradication programs. *Pac. Sci.* **47**: 1–16.
- Beardsley, J.W.** 1956. A new *Dictyophorodelphax* from Kauai (Homoptera: Delphacidae). *Proc. Hawaii. Entomol. Soc.* **16**: 21–23.
- _____. 1960. Two unusual delphacid leafhoppers from Kauai (Homoptera). *Proc. Hawaii. Entomol. Soc.* **17**: 194–98.
- Bridwell, J.C.** 1918. Notes on the entomology of Hawaiian *Euphorbia* with the description of a new *Dictyophorodelphax*. *Proc. Hawaii. Entomol. Soc.* **3**: 385–87.
- _____. 1919. *Dictyophorodelphax praedicta* sp. nov. *Proc. Hawaii. Entomol. Soc.* **4**: 72–73.
- Carson, H.L.** 1980. Chromosomes and evolution in some relatives of *Drosophila grimshawi* from Hawaii. *Symp. R. Entomol. Soc. Lond.* **10**: 195–205.
- _____. 1987. Tracing ancestry with chromosomal sequences. *Trends Ecol. Evol.* **2**: 203–07.
- _____. & **A.R. Templeton**. 1984. Genetic revolutions in relation to speciation phenomena: the founding of new populations. *Ann. Rev. Ecol. Syst.* **15**: 97–131.
- _____. **D.E. Hardy, H.T. Spieth & W.S. Stone**. 1970. The evolutionary biology of the Hawaiian Drosophilidae, p. 437–543. In: Hecht, M.K. & W.C. Steere, eds., *Essays in evolution and genetics in honor of Theodosius Dobzhansky*. Appleton-Century-Crofts, New York.
- Cooke, C.M. Jr.** 1931. The land snail genus *Carelia*. *Bernice P. Bishop Mus. Bull.* **85**: 1–97.
- Cowie, R.H., N.L. Evenhuis & C.C. Christensen**. 1995. Catalog of the native land and

- fresh water molluscs of the Hawaiian Islands. *Bishop Mus. Bull. Zool.* **3**: in press.
- Evenhuis, N.L. & D.A. Polhemus.** 1994. Review of the endemic Hawaiian genus *Sigmatineurum* Parent (Diptera: Dolichopodidae). *Bishop Mus. Occas. Pap.* **37**, 19 p.
- Gagné, W.C.** 1979. Canopy-associated arthropods in *Acacia koa* and *Metrosideros* tree communities along an altitudinal transect on Hawaii Island. *Pac. Insects* **21**: 56–82.
- _____. 1995. Insular evolution and speciation of the genus *Nesiomiris* Kirkaldy (Heteroptera: Miridae) in the Hawaiian Islands. *Bishop Mus. Bull. Entomol.* **6**: in press.
- _____. & **L.W. Cuddihy.** 1990. Vegetation, p. 45–114. In: Wagner, W.L., D.A. Herbst & S.H. Sohmer, *Manual of the flowering plants of Hawai'i*. University of Hawaii Press & Bishop Museum Press, Honolulu.
- Gavenda, R.T.** 1992. Hawaiian Quaternary paleoenvironments: a review of geological, pedological, and botanical evidence. *Pac. Sci.* **46**: 295–307.
- Giffard, W.M.** 1925. A review of the Hawaiian Cixiidae, with descriptions of new species. *Proc. Hawaii. Entomol. Soc.* **6**: 51–171.
- Gillespie, R.G. & H.B. Croom.** 1995. Comparison of speciation mechanisms in web building and non web-building groups within a lineage of spiders. In: Wagner, W.L. & V. Funk, eds., *Patterns of speciation and biogeography of the Hawaiian biota*. Smithsonian Institution Press, Washington, D.C.: in press.
- Gressitt, J.L.** 1978. Evolution of the endemic Hawaiian cerambycid beetles. *Pac. Insects* **18**: 137–67.
- Howarth, F.G.** 1990. Hawaiian terrestrial arthropods: an overview. *Bishop Mus. Occas. Pap.* **30**: 4–26.
- _____. & **G.W. Ramsay.** 1991. The conservation of island insects and their habitats. In: Collins, N.M. & J.A. Thomas, eds., *The conservation of insects and their habitats*. Academic Press, New York. 450 p.
- Kaneshiro, K.Y.** 1983. Sexual selection and direction of evolution in the biosystematics of the Hawaiian Drosophilidae. *Ann. Rev. Ecol. Syst.* **28**: 161–78.
- Lorence, D.H. & T. Flynn.** 1991. Botanical survey of the Wahiawa drainage, Kauai. Final Report to the State of Hawaii, Dept. of Land and Natural Resources, Honolulu, Hawaii.
- Maciolek, J.A. & F.G. Howarth.** 1979. *Megalagrion paludicola*, a new species of damselfly (Odonata: Zygoptera: Coenagrionidae) from Kauai. *Pac. Insects* **21**: 165–71.
- Mayr, E.** 1969. *Principles of systematic zoology*. McGraw-Hill, New York. 428 p.
- Montgomery, S.L.** 1975. Comparative breeding site ecology and the adaptive radiation of picture-winged *Drosophila* (Diptera: Drosophilidae) in Hawaii. *Proc. Hawaii. Entomol. Soc.* **22**: 65–103.
- Otte, D.** 1989. Speciation in Hawaiian crickets, p. 482–526. In: Otte, D. & J.A. Endler, eds., *Speciation and its consequences*. Sinauer Associates, Inc., Sunderland, Massachusetts.
- _____. 1994. *The crickets of Hawaii: origin, systematics and evolution*. The Orthopterists Society, Academy of Natural Sciences of Philadelphia, Philadelphia. 396 p.
- Perkins, R.C.L.** 1913. Introduction. *Fauna Hawaiiensis*. **1**: xv–ccxxviii. Cambridge University Press, Cambridge.
- Sharp, D., ed.** 1899–1913. *Fauna Hawaiiensis*. 3 vols in 18 parts. Cambridge University Press, Cambridge.

- Stearns, H.T.** 1985. *Geology of the State of Hawaii*. 2nd edition. Pacific Books, Palo Alto, California. 335 p.
- Tenorio, J.M.** 1969. *Insects of Hawaii*. Vol. 11. Supplement, Diptera: Dolichopodidae, appendix (Phoridae). University of Hawaii Press, Honolulu. 73 p.
- Thornton, I.W.B.** 1984. Psocoptera of the Hawaiian Islands: Part III. The endemic *Ptycta complex* (Psocidae): systematics, distribution, and elevation. *Int. J. Entomol.* **26**: 1-128.
- Uchida, G.K. & J.W. Beardsley.** 1988. Taxonomy and biology of the *Megatrioza palmicola* group (Homoptera: Psyllidae) in Hawaii. *Proc. Hawaii. Entomol. Soc.* **28**: 57-100.
- _____. 1992. The genus *Hemischizocranium* Tuthill (Homoptera: Psyllidae), with descriptions of immature stages. *Proc. Hawaii. Entomol. Soc.* **31**: 183-96.
- Usinger, R.L.** 1942. The genus *Nysius* and its allies in the Hawaiian Islands. *Bernice P. Bishop Mus. Bull.* **173**: 1-167.
- Wagner, W.L., D.A. Herbst & S.H. Sohmer.** 1990. *Manual of the flowering plants of Hawai'i*. Bishop Museum Press & University of Hawaii Press, Honolulu. 1853 p.
- Yoon, J.S., K. Resch, M.R. Wheeler & R.H. Richardson.** 1975. Evolution in the Hawaiian Drosophilidae: chromosomal phylogeny of the *Drosophila crassifemur* complex. *Evolution* **29**: 249-56.
- Zimmerman, E.C.** 1948a. *Insects of Hawaii*. Vol. 1. Introduction. University of Hawaii Press, Honolulu. xvii + 206 p.
- _____. 1948b. *Insects of Hawaii*. Vol. 4. Homoptera: Auchenorrhyncha. University of Hawaii Press, Honolulu. vii + 268 p.
- _____. 1958. *Insects of Hawaii*. Vol. 8. Lepidoptera: Pyraloidea. University of Hawaii Press, Honolulu. ix + 456 p.

Hydrovatus sandwichensis, n. sp. (Coleoptera: Dytiscidae) and a New Record of *Hydrovatus* from the Hawaiian Islands

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Only 1 species of *Hydrovatus* has thus far been reported from the Hawaiian Islands: *H. confertus* Sharp (Fullaway 1922, Williams 1936, Balfour-Browne 1945). In my revision of the genus (Biström 1994), I did not examine any material from the Hawaiian Islands, but referred simply to previous authors.

Recently, Dr. G.A. Samuelson at Bishop Museum (BPBM), kindly sent for examination both comparatively old and recently collected material of *Hydrovatus* from different parts of the Hawaiian Islands. It immediately became clear that these specimens did not belong to the Oriental species *H. confertus*, but to a previously undescribed species, the description of which is given below. Among the material studied was also 1 specimen that belongs to the real *H. confertus*. However, it only has a code label "7/11/71 Km100" and an additional label "HI: Hawaii Island?", which strongly suggests that it had not been sampled in the Hawaiian Islands at all but had been used as material for comparison. The occurrence of *H. confertus* in the Hawaiian Islands was considered a case of immigration due to human agency (Balfour-Browne 1945). I suspect Balfour-Browne's view was based on the title of the article in which the first record of the species was given: "Notes on immigrant Coleoptera" (Fullaway 1922). No other indication of a recent immigration of the species seems to exist; on the other hand, transportation by man cannot be excluded.

Specimens are deposited at Bishop Museum (BPBM) and the Zoological Museum, Helsinki (ZMH).

Hydrovatus sandwichensis Biström, new species

Figs. 1–6

Hydrovatus confertus: Fullaway, 1922: 78; Williams, 1936: 239, 257–61; Balfour-Browne, 1945: 105, 106, 112, incorrectly assigned to this species.

Diagnosis: *H. sandwichensis*, n. sp. is most closely related to *H. subtilis* Sharp and *H. stridulus* Biström. A portion of the type material of *H. sandwichensis* was earlier attributed to *H. confertus* Sharp. The new species is distinguished from *H. subtilis* and *H. stridulus* by the appearance of the stridulation file of the male. In *H. subtilis* and *H. stridulus* the file consists of 13–18 separate ridges, which are easily recognized with a binocular magnification of 25 x. The corresponding file of *H. sandwichensis* consists of narrow, hardly visible ridges (requiring magnification of 75–100 x), the number of which exceeds 2. The ventral outline of the apical part of the penis posterior to the downwards bent tip is almost straight in *H. sandwichensis* while generally distinctly curved in *H. subtilis* and *H. stridulus*. Additionally, *H. sandwichensis* is smaller (see below) than *H. stridulus* (length of body 2.46–2.58 mm). *H. sandwichensis* is separated from *H. confertus* by having distinctly sparser elytral punctation and by its more elongated body. The 4 taxa involved all belong to a separate species group distinguished in Biström (1994).

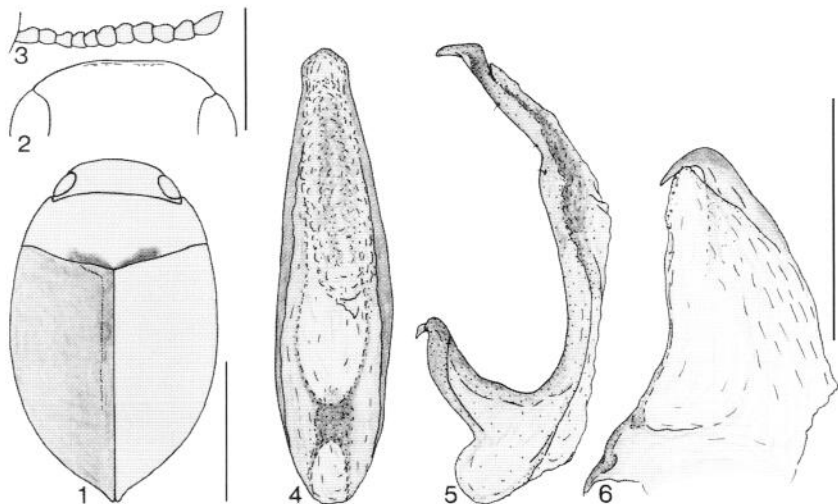
Description [only differences from redescrptions of *H. confertus* and *H. subtilis* and the description of *H. stridulus* (Biström 1994) are included here]: Length of body: 2.22–2.46 mm, breadth 1.40–1.54 mm. Habitus (Fig. 1): body more elongated than in *H. confertus*, approximately as in *H. subtilis*. Head: Frontal aspect of head (Fig. 2). Antenna modified, segments 6–8 broadest (segments almost equally broad). Apical segments also distinctly enlarged but slightly narrower than pre-

ceding ones (Fig. 3). Shape of the antenna resembles most closely the antenna of *H. stridulus*. Elytra: Ferruginous to brownish, main color somewhat darker than on head and pronotum. Punctuation somewhat sparse; distance between separate punctures generally greater than the diameter of one puncture (punctuation approximately as in *H. stridulus*). Venter: Width of stridulation file narrow, ridges hardly visible even at magnification of 100 x. Number of ridges unclear but at least over 20. Male genitalia: Figs. 4–6. Penis almost as in *H. stridulus* and *H. subtilis* except for ventral aspect of penis–apical–part. In lateral view, outline of apical part of penis almost straight up to quite strongly bent tip of penis. Female: Antennal segments not distinctly enlarged. Lacks stridulatory file.

Type material: *Holotype*, male: Hawaiian Is: Oahu I, Kawaiui Marsh, sea level, 30.i.1982 (W.C. Gagné) (BPBM 15,371). *Paratypes*: same data as holotype (1 ex ZMH); OAHU: Kawaiui Marsh, 14.ii.1982, in submerged plants, Bishop Mus. Acc. 1982.538 (3 exx. BPBM 1 ex. ZMH); Oahu, T.H., Sept. 1913, *Hydrovatus confertus* Sharp (3 exx. BPBM); Oahu, T.H., Nov. 1914 (1 ex. BPBM); Honolulu, T.H., ix–37 (E.H. Bryan, Jr.) (1 ex. BPBM); Honolulu, 21.xii.1927 (MaMankei), *Hydrovatus confertus* Shp. det. by O.H. Swezey (1 ex. BPBM); Manoa, 15.x.1936, at light (N.L.H. Krauss) (2 exx. BPBM); KAUAI: Lawai Valley, Pacific Tropical Botanical Garden, ca. 20 m, 7–9.ix.1988 (S.E. Miller) (1 ex. BPBM); HAWAII: Olaa, 19–20.iv.1920 (O.H. Swezey) (1 ex. BPBM). In all, 16 exx.

Distribution: Known only from the Hawaiian Islands.

Biology: According to Williams (1936), the species (as *H. confertus*) may be sampled in weedy and sometimes malodorous shallows. Additionally, it is reported by Williams in certain weedy lowland swamps, in abandoned rice fields, in hoof prints of cattle, and in other small water pockets by taro patches, particularly where fish have not yet penetrated and where protozoans, rotifers, minute crustaceans, and other diminutive organisms abound. The species often inhabits the same waters as the hydrophilid *Enochrus pygmaeus* (Fabricius) and *Coelostoma fabricii* (Montrouzier).



Figs. 1–6. *Hydrovatus sandwichensis*, n. sp. 1, habitus. 2, male head, frontal aspect. 3, male antenna. 4, penis, dorsal aspect. 5, penis, lateral aspect. 6, paramere. Left bottom scale = 1 mm. for habitus; left top scale = 0.5 mm for head and antenna; right scale = 0.4 mm for genitalia.

H. acuminatus Motschulsky

New state record

This species has a wide distribution in the Old World ranging from Turkey to the South of Japan, the Philippines, Yap Island (Federated States of Micronesia) and most of Indonesia. Additionally, there are scattered records from Africa between Egypt and Gambia to South Africa and Madagascar (Biström 1994). This is the first record of this species from Hawaii.

The specimen was discovered mixed with the Hawaiian material determined as *H. confertus*. Because of its commonness, particularly in the Oriental region, the possibility of human introduction to the Hawaiian Islands must be seriously considered, although the original manner of immigration will probably remain unknown. Its wide global distribution including many remote areas indicates that the species undoubtedly has a well developed ability to migrate.

Material studied: 1 M, Keanae Camp, Maui, vi.24 (30?) ex *Cyanea* (E.H. Bryan, Jr.) (BPBM).

References

- Balfour-Browne, J.** 1945. Aquatic Coleoptera of Oceania (Dytiscidae, Gyrinidae, and Palpicornia). *Occas. Pap. Bernice P. Bishop Mus.* **18**: 103-32.
- Biström, O.** 1995. Taxonomic revision of the genus *Hydrovatus* Motschulsky (Coleoptera, Dytiscidae). *Entomol. Scand. Suppl.*: in press
- Fullaway, D.T.** 1922. Notes on immigrant Coleoptera. *Proc. Hawaii. Entomol. Soc.* **5**: 75-82.
- Williams, F.X.** 1936. Biological studies in Hawaiian water-loving insects. 1. Coleoptera or beetles. *Proc. Hawaii. Entomol. Soc.* **9**: 235-73.

First Endemic Click Beetle From Nihoa Island (Coleoptera: Elateridae)¹

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The Hawaiian genus *Itodacnus* Sharp (1885) contains 11 species including the 1 described herein, and it is one of 3 endemic genera of click beetles from the Hawaiian Islands. The occurrence of the new species on Nihoa Island (26°6'N, 161°58'W) was not unexpected, as 2 species are found on Necker Island, a similar but much smaller high island which lies 270 km beyond, marking the NW limit of *Itodacnus* (Van Zwaluwenburg 1926, Samuelson & Van Zwaluwenburg 1966, Beardsley 1966). The bulk of the species reside in the opposite direction, on the newer and larger high islands of the SE end of the chain. These latter species were treated by Sharp (1908) in *Fauna Hawaiiensis*, covering all the known species at the time.

Methods

Measurements: body length and breadth are rounded to the nearest 0.05 mm; all others are rounded to the nearest 0.01 mm. Specimens are deposited in Bishop Museum (BPBM).

Itodacnus nihoae Samuelson & Johnson, new species

Figs. 1, 2a-e

Male (holotype). Body form moderately elongate, attenuate posteriorly, narrowly elliptical in lateral outline, widest across pronotal hind angles, moderately convex. Integument with punctures moderately dense, umbilicate; each puncture bearing an adpressed to suberect, moderately long, aureorufous seta; ventral punctures mixed simple and umbilicate, each with a short seta. Dorsum and antenna largely rufotestaceous, with some fuscous staining on pronotal disc anteriorly and submedially extending to past middle; anterior margin of frons, extreme lateral margin of pronotum and basal margin of elytron fuscous. Body length 13.9 mm, breadth 4.0 mm. **Head** with frons broadly and shallowly concave, becoming flattened anteriorly; punctures moderately dense, with densest area on median of upper frons. Eye large, ocular index = 64. Supra-antennal ridge obtusely carinate, shallowly arcuate, confluent with truncate frontoclypeal margin. **Antenna** nearly half length of body (39:82), exceeding apex of pronotal hind angle by 2.5 segments; segment 1 fusiform anteriorly, flattened posteriorly; segment 2 short, subquadrate; segment 3 elongate, subcylindrical; segments 4-7 narrowly serrate; segments 8-10 subserrate; last narrowly rounded apically; relative length/breadth of segments (1/100ths of mm) are: 52/28 : 26/20 : 44/20 : 72/26 : 72/28 : 72/26 : 70/26 : 70/24 : 68/22 : 66/22 : 72/20. Maxillary and labial palpi with last segment narrowly securiform. **Pronotum** moderately convex, deplanate posterolaterally; slightly broader at apices of posterior angles than along mesal length (100:93); median longitudinal impression obsolete on disc, shallow posteriorly; basal incisures obsolescent; punctation coarse, commonly about 1 x as large as interspaces with flat, shining interspaces at central disc but punctures becoming closer with convex interspaces anterolaterally where they are commonly 2 x as large as interspaces; occasional small punctures also occur on discal interspaces. Hind angles subparallel, dorsally tectiform, with carina evanescent; apex broadly rounded in dorsal aspect, obliquely subtruncate in ventrolateral aspect. **Scutellum** about 1.3 x as long as broad, attenuate posteriorly; finely punctured. **Elytron** about 5 x as long as broad; side rather evenly convex; striae finely sulcate and punctured, intervals shallowly convex and with 3-4 poorly defined series of minute and setiferous punctures. **Ventral surfaces:** Hypomerion with large and sparse umbilicate punctures, mesal margin slightly thickened, flat and impunctate; posterior margin thickened around coxal cavity, with post-coxal tubercle, broad emargination, and angular notch near hind angle. Pronotosternal sutures closed anteriorly, shallowly arcuate towards median. Prosternum

1. Contribution No. 1995-005 to the Hawaii Biological Survey

with large and sparse umbilicate punctures becoming smaller posteriorly; anterior lobe short, margin with a strong and feebly sinuate bead; intercoxal process arcuately depressed below plane and posterior of coxae, narrowly rounded apically. Mesosternum with median fossa constricted at midlength; lateral margins broad, shallowly inclined medially; elevated posteriorly. Mesepisternum acuminate at coxal cavity; elytral locking flange flattened, broadly rounded apically. Metasternum sparsely, simply punctured; median line briefly engraved anteriorly. Metacoxal plate with posterior margin acutely angled. Abdominal punctures simple, elongate, becoming rounded and denser apically from basal 1/3 of sternite 5, the latter with apex broadly rounded. **Legs** elongate, segments finely punctured; femur narrowly fusiform, flattened ventrally; tibia narrow, spinose apically. Tarsus slightly longer than tibia, excluding pretarsal claws; each segment with a dense brush of setae ventrally, apices spinose; segments 1 and 2 with ventrolateral rows of spines. **Aedeagus** with penis broad apically and sinuate at apex; parameres shallowly sinuate at midlength and slightly expanded subapically.

Female. Unknown.

Type material. Holotype male (BPBM 14,746), HAWAIIAN IS (NW): Nihoa I: Devil's Slide, 28.vi.1990 (J. S. Strazanac).

Habitat. Nihoa is the largest and highest island of the Northwestern Hawaiian Islands, with a land area of 63 ha and elevation of 273 m (Palmer 1927). Annual rainfall is about 8–12 cm. Twenty-five species of vascular plants are recorded from Nihoa, including the endemic palm, *Pritchardia remota* (Kuntze) Becc., the only tree found on the island (Christophersen & Caum 1931, Clapp *et al.* 1977). *Chenopodium oahuense* (Meyen) Aellen is probably the commonest plant on the island. Its distribution includes Necker where it may be a possible host or a microhabitat indicator for *Itodacnus paradoxus*; this plant may also be important to *I. nihoae*.

Remarks. The new species resembles *I. gracilis* Sharp (Oahu I, Hawaii I) in having the metacoxal lamina with an acute posterior angle, slender antenna in male with more than 2 segments exceeding the pronotal posterior angle apex, aedeagus with parameres nearly as long as penis, and body length >12 mm; it differs from *I. gracilis* in having a more robust body, with the sides more convex in outline, pronotum more strongly convex, posterior angles of prothorax stouter, and dorsal carina of the posterior angle obsolescent.

Contrasting the new species with its congeners from Necker I (see also key below), it more closely resembles *I. novicornis* Van Zwaluwenburg than *I. paradoxus* Samuelson & Van Zwaluwenburg in size, build, antennal length, and sculpture. However, *I. novicornis* and *I. paradoxus* have the aedeagal parameres proportionally much shorter and with deep lateral incisures, while those of the new species are elongate and without incisures.

The following key is provisional and designed to help determine only the described species, as most of the species of the main islands remain poorly delimited.

Key to described species of *Itodacnus*

1. Antennal segment 3 short, 0.43–0.48 x as long as segment 4; segments 2 and 3 sparsely punctate, segments 4–11 densely microrugose throughout..... 2
- Antennal segment 3 longer, 0.55–0.69 x as long as segment 4; segments 4–11 sparsely punctate along lateral median line..... 3
2. Metacoxal plate with posterior angle obtuse; pronotal puncture diameter 1.5–2 x as large as interspaces; body length 11.2–16.7 mm ... (Necker I) *novicornis* Van Zwaluwenburg
- Metacoxal plate with posterior angle acute; pronotal puncture diameter 3–4 x as large as interspaces; body length 9.7–11.8 mm ... (Necker I) *paradoxus* Samuelson & Van Zwaluwenburg

3. Pronotal surface dulled from conspicuous microsculpture; pronotum subquadrate; pronotal hind angle with dorsal carina evanescent; elytra depressed 4
 — Pronotal surface shining; pronotum trapezoidal anteriorly; pronotal hind angle with carina distinct; elytra convex 5
4. Frontoclypeal margin with arcuate carina extending from supra-antennal ridge; body length 8.35–9.5 mm ... (Kauai I) *sordidus* Sharp
 — Frontoclypeal margin without carina, supra-antennal ridge not extending onto frons; body length 6–8 mm ... (Oahu I) *chloroticus* Sharp
5. Pronotum subparallel in basal 2/3, gradually narrowing at anterior angles 6
 — Pronotum trapezoidal, narrowing from basal 1/3 8
6. Metacoxal plate with posterior margin obtuse 7
 — Metacoxal plate with posterior margin acute; body length ca. 11.5–12 mm ... (Kauai I)..... *kauaiensis* Sharp
7. Abdominal sternites with punctures small, round; body length 7.75–9.9 mm ... (Hawaii I) *blackburnianus* Sharp
 — Abdominal sternites with punctures larger, elongate; body length 9–10.15 mm ... (Molokai I) *collaris* Sharp
8. Pronotal punctures coarse and dense sublaterally, punctures larger than interstices; body length 13.9 mm ... (Nihoa I)..... *nihoae*, n.sp.
 — Pronotal punctures moderate sublaterally, smaller than interstices 9
9. Posterior pronotal angles divergent; frons moderately deeply concave; body length 12–14.9 mm ... (Maui I)..... *coruscus* (Karsch)
 — Posterior pronotal angles subparallel; frons flattened to shallowly concave.... 10
10. Apex of pronotal hind angle narrowly and evenly rounded; body length ca. 10.65–15.5 mm ... (Oahu I, Hawaii I) *gracilis* Sharp
 — Apex of pronotal hind angle broadly rounded and subdenticulate; body length ca. 15–17 mm ... (Kauai I) *major* Sharp

Acknowledgments

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References

- Beardsley, J.W., Jr., 1966. Insects and other terrestrial arthropods from the Leeward Hawaiian Islands. *Proc. Hawaii. Entomol. Soc.* **19**(2): 157–85, 5 maps.
- Christophersen, E. & E.L. Caum. 1931. Vascular plants of the Leeward Islands, Hawaii. *Bishop Mus. Bull.* **81**: 1–41, 16 pl.
- Clapp, R.B., E. Kridler, & R.R. Fleet. 1977. The natural history of Nihoa Island, Northwestern Hawaiian Islands. *Atoll Res. Bull.* **207**: 1–147.
- Palmer, H. S. 1927. Geology of Kaula, Nihoa, Necker and Gardner Islands, and French Frigate Shoal. *Bishop Mus. Bull.* **35**: 1–35, 3 pl.
- Samuelson, G.A. & R.H. Van Zwaluwenburg. 1966. A new elaterid from Necker Island (Coleoptera: Elateridae). *Proc. Hawaii. Entomol. Soc.* **19**(2): 289–92, 2 fig.
- Sharp, D. 1885. On some new species and genera of Coleoptera, p. 156. In: Blackburn, T. & D. Sharp, Memoirs on the Coleoptera of the Hawaiian Islands. *Trans. R. Dublin*

Soc. (2) 3: 119-300, 2 pls.

Sharp, D. 1908. Elateridae, p. 368-400. *In*: Sharp, D. & H. Scott, IV. Coleoptera (various). *Fauna Hawaiiensis* 3(5): 367-579, 4 pls.

Van Zwaluwenburg, R.H. 1926. *Itodacnus novicornis*, a new elaterid species. *Bishop Mus. Bull.* 31: 50-52.



Fig. 1. *Itodacnus nihoae*, n. sp.: dorsal view, body length 13.9 mm.

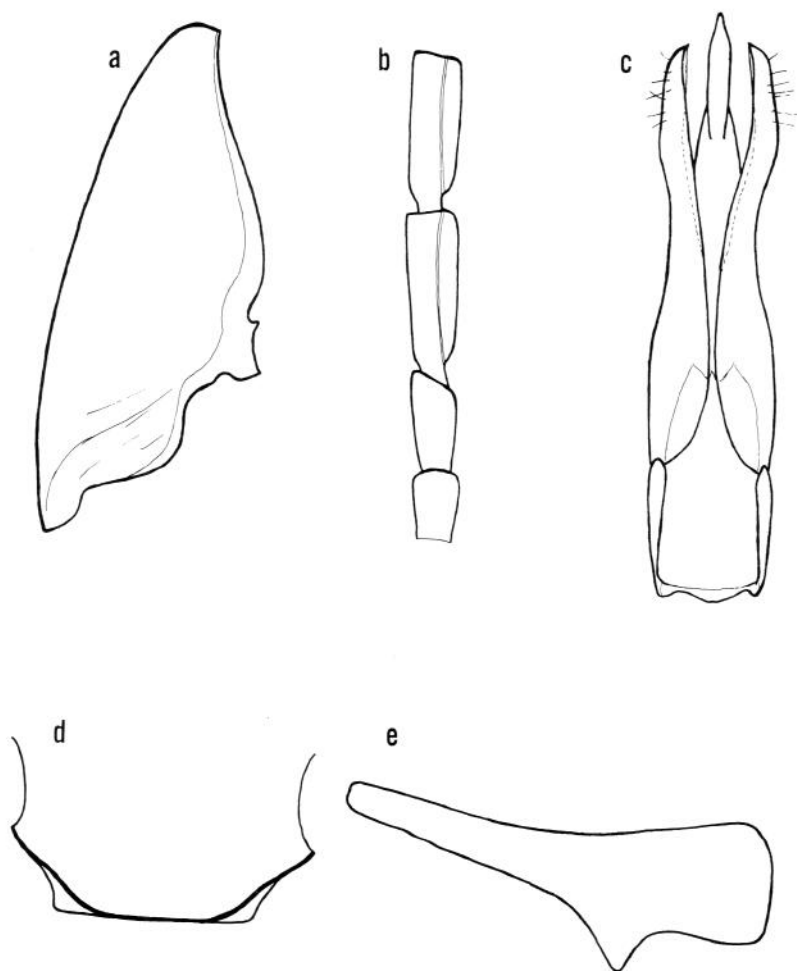


Fig. 2. *Itodacnus nihoae*, n. sp.: a, hypomeron (right), apex up, length 4.3 mm; b, antenna, segments 2-5; c, aedeagus, dorsal view, apex up, length 2.8 mm; d, fore margin of frons, apex down, breadth 1.5 mm; e, metacoxal lamina (right), length 2.15 mm.

New Taxonomic Changes Published In This Volume

INSECTA:

Homoptera: Delphacidae

Dictyophorodelphax zwaluwenburgi *vicar* Asquith, **new subspecies**

Coleoptera: Dytiscidae

Hydrovatus sandwichensis Biström, **new species**

Coleoptera: Elateridae

Itodacnus nihoae Samuelson & Johnson, **new species**