

**RECORDS OF THE
HAWAII BIOLOGICAL SURVEY
FOR 1998
Part 1: Articles**

Editors' Preface

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

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

Some of the highlights of *Records of the Hawaii Biological Survey for 1998* include:

- an update of numbers of species in Hawai'i;
- a checklist of the Hymenoptera of Midway Atoll;
- a list of the terrestrial isopods from Midway Atoll;
- results of an extensive survey of apple snails from watercourses on O'ahu;
- new records of plants, insects, and other invertebrates resulting from field surveys and continued curation of Hawaiian collections at Bishop Museum and elsewhere

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

lists of various fossil taxa occurring in Hawai‘i that could not be printed in these volumes due to space restrictions. These lists can be viewed at:

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

Our Main Web Addresses:

Hawaii Biological Survey Home Page

<http://hbs.bishopmuseum.org>

Bishop Museum Entomology Home Page

<http://www.bishopmuseum.org/bishop/ento/>

Hawaii Biological Survey Databases

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Hawaii Endangered and Threatened Species Web Site

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

“Insect and Spider Collections of the World” Home Page

<http://www.bishopmuseum.org/bishop/ento/codens-r-us.html>

The *Records of the Hawaii Biological Survey for 1998* were compiled with the assistance of George Staples (botany), Robert Cowie (malacology), and Gordon Nishida (entomology), who helped edit papers in their disciplines; and was partially supported by a grant from the John D. and Catherine T. MacArthur Foundation. Many of the new records reported here resulted from curatorial projects funded by the National Science Foundation and field surveys funded by the David and Lucile Packard Foundation, U.S. Geological Survey Biological Resources Division, U.S. Fish and Wildlife Service, U.S. Department of Defense Legacy Program, and the Hawaii Department of Land and Natural Resources.

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

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

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

—N.L. Evenhuis &
L.G. Eldredge, editors

In Appreciation

The editors take this opportunity to thank Scott E. Miller for his foundational work with the Hawaii Biological Survey, the editing of the *Records*, and his collegial companionship to us over the years. Scott was instrumental in the concept, development, and organization of HBS and his tireless work put HBS on the map. We hope that we can maintain the trail of success that he has blazed for us, and we wish him well in his future endeavors.

New Hawaiian plant records for 1998¹

HERBARIUM PACIFICUM STAFF (Hawai'i Biological Survey, Bishop Museum,
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These previously unpublished Hawaiian plant records report new state and new island records, nomenclatural changes, and reidentifications of previously misnamed species in Hawai'i. These records supplement information published in Wagner *et al.* (1990) and in the *Records of the Hawaii Biological Survey* for 1994–1997 (Evenhuis & Miller, 1995, 1996, 1997, 1998). All identifications were made by the authors except where noted in the acknowledgments, and all supporting voucher specimens are on deposit at BISH except as otherwise noted.

Aloaceae

Aloe vera (L.) Burm. f.

New island record

Formerly known to be naturalized only on Kaua'i (Lorence *et al.*, 1995), the following specimen represents the first record of the species on O'ahu. The 3 discrete populations at Makapu'u Head are well established, spreading vegetatively, and also setting limited amounts of fruit (2 old inflorescence stalks bearing capsules seen).

Material examined. **O'AHU:** Makapu'u Head, around old building sites near summit where lighthouse-keeper's residence was formerly located, 14 Dec 1997, *G. Staples & B. Pope 1154*.

Asteraceae

Hesperomannia arborescens A. Gray

New island record

Previously recorded from O'ahu, Moloka'i, and Lāna'i (Wagner *et al.*, 1990), this endemic thistle has also been collected from West Maui.

Material examined. **MAUI:** West Maui: Kahakuloa-Waihe'e ridge, between Lanilili and Keahikauō, 21 Jan 1989, *J. Lau & G. Uchida 3230, 3231*; steep W wall of Honokōhau Valley, 1900 ft, 22 Aug 1996, *J.S. Meidell & H.L. Oppenheimer 126*, [same locality] 1840 ft, 29 Aug 1996, *J.S. Meidell & H.L. Oppenheimer 141*.

Euphorbiaceae

Chamaesyce hyssopifolia (L.) Small

New island record

Documented from Kaua'i, O'ahu, Maui, and Hawai'i (Wagner *et al.*, 1990), this herbaceous weed was collected in the vicinity of Lāna'i Airport in the company of roadside weeds dominated by *Panicum maximum*.

Material examined. **LĀNA'I:** weedy herb along access road to Lāna'i Airport, 1300 ft elevation, 27 Mar 1998, *C. Imada 98-2*.

Iridaceae

In addition to the population of *Aristea gerrardii* Weim. that was reported as naturalized in the *Manual* (Wagner *et al.*, 1990), vouchers for what appeared to be a different *Aristea*, also from the Big Island, were collected by the late Lani Stemmermann and filed among the unidentified Iridaceae at BISH. These were tentatively identified by Peter Goldblatt in 1992 as a distinct species. We bring these taxa to the attention of field collectors because more collections for both *Aristea* taxa are desirable so that the identity of the second species can be confirmed and the distribution and abundance of both taxa bet-

1. Contribution No. 1999-015 to the Hawaii Biological Survey.

ter understood.

Aristea* cf. *compressa* Buchinger ex Baker **New state record*

In his monograph of *Aristea*, Weimarck (Weimarck, 1940) acknowledged that his new species, *A. gerrardii*, was very close morphologically to *A. compressa*, differing principally in being larger in all parts. Weimarck allowed that the two may represent subspecies, yet elected to give both species rank. Forty-five years later, in a partial revision of the genus, both species were again maintained (Vincent, 1985) with equally weak justification, the principal key character separating the two being the leaf rosette "loose" (*A. compressa*) versus "tight" (*A. gerrardii* and others). Thus it is difficult to give diagnostic characters to separate these two naturalized species, aside from the larger size of *A. gerrardii*. Two populations are documented here and collectors may well locate others.

Material examined. **HAWAII:** 15–16 mi outside Hilo on Saddle Rd., small naturalized population, 16 Apr 1980, *L. Stemmermann 6647*; Hawaii Volcanoes National Park, between Volcano House and the Superintendent's residence, 21 Apr 1980, *L. Stemmermann 6648*.

Sisyrinchium exile* E. P. Bicknell **New island record*

The *Manual* (Wagner *et al.*, 1990) listed the distribution for this species as East Maui and the Big Island. The following specimen represents the first record from Moloka'i.

Material examined. **MOLOKA'I:** Pu'ukauwā, roadside with grasses, 680 m, 10 May 1992, *G.D. Hughes s.n.* (BISH 626527).

Malvaceae

Abutilon menziesii* Seem. **New island record?*

Ko'oloa 'ula is a federally listed endangered species whose native range is documented as dry forests from 200–520 m elevation on Lāna'i, East Maui, and Hawai'i (Wagner *et al.*, 1990). It has also been long cultivated on O'ahu. A number of vouchers deposited at Bishop Museum (BISH) were collected in the 1930s from the cultivated Hawaiian forest at Kamehameha Girl's School. One collection (*A.F. Judd s.n.*, BISH 57290) from 1933 includes a notation that the plant was brought over from Lāna'i by G.C. Munro. This shrub has much ornamental merit, and it is seen more frequently in cultivated settings today. An anomalous collection from a single individual was made in an abandoned sugar cane field adjacent to Campbell Industrial Park in 1981 by W. Char (*W. Char 81.002*), which Wagner *et al.* (1990) surmised to be an escape from cultivation. In 1996, further anomalous collections were made in 2 separate locations on O'ahu. A single 6 ft tall shrub was discovered by J. Moribe (*J. Moribe s.n.*, BISH 643256) in Lualualei Valley along the Wai'anae coast near the Niuli'i Ponds Wildlife Refuge along a remote, unused road in the shade of *Prosopis*. Later in the year, K. Nagata noted a number of plants growing in abandoned sugar cane fields in the 'Ewa Plains mauka of Varona Village: in one case 25 plants were seen in a 100 acre area, associated with *Abutilon incanum*, *Sida fallax*, *Waltheria*, and *Chloris* (*K. Nagata 4433*); in the other case, at least 10 plants in a 10 acre area (*K. Nagata 4439*). Whether these plants are growing naturally or were intentionally planted is a question that remains unanswered.

Material examined. **O'AHU:** 'Ewa, mauka of Varona Village, just E of Kalo'i Gulch, ca 25 plants scattered over 100 acres in abandoned sugar cane fields, 23 m, 27 Sep 1996, *K. Nagata 4433*; 24 m, 3 Oct 1996, *K. Nagata 4439*; one plant found in abandoned cane field adjacent to Campbell Industrial Park, 23 Jan 1981, *W. Char 81.002*; Wai'anae Dist., RTS Lualualei Antenna field, Niuli'i Ponds Wildlife Refuge, 30 Jan 1996, *J. Moribe s.n.* (BISH 643256); Lualualei, single isolated plant along remote, unused road, 27 Feb 1996, *D. Orr & J. Obata V50*.

Melastomataceae***Tibouchina herbacea*** (DC.) Cogn.**New island record**

A locally abundant weed on West Maui, East Maui, and Hawai'i (Wagner *et al.*, 1990), *T. herbacea* had been reported from Lāna'i but apparently never vouchered. It is naturalizing and perhaps starting to spread on slopes approaching the Lāna'ihale summit area.

Material examined. **LĀNA'I:** Munro Trail, alongside dirt road approaching Lāna'ihale summit from NW side, 2780 ft, 27 Mar 1998, C. Imada, H. Oppenheimer, J.S. Meidell, & C. Gemmill 98-3.

Myrtaceae***Leptospermum*** J.R. & G. Forst.

In the course of verifying voucher specimens of cultivated plants for the *In Gardens of Hawai'i II* project, specimens of *Leptospermum* from BISH were sent on loan to Joy Thompson (NSW), who had recently revised the genus (Thompson, 1989). This revealed that 5, not 3, species of *Leptospermum* occur in Hawai'i and that some species concepts were muddled, authors in Hawai'i having applied names to mixtures of species. Only *L. scoparium* seems to have been interpreted correctly. To attempt to clarify the application of the other 4 *Leptospermum* names we list them below along with the various misapplied names and synonyms pertaining to each. Voucher specimens have been cited as the basis for each species concept and as a guide to how earlier workers have applied names. Trustworthy descriptions for all taxa are readily available in Australian botanical literature (Harden, 1991; Thompson, 1989).

Given that *Leptospermum* was planted for reforestation on several islands and that it is now apparent that more than 1 species was involved, further Hawaiian collections and field observations are desirable in order to assess the distribution and abundance of all *Leptospermum* species in the Hawaiian Islands. At present, only *L. scoparium* could be considered well represented in the BISH herbarium, yet collections are lacking for Maui, where it was planted for reforestation in the 1930s (Skolmen, ca. 1980).

Leptospermum laevigatum (Gaertner) F. Muell.

L. fabricia sensu Neal (1965), St. John (1973), non Bentham (1867) (= *Neofabricia myrtifolia* (Gaertner) J. Thompson)

Material examined. **O'AHU:** Honolulu, 25 Jun 1956, Mrs. Crowe s.n. (BISH 60010). **LĀNA'I:** locality not stated, in bare areas among *Eucalyptus* trees, 10 Jun 1985, R. Hobdy 2403.

Leptospermum morrisonii J. Thompson**Reidentification/new state record**

L. laevigatum sensu Wagner *et al.* (1990), in part, non (Gaertner) F. Muell.

The following 2 specimens were misidentified as 2 different species. They represent the first record of *L. morrisonii* in the Hawaiian Islands.

Material examined. **MAUI:** along ditch trail between Honomanū Valley and Ke'anae Valley, planted in forest reserve in moderately dry, open region, 14 Jul 1927, O. Degener 8194; Ko'olau Forest Reserve, 1800 ft, 15 Jul 1980, K. Adee s.n. (BISH 580695).

Leptospermum petersonii Bailey**Reidentification**

L. flavescens sensu Wagner *et al.* (1990), in part, non Sm.

L. flavescens Sm. var. *citriodorum* sensu Neal (1965), St. John (1973), non F. Bailey

Material examined. **HAWAI'I:** South Kona distr., Captain Cook, McCandless Ranch, 15 Jun 1960, Mrs. A.L. Marks s.n. (BISH 60011); cultivated in Hilo Forestry Arboretum, 27 Nov 1979, W. Teraoka & K. Nagata 174.

Leptospermum polygalifolium* Salisb.*Nomenclatural change**

Syn. *L. flavescens* Sm.

Thompson (1989) reduced *L. flavescens* to synonymy with *L. polygalifolium* subsp. *polygalifolium*. Plants naturalized and cultivated in Hawai'i are all referable to subsp. *polygalifolium*. Hawaiian authors have applied the name *L. flavescens* to a mixture of 2 species (Neal, 1965; St. John, 1973; Wagner *et al.*, 1990). Specimens correctly identified as *L. flavescens* are now called *L. polygalifolium*; others have been reidentified as *L. petersonii*. This species has been cultivated for many years at locations around O'ahu, yet it has been recorded only once as a naturalized species. The following list of vouchers may be helpful in guiding field collectors to localities where the species is establishing itself.

Material examined. **O'AHU:** Kalihi, Kamehameha School for Girls, 25 Sep 1937, A.F. Judd, E.H. Bryan Jr., & M.C. Neal *s.n.* (BISH 60013), same loc., 15 Mar 1938, P. Rankin *s.n.* (BISH 427657); Mānoa Valley, cultivated in HSPA Arboretum, 12 Jan 1927, L.H. McDaniels 402, same loc., spreading aggressively in grass cover below *koa*, 4 June 1937, F.E. Egler 37–47, Lyon Arboretum, volunteer in sect. 13, 12 Oct. 1967, D. Herbst 645.

Oleaceae***Ligustrum sinense* Lour.****New island record**

The genus *Ligustrum* has not previously been found naturalized in the Hawaiian Islands. *Ligustrum sinense*, native to China and Vietnam, is widely cultivated and has escaped in many subtropical and warm temperate places to become a weedy pest (Green, 1995). For example, it is considered an invasive woody weed on rainforest margins and along fence lines in cleared areas in New South Wales (Harden, 1992). Elsewhere in this issue it is documented as naturalized on Kaua'i (Lorence & Flynn, 1999). The small blackish drupes are attractive to birds, which spread the seeds.

Material examined. **HAWAI'I:** Ka'ū Distr., Hawai'i Volcanoes National Park near Thurston Lava Tube, elev. 3800 ft, shrub in closed *Metrosideros* forest, 11 Jul 1985, T. Tunison *s.n.* (BISH 605525).

Pittosporaceae***Pittosporum pentandrum* (Blanco) Merr.****New state record**

Native to northern Sulawesi in Indonesia, Taiwan, and throughout the Philippines (Bakker & Steenis, 1957), this species was introduced to Hawai'i as an ornamental early in the 1970s. It is listed as a recommended street tree for planting in Honolulu (Department of Parks & Recreation, undated). In recent years specimens have been brought in for identification from populations that are clearly growing outside of cultivation on O'ahu. The bright yellow capsules, which split open to reveal orange-red seeds, are attractive to frugivorous birds, which seem to be the dispersal vector. Given the rapidity with which *P. pentandrum* appears to be spreading out of cultivation on O'ahu, it can no longer safely be recommended for use as a street tree. Collectors are encouraged to look for it on O'ahu and the neighbor islands. It is also escaping in southern Florida (Judd, 1996).

Material Examined: **O'AHU:** He'eia, slope of Pu'u Mā'eli'eli above He'eia State Park, many plants of different sizes, in alien forest with *Syzygium cumini*, *Ochna*, *Passiflora*, ca 100 ft, 2 Dec 1998, E. Koes & L. Pyle 1. **HAWAI'I:** Kohala Mts, vicinity of Wai'aka Gulch, Pu'u o 'Umi NAR transect #1, ca 61 m, 1 Nov 1996, B. Stevens 3.

Plumbaginaceae***Plumbago auriculata* Lam.****New state record**

The Cape leadwort is a familiar cultivated shrub and hedge plant widely grown in Hawai'i. Native to South Africa, it differs from the indigenous *P. zeylanica* in having pale blue (rarely white) flowers 1–1.5 inches long and 1 inch in diameter; *P. zeylanica* has white flowers less than 1 inch long and 0.5–0.66 inches in diameter (G. Staples & D. Herbst, unpubl.). Not previously documented as escaping from cultivation, it is apparently doing so on the dry, scrubby slopes at around 2,500 ft elevation in Kēōkea on the slopes of Kula, East Maui. Rounded shrubs are randomly scattered in openings of *Acacia mearnsii* forest, associated with *Lantana* and *Pennisetum clandestinum*.

Material examined. **EAST MAUI:** Kēōkea, dry scrubland downslope of Kula Hwy, large, rounded, 7 ft tall shrub, ca. 2500 ft, 18 Aug 1998, C. Imada, W. Char, & C. Morden 98-14.

Poaceae***Andropogon virginicus* L.****New island record**

Previously documented from O'ahu, Moloka'i, and Hawai'i (Wagner *et al.*, 1990; Hughes, 1995), broomsedge was collected on Lāna'i along the Munro Trail in a disturbed mesic shrubland featuring planted *Araucaria*, along with *Machaerina*, *Dicranopteris*, and *Diplopterygium*.

Material examined. **LĀNA'I:** Munro Trail, alongside dirt road approaching Lāna'ihale summit from NW side, 3000 ft, 27 Mar 1998, C. Imada, H. Oppenheimer, J.S. Meidell, & C. Gemmill 98-4.

Bromus rigidus* Roth*New island record**

Documented from Kaua'i and Hawai'i (Wagner *et al.*, 1990), ripgut grass has now been collected from East Maui as well. The species was first documented on Maui from the 'Ulupalakua area in 1937 as a localized patch in pastureland at 1,800 ft elevation (*Hosaka 1787*). See Herbst & Clayton (1998) for a note concerning the present taxonomic placement of this species.

Material examined. **EAST MAUI:** Kēōkea, dry scrubland downslope of Kula Hwy with *Sporobolus indicus*, *Ehrharta*, *Lantana*, *Bocconia*, *Gomphocarpus*, 2600 ft, 17 Aug 1998, C. Imada, W. Char, & C. Morden 98-11.

Distichlis spicata* (L.) Greene*Range extension**

This species was treated as a note in the Poaceae treatment of Wagner *et al.* (1990), where it was described as being first collected at Ala Moana Beach Park on O'ahu in 1977 (*Watanabe s.n.*, BISH 419283) but not collected since on the island, while on the central Maui plain it was first collected in 1980 by R. Hobdy (*Hobdy 906, 907, 908*) in sandy-salty soil near Kānaha Pond, sometimes in dense patches. It has now been documented from the southern end of central Maui as a thick sod on the pond banks of a former baitfish facility west of Keālia Pond, growing with *Paspalum vaginatum*, *Pluchea indica*, and *P. × fosbergii*.

Material examined. **MAUI:** Keālia Pond National Wildlife Refuge, dense groundcover on pond banks in former baitfish facility W of Keālia Pond, 6 Oct 1998, C. Imada, K. Evans, & M. Nishimoto 98-29.

Paspalum vaginatum* Sw.*New island record**

Seashore paspalum, previously documented from Kaua'i, O'ahu, and Hawai'i (Wagner *et al.*, 1990), has now been collected on Maui.

Material examined. **MAUI:** Keālia Pond National Wildlife Refuge, common weedy grass on pond banks in former baitfish facility W of Keālia Pond, 6 Oct 1998, *C. Imada, K. Evans, & M. Nishimoto* 98-30.

***Sacciolepis indica* (L.) Chase**

New island record

Glenwood grass is a common element of open, wet areas on most of the main islands except for Ni‘ihau and Kaho‘olawe (Wagner *et al.*, 1990). It has now been documented from Lāna‘i as well.

Material examined. **LĀNA‘I:** Munro Trail, alongside dirt road at Lāna‘ihale summit, in *Dicranopteris/Leptospermum* shrubland, 3370 ft, 27 Mar 1998, *C. Imada, H. Oppenheimer, J.S. Meidell, & C. Gemmill* 98-6.

Proteaceae

***Grevillea robusta* A. Cunn. ex R. Br.**

New island record

Silk oak is an Australian tree extensively planted for reforestation in the Hawaiian Islands. Wagner *et al.* (1990) report that plantings were made on all of the main islands except Kaho‘olawe, and the species had been documented as naturalizing on Kaua‘i, O‘ahu, Maui, and Hawai‘i. It has now been documented on Lāna‘i as well.

Material examined. **LĀNA‘I:** Munro Trail, alongside dirt road on SE side of Lāna‘ihale summit, alien dry forest, 2780 ft, 27 Mar 1998, *C. Imada, H. Oppenheimer, J.S. Meidell, & C. Gemmill* 98-7.

Rhizophoraceae

***Rhizophora mangle* L.**

New island record

Previously documented from Kaua‘i, O‘ahu, Moloka‘i, Lāna‘i, and Hawai‘i (Wagner *et al.*, 1990), this is the first collection of the American mangrove from Maui, where it forms small but solid patches on the north-northeast border of Keālia Pond proper.

Material examined. **MAUI:** Keālia Pond, solid stand on NE shore of pond, fronted by *Batis* and *Bolboschoenus*, 6 Oct 1998, *C. Imada, K. Evans, & J. Palma* 98-27.

Rosaceae

***Cotoneaster pannosa* Franch.**

New island record

This cultivated species was noted in Wagner *et al.* (1990) as persisting and sometimes reproducing in Volcano, Hawai‘i, and Kula, Maui, and more recently was documented as definitely naturalizing on Kaua‘i (Lorence *et al.*, 1995). The only previous Maui specimen at BISH was collected in 1986 from Polipoli Park in the Kula Forest Reserve (*Hobdy* 2697), located at about 6,500 ft elevation. The plant (although not specifically stated) was apparently cultivated and described as bushy tree about 12 ft tall. A collection was made in 1998 far downslope at 2,450 ft elevation, below the town of Kēōkea in open *Lantana* scrubland/*Pennisetum clandestinum* pastureland from a 20 ft tall shrub with long, arching branches suckering profusely from the base. Smaller plants were randomly scattered in the surrounding pasturelands and adjoining black wattle forest.

Material examined. **EAST MAUI:** Kēōkea, in open *Lantana* scrubland/kikuyu grassland downslope of Kula Hwy, 2450 ft, 17 Aug 1998, *C. Imada, W. Char, & C. Morden* 98-10.

***Eriobotrya japonica* (Thunb.) Lindl.**

New island record

First documented as naturalized on Kaua‘i (Lorence *et al.*, 1995), loquat was noted as naturalizing in a dumpsite area below the town of Kēōkea in the Kula District of East Maui.

Material examined. **EAST MAUI:** Kēōkea, dry scrubland downslope of Kula Hwy, in shaded gulch next to dumpsite, 2500 ft, 18 Aug 1998, C. Imada, W. Char, & C. Morden 98-13.

Pyracantha

The *Manual* (Wagner *et al.*, 1990) treated *Pyracantha angustifolia* as a naturalized species known from Kauaʻi and the Volcano area of Hawaiʻi. Reidentification of the voucher specimens seen for the *Manual* and the acquisition of new specimens since 1990 revealed that 3 species of *Pyracantha* can be documented as naturalizing in the Hawaiian Islands at higher, cooler elevations. Some specimens identified as *P. angustifolia* were confirmed as that species; others were subsequently reidentified as other species. All 3 species have red-orange, fleshy fruits that are attractive to birds, which disseminate the seeds. Brief diagnostic features are presented for each species to facilitate correct identifications. More detailed information will appear in the new *In Gardens of Hawaiʻi* (G. Staples & D. Herbst, unpubl.).

***Pyracantha angustifolia* (Franch.) C.K. Schneid. Amended record**

Verification of BISH specimens by J.B. Phipps, specialist in the Rosaceae, Maloideae, revealed that the taxon identified in the *Manual* (Wagner *et al.*, 1990) as *P. angustifolia* was a mixture of similar species. Genuine *P. angustifolia* is recognized by its narrowly oblanceolate leaves, 0.5–2 inches long, that are woolly-hairy on the underside; the inflorescences are usually 3–10-flowered, their axes appressed rusty-pubescent. Fruits are about 0.2 inches in diameter, varying from orange to red. The amended naturalized distribution is only documented for Kauaʻi, although the species is cultivated on Oʻahu (based on vouchers in BISH) and possibly other islands.

Material examined. **KAUAʻI:** along Hwy 550, at the 16 mile marker, crossing Kaunuohua Ridge, 15 Mar 1986, J. Plews *s.n.* (BISH 502793).

***Pyracantha crenatoserrata* (Hance) Rehder New naturalized record**

This species, native to China, is similar to *P. koidzumii* but is distinguished by having smaller leaves that are always distinctly crenate on the margins, and smaller, usually red fruits about 0.2 inches in diameter. It has been reported from cultivation in the Hawaiian Islands (Neal, 1965; St. John, 1973) and is now known to be naturalized on 2 of them.

Material examined. **KAUAʻI:** Waimea Distr., Kōkeʻe State Park, mile 18.4 on Hwy 550, just before Puʻu o Kila Lookout on southern rim of Kalalau Valley, 1220 m, 20 May 1988, D. Lorence, T. Flynn, & J. Talbot 6002. **HAWAIʻI:** Hawaiʻi Volcanoes National Park, Kilauea Military Camp, established in weedy, disturbed places on pyroclastic soil, 1210 m, 25 Nov 1963, F.R. Fosberg 44463.

***Pyracantha koidzumii* Rehder, vel aff. Reidentification**

P. angustifolia sensu Wagner *et al.*, 1990, non (Franch.) C.K. Schneid.

Endemic to Taiwan, this species (or hybrids derived from it) appears to be the most frequently cultivated firethorn in the Hawaiian Islands, based on vouchers seen from Kauaʻi, Oʻahu, Lānaʻi, and the Big Island. The species is recognized by its oblong-obovate leaves, 0.5–1 inches long, hairy along the nerves on the underside when young and later nearly glabrous, and with entire margins. Inflorescences are typically 15–30-flowered and have shortly rough-hairy axes. The fruits are about 0.3 inches in diameter and orange. What appear to be possible hybrids have very slight scalloping on the margins

toward the apex of the blade. One voucher specimen examined for the *Manual* (as *P. angustifolia*) from the Big Island was reidentified by Professor J.B. Phipps in 1991 as “*P. koidzumii* or a hybrid thereof.” The following naturalized specimens have been seen.

Material examined. **KAUAI:** Kōke’e, Camp 10 Road, Plew’s residence, seedling found growing along highway between 16 and 17 mile markers, 23 Oct 1986, *J. Plews s.n.* (BISH 523723). **HAWAII:** Volcano dump, 28 Feb 1984, *W.L. Wagner; S. Mill, T. Flynn, & R. Gustafson* 5267.

Acknowledgments

We are grateful to the following for determinations of specimens: P. Goldblatt (MO), *Aristea*; D. Herbst (BISH), *Abutilon*, *Cotoneaster*; Poaceae; C. Morden (HAW), *Bromus*; J.B. Phipps (UWO), *Pyracantha*; J. Thompson (NSW), *Leptospermum*; and W.L. Wagner (US), *Hesperomannia*. Herbarium Pacificum staff members contributing to this paper were K. Anderson, J. Fisher, C. Imada, B. Kennedy, and G. Staples.

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Contributions to the flora of Hawai'i. VII¹

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More than 10 years have passed since the publication of the *Manual of the flowering plants of Hawai'i* (Wagner *et al.*, 1990). Since that time we, and other interested botanists, have attempted to keep the information in the *Manual* current through the publication of new information in scientific journals. The Hawaii Biological Survey, initiated by the Hawaii State Legislature in 1992 as a program of the Bishop Museum, has greatly helped us in this task. Since 1994, the Hawaii Biological Survey has published the annual *Records* of the Survey. These comprise short papers listing new state or island records of plants and animals, longer papers describing new taxa or reviewing various aspects of the islands' flora or fauna, and updates of the information published in the *Manual* (Evenhuis & Miller, 1995, 1996, 1997, 1998).

A reprint of the *Manual* is scheduled to be published in late spring of 1999¹. It will include a supplement presenting information, listed in tabular form, acquired since 1987, the *Manual's* mandatory cut-off for incorporation of new information. This paper follows in the spirit, format, and purpose of the previous publications. It contains new information included in the supplement, but gives additional information about the entries. It also notes taxa of Hawaiian plants published as new or resurrected since the publication of the *Manual*, as many are in journals overlooked by or unavailable to the general public.

This paper reports previously unpublished Hawaiian plant records for 10 new state and 9 new island records, 15 new naturalized records, 5 new synonymies, 5 corrections of previous misidentifications, 2 identifications of taxa previously known only to the generic level, 1 resurrection of native taxa previously relegated to synonymy, 1 orthographic correction, and 13 taxonomic changes. Also included are summaries of similar information published elsewhere over the past few years, which may have been overlooked by casual users of general taxonomic literature in Hawai'i. All identifications were made by the authors except where otherwise noted.

Acanthaceae

Hypoestes phyllostachya Backer

New naturalized record

The first herbarium specimen of *Hypoestes phyllostachya* in Hawai'i was made in 1985, but the plant had been grown as an ornamental in the state for many years prior to that time. The following collection is the first record of the species as naturalized in Hawai'i. The mother plant is growing in an abandoned garden of a tenant farmer who had leased the land from Amy Greenwell to grow coffee. It apparently is at least sparingly naturalized as there are many seedlings in the area. The species also is cultivated as an ornamental on Kaua'i and O'ahu but is not known to have escaped on either of these islands.

Material examined. HAWAII: South Kona District, Amy B.H. Greenwell Garden, Captain Cook, ca. 1500 ft, 19 May 1990, *Botany Dept. sub G. Staples* 625 (BISH).

Pseuderanthemum variable (R. Br.) Radlk.

The Herbarium Pacificum Staff (1998: 8) first reported *Pseuderanthemum fasciculatum* (Oerst.) Leonard as new to the state. According to D. Wasshausen of the Smithsonian Institution (pers. comm., 1998), an authority in the family, the collection docu-

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menting the presence of the species in Hawai'i was an incorrectly identified specimen of *P. variable*.

Ruellia brevifolia (Pohl) C. Ezcurra

In her revision of the southern South American members of the genus *Ruellia*, Ezcurra (1993: 802) placed *R. graecizans* Backer (Wagner *et al.*, 1990: 174) in synonymy under this taxon.

Sanchezia speciosa Leonard

Correction

The author for this newly naturalized species reported by Lorence *et al.* (1995: 20), was incorrectly given as J. Leonard. The correct author is E. Leonard. Following Brummitt & Powell (1992: 367), the standard form for the citation of this author's name is Leonard.

Amaranthaceae

Nototrichium divaricatum Lorence

This species is known only from the Nā Pali coast region, Kalalau, Honopū, and Pohakuao Valleys, at ca. 600–1100 m, Kaua'i (Lorence, 1996: 64). It differs from other species of the genus by its compoundly branched inflorescences with divaricate branches and shorter spikes, 5–20 (–35) mm long, with (4–) 8–30 (–66) flowers per spike. It is known only from north-facing cliffs and ridges in diverse mesic forests; its conservation status is rare.

Arecaceae

Pritchardia lanaiensis Becc. & Rock

Read & Hodel (1990: 1365) included *P. lanaiensis* only as a note in their treatment of the genus explaining that the taxon had not been placed because its identity remained in doubt. They stated that further work may determine that it is a distinct species, a conclusion reached by C. Gemmill (pers. comm., 1997) as a result of her studies of the genus. Read & Hodel (1990) stated that if the taxon were accepted, it would key out near *P. lowreyana* Rock in their treatment of the genus, while Beccari & Rock (1921: 42), believe that it is most closely related to *P. affinis*.

Pritchardia limahuliensis H. St. John

The type was collected in Limahuli Valley, Kaua'i (St. John, 1988: 177). According to Gemmill (1998: 21) it differs from other Kaua'i species in its combination of a short inflorescence, barely equaling or just slightly longer or shorter than the petiole; leaf blades green, not densely silvery tomentose, ca 80 cm long; moderate habit up to 10 m tall, with a trunk DBH of ca. 12 cm; small crown with ca. 14 leaves; and ellipsoid fruit. This species is very rare and should be considered endangered.

Pritchardia perlmannii Gemmill

This new, endemic species of palm was described from Kaua'i by Gemmill (1998: 18). It is characterized by the combination of its slender trunk, 5–10 m tall; symmetrical crown with ca. 30 leaves; leaf blades ca. 105 cm long, lower surface glabrous to sparsely lepidote; inflorescence with two orders of branching; glabrous rachillae; and distinctively shaped obovoid to pyriform fruits. It presently is known only from Wai'oli Valley where it occurs primarily on the north-facing slopes and steep sidewalls of the valley at an elevational range of 420–850 m. An estimated total of 500 trees are in the valley occurring in populations ranging from 25–50 individuals. The species should be considered endangered.

Asteraceae***Adenostemma viscosum* J.R. Forst. & G. Forst. Taxonomic change & misidentification**

Following the taxonomy of King & Robinson (1987: 58), the taxon published in Wagner *et al.* (1990: 254) as *Adenostemma lavenia* (L.) Kuntze actually is *A. viscosum*.

***Delairea odorata* Lem.**

The placement of *Senecio mikanioides* Otto ex Walp. (Wagner *et al.*, 1990: 356) in the monotypic segregate genus, *Delairea*, has recently gained wide acceptance (Bremer, 1994: 500; Jeffrey, 1992: 83; Mabberley, 1997: 218; among others). We include this taxonomic concept in the supplement to the revised edition of the *Manual*.

***Dubautia kenwoodii* G.D. Carr**

Dubautia kenwoodii is one of the two new species of the genus described from Kaua'i in 1998 (Carr, 1998: 8). The taxon is known only from a single collection made on the steep slopes near the rim of Kalalau Valley, growing in a Diverse Lowland Mesic Forest community. It differs from other species of *Dubautia* in its combination of uniseriate, firmly coalescent bracts; cymose-glomerate capitula; and coriaceous, lustrous leaves with sharply cartilaginous-toothed margins and abruptly narrowed, broadly clasping bases.

***Dubautia syndetica* G.D. Carr & Lorence**

Dubautia syndetica is known only from the headwaters of the Wahiawa Stream, mostly on the slopes of the Wahiawa Mountains draining into the northern end of the Kanaele Swamp basin, 680–950 m, Kaua'i. The taxon occurs as scattered to locally abundant individuals along the banks of the upper reaches of the Wahiawa Stream, its tributaries, and the adjacent slopes of Kapalaoa (Carr & Lorence, 1998: 4). It differs from other species of *Dubautia* in its combination of uniseriate, somewhat coalescent bracts; coarsely glandular peduncles; glandular corolla tubes; and conspicuously strigose achenes. These features suggest a hybrid origin from *D. laxa* Hook. & Arn. subsp. *hirsuta* (Hillebr.) G.D. Carr and *D. raillardoides* Hillebr.

***Euchiton japonicus* (Thunb.) Anderb. New island record & earlier record**

Euchiton japonicus was reported as a new state record in 1997 (Wagner *et al.*, 1997: 54). The record was based upon a single collection from the Upper Waiākea Forest Reserve, Hawai'i Island, in 1983. Since the publication of that record two other specimens inadvertently omitted from that publication have been rediscovered: one is a new island record, the other an earlier record from the island of Hawai'i.

Material examined. MAUI: East Maui, Haleakalā National Park, Kīpahulu Valley, along Koukou, 10 Jul 1983, *Medeiros 462* (BISH). HAWAII: Mauna Loa, along Stainback Hwy, ca. 18 mi. above junction with Volcano Highway, ca. 5000 ft, disturbed roadside, 13 Aug 1974, *Herbst & Ishikawa 4069* (BISH).

Kalimeris indica* (L.) Sch.Bip. subsp. *indica

Boltonia indica (L.) Benth. is mentioned in passing by Wagner *et al.* (1990: 242) as having been reported as a garden escape on O'ahu but at that time was not believed to be fully naturalized. It was later reported to be naturalized on Kaua'i (Nagata, 1995: 11). A recent treatment of the genus *Kalimeris* by Gu & Hoch (1997:785) accepts *K. indica* as the correct name for this taxon.

***Leucanthemum vulgare* Lam.**

Modern studies of the Asteraceae tribe Anthemideae, which include the two species of *Chrysanthemum* treated by Wagner *et al.* (1990: 286), have shown that the genus *Chrysanthemum* is not monophyletic. Recently, a better understanding of the relationships between the genera within the tribe has been achieved, leading to revised generic concepts of the *Chrysanthemum* complex. *Chrysanthemum*, as applied in the historic concept of the genus used by Wagner *et al.* (1990) comprised more than 200 species, all but 3 of which have now been transferred to at least 14 other genera. Following the taxonomy of Bremer & Humphries (1993: 141) *Chrysanthemum leucanthemum* L. is now *Leucanthemum vulgare*.

***Tanacetum parthenium* (L.) Sch.Bip.**

According to the Bremer & Humphries (1993: 103) study mentioned in the preceding entry, *Tanacetum parthenium* is the correct name for the species treated as *Chrysanthemum parthenium* (L.) Bernh. by Wagner *et al.* (1990: 286).

Pseudelephantopus spicatus* (Juss. ex Aubl.) Vahl **Taxonomic change*

Following Clonts (1972), Wagner *et al.* (1990: 310) included *Pseudelephantopus* Rohr in *Elephantopus*. This delimitation has subsequently not been followed (e.g., Bremer, 1994: 233). We here return to the concept of *Pseudelephantopus* as a distinct genus, differing from *Elephantopus* in that its capitula are not densely held in tight glomerules, its subtending bracts are not specialized but are foliaceous, its clusters of capitula are arranged in long spikes, and at least some or all pappus bristles are bent or curled (Bremer, 1994: 232).

Balsaminaceae***Impatiens sodeni* Engl. & Warb. ex Engl.****Taxonomic change**

Following the taxonomy of Grey-Wilson (1980: 90), *I. oliveri* C.H. Wright ex W. Watson. (Wagner *et al.*, 1990: 380) is now considered a synonym of *I. sodeni*.

Boraginaceae***Heliotropium procumbens* Mill.****New island record**

var. *depressum* (Cham.) Fosberg

Documented as occurring in low elevation, dry sites on Midway Atoll, French Frigate Shoals, O'ahu, and Maui (Wagner *et al.*, 1990: 396), *Heliotropium procumbens* var. *depressum* is now also known from Kaua'i.

Material examined. **KAUAI:** Kawaihau District, Kapa'a Town, along Highway 56, vacant lot near Otsuka's Furniture with secondary vegetation, 5–10 m, 21 Feb 1995, *Lorence 7638*. (BISH).

Brassicaceae***Nasturtium microphyllum* Boenn. ex Rchb.**

Nasturtium, which is often reduced to synonymy of *Rorippa*, is recognized as a distinct genus by Al-Shebaz & Price (1998: 126), a status supported by chloroplast DNA studies. These new molecular results show that the aquatic species with hollow stems sometimes placed in *Nasturtium* are more closely related to *Cardamine* than *Rorippa*, where they are often placed. The name change from *Nasturtium microphyllum* to *Rorippa microphyllum* (Boenn. ex Rchb.) Hylander ex Love & Love reported in Wagner & Herbst (1995: 18) should now be changed back to *Nasturtium microphyllum*, the name originally used in the Manual (Wagner *et al.*, 1990: 411).

Cactaceae***Selenicereus macdonaldiae* (Hook.)**

Britton & Rose

Selenicereus grandiflorus (L.) was reported as a newly naturalized species by Lorence *et al.* (1995: 28). The plants in Hawai'i formerly called *S. grandiflorus* are misidentified specimens of *S. macdonaldiae*, the correct name for our taxon.

Misidentification**Campanulaceae**

In a series of papers, Lammers, alone or in collaboration with other botanists, published many changes to the treatment of the Campanulaceae in the *Manual* (Lammers, 1990). To call attention to these changes, they are listed below, with a brief statement of the change.

***Clermontia arborescens* (H. Mann) Hillebr. subsp. *wailoluensis* (H. St. John) Lammers**

Resurrected by Lammers (1991: 25) from synonymy of *C. arborescens* subsp. *wai-hiae* (Wawra) Lammers (Lammers, 1990: 427) and now recognized as a distinct subspecies.

***Clermontia grandiflora* Gaudich. subsp. *maxima* Lammers**

Known from a single collection made in a montane cloud forest at 1645 m on the windward slopes of Haleakalā, East Maui (Lammers, 1991: 77).

***Clermontia peleana* Rock subsp. *singuliflora* (Rock) Lammers**

Resurrected by Lammers (1991: 32) from synonymy of *C. peleana* (Lammers, 1990: 435) with a new status and combination.

***Cyanea calycina* (Cham.) Lammers**

Published as a subspecies of *C. lanceolata* in 1993 (Lammers *et al.*, 1993: 439), the taxon was later raised to the specific level (Lammers, 1998: 32).

***Cyanea cylindrocalyx* (Rock) Lammers**

Originally treated by Lammers as a subspecies of *C. grimesiana* Gaudich. (Lammers, 1990: 451), Lammers (1998: 31) now recognizes this taxon as a distinct species.

***Cyanea dolichopoda* Lammers & Lorence**

Known only from the "Blue Hole" area at the head of the north fork of the Wailua River, ca. 700 m in elevation (Lammers & Lorence, 1993: 432). Although collected in 1990 this species may have gone extinct after Hurricane 'Iniki.

Cyanea dunbariae* Rock*Orthographic correction**

The name of this taxon (Lammers, 1990: 448) should be spelled *C. dunbariae* as it was named in honor of a Mrs. L. M. Dunbar, who collected the type material.

***Cyanea eleeleensis* (H. St. John) Lammers**

Originally described by St. John (1987: 341) as *Delissea eleeleensis*, Lammers has transferred the taxon to the genus *Cyanea* (Lammers, 1992: 129).

***Cyanea habenata* (H. St. John) Lammers**

Originally described by St. John (1987: 342) as *Delissea habenata*, Lammers transferred the species to the genus *Cyanea* (Lammers, 1998: 33).

***Cyanea kahiliensis* (H. St. John) Lammers**

Originally described by St. John (1987: 343) as *Delissea kahiliensis*, Lammers transferred the species to the genus *Cyanea* (Lammers, 1998: 33).

***Cyanea kolekoleensis* (H. St. John) Lammers**

Originally described by St. John (1987: 344) as *Delissea kolekoleensis*, Lammers transferred the species to the genus *Cyanea* (Lammers, 1992: 130).

Cyanea kuhihewa Lammers

Known only from Limahuli Valley on northern Kaua'i where it is an element of the Lowland Wet Forest vegetation association at 520–580 ft elevation (Lammers, 1996: 238).

Cyanea mauiensis (Rock) Lammers

The name *C. grimesiana* var. *mauiensis* Rock was resurrected by Lammers (1998: 31) from synonymy of *C. grimesiana* Gaudich. subsp. *grimesiana* (Lammers, 1990: 451) and elevated to the specific rank.

Cyanea munroi (Hosaka) Lammers

The name *C. grimesiana* var. *munroi* Hosaka was resurrected by Lammers (1998: 31) from synonymy of *C. grimesiana* Gaudich. subsp. *grimesiana* (Lammers, 1990: 451) and recognized as a distinct species.

Cyanea remyi Rock

In a note, Lammers (1990: 466) stated that the holotype, and only known specimen of *C. remyi*, was too fragmentary to be able to identify. He tentatively referred it to *C. truncata* (Rock) Rock. The rediscovery of the plant from the “Blue Hole” on Kaua'i enabled him to determine that it was a distinct species (Lammers & Lorence, 1993: 432).

Cyanea

Phylogenetic analyses based on molecular data indicate that the genera *Cyanea* and *Rollandia* are monophyletic, and that the species of *Rollandia* are highly derived within the genus *Cyanea*. This has required the transferring of *Rollandia* species to the genus *Cyanea* (Lammers *et al.*, 1993). The taxonomic changes are listed below:

Cyanea calycina (Cham.) Lammers

Rollandia lanceolata Gaudich. subsp. *calycina* (Cham.) Lammers as treated by Lammers (1990: 483) is now a synonym of *Cyanea calycina* (Lammers, 1998: 32).

Cyanea crispa (Gaudich.) Lammers, Givnish, & Sytsma

Rollandia crispa Gaudich. as treated by Lammers (1990: 481) is a synonym of *Cyanea crispa* (Lammers *et al.*, 1993: 439).

Cyanea humboldtiana (Gaudich.) Lammers, Givnish, & Sytsma

Rollandia humboldtiana Gaudich. as treated by Lammers (1990: 483) is a synonym of *Cyanea humboldtiana* (Lammers *et al.*, 1993: 439).

Cyanea koolauensis Lammers, Givnish, & Sytsma

A new name for *Rollandia angustifolia* (Hillebr.) Rock because the name *C. angustifolia* was preoccupied in *Cyanea*.

Cyanea lanceolata (Gaudich.) Lammers, Givnish, & Sytsma

Rollandia lanceolata Gaudich. as treated by Lammers (1990: 483) is a synonym of *Cyanea lanceolata* (Lammers *et al.*, 1993: 439).

Cyanea longiflora (Wawra) Lammers, Givnish, & Sytsma

Rollandia longiflora Wawra as treated by Lammers (1990: 484) is a synonym of *Cyanea longiflora* (Lammers *et al.*, 1993: 439).

Cyanea parvifolia (C.N. Forbes) Lammers, Givnish, & Sytsma

Rollandia parvifolia C.N. Forbes as treated by Lammers (1990: 484) is a synonym of *Cyanea parvifolia* (Lammers *et al.*, 1993: 439).

Cyanea purpurellifolia (Rock) Lammers, Givnish, & Sytsma

Rollandia purpurellifolia Rock as treated by Lammers (1990: 484) is a synonym of *Cyanea purpurellifolia* (Lammers *et al.*, 1993: 439).

Cyanea st.-johnii (Hosaka) Lammers, Givnish, & Sytsma

Rollandia st.-johnii Hosaka as treated by Lammers (1990: 484) is a synonym of *Cyanea st.-johnii* (Lammers *et al.*, 1993: 440).

Cyanea sessilifolia (O. Deg.) Lammers

Resurrected by Lammers (1998: 32) from synonymy of *Rollandia longiflora* Wawra (Lammers, 1990: 484) and transferred to the genus *Cyanea*.

Delissea lanaiensis (Rock) Lammers

A taxonomic change elevating *D. sinuata* subsp. *lanaiensis* (Rock) Lammers (Lammers, 1990: 471) to the specific level (Lammers, 1998: 34).

Caryophyllaceae

Schiedea globosa H. Mann

New island record

The following collection represents a first record of this widespread species on the island of Hawai'i. It was previously known from steep, north-facing rocky slopes or cliffs in coastal habitats, 0–300 m, southeastern O'ahu, the north and northwest coasts of Moloka'i, and the north coasts of East and West Maui (Wagner *et al.*, 1990: 512).

Material examined. HAWAII: Kohala Mountains, Waipi'o Valley, sea cliffs, E of valley along coast, one plant, 6 Dec 1995, *Perlman & Wood 15191* (PTBG, US).

Schiedea hawaiiensis Hillebr.

Resurrection

TYPE: HAWAIIAN ISLANDS. HAWAII: Waimea, *Lydgate s.n.* No original material located so we here designate a neotype. TYPE: HAWAIIAN ISLANDS. HAWAII: Pohakuloa Training Area, west side along MPRC access rd. at power pole #402, *Metrosideros* forest with *Zanthoxylum hawaiiense*, *Dodonaea*, and *Tetramolopium consanguineum*, 1,200 yr old pahoehoe lava, 1,640 m, 3 Dec 1996, *Gon & Tierney s.n.* (neotype, US 335666!, here designated).

This species was included in the synonymy of *Schiedea diffusa* by Wagner *et al.*, (1990: 511). The only collection, which was from near Waimea, Hawai'i, and deposited in Berlin, apparently was destroyed during World War II. Despite a few discrepancies between the descriptions of *S. diffusa* and *S. hawaiiensis*, notably the habit, leaf shape, inflorescence, and seed surface morphology, we included it with *S. diffusa*. As we had no material to examine, and as the only species of the genus known from the island of Hawai'i was *S. diffusa*, we assumed that Hillebrand's description was inaccurate. When Wagner and Weller examined the 1996 Pohakuloa Training Area collection, it was thought to represent a new island record for *S. pubescens* Hillebr., albeit a depauperate one. Seeds from this collection were grown in the University of California, Irvine, as part of the ongoing monographic, evolutionary, and ecological studies of *Alsiniidendron* and *Schiedea* by A.K. Sakai, W.L. Wagner, and S.G. Weller. When the first few sets of leaves appeared, it was clear that the collection did not represent *S. pubescens*. The plants had narrower leaves and the habit was more erect. The plants also grew much more quickly to the flowering stage, unlike *S. pubescens* which typically grows vegetatively for a long period before flowering. When the plants flowered they fit Hillebrand's original description of *S. hawaiiensis* exactly. We here use the new collection as the neotype for the species. The following is an emended description based upon Hillebrand's description augmented by the results of the recent studies of the wild collection and its cultivated offspring.

Perennial herbs or shrubs, pale yellowish green throughout or stems purple-tinged in lower portion of the plant (at least in cultivation); stems 3–7 dm long or perhaps longer, ascending to sprawling when longer, conspicuously compressed-quadrangular, the angles weakly winged, glabrous throughout, except sparsely puberulent at the base of the internodes of the inflorescence and on

the margins and adaxial surface of bracts and sepals. Leaves opposite, the blades thinly coriaceous, 4–5.8 cm long, 1.7–2.8 cm wide, ovate to elliptic-ovate, with only the midvein evident, the midvein slightly eccentric, purple on lower leaves, margin very slightly thickened, apex acuminate to acute, base acute to obtuse, petioles 0.5–0.7 cm long, the base often slightly flared at juncture with stem and the leaf pair slightly connate. Flowers perfect, in dichasia and upper lateral branches forming an open, panicle-like inflorescence 30–40 cm long, the branches 8–20 cm long, spreading, each branch with 5–12 flowers, sparsely puberulent with hairs 0.3–0.5 mm long at the base of the internodes of the inflorescence; bracts yellowish green, foliaceous, the lower ones foliaceous and nearly as large as the leaves, those in the upper part of the inflorescence and subtending the flower narrowly subulate, 3–5 mm long, ciliate and puberulent on the adaxial surface with hairs 0.1–0.2 mm long; pedicels 4–10 mm long at anthesis, elongating slightly in fruit, conspicuously asymmetrically flattened. Sepals 3–4 mm long, lanceolate, dull yellowish green, purple tinged, opaque, concave to shallowly navicular toward the apex, oriented at 90° to the pedicel at base, then abruptly curved upward at 130°–160° angle to the pedicel, often strongly inrolled late and post anthesis, abaxially smooth and rounded, glabrous, adaxially moderately puberulent with hairs 0.1–0.2 mm long, margins weakly scarios, ciliate, apex attenuate. Nectary base 0.7 mm long, broadened and flattened at base, dark yellow, the nectary shaft 1.8–2 mm long, apex deeply bifid. Stamens 10; filaments weakly dimorphic; anthers attached near the middle, subequal, yellow. Styles 3–4, the stigmatic area extending nearly the full length of the style. Capsules broadly ovoid, 3.5–4 mm long. Seeds 0.9–1 mm long, suborbicular, asymmetrical, compressed brown, margin tuberculate.

Flowers of greenhouse-grown plants of *S. hawaiiensis* often produce teratological forms such as styles arising from anthers, extra nectaries and stamens, completely divided nectary shafts, atypically formed nectaries, and an extra small ovary with a single style growing laterally from the base of the main ovary. These may reflect genetic abnormalities resulting from an extreme level of autogamy in the only known individual of this apparently outcrossing species.

Chenopodiaceae

Salsola tragus L.

New island record

The following collection documents a new island record of this species from Kaho'olawe. It previously was known only from near Waimea and the Pohakuloa Training Area on the island of Hawai'i.

Material examined. **KAHO'OLAWA:** S.E. quadrant, slightly south of Beck's Cove, 243.8 m, 24 Apr 1989, *Aschmann s.n.* (BISH 634258, 634259); S.W. extremities of a hard pan area, 18 Apr 1990, *Aschmann s.n.* (BISH 634257).

Cyperaceae

Carex inversa R. Br.

Shaw & Douglas (1995) recently reported the discovery of *Carex inversa* in the Pohakuloa Training Area on the island of Hawai'i. They report the taxon as new to Hawai'i and the United States. We have not seen the specimens.

Cyperus

Taxonomic change

The majority of recent botanists specializing in *Cyperus* and Cyperaceae no longer recognize the subgenera of *Cyperus*, except for *Kyllinga*, at the generic rank (Tucker, 1994). Strong & Wagner (1997: 39) elected to follow the broad circumscription of the genus to include the subgenus *Mariscus* in their discussions of the Hawaiian members of that subgenus; the 3 taxa listed below also must be included in this change in taxonomic concepts.

Cyperus odoratus L.

Torulium odoratum (L.) S.S. Hooper in Wagner *et al.* (1990: 1434) should now be considered in the genus *Cyperus* (Tucker, 1994: 180).

Cyperus polystachyos Rottb.

Following the taxonomic treatment of Tucker (1994: 72), the sedge treated as *Pycrus polystachyos* (Rottb.) P. Beauv. by Wagner *et al.* (1990: 1425) should now be included in the genus *Cyperus*. Also the infraspecific taxa previously recognized do not seem to warrant recognition but rather represent genetic variation that occurs widely within this variable taxon.

Cyperus sanguinolentus Vahl**Taxonomic change**

The genus *Cyperus* as recently circumscribed by specialists necessitates the inclusion of the species treated by Wagner *et al.* (1990: 1426) as *Pycrus sanguinolentus* (Vahl) Nees here.

Eriocaulaceae*Eriocaulon scariosum* Sm.**Identification**

An unidentified species of *Eriocaulon* (sp. A) was reported from the island of Hawai'i by Wagner *et al.* (1990: 1440). It has been identified as *Eriocaulon scariosum* by S. Phillips (pers. comm., 1998).

Euphorbiaceae*Aleurites moluccana* (L.) Willd.**Correction**

var. *katoi* O. Deg., I Deg. & B.C. Stone

Aleurites moluccana var. *katoi*, included in synonymy under *A. moluccana* by Wagner *et al.* (1990: 598) has an incorrect authority citation. The authors are O. Deg., I. Deg., & B.C. Stone.

Chamaesyce eleanoriae Lorence & W.L. Wagner

Known only from the Nā Pali coast at elevations of 270–1100 m, northern Kaua'i (Lorence & Wagner, 1996: 68). It is the only Hawaiian species of the genus to consistently have white-glandular cyathial appendages. Apparently it is restricted to cliff habitats, steep ridge tops, and steep rocky slopes in wind-swept areas; it appears to be relatively rare and is vulnerable to decline if the impact of feral goats continues at the present pace.

Phyllanthus distichus Hook. & Arn.

Govaerts & Radcliffe-Smith (1996: 176) made two new combinations in the native species of *Phyllanthus*: *P. distichus* var. *degeneri* (Sherff) Govaerts & Radcl.-Sm. and var. *ellipticus* (Muell. Arg.) Govaerts & Radcl.-Sm. We do not recognize these new combinations; they were published without a critical review of the taxonomy of this Hawaiian species.

Fabaceae*Desmodium heterophyllum* (Willd.) DC.**New island record**

The following collection documents a new island record for this naturalized legume. *Desmodium heterophyllum* was previously reported from the islands of Moloka'i and East Maui (Wagner & Herbst, 1995: 20).

Material examined. **HAWAII:** Hamakua District, Kapulena, common along cane road paralleling the Lower Hamakua Ditch, 1000 ft, 12 Jul 1996, *Herbst 9791* (BISH).

***Indigofera hendecaphylla* Jacq.**

Du Puy *et al.* (1993) concluded that *Indigofera spicata* Forssk., sensu lato, comprised two separate species: *I. spicata*, restricted to Africa, Yemen, Madagascar, and the Mascarenes; and *I. hendecaphylla*, which is widely distributed throughout the Old World tropics and subtropics to the Pacific Islands. Following the species concept of Du Puy *et al.*, the plant treated as *I. spicata* by Wagner *et al.* (1990: 675), is *I. hendecaphylla*.

***Kanaloa kahoowawensis* Lorence & K.R. Wood**

Known only from two plants on 'Ale'ale stack on the south coast of Kaho'olawe Island (Lorence & Wood, 1994: 137–45), this unique mimosoid legume apparently was relatively common, at least on leeward O'ahu, in the Pleistocene. Lorence & Wood believe the affinities of the Hawaiian endemic to be with the *Leucaena* and *Dichrostachys* groups of the Mimoseae tribe from which it differs in its tergeminate leaves, monospermous fruits inertly dehiscent along two sutures with the valves separating into inner and outer envelopes, and large cordiform seeds. Hughes (1998) in a morphological phylogenetic analysis showed *Kanaloa* to be an isolated sister clade to one consisting of *Cal-liandropsis*, *Alantsilodendron*, *Dichrostachys*, *Gagnebina*, *Leucaena*, *Schleinitzia*, *Desmanthus*, and *Neptunia*. The two clades are in turn a sister clade to *Xylinia* and *Parkia*.

***Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S.M. Almeida**

Following the taxonomy of Wiersema *et al.* (1990: 430), the plant treated by Wagner *et al.* (1990: 693) as *P. lobata* (Willd.) Ohwi is now considered a variety of *P. montana*.

Flacourtiaceae

***Xylosma hawaiiense* Seem.**

Govaerts & Radcliffe-Smith (1996: 175) published a new name, *Drypetes sherffii* Govaerts & Radcl.-Sm. to replace *D. forbesii* Sherff, a name previously used by Pax & Hoffmann. This new name was published without a critical review of names in the Hawaiian Euphorbiaceae. *Drypetes forbesii* is a later homonym for this species of Flacourtiaceae.

Geraniaceae

***Geranium hillebrandii* Aedo & Muñoz Garm.**

Aedo & Muñoz Garmendia (1997: 725) discovered that the binomial *Geranium humile* applied to a Hawaiian endemic species in the genus had previously been used by Cavanilles. This requires that a new epithet be selected for the Hawaiian taxon. The authors chose the new name to commemorate W. Hillebrand, who originally described *G. humile* and who authored the *Flora of the Hawaiian Islands*.

Gesneriaceae

***Cyrtandra munroi* H. St. John**

Cyrtandra imparis H. St. John

Cyrtandra acmule H. St. John

Cyrtandra imparis H. St. John, *Phytologia* 63: 489. 1987. **Syn. nov.** TYPE: HAWAIIAN

ISLANDS. MAUI: West Maui, south branch of Makamaka 'ole Stream, 1000 ft, 28 Nov 1950, W. H.

New island record

New synonymy

New synonymy

Hatheway 457 (BISH 520421!, HOLOTYPE;). Another sheet of *Hatheway 457* (BISH 520422), in which the inflorescence is at an earlier stage of maturation than the holotype, is annotated in pencil with an "A" directly after the collection number. St. John designated this sheet as an isotype of *C. imparis* and returned it to BISH with the holotype of that species. It was noted subsequently by Wagner that the missing type of *C. acmule* was the sheet St. John had so annotated and had designated as an isotype of *C. imparis*.

Cyrtandra acmule H. St. John, *Phytologia* 63: 487. 1987. **Syn. nov.** TYPE: HAWAIIAN ISLANDS. MAUI: West Maui, south branch of Makamaka'ole Stream, 1000 ft, 28 Nov 1950, W. H. *Hatheway 457A* (BISH 520422!, HOLOTYPE). Apparently St. John intended his epithet to be spelled "aemule." The letter "A" was appended in pencil directly after the collection number, apparently by St. John, to a second sheet of *Hatheway 457*, as discussed above.

The types of *Cyrtandra imparis*, *C. acmule*, and one additional collection represent previously unknown localities for *C. munroi* on West Maui, none of which were reported by Wagner *et al.* (1990: 1196). The West Maui specimens differ slightly from Lāna'i plants primarily in that the leaves are larger (up to 30 cm long and 13 cm wide) and less pubescent. *Cyrtandra munroi* is known from scattered collections in low elevation rain forest, probably about 910–920 m, on the west and east sides of Lāna'ihale above Waiopa'a, Lāna'i, from the south branch of Makamaka'ole Stream at about 300 m, and Kahana Valley.

Additional material examined. MAUI: West Maui, Makamaka'ole Gulch, 1200 ft, common in area, 11 Apr 1971, *Bishop et al. 047127* (BISH); Pu'u Kukui Watershed, S wall of Kahana Valley, on steep slope just below the ridge line, 695 m, 17 Jun 1997, *Oppenheimer 204* (US); Wailuku District; Makamaka'ole Gulch; east fork along pipeline trail; above Camp Maluhia, ca. 100 plants, 27 May 1992, K. R. Wood *et al.* 1937 (PTBG).

***Cyrtandra biserrata* Hillebr.**

Cyrtandra higashinoi H. St. John

Cyrtandra ustulata H. St. John

Cyrtandra hemisphaerica H. St. John

Cyrtandra higashinoi H. St. John, *Phytologia* 63: 479. 1987. **Syn. nov.** TYPE: HAWAIIAN ISLANDS. MAUI: East Maui, Kahikinui, Manawainui, U.S. Fish & Wildlife Service Forest Bird Survey Transect 25, Station 19, 5960 ft, 20 Jun 1980, P. K. Higashino & R. A. Holt 9226 (BISH 520519! and a portion in spirit collection, HOLOTYPE; BISH! 2 sheets, ISOTYPES).

Cyrtandra ustulata H. St. John, *Phytologia* 63: 483. 1987, non H. St. John, *Phytologia* 63: 493. 1987. **Syn. nov.** *Cyrtandra hemisphaerica* H. St. John, *Phytologia* 65: 200. 1988. **Syn. nov.** TYPE: HAWAIIAN ISLANDS. MAUI: East Maui, Kahikinui Forest Reserve, Wailaulau Gulch, 5350 ft, A. C. Medeiros 234 (BISH 520719!, HOLOTYPE).

Additional specimen examined: MAUI: Kahikinui, Wailaulau drainage, common in remnant pockets of native vegetation on S slope, 4,000 ft, 12 Dec 1985, *Hobdy 2460* (BISH).

St. John described several new species of *Cyrtandra* in a series of papers cited by Wagner *et al.* (1990: 739); these publications have since been evaluated. Some, like the following, represent new distributional records. The types of two of these names, *C. ustulata* and *C. higashinoi*, and one additional collection represent a range extension of a Moloka'i species to Maui. The type of *C. ustulata* appears to represent a high elevation form of *C. biserrata* and differs from other collections of this species in its somewhat more coriaceous leaves and conspicuously smaller leaf serrations. The type locality for *C. higashinoi* is slightly more than 2 km east; this form of *C. biserrata* is morphologically very similar to the Moloka'i populations but has slightly smaller leaf serrations. A third collection of *C. biserrata*, also from the Wailaulau drainage area but at 1220 m, is similar

New island record

New synonymy

New synonymy

New synonymy

in that it also has only slightly smaller serrations than the Moloka'i populations. Further exploration of the East Maui locations is needed in order to evaluate the situation. *Cyrtandra biserrata* apparently is rare and local in montane rain forest, 760–1160 m. It presently is believed to be restricted to a small area of eastern Moloka'i including Wailau, Puko'o, and Mapulehu Valleys and Oloku'i; but also is known from three collections from East Maui, the Kahikinui Forest Reserve and Wailaulau and Manawainui Gulches.

Liliaceae

Hippeastrum striatum (Lam.) H.E. Moore **Misidentification**

The specimens in the Bishop Museum herbarium which were reported as *H. puniceum* (Lam.) Vahl by Wagner *et al.* (1990: 1463) were incorrectly identified. The museum specimens have been annotated *H. striatum* by Alan Meerow.

Loganiaceae

Labordia triflora Hillebr.

Labordia triflora was resurrected by Motley (1995: 221) based upon additional information obtained from a recently discovered small population of the species. Before its rediscovery, only the type was available for study, and it was surmised that that collection may have represented an anomalous specimen of *Labordia tinifolia* var. *lanaiensis* Sherff (Wagner *et al.*, 1990: 861).

Lythraceae

Ammannia coccinea Rottb. **Misidentification**

Wagner *et al.* (1990: 865) included two species of *Ammannia* in their treatment of the genus in Hawai'i. *Ammannia auriculata* Willd. does not occur in Hawai'i; specimens formerly identified as that species were incorrectly identified specimens of *A. coccinea* (S. Graham, pers. comm., 1996).

Lythrum maritimum Kunth

Correction

This species was once considered to be indigenous to the Hawaiian Islands (Wagner *et al.*, 1990: 868). It is now believed to be an early introduction to the state (S. Graham, pers. comm., 1996).

Malvaceae

Hibiscadelphus woodii Lorence & W. L. Wagner

Known from a population of four trees on the rim of Kalalau Valley, north of Kahuama'a Flat, 1020 m, Kaua'i (Lorence & Wagner, 1995: 183), this highly endangered species differs from others in the genus by its glabrate leaves, except for rare stellate trichomes adaxially, and sparse stellate trichomes on the veins and in the principal vein axils abaxially; its stellate trichomes on the calyx, with rays free to the base; and its yellow corollas with a coppery tinge, rapidly becoming purplish maroon with age.

Hibiscus brackenridgei A. Gray subsp. *molokaiana* (Rock ex Caum) F.D. Wilson

Hibiscus brackenridgei subsp. *molokaiana* was resurrected from the synonymy of *H. brackenridgei* subsp. *brackenridgei* (Wagner *et al.*, 1990: 883) and raised from the varietal to subspecific rank (Wilson, 1993: 278).

Meliaceae***Toona ciliata* Roem.**

In their treatment of *Toona ciliata*, Wagner *et al.* (1990: 920) stated that the plants naturalized in Hawai'i could be referred to variety *australis* because of their glabrous leaflets. According to Edmonds (1995: 366), the species of this genus exhibit a wide range of genetic variation and many of the morphological features used by earlier workers, including leaf indumentum types and density, merely represent slight morphological variants and should not be formally recognized as taxa.

Myrtaceae

In their studies of the bloodwood eucalypts, Hill & Johnson (1995) completed extensive field observations on nearly all of the species throughout their natural range, analyzed new phylogenetic information, and re-evaluated previous cladistic studies in the *Eucalyptus*. Their studies led them to conclude that the bloodwoods should be maintained as a separate genus which they named *Corymbia*. The taxonomic changes concerning the species which have become naturalized in Hawaiian are as follows:

***Corymbia calophylla* (Lindl.) K.D. Hill & L.A.S. Johnson**

Eucalyptus calophylla R. Br. as treated in Chippendale (1990: 951) is now considered a synonym of *Corymbia calophylla* (Hill & Johnson, 1995: 249).

***Corymbia citriodora* (Hook.) K.D. Hill & L.A.S. Johnson**

Eucalyptus citriodora Hook. as treated by Chippendale (1990: 952) is a synonym of *Corymbia citriodora* (Hill & Johnson, 1995: 388).

***Corymbia ficifolia* (F. Muell.) K.D. Hill & L.A.S. Johnson**

Eucalyptus ficifolia F. Muell. as treated in Chippendale (1990: 953) is a synonym of *Corymbia ficifolia* (Hill & Johnson, 1995: 245).

***Corymbia gummifera* (Gaertn.) K.D. Hill & L.A.S. Johnson**

Eucalyptus gummifera (Gaertn.) Hochr. as treated by Chippendale (1990: 956) is a synonym of *Corymbia gummifera* (Hill & Johnson, 1995: 233).

Nyctaginaceae***Boerhavia acutifolia* (Choisy) J.W. Moore****Taxonomic change**

According to the late F.R. Fosberg (pers. comm., 1990), the species he treated as *B. glabrata* in Fosberg (1990: 978) is *B. acutifolia*. He had tentatively included *B. acutifolia* in his 1990 treatment as a synonym of *B. glabrata* without having seen the type of *B. glabrata*. After seeing the type at L he concluded that the two were distinct species.

Oleaceae***Olea europaea* L. subsp. *cuspidata* (Wall. ex G. Don) Ciferri**

Following the taxonomy reported by Green (1994: 328) and his annotations of specimens at BISH, the species treated by Wagner *et al.* (1990: 992) as *Olea europaea* L. subsp. *africana* (Mill.) P. Green is more correctly called *Olea europaea* subsp. *cuspidata*, an older name.

Orchidaceae***Habenaria rodeiensis* Barb. Rodr.****Identification**

A single collection of an orchid naturalized in a pasture in Kula, Maui (Wagner *et al.*, 1990: 1468), has been identified by E.A. Christenson as *H. rodeiensis*, a species native to South America.

Oxalidaceae***Oxalis debilis* Kunth**

The taxon treated as *Oxalis corymbosa* DC. by Wagner *et al.* (1990: 1002) is now considered a synonym of *Oxalis debilis* (Mabberley, 1997: 516).

Piperaceae***Peperomia blanda* Kunth var. *floribunda* (Miq.) H. Huber**

This widespread lowland species, long known in Hawai'i as *Peperomia leptostachya* Hook. & Arn. (Wagner *et al.*, 1990: 1029) was recently placed in synonymy by Huber (1987: 294) under *Peperomia blanda* var. *floribunda*. This new combination has also been taken up by Fosberg (1992: 181), Florence (1997: 173), and Welsh (1998: 214).

Poaceae***Bromus madritensis* L.****New naturalized record**

Included in a note by O'Connor (1990: 1505), *Bromus madritensis* is here treated as a naturalized species. The following collections document its presence on three islands of Hawai'i. It is native to Europe, the Mediterranean, and western Asian areas, but has been widely introduced elsewhere. Keys in Herbst & Clayton (1998) include the grasses, such as this species, that were mentioned but not accepted as naturalized by O'Connor (1990), and can be used for their identification.

Material examined. **MOLOKA'I:** Settlement Trail, 29 Mar 1915, *Forbes 650.Mo.*(BISH). **MAUI:** growing along roadside above Makawao, Apr 1979, *Hobdy 489* (BISH). **HAWAII'I:** in meadow south of Kīlauea near Kīpuka Nēnē, locally frequent, 2600 ft, 22 Mar 1945, *Fagerlund & Mitchell 1011* (BISH).

Bromus rubens* L.*New naturalized record**

This species also was included only in a note by O'Connor (1990: 1507), but we here accept it as a naturalized species. It also is native to Europe, the Mediterranean, and western Asian areas.

Material examined. **MOLOKA'I:** Mauna Loa, Pu'u Nana, occasional in pasture, 1300 ft, 16 Apr 1937, *Hosaka 1845* (BISH); Kala'e, rare in pasture, 1400 ft, 17 Apr 1937, *Hosaka 1853* (BISH). **HAWAII'I:** South Kohala, Waiki'i, 6000 ft, 16 May 1940, *Hosaka 2521* (BISH); Hawaii Volcanoes National Park, Kīpuka Nēnē, 3000 ft, 15 Aug 1966, *Herbst 271* (BISH).

Chloris truncata* R. Br.*New naturalized record**

The presence of *Chloris truncata* in Hawai'i was mentioned in a note by O'Connor (1990: 1513). We believe that it should be considered as naturalized in Hawai'i. The following collections document it from O'ahu and Kaho'olawe; it also has been reported from Maui (Whitney *et al.*, 1939: 41). It is native to Australia.

Material examined. **O'AHU:** Punchbowl, 24 Mar 1904, *Smith s.n.* (BISH 118369); Honolulu, Fort Shafter, 23 Jun 1916, *Hitchcock 13849* (BISH); Grown by U.S. Experiment Station, n.d., *McClellan s.n.* (BISH 118367). **KAHO'OLAWA:** eastern central part of island, slope of Moa'ula, 1300 ft, 25 Apr 1980, *Cuddihy & Char 425* (BISH); eastern central part of island, slope of Moa'ula, 1300 ft, 25 Apr 1980, *Cuddihy & Char 430* (BISH).

Cynodon nlemfuensis* Vanderyst*New naturalized record**

Cynodon nlemfuensis was included as a note in O'Connor's treatment of the genus (1990: 1520) stating that it was an adventive at least on Moloka'i and Hawai'i. Although

not common, it should be considered as naturalized in Hawai'i. A key in Herbst & Clayton (1998: 22) can be used to assist in its identification. It is an African species.

Material examined. **MOLOKA'I:** Kaunakakai, near beach, 20 ft, 11 Nov 1974, *Herbst & Spence 5096* (BISH). **HAWAI'I:** Hawai'i, 29 Jan 1963, *Shipman s.n.* (BISH 118468).

***Digitaria horizontalis* Willd.**

New naturalized record

Digitaria horizontalis has been collected once on O'ahu, in an abandoned pineapple field where it was common. O'Connor (1990: 1530) reported the species from Lāna'i based upon a collection by Sakimura in 1944. This specimen could not be located. *Digitaria horizontalis* is native to tropical regions of North and South America.

Material examined. **O'AHU:** Waipi'o, forming extensive mats in abandoned pineapple fields, 650 ft, 8 Nov 1967, *Herbst 696* (BISH).

***Ehrharta calycina* Smith**

New state record

A collection made in 1997 is the second known collection of this species from Hawai'i, the first being from a trial grass plot at the Haleakalā Branch of the Hawaii Agricultural Experimental Station at Makawao, Maui (*Hosaka, 2444*). The collection is from a small, but definitely naturalized, population growing intermixed with the endemic *Eragrostis atropioides* and several naturalized grasses such as *Bromus catharticus* and *Pennisetum setaceum*. It is native to South Africa but has become naturalized in other parts of the world. A key, given below, can assist in differentiating the three species of *Ehrharta* naturalized in Hawai'i.

Material examined. **MAUI:** Haleakalā Branch Station, Makawao, 9 Apr 1939, *Hosaka 2444* (BISH). **HAWAI'I:** North Kona District, Pohakuloa Training Area, Pu'u Ke'ek'e'e, 5600 ft, growing with *Eragrostis atropioides* and several other species of naturalized grasses in a bowl on the western side of the cinder cone, 1 Dec 1997, *Herbst 9843* (BISH).

KEY TO THE SPECIES OF *EHRHARTA* IN THE HAWAIIAN ISLANDS:

1. Callus hairy, palea almost as long as the fertile lemma, finely 2-nerved, spikelets in narrow panicles or racemes *E. stipoides*
1. Callus without hairs, palea shorter than fertile lemma, 1-nerved, spikelets in open panicle or raceme (2)
- 2(1). Sterile lemmas with long hairs on sides, keel, or margin, acute or mucronate, spikelets 4–8 mm long *E. calycina*
2. Sterile lemmas glabrous or strongly scabrous, occasionally with tuft of hair at the base, awnless, spikelets 3–5 mm long *E. erecta*

***Eragrostis ciliaris* (L.) R. Br.**

New naturalized record

Based upon the specimens examined below, *Eragrostis ciliaris* (O'Connor, 1990: 1537) should be considered a naturalized species in Hawai'i. It is widespread in tropical parts of the world.

Material examined. **O'AHU:** Barbers Point, roadside weed in limestone quarry, 5 ft, 9 Jun 1976, *Herbst 5872* (BISH); Kahaka'aulana I, Ke'ehi Lagoon, 30 Apr 1978, *Herbst & Walker 6090* (BISH).

***Eragrostis uniolooides* (Retz.) Nees ex Steud.**

New naturalized record

Mentioned by O'Connor (1990: 1538) as an adventive on Hawai'i Island, *Eragrostis uniolooides* is here considered a naturalized species. It is native to tropical Asia.

Material examined. **HAWAI'I:** Pepe'ekeo, along plantation road next to Kawaiinui Gulch, 14 May 1958, *Kawasaki, s.n.* (BISH 118925); Kaumana Substation, disturbed vegetation on 1881 lava

flow, 320 m, 16 Nov 1982, *Wagner & Stemmermann 4634* (BISH); Hilo Airport, 11 Nov 1986, *Stemmermann 7128* (BISH); Puna District, along highway southeast of Lava Tree State Monument ca. 1 mile past junction of road to Kapoho, 200 m, 13 Mar 1988, *Wagner et al. 5969* (BISH).

***Glyceria fluitans* (L.) R. Br.**

New naturalized record

Three collections have been made of this species: one on East Maui in 1916, and two on Hawai'i in 1951 and 1953; the present status of the species in the Hawaiian islands is unknown. Though not treated as such by O'Connor (1990: 1482), it appears to have been at least sparingly naturalized on two islands.

Material examined. MAUI: East Maui, Haleakalā crater, open bog in crater, 6000–10000 ft, 2–5 Oct 1916, *Hitchcock 14996* (US). HAWAII: North Kohala, Kahua, rare in moist pasture, 3700 ft, 15 Aug 1951, *Hosaka 3646* (US); same locality, 9 Jun 1953, *Hosaka 3694* (US).

***Hackelochloa granularis* (L.) Kuntze**

New naturalized record

A single collection of this species was made in 1941, on the island of Hawai'i (O'Connor (1990: 1483). Though not treated as such by O'Connor (1990), the collection appears to represent a naturalized population of this pantropical species. Its present status is unknown.

Material examined. HAWAII: Wai'ohinu, Ka'ū, in pasture, rare, 22 Aug 1941, *Hayselden s.n.* (US).

***Hordeum vulgare* L.**

New naturalized record

Although there may be some question as to whether this species should be considered an escape, as O'Connor (1990: 1552) reported it, because it usually is cultivated and is short-lived outside of cultivation. We have included it here as a naturalized species. This is the cultivated barley of temperate areas.

Material examined. KAUA'I: Kumuwela Ridge, Waimea Canyon, dry open slope, 1100 ft, 28 Dec 1935, *V.O. Fosberg 17* (BISH). O'AHU: Waimānalo, edge of cane field, 100 ft, 24 Mar 1927, *Leelman 306* (BISH); Wai'anae Mountains, Mokule'ia, Peacock Flats, Piko Trail, dry, open brushy country, 460 m, 4 Dec 1936, *Fosberg 13047* (BISH). MAUI: East Maui, 'Ulupalakua, occasional in open pasture, 8 Apr 1937, *Hosaka 1785* (BISH); East Maui, Waiakoa, Dr. C.M. Cooke's place, rare, 2800 ft, 13 Apr 1937, *Hosaka 1826* (BISH). HAWAII: Parker Ranch, Pu'u Papapa, volunteer in plowed field, 3000 ft, 16 June 1932, *Ewart 252* (BISH); South Kohala, Waiki'i, abundant in pasture, 4000 ft, 7 Sep 1936, *Hosaka 1583* (BISH); Volcano, end of 'I'iwi Road, Kokubon farm, planted as green manure, 4000 ft, 7 May 1984, *Higashino 10330* (BISH).

***Ixophorus unisetus* (K. Presl) Schltld.**

The following collections document the presence of *Ixophorus unisetus* on three islands in Hawai'i. It appears that the species was first grown in experimental plots at the agricultural experimental station in Honolulu, and later grown experimentally in test fields or pastures on Kaua'i and Lāna'i; the Mānoa specimens may represent collections of a sparingly naturalized species. The present status of this species is unknown, but, as grasses are not well collected in Hawai'i, there remains the possibility that it may still be extant on one or more of the islands on which it once grew. It is included here, along with several other poorly known grasses, to alert the botanical community; and to call attention to the note concerning it in O'Connor (1990: 1483). The species is native to Mexico.

Material examined. KAUA'I: Kekaha, Field J, 5 Sep 1941, *Caum s.n.*, (BISH 119543, 119544). O'AHU: Honolulu, experimental station, 19 Sep 1927, *Cooke 7* (BISH); Honolulu, King Street, campus of Kamehameha Schools, cult. for forage, 26 Jan 1928, *Brown 1471* (BISH); Honolulu, Mānoa

Valley, 27 Dec 1942, *Krauss s.n.* (BISH 119548); Honolulu, Mānoa Valley, 11 Jan 1943, *Krauss 7* (BISH). **LĀNA'I:** Ko'ēle, introduced grass, seed from experimental station, Honolulu, no date, *no name 708* (BISH 119542); seed furnished by U.S. Experimental Station, no date, *Munro 532* (BISH).

***Lolium temulentum* L.**

New naturalized record

Although there are no recent collections of this species in the Bishop Museum herbarium and its present status is unknown, we have included it here as naturalized in Hawai'i. This will serve to call attention to the species as it very likely is still extant as a pasture grass in Hawai'i. It is native to the Mediterranean and SW Asia. The following key will aid in distinguishing the species of the genus present in Hawai'i.

KEY TO THE SPECIES OF *LOLIUM* IN THE HAWAIIAN ISLANDS:

1. Upper glume reaching or exceeding the uppermost lemma; florets elliptic to ovate, turgid *L. temulentum*
1. Upper glume much shorter than the rest of the spikelet; florets oblong or lanceolate-oblong, not turgid (2).
- 2(1). Lemma awned; annual *L. multiflorum*
2. Lemma awnless; perennial *L. perenne*

Material examined. **O'AHU:** without locality, Apr 1925, *Lee 276* (BISH); Wai'ālae, Hind Clarke Dairy, sea level, 17 May 1926, *Haddon 289* (BISH); Nanakuli, at top of cliffs near Nanakuli, 16 Feb 1936, *Whitney 4053* (BISH). (Two other sheets are in the Bishop Museum, one with no label information; the other by an unknown collector in 1913 on either Maui or Hawai'i Island.)

***Paspalum distichum* L.**

New state record

This species is very similar to *P. vaginatum* Sw. and is considered by some as conspecific with it. In this treatment, *P. distichum* is considered a distinct species. It is widespread throughout the subtropics.

Material examined. **KAUAI:** U.S. Fish & Wildlife Reservation, Hanalei Valley, in and around taro patches, 10 ft, 18 Jul 1977, *Herbst 5954* (BISH). **O'AHU:** Mokule'ia, 16 Sep 1936, *Dillingham, s.n.* (BISH 120043, 120044). An additional collection from Maui made by C. Imada in 1998 is reported elsewhere in this year's *HBS Records*.

***Paspalum paniculatum* L.**

New naturalized record

O'Connor (1990: 1575) treated this and the previous taxon as adventives, but we believe that it is common enough to be considered a naturalized species in Hawai'i. It is native to South America.

Material examined. **O'AHU:** Hakipu'u, Ko'olaupoko, single plant in grass garden, 9 Feb 1939, *Ripperton & Lyman s.n.* (BISH 448985). **HAWAI'I:** Ka'u District, Ka'u Forest Reserve, Kiolaka'a Ranger Station below Kiolaka'a Kea'a Homestead Addition, 1950 ft, 13 Aug 1980, *Cuddihy & Davis 527* (BISH); Hilo, Veterans Cemetery, occasional in vacant field adjacent to cemetery, 53 m, 23 July 1996, *Nagata 4432* (BISH).

***Phalaris minor* Retz.**

New naturalized record

O'Connor (1990: 1483) reports that *Phalaris minor* has been recorded as an escape on three islands: O'ahu, Moloka'i, and Hawai'i. We believe that it should be treated as a naturalized species. It is native to the Mediterranean and SW Asian areas but has been widely introduced to other parts of the world.

Material examined. **O'AHU:** Schofield Barracks, weed on edge of a sugar cane field, 30 Jun 1916, *Hitchcock 13915* (BISH). **MOLOKA'I:** Mauna Loa, May 1903, *Munro 126* (BISH). **HAWAI'I:** Mauna Loa Truck Trail, near horse corral at end of trail, probably introduced in horse feed, 6600 ft, May 1939, *Olson s.n.* (BISH 120196); Ka'ohe, Pohakuloa State Park, in pens at bird propagation facility, apparently brought in with bird feed, 6500 ft, 7 Jul 1977, *Herbst 5945* (BISH).

***Phleum pratense* L.**

New naturalized record

Phleum pratense was treated as an escape by O'Connor (1990: 1483). We accept it here as a naturalized species in Hawai'i. It is native to the temperate Old World.

Material examined. **KAUAI:** Waimea Drainage Basin, west side, Waimeke paddock, 3 Jul–18 Aug 1917, *Forbes 1019.K* (BISH). **O'AHU:** Wai'anae Mountains, Mt. Ka'ala summit, occasional in disturbed places near Army installations, 4000 ft, 10 Sep 1950, *Hatheway et al. 338* (BISH). **MAUI:** Makawao, Hawaiian Agricultural Experiment Station, branch station, in grass garden, 2100 ft, *Hosaka 2597* (BISH).

***Rhytidosperma pilosum* (R. Br.) Connor & Edgar** **New island record**

In the earlier literature concerning the Hawaiian flora, this species was listed as *Danthonia pilosa* R. Br. (e.g., O'Connor, 1990: 1522). A later paper (Herbst & Clayton, 1998: 34) calls attention to the fact that Connor and Edgar had transferred this taxon to a new genus, and that a more current name for the species was *Rhytidosperma pilosum* (R. Br.) Connor & Edgar. Originally the grass was known only from the island of Hawai'i; the following collection documents its occurrence on the island of Maui, a range extension for the species.

Material examined. **MAUI:** [East Maui], Haleakalā Crater, base of Crystal Cave, 7200 ft, on open cinder slope with *Deschampsia*, *Styphelia*, *Sophora*, 25 Jun 1998, *Haus s.n.* (BISH); Haleakalā nursery, volunteer, 13 Sep 1938, *no name s.n.* (BISH 448988).

Polygonaceae

The genus *Polygonum* has presented taxonomic problems since its establishment by Linnaeus in 1753. In the ensuing years, several authors have attempted to divide the genus into more natural units, the most recent being Louis-Philippe Ronse Decraene who chose to investigate the floral morphology of the genus as a research topic for his Master of Science degree in plant taxonomy. His data supports the division of *Polygonum* into two tribes containing ten genera, a classification that is gaining wide acceptance. Following the taxonomy of Ronse Decraene & Akeroyd (1988), the Hawaiian species of *Polygonum* (Wagner *et al.*, 1990: 1060–1064) are treated in 3 distinct genera; the taxonomic changes required to bring the *Manual* into compliance with their classification scheme are listed below:

***Persicaria capitata* (Buch.-Ham. ex D. Don)** **Taxonomic change**

Masamune

Polygonum capitatum F. Ham. (Wagner *et al.*, 1990: 1063) is now considered a synonym of *Persicaria capitata* (Ronse Decraene & Akeroyd, 1988: 367).

***Persicaria chinensis* (L.) Nakai** **Taxonomic change**

Polygonum chinense L. (Wagner *et al.*, 1990: 1063) is now considered a synonym of *Persicaria chinensis* (Ronse Decraene & Akeroyd, 1988: 367).

***Fallopia convolvulus* (L.) A. Love** **Taxonomic change**

Polygonum convolvulus L. (Wagner *et al.*, 1990: 1063) is now considered a synonym of *Fallopia convolvulus* (Ronse Decraene & Akeroyd, 1988: 369).

***Persicaria glabra* (Willd.) Gomez de la Maza Taxonomic change**

Polygonum glabrum Willd. (Wagner *et al.*, 1990: 1064) is now considered a synonym of *Persicaria glabra* (Wilson 1990: 632).

***Persicaria punctata* (Elliot) Small Taxonomic change**

Polygonum punctatum Elliot (Wagner *et al.*, 1990: 1064) is now considered a synonym of *Persicaria punctata*.

Potamogetonaceae***Stuckenia pectinata* (L.) C. Borner**

In a previous publication, Herbst (1997: 4) reported that Les & Haynes (1996) had elevated *Potamogeton* subg. *Coleogeton* to generic status and had made a new combination for one of the species of *Potamogeton* treated by Wagner *et al.* (1990: 1608), *Coleogeton pectinatus* (L.) Les & Haynes. Shortly after the article appeared, it was discovered that Borner had provided an earlier generic name *Stuckenia*, rendering the generic name *Coleogeton* superfluous. *Stuckenia pectinata* is the correct name for this species (Haynes *et al.*, 1998: 241).

Primulaceae***Lysimachia daphnoides* (A. Gray) Hillebr.**

In their revision of the Hawaiian species of *Lysimachia*, Marr & Bohm (1997: 272) recognize St. John's *L. kahiliensis* as a valid species. As the species is based on a single, incomplete specimen collected in 1909, we take a conservative stance and believe it best that it be considered conspecific with *L. daphnoides* (Wagner *et al.*, 1990: 1080), which it closely resembles, at least until additional material is available for study.

***Lysimachia hillebrandii* J.D. Hook. ex A. Gray**

In their revision, Marr & Bohm (1997) recognize 3 of St. John's species that we believe fall within the variable *L. hillebrandii* complex (Wagner *et al.*, 1990: 1081). The species are: *Lysimachia haupuensis* H. St. John, *L. ovoidea* H. St. John, and *L. waianaeensis* H. St. John (Marr & Bohm, 1997: 268, 274, and 284, respectively). Subspecific status may prove to be appropriate for some of these entities upon further analyses of the overall variation pattern.

***Lysimachia iniki* Marr**

Known only from the "Blue Hole" at the headwaters of the north fork of the Wailua River, 720 m in elevation, Kaua'i. Approximately 25 plants from two populations are known, growing on rocky or mossy wet cliffs (Marr & Bohm, 1997: 270).

***Lysimachia pendens* Marr**

Like the previous species, known only from the wet mossy or rocky cliffs of the "Blue Hole" where it is rare (Marr & Bohm, 1997: 275). Material of this species was included by Wagner *et al.* (1990: 1080) in *L. filifolia* C.N. Forbes.

***Lysimachia scopulensis* Marr**

A member of the Diverse Lowland Mesic Forest vegetation association growing on the steep cliffs of upper Kalalau Valley, 780–880 m in elevation, Kaua'i (Marr & Bohm, 1997: 282).

***Lysimachia remyi* Hillebr.**

Marr & Bohm (1997: 275) newly delimit the species and subdivide it into 4 subspecies. At present, we maintain our broad delimitation of the species (Wagner *et al.*, 1990: 1083) and do not recognize the new subspecies, which do not seem to represent natural groupings.

Rhizophoraceae

Bruguiera sexangula (Lour.) Poir.

Misidentification

Specimens of the O'ahu population of *Bruguiera* collected by personnel of the U.S. Forest Service Institution of Pacific Islands Forestry in October 1997 were sent to Norman C. Duke of Mangrove Research, Australia, for verification (J.A. Allen, pers. comm., 1997). Dr. Duke determined that the taxon previously called *B. gymnorrhiza* (L.) Lam. by Hawaiian botanists (Wagner *et al.*, 1990: 1099) was based upon incorrectly identified specimens of *B. sexangula*. *Bruguiera sexangula* is characterized by petals with obtuse tips that either lack or have 2 relatively short bristles at their tips. In contrast, *B. gymnorrhiza* has petals with acute tips, each extended into three filamentous appendages (J.A. Allen *et al.*, unpubl.). The Hawaiian populations had earlier been correctly identified by Degener (1934) in his *Flora Hawaiiensis*, and Ding Hou (1958: 464) in his treatment of Rhizophoraceae of the Malesian Region.

Rubiaceae

Psydrax odorata (G. Forster) A.C. Sm. & S.P. Darwin

In a note under the genus *Canthium*, Wagner *et al.* (1990: 1119) stated that recent studies indicated that the Hawaiian indigenous species, *Canthium odoratum* (G. Forster) Seem., would more correctly be placed in the genus *Psydrax*. The combination was not available when the *Manual* went to press. The new combination has since been published (Smith & Darwin, 1988: 230) and should now be adopted.

Coprosma granadensis (L.f.) Heads

Noting that no character or combination of characters has been found which separate the genera *Coprosma* and *Nertera*, Heads (1996) has reduced *Nertera* to a section of *Coprosma*, subgenus *Coprosma*. Following this taxonomic concept, *Nertera granadensis* (L.f.) Druce (Wagner *et al.*, 1990: 1158) is now *Coprosma granadensis* (L.f.) Heads (Heads, 1996: 388).

Hedyotis flynnii W.L. Wagner & Lorence

Known only from northern and northwestern Kaua'i, in valleys along the Nā Pali coast from Limahuli to Kawai'ula, 450–1100 m; most of the collections have been made in Kalalau Valley. The species is usually restricted to north and northeast-facing cliffs and steep, narrow ridge crests and outcrops. It generally occurs in windswept areas in small populations of 30 to 50 or more scattered plants (Wagner & Lorence, 1998: 311).

Hedyotis schlechtendahliana subsp. *waimeae* (Wawra) W.L. Wagner & Lorence

Wagner *et al.* (1990: 1150) included this taxon in synonymy of *H. schlechtendahliana* Steud. var. *schlechtendahliana* (as *H. glaucifolia* (A. Gray) Fosberg var. *waimeae* (Wawra) Fosberg). Wagner & Lorence (1998: 316) reassessed the taxon and proposed that it should be accepted as a valid subspecies of *H. schlechtendahliana*.

Hedyotis schlechtendahliana subsp. *remyi* (Hillebr.) Fosberg

As part of the reevaluation by Wagner & Lorence (1998), *Hedyotis schlectendahl-iana* var. *remyi* (Hillebr.) Fosberg was restored to subspecific status.

Rutaceae

Melicope munroi (H. St. John)

New island record

T.G. Hartley & B.C. Stone

The following collection extends the range of this Lānaʻi species to eastern Molokai. It was determined by Rock as *Pelea molokaiensis* Hillebr. and redetermined in 1989 but not reported by Stone *et al.* (1990: 1196).

Material examined. MOLOKAʻI: above Kamolo, April 1910, *Rock 10222* (BISH).

Melicope sessilis (H. Lév.) T.G. Hartley (ined.) **Taxonomic change**

In their treatment of the genus *Pelea* (now *Melicope*) Stone *et al.* (1990: 1199) placed *P. sessilis* in synonymy under *P. parvifolia* Hillebr. Hartley (in press) has transferred it to the genus *Melicope* as the earliest name for this species. Earlier Hartley & Stone (1989: 121) provided a new name, *M. mauii* T.G. Hartley & B.C. Stone, for *P. parvifolia* Hillebr. as the epithet had already been used in *Melicope*. However, they did not realize then that if *P. sessilis* H. Lév. is placed in the synonym of this species, the correct final epithet is *sessilis* as it is the oldest available name. For nomenclatural purposes this combination is not accepted as being made here; it will be published by T.G. Hartley in a forthcoming monograph of the non-Hawaiian members of the genus.

Verbenaceae

Stachytarpheta australis Moldenke

Taxonomic change

The description of the plant treated by Wagner *et al.* (1990: 1321) as *S. dichotoma* (Ruiz & Pav.) Vahl is actually that of *Stachytarpheta australis*, a species with which it had often been confused in the past. The type of *S. dichotoma* is the same taxon as *S. cayennensis* and has been placed in synonymy with that species.

Stachytarpheta cayennensis (Rich.) Vahl

In his revision of the genus *Stachytarpheta* in Australia, Munir (1992: 145) considers *S. cayennensis*, *S. dichotoma*, and *S. urticaefolia* as conspecific, retaining *S. cayennensis* as the oldest valid name and placing the other two in synonymy.

Viscaceae

Korthalsella Tiegh.

Note

In a synopsis of the genus *Korthalsella*, Molvray (1997) proposed many sweeping taxonomic changes, some of which concern the Hawaiian members of this genus. Her delineation of the taxa is based upon her morphological and anatomical evaluations as well as the molecular evidence. The proposed changes are listed below. We believe that these changes should be further evaluated before they are adopted.

Korthalsella complanata (Tiegh.) Engl.: included by Molvray in the broadly delimited and widespread *K. taenioides* (Commerson ex DC.) Engl. forma *taenioides*.

Korthalsella cylindrica (Tiegh.) Engl.: Molvray accepted this taxon at the specific level, but extended its distributional range to include Tahiti.

Korthalsella degeneri Danser: placed in synonymy under *K. taenioides* (Commerson ex DC.) Engl. forma *horneana* (Tiegh.) Molvray.

Korthalsella latissima (Tiegh.) Danser: placed in *K. taenioides* (Commerson ex DC.)

Engl. forma *pendula* (Wawra) Molvray, a taxon native to Australia and the Hawaiian Islands.

Korthalsella platycaula (Tiegh.) Engl.: placed along with *K. complanata* in *K. taenioides* (Commerson ex DC.) Engl. forma *taenioides*.

Korthalsella remyana Tiegh.: Molvray proposed a change in status for this taxon, as a form of the widespread *K. taenioides* (*K. taenioides* (Commerson ex DC.) Engl. forma *remyana* (Tiegh.) Molvray), and extended its distributional range to include Tahiti.

Acknowledgments

We thank the staff of the Herbarium Pacificum of the Bishop Museum for invaluable assistance during the compilation of this paper.

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Hymenoptera from Midway Atoll¹

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The present paper reports the Hymenoptera species collected on Midway Atoll, mostly during 1997 by workers associated with the Bishop Museum. Records of a few previously unreported specimens collected on Midway during the 1960s and 1970s also are included as is one new record from an incompletely studied collection made in 1998. All of the Parasitica as well as the family Bethyilidae of the Aculeata are treated. The remaining aculeate families will be covered by others. No Symphyta are known to occur on Midway.

The last comprehensive survey of the insects of Midway was by Suehiro (1960). That author reported 35 species of Hymenoptera, 16 in the groups considered here. Based on my examination of the specimens, one of the species listed by Suehiro (*Idechthis canescens* (Gravenhorst)) represents a misidentification of another species (*I.* sp.) that is also listed there. Nishida (1997) listed three additional species of Hymenoptera Parasitica for Midway, but he omitted from his list those species determined to genus only in Suehiro's.

The collections here reported contained the 76 species listed below, and include all but the following two of the species listed from Midway by Nishida (1997); *Liriophagus texanus* Crawford (Pteromalidae) and *Urosigalphus bruchi* Crawford (Braconidae). Two species listed by Suehiro (1960) but not by Nishida (1997), *Epyris* sp. (Bethyilidae) and *Tetrastichus* sp. (Eulophidae), were not represented by voucher specimens in material available for study and were not recognized in recent collections. Whether any of these species are extinct on Midway cannot be presently determined.

Several species included in the following list are represented in the collections available by single specimens, despite the extensive collecting that was done during the 1997 survey. This suggests that these species either were very uncommon, or that the collecting localities and/or techniques utilized were not suitable for obtaining a more adequate sample. Furthermore, if several species were each represented by single specimens in the collections obtained, then it seems likely that others were also present which were missed entirely, and these could have included any or all of the species that were recorded previously from Midway but which were not recollected during this survey.

Certainly, additional Hymenoptera species are present on Midway which are not included in the present list. I have excluded several species because they were represented only by unique, imperfect specimens or by unique specimens of the sex opposite that on which the taxonomy of their group is largely based. Hopefully, additional collecting on Midway may yield specimens of these that can be more readily determined.

Sixty-two of the species listed here are new records for Midway Atoll. None of these are believed to be native to Midway, and this relatively large number of new Midway records probably reflects the increased air and surface traffic between Midway and areas such as the main Hawaiian Islands (where nearly all of these species are known to occur) during the recent past. One species, *Dicarnosis ripariensis* Kerrich, also is a new state record for Hawai'i. Whether this species is present on the main Hawaiian Islands has not been determined, but it is unrepresented in extensive collections of Hymenoptera Parasitica that I have examined, which were made on the main islands during the past five years.

Identifications of species listed here were made by me, through comparison with determined specimens in collections of the Bishop Museum and the Hawaii Department of Agriculture (Honolulu), and using available literature. In several instances identification is to genus only, as the species present in the Hawaiian Islands have not yet been authoritatively determined. Voucher specimens are deposited in the Bishop Museum, Honolulu.

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ICHNEUMONOIDEA**Braconidae*****Apanteles carpatus* (Say)**

This species was previously recorded from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1).

Apanteles* sp.*New island record**

This undetermined species is also known from O'ahu. It is listed from that island as *Apanteles* sp. 2 in Beardsley (1961).

Material examined. **MIDWAY:** Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1).

***Chelonus blackburni* Cameron**

Previously recorded from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (2); same data except 14.iv.1997 (1).

Cotesia marginiventris* (Cresson)*New island record**

A parasitoid that develops in a wide range of lepidopterous larvae, this species was purposely introduced into the main Hawaiian Islands from Texas in 1942 for biological control of armyworms. It has been reported to be established on most of the main Hawaiian Islands, as well as Laysan (Beardsley, 1961).

Material examined. **MIDWAY:** Sand I: 28.i.1964, C.F. Clagg, at light (1).

Cotesia plutellae* (Kurdjumov)*New island record**

This species was purposely introduced into the main Hawaiian Islands to combat the diamondback moth, *Plutella xylostella* (L.), and was reported to have become established there in 1982 (Lai & Funasaki, 1985).

Material examined. **MIDWAY:** Sand I: E., 17.v.1997, G.M. Nishida (3); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (2); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (36); same data except 10.iv.1997, L. Patrick (3); same data but 14.iv.1997 (6); Sand I: Interior, 16.v.1997, G.M. Nishida (1); Sand I: Roosevelt & Halsey Drives, G.M. Nishida, Malaise (23).

***Lysiphlebus testaceipes* (Cresson)**

A widespread primary parasitoid of aphids; previously recorded from Midway (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Citrus grove, 19.xii.1997, G.M. Nishida, sweeping flowering clover (2).

Parallorhogas pallidiceps* (Perkins)*New island record**

This species, a common parasitoid of larval cerambycid beetles that is known also from the south Pacific, has been reported from most of the main Hawaiian Islands (Beardsley, 1961).

Material examined. **MIDWAY:** Sand I: 0.5 mi S of Rusty Bucket, 29.vii.1997, G.M. Nishida (1).

***Phanerotoma hawaiiensis* Ashmead**

Recorded from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: near Bulky Dump, 16.ii.1997, A. Asquith, under logs & sweeping *Gnaphalium* (1); Sand I: Dump lake, 18.ii.1997, G.M. Nishida, ex flowering *Pluchea* (1); Sand I: Dump lake, 31.viii.1997, G.M. Nishida, at UV light (4); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1); Sand I: NE of Frigate Point, 28.viii.1997, G.M. Nishida, at

UV light (7); Sand I: Henderson Drive at airstrip, 28.viii.1997, G.M. Nishida, sweeping *Bidens* (1); Sand I: Henderson & Roosevelt Drives, 28.viii.1997, G.M. Nishida, at UV light (9); Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1).

Rhaconotus vagrans (Bridwell)

New island record

This parasitoid of larvae of cerambycid beetles occurs on all of the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (3); Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (1); Sand I: Roosevelt & Halsey Drives, 17.ii.1997, sweeping *Poinsettia* (1); Sand I: W. Beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (3).

Ichneumonidae

Casinarina infesta (Cresson)

New island record

A widespread species that occurs on all of the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (3); same data except 10.iv.1997, L. Patrick (1).

Diplazon laetatorius (Fabricius)

This widespread parasitoid of aphidophagus syrphid larvae was reported from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (7); same data except 10.iv.1997, L. Patrick (1); same data except 14.iv.1997 (1).

***Venturia* sp.**

This species was listed from Midway by Suehiro (1960) as “*Idechthis* sp. near *canescens*.” It is an as yet unidentified bisexual species that occurs also on O‘ahu and several other of the main Hawaiian Islands (Beardsley & Perreira, unpubl.). The Midway record of *I. canescens* (Gravenhorst) in Suehiro (1960) was based on a misidentification of a specimen of this unidentified species.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (8); same data except 10.iv.1997, L. Patrick (5); same data but 14.iv.1997 (3); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida & L. Patrick, Malaise (2).

CHALCIDOIDEA

Agaonidae

Pleistodontes froggatti Mayr

New island record

This species is the caprifier of *Ficus macrophylla* Desf. (Pemberton, 1921), and is established on the main Hawaiian Islands (Nishida, 1997). If it is established on Midway, that tree must be present there.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Aphelinidae

Aphytis ?hispanicus Mercet

New island record

This primary parasitoid of armored scale insects has not been listed previously in Hawai‘i. However, it occurs on the main Hawaiian Islands, and may have been confused with *A. diaspidis* Howard, which also occurs there (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: Henderson Ave., 15–20.xii.1997, G.M. Nishida, yellow window trap amongst *Malva/ Acacia* trees (4); Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (1).

Azotus sp.**New island record**

This appears to be the same undetermined species as that listed from O'ahu by Nishida (1997). *Azotus* species are hyperparasites in armored scale insects.

Material examined. MIDWAY: Sand I: 15–20.xii.1997, G.M. Nishida, yellow window trap (1); Sand I: central, 13–15.viii.1997, A. Gall, Malaise (1). Sand I: Dump Lake, 17.xii.1997, G.M. Nishida, sweeping Bermuda grass (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2); same data except 10.iv.1997, L. Patrick, (1); same data except 14.iv.1997 (6); Sand I: Roosevelt & Halsey Aves., 1–17.v.1997, G.M. Nishida & L. Patrick, Malaise (2).

Centrodora xiphidii (Perkins)**New island record**

Parasitoid of eggs of *Xiphidiopsis lita* Hebard (Orthoptera: Tettigoniidae) (Swezey, 1929); it has been reported from most of the main Hawaiian Islands (Nishida, 1997).

Material examined. MIDWAY: Sand I: Henderson & Halsey Aves., 10.iv.1997, L. Patrick, Malaise (2); same data except 14.iv.1997 (3).

Coccophagus ceroplastae (Howard)**New island record**

This is a widespread parasitoid of soft scale insects (Coccidae); it has been reported from most of the main Hawaiian Islands (Nishida, 1997).

Material examined. MIDWAY: Sand I: Frigate Point, 17.xii.1997, G.M. Nishida, sweeping *Hibiscus* (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (3); Sand I: W. Beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (2).

Encarsia lounsburyi (Berlese & Paoli)**New island record**

A widespread internal parasitoid of armored scale insects, it is known to occur on most of the main Hawaiian Islands (Nishida, 1997).

Material examined. MIDWAY: Sand I: 15–20.xii.1997, G.M. Nishida, yellow window trap in *Bidens* patch (1); same data except in *Pluchea/Bidens* patch (1); same data except in *Verbesina* patch (2).

Encarsia pergandiella Howard**New island record**

This is a parasitoid of Aleyrodidae which is also known from most of the main Hawaiian Islands (Nishida, 1997).

Material examined. MIDWAY: Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (6); same data except 14.iv.1997, L. Patrick (3); Sand I: Inner Harbor area, 12–13.v.1997, Malaise (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida & G.A. Samuelson, Malaise (2).

Encarsia sp.**New island record**

This unidentified species is also known from the main Hawaiian Islands (Beardsley, unpubl.).

Material examined. MIDWAY: Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (1).

Eretmocerus sp.**New island record**

Species of this genus are primary parasitoids of Aleyrodidae. The unidentified species recorded here also occurs on the main Hawaiian Islands (Beardsley, unpubl.).

Material examined. MIDWAY: Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (3); same data except 10.iv.1997, L. Patrick (1); same data except 14.iv.1997 (10); Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1).

Chalcididae*Antrocephalus apicalis* (Walker)**New island record**

This species is recorded from the Kaua'i and O'ahu (Nishida, 1997).

Material examined. MIDWAY: Sand I: near Bulky Dump, 16.ii.1997, A. Asquith, under logs & sweeping *Gnaphalium* (2); Sand I: E. peninsula, 14.ii.1997, G.M. Nishida, sweeping *Verbesina* (1);

Sand I: Frigate Point, 28.viii.1997, G.M. Nishida, sweeping mostly grass (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (1); same data except 14.iv.1997 (3); Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida & L. Patrick, Malaise (1).

Antrocephalus pertorvus (Girault)

Previously recorded from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: near Bulky Dump, 16.ii.1997, A. Asquith, under logs & sweeping *Gnaphalium* (2); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 14.iv.1997, L. Patrick (2); Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (3); Sand I: Roosevelt Drive, 28.viii–3.ix.1997, G.M. Nishida, yellow sticky trap (2); Sand I: S. of Rusty Bucket, 28.viii–3.ix.1997, G.M. Nishida, yellow sticky trap (1).

Proconura sp.

New island record

This is an apparently undescribed species that is also known from several of the main Hawaiian Islands (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: near Bulky Dump, 16.ii.1997, A. Asquith, sweeping *Gnaphalium* (1); same locality but 17.ii.1997, G.M. Nishida, sweeping foliage at night (1); Sand I: Frigate Point, 28.viii.1997, G.M. Nishida, sweeping mostly grass (2); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2); same data except 10.iv.1997, L. Patrick (5); same data except 14.iv.1997 (2); Sand I: residential area, 16.v.1997, G.M. Nishida, sweeping Bermuda grass (1); Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (1); Sand I: Roosevelt & Halsey Drives, 17.v.1997, G.M. Nishida, Malaise (2); Sand I: 0.5 mi S. of Rusty Bucket, 29.viii.1997, G.M. Nishida, sweeping *Bidens* (2); Sand I: S. central, 16.ii.1997, G.M. Nishida, sweeping *Cyperus* (1); Sand I: W. of deep water harbor, 14.ii.1997, G.M. Nishida (1).

Encyrtidae

Adelencyrtus odonaspidis Fullaway

New island record

This is a primary parasitoid of a widespread armored scale of grasses, *Odonaspis ruthae* Kotinsky; no other host is known. The scale and its parasitoid both occur on all the main Hawaiian Islands and on several of the Leeward Islands (Nishida, 1997). Although the scale is not recorded from Midway, it is almost certainly present there.

Material examined. **MIDWAY:** Eastern I: 15.v.1997, G.M. Nishida, on Bermuda grass (1); Sand I: Dump Lake, 17.xii.1997, G.M. Nishida, sweeping Bermuda grass (2); same data but 19.xii.1997 (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (3); same data except 14.iv.1997, L. Patrick (6); Sand I: residential area, 16.v.1997, G.M. Nishida, sweeping Bermuda grass (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (3).

Apterencyrtus bruchi De Santis

New island record

This species is known from Kaua'i, Moloka'i, and O'ahu (Trjapitzin & Beardsley, 1999). The host, presently unknown, probably is a grass-infesting pseudococcid.

Material examined. **MIDWAY:** Sand I: Harbor area, 13.v.1997, G.M. Nishida, sweeping mostly grass (1); Sand I: S.E., 16.v.1997, G.M. Nishida, sweeping *Bidens* (2).

Anagyrus swezeyi Timberlake

This is a well known parasitoid of a grass-infesting mealybug, *Chorizococcus rostellum* (Lobdell), on the main islands of Hawai'i (Beardsley, 1969). However, that mealybug has not been reported on Midway. *A. swezeyi* was previously reported from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Dump Lake, 19.xii.1997, G.M. Nishida, sweeping Bermuda grass (3); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (2); same data except 14.iv.1997 (4); Sand I: inner harbor area, 12–13.v.1997, G.M. Nishida, Malaise (2); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M.

Nishida, Malaise (17); Sand I: S. central, 16.ii.1997, G.M. Nishida, sweeping grass (3); Sand I: W. Beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (2).

***Blepyrus insularis* Cameron**

New island record

This is another widespread mealybug parasitoid. The usual host on the main Hawaiian Islands and elsewhere is *Ferrisia virgata* (Cockerell) (Beardsley, 1976).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2); Sand I: Henderson & Roosevelt Drives, 15.ii.1997, G.M. Nishida, yellow pan trap (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1); same data except G.M. Nishida & L. Patrick (1).

***Cheiloneurus* sp.**

New island record

This species is the same as *Cheiloneurus* sp. 1 of Beardsley (1976), and occurs on most of the main Hawaiian Islands. It is believed to be hyperparasitic in mealybug primary parasitoids.

Material examined. **MIDWAY:** Sand I: central, 13–15.viii.1997, A. Gall, Malaise (1); Sand I: residential area, 16.v.1997, G.M. Nishida, sweeping Bermuda grass (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1); same data except G.M. Nishida & L. Patrick (1); Sand I: S. central, 16.ii.1997, G.M. Nishida, sweeping grass (1).

***Coccidoxenoides peregrina* (Timberlake)**

This primary parasitoid of the citrus mealybug, *Planococcus citri* (Risso) and related forms, was reported from Midway by Suehiro (1960), under its synonym *Pauridia peregrina* Timberlake.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1).

***Dicarnosis ripariensis* Kerrich**

New state record

The description of this species was based on specimens from southern California, reared from *Phenacoccus maderiensis* Green, and misidentified as *P. gossypii* (Townsend & Cockerell) (Kerrich, 1978). This host is widespread, and was reported from Midway (misidentified as *P. gossypii*) by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (10); same data except 10.iv.1997, L. Patrick (11); same data except 14.iv.1997 (14); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (8); same data except G.M. Nishida & L. Patrick (4); Sand I: S.E., 16.v.1997, G.M. Nishida, sweeping *Bidens* (1).

***Diversinervus elegans* Silvestri**

This widely distributed parasitoid of *Saissetia* spp. (Coccidae) was previously reported from Hawai'i, Maui, O'ahu, and Midway.

Material examined. **MIDWAY:** Eastern I: 15.ix.1964, J.W. Beardsley, sweeping (2); Sand I: nr. Frigate Point, 17.xii.1997, G.M. Nishida, sweeping *Hibiscus* (1).

***Encyrtus infelix* (Embleton)**

New island record

A widespread parasitoid of soft scales (Coccidae); it occurs on all of the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: 13–17.xii.1970, J.L. Gressitt, Malaise (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.vi.1997, L. Patrick (1); Sand I: SE., 18.v.1997, G.M. Nishida, sweeping *Bidens* (1).

***Gyranusoidea phenacocci* (Beardsley)**

New island record

Described from Hawai'i as a parasitoid reared from *Phenacoccus maderiensis* Green, misidentified as *P. gossypii* (Townsend & Cockerell) (Beardsley, 1969). Known previously from O'ahu, Moloka'i, and Hawai'i (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2); same data except 10.iv.1997, L. Patrick (6); same data except 14.iv.1997 (10); Sand I: Roosevelt & Halsey Aves., 1–17.v.1997, G.M. Nishida, Malaise (6); same data except G.M. Nishida & L. Patrick (2).

Leptomastidea abnormis (Girault)**New island record**

This is a widely distributed primary parasitoid of the citrus mealybug, *Planococcus citri* (Risso), and related species. It was purposely introduced into the main Hawaiian Islands for biological control of that pest (Beardsley, 1976).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2).

Metaphycus flavus (Howard)**New island record**

A widespread primary parasitoid of soft scale insects (Coccidae) (Beardsley, 1976). This species is an accidental immigrant into Hawai'i, where it has been reported from Moloka'i, and O'ahu (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: 15–20.xii.1997, G.M. Nishida, yellow window trap in *Bidens* patch (1); Sand I: W. Beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Neodusmetia sangwani (Subba Rao)**New island record**

This parasitoid of the Rhodes-grass mealybug, *Antonina graminis* (Maskell), has been distributed widely for biological control of that pest (Dean *et al.*, 1979). However, it appears to have been accidentally introduced into Hawai'i (Beardsley, 1976). It now occurs on most of the main Hawaiian Islands and on Pearl & Hermes Atoll (Nishida, 1997). Rhodes-grass mealybug has not been reported from Midway, although it very probably occurs there.

Material examined. **MIDWAY:** Sand I: Dump Lake, 17.xii.1997, G.M. Nishida, sweeping Bermuda grass (1).

Plagiomerus* sp.*New island record**

This is the same as the unidentified species that was reported for the main Hawaiian Islands, where it was reared from the armored scale *Hemiberlesia lataniae* (Signoret) (Beardsley, 1976).

Material examined. **MIDWAY:** Sand I: Citrus grove, 19.xii.1997, G.M. Nishida, sweeping flowering clover (3); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (5).

Eulophidae***Aprostocetus hagenowi*** (Ratzeburg)**New island record**

This species develops in the eggs of cockroaches (e.g., *Periplaneta* spp.). It has been reported from most of the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (1).

Aprostocetus* sp.*New island record**

This species has been reported from O'ahu and Hawai'i (Beardsley, 1991a) where it develops as a pupal parasitoid of the tephritid fly *Dioxyna sorocula* (Wiedemann) in seed heads of *Bidens pilosa* L.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (2).

Elachertus advena Timberlake

Recorded from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Dump Lake, 18.ii.1997, G.M. Nishida, ex flowering

Pluchea (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (4); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (10); same data except G.M. Nishida & L. Patrick (4); Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (1).

***Hemiptarsenus semialbiclavus* (Girault) New island record**

A widespread parasitoid of leaf-mining larvae; known from the main Hawaiian Islands, Nihoa, and French Frigate Atoll (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1); Sand I: Frigate Point, 28.viii.1997, G.M. Nishida, sweeping mostly grass (1); Sand I: golf course, 13.v.1997, G.M. Nishida, sweeping *Portulaca*-like plant (2); Sand I: (no locality), 15–20.xii.1997, G.M. Nishida, yellow window trap in *Scaevola* stand (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (7); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (15); Sand I: SE., 16.v.1997, G.M. Nishida, sweeping *Bidens* (1); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (7).

***Neochrysocharis formosa* (Westwood) New island record**

This parasitoid of agromyzid leafminers has been reported from most of the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Citrus grove, 19.xii.1997, G.M. Nishida, sweeping flowering clover (1); Sand I: Dump Lake, 19.ii.1997, G.M. Nishida, sweeping Bermuda grass (1); Sand I: E. peninsula, 18.ii.1997, G.M. Nishida, sweeping *Verbesina* (2); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (48); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (21).

***Neotrichoporoides viridimaculata* (Fullaway) New island record**

This widespread species, described originally from Hawai'i but believed to be an accidental introduction there, is known from Hawai'i and O'ahu (Nishida, 1997). It is associated with Bermuda grass and may be phytophagous (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: Dump Lake, 19.xii.1997, G.M. Nishida, sweeping Bermuda grass (3); Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (1); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

***Tetrastichus beardsleyi* Fullaway New island record**

This species is believed to be an accidental introduction into Hawai'i, although as yet unreported elsewhere (Nishida, 1997). It was described from O'ahu, but has been found also on Moloka'i (Beardsley & Perreira, unpubl.), and probably occurs on all of the main Hawaiian Islands. It is commonly associated with Bermuda grass.

Material examined. **MIDWAY:** Sand I: Dump Lake, 19.xii.1997, G.M. Nishida, sweeping Bermuda grass (3); Sand I: golf course, 19.xii.1997, G.M. Nishida, sweeping *Chloris* (4).

Eupelmidae

***Anastatus koebelei* Ashmead New island record**

This species is known also from the main Hawaiian Islands (Nishida, 1997), and has been reported as a parasitoid of tettigoniid eggs (Swezey, 1929).

Material examined. **MIDWAY:** Sand I: nr. Bulky Dump, 16.ii.1979, A. Asquith, under logs and sweeping *Gnaphilium* (1); Sand I: central, 13–15.viii.1997, A. Gall, Malaise (2); Sand I: E. peninsula, 18.ii.1997, G.M. Nishida, sweeping *Verbesina* (1); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (3); same data except 10.iv.1997, L. Patrick (3); same data except 14.iv.1997 (2); Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, ex *Malva*, *Leucaena*, *Casuarina* (2); Sand I: Roosevelt & Halsey Drives, 29.viii–3.ix.1997, G.M. Nishida, yellow sticky trap (1); Sand I: Roosevelt & Halsey Drives, 17.ii.1997, G.M. Nishida (2); Sand I: betw. seaplane hanger & Hennessy Dr., 14.ii.1997, A. Asquith, on *Pluchea* (6); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Eurytomidae***Tetramesa* sp.****New island record/name change**

This species is the same as “*Harmoletia* sp. 1” of Beardsley (1991b) from O‘ahu and Moloka‘i. It appears to be an accidental immigrant into Hawai‘i, of unknown origin.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.1v.1997, L. Patrick (1).

Mymaridae***Anagrus frequens* Perkins****New island record**

This parasitoid was purposely introduced into the main Hawaiian Islands in 1904 for biological control of the delphacid planthopper *Perkinsiella saccharicida* Kirkaldy. It develops in the eggs of this and other Delphacidae (Trjapitzin & Beardsley, in press).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (42); same data except 14.iv.1997, L. Patrick (30); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (2).

Anagrus nigriventris* Girault*New island record**

This accidentally introduced species was first found in the main Hawaiian Islands around 1930, and has been reared from the eggs of a widespread cicadellid leafhopper, *Empoasca solana* DeLong (Trjapitzin & Beardsley, in press).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 10.iv.1997, L. Patrick, Malaise (5); same data except 14.iv.1997 (49); Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (6); same data except G.M. Nishida & L. Patrick (3).

Anaphes calendrae* (Gahan)*New island record**

This species was purposely introduced into the main Hawaiian Islands to combat spheonophorine weevil pests. It was not reported to be established there until 1997 (Beardsley, in press).

Material examined. **MIDWAY:** Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Camptoptera* sp.*New island record**

This species also occurs on the main Hawaiian Islands where it apparently is a previously unreported accidental immigrant. It is listed as *Camptoptera* sp. 1 by Beardsley & Huber (in press).

Material examined. **MIDWAY:** Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Gonatocerus* sp.*New island record**

This species also is found on the main Hawaiian Islands where it apparently is an accidental immigrant; the first known collection was made in 1961. It is the same as *Gonatocerus* sp. 2 of Huber & Beardsley (in press).

Material examined. **MIDWAY:** Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Gonatocerus* sp., *membraciphagus* group*New island record**

This species has been known in the main Hawaiian Islands since 1955 (Huber & Beardsley, in press), and appears to be an accidental immigrant there. It is a parasitoid in eggs of membracid treehoppers.

Material examined. **MIDWAY:** Sand I: 13–17.xii.1970, J.L. Gressitt, Malaise (9); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (1); Sand I: harbor area, 13.v.1997, G.M. Nishida, sweeping mostly grass (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (12); same data except 10.iv.1997, L. Patrick (17); same data except 14.iv.1997 (5); Sand I:

W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (5); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1).

***Gonatocerus ornatus* Gahan**

New island record

This species, a parasitoid in the eggs of the widespread membracid *Spissistilus festina* (Say), is known also from O'ahu where it was first collected in 1938; a presumed accidental immigrant (Huber & Beardsley, in press).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (1).

***Stephanodes reduvioli* (Perkins)**

This species was recorded from Midway as *Polynema reduvioli* Perkins by Suehiro (1960). Nishida (1997) listed it as *Stephanodes similis* (Foerster), but I consider this a misidentification as *reduvioli* has never been formally synonymized with *similis*. *Stephanodes reduvioli* develops as a parasitoid in eggs of *Nabis capsiformis* (Germar) and is recorded from most of the main Hawaiian islands (Swezey, 1929).

Material examined. **MIDWAY:** Sand I: golf course, 13.v.1997, G.M. Nishida, sweeping *Portulaca*-like plant (1); Sand I: harbor area, 13.v.1997, G.M. Nishida, sweeping mostly grass (1); Sand I: Henderson & Halsey Drives, 14.iv.1997, L. Patrick, Malaise (3); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (2); same data except G.M. Nishida & L. Patrick (2).

Pteromalidae

***Chlorocytyus longiscapus* Gahan**

New island record

This species occurs also on several of the main Hawaiian Islands and is a previously unreported accidental immigrant there (determination by C.M. Yoshimoto). It has been reared from larvae of agromyzid leafminers (Beardsley, unpubl.).

Material examined. **MIDWAY:** Eastern I: 13–16.v.1997, G.M. Nishida, yellow pan trap (1); Sand I: (no specific locality), 15–20.xii.1997, G.M. Nishida, yellow window trap in *Verbesina* patch (1); Sand I: E. peninsula, 14.ii.1997, G.M. Nishida, sweeping *Verbesina* (1); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (16); Sand I: inner harbor area, 12–13.v.1997, G.M. Nishida, Malaise (1); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (2).

***Halticoptera circulus* (Walker)**

New island record/name change

Nishida (1997) listed this widespread parasitoid of agromyzid leafminer larvae from the main Hawaiian Islands as *H. patellana* (Dalman), which appears to be a misidentification of long standing.

Material examined. **MIDWAY:** Eastern I: 13–16.v.1997, G.M. Nishida, yellow pan trap (2); Eastern I: 13.v.1997, G.M. Nishida, sweeping sweet alyssum (2); Eastern I: 14.v.1997, G.M. Nishida (1); Sand I: E., 17.v.1997, G.M. Nishida (2); Sand I: Frigate Point, 13–18.ii.1997, G.M. Nishida & A. Asquith, Malaise (8); Sand I: Henderson Drive at airstrip, 28.viii.1997, sweeping *Bidens* (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (12); same data except 10.iv.1997, L. Patrick (2); same data except 14.iv.1997 (6); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (10); Sand I: SE., 16.v.1997, G.M. Nishida, sweeping *Bidens* (2).

***Heteroschema* sp.**

New island record

This parasitoid has been reared from larvae of *Melanagromyza virens* (Loew) on O'ahu (Beardsley, 1956). It is most likely *Heteroschema punctata* (Ashmead), but this requires confirmation. Nishida (1997) recorded it from O'ahu, Maui and Hawai'i.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 10.iv.1997, L. Patrick, Malaise (2); same data except 14.iv.1997 (2); Sand I: betw. seaplane hanger & Hennessey Ave., 14.ii.1997, A. Asquith, on *Pluchea* (1).

Spalangia cameroni* Perkins*New island record**

Adults of this parasitoid emerge from puparia of muscoid Diptera. It is a widespread species described originally from Hawai'i (Perkins, 1910) and has been reported from most of the main Hawaiian Islands.

Material examined. **MIDWAY:** Sand I: golf course, 2.v.1998, G.M. Nishida, sweeping mixed weeds (2).

Signiphoridae***Signiphora* sp.****New island record**

This may be *Signiphora aspidioti* Ashmead, a hyperparasitoid in armored scale insects that is recorded from both O'ahu and Necker (Nishida, 1997), but is widespread.

Material examined. **MIDWAY:** Sand I: 15–20.xii.1997, G.M. Nishida, yellow window trap in *Hibiscus/Coccoloba* stand (1).

Trichogrammatidae***Oligosita* sp.****New island record**

Several species of this genus occur on the main Hawaiian Islands.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (1).

Trichogramma* sp.*New island record**

A male and a female of what appears to be a single species of this genus were taken during this survey. It is believed to be one of several non-native *Trichogramma* that are known from the main Hawaiian Islands (Oatman *et al.*, 1982), but I am unable to place the species with certainty.

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (2).

Uscana* sp.*New island record**

This appears to be the same as a species from the main Hawaiian Islands that is known as *Uscana semifumipennis* Girault (Nishida, 1997), but I am not certain

Material examined. **MIDWAY:** Sand I: Henderson Ave, 15–20.xii.1997, G.M. Nishida, yellow window trap amongst *Malva/Acacia* trees (2); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

CYNIPOIDEA**Eucoilidae*****Gronotoma micromorpha* (Perkins)****New island record**

This species is a parasitoid of larvae of agromyzid leafminers. It has been recorded from the main Hawaiian Islands, Guam, and Florida (Beardsley, 1988).

Material examined. **MIDWAY:** Sand I: E., 17.v.1997, G.M. Nishida (12); Sand I: golf course, 17.v.1997, sweeping *Portulaca*-like plant (4); Sand I: harbor area, 13.v.1997, G.M. Nishida, sweeping mostly grass (5); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (20); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (41); Sand I: Roosevelt & Halsey Drives, 15.ii.1997, G.M. Nishida, sweeping *Poinsettia* (2); same data except 17.ii.1997, sweeping *Verbesina* (2); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (15).

EVANIOIDEA**Evaniiidae*****Evania appendigaster* (L.)**

This widespread species develops in the oothecae of cockroaches such as *Periplaneta* spp. It was reported from Midway by Suehiro (1960).

Material examined. **MIDWAY:** Sand I: Bulky Dump, 31.viii.1997, G.M. Nishida, in flight (1); Sand I: Frigate Point, 28.viii.1997, G.M. Nishida (1).

PROCTOTRUPOIDEA

Diapriidae*Trichopria* sp.**New island record**

This appears to be the same as an unidentified species from the main Hawaiian Islands (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: Roosevelt Drive, 15.ii.1997, A. Asquith, *Casuarina* (1); Spit I: N. end, 16.ii.1997, A. Asquith, under logs (14).

CERAPHRONOIDEA

Ceraphronidae*Ceraphron plebeius* Perkins**New island record**

This species was described from the Hawaiian Islands and has been recorded from Kaua'i and O'ahu (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 10.iv.1997, L. Patrick, Malaise (13); same data except 14.iv.1997 (2); Sand I: Roosevelt & Halsey Drives, 1-17.v.1997, G.M. Nishida, Malaise (2).

Ceraphron sp.**New island record**

This undetermined species appears to be the same as one known from O'ahu and Moloka'i (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (15); same data except 10.iv.1997, L. Patrick (1); same data except 14.iv.1997 (4); Sand I: Roosevelt & Halsey Drives, 1-17.v.1997, G.M. Nishida, Malaise (1).

SCELIONOIDEA

Platygasteridae*Fidiobia* sp.**New island record**

This species appears to be the same as one recorded from the main Hawaiian Islands (Nishida, 1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 14.iv.1997, L. Patrick (1).

Scelionidae*Anteromorpha dubiosa* (Perkins)**New island record**

This appears to be an accidental introduction into Hawai'i and has been reported from O'ahu and Maui (Nishida, 1997); its host is unknown.

Material examined. **MIDWAY:** Sand I: Roosevelt & Halsey Drives, 1-17.v.1997, G.M. Nishida, Malaise (1).

Encyrtoscelio sp.**New island record**

Members of this genus develop as parasitoids in eggs of cydnid burrowing bugs. This unidentified species also is known from Kaua'i and O'ahu (Beardsley, 1989; Nishida, 1997).

Material examined. **MIDWAY:** Sand I: central, 12-15.viii.1997, A. Gall, Malaise (5).

Idris ?peregrinus (Perkins)**New island record**

This species was described from O'ahu; type locality Honolulu (Perkins, 1910); the host is unknown. The specimen listed below is tentatively placed here, pending comparison with the holotype.

Material examined. **MIDWAY:** Sand I: Dump Lake, 17.xii.1997, G.M. Nishida, sweeping Bermuda grass (1).

Telenomus nawai Ashmead

This species develops as a parasitoid in the eggs of armyworms (Noctuidae) (Swezey, 1929). It was recorded from Midway by Nishida (1997).

Material examined. **MIDWAY:** Sand I: Henderson & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (3).

Telenomus vulcanus* Perkins*New island record**

This species is recorded from Hawai'i and Laysan (Nishida, 1997), but probably occurs on all Hawaiian Islands. It develops as a parasitoid in eggs of *Nysius* spp. (Lygaeidae) (Swezey, 1929).

Material examined. **MIDWAY:** Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (3); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Telenomus* sp.*New island record**

This species is present in the main Hawaiian Islands where it has been reared from eggs of *Zelus renardii* Kolenati (Reduviidae) (Beardsley, unpubl.).

Material examined. **MIDWAY:** Sand I: Henderson Ave., 15–20.xii.1997, G.M. Nishida, yellow window trap among *Malva/Acacia* trees (1); Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (1); same data except 10.iv.1997, L. Patrick (2); same data except 14.iv.1997 (2); Sand I: Roosevelt & Halsey Drives, 1–17.v.1997, G.M. Nishida, Malaise (1).

BETHYLOIDEA**Bethylidae*****Sierola* sp.****New island record**

Sierola spp. develop as parasitoids of larvae of Lepidoptera.

Material examined. **MIDWAY:** Sand I: Henderson Ave., 15–20.xii.1997, G.M. Nishida, yellow window trap among *Malva/Acacia* trees (1); Sand I: Sand I: Henderson & Halsey Aves., 6.iii.1997, N. Seto, Malaise (3); Sand I: W. beach, 15–20.xii.1997, G.M. Nishida & G.A. Samuelson, Malaise (1).

Acknowledgments

I thank Gordon Nishida and the staff of the Hawaii Biological Survey, Bishop Museum for the opportunity to study this collection.

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New records for Diptera in Hawai‘i¹

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In this reporting we present new distribution records for 41 species, 5 of which are new to the state. This list resulted largely from recent collecting and identification efforts that were done in connection with a survey of tephritid fruit flies of economic importance. At least 3 of the species reported here may be of medical (*Drosophila quadrlineata* and *Liohippelates collusor*) and economic (*Liriomyza* sp. near *blechi*) concern. The majority of the new records are for Moloka‘i, where this survey work was concentrated. One of us (WDP) conducted most of the collecting activities. Yellow sticky board traps (YSBT) and the sweeping of grasses and bushes with hand-held insect nets were the principal collecting methods employed. Some unpublished records based on specimens collected by others are also included. Nishida (1997) was the primary reference used to determine whether a species had been recorded previously from a given island. Voucher specimens are deposited in the collections of the Bishop Museum.

Agromyzidae

Liriomyza sp. near *blechi* Spencer

New state record

The distinct black and yellow color pattern of the mesonotum (Spencer & Steyskal, 1986: fig. 673) is shared with two non-Hawaiian species, *L. marginalis* (Malloch) and *L. sorosis* (Williston) and is used to distinguish this species from other *Liriomyza* in Hawai‘i. Characters of the male genitalia including the presence of a single long hair on the end of the cercus separate it from *L. marginalis* and *L. sorosis* and fit it closest to *L. blechi* Spencer (Spencer & Stegmaier, 1973: 98–99), a polyphagous species described from Florida. Unfortunately, we have been unable to compare the type of *L. blechi* with the O‘ahu specimens, nor do we have any host records for this leaf miner in Hawai‘i. Spencer (1990: 386) provided a list of host plants for *L. blechi*.

Material examined. O‘AHU: Pūpūkea, 90 ft, 15–28.v.1996 (YSBT, WDP).

Anthomyzidae

Amygdalops thomasetti Lamb

New island record

An immigrant species previously recorded from Kaua‘i, O‘ahu, Moloka‘i and Hawai‘i.

Material examined. MAUI: Haleakalā Hwy, 90 ft, 18.xi–2.xii.1995 (YSBT, WDP).

Asteiidae

Loewimyia orbiculata Hardy

New island records

Previously recorded from O‘ahu, this endemic species is most commonly found in coastal areas.

Material examined. MOLOKA‘I: Honomuni Stream, ca. 10 ft, 3–17.iii.1995 YSBT WDP. KAUA‘I: Mānā, N end of PMRF [Pacific Missile Range Facility], 10 ft, 1.iv.[19]96, sweeping. D.W. Jamieson.

1. Contribution No. 1999-018 to the Hawaii Biological Survey.

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Sigaloessa* sp.*New state record**

A genus of 14 described species, *Sigaloessa* (Sigaloessinae) differs from other Hawaiian asteiids, *Asteia*, *Bryania*, and *Loewimyia* (all Asteinae), by having both the hind cross vein and alula present. The testaceous-yellow colored *S. insularis* Malloch is from Tahiti. All other species of *Sigaloessa* are from the Americas.

Specimens from Hawai'i have the mesonotum polished and shining black and are strikingly sexually dimorphic with females possessing yellow legs with black banded femora and having a conspicuous yellow to yellowish white anterior thoracic spiracular protrusion. Males have legs completely yellow and the anterior thoracic area normal and lacking any distinctive protrusion. Using the key in Sabrosky (1957: 53–54), females key to *S. hillifera* Sabrosky and males with their characteristic genital forceps to *S. nigrifrons* Sabrosky. Both are Costa Rican. Notably, *S. hillifera* was described from three females and *S. nigrifrons* only from the holotype male, in both instances Sabrosky did not positively associate members of the opposite sex in the described material of either species. Based on the Hawai'i material (ca. 40 specimens), it appears that *S. hillifera* and *S. nigrifrons* are conspecific. If this proves to be true then *nigrifrons* will be the junior synonym. However, as we have not examined the type material of either species, positive species determination and a clarification of this matter will have to occur at a later date.

Material examined. MAUI: Hāna Airport Rd., 70 ft, and Ke'ānae, 3 ft, 18.xi–2.xii.1995, both YSBT, WDP. O'AHU: Round Top Dr., 900 ft, 10–24.vi.1997, YSBT, WDP.

Cecidomyiidae***Mycodiplosis pucciniacola* (Hardy)****New island record**

An endemic species previously recorded from O'ahu.

Material examined. MOLOKA'I: Hālawā Valley, 200 ft, 16–30.ix.1994, YSBT, WDP.

Ceratopogonidae***Forcipomyia borbonica* Clastrier****New island record**

An immigrant species previously recorded from O'ahu, this midge was collected only in the coffee fields of Moloka'i.

Material examined. MOLOKA'I: Kualapu'u, 750 ft, 31.iii–14.iv.1995, in coffee field, YSBT, WDP.

Chironomidae***Cricotopus bicinctus* (Meigen)****New island record**

An immigrant species previously recorded from Kaua'i and O'ahu.

Material examined. MOLOKA'I: Pāpio Stream, 600 ft, 2–16.ix.1994, YSBT WDP.

Goeldichironomus holoprasinus* (Goeldi)*New island record**

An immigrant species previously recorded from O'ahu.

Material examined. MOLOKA'I: Pala'au State Park, 1500 ft, 15.iv.1994, WDP.

Thalassomya setosipennis* Wirth*New island record**

An endemic marine species previously recorded from Kaua'i, O'ahu, Maui and Hawai'i.

Material examined. MOLOKA'I: Puko'o Harbor, at sea level. 17.ii.1995 WDP.

Chloropidae***Gampsocera hardyi*** Kanmiya**New island records**

An immigrant species previously recorded from Kaua'i and O'ahu.

Material examined. **MOLOKA'I:** Hälawa Valley, 200 ft, 5–19.viii.1994, in melon fly trap. WDP. **HAWAI'I:** Pāpa'ikou along the road to Onomea Bay, 150–200 ft, and Manukā nr. mile post 82, ca. 1700 ft, both 20.x–3.xi.1995, YSBT, WDP. **MAUI:** Ke'anae, 3 ft, Honomanū Bay, 5 ft, nr. Huelo, ca. 600 ft, Lo'iloa, ca. 600 ft, and nr. O'opuola, ca. 800 ft, all 18.xi–2.xii.1995, YSBT, WDP.

Liohippelates collusor (Townsend)**New island record**

First reported by Hardy (1963: 210–11) from Kure, the establishment of this pest species in Hawai'i was later questioned as possibly being erroneous (Hardy, 1980: 419). A large series was taken at Barbers Point. Fortunately no reports of this species causing irritations or conjunctivitis on O'ahu have been filed.

Material examined. **O'AHU:** Barbers Point Lighthouse, 5 ft, i.1995, YSBT, T.M. Mitomi, WDP (det. by Curtis Sabrosky).

Meromyza communis Fedoseeva**New state record**

A wide ranging Nearctic species which has been collected across the Continental United States, north to Alaska and south to Mexico (Fedoseeva, 1971: 521). The large swollen hind femur of this species serves as a good character to separated it from other Hawaiian chloropids.

Material examined. **MAUI:** Kahalui, Kanahā Pond, sea level, 6.ix.1996, in grass, WDP (det. by Curtis Sabrosky).

Neoloxotaenia gracilis (Meijere)**New island records**

An immigrant species previously recorded from Kaua'i and O'ahu.

Material examined. **MOLOKA'I:** Pala'au State Park, 1500 ft, 30.ix–14.x.1994, YSBT, WDP. **MAUI:** Ke'anae, 3 ft, and nr. O'opuola Stream, ca. 800 ft, both 18.xi–2.xii.1995, YSBT, WDP.

Rhodesiella elegantula (Becker)**New island records**

An immigrant species previously recorded from Kaua'i, O'ahu and Hawai'i.

Material examined. **MOLOKA'I:** Pala'au State Park, 1500 ft, 20.i–3.ii.1995, YSBT, WDP. **MAUI:** Lo'iloa, ca. 600 ft, 18.xi–2.xii.1995, WDP.

Chyromyidae***Gymnochironomyia hawaiiensis*** Hardy**New island record**

An immigrant species previously recorded from O'ahu, Maui and Hawai'i.

Material examined. **MOLOKA'I:** Honomuni Stream, ca. 10 ft, 30.ix–14.x.1995, YSBT, WDP.

Nannodastia horni Hendel**New island record**

An immigrant species previously recorded from O'ahu.

Material examined.: **MOLOKA'I:** Kalaniana'ole Colony, 3 ft, 5–19.i.1996, YSBT, WDP.

Drosophilidae***Dettopsomyia formosa*** (Lamb)**New island record**

An immigrant species previously recorded from O'ahu, Maui and Hawai'i.

Material examined. **MOLOKA'I:** Honomuni Stream, ca. 10 ft, 16–30.ix.1994, YSBT, WDP.

Drosophila quadrilineata (Meijere)**New state record**

A species which is attracted to ripe fruits, their exudates and animal excreta. Consumption of fruit containing the eggs of this species may result in transitory intestinal myiasis (Bohart & Gressitt, 1951: 92).

Material examined. **O'AHU:** UH Manoa Campus, ca. 80 ft, 16.iii.1995, L.T.Doescher (det. Hampton Carson).

Drosophila suzukii (Matsumura)**New island record**

An immigrant species previously recorded from Kaua'i, O'ahu and Hawai'i.

Material examined. **MOLOKA'I:** Mapulehu nr. 'Ili'ili'ōpae Heiau, 50 ft, 30.ix–14.x.1994, YSBT WDP.

Leucophenga maculosa (Coquillett)**New island record**

An immigrant species previously recorded from O'ahu, Lāna'i, Maui, and Hawai'i.

Material examined. **MOLOKA'I:** Moloka'i Airport, ca. 300 ft, 3.ii.1995, WDP.

Empididae***Chersodromia hawaiiensis*** Melander**New island records**

A small dark endemic species previously recorded from O'ahu has been collected on both dark and light colored beach sands.

Material examined. **MAUI:** Kahalui, Maui Beach, 3–vii–[19]68, J.A. Tenorio. **MOLOKA'I:** Kamalo, sea level. 17.iii.1995, WDP.

Elaphropeza* sp.*New state record**

This species belongs a very large cosmopolitan genus. We have been unable to identify it to species.

Material examined. **MOLOKA'I:** Kalaniana'ole Colony, 5 ft, 9–23.vi.1995, YSBT placed in *Atriplex* and *Chenopodium* shrubs. J.W. Beardsley, WDP. **O'AHU:** West Loch of Pearl Harbor, 3 ft, YSBT, WDP

Ephydriidae***Donaceus nigronotatus*** Cresson**New island record**

An immigrant species previously recorded from Kaua'i, O'ahu, Maui, and Hawai'i.

Material examined. **MOLOKA'I:** Mouth of Honoulimalo'o Stream, sea level, 17.ii.1995, WDP.

Notiphila insularis Grimshaw**New island record**

An endemic species previously recorded from Kaua'i, O'ahu, Moloka'i and Hawai'i.

Material examined. **MAUI:** Honomanu Bay, 5 ft, 2.xii.1995, WDP.

Ochthera circularis Cresson**New island record**

An immigrant species previously recorded from Kaua'i, O'ahu and Maui.

Material examined. **MOLOKA'I:** Kīpapa, 3 ft, 26.v.1995, pond of brackish water, WDP.

Heleomyzidae***Spilochroa ornata*** (Johnson)**New state record**

The infuscation pattern of the wings (Williston, 1908: 297, fig. 117: 3) is unique to this species.

Material examined. **O'AHU:** Campbell Industrial Park, 5–10 ft, 6–17.ii.1997, yellow pan trap, J.W. Beardsley, WDP (det. by A. Norrbom & Curtis Sabrosky).

Lauxaniidae***Poecilominetta sexseriata*** Hendel**New island records**

An immigrant species previously recorded from Kauaʻi, Oʻahu, and Hawaiʻi.

Material examined. **MOLOKAʻI:** Mapulehu, 10–40 ft, 13.v.1994, sweeping, J.W. Beardsley, WDP. **MAUI:** Honomanū Bay, 5 ft, 2.xii.1995, WDP.

Lonchaeidae***Lamprolonchaea metatarsata*** (Kertész)**New island record**

An immigrant species previously recorded from Kauaʻi, Oʻahu, Maui, and Hawaiʻi.

Material examined. **MOLOKAʻI:** Mapulehu, 40 ft, 30.ix.1994, WDP.

Neriidae***Teleostylinus lineolatus*** (Wiedemann)**New island record**

An immigrant species previously recorded from Kauaʻi, Oʻahu, and Hawaiʻi.

Material examined. **MOLOKAʻI:** Honomuni Stream, ca. 10 ft, 22.vii.1994, reared from fruits of *Passiflora* sp., WDP. **MAUI:** Loʻiloa, ca. 600 ft, 18.xi–2.xii.1995, YSBT, WDP.

Otitidae***Notogramma cimiciforme*** Loew**New island record**

An immigrant species previously recorded from Niʻihau, Kauaʻi, Oʻahu, Lānaʻi, and Maui.

Material examined. **MOLOKAʻI:** Manawai, 10 ft, WDP.

Phoridae***Puliciphora borinquenensis*** Wheeler**New island record**

An immigrant species previously recorded from Oʻahu.

Material examined. **MOLOKAʻI:** Palaʻau State Park, 1500 ft, 18.viii.–ix.1995, YSBT, WDP.

Piophilidae***Piophila australis*** (Harrison)**New island record**

An immigrant species previously recorded from Kauaʻi and Oʻahu.

Material examined. **MOLOKAʻI:** Hanalilililo Trail, 3300 ft, 14.ix.1994, WDP.

Sarcophagidae***Johnsonia elegans*** Coquillett**New island records**

An immigrant species previously recorded from Oʻahu.

Material examined. **HAWAIʻI:** Mile post 18 along Hawaiʻi Belt Road nr. Puʻu Anahulu, ca. 2150 ft, 20.x–3.xi.1995, YSBT, WDP. **MOLOKAʻI:** Hālawa Valley, 200 ft, 26.iv–10.v.1996, YSBT, WDP.

Scatopsidae***Coboldia fuscipes*** (Meigen)**New island record**

An immigrant species previously recorded from Oʻahu.

Material examined. **MOLOKAʻI:** Mapulehu nr. ʻIliʻiliʻōpae Heiau, 40–60 ft, 28.x–11.xi.1994, YSBT, WDP.

Psectrosciara brevicornis Johannsen**New island record**

An immigrant species previously recorded from Oʻahu and Maui.

Material examined. **MOLOKAʻI:** Honomuni Stream, ca. 10 ft, 14–28.x.1994, YSBT, WDP.

***Rhegmoclemina parvula* Hardy** **New island records**

An immigrant species previously recorded from O'ahu.

Material examined. **MOLOKA'I:** Kakahai'a County Park, 2 ft, 3–17.iii.1995, YSBT, WDP. **MAUI:** Ke'anae, 3 ft, nr. Pa'akea Gulch, ca. 1250 ft, Honomanū Bay, 5 ft, all 18.xi–2.xii.1995, YSBT, WDP.

Stratiomyidae***Evaza javanensis* Meijere** **New island record**

An immigrant species previously recorded from Kaua'i, O'ahu, Maui, and Hawai'i.

Material examined. **MOLOKA'I:** Hālawa Valley, 200 ft, 16–30.ix.1994, YSBT, WDP.

***Odontomyia ochropa* Thomson** **New island record**

An immigrant species previously recorded from O'ahu.

Material examined. **MOLOKA'I:** Kīpapa, 1 ft, 23.vi.1995, pond of brackish water, WDP.

Syrphidae***Eumerus aurifrons* (Wiedemann)** **New island record**

An immigrant species previously recorded from Kaua'i, O'ahu Lāna'i, and Hawai'i.

Material examined. **MOLOKA'I:** Kalaniana'ole Colony, 3 ft. 26.iv–10.v.1996, WDP.

Tephritidae***Dioxya sororcula* Lawson** **New island record**

An immigrant species previously recorded from Kaua'i, O'ahu, and Moloka'i.

Material examined. **HAWAI'I:** Kohala Mountain Road, ca. 3400 ft, 20.x–3.xii.1995, YSBT, WDP.

***Tetreuaresta obscuriventris* (Loew)** **New island record**

In 1961 this species was purposely introduced from Fiji and released on Kaua'i, O'ahu, Maui, and Hawai'i as a biological control agent for the noxious weed, elephants-foot, *Elephantopus mollis* Kunth (Asteraceae) (Hardy, 1980: 57).

Material examined. **MOLOKA'I:** Pāpio Stream, 600 ft, 19.viii–2.ix.1994, YSBT, WDP.

Acknowledgments

We thank Dr. A. Norrbom and the late Dr. Curtis W. Sabrosky, Systematic Entomology Laboratory, USDA, Mr. Gordon Nishida, Bernice P. Bishop Museum and Dr. Hampton Carson and Messrs. Kelvin Kanegawa and Dick Tsuda of the University of Hawaii at Manoa and their staffs for access to collections and help in identifying specimens. Special thanks to Kaluakoi Resorts, Coffees of Hawaii, Mr. and Mrs. Steven Petro and the late Dr. Jan Newhouse and Mrs. Jan Newhouse, all Moloka'i land owners, without whose cooperation much of this paper would not be possible. Field work on Moloka'i was funded by a grant from the State of Hawaii, Governor's Agricultural Coordinating Committee to the University of Hawaii at Manoa.

This paper is dedicated in memory of the late Drs. Jan Newhouse and Curtis Sabrosky.

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**The occurrence and description of
Neocaridina denticulata sinensis (Kemp, 1918) (Crustacea: Decapoda:
Atyidae), a new introduction to the Hawaiian Islands¹**

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First found in the Hawaiian Islands in 1991 (Devick, 1991), the introduced freshwater shrimp *Neocaridina denticulata sinensis* (Kemp) is now widespread throughout O'ahu. Recently, we examined specimens collected from widely separated O'ahu localities that had previously been reported as *Caridina weberi* by Devick (1991). These specimens proved to be *N. d. sinensis*, a subspecies previously known only from the Chinese mainland and Taiwan. The discovery of this introduced shrimp species raises the total number of atyid species from Hawaiian Islands to five, with two species now found in freshwater habitats. Atyid shrimp native to Hawai'i are: *Atyoida bisulcata* Randall, *Antecaridina lauensis* (Edmondson), *Halocaridina rubra* Holthuis, and *Halocaridina palahemo* Kensley & Williams (Eldredge & Miller, 1997). Both species of *Halocaridina* are found in anchialine pool habitats, *A. lauensis* is marine, and *A. bisulcata* is the only native freshwater atyid shrimp in Hawai'i.

In this paper we redescribe *N. d. sinensis* from specimens collected in O'ahu, Hawai'i, provide ecological and distributional information, and discuss potential impacts on the culturally important endemic Hawaiian stream shrimp, *Atyoida bisulcata*. As there is a size overlap between the native *A. bisulcata* and *N. d. sinensis*, we provide detailed drawings of the latter species to enable the differentiation between the native and introduced freshwater atyid shrimp species. We also provide evidence that *N. d. sinensis* originated from aquarium releases into O'ahu streams.

Specimens are vouchered in Bishop Museum (BPBM) and Zoological Reference Collection, National University of Singapore (ZRC).

***Neocaridina denticulata sinensis* (Kemp) New state record**
(Figs. 1–3)

Caridina denticulata sinensis Kemp, 1918: 287, fig.11(c,d). [type locality: Taihu Lake, near Shanghai, eastern China.]

Neocaridina denticulata sinensis: Kubo, 1938: 28, fig. 10(c,f), fig.11(c); Cai, 1996: 132, figs.1–2. [See Cai, 1996 for full synonymy.]

Material examined. O'AHU: 1 male, cl. 3.8 mm, 4 females, cl.3.8–4.8 mm, ZRC; 1 male, 3.1 mm, 5 females, 4.0–4.8 mm, BPBM; Maunawili Stream, at Maunawili Road bridge, 24 m, 21 April 1998 (R.A. Englund). 5 males, cl. 3.7–4.4 mm, 5 females (4 ovigerous), cl. 4.3–5.0 mm, ZRC; 1 male, cl. 3.8 mm, 6 females (3 ovigerous), cl.4.7–6.2, BPBM; Nu'uuanu Stream, Board of Water Supply pump house area, 240 m, 9 July 1998 (R.A. Englund & D.J. Preston). 1 male, cl. 3.5 mm, 2 females (1 ovigerous), cl. 4.6–4.9 mm, ZRC; 2 males, cl. 3.0–3.2mm, 3 females, cl. 3.7–4.8 mm, BPBM; Pet's Plus Petshop, 4 July 1998, Ward Avenue, Honolulu (R.A. Englund). 3 males, cl. 3.0–3.3 mm, 4 females (3 ovigerous), cl. 3.8–5.0 mm, ZRC, 11 males, cl.1.7–2.9 mm, 27 males (7 ovigerous), cl. 2.3–4.5 mm, BPBM, Waikele Stream at Waikele Springs, 1–7 m, 9 July 1998, (R.A. Englund & D.J. Preston). Numerous individuals, Mānoa Stream near Mānoa Elementary School, 55 m eleva-

1. Contribution No. 1999-019 to the Hawaii Biological Survey.

tion, 8 May 1998 (R.A. Englund & D.J. Preston). Numerous individuals, Ho'omaluhia Reservoir and Kamo'oali'i Stream (a Kane'ohe Stream tributary), 1993, (M. Yamamoto & A. Tagawa, Hawaii Division of Aquatic Resources).

Description

The abbreviation, cl. is used for carapace length (measured from the postorbital margin to the posterior margin of the carapace). Rostral formula citation and morphological terminology follow that by Chace & Bruce (1993).

Rostrum straight, reaching to end of 2nd segment of antennular peduncle in male; to end of 3rd segment in females, never beyond it. Rostral formula 1-3 (mode 2)+8-18 (11-14)/1-6(mode 2-4); inferior orbital angle of carapace fused with antennal spine; pterygostomial angle rectangular with tiny spine. Telson ending in median projection; 4 pair of dorsal spinules, 1 pair of dorsolateral spines near distal end, 4 pair of spines on distal margin, lateral pair longer than sublateral pair, subequal to intermediate pairs; preanal carina rounded, no spine. Scaphocerite $3.0 \times$ as long as wide.

Eyes well developed. Antennular peduncle stout, $0.75\text{--}0.85 \times$ as long as carapace; stylocerite distinctly reaching not beyond end of basal segment of peduncle. Scaphocerite $3.5 \times$ as long as wide. Mouthparts as in Fig. 1, palp of first maxilliped broadly rounded. Third maxilliped reaching the end of second segment of antennular peduncle, ultimate segment as long as penultimate segment.

First pereopod reaching to end of basal segment of antennular peduncle; chela $2.0\text{--}2.2 \times$ as long as broad, fingers slightly longer or as long as palm; carpus short, as long as palm, $1.4 \times$ in female, $1.7 \times$ in male, as long as high; merus stout, as long as carpus, $2.5 \times$ as long as wide. Second pereopod slender, reaching slightly beyond end of second segment of antennular peduncle, chela $2.4\text{--}2.6 \times$ as long as broad; fingers $1.3 \times$ as long as palm; carpus $1.2 \times$ longer than chela, $5.0 \times$ as long as high; merus as long as chela. Third pereopod reaching end of antennular peduncle, dactylus terminating in 2 claws, 5-8 accessory spines on flexor margin; propodus slightly curved inwards, $3.0 \times$ as long as dactylus (terminal spine included), $8.0 \times$ as long as broad, numerous spinules on posterior margin; merus stout. Fifth pereopod reaching end of basal segment of antennular peduncle; dactylus stout, 35-56 denticulate spines on flexor margin in male, slender, 50-65 denticulate spines on flexor margin in female. Propodus stout, $9.0 \times$ as long as broad, $3.4 \times$ as long as dactylus in female, slender, $12 \times$ as long as broad, $2.7 \times$ as long as dactylus in male.

Endopod of the male first pleopod extending to $0.7 \times$ exopod length, rounded, pear-shaped, $1.2 \times$ as long as broad, numerous tiny spinules on dorsal surface. Appendix interna short, at base of swollen part. Appendix masculina of male second pleopod dilated, reaching to $0.6 \times$ endopod length, inner and distal surface densely lined with long spinules; appendix interna at basal quarter of appendix masculina, extending to distal $1/3$ of appendix masculina. Uropodal diaeresis with 9-13 spinules. Eggs $1.00\text{--}1.18 \times 0.65\text{--}0.78$ mm diam.

Kemp (1918) separated *Neocaridina denticulata sinensis* from the nominal subspecies mainly on the basis of the rostral formula: $14\text{--}22/3\text{--}8$ (vs. $10\text{--}15/2\text{--}5$), and the anterior carpus margin of the first pereopod, which is deeply excavate as compared to slightly excavate. The difference in the rostral formula for the 2 subspecies is not significant ($8\text{--}19/1\text{--}9$ in *N. d. sinensis* vs. $10\text{--}20/0\text{--}7$ in *N. d. denticulata*), but rostrum length is more helpful for separation (Kubo, 1938). The rostrum of *N. d. sinensis* does not reach beyond the end of antennular peduncle as compared to much beyond in *N. d. denticulata*.

Color

Hung *et al.* (1993) reported the color for this subspecies as "Body color varying from black, brown, dark red, dark green, white to translucent, sometimes also covered with stripes". The specimens from the Chinese mainland have the same color pattern as those from Taiwan. (Y. Cai, pers. observ.). On O'ahu, the body color of wild *N. d. sinensis* collected in streams ranged from a nearly translucent light brown to dark brown, often with

a darker brown stripe running along the entire dorsal portion of the body. Purchased shrimp were lighter with little coloration, and almost translucent in coloration.

Habitat

In its native range, *N. d. sinensis* was reported from rivers, channels in agricultural fields, mountain streams, reservoirs, and ponds (Cai, 1996). On O'ahu, this species has been collected in Nu'uuanu and Ho'omaluhia Reservoirs and in natural and channelized stream habitats. *Neocaridina d. sinensis* was found only in areas of freshwater on O'ahu and inhabited a wide range of stream habitats, from the clear, cool Waikele Spring complex found at Waikele Stream, to high water velocity riffles downstream of this spring area, and also in aquatic vegetation lining the stream channel. This species was also common in disturbed aquatic habitats such as the concrete channel raceways below Nu'uuanu Reservoir.

Discussion

No major differences were apparent between the Hawaiian, Chinese mainland, and Taiwan populations of *N. d. sinensis* except egg size. Eggs were slightly larger in Hawai'i ($1.00\text{--}1.18 \times 0.65\text{--}0.78$ mm) than in the Chinese mainland ($0.85\text{--}1.05 \times 0.55\text{--}0.65$ mm) or Taiwan (1.08×0.57 mm) populations. *Neocaridina d. sinensis* is widely distributed in central and eastern China, Yunnan province of China, and Taiwan (Hung *et al.*, 1993; Cai, 1996).

The occurrence of *N. d. sinensis* in Yunnan province in southwestern China may also be due to human introduction. Although it is now commonly found in most parts of Yunnan province, *N. d. sinensis* had not been recorded from this area until the 1980s. It is likely that *N. d. sinensis* was introduced when needle fish (*Neosalanx* sp.) from Taihu Lake in eastern China were introduced to the plateau lakes of Yunnan province (Y. Cai & Dai A.Y., unpubl.). Taihu Lake is the type locality of *N. d. sinensis*.

Neocaridina d. sinensis appears to be spreading rapidly throughout O'ahu, and was found in high densities in five widely separated windward and leeward O'ahu drainages. This species was not found during surveys conducted in Waikele Stream or its tributaries in 1993 or April 1997 (Englund, 1993, 1997), but was abundant in Waikele Stream in 1998. In O'ahu streams, the introduced atyid shrimp was most abundant in high water velocity areas such as run and riffles but was also common in aquatic vegetation and stream side margins. In Waikele Stream *N. d. sinensis* were most common in areas of higher water velocities that averaged 33–52 cm/second but were also found in clear, cold spring areas with velocities as low as 10 cm/second (Englund & Filbert, in press).

Nu'uuanu and Ho'omaluhia Reservoirs also contain large *N. d. sinensis* populations. Unlike the native freshwater atyid shrimp *Atyoida bisulcata*, *N. d. sinensis* does not have an obligate marine phase (Hung *et al.*, 1993) and is restricted to freshwater. Thus, *N. d. sinensis* must have spread into separate watersheds by repeated human introductions. Small feeder aquarium shrimp were purchased at Pet's Plus Petshop on Ward Avenue in Honolulu, and these specimens were identified as *N. d. sinensis*. This is strong evidence that *N. d. sinensis* was introduced to O'ahu streams as an escaped or released aquarium species. According to the pet shop owner, these feeder shrimp are regularly purchased from O'ahu breeders rearing these shrimp in their backyards in 200 liter drums.

It is possible that *N. d. sinensis* will compete for food and space with the native atyid shrimp *Atyoida bisulcata*, as they occupy similar habitats and have overlapping eleva-

tional distributions. In Waikele Stream, *N. d. sinensis* was found in high densities, and several hundred introduced shrimp were collected in each aquatic dip net sample. We did not observe any native atyid shrimp in O'ahu streams where the introduced *N. d. sinensis* was found, despite these areas being suitable elevations and habitats for the native *A. bisulcata*. Native Hawaiian atyid shrimp are amphidromous (Meyers, 1949), and require access to the ocean to complete their life cycle, while the introduced *N. d. sinensis* reproduce only in freshwater (Hung *et al.*, 1993). While this difference in reproductive biology could slow the island-wide spread of *N. d. sinensis*, it could also provide a competitive advantage to this introduced species in the numerous diverted streams found in the Hawaiian Islands.

The Chinese experience in translocating *N. d. sinensis* into areas outside of its native range may indicate this species could adversely impact the native freshwater Hawaiian atyid shrimp, *A. bisulcata*. In China, *N. d. sinensis* is one of the most adaptable and hardy shrimp species, and the large eggs of this species ensure that the larvae undergo a rapid development period (Zhang & Sun, 1979). In contrast, migratory atyid shrimp undergo an extended larval development period (March *et al.*, 1998). In areas where it has been introduced or is naturally found, *N. d. sinensis* occurs in large numbers, and it rarely occurs sympatrically with other atyid shrimp species (Y. Cai, pers. observ.). The introduction of *N. d. sinensis*, *Exopalaemon modestus* (Heller), and *Caridina aff. gracilipes* De Man, and exotic fish species into Dianchi Lake, China is believed to be responsible for the disappearance of an endemic atyid shrimp species, *Caridina dianchiensis* (Liang & Yan). *Caridina dianchiensis* is now found only in rivers and mountain streams lacking *N. d. sinensis* (Liang & Yan, 1985).

Acknowledgments

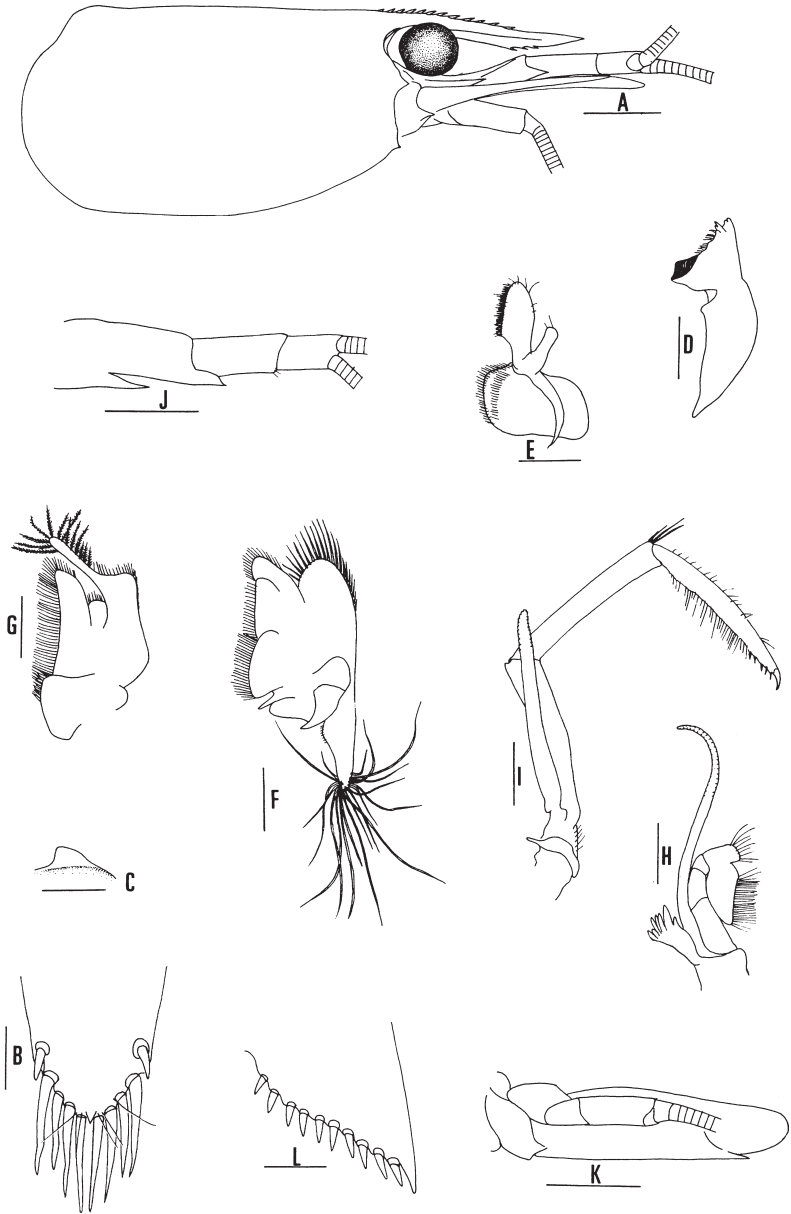
This study was funded as part of a grant from the David and Lucile Packard Foundation. We thank L.G. Eldredge, Bishop Museum for his helpful reviews and encouragement of this publication, and Peter K.L. Ng of the National University of Singapore for his support and critical manuscript reviews. Mike Yamamoto and Annette Tagawa of the Hawaii Division of Aquatic Resources also assisted by providing location information and site locations. D.J. Preston, Bishop Museum enthusiastically assisted with field work.

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Fig. 1. *Neocaridina denticulata sinensis*, male, cl. 4.2 mm (ZRC. 1998.901) **A.** cephalothorax and its appendages; **B.** distal portion of telson, **C.** preanal carina, **D.** mandible, **E.** maxillula, **F.** maxilla, **G.** first maxilliped, **H.** second maxilliped, **I.** third maxilliped, **J.** antennular peduncle, **K.** scaphocerite, **L.** uropodal diaeresis. Scales: A, J, K = 1 mm; C, D, E, F, G, H, I = 0.5 mm; B, L = 0.2 mm.



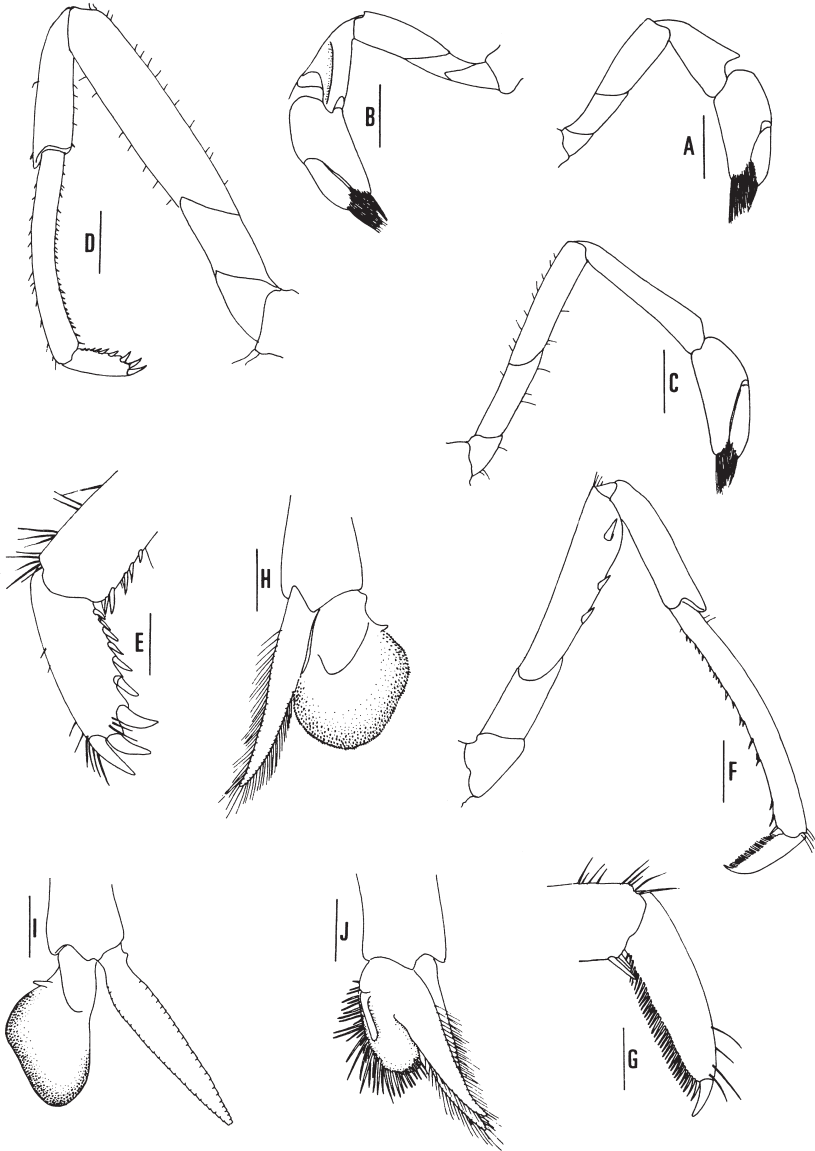


Fig. 2. *Neocaridina denticulata sinensis*. male, cl. 4.2 mm (ZRC. 1998. 901) A, B. first pereiopod, C. second pereiopod, D. third pereiopod, E. dactylus of third pereiopod, F. fifth pereiopod, G. dactylus of fifth pereiopod, H, I. first pleopod, J. second pleopod. Scales: A, B, C, D, F, H, I, J = 0.5 mm; E, G = 0.2 mm.

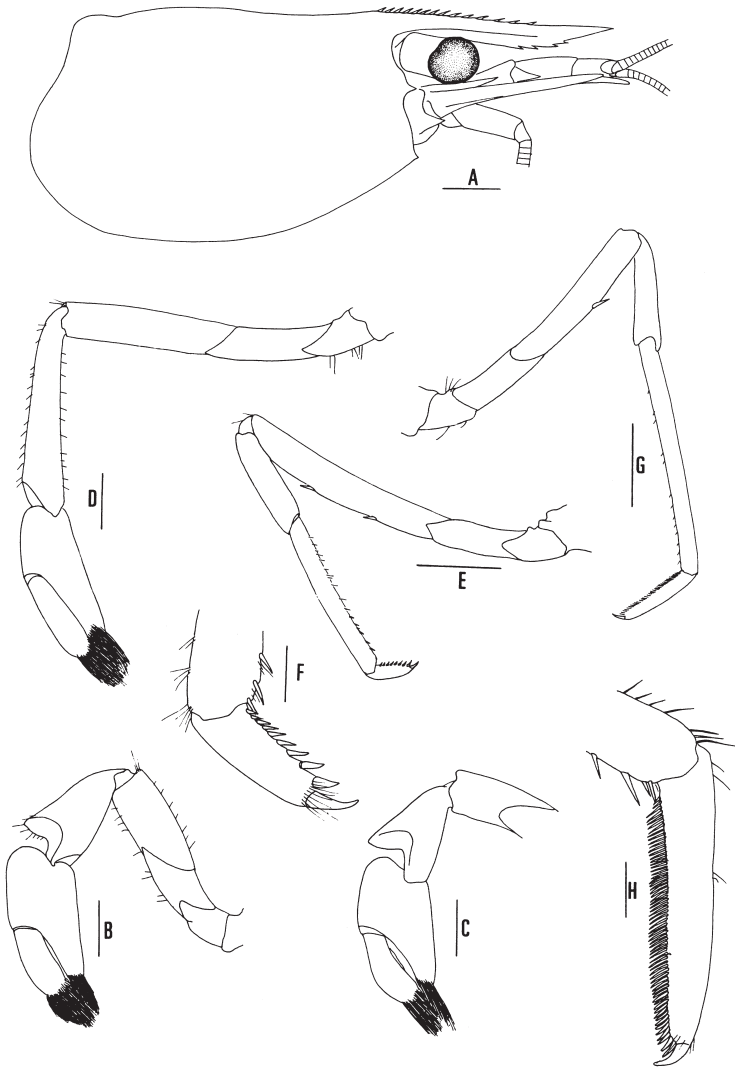


Fig. 3. *Neocardina denticulata sinensis*. female, cl. 5.4 mm (ZRC. 1998.901) **A.** cephalothorax and its appendages, **B.** **C.** first pereopod (**C.** another female, from same lot, cl. 5.7 mm), **D.** second pereopod, **E.** third pereopod, **F.** dactylus of third pereopod, **G.** fifth pereopod, **H.** dactylus of fifth pereopod. Scales: **A,** **E,** **G** = 1 mm; **B,** **C,** **D** = 0.5 mm; **F,** **H** = 0.2 mm.

The spread of the introduced freshwater apple snail *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) on O'ahu, Hawai'i¹

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Pomacea canaliculata, a native of South America, was first reported in the Hawaiian Islands on Maui in 1989. By the end of July 1992, the snail had been found at an additional two locations on Maui, two on Kaua'i, five on O'ahu, and two on the island of Hawai'i (Cowie, 1995). In 1995 it was reported from Lāna'i (Cowie, 1996).

Most of the documented impacts of the spread of *P. canaliculata* in the Hawaiian Islands are agricultural (Cowie, 1995, 1997). Initially, it was introduced to taro fields deliberately, in order to provide a secondary source of food and income for the taro-growers. However, the animal is now widely regarded as a pest of taro. Damage level is likely related to snail density, and in taro fields in Hawai'i, densities have exceeded 130 per m² (Cowie, in press). Though no figures are available for taro losses, in south-east Asia a density of 1 snail per m² can reduce rice yields by 20 % and yields decrease more than 90 % when 8 snails per m² are present (Naylor, 1996).

Little is known of the snail's impact on native freshwater snails or freshwater communities. *Pomacea canaliculata* feeds relatively indiscriminately on macrophytes (Neck, 1986; Schnorbach, 1995; Cowie, in press). The animal's voracious appetite, combined with its high fecundity, suggests that it has the potential to significantly alter community dynamics where it establishes (Cowie, in press). In Asia, it has been implicated in the decline of native freshwater snails (Halwart, 1994). Hawai'i's lowland aquatic habitats are already imperiled by urbanization, channelization, and the introductions of other invasive species, both plants and animals; its indigenous snail and other invertebrate species may not be able to withstand further assault.

Ampullariidae

Pomacea canaliculata (Lamarck, 1804)

Range extension

Here we report on material collected on O'ahu since 1992. Earlier material was reported by Cowie (1995). Two collections were made in 1993 and 1995 (see Material examined), but the majority of these new collections were made by us in 1998. Our focus was on natural, not agricultural (taro), ecosystems, although some collections were made from taro fields.

Snails were found at 28 sites (eggs but no snails at an additional site) in 19 bodies of water (see Material examined) out of a total of 139 sites surveyed in 98 bodies of water (Fig. 1). The appendix lists sites at which *P. canaliculata* was not found. The sites covered most of the localities on O'ahu that we considered possibly suitable for *P. canaliculata*, i.e., slow-flowing low-elevation streams, usually with muddy bottoms (not channelized), ponds, drainage ditches. Some sites at which no *P. canaliculata* were found may, in fact, have been unsuitable (e.g., streams that were too fast-flowing, intermittent streams, slightly brackish water), but we list them because we cannot make that judgement. Of the five locations on O'ahu reported by Cowie (1995), we revisited two (Waialua, Waipahu); snails were present at both. We did not revisit the 1990–92 Kualoa locality but *P. canaliculata* is known to be still present there (R. Helling, pers. comm.). We did not revisit the

1. Contribution No. 1999-020 to the Hawaii Biological Survey.

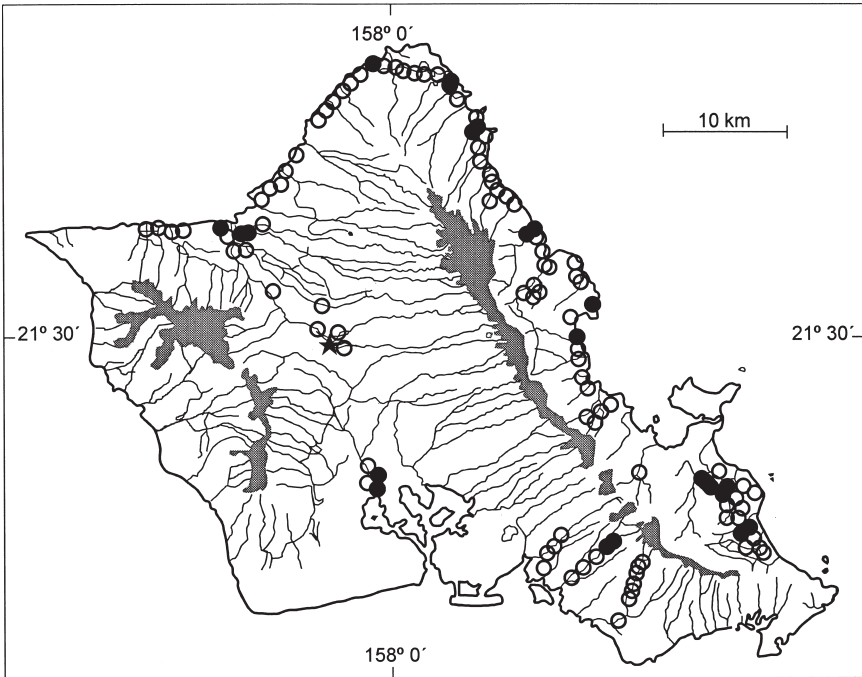


Fig. 1. Map of O'ahu showing water courses. Closed circles are locations at which *Pomacea canaliculata* was found. Open circles are locations that were searched but at which *P. canaliculata* was not found. In some cases circles are coincident because of the scale of the map. The star is the single site at which only eggs (no snails) were found. Shaded areas represent relief above 610 m elevation.

1991 Kahalu'u location, as this was in taro fields, although we investigated nearby areas and found no *P. canaliculata*. Neither did we revisit the precise location of the 1991 Hau'ula site, although we looked at several other sites in the vicinity but found no *P. canaliculata*. Eggs were collected from emergent vegetation in Wahiawā Reservoir (Lake Wilson), but despite extensive searching, no snails have been found there. No snails (or eggs) have been seen in any of the streams, other than those reported here, feeding into Pearl Harbor or Honolulu Harbor, despite extensive biological survey work (R. Englund, pers. comm.). Field notes and maps relating to our 1998 survey are archived at Bishop Museum.

These new records indicate that the distribution of *P. canaliculata* has increased greatly. Moreover, the snail is now found much more widely in areas not associated with agriculture (taro farming), including: Kahawai Stream, Maunawili Stream, Kawainui Marsh, Waikāne Stream, an unnamed stream in Lā'ie connecting 'Ihi'ihi Stream and Kahawainui Stream, Wahiawā Reservoir (eggs only recorded), Kapakahi Stream, and Nu'uauu Freshwater Fish Refuge. Relative to the distribution of apparently suitable freshwater systems, there does not appear to be a geographic pattern in the snail's known distribution on the island. Field observations suggest that *P. canaliculata* can survive, or even

thrive, in polluted and littered freshwater habitats; frequently we observed snails and eggs on emergent refuse.

The spread of *P. canaliculata* is probably due to a suite of causes: deliberate moving of snails for culture either in artificial aquaculture facilities (from which they escape) or in taro fields; accidental transport of eggs and/or young snails on taro for transplanting; release of snails used in domestic aquaria; natural spread via streams and other interconnected bodies of water; spread resulting from abnormal hurricane or flood events; and possible accidental transport of young snails attached to birds. We do not believe the snail has reached its full potential distribution on O'ahu. Many freshwater habitats appear suitable in terms of flow, vegetation, and available oviposition sites, but are not yet colonized.

Material examined. Unless otherwise stated, all material was collected together by Lori Lach and Robert H. Cowie. All catalog numbers are Bishop Museum (BPBM) Malacology Collection numbers. **O'AHU:** Kualoa Ranch, taro field, D. Carvalho, 7 January 1993 (251211); Waikāne Stream, at Kamehameha Highway bridge, R. Englund & R. Filbert, 28 December 1995 (253569); Kapakahi Stream, downstream of Farrington Highway, 19 May 1998, D.J. Preston, R. Englund, H. James (254031), 11 June 1998 (254054); Kawainui Marsh, off of Kapa'a Quarry Road (five locations from c. 200 m south of the refuse transfer station to just beyond the sharp bend in the road to the north of the model airplane field), 20 May 1998 (254048; dead shell only), 15 June 1998 (254060), 13 August 1998, R.H. Cowie (254049, 254050), 24 August 1998, R.H. Cowie (254051); Maunawili Stream, under bridge on road to country club, 21 May 1998 (254052); Kawai Nui Marsh, stream below Hanale Place, 5 June 1998 (254053); Waipahu Plantation Village, taro fields, 11 June 1998 (254055); Nu'uaniu Freshwater Fish Refuge, at weir under Nu'uaniu Pali Drive bridge, 11 June 1998 (254056); Nu'uaniu Freshwater Fish Refuge (upper lake), 11 June 1998 (254057); Waialua, ditches either side of Pu'uiki Street, 13 June 1998 (254058); Hale'iwa, roadside ditch at 66-240 Waialua Beach Road, 13 June 1998 (254059); Waikāne Stream, c. 100 m upstream from Kamehameha Highway bridge, 17 June 1998 (254061); Waimānalo, Kahawai Stream, at Mahailua Street bridge, 23 June 1998 (254062); Waimānalo, Kahawai Stream, under Kalaniana'ole Highway bridge, 23 June 1998 (254063); Waikāne Stream, c. 300 m downstream from Kamehameha Highway Bridge, 22 June 1998, Alakai Kim-Davis (254064); Punalu'u, ditch alongside Punalu'u Valley Road, 2 July 1998 (254065); ditch beside taro field alongside Punalu'u Valley Road (254066); Kahuku, ditch alongside unpaved road leading to Campbell National Wildlife Refuge, 2 July 1998 (254067); Lā'ie, in stream connecting 'Ihi'ihi Stream and Kahawainui Stream, alongside Po'oha'ili Street, 2 July 1998 (254068); Lā'ie, Hawai'i Reserves, Inc., ditch around taro fields, 2 July 1998 (254069); Kahuku, in stream at western edge of Campbell National Wildlife Refuge, 21 July 1998 (254070); Kawela Stream, where it goes under Kamehameha Highway, just west of Hanopu Street, 21 July 1998 (254071); Hale'iwa, taro field on south side of Waialua Beach Road, just east of Hale'iwa Road, 21 July 1998 (254072); Hale'iwa, ditch on north side of Waialua Beach Road, just east of Hale'iwa Road, 21 July 1998 (254073); Wahiawā, Wahiawā Reservoir (Lake Wilson), near bank opposite Schofield Barracks main entrance, 9 September 1998, A. Brasher, eggs only (254551).

Acknowledgments

We thank Anne Brasher for discussion and for assistance with field work, and the various people who provided material in addition to our own survey material. The 1998 field work was supported in part by a grant to LL from the Edna Bailey Sussman Fund.

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Appendix. Sites where neither *P. canaliculata* nor its eggs were observed

O‘AHU: Windward: Waimānalo, unnamed stream at Kalaniana‘ole Highway near Kaiona Beach Park; Waimānalo, tributary to Ino‘a‘ole Stream at Hihimanu Street; Waimānalo, tributary to Ino‘a‘ole Stream at Ahiki Street, at Makakalo Street, and at Hihimanu Street; Waimānalo, Ino‘a‘ole Stream off of Kalaniana‘ole Highway; Waimānalo, unnamed stream at Waikupanaha Street, at Mokulama Street, and at Hihimanu Street; Waimānalo, Kahawai Stream at Waikupanaha Street, at Kaka‘ina Street, and at Mekia Street; Waimānalo, Waimānalo Stream at Kalaniana‘ole Highway, at Kumuhau Street, and at Kaka‘ina Street; Enchanted Lake, Ka‘elepulu tributary between Kanapu‘u Drive and Kalaniana‘ole Highway, at Keolu Drive, and as it enters Enchanted Lake at Kiuke‘e Place; Enchanted Lake, stream at ‘Akumu Street, at Kāhili Street, at Alahaki Street, and at Keolu Drive; Lanikai, unnamed stream at ‘A‘alapapa Drive; Kailua, east side of Kawainui Marsh, alongside levee from Oneawa Channel to Kailua Road; Kailua, stream under Kailua Town Bridge, Kailua Road; Kailua, Ulupō Heiau off Kailua Road; Maunawili, Kahana Iki Stream under Kalaniana‘ole Highway, and at Auloa Road; Maunawili, unnamed tributary to Maunawili Stream at Auloa Road between Maunawili Road and Luna‘ai Street; Maunawili, unnamed tributary to Maunawili Stream off Maunawili Road before Aloha ‘Oe Drive, and at Aloha ‘Oe Drive between Kika Street and Mei Place, and at Aloha ‘Oe Drive between Kukana Place and Maleko Street, and its tributary at Aloha ‘Oe Drive between Hepaki Place and Lopaka Place; Maunawili, unnamed tributary to Maunawili Stream before Aloha ‘Oe Drive at Maunawili Road; Maunawili, unnamed tributary to Maunawili Stream at Kelewina Street, and at Maunawili Road between Aloha ‘Oe Drive and Kelewina Street; Maunawili, unnamed tributary to Maunawili Stream between Maunawili Road and Kelewina Place; Maunawili, Maunawili Stream upstream of Kelewina Street, after trailhead, at electric gate; Kāne‘ohe, Ho‘omaluhia Botanical Garden Reservoir; Kahalu‘u, unnamed stream at Kahekili Highway and Aha‘olelo Road; Kahalu‘u, tributary to Waihe‘e Stream at Ahilama Road and Māpele Roads; Kahalu‘u, taro fields at Ahilama Road; Kahalu‘u, tributary of Waihe‘e Stream at Māpele Road and Māpele Place; Kahalu‘u, Waihe‘e Stream at Ahilama Road; Kahalu‘u, unnamed stream at 47-653 Kamehameha Highway; Kahalu‘u, Ka‘alea Stream at Country Market; Waikāne, stream just south of Waikāne Stream off of Kamehameha Highway; Kualoa, stream at 49-176 Kamehameha Highway; Ka‘a‘awa, Ka‘a‘awa Stream at Kamehameha Highway; Ka‘a‘awa, unnamed stream between Ka‘a‘awa Place and Pōhuehue Road; Ka‘a‘awa, Makaua Stream at Kamehameha Hwy; Kahana, taro field at Kahana Bay across Kamehameha Highway from lagoon; Kahana, tributary to Kahana Stream near Kahana Valley

State Park; Kahana, Kahana Stream back of Kahana Beach Park; Punalu'u, unnamed stream near southern end of Punalu'u Beach Park; Punalu'u, Punalu'u Stream at Kamehameha Highway; Punalu'u, unnamed stream off of Punalu'u Valley Road; Punalu'u, Ponds at Punalu'u; between Punalu'u and Hau'ula, unnamed stream at Puhuli Street; Hau'ula, Kaluanui Stream from parking lot to Sacred Falls; Hau'ula, unnamed stream at Pokiwa'i Place; Hau'ula, Māka'o Stream at Hāla'i Street and Hau'ula Homestead Road; Hau'ula, unnamed stream at Kamehameha Highway between Kukuna Road and fire station; Hau'ula, Mahe'iwi Stream at Kamehameha Highway and at Hau'ula Homestead Road; Hau'ula, ditch along Kamehameha Highway between Pipilani Place and Hau'ula Homestead Road; Hau'ula, Kaipapa'u Stream near Pipilani Place; Hau'ula, Kokololio Stream at Kamehameha Highway; Lā'ie, Koloa Stream at Kamehameha Highway; Lā'ie, unnamed stream at Kamehameha Highway just south of Pakelo Place; Lā'ie, Lā'ieloa Stream at Kamehameha Highway; Lā'ie, Kahawainui Stream at Kamehameha Highway.

North: Kahuku, Māla'ekahana Stream at Kamehameha Highway; Kahuku, unnamed stream at Kamehameha Highway between unnamed road to airstrip and gated road, 0.25 km from each; Kahuku, unnamed stream at Kamehameha Highway between Marconi Road and unnamed road to airstrip; Kuilima, unnamed stream at Kamehameha Highway just north of Marconi Road; Kuilima, unnamed stream at Kamehameha Highway opposite golf links; Kuilima, Ō'io Stream at Kamehameha Highway; Kawela, Kawela Stream at Hanopū Street; Waiale'e, Pahipahi'ālua Stream at Kamehameha Highway; Waiale'e, Waiale'e Stream at Kamehameha Highway; Waiale'e, unnamed stream at Kamehameha Highway near University of Hawaii Waiale'e Livestock Research Farm; Sunset Beach, unnamed stream at Kamehameha Highway between Mamao Place and Wehiwa Place; Sunset Beach, Paumahu Stream at Kamehameha Highway near Paumalū Place; Sunset Beach, Pākūlena Stream at Ke Wa'ena Road and Kamehameha Highway; between Sunset Beach and Waimea, Kālunawaika'ala Stream at Kamehameha Highway near Kaha'e Road; Kawailoa Beach, unnamed stream at Kamehameha Highway and Punalau Place; Kawailoa Beach, unnamed stream between Pōhakuloa Way and Ashley Road at 68-489 Kamehameha Highway; between Kawailoa Beach and Hale'iwa, unnamed stream between Pāpa'iloa Road and Pōhakuloa Way; Hale'iwa, 'Uko'a Pond along Kawailoa Road, and behind the sugar mill, and at Hale'iwa bypass; Hale'iwa, Lokoea Pond at Kamehameha Highway and at Lokoea Place; Hale'iwa, Anahulu River at Hale'iwa bypass; Hale'iwa, Paukaui Stream at Kamehameha Highway, and at Hale'iwa bypass; Hale'iwa, Ki'iki'i Stream at Waiialua Beach Road; Hale'iwa, Poamoho Stream at Kaukonahua Road; Waiialua, Kaukonahua Stream at Farrington Highway; Mokulē'ia, unnamed stream at Farrington Highway west of Mahina'ai Street; Mokulē'ia, unnamed stream at Farrington Highway just east of polo field; Mokulē'ia, unnamed stream at Farrington Highway between Lā'au Pa'ina Place and Ho'omana Place; Mokulē'ia, unnamed stream at Farrington Highway, across from Dillingham Airfield.

Central: between Wahiawā and Waiialua, Poamoho Agriculture Research Station pond and irrigation ditches along Kaukonahua Road; Wahiawā, Poamoho Stream at Kamehameha Highway near Poamoho Camp; Wahiawā, Wahiawā (Wilson) Reservoir at Kamehameha Highway and Avocado Street, and at the west end of Wahiawā Freshwater Park, and at Wilikina Drive just west of Lakeview Circle, and at Wilikina Drive just east of the main entrance to Schofield Barracks, and at Wilikina Drive opposite Schofield Barracks near Kemo'o Farm; Wahiawā, stream outlet from reservoir at Wilikina Drive.

Leeward: Waipahu, Waikele Stream under Waipahu Street bridge, and between Farrington Highway and Waipahu Plantation Village.

East: Honolulu, Mānoa Stream and tributaries at Date Street and alongside Kaimukī High School playing field, and at Woodlawn Drive at Mānoa Market Place, East Mānoa Road at 'Ono Road, Lowrey Avenue near East Mānoa Road, Mānoa Gardens at Kahaloa Drive, East Mānoa Road below Kaamali Drive, at footbridge between Pāwaina Street and Paumaka Place, Wa'akaua Road,

and Wa'aloa Way; Honolulu, Nu'uaniu Stream at the two sites where Nu'uaniu Pali Drive crosses the stream downstream from the Nu'uaniu Freshwater Fish Refuge; Honolulu, Nu'uaniu Stream at Lili'uokalani Gardens; Honolulu, Kapālama Drainage Channel alongside Kohou Street; Honolulu, Kalihi Stream at Wilson Street and Likelike Highway, at Nalani'eha Street, and at Numana Road.

Numbers of Hawaiian species: supplement 4¹

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This is the fourth supplement to the earlier tabulations of species known from the Hawaiian Islands (Eldredge & Miller, 1995, 1997, 1998; Miller & Eldredge, 1996).

The Hawaiian Islands, by virtue of their geographic isolation, rich volcanic soils, and enormous topographic and climatic diversity, have produced a highly endemic biota, which includes many of the world's outstanding examples of adaptive radiation. The biota includes more than 23,000 species (Table 1). Much of this biota has proved vulnerable to extreme population reduction and even extinction from introduced predators, competitors, and diseases. Although Hawai'i comprises only ca. 0.2% of the land area of the United States, it has 31% of the nation's endangered species and 42% of U.S. endangered birds. Of the total of nearly 1,000 native flowering plant species, nearly 120 (12%) are down to ca. 20 or fewer individuals in the wild. Almost 75% of the historically documented extinctions of plants and animals in the United States has occurred in Hawai'i (A. Allison & S.E. Miller, unpubl.).

Hawaii Biological Survey is continually posting species checklists in searchable interfaces for the Hawaiian biota on our web server at: <http://hbs.bishopmuseum.org/>

More than 15,000 species are currently available (including terrestrial arthropods, native and alien land and freshwater snails, foraminiferans, flowering plants, amphibians, reptiles, birds, and mammals; marine invertebrates are being added).

In a recent review of the biota of Bermuda, Sterrer (1998) in "How many species are there in Bermuda?" compares that island's biota with that of the Hawaiian Islands. "Hawaii and Bermuda share gross similarities in latitude, isolation, and distance to the nearest continent, as well as a long record of natural history and research, any comparison of the biodiversity of the two archipelagos must consider a host of differences." Among these are significant geological and meteorological considerations; historical differences in human colonization patterns; and differential knowledge of Hawaiian and Bermudan biota. Bermuda has at least 8,299 species of which 4,597 are marine and 3,702 are terrestrial; Hawai'i, which has $2.68 \times$ more species, has an overall endemism rate of 38.0%, more than $10 \times$ that of Bermuda (3.0%) (Sterrer, 1998).

The aquatic fauna of a unique habitat—Sailor's Hat crater, an artificially formed anchialine pool on Kaho'olawe—was described for the first time (Brock & Bailey-Brock, 1998). The atyid shrimp *Halocaridina rubra*, an endemic species, is the only species that is restricted to anchialine habitats. In addition, the gastropod *Bittium zebra* is widely distributed in the Indo-Pacific; the serpulid tubeworm, *Vermiliopsis torquata*, is common in tidepools but is unknown in other anchialine pools; the aquatic insect, *Trichocorixa reticulata*, a nonindigenous species, is found in many coastal saline pools; 2 amphipods, *Nuuanu amikai* and *Eriopsis laakona*, have been reported from anchialine pools; other taxa were unidentified (Brock & Bailey-Brock, 1998).

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Table 1. Estimates of numbers of known species of Hawaiian biota (based on Eldredge & Miller, 1995, 1997, 1998; Miller & Eldredge, 1996; and including this paper and other papers in this issue of the *Records*). Algae, other protists, lichens, cnidarians, echinoderms, amphibians, and mammals remain the same as previous editions; other categories are based on updated counts.

Taxon	Total	Endemic	NIS
Algae	811	2	5?
Other protists	1128	2?	?
Fungi	1364	?	?
Lichens	723	240	?
Flowering plants	2443	1054	1090
Other plants	763	241	44
Cnidarians	356	75	10
Insects	8069	5315	2653
Other arthropods	1065	353	654
Molluscs	1653	956	89
Annelids	413	80	36
Crustaceans	1202	61+	51
Echinoderms	283	150	0
Other invertebrates	1337	439	33+
Fish	1207	144	73
Amphibians	5	0	5
Reptiles	27	0	23
Birds	294	63	46
Mammals	44	1	19
Totals	23,187	9176	4831

Bacteria

Antibody titers of the cat-scratch disease, bacillary angiomatosis, or bacteremia, *Bartonella henselae*; Hawai'i has a 47.4% prevalence (Jameson *et al.*, 1995); from the data, it appears that average daily temperature and annual precipitation play a role in the prevalence of cat infection. The intracellular bacteria, *Wolbachia*, was noted from *Drosophila simulans* from Hawai'i (Bourtzis *et al.*, 1998).

Fungi: Myxomycetes

Ten species and one variety of dictyostelid cellular slime molds noted, seven of which have not been reported previously from Hawai'i (Landolt & Wong, 1998).

Flowering Plants

The total of 2443 taxa includes native and naturalized plants, including Polynesian introductions that have naturalized. Of the naturalized flora, there are 1068 species, plus 22 Polynesian introductions which are naturalized (W.L. Wagner, pers. comm.).

The *Manual for the flowering plants of Hawai'i. Revised edition* (Wagner *et al.*, 1999) includes 33 new native taxa, 108 records of naturalized species previously undocumented, 75 records for naturalized species previously known only in cultivation or as adventives, 233 new island records, and 13 significant intraisland range extensions of both naturalized and native species. Seven articles on plants are included in the *Records of the Hawaii Biological Survey for 1998* [Bishop Mus. Occas. Pap. 58 and 59].

Cnidaria: Anthozoa

The suspected neoplasma in the Hawaiian deep-water coral *Madrepora kauaiensis* Vaughan is reinterpreted as cavities produced by a new species of endoparasitic petrarcid ascothoracid barnacle, *Petrarca madreporae* Grygier (*in* Grygier & Cairns, 1996).

Annelida

Two species of naidid oligochaete [*Haemonaid waldvogeli*, *Dero* (*Aulophorus*) *furcata*] have been reported, living symbiotically with the introduced apple snail *Pomacea canaliculata* (Britton & Wetzell, 1999), these are the first documented freshwater oligochaetes reported from Hawai'i. One leech [*Placobdelloides bdellae*] is newly reported from Kaua'i (Englund, 1999).

Mollusca

A new species of the "*Octopus aegina* group" has been discovered in shallow, coastal, subtropical waters of the Hawaiian Islands (Huffard & Hochberg, 1997). Three newly recognized snails were reported by Cowie (1999).

Arthropoda: Insecta and Related Forms

Nishida (1997a,b) provided a full bibliography and updated checklist for the Hawaiian insects and related arthropods. The major systematic papers that include Hawaiian material: review of the planthopper genus *Nesodryas* (Asche, 1998); investigations on the Salticidae (Berry *et al.*, 1998); notes on the mite genus *Euptyctima* (Niedbala, 1998); and a review of the genus *Aeletes* of the Hawaiian Islands (Yelámos, 1998). Nine additional articles on insects are included in the *Records of the Hawaii Biological Survey for 1998* [Bishop Mus. Occas. Pap. 58 and 59].

Arthropoda: Crustacea: Anostraca

A recent review identified *Artemia franciscana* from Laysan (Triantaphyllidis *et al.*, 1998), replacing *Artemia salina* var. *pacifica* reported by Sars (1904) and *Artemia salina* of Caspers (1981).

Arthropoda: Crustacea: Isopoda

The total number of oniscidean isopod species in Hawaii is 19, belonging to 13 genera and 7 families; 4 new species are described (Taiti & Howarth, 1997): *Hawaiioscia microphthalma*, *H. rotundata*, *H. paeninsulae*, *Aulaconiscus caecus* [*Aulaconiscus*, n. gen.]. Oniscidean *Halophiloscia couchii* (Kinahan) reported from Midway Atoll, first Hawaiian and first Pacific record (Taiti, 1999).

Arthropoda: Crustacea: Copepoda

A new species of parasitic copepod, *Jusheyhoea moseri* Kabata, from deep-water fishes is described (Kabata, 1991).

Arthropoda: Crustacea: Cirripedia

The chthamalid barnacle *Chthamalus proteus* Dando & Southward is reported from the main Hawaiian Islands and Midway Atoll (Southward *et al.*, 1998); this species has been found previously only from the Caribbean, Gulf of Mexico, and Brazil. Newly described ascothoracidan, *Petrarca madreporae* Grygier (*in* Grygier & Cairns, 1996) from galls in deep-water corals.

Arthropoda: Crustacea: Decapoda

Ten species of Hawaiian lobsters are photographed in color (Hoover, 1998). The pagurid hermit crab *Propagurus deprofundis* (Stebbing) is reported for the first time from Hawaiian waters (McLaughlin & de Saint Laurent, 1998). Seventeen of the largest and most common shallow water hermit crabs are photographed in color (Hoover, 1997a,b). New species of shrimp *Cinetorhynchus hawaiiensis* Okuno & Hoover [family Rhynchocinetidae] described (Okuno & Hoover, 1998), *C. concolor* (Okuno) newly reported (Okuno & Hoover, 1998). New island record for the atyid shrimp *Halocaridina rubra* (Holthuis) on Kaho'olawe in artificially formed Sailor's Hat crater (Brock & Bailey-Brock, 1998), previously known from O'ahu, Maui, and Hawai'i. First record of the nonindigenous atyid shrimp, *Neocaridina denticulata sinensis* (Kemp), numerous streams on O'ahu (Englund & Cai, 1999). The parthenopid crab, *Aethra edentata* Edmondson, previously known only from Hawai'i, is reported from the Ogasawara and Mariana Islands (Ng & Takeda, 1998).

Bryozoa

Four new records of introduced fouling bryozoans [*Bugula dentata*, *B. robusta*, *Caulibugula dentrograpta*, *C. calculata*] are reported (Zabin, 1999).

Echinodermata

Detailed observations on the deep-water echinoid, *Chaetodiadema pallidum* Agassiz & Clark, were given by Burch & Burch (1998).

Chordata: Pisces

New species described from Hawaiian waters: *Oxyurichthys heisei* Pezold [Gobiidae] (Pezold, 1998); *Pseudoamiops diaphanes* Randall and *Apogon deetsie* Randall [Apogonidae] (Randall, 1998a); *Sargocentron iota* Randall [Holocentridae] (Randall, 1998b); *Eustomias tomentosus* Clarke [Melanostomiidae] (Clarke, 1998). New records of fishes from Hawaiian waters: *Xanthichthys caeruleolineatus* Randall (Randall & Mundy, 1998); *Sargocentron spinosissimum* (Temminck & Schlegel) (Randall, 1998b); *Callichelys catostoma* (Forster) (McCosker, 1998); the long-nosed chimaera *Rhinochimaera pacifica* (Mitsukurii) is reported for the first time (Chave & Malahoff, 1998). *Balistes polylepis* Steindachner, previously considered to be waif in Hawaiian waters, is considered confirmed through a photograph of one guarding a nest which indicated the spawning has occurred (Randall & Mundy, 1998). The formerly known *Vitraria clarescens* Jordan and Everman is now considered a junior synonym of the freshwater goby *Sicyopterus stimpsoni* (Gill) (Greenfield *et al.*, 1998).

Chordata: Reptilia

Eighteen species of parasites [6 species of coccidia, 7 species of nematodes, 2 species of cestodes, 1 pentastomid species, and 2 species of ectoparasitic mites] are reported from the geckos *Hemidactylus frenatus* and *Lepidodactylus lugubris* (Hanely *et al.*, 1998).

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