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Cover photo *Solva* sp. (Diptera: Solvidae). Photo: Lowell Tyler.

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RECORDS OF THE HAWAII BIOLOGICAL SURVEY FOR 2015

Editor's Preface

I am pleased to present the annual compilation of *Records of the Hawaii Biological Survey*; this year for the year 2015. The Hawaii Biological Survey, established by the Hawaii State Legislature in 1992 as a program of Bishop Museum, is an ongoing natural history inventory of the Hawaiian Archipelago. It was created to locate, identify, and evaluate all native and nonnative species of flora and fauna within the state; and by State Law to maintain the reference collections of that flora and fauna for a wide range of uses. In coordination with related activities in other federal, state, and private agencies, the Hawaii Biological Survey gathers, analyzes, and disseminates biological information necessary for the wise stewardship of Hawaii's biological resources.

An intensive and coordinated effort has been made by the Hawaii Biological Survey to make our products, including many of the databases supporting the papers published here, available to the widest user-community possible through our web server. Products currently available include taxonomic authority files (species checklists for terrestrial arthropods, flowering plants, nonmarine snails, marine invertebrates, fossil taxa, and vertebrates), bibliographic databases (vascular plants, nonmarine snails, and insects), specimen databases (fungi, fish, invertebrates, portions of the insect collection) and type specimens (entomology; botany—including algae and fungi; and vertebrates), collections data (lists of holdings for select groups of flies as well as Cicadellidae and Pentatomidae), detailed information and/or images on endangered, threatened, and extinct plants and animals; as well as our staff publication lists. Additional reference databases include: the list of insect and spider collections of the world (based on Arnett, Samuelson & Nishida, 1993, *Insect and spider collections of the world*) with links to institutional web pages where known; and the historical world Diptera taxonomists list with names of over 5,800 authors who have described flies.

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

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

World Diptera taxonomist list

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

The *Records of the Hawaii Biological Survey for 2015* were compiled with reviews by and/or assistance of Clyde Imada (botany), Richard Pyle (ichthyology), and Robert Cowie (malacology). Many of the new records reported here resulted from curatorial projects and field surveys funded by the National Science Foundation, the U.S. Geological Survey Biological Resources Division, the U.S. Fish & Wildlife Service, and the Hawaii Department of Land and Natural Resources; they are thanked for their support and partnership of the Hawaii Biological Survey over the years..

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

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

—N.L. Evenhuis

Alien Freshwater Clams in the Hawaiian Islands¹

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Cowie (1997) reviewed Hawaiian records of alien nonmarine snails and slugs but did not address alien nonmarine bivalves. This note summarizes the literature on alien freshwater clams of the Families Corbiculidae and Sphaeriidae that have been reported to occur in the Hawaiian Islands and presents evidence refuting the suggestion that sphaeriids were introduced to the Hawaiian Islands prehistorically; they are instead modern introductions.

Corbiculidae

Corbicula fluminea (Müller, 1774)

Corbicula fluminea is a highly invasive freshwater clam of Asian origin (Counts 1986; Sousa *et al.* 2008) that first made its appearance in the Hawaiian Islands when living individuals were found for sale in an O'ahu market (Burch 1978). *C. fluminea* is now well established on that island (Devick 1991a; Eldredge 1994; Burch 1995; Englund & Filbert 1999; Englund & Godwin 2002; Englund *et al.* 2003; Brasher *et al.* 2004; Englund & Arakaki 2004) and has also been reported from the islands of Kaua'i (Heacock 1991; Devick 1991a; Eldredge 1994; Englund *et al.* 2002), Lāna'i (Staples & Cowie 2001), Maui (Hau 1991; Devick 1991a; Eldredge 1994; Higashi *et al.* 2008; Parham *et al.* 2008), and Hawai'i (Devick 1991a; Eldredge 1994; Englund *et al.* 2001).

Sphaeriidae

Musculium lacustre (Müller, 1774)

Musculium partumeium (Say, 1822)

Pisidium casertanum (Poli, 1791)

All three of these species are native to North America; *Musculium lacustre* has also been reported from Europe and Japan, while *Pisidium casertanum* also occurs in Eurasia, Central and South America, Africa, Australia, and New Zealand (Herrington 1962). In the Hawaiian Islands, Bryan (1915: 436–437, 440) reported unidentified species of *Sphaerium* and *Pisidium* to occur on “Oahu, Molokai, Kauai, and perhaps other islands of the group,” and Devick (1991b) and Eldredge (1994) reported the presence of an unidentified species of *Musculium* on O'ahu and Maui. *Musculium* was formerly regarded as a subgenus of *Sphaerium*, and Bryan's records may well refer to taxa now generally classified in *Musculium*. Herrington (1962) reported *M. lacustre* (as *Sphaerium lacustre*) to occur in the Hawaiian Islands but cited no authority or specimens to support that assertion; Miller (1966) included Hawai'i within range of the species on Herrington's authority. Its occurrence in the Hawaiian Islands requires verification. Burky *et al.* (2000) reported *M. partumeium* and *P. casertanum* to be present in taro ponds at Ke'anae, Maui, and subsequently Higashi *et al.* (2008) and Parham *et al.* (2008) reported *M. partumeium* and an unidentified species of *Pisidium* from the same Maui watershed.

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Although a discussion of the details of the suprageneric classification of the Sphaeriidae is beyond the scope of this note, it should be noted that Lee & Ó Foighil (2003) have proposed a substantial revision of the generic-level classification of the Sphaeriinae that would transfer *P. casertanum* to the genus *Cyclocalyx* Dall, 1903; they also contend that this widely distributed species is not monophyletic.

Burky *et al.* (2000:163) stated with regard to *M. partumeium* and *P. casertanum* that “it is probable that these clams have been continuously reintroduced in association with taro cultivation and the exchange of root stock from elsewhere in Polynesia ... over the approximately 1,500 year history of native Hawaiian culture.” While it is true that at least two and as many as four species of land snails were introduced to the Hawaiian Islands as a result of the pre-contact voyages of the Polynesians, all of these have been reported archaeologically from a number of other islands in tropical Polynesia and all are widely distributed in the region (Christensen & Weisler 2013). Sphaeriid clams, on the other hand, are absent from tropical Polynesia except for the few modern Hawaiian records (Bogan 2008), and recent studies of nonmarine mollusks from archaeological excavations in Hawaiian wetlands have revealed no evidence of their presence here prior to initial European contact in AD 1778 (Christensen unpubl.). Accordingly, all available evidence indicates that sphaeriids now established in the Hawaiian Islands were transported here by modern commerce, not by the voyages of the pre-contact Polynesians.

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**Change of Status and Name for a Hawaiian Freshwater
Limpet: *Ancylus sharpi* Sykes, 1900, is the Invasive North
American *Ferrissia californica* (Rowell, 1863),
Formerly Known as *Ferrissia fragilis* (Tryon, 1863)
(Gastropoda: Planorbidae: Ancyliinae)¹**

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The freshwater limpet heretofore known as *Ferrissia sharpi* (Sykes, 1900) was described as *Ancylus sharpi* from material collected on the Island of O'ahu (Sykes 1900). The discussion of the species by Hubendick (1967) added little new information, but by the end of the 20th century it had been reported from the islands of Kaua'i and Hawai'i in addition to its type locality (Cowie *et al.* 1995; Cowie 1997). Recent surveys of Hawaiian stream fauna have recorded it from numerous localities on those islands and have added the islands of Moloka'i and Maui to its known range within the state of Hawai'i (Englund & Godwin 2002; Englund & Preston 2002; Anthony *et al.* 2004; Brasher *et al.* 2004; Parham *et al.* 2008).

Ferrissia sharpi has been a cryptogenic species in the Hawaiian fauna as its status as native or introduced has been unclear. Most recent authors have regarded its status as uncertain (Cowie *et al.* 1995; Cowie 1997, 1998; Englund & Godwin 2002; Englund & Preston 2002; Ziegler 2002; Anthony *et al.* 2004; Brasher *et al.* 2004), but Parham *et al.* (2008) treated it as native and the Hawaii Department of Land and Natural Resources has identified it as among its "species of greatest conservation need" (Mitchell *et al.* 2005).

The status of *F. sharpi* has recently been resolved in the course of phylogenetic studies of a North American species generally known as *Ferrissia fragilis* (Tryon, 1863). *Ferrissia fragilis* has now been shown to be conspecific with *F. sharpi* (Walther *et al.* 2010) as well as with a European snail described as *Watsonula wautieri* Mirolli, 1960 (Walther *et al.* 2006). In addition to Europe and the Hawaiian Islands, this highly invasive species has been reported (as *F. fragilis* or *F. wautieri*) from North Africa (Khalloufi & Boumaïza 2007), the Middle East (Marrone *et al.* 2014), East Asia and nearby islands (Beckmann *et al.* 2006; Walther *et al.* 2006, 2010; Sharapova 2008), and South America (Lacerda *et al.* 2015). As an alien in the Hawaiian Islands its conservation here need no longer be a matter of concern.

Ferrissia fragilis has long been regarded as conspecific with a taxon described as *Gundlachia californica* Rowell, 1863 (Basch 1963; Burch 1982; Walther *et al.* 2010), and as it has been assumed that Tryon's *fragilis* has priority over Rowell's *californica* the former name has been in general use by these and other recent authorities (*e.g.*, Turgeon *et al.* 1998; Dillon & Herman 2009; Marrone *et al.* 2014; Bouchet & Neubauer 2015; Lacerda *et al.* 2015). Bequaert & Miller (1973: 212), however, concluded that *californica* had priority over *fragilis*, stating that "so far as could be traced, the description [of *frag-*

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ilis] was published in June or early July [of 1863], while that of *G. californica* appeared not later than May [1863.]” Taylor (1981) also regarded *californica* as a senior synonym of *fragilis*, though he cited no authority for this conclusion. Coan (1989: 45) noted Bequaert & Miller’s conclusion that *californica* has priority over *fragilis*, stating that “Rowell’s paper was published in May, [and] Tryon’s paper was published in July[.]” The priority of *californica* has also been acknowledged by the International Union for the Conservation of Nature (Cordeiro & Perez 2011). Standard bibliographic authorities (Evenhuis 2011) confirm that Rowell’s paper (Rowell 1863) had been published by May, 1863 (Meisel 1929: 149), whereas Tryon’s description (Tryon 1863) cannot be shown to have been published before 13 July 1863 (Nolan 1913: xiii). Pursuant to Articles 21.3 and 21.4 of the *International Code of Zoological Nomenclature* (I.C.Z.N. 1999, hereinafter “the Code”) the dates of publication of *californica* and *fragilis* must be regarded as 31 May 1863, and 13 July 1863, respectively, establishing the priority of the former name.

Article 23.9 of the *Code* provides that a long-overlooked senior synonym can be suppressed as a *nomen oblitum* and the junior synonym in general use can be conserved as a *nomen conservandum* if the senior synonym has not been used as a valid name after 1899 and the junior synonym meets certain criteria for frequency of recent usage. Tryon’s *fragilis* is ineligible for conservation under this provision because Rowell’s *californica* has been used at least twice since 1899 as a valid name (Bequaert & Miller 1973: 211–212; Taylor 1981: 161). Accordingly, the senior synonym *californica* must replace *fragilis* as the valid name for this species, which must henceforth be known as *Ferrissia californica* (Rowell, 1863).

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Multiple Records of Monoecy and Leakiness in Dioecious Taxa of Hawaiian *Coprosma* spp. (Rubiaceae)¹

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The breeding systems of the 110+ species of *Coprosma* J.R. Forst. & G. Forst. across the Pacific are largely considered dioecious, with male and female flowers occurring on separate plants (Oliver 1935). However, for many species, particularly of New Zealand, the dioecious breeding system is leaky. *Coprosma* species exhibiting leaky dioecy are primarily dioecious, with male and female flowers on separate plants, but individuals occasionally develop apparently functional bisexual flowers, which sporadically occur among an abundance of unisexual flowers. A putative monoecious *Coprosma* taxon was once reported for the Macquarie Island individuals of *C. perpussilla* Colenso (= *C. pumila* Hook.f.), but later dispelled as being dioecious (Lloyd & Horning 1979).

In March 2016, the first author of this paper embarked on an archipelago-wide trip of the Hawaiian Islands aiming to collect and observe multiple populations of all endemic Hawaiian species of *Coprosma* (Rubiaceae). As a result, four confirmed cases of monoecious individuals were documented for Hawaiian *Coprosma* for the first time. Three additional instances may represent either monoecious or leaky dioecious observations. The collection results are detailed below. All specimens are deposited at BISH and duplicates were either sent to PTBG or US herbaria. Figure 1 depicts photos of monoecious individuals collected in the field.

Confirmed Cases of Monoecious Individuals

Confirmation of monoecy occurred if both male and female flowers were observed on the same plant at the same time. Collections were made where possible.

Coprosma ochracea W.R.B. Oliv., Mt. Ka'ala Bog, O'ahu.

One 2 m tall individual of *C. ochracea* was observed in the Mt. Ka'ala Bog on March 10, 2016. The plant was fully exposed in light and had a few female flowers. Flowers otherwise were male. Apparently, each inflorescence on terminal branches were of one sex. No inflorescence included male and female flowers in the same inflorescence. At least 30 other individuals were observed along the boardwalk of the bog without noting further monoecious individuals.

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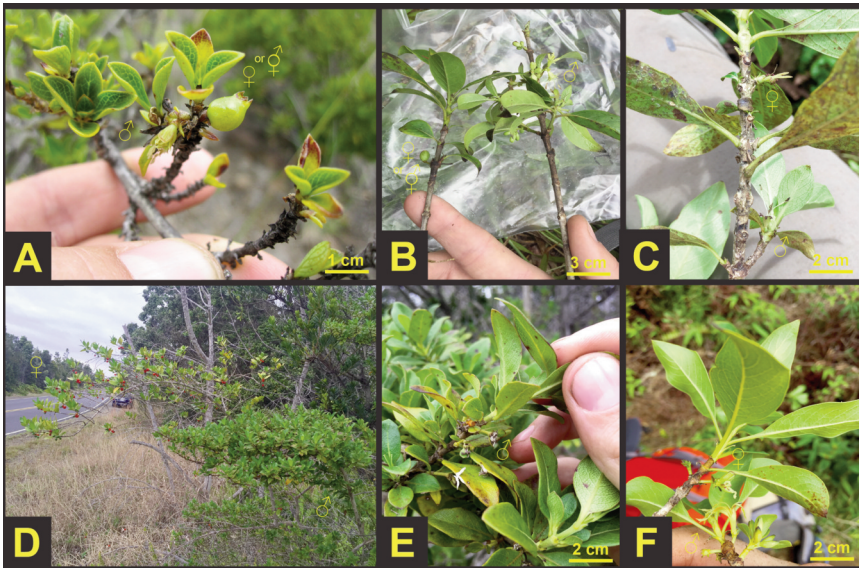


Figure 1. Photos of monoecious *Coprosma* taxa. **A)** *C. montana* in Haleakalā Crater, Maui, showing immature fruit (right) and male flower with anthers not yet fully exerted (left). **B)** *C. waimeae* showing immature green fruit (left) and male flowers (right). **C)** Monoecious individual of *C. aff. pubens* ‘B’ from Munro Trail Lāna‘i. **D)** *C. menziesii* showing dimorphic female (upper left) and male (lower right) branches. **E)** Closer view of old male inflorescences with orange fleshy receptacle tissue. **F)** Monoecious branch of *C. aff. pubens* ‘A’ from Waihe‘e Trail, West Maui.

Material examined. **O‘AHU:** Wai‘anae Mountains, Mt. Ka‘ala Bog, individual growing along boardwalk, 10 March 2016, *J.T. Cantley* JC-1077.

Coprosma menziesii A. Gray, Hawai‘i Volcanoes National Park, Hawai‘i Island.

One monoecious individual was noted on 8 March 2016 along Chain of Craters Road just downslope of Pauahi Crater. The shrub was around 2.5 m tall, and had male and female flowers on separate branches of the plant. Two main branches with nearly a 5 cm diameter separated the male portion of the plant from the female portion. Differently-sexed branches varied vegetatively in the number and distribution of leaves. The male branch was much more foliose, whereas the female branch had fewer, more loosely-arranged leaves, with fruits conspicuously presented on peduncles hanging below the leaves. Curiously, the basal receptacle area of each male flower developed a fleshy orange tissue similar to female fruit tissue in color, but much smaller than fully-developed fruits borne from the female portion of the plant (2–4 mm wide vs. 8–12 mm wide). It was not determined if aborted ovules were present in this tissue. Approximately 30–50 individual plants were observed in the vicinity of Pauahi Crater along Chain of Craters Road without noting further instances of monoecious individuals.

Material examined. **HAWAI‘I:** Hawai‘i Volcanoes National Park, individual growing along Chain of Craters Road near Pauahi Crater, 8 March 2016, *J.T. Cantley* JC-1066.

Coprosma* aff. *pubens A. Gray ‘A’, Waihe‘e Trail, Maui.

One individual monoecious plant was collected from a tree greater than 3 m in height growing in an exposed gully with an understory of *Dicranopteris linearis* (Burm.f.) Underw. and co-occurring with *Metrosideros polymorpha* Gaudich. and *Psychotria* sp. on 5 March 2016. Male and female flowers were found on the same main branch, but terminal branches maintained unisexual inflorescences. Fewer than 10 individuals were observed in this population, but not thoroughly looked for, due to time constraints. At least one individual was completely female, but the remaining were in bud or lacking reproductive parts.

Material examined. MAUI: Waihe‘e Trail, West Maui, individual growing in exposed gulch, 5 March 2016, J.T. Cantley JC-1054.

Coprosma* aff. *pubens A. Gray ‘B’, Munro Trail, Lāna‘i.

One monoecious individual of this taxon, which shares morphological affinities with *C. pubens*, was noticed along the roadside of the Munro Trail on Lāna‘i. The tree was only around 0.8 m tall, but otherwise shared similar morphological features with *C. aff. pubens* ‘A’. No other cases of monoecy were observed for the less than 10 other individuals of this taxon observed during the survey.

Material examined. LĀNA‘I: Munro Trail Road near Lāna‘ihale summit, individual growing just off the road with 25% canopy exposure, 8 March 2016, J.T. Cantley JC-1055.

Unconfirmed Cases of Either Monoecy or Bisexually-Facilitated Leaky Dioecy

The four individuals described below may be cases of either monoecious (unisexual) or leaky dioecious (bisexual) flowers, but without the presence of floral parts, it was not possible to determine if the fruits found on each plant were borne from female or bisexual flowers.

Coprosma waimeae Wawra, Mōhihi Trail, Kaua‘i.

One individual of *C. waimeae* was observed along an exposed cliff ridgeline with many male flowers and many immature green fruits.

Material examined. KAUA‘I: Mōhihi Trail, individual growing on exposed ridge in a *Dicranopteris linearis* understory, 16 March 2016, J.T. Cantley JC-1103.

Coprosma montana Hillebr. (no collection); Haleakalā Crater, near Palikū Cabin, Maui.

An observation in July 2013 documented a male plant with an immature green fruit along the hiking trail leading to Palikū Cabin. The first author’s photos document that the fruit was likely not in the same inflorescence as other male flowers, but rather very closely situated to a male inflorescence. The fruit occurred as the next successive inflorescence on a terminal branch approximately separated by less than 1 cm of distance.

Coprosma montana Hillebr. (no collection); Pu‘u Huluhulu, Hawai‘i Island.

Large individuals of *C. montana* occur within Pu‘u Huluhulu Tree Sanctuary. In 2014, an orange fruit, smaller than typical female fruits, was observed on a male individual in a male inflorescence. Without a collection, it is not possible to tell if this ‘fruit’ was similar to the fleshy orange male receptacle tissue as observed for *C. menziesii*, or if the material was a properly formed fruit. Additionally, some fruit of the population were observed with four carpels (four seeds in a fruit).

Coprosma foliosa A. Gray (no collection); unknown location.

A photo exists of two bisexual flowers that are observable in two inflorescences of *C. foliosa* s.l. taxon. The image of the taxon displaying leaky dioecy is currently hosted at <http://www.botany.hawaii.edu/faculty/carr/coprosma.htm>.

Conclusions

The breeding system of *Coprosma* spp. in the Hawaiian Islands deserves closer investigation. On one short three-week collection trip in March 2016 to six islands, observations confirmed four cases of monoecious individuals in populations of predominately dioecious taxa. It is possible that Hawaiian taxa may also occasionally produce bisexual flowers resulting in leaky dioecious individuals like many of their New Zealand congeners, but no observation was able to directly confirm this. It is difficult not to speculate that the flexible breeding systems of *Coprosma* in the Hawaiian Islands may correlate to the ability to reproduce via geitonogamous selfing when population sizes are small (due to human degradation of habitat, colonization of a new island, or otherwise), which may help explain the fact that almost no species of *Coprosma* are endangered in the Hawaiian Islands, while so many other lineages continue to decline in number.

Acknowledgments

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New Plant Records from Maui, Hawai‘i, and Kure Atoll¹

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The following contributions include new island, state, and high elevation records from Maui, Hawai‘i, and Kure Atoll. All records are for nonindigenous species. Images of most of the material examined can be seen at starrenvironmental.com. Voucher specimens and collections mentioned in the text are housed in Bishop Museum’s *Herbarium Pacificum* (BISH), Honolulu, Hawai‘i.

Acanthaceae

Asystasia gangetica (L.) T. Anderson

subsp. *micrantha* (Nees) Ensermu

New state record

Native to Africa, India, and Sri Lanka, this subspecies of *A. gangetica* is now an emerging weed in Australia and southern Taiwan (Hsu *et al.* 2005; Weeds of Australia 2011). It is distinguished by the following characters: “Herbs perennial. Leaves ovate to lanceolate, entire or somewhat dentate. Inflorescences terminal racemes or spikes, unilateral; bracts linear to narrowly deltoid; calyx lobes 5; corolla zygomorphic, purplish, blue, yellow, and white, the limb lobes 5; stamens 4, didynamous; anthers 2-loculate; style subulate; ovary with 2 ovules per locule; capsule distinctly stipitate; seeds 2–4, compressed orbicular” (Hsu *et al.* 2005). This diminutive-flowered herb is now known from Hawai‘i, where it was first collected in Hilo in 2001, and more recently in Hōnaunau in 2014.

Material examined. **HAWAI‘I:** Hilo, Waiākea streambed near UH-Hilo, in association with *Rhodomyrtus tomentosa* and *Melastoma candidum*, 200 ft [60 m], 1 Aug 2001, *Starr & Martz 010801-4*; Hōnaunau, 84-5094 Painted Church Rd., volunteer that appeared in home fruit orchard a few years ago and has taken off, now established in another part of the orchard ca 500 ft away, 800 ft [244 m], 1 Mar 2014, *P. van Dyke s.n.* (BISH 764374).

Asteraceae

Kalimeris indica (L.) Sch. Bip. subsp. *indica* **New island record**

Native to eastern Asian countries including China, Korea, and Japan, where it is grown for its edible and medicinal qualities, Indian aster was first reported (as *Boltonia indica* (L.) Benth.) in Hawai‘i from O‘ahu as a garden escape, but not quite naturalized (Wagner *et al.* 1999; Wikipedia 2015). Nagata (1995) then reported it as naturalized on Kaua‘i. Herbst & Wagner (1999) provided the correct taxonomic name as *K. indica* subsp. *indica*. On Maui, this showy groundcover has become established in and near lawns at Ke‘anae.

Material examined. **MAUI:** East Maui, Ke‘anae Elementary School, planted as a bedding plant and escaping into lawn areas, wet lowland, urban, lawn and ornamental plantings with *Peltophorum pterocarpum*, *Cordyline fruticosa*, spreading locally into lawn areas through underground stoloniferous runners, 282 ft [86 m] (797774, 2308334), 27 Oct 2014, *Starr & Starr 141027-01*.

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Brassicaceae***Capsella bursa-pastoris*** (L.) Medik.**High elevation record**

The previous known high elevation record in Hawai'i was made in 1981 on Maui by R. Nagata at a recent landfill near the stable area of Haleakalā National Park, elevation 6759 ft [2060 m] (Smithsonian Institution 2015). A collection was made recently near the summit of Haleakalā, elevation 9760 ft [2975 m], representing a new high elevation record.

Material examined. **MAUI:** East Maui, Haleakalā National Park, Haleakalā Visitor Center by interpretive sign near Sliding Sands trailhead, subalpine shrubland/grassland with *Dubautia menziesii* and *Erodium cicutarium*, few small plants found in a small area, 9760 ft [2975 m] (786331, 2292984), 30 Oct 2014, *Starr & Starr 141030-03*.

Caryophyllaceae***Petrorhagia velutina*** (Guss.)

P.W. Ball & Heywood

High elevation record

Previously reported by Medeiros *et al.* (1998) from a few roadside populations on the west slope of Haleakalā National Park. Recently, it was collected near the summit of Haleakalā at the Haleakalā Visitor Center, elevation 9760 ft [2975 m], representing a high elevation record.

Material examined. **MAUI:** East Maui, Haleakalā National Park, Haleakalā Visitor Center, in cinder planter areas near building, subalpine shrubland/grassland with *Deschampsia nubigena* and *Dubautia menziesii*, scattered plants, 9760 ft [2975 m] (786424, 2293037), 30 Oct 2014, *Starr & Starr 141030-02*.

Sagina japonica (Sw.) Ohwi**New island record**

Previously collected in 1985 at the Honolulu Airport, O'ahu and described as probably not established (Wagner *et al.* 1999). First collected in the Northwestern Hawaiian Islands on Midway Atoll (Starr *et al.* 2003) from the hard-packed areas of the runway. On Kure Atoll, first observed and collected in 2001, in a similar habitat by the abandoned runway. This collection represents a new island record of Kure Atoll for its distribution.

Material examined. **KURE ATOLL:** Occasional in compacted soils on and near the runway, 10 ft [3 m], 22 May 2001, *Starr & Martz 010522-3*.

Crassulaceae***Kalanchoe rotundifolia*** (Haw.) Haw.**New state record**

Kalanchoe rotundifolia (common kalanchoe) is native to South Africa and Zimbabwe and was traditionally used by the Zulu as a charm to make one invisible (PlantZAfrica.com 2015). It is now used mostly as an ornamental for its showy flowers and succulent growth habit. It is a brittle, succulent plant growing to 1 m in height, with tubular flowers ranging in color from yellow to orange or red, borne on a long erect stalk; and fleshy, rounded or lobed, blue-green leaves that are 2.5 cm broad and are clustered at the base of erect stems (PlantZAfrica.com 2015). It was recently found established along a steep roadside in Kula. A collection was made, representing a new state record.

Material examined. **MAUI:** East Maui, Kula, Haleakalā Hwy. near Kalialinui Gulch, dry roadside scrub with *Leonotis nepetifolia* and *Nicotiana glauca*, dozens of plants along the road here, all size classes present, 2125 ft [2975 m] (778181, 2302907), 24 Jun 2014, *Starr & Starr 140624-01*.

Lamiaceae***Lamium amplexicaule* L.****High elevation record**

Lamium amplexicaule (henbit) was first collected in Hawai'i on Maui in 1982 at Haleakalā National Park by R. Nagata from the margin of the parking lot at Headquarters, elevation 7000 ft (2140), where it was spreading in disturbed areas (Wagner *et al.* 1999). Medeiros *et al.* (1998) report that by 1986 it was absent from that area. Henbit was later reported as naturalized on Moloka'i, at Nihoa Pali, growing on the north-facing gray-white basalt cliffs (Wysong *et al.* 2007). On Maui, henbit was again recently observed and collected at Haleakalā National Park, this time near the summit, just outside the Haleakalā Visitor Center, at an elevation of 9760 ft (2975 m), representing a high elevation record for this species in Hawai'i.

Material examined. MAUI: East Maui, Haleakalā National Park, Haleakalā Visitor Center, in cinder area outside building, subalpine shrubland/grassland with *Deschampsia nubigena* and *Dubautia menziesii*, few mature and many seedlings, locally established despite attempts at control, 9760 ft [2975 m], (786424, 2293037), 30 Oct 2014, Starr & Starr 141030-01.

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New Plant Records from the Big Island for 2015

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The Big Island Invasive Species Committee (BIISC) Early Detection program in May of 2008. Roadside surveys are conducted in order to document the presence of newly naturalizing invasive plants. This contribution documents collections made between 2011 and 2014 on Hawai'i Island.

Here, BIISC Early Detection documents 1 new state record, 7 new naturalized records and 6 new island records. A total of 11 plant families are discussed. Information regarding the formerly known distribution of flowering plants is based on the *Manual of the Flowering Plants of Hawai'i* (Wagner *et al.* 1999), *A Tropical Garden Flora* (Staples & Herbst 2005) and information subsequently published in the *Records of the Hawaii Biological Survey*. Voucher specimens are deposited at B.P. Bishop Museum's *Herbarium Pacificum* (BISH), Honolulu, Hawai'i.

Acanthaceae

Justicia spicigera Schldtl.

New island record

Mexican indigo is native to Central America and has a variety of uses, including plant dye. It is not commonly cultivated on the Big Island and it is described as rarely fruiting in Hawai'i. This population was found in close proximity to the ocean even though it is described as being salt-intolerant (Staples & Herbst 2005). Previously documented as naturalized on O'ahu and Moloka'i.

Material examined. **HAWAI'I:** Puna Distr., Hwy 130, Kalapana, 2142187N 293446E, 6 ft tall shrub found on roadside with large simple leaves and slender, orange, tubular flowers, 11 Aug 2011, J. Parker & R. Parsons BIED161.

Apocynaceae

Vinca major L.

New island record

Large periwinkle is a vigorous creeper but not as often cultivated as its congener *V. minor*. A naturalized population growing as a dense mat was found at high elevation (6,000 ft) in full sun. It has also been collected as naturalized on Maui. A description is included in this writeup to help distinguish from the more common *V. minor*. A low, slightly woody perennial with arching to ascending, often trailing vegetative stems up to 1.5 m length and flowering stems up to 30 cm length. The opposite and entire leaves are ovate, 2.5–9 cm long and 2–6 cm wide, have short petioles and ciliate margins. Bluish-purple flowers of 3–5 cm diameter grow solitary in the axils of leaves. Pedicels are 3–5 cm long. Fruits are spreading follicles of *c.* 5 cm diameter and 3.5–5 cm length. Seeds are oblong and 7–8 mm long (Weber 2003).

Material examined. **HAWAI'I:** North Hilo Distr., Mānā Road, 2196453N 254953E, naturalized population forming large mound, 3 Apr 2013, *J. Parker & R. Parsons BIED174.*

Asteraceae

***Porophyllum ruderale* (Jacq.) Cass.**

New state record

This strongly-scented, low-growing herb was found naturalizing in the vicinity of an agricultural park, growing in thickets up to 1 m tall. Determined *P. ruderale* as it has characteristics in between the two subspecies, *runderale* and *macrocephalum*. In the reference following, the author mentions intermediate plants generally having floral characteristics of *macrocephalum* and vegetative characteristics of *runderale*. The plants found in Hawai'i commonly have purple coloring on the leaves, stems, and involucre. Following is the description of *P. ruderale* ssp. *runderale*: Blades 1–6 cm long, up to 30 mm wide, thin, elliptical, rarely ovate or obovate, rarely with glands scattered on the surface or without glands, apex mucronate to obtuse, base usually attenuate, sometimes acute, rarely obtuse; peduncles usually slightly to moderately clavate; phyllaries 16–22.5 mm long, 2–3 mm wide, apex acuminate; corolla 8.2–13.5 mm long; pappus 9–11.5 mm long, light to dark straw-colored; achenes 8.1–8.9 mm (Johnson 1969). Achene characteristics fit well within the description given for *macrocephalum*: Achenes 9.5–12.4 mm long, hispidulous (Johnson 1969). Subspecies *runderale* is common as a weed in low, flat areas, such as fields and vacant lots, through much of its range. It usually is found at elevations below 1,300 m but may occur up to 2,500 m or more. In contrast, subsp. *macrocephalum* occurs more commonly at higher elevations in rocky terrain, although it is sometimes found in weedy situations, such as in roadside clearings, and even forms thickets near Progreso, Yucatan (Standley 1931).

Material examined. **HAWAI'I:** North Kona Distr., Keāhole Agricultural Park, Kaiminani Road, 2183897N 182587E, growing in rocks between a sod farm and a plumeria farm, strong smell associated with all parts of plant, 9 Jul 2014, *J. Parker & R. Parsons BIED176.*

***Tagetes patula* L.**

New naturalized record

Marigolds are common in cultivation in gardens of Hawai'i, often because of their natural insecticidal properties. This species, French marigold, was found naturalizing near a garden plot, in a heavily disturbed area. Horticulturists distinguish this species from *T. erecta* with its shorter, more branched stature and smaller flowers often in deeper shades of orange, or red-brown, or with two-toned ray flowers (Staples & Herbst 2005). This collection represents a new naturalized record for Hawai'i Island.

Material examined. **HAWAI'I:** Puna Distr., Shipman Industrial Park, 2172616N 284889E, sprouting out of roadside corridor, many fruits and seeds. 1.5 ft tall with seeds germinating on mother plant. Corolla reddish-brown with pinnately lobed leaves, 28 Mar 2012, *J. Parker & R. Parsons BIED166.*

***Tithonia rotundifolia* (Mill.) S.F. Blake**

New naturalized record

This Mexican sunflower is related to the more common *T. diversifolia* but differs in that it is a smaller species, up to 12 ft tall, with scarlet to orange-red ray flowers. Leaves are either entire or 3–5-lobed with coarsely toothed or serrate leaf margins and cordate leaf bases. Also, it has finely hairy involucre bracts in 2 or 3 whorls (Staples & Herbst 2005). This species is difficult to identify in its vegetative form due to its superficial similarity to the very common *Hyptis pectinata*.

Material examined. **HAWAII:** North Kona Distr., Donkey Mill Road, Hōlualoa, 2167127N 191318E, vigorous, bushy, multi-branched shrub about 8–10 ft tall, 6 Oct 2014, *J. Parker & R. Parsons BIED180*.

Begoniaceae

Begonia nelumbifolia Schlttdl. & Cham.

New island record

Originally collected by G. Staples on the Big Island in 2007, this *Begonia* is distinct with its circular, dinner-plate sized, lotus-shaped leaves, which give it its specific epithet. The material examined from our collection was from a steep hillside in a wet, shady valley in Honomū. Also collected by G. Staples in 2007 was material from Oʻahu and determined to be a new naturalized record.

Material examined. **HAWAII:** South Hilo Distr., Old Māmalahoa Hwy, Honomū Gulch, 2198093N 278941E, leaves over 12" across, white flowers on stalks 3–4 ft tall, 25 Jan 2012, *J. Parker & R. Parsons BIED165*; boundary between North and South Hilo Distr., roadside on Hwy 19, mauka side of highway, on crumbling lava embankment in heavy shade, damp pockets of humus on steep rock face, first naturalized record for the species on Hawaiʻi Island, 15 Apr 2007, *G. Staples 1303*. **OʻAHU:** Pali Hwy, windward side, 50 ft uphill from pulloff parking area by hairpin turn, steep rock bank in deep shade, under secondary disturbed vegetation of *Psidium cattleianum*, *Citharexylum caudatum*, *Fraxinus*, *Schinus*, growing in pockets of humus on rock face, first genuinely naturalized record for this species on Oʻahu, 9 Mar 2007, *G. Staples 1300*.

Bignoniaceae

Markhamia lutea (Benth.) K.Schum.

New naturalized record

Nile tulip is a tree with pinnately compound leaves, broadly bell-shaped yellow flowers with red lines inside the tube, incompletely spathe-like calyxes, and leafy false stipules. It is native to tropical Africa, where it is a fast-growing second-growth tree, and is rarely cultivated elsewhere (Staples & Herbst 2005). In Hawaiʻi, Nile tulip has been observed spreading in two locations in the Puna and North Kona districts. Cultivated specimens are often seen fruiting heavily, and with its wind-dispersed seeds, this species has been suggested to the committee to become an eradication target.

Material examined. **HAWAII:** Puna Distr., Hwy 11, Mountain View, 2162718N 278366E, trees to 40 ft tall, 6 Jan 2014, *J. Parker & R. Parsons BIED175*.

Fabaceae

Parkia timoriana (DC.) Merr.

New naturalized record

Tree bean is native to East Asia and several large specimens can be found cultivated in Hawaiʻi. East of Hilo, at the collection site, hundreds of germinated seeds can be found littering the ground underneath a large specimen. Many saplings up to 20 ft tall were also observed. Trees attain 60–150 ft in height, with buttress roots 3–15 ft high at the trunk base; the leaves are 2x-pinnately compound with 14–30 pairs of pinnae, each pinna composed of 50–72 pairs of elongate, s-shaped, 0.25–0.4" long leaflets. The inflorescences, which hang downward in loose clusters of 4–7 on individual stalks 6–14" long, are globose or pear-shaped heads composed of hundreds of tiny, densely packed, white or yellowish mimosa-type flowers; only those at the apex are bisexual and capable of setting fruit. The black, indehiscent pods are strap-shaped, 8–14" long and 1.5–2.2" wide, and contain 12–20 crosswise-oriented seeds (Hopkins 1994). Tree beans are most often pollinated by bats and insects are rarely successful at pollination (Bumrungsri *et al.* 2008), which could be a limiting factor for its spread in Hawaiʻi where the only bat present is insectivorous.

Material examined. **HAWAII:** South Hilo Distr., Hwy 11, Pana'ewa, 2175956N 283765E, tall tree with long, twisted bean pods, 7 Jan 2013, *J. Parker & R. Parsons BIED172*.

***Sesbania sesban* (L.) Merr.**

New island record

Egyptian river hemp is native to Northern Africa and the Middle East and has been collected as naturalized on Kaua'i and O'ahu. This specimen was collected from an abandoned field in South Kona. It is cultivated as an important source of fodder, fiber, and green manure. It also is a source for some interesting compounds known as molluscicidal saponins (Mabberley 2008). Although the tree fruits profusely, the seeds are apparently short-lived, especially in humid environments, and are heavily predated upon by insects (Gutteridge 1994).

Material examined. **HAWAII:** South Kona Distr., Old Tobacco Road, 2149502N 198119E, growing in an abandoned field, bipinnately compound leaves, attractive yellow flowers and long cylindrical seedpods, 30 Apr 2014, *R. Parsons, L. Nelson BIED177*.

Marcgraviaceae

***Norantea guianensis* Aubl.**

New naturalized record

Red-hot poker is a popular ornamental vine grown in many regions of the Big Island. This collection represents a new naturalized record for Hawai'i and the first time that fruit has been observed. It is a woody climber with alternate, leathery, elliptic to obovate leaves, 4–6" long and 2–3.25" wide. It bears terminal racemes to 4 ft long consisting of red-orange flowers, mostly hidden among similarly colored nectar-producing tubular appendages open at the top; these appendages (modified bracts) make up the visible bulk of the inflorescence (Staples & Herbst 2005). In a description of the family, it is mentioned that the fruit is a tardily dehiscent capsule, sometimes berry-like, with few to infinite small seeds with straight or weakly curved embryo in little or no endosperm (Mabberley 2008).

Material examined. **HAWAII:** Puna Distr., Leilani Estates, 2154339N 299706E, vine with large spikes of red, unusual flowers, fruit spherical, green and burgundy, multi-seeded with red juice, 16 Jul 2012, *J. Parker & R. Parsons BIED171*.

Poaceae

***Cenchrus elegans* (Hassk.) Veldk.**

New naturalized record

Burgundy giant is a tall cane grass with purple coloration over much of the foliage. It is the variety most often grown in Hawai'i and is sometimes referred to as Foxtail bamboo (Staples & Herbst 2005). This perennial has culms erect to geniculate at base, not rooting in the decumbent nodes, not stoloniferous, rhizomatous, 1–3 m long, solid, nodes glabrous. Ligule a ciliolate rim, c. 0.15 mm long. Blades flat, 10–65 cm by (6–)8–35 mm, margins scaberulous. Peduncle puberulous below the panicle. Panicle exserted, many-spikeled, 15–40 cm long, common axis puberulous. Involucre stipitate, disarticulating at base. Bristles many, rather stiff, scaberulous, unequal, longest ones 32–55 mm long. Spikelets 1 within the involucre, pedicelled, 4.5–6.5 mm long. Lower glume 1.25–1.75 mm long, 0.39–0.53 times as long as the upper glume; upper glume 2.5–3.4 mm long, 1-nerved. First lemma epaleate, acuminate, membranous, 3–5-nerved, glabrous, nerves smooth; second lemma membranous. Anthers 1.65–2.1 mm long, apex glabrous (Veldkamp 2014). A form with uniformly reddish purple stems, leaves, and panicles occurs between 1500–2100 m altitudes. This might be the same as what is known as the cv. Burgundy Giant of horticulturists (Veldkamp 2014).

Material examined. **HAWAII:** Puna Distr., Kalapana Seaview Estates, 2146873N 298234E, 12 ft tall stalks with long purple leaves more prominent in the top half, large cylindrical panicles, to 10", semi-erect to drooping, pale pink to purple, 1 Aug 2011, *J. Parker & R. Parsons BIED160*.

Scrophulariaceae

Linaria purpurea (L.) Mill.

New naturalized record

Purple toadflax is a perennial herb from stout, woody rootstock, native to the Mediterranean region. Leaves 20–50 mm, linear to oblanceolate. Flower corolla 15–18 mm, lavender to purple, throat swelling darker; stigma lobes 0. Fruit about 3 mm containing one 1 mm seed, more or less pyramid shaped and ridged. Generally found at less than 500 m elevation in disturbed areas (Preston & Wetherwax 2016). The plants collected were found naturalizing on the easement not near any other cultivated plants.

Material examined. **HAWAII:** Ka'ū Distr., Hawaiian Ocean View Estates, 2114337N 209061E, 4 plants on road easement, ca 2.5 ft tall, stems slightly woody at base, leaves sage green, linear, whorled, sometimes alternate, 12 Apr 2012, *J. Parker & R. Parsons BIED169*.

Solanaceae

Capsicum annuum L.

New island record

Chili peppers have been collected as naturalized on all the major Hawaiian Islands. This orange-fruited specimen was collected from near a garden plot in a heavily disturbed industrial park.

Material examined. **HAWAII:** Puna Distr., Shipman Industrial Area, 2172616N 284889E, roadside wash, fruit orange, probably Habanero, 28 Mar 2012, *J. Parker & R. Parsons BIED167*.

Vitaceae

Cissus verticillata (L.) Nicolson & C.E. Jarvis **New island record**

Princess vine is native to tropical America, the Galapagos Islands, and Africa. It has been previously collected as naturalized from Kaua'i and O'ahu. It is known to be spreading in only a couple of locations on the Big Island.

Material examined. **HAWAII:** South Hilo Distr., Stainback Hwy, 2174901N 283586E, growing over areca palms on border of property and across street, inflorescence axillary with small, white flowers and large, dark, juicy fruit, 27 Apr 2011, *J. Parker & R. Parsons BIED155*.

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New Hawaiian Plant Records for 2015¹

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Ongoing field work, collections, and research continue to produce new, previously unpublished distributional records for the Hawaiian flora. In this paper, 3 new naturalized and state records, and 13 new island records are reported. A total of 16 taxa in 14 plant families are discussed. One is a pteridophyte, nine are dicotyledonous angiosperms, and six are monocots. Three of the taxa are native. Collections were made on the islands of Moloka'i, Lāna'i, and Maui. Information regarding the formerly known distribution of flowering plants is based on the *Manual of the Flowering Plants of Hawai'i* (Wagner *et al.* 1999) and information subsequently published in the *Records of the Hawaii Biological Survey*. Distribution and taxonomy of ferns follows *Hawai'i's Ferns and Fern Allies* (Palmer 2003).

Voucher specimens are deposited at the Bernice Pauahi Bishop Museum *Herbarium Pacificum* (BISH), Honolulu, with duplicates at the National Tropical Botanical Garden (PTBG), Lāwa'i, Kaua'i. A few specimens may be at only one or more facilities; only in these cases will the herbarium acronym be cited.

Annonaceae

***Annona cherimola* Mill.**

New island record

The cherimoya was first documented as naturalized on Hawai'i Island (Staples *et al.* 2002: 4). This tree, cultivated for its fruit, is not uncommon in areas of upcountry Maui. The trees are quite common in Hālonā Gulch on West Maui, where they form a common element along an intermittent stream. Feral pigs and occasional stream flow are probably dispersing the seeds. The East Maui specimen is also cited since it seems this is sparingly naturalized, with many seedlings in and around mature trees planted in the 1950s at the bottom of the cinder cone, as well as occasional trees on the outer slopes. Feral pigs and humans are likely the dispersal agents.

Material examined. **MAUI:** West Maui, Lahaina Distr., West Maui Natural Area Reserve, Pana'ewa section, Hālonā Gulch, naturalized trees, common in gulch bottom, 610 m, 3 Sep 2015, Oppenheimer, K. Palolo & K. Alreck #H91501; East Maui, Makawao Distr., Pu'u Māhoe, 725 m, 6 Mar 2015, Oppenheimer H31503.

Asteraceae

***Parthenium hysterophorus* L.**

New island record

Known from Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i (Wagner *et al.* 1999: 347; Wagner & Herbst 1995: 16), false ragweed was recently found on Lāna'i. Pūlama Lāna'i, the landowner, responded immediately with control efforts, and will continue to monitor the infestation and respond appropriately. Although there were hundreds if not thousands of plants, it seems to be restricted to a few acres in extent. It is believed to have arrived as a contaminant in a container shipment of hay from upcountry Maui, where this is a common roadside weed.

1. Contribution No. 2016-012 to the Hawaii Biological Survey.

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Material examined. **LĀNAʻI:** Kōʻele, across from stables, along unpaved road to Keahikawelo and Kānepuʻu, white-flowered shrubs in disturbed area, localized but dense infestation, 488 m, 24 Mar 2015, *Oppenheimer & Bustamente H31510.*

Costaceae

Costus malortieanus H. Wendl.

New naturalized record

Native to the forests and lowlands of Nicaragua and Costa Rica (Whistler 2000: 153; Staples & Herbst 2005: 652), stepladder plant differs from other Costaceae naturalized in Hawaiʻi by its short ligule and pubescent leaves, the adaxial surface with dark green bands converging from apex to base.

Material examined. **MAUI:** East Maui, Hāna Distr., Hāhālawe Gulch, 2 m tall herbs forming thickets in open gullies, with *Hedychium*; flowers white, distal end tinged red, 340 ft., 17 Dec 2005, *Oppenheimer H120505* (BISH).

Cyperaceae

Schoenoplectus tabernaemontani

New island record

(C.C. Gmel.) Palla

An indigenous sedge with a Hawaiian distribution of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, and Hawaiʻi (Wagner *et al.* 1999: 1432), its name was later changed from *S. lacustris* (L.) Palla subsp. *validus* (Vahl) T. Koyama (Kennedy *et al.* 2010:21). It was found on West Maui growing over several acres in saturated, muddy ground.

Material examined. **MAUI:** West Maui, Wailuku Distr., ʻĪao Valley, 543 m, 2 Apr 2014, *Oppenheimer, Bustamente & J. Nielsen H41402.*

Euphorbiaceae

Euphorbia degeneri Sherff

New island record

Scattered in coastal and strand vegetation on all of the main islands except Lānaʻi and Kahoʻolawe (Wagner *et al.* 1999: 607), this species was recently collected on Lānaʻi on the northeast coast.

Material examined. **LĀNAʻI:** Laewahie, rare, 10 m, 7 Apr 2015, *Oppenheimer & Bustamente H41517.*

Molluginaceae

Mollugo cerviana (L.) Ser.

New island record

This annual herb has been documented from Oʻahu, Lānaʻi, and Hawaiʻi (Herbst *et al.* 2004: 9; Imada *et al.* 2008: 13; Wagner *et al.* 1999: 922). Recently it was found on East Maui, in coastal vegetation.

Material examined. **MAUI:** East Maui, Makawao Distr., ½ mi. E of Māliko Gulch, locally common on soil ledges at base of bluffs, 6 m, 15 Apr 2015, *Oppenheimer & Bustamente H41527.*

Myrtaceae

Eucalyptus pulchella Desf.

New state record

Endemic to Tasmania and known as white peppermint or narrow-leaved peppermint, this tree was not previously documented from Hawaiʻi. This population was previously identified as *E. amygdalina* Labill. (Medeiros *et al.* 1998:113), which may or may not also occur in this area.

Material examined. **MAUI:** East Maui, Makawao Distr., Kāliālinui, growing in forestry plantings along road between Hosmer Grove and Waikamoi, 2042 m, 29 Nov 2001, *Oppenheimer H110159.*

Onagraceae***Epilobium billardierianum*** Ser.**New island record**subsp. *cinereum* (A. Rich) P.H. Raven & Engelhorn

This small herb is naturalized on the islands of Kauaʻi, Oʻahu, Maui, and Hawaiʻi (Wagner *et al.* 1999: 995). It was recently collected on Molokaʻi.

Material examined. **MOLOKAʻI:** Puaʻahala ahupuaʻa, upper drainage of Kua Gulch, W of Kalapamoa Ridge, single mature plant, many seedlings, all pulled, 1180 m, 19 May 2015, *Oppenheimer & Kallstrom H51516* (BISH); Wailau Valley, Pūlena Stream, S side tributary, 380 m, 14 Jul 2015, *Oppenheimer et al. H71515*.

Orchidaceae***Polystachya concreta*** (Jacq.) Garay & Sweet**New island record**

Previously known as a naturalized epiphyte on Oʻahu (Staples *et al.* 2003: 17) and West Maui (Oppenheimer 2013: 18), this orchid was found locally common in lowland wet forest on Molokaʻi. Consistent with the reports from Oʻahu and Maui, it seems to be an obligate epiphyte.

Material examined. **MOLOKAʻI:** Wailau Valley, Pūlena Stream, S side tributary, 406 m, 13 Jul 2015 *Oppenheimer et al. H71513*; *loc. cit.*, 391 m, 16 Jul 2015, *Oppenheimer et al. H71525*.

Poaceae***Axonopus compressus*** (Sw.) P. Beauv.**New island record**

This species of carpetgrass has been previously documented from Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi (Oppenheimer 2003:19; 2004:15; Starr *et al.* 2004:26; Oppenheimer 2007: 29). It is now known from Lānaʻi.

Material examined. **LĀNAʻI:** in lawn near Mānele Harbor, 3 m, 22 Jan 2015, *Oppenheimer H1150*; Lānaʻi City, weed in residential lawn, 495 m., 26 Mar 2015, *Oppenheimer & Bustamente H31514*.

Elymus repens (L.) Gould**New naturalized record**

The genus *Elymus* L. has not been previously documented as an element of the naturalized flora in Hawaiʻi. In a note in the introduction to the Poaceae in Wagner *et al.* (1999: 1482), *E. triticoides* Buckley was mentioned as having been collected once in a pasture on Hawaiʻi Island in 1936. *Elymus repens* (couch grass or quackgrass), is a perennial native to most of Europe, Asia, the Arctic biome, and northwestern Africa, but has been introduced to other areas for forage or erosion control, but is often considered a weed.

Material examined. **MAUI:** East Maui, Makawao Distr., top of Olinda Rd. at gate to pasture, clumping grass, 1219 m, 9 May 2006, *Oppenheimer H50609* (BISH, K, PTBG)

Rubiaceae***Kadua fosbergii*****New island record**

(W.L. Wagner & D.R. Herbst) W.L. Wagner & Lorence

Occurring on windswept ridges and upper slopes in wet forest from 610–900 m on Lānaʻi, and 795–1000 m in the Koʻolau Mountains of Oʻahu (Wagner *et al.* 1999: 1146), plants referable to this species were recently found on East Maui at higher elevations. The plants here are also taller—up to 6m—and are on the leeward side of the island. They also differ in the denser pubescence and smaller calyx lobes (Dave Lorence, PTBG, pers. comm.), but share the characteristic rugose upper leaf surface, revolute leaf margins, and spreading calyx lobes. Only a half -dozen widely separated trees have been found so far.

Material examined. **MAUI:** East Maui, Hāna Distr., Kahikinui, upper Kepuni drainage basin, 1669 m, 17 Sep 2013, *Oppenheimer et al. H91313* (PTBG); west fork of Manawainui, 1585 m, 26 Aug 2014, *Oppenheimer et al. H81413*; central Manawainui drainage basin, 1521 m, 24 Jul 2015, *Oppenheimer et al. H71546*.

Scrophulariaceae

Castilleja arvensis Cham & Schldtl.

New island record

A small herb known from Kaua'i, O'ahu, Lāna'i, Maui, and Hawai'i (Wagner *et al.* 1999: 1240; Staples *et al.* 2003: 19; Oppenheimer 2007:31), it is not surprising it occurs on Moloka'i as well.

Material examined. **MOLOKA'I:** Wailau Valley, Pūlena Str., S side, 450 m, 14 Jul 2015, *Oppenheimer et al. H71517*.

Parentucellia viscosa (L.) Caruel

New island record

This species was treated in the *Manual* (Wagner *et al.* 1999: 1246) as occurring only on Hawai'i Island; it was found on Haleakalā, Maui after the cut off date (1987) prior to publication. There have been two colonies near each other—one east and one west of Pōhakupālahā. Medeiros *et al.* (1998:140) reported the following: “Single small population discovered in 1988 in southeast corner of grassland, east of Pōhakupālahā on the Kīpahulu side of ridgeline fence, 8050 ft. In 1989, all plants (305 individuals) in this small population were removed and site marked with pvc stakes to allow for monitoring of future germinants; annually, between 10 to 30 plants have been removed (P. Welton and W. Haus, pers. comm.). New island record. [Alien: native to Mediterranean region].” In July 2015 the colony west of Pōhakupālahā was encountered and again all plants (at least 50) were uprooted. It is unclear if the colony east is still extant and when it was last monitored. Vouchers collected by Stemmermann and Gagné were indicated as being deposited at BISH (Medeiros *et al.* 1998), but could not be located there during a recent search (B. Kennedy, pers. comm.).

Material examined. **MAUI:** East Maui, Hāna Distr., E of Pōhakupālahā, *L. Stemmermann & Luce 7205* (BISH?); *loc. cit.*, *B.H. Gagné 1020* (BISH?); between Pōhakupālahā and Lau'ulu, 20 Jul 2015, *Oppenheimer et al. H71542* (BISH, HALE).

Thelypteridaceae

Macrothelypteris torresiana (Gaudich.) Ching

New island record

A naturalized, terrestrial fern documented in Hawai'i from Kaua'i, O'ahu, Maui, and Hawai'i, Palmer (2003: 178) speculated that it was likely present as well on Moloka'i and Lāna'i, but there were no specimens to document its occurrence. This species was recently found on Moloka'i.

Material examined. **MOLOKA'I:** Wailau Valley, Pūlena Stream, S side tributary, 475 m, 14 Jul 2015, *Oppenheimer et al. H71516*.

Zingiberaceae

Hedychium gardnerianum Sheppard

ex Ker Gawl.

New island record

Himalayan ginger was first discovered to be naturalized on Moloka'i on September 30, 2013 during a MoMISC aerial survey. The Division of Forestry and Wildlife began controlling ginger on October 30, 2013. Several trips have been made in 2014 and 2015 to search for all plants in the hopes this habitat modifier can be eradicated before it disperses into more pristine adjacent areas. Previously it was documented from Kaua'i, O'ahu, Lāna'i, Maui, and Hawai'i (Wagner *et al.* 1999:1623; Staples *et al.* 2006: 9).

Material examined. MOLOKA‘I: Wailau Valley, 4 Nov 2013, *W. Moses & S. Dunbar-Co s.n.*, (BISH 763746); Pūlena Stream, S side, 405 m, 14 Jul 2015, *Oppenheimer et al. H71514; loc. cit.*, 413 m, 16 Jul 2015, *Oppenheimer et al. H71526.*

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First Record of the Family Xylomyidae (Insecta: Diptera) in the Hawaiian Islands¹

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Xylomyids, or wood soldier flies, are worldwide in distribution and can be found almost everywhere except Oceanic islands and New Zealand. Immatures are associated with dead and dying wood and adults are most often collected near such habitats. The vast majority of the 138 known species of xylomyids (Woodley 2012) are those in the genus *Solva* Walker. Little revisionary work has been conducted on the genus with most species described being based on one or a few species from collections or based on collecting expeditions to various parts of the world. The record here of its introduction marks the first time the genus and the family have been reported from the Hawaiian Islands. Its presence here does not pose any particular threat to the environment since the immatures are scavengers in rotting wood (Woodley 2012). All specimens examined are vouchered in the entomological collection of the Bishop Museum (BPBM).

Diptera: Xylomyidae

Solva sp.

New State Record

(Figs. 1–2)

Four females of an undetermined species of *Solva* were recently collected and photographed at localities in central O'ahu and the North Shore of O'ahu. Species in the genus typically have swollen and armed hind femora and are roughly 4–6 mm in length. Determination to species is difficult as there are no keys to all species in the genus and the genus is known from 100 species worldwide (Woodley 2012). It is presumed (but there is no guarantee) that the species derives from the Oriental Region since that is the region of highest diversity for the genus (58 of 100) and many introductions of Diptera to Hawai'i derive from that region. Since the immatures breed in dead and dying wood, it is possible that the species here in Hawai'i was brought in as immatures with rotting timber or bamboo.

Photographs and a detailed description [format and terminology following Woodley (2004)] are presented here in hopes it will eventually assist in identifying this to species level.

Description

Female. *Lengths:* body: 5.2–6.5 mm; wing 5.5–6.2 mm. *Head.* Black, 1.5 times higher than long; slightly dichoptic, eye bare, notched medially just above antennae, ommatidia uniform in size; ocellar tubercle slightly prominent; vertex with short silvery tomentum; face convex; frons slightly concave, narrow, as wide as ocellar tubercle dorsally, gradually widening ventrally; postgena silvery gray tomentose, densely shaggy gray pilose; semi-appressed golden tomentum medially on frons, laterally with dull yellow erect hairs; other areas of head bare; antenna 2.5 times length of head, ratio of segments: 5:5:25 [35:10:12:12:12:12:15:12], scape and pedicel brownish yellow, first flagellomere

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Fig. 1. *Solva* sp., female, anterolateral view showing detail of head and legs. Photo: © Lowell Tyler.

brownish black, yellowish mesally, flagellomeres 2–8 black, segments 2–5 yellowish brown mesally at base; hair of scape and pedicel blackish with some pale hairs ventrally, longest dorsolaterally; palpus yellowish white to yellow, second segment linear-ellipsoid, about 3.5 times as long as first; both palpal segments with pale hairs, second segment bare apically; proboscis yellowish brown to yellow.

Thorax. Scutum and pleura black; scutellum, postpronotal lobe, and notopleural stripe yellow; integument of scutum and pleura densely and finely punctate; prosternum, anepimeron, mediotergite, and laterotergite with sparse, inconspicuous, pale tomentum; scutum and scutellum with dense yellowish white, semi-appressed pilosity, sparse golden tomentum laterally above base of wing; pilosity of pleura most conspicuous on propleuron and upper part of katapisternum; meron bare except for small patch of dense short hairs on front part of anterior depression; anepimeron mostly bare; anepisternum with short, inconspicuous yellowish white pilosity; halter yellowish white.

Wing. Hyaline; costa ending just beyond vein R_5 ; R_{2+3} ending in wing margin beyond junction of R_4 and R_5 ; r-m crossvein at basal one-third of cell dm; fourth posterior cell closed before wing margin and without a stalk, base of cell with short stalk; vein closing cell dm at midpoint of fourth posterior cell; anal cell closed before wing margin with a stalk, length of which is slightly shorter than vein closing cell dm; wing margin indented at end of vein $A_1 + CuA_2$.

Legs. Vestiture of all legs short and dense, yellowish to white; fore and mid coxae creamy yellow with brown at extreme base; fore and mid femora and tibiae creamy yellow; fore and mid tarsi with basitarsi subequal in length to tibiae, yellowish, remainder of tarsomeres very short, brownish, claws black; hind coxa yellow on apical half, shining



Fig. 2. *Solva* sp., female, dorsolateral view showing wing venation and thoracic vestiture. Photo: © Lowell Tyler.

black on basal half; hind femur swollen, finely punctate, with broad shining black stripe lateroventrally along entire length, with short black denticles ventrally, hind tibia curved, yellow basally, brownish black on apical one-third, tarsomeres as in fore and mid legs, claws black.

Abdomen. Tergite I extensively membranous, white; remainder of abdominal tergites black, lateral margins of tergites VII–VIII yellowish brown; tergites sparsely punctate, sternites brown; pilosity of tergites brownish, short, semi-appressed, a few longer, pale hairs along lateral margins, especially tergite I; tomentum sparse. Genitalia not dissected; cercus yellowish, segments about equal in length, first segment thicker than second.

Material Examined: O'AHU: 2♀, Dillingham Field, 5–30 ft [1.5–9 m], 14 May 2014, D.A. Yee & W.D. Perreira; 1♀, Kealia Trail, 200 ft [61 m], 21 June 2015, W.D. Perreira (all BPBM).

Material Photographed: 1♀, O'AHU: Wahiawa, 6 Oct 2015, L. Tyler (specimen not collected).

Remarks. Using the key in Yang & Nagatomi (1993) these specimens key to *S. yunnanensis* Yang & Nagatomi from southern China, but the hind leg patterning is different. The species doesn't key out at all using the keys in Brunetti (1923), Nagatomi & Tanaka (1971), Adisoemarto (1973) or Daniels (1976). It appears close in appearance to two specimens of an undetermined species from Kalimantan in Borneo in the BPBM. Woodley (2004) described a species from Borneo (from Sabah) and Enderlein (1921) described two species from Borneo, but the species at hand is clearly different from those species. The genus is poorly known in the Orient and many undescribed species await description (roughly 200 specimens from New Guinea and SE Asia sit undetermined in the BPBM collections alone). The species here in Hawai'i may in fact be new, but am reluctant to

describe a new species based on specimens introduced to Hawai'i when its native provenance is unknown.

Acknowledgments

Lowell Tyler is thanked for generously providing photographs of the fly and initially alerting me to the new introduction to the state. Karl Magnacca is thanked for bringing the specimens collected by Bill Perreira to my attention coincidentally a few days after the photographs were sent.

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Simply *ridiculus*: New Species of the *Campsicnemus ridiculus* Group from Hawai‘i and the Marquesas (Diptera: Dolichopodidae)

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Introduction

The long-legged fly genus *Campsicnemus* Haliday is found throughout the Holarctic Region and a monophyletic clade separate from the Holarctic species are found in the Pacific (primarily the Hawaiian Islands and French Polynesia with undescribed outliers in Fiji and Tonga). Goodman *et al.* (2014) recently analyzed the relationships of the Pacific clade and during that study various species groups were proposed for clusters of species with similar leg modifications in males (male secondary sexual characters - MSSC). One such group was the *C. ridiculus* group, which is comprised of two described species from the Hawaiian Islands (*C. miritibialis* from O‘ahu; and *C. ridiculus* Parent from Maui and Moloka‘i). These species are water skaters on upland streams in the Hawaiian Islands. This paper describes and illustrates an additional two species that have similar leg modifications (one from the Big Island of Hawai‘i, *C. konahema*, **n. sp.** and the other from the Marquesan island of Nuku Hiva, *C. ridiculoides*, **n. sp.** and extends the *C. ridiculus* group into French Polynesia. A key to species in the *C. ridiculus* group is given.

Material and Methods

Specimens examined in this study derive from collections of the Bishop Museum (BPBM). French Polynesian specimen data contains database records in the format BPBMxxxxxx. These data are held in the Essig Museum, University of California, Berkeley. Morphological terminology, description format, and abbreviations used in the description follow Evenhuis (2012). Holotypes and paratypes of all new species are deposited in BPBM; where series are long enough duplicate paratypes are in USNM.

Taxonomy

Genus *Campsicnemus* Haliday

Camptosceles Haliday, 1832: 357 (subgenus of *Medeterus*). Suppressed by I.C.Z.N. (1958: 349 [Opinion 531]).

Leptopezina Macquart, 1835: 554. Type species *Diastata gracilis* Meigen, 1820, by monotypy. *Nomen oblitum* (see Evenhuis 2003).

Campsicnemus Haliday in Walker, 1851: 187. Type species: *Dolichopus scambus* Fallén, 1823, by validation of I.C.Z.N., 1958: 351. *Nomen protectum* (see Evenhuis, 2003: 3).

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Figs. 1–4. *Campsicnemus ridiculus* species group, apices of mid tibiae, showing subapical processes. 1. *C. konahema*, n. sp. 2. *C. miritibialis* Van Duzee. 3. *C. ridiculus* Parent. 4. *C. ridiculoides* Evenhuis, n. sp.

The *Campsicnemus ridiculus* group

(Figs. 1–5)

This species group is defined by the male mid leg having a relatively short basitarsus (length to width ratio = 1.0–2.0) with apical processes or a spine and the mid tibia having a prominent subapical process capped by thick thorn-like processes (Figs. 2–4) or short blunt peg-like spinules (Fig. 1). The two previously described species have been observed to be water skaters on streams in the Hawaiian Islands (see e.g., Williams 1940 for observations of *C. miritibialis*). One of the two new species described here has also been observed to be a water skater (*C. ridiculoides* from Nuku Hiva in the Marquesas); the other (*C. konahema* from the Big Island in Hawai'i) has not been observed in nature but is presumed to also have this behavior. Water skating *Campsicnemus* in the Pacific are found only in the Hawaiian Islands and the Marquesas (both island groups of which coincidentally lack gerrid water skaters).

Included species:

- konahema*, n. sp. (Hawaiian Islands: Hawai'i)
miritibialis Van Duzee (Hawaiian Islands: O'ahu)
ridiculus Parent (Hawaiian Islands: Maui, Moloka'i)
ridiculoides, n. sp. (Marquesas: Nuku Hiva)

KEY TO SPECIES IN THE *CAMPSICNEMUS RIDICULUS* GROUP BASED ON MALES

1. Subapical process of mid tibia long, narrow with thick thorn-like processes apically . 2
- . Subapical process of mid tibia broad, sub-hemispherical, with numerous short peg-like spinules (Fig. 1) ... (Hawai'i Island) *C. konahema* Evenhuis, n. sp.
2. Mid basitarsus with single apical thickened black thorn-like process (Fig. 4) (Hawaiian Islands) 3
- . Mid basitarsus with two apical thorn-like processes (Marquesas)
 *C. ridiculoides* Evenhuis, n. sp.



Fig. 5. *Campsicnemus konahema* Evenhuis, n. sp. holotype male, habitus.

- 3. Subapical process of mid tibia with two long, narrow thickened thorn-like processes apically (Fig. 2); vestiture of mid tibia consisting of long dense fine hairs; body generally dark brown to black (O'ahu) *C. miritibialis* Van Duzee
- . Subapical process of mid tibia with 3 or 4 paired strong pointed processes apically (Fig. 3); vestiture of mid tibia consisting of sparse short setae with single long strong black seta distad of subapical process; body generally brown ... (Maui, Moloka'i) *C. ridiculus* Parent

Campsicnemus konahema Evenhuis, new species

(Figs. 1, 5)

Diagnosis. Similar to the Hawaiian species *C. miritibialis* and *C. ridiculus*, but can be distinguished by the presence of a patch of short spicules on the fore basitarsus (absent in *C. miritibialis* and *C. ridiculus*) and the large hemispherical bulge subapically on the male mid tibia (this process longer and narrower in *C. miritibialis* and *C. ridiculus*).

Description. Male (Fig. 5): Body length: 3.7 mm. Wing length: 3.4 mm. *Head:* Predominantly black; face and clypeus yellow, silvery gray tomentose; oc and vt black, about one-third length of antennal arista; occiput, and vertex black with blue-gray highlights; postgena with sparse white hairs; face constricted at middle, holoptic for a length of 4 ommatidia; palpus small, yellow; proboscis yellowish brown, extending below eye in lateral view; antenna with all segments yellow; scape subcylindrical, length subequal to width; pedicel obconical, with ring of short spiky black setae subapically; postpedicel subelliptical, length 2.5 times width, pointed but rounded apically; arista much longer than head height.

Thorax: Mesonotum brown, paler laterally and anteriorly; scutellum and pleura (except dark brown anepimeron) yellow; thoracic setae black: 4 dc; 2 np; 2 ph; 1 pa; 1 sc; 5 ac; halter yellow.

Legs: Yellowish brown; fore coxa with normal anteroapical setation; It₁ with small patch of minute spicules on widened apex (MSSC), otherwise foreleg unmodified; FII with row of 10–12 strong black hairs along mesoventral surface (MSSC); mid tibia (Fig. 1) slightly curved, gradually widening apically, with subapical process consisting of prominent subhemispherical bulge with numerous short, peg-like spinules (MSSC), single strong, thick black seta subapically, distad of subapical bulge; IIt₁ shorter than IIt₂, with strong thick black apical spine (MSSC). Remaining leg segments unmodified and without MSSC.

Wing: Subhyaline, veins brown; posterior crossvein length about 1/4 apical segment of CuA₁.

Abdomen: Brown, tergal vestiture black. Hypopygium brown with yellowish brown cerci, not dissected.

Female: Unknown:

Material Examined. HOLOTYPE ♂ (BPBM 16,824) (preserved in ETOH) from HAWAIIAN ISLANDS: **Hawai'i:** Kona Hema Nature Reserve, 19°11.809' N, 155°48.568' W, 11 Jan 2006, R. Peck, Malaise Trap #6. *Condition of type:* the left midleg IIt₃₋₅ are broken off and missing, otherwise holotype in excellent condition.

Etymology. The specific epithet derives from the type locality, the Hawaii Nature Conservancy's Kona Hema Nature Reserve on the Big Island of Hawai'i.

Campsicnemus ridiculoides Evenhuis, new species

(Fig. 4)

Diagnosis. Similar to *C. miritibialis* but can be distinguished from it by the presence of paired thorn-like spines apically (with single strong spine in *C. miritibialis*), the rows of long thick curved setae on the posterior surface (vestiture in *C. miritibialis* consisting of dense, fine hairs not in rows), and the lack of fine vestiture on the hind basitarsus (vestiture of hind basitarsus in *C. miritibialis* short, dense, fine).

Description. Male: Body length: 2.8–3.2 mm. Wing length: 2.5–3.0 mm. *Head:* Black; oc and vt black, about one-half length of antennal arista; occiput, and vertex black with blue-gray highlights; postgena with sparse short white hairs; face constricted at middle, holoptic for a length of 4 ommatidia; palpus small, brown; proboscis dark brown, extending below eye in lateral view; antenna with scape and pedicel black; postpedicel, brown; scape subcylindrical, length subequal to width; pedicel obconical, with ring of short spiky black setae subapically; postpedicel subtriangular, length 1.25 times width, pointe apically; arista slightly longer than head height.

Thorax: Mesonotum and pleura (except black anepimeron) brown; disc of mesonotum darker brown than surrounding mesonotum; thoracic setae black: 4 dc; 2 np; 2 ph; 1 pa; 1 sc; 4 ac; anepisternum with brassy greenish highlights; halter white.

Legs: Fore coxa yellow, mid and hind coxae brown; fore femur yellow with brown border, mid femur yellow, hind femur yellow on basal half, black on apical half; fore femur with pair of long stiff black hairs subbasally on ventral surface (MSSC); fore tibiae and tarsi brown, without MSSC; mid femur swollen, with rows of strong, long thick black setae and shorter thick spicules ventrally along entire length (MSSC); mid tibia (Fig. 4) brown, small patch of yellow at extreme base, flared apically with long narrow subapical process armed with pair of thick black, spine-like processes apically, row of 18–20 long curved setae on apical two-thirds of posterior surface, row of short stiff hairs along anterior surface, with dense patch of medium-length hairs basomesally (all MSSC); IIt₁ brown, short, subcylindrical, length subequal to width, with pair of short, thorn-like processes apically (MSSC); remainder of tarsi brown, unmodified; hind femur with row of 8 long thick curved setae ventrally along entire length (MSSC), shorter, sparse hairs elsewhere; hind tibia 1.25 times length of hind femur; remainder of legs brown, unmodified, without MSSC.

Wing: Subhyaline, veins dark brown; posterior crossvein length less than 1/2 apical segment of CuA₁.

Abdomen: Brown, with brassy, greenish, and magenta highlights; tergal vestiture black. Hypopygium dark brown with brown cerci, not dissected.

Female: Similar to male except as follows: antennal postpedicel subhemispherical, length subequal to width, rounded apically; leg coloration similar to male but without setal or shape modifications; abdomen with predominantly magenta highlights.

Material Examined. Type. Holotype ♂ (BPBM 16,661) [BPBM101281] and 65♂ [BPBM101282], 39♀ [BPBM101283] *paratypes* from FRENCH POLYNESIA: MARQUESAS: **Nuku Hiva:** Toovi Plateau stream, 2800 ft [853 m], 23 Aug 2001, on falls and seep headwall, R. Englund. Other paratypes: FRENCH POLYNESIA: MARQUESAS: **Nuku Hiva:** 1♂ [BPBM101284], 7♀ [BPBM101285], stream on south side of Tekao Ridge, 2700 ft [823 m], 8°50'58"S, 140°09'14"W, 23 Aug 2001, skating on pools, D.A. Polhemus. Holotype in BPBM, paratypes in BPBM and USNM.

Etymology. The specific epithet derives from the similar appearance of this species to *C. ridiculus* (*ridiculus* + *-oides*).

Acknowledgments

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Discovery of the *Apristurus* “*brunneus* Group” of Catsharks (Carcharhiniformes: Scyliorhinidae) in Hawaiian Waters with Comments on Catshark Ecology in the Hawaiian Archipelago¹

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The Pacific Ocean consists of some 30,000 seamounts, islands, and atolls that can serve as either stepping stones for dispersal or “oases” for biodiversity (Smith & Jordan, 1988; Crow *et al.*, 1996; Kvile *et al.*, 2014). Those that comprise the Hawaiian Archipelago are located in the central North Pacific Ocean and extend 3,450 km. They are considered to be the most isolated marine habitats in the world (Carlquist, 1980; Clague & Dalrymple, 1989). This isolation is believed to reduce species dispersal rates. However, accurately determining these rates is complicated even for shallow species (Hilario *et al.*, 2015), and extremely difficult for deep-sea species. This is especially true for animals that do not occur in high densities and which have been very difficult to collect, such as engybenthic sharks.

Within this group, the genus *Apristurus* catsharks (family Scyliorhinidae) are believed to be restricted to continental shelves with only a few exceptions (Springer, 1982). These sharks are thought of as sluggish swimmers, and presumably the abyssal plains serve as natural barriers to range expansion (Nakaya & Shirai, 1992). The genus *Apristurus* has 38 described species (Nakaya, pers. comm., 2016) and has been captured in deep-water on continental slopes, trenches, and submarine ridges at depths of 400 – 2,000 m in all oceans except polar seas (Nakaya & Kawauchi, 2013). However, the general lack of sampling in deeper water throughout the Hawaiian Archipelago (Gilbert & Cramer, 1897; Gilbert, 1905; Clark, 1972; Struhsaker, 1973; Humphreys *et al.*, 1984; Borets, 1986; Chave & Jones, 1991) as well as throughout the central Pacific is undoubtedly the reason why so few *Apristurus* specimens exist.

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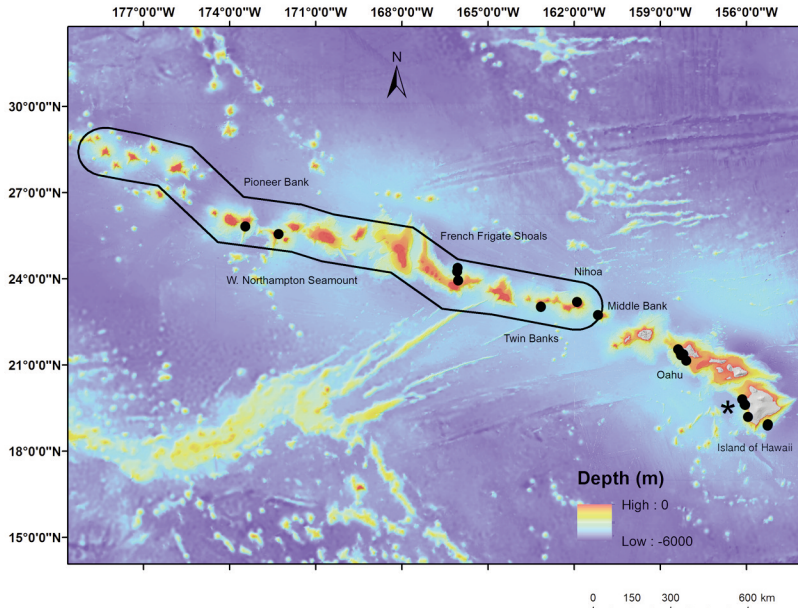


Figure 1. Map of locations where catsharks have been observed or captured throughout the Hawaiian Archipelago. Filled circles are HURL *in situ* submersible observations and star location of the NELHA pumping station. The curved circular line represents the pre-September 2016 boundary of the Papāhānaumokuākea Marine National Monument.

Apristurus catsharks are divided into three main groups; 1) the “longicephalus group” with *Apristurus longicephalus* and *A. herklotsi* that have a long snout; 2) the “brunneus group” with a longer upper labial furrow, discontinuous supraorbital sensory canal and 13–22 valvular intestine turns; and 3) the “spongiceps group” with upper labial furrows subequal or shorter than lower labial furrows, continuous supraorbital sensory canal and 7–12 valvular intestine turns (Nakaya & Sato, 1999). These groupings provide natural subdivisions within the *Apristurus* that can help in specimen placement (Nakaya & Sato, 1999).

Only one specimen of *Apristurus* has previously been collected in Hawai‘i. Identified as *Apristurus spongiceps* (Gilbert, 1905), it had upper labial furrows that were shorter than the lower ones and continuous supraorbital sensory canals (Springer, 1979; Nakaya & Sato, 1999). This specimen was captured 5 Aug 1902 via black beam trawl at a depth of 572–1593 m off the island of Nihoa, Northwestern Hawaiian Islands (NWHI) (Gilbert, 1905; Nakaya & Sato, 1999; Mundy, 2005; USNM 51590). The 514 mm TL female (Gilbert, 1905; Nakaya & Sato, 1999) had two eggs *in utero* with a non-tendril case length of 52 mm and 23 mm width (Springer, 1979; photos see Crow & Crites, 2002). One additional specimen of this species was collected from the Banda Sea off southern Sulawesi. It was a male, 105 mm TL, captured on mud bottom at 1,158 m (Weber, 1913; Compagno, 1984). The only other catshark recorded in the vicinity of the Hawaiian Archipelago was



Figure 2. Hawai'i NELHA catshark specimen (BPBM 40879) immature male 174 mm TL. Courtesy of J.E. Randall.



Figure 3. Lateral view of Hawai'i catshark (BPBM 40879). Courtesy of Doug Perrine.



Figure 4. Ventral view of Hawai'i catshark (BPBM 40879). Courtesy of Doug Perrine.

a specimen of *Apristurus fedorovi* collected from the Emperor Seamount chain (38°46' N, 171°11'E) (Dolganov, 1985; Nakaya & Shirai, 1992). The Emperor Seamounts are the northern part of what is considered to be the Hawaiian-Emperor seamount chain and continue northward from the Hawaiian Archipelago for an additional 2,300 km (Clague & Dalrymple, 1989; Mundy, 2005). Both *A. spongiceps* and *A. fedorovi* belong to the “*spongiceps* group” (Nakaya & Sato, 1999).

The Hawaiian Archipelago has been explored by the Hawai'i Undersea Research Laboratory (HURL) at the University of Hawai'i. This laboratory began submersible operations in 1986 to a maximum depth of 366 m using its *Makali'i* submersible. In 1996, HURL acquired its first 2,000 m *Pisces* submersible and since then, HURL submersible dives have led to the collection and video documentation of numerous new species to science and new species records for the central Pacific (Chave & Mundy, 1994; Chave & Malahoff, 1998). The greater depth capability of the *Pisces* resulted in 41 observations of catsharks in the Hawaiian Archipelago from 17 September 1996 to 15 September 2011 (HURL Dive Operation log records). Of these, 21 separate day submersible *in situ* observations were used to map catshark location and depth records (Fig 1). From these observations, it is clear that *Apristurus* catsharks are widely distributed throughout the Hawaiian Archipelago in areas ranging from the new underwater volcano Lo'ihī east of the island of Hawai'i, all the way up to Pioneer Banks in the NWHI. These observations were all made along slopes or on seamounts and banks at depths between 842 and 1,479 m.

In Hawai'i, water temperature varies from 23 to 28 °C at the surface and drops abruptly to 9 to 12 °C at the thermocline—roughly 100 to 300 m below the surface (Chiswell *et al.*, 1990). Oxygen concentrations in Hawaiian waters are typically 4.8 mg/L at 300 m depth, declining to 0.64 mg/L at 600 m (Chiswell *et al.*, 1990; Chave & Mundy, 1994). The water temperature and oxygen concentrations associated with the catshark observations from submersible dives between 500–800 m were 3.5 to 5.3 °C and 1.4 to 2.4 mg/L, respectively. In Japan, catsharks identified as *Apristurus platyrhynchus* were captured in water temperatures of 4.5 to 8.0 °C and oxygen levels of 1.8 to 2.5 mg/L (Kobayashi, 1986). The presence of a faunal break—observed in Hawai'i at a depth range of 500 to 1,000 m—corresponds to the oxygen minimum zone (OMZ) (Yeh & Drazen, 2009). The OMZ has relatively stable conditions of continuously low oxygen levels and low temperatures at intermediate ocean depths (400 to 1,000 m) over vast areas of the ocean (Childress & Seibel, 1998). The depths that the catsharks occupy in Hawai'i correspond to the depths where the oxygen levels are the lowest. Similar to crustaceans, cephalopods and bony fishes (Childress & Seibel, 1998) that live in the OMZ, catsharks appear to have adapted to the OMZ by developing the ability to regulate their oxygen consumption rate in this reduced oxygen environment.

An unusual collecting opportunity presented itself when a shark was captured at the Natural Energy Laboratory of Hawai'i Authority (NELHA), at Keahole Point on the Island of Hawai'i. This facility has several seawater suction pipelines that provide water to onsite research facilities, and these pipelines occasionally entrap specimens that can be captured near the onshore pumping station. The deepest of these pipelines extends 3,124 m from the shoreline to a depth of 915 m with an intake 6.1 m off the bottom. It also has a 1.4 m diameter pipe with a pumping capacity of 1.8 m³/sec flow. On 30 August 2007 this pipeline captured a 174 mm TL male catshark that was clearly not *Apristurus spongiceps* or from the "*spongiceps* group". The specimen was photographed and maintained in a cold water aquarium for two days before being frozen and shipped to Bernice P. Bishop Museum (BPBM), preserved in 10% formalin and transferred to alcohol for curation.

Apristurus sp. "brunneus group"

Material examined. **Island of Hawai'i**, Keahole Point, NELHA deep water pumping station, Jan War collector: BPBM 40879; male 174 mm TL (1 spm) with healed umbilical scar, (Figs. 2 - 4).

Diagnosis: General identification: The “brunneus group” identification for this specimen was based on a combination of the following: 1) longer upper labial furrows (7.1 mm; 4.1 % of TL) than lower labial furrow (4.4 mm; 2.5% of TL); and 2) discontinuous type of supraorbital sensory canal.

In the genus *Apristurus*, species identification has proven challenging due to the soft body form that is easily deformed and shrivels in preservative, making accurate measurements difficult (Nakaya *et al.*, 2008). Ontogenetic changes in proportional measurements can also impact positive species identification (Nakaya *et al.*, 2008). As a result of the juvenile nature of this specimen and formalin preservation, a positive species identification was not possible. However based on this specimen diagnosis, the Hawai‘i catshark belongs to the “*brunneus* group”. Two of the three groups of catsharks—the “*spongiceps* and *brunneus* groups”—are now documented in Hawai‘i.

Ecological Comments: The location of capture for the catshark at NELHA had the following water parameter means and (ranges) for salinity 34.48 (33.85–34.77) ppt, temperature 5.4 (4.6–6.5) °C, pH 7.61 (7.44–8.26), alkalinity 2.37 (1.79–2.72) mEq/L, total suspended solids 0.86 (0.19–4.31 mg/L and dissolved oxygen 1.77 (1.28–3.86) mg/L (nelha.hawaii.gov/wp-content/uploads/2014/01/appendix_c_pipeline_2015.pdf) (11 Aug 2005 to 3 Jun 2015, NELHA records for 1.4 m diameter, deep water pipeline last accessed 30 May 2016).

The depth of capture, water temperature and dissolved oxygen concentration from NELHA matches the HURL submersible observations that catsharks in Hawai‘i are present in the OMZ.

Conclusions

Catsharks of the genus *Apristurus* are more common and widespread in the Hawaiian Archipelago than previously thought. Two groups of *Apristurus* catsharks are now recognized in Hawai‘i, “*spongiceps*” and “*brunneus*”. These sharks reside in the OMZ at submersible observed depths of 842 to 1,479 m. In recent decades the OMZ has increased worldwide in size both vertically and horizontally, has experienced a reduction of oxygen concentration and was estimated to have expanded by 4.5 million km² (Sramma *et al.*, 2010). This expansion will have profound impacts on species habitat utilization and may alter biodiversity. This paper represents only the second report of catsharks in the Hawaiian Islands since the first capture in 1902. The deep-sea benthic habitat surrounding the Hawaiian Islands undoubtedly has a higher biodiversity than is currently reported and is in need of more detailed scientific investigation before manganese mining and other harvesting permanently alters this environment.

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