

NUMBER 155, 204 pages

3 January 2024

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# BISHOP MUSEUM OCCASIONAL PAPERS

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RECORDS OF THE  
HAWAII BIOLOGICAL  
SURVEY FOR 2023

*NEAL L. EVENHUIS, EDITOR*



BISHOP MUSEUM PRESS  
HONOLULU

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Cover: *Isopaches bicrenatus* (Schmidel ex Hoffm.), new state record from Maui (see p. 169). Photo: Zachary Pezzillo.

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Bishop Museum Bulletins in Cultural and Environmental Studies	(eISSN 2376-3159)

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ISSN 0893-1348 (print)  
ISSN 2376-3191 (online)  
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**RECORDS OF THE  
HAWAII BIOLOGICAL SURVEY  
FOR 2023**

**Editor's Preface**

I am pleased to present the annual compilation of *Records of the Hawaii Biological Survey*; this year for the year 2023. 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 Hawai'i'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 sites; and an authority file with full names and vital dates of more than 7,000 authors who have described new taxa of flies (Diptera).

The Records for 2023 include descriptions of 1 new endemic species, 54 new state records of alien species, 137 new island records of alien species.

**Our Primary Web Products:**

Hawaii Biological Survey Home Page

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

**Natural Sciences Databases**

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

**Hawaii Endangered and Threatened Species Web Site**

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

**Insect and Spider Collections of the World Web Site**

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

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

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

World Diptera taxonomist list

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

Many of the new records reported here resulted from curatorial projects and field surveys funded by the National Science Foundation, the U.S. Department of Defense, the U.S. Geological Survey, the U.S. Fish & Wildlife Service, the U.S. National Park 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 format of recent papers. Information on submission of manuscripts and guidelines for contributors may be obtained at: <http://hbs.bishopmuseum.org/guidelines.pdf> —*N.L. Evenhuis, editor*

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## New records of weedy *Phyllanthus* spp. in Hawai‘i

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New records of *Phyllanthus* spp. were found across several islands during both casual botanizing and roadside grass surveys. *Phyllanthus amarus* and *Phyllanthus leucanthus* are reported as naturalized for the first time in Hawai‘i and several new island records are recorded for *Phyllanthus urinaria*. All identifications were made by the author, unless otherwise noted. Voucher collections mentioned are housed in Bishop Museum’s Herbarium Pacificum (BISH), Honolulu, Hawai‘i.

### *Phyllanthus amarus* Schumach. & Thonn. **New state record**

*Phyllanthus amarus* was found naturalized in a *Megathyrsus maximus* and *Samanea saman* pasture at Kualoa Ranch on O‘ahu. The plant was spotted out of a car window and a specimen was quickly grabbed, but only approximately 5 square meters were examined and ca. 30 plants were found. It is likely that many more plants exist at this site. A second population was also found consisting of hundreds of plants growing in Koko Crater Botanical Garden and along the road leading into it.

*Phyllanthus amarus* is a native to Central & South America but is well adapted to disturbance and transport by man and now has a pantropical distribution (Webster 1957). *Phyllanthus amarus* is likely the most common tropical species of *Phyllanthus* worldwide (Webster 1970). Given the notorious weediness of this species, it will likely spread rather rapidly across Hawai‘i.

*Phyllanthus amarus* can be distinguished from the other weedy *Phyllanthus* of Hawai‘i by its 5 tepals, short pedicels, and its male and female flowers occurring at the same nodes and not segregated in different parts of the inflorescence. A key is also provided to help identify these species. The plant is overall most similar to *P. debilis*, but differs in the characters mentioned above, along with *P. debilis* having narrowly elliptic leaves with acute tips, whereas *P. amarus* has oblong leaves with a blunt tip (Figure 2E).

The following description is from Webster (1970: 69): “Glabrous annual herbs, 1–5 dm high; main stems smooth, terete, cataphylls spirally arranged; stipules of cataphylls deltoid, acuminate, entire, not auriculate, 1.3–2.1 mm long; deciduous branchlets 4–12 cm long, subterete (not winged nor sharply angled), smooth or at most slightly thickened, elliptic-oblong or somewhat obovate, obtuse or rounded and often apiculate at tip, obtuse or rounded and sometimes slightly inequilateral at base, paler or glaucous beneath, the veinlet reticulum delicate or obscure; stipules ovate-lanceolate or lanceolate, acuminate, 0.8–1.3 mm long. Monoecious; proximal 1 or 2 axils of branchlet with unisexual cymules of 1 or 2 ♂ flowers,

distal axils with bisexual cymules of 1 ♂ and 1 ♀ flower. Staminate flowers with pedicels 0.6–1.3 mm long; calyx lobes 5 (very rarely 6), ovate or elliptic, abruptly acute, entire, 1-veined, 0.3–0.6 mm long; disk segments 5, roundish, entire, ca. 0.1 mm across; stamens 3 (rarely 2), filaments completely connate into a column 0.2–0.3 mm high; anthers sessile atop column (1 anther sometimes reduced), dehiscing obliquely to horizontally, 0.2–0.3 mm across; pistillate flowers with pedicels becoming (1.0–)1.2–2.0 mm long in fruit; calyx lobes 5 (very rarely 6), obovate-oblong, acute, entire, herbaceous with broad pale margins, 1-veined, 0.8–1.1 mm long; disk deeply 5-lobed (rarely lobes 6 or 7); ovary smooth; styles free, erect or ascending, ca. 0.1–0.15 mm long, very shallowly bifid, the tips blunt. Capsules 1.9–2.1 mm broad; seeds light brown, with 5–7 straight longitudinal ribs and many fine transverse striae on back, 0.9–1.0 mm long.”

*Material examined.* O‘AHU: Kualoa Ranch, ca. 1 km N of ranch headquarters, monkeypod and Guinea grass pasture, partly sunny area, area not examined in detail but ca. 30 plants briefly seen, grazed by cattle, 21.530236, -157.837666, 07 Mar 2023, K. Faccenda & J. Lee 3056; Koko Crater Botanical Garden, *Plumeria* garden at entrance to garden, dry, sunny area in partial shade of *Plumeria*, starting to die from lack of moisture, hundreds of plants seen scattered in the eastern part of the crater floor and also along the road leading into the crater, 21.293146, -157.678154, 28 Apr 2023, K. Faccenda & M. Ross 3094.5.

### *Phyllanthus leucanthus* Pax

### New state record

A new weedy species of *Phyllanthus* was observed growing abundantly in gardens, nurseries, and disturbed areas around O‘ahu, and to a lesser extent on Kaua‘i, Maui, and Hawai‘i. No misidentified specimens of this species could be found in the BISH herbarium, making it unclear when it first appeared on the islands. The earliest record is an iNaturalist.org observation dated from 2017 (<https://www.inaturalist.org/observations/8332079>), although it is likely that this plant naturalized much earlier. Identification of this species proved quite difficult; it could not be identified using keys from North America, South America, Asia, or India. Only after a key from Central Africa (Pope 1996) was used, could this species be identified as *Phyllanthus leucanthus*, a species native to East Africa from Sudan to Mozambique and west to Gabon. *Phyllanthus leucanthus* has not previously been documented outside of its native range, although it is predicted that reports will soon be published of this species naturalizing in other parts of the world. As this plant is a common nursery weed in Hawai‘i, it was likely imported into Hawai‘i via nursery stock and will likely be exported via the same mechanism.

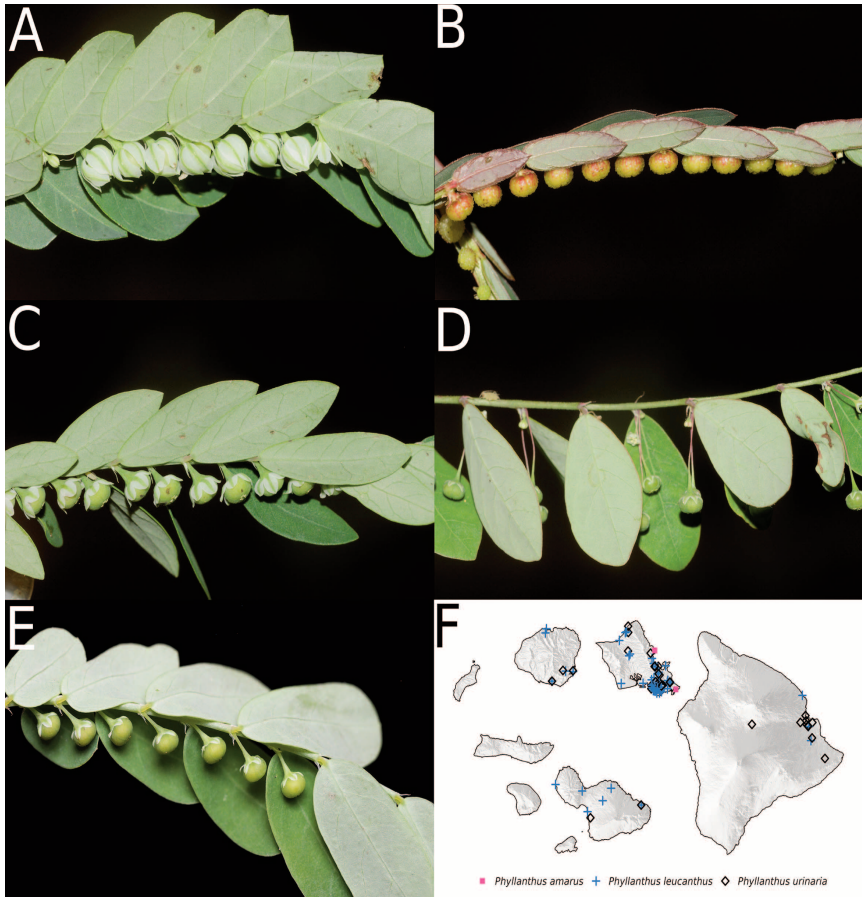
*Phyllanthus leucanthus* can be differentiated from other weedy species of *Phyllanthus* by its large, whitish green tepals that enclose the fruit (Figure 2A). The key below will also separate it from other weedy *Phyllanthus* that occur in Hawai‘i. It is taller than most other weedy *Phyllanthus* in Hawai‘i, reaching a height of almost 1 meter, and becomes rather woody at the base. In its native range it is found in shady places in riverine or lakeshore vegetation, high rainfall miombo woodlands, evergreen forest margins, dambos, submontane grasslands, and disturbed and cultivated ground (Pope 1996). In Hawai‘i it is found in dry to wet, sunny or partly sunny areas along roadsides and in gardens and nurseries. It has not been observed in any abundance in natural areas, but



**Figure 1.** *Phyllanthus leucanthus* habit. Photograph by James Bailey (<https://www.inaturalist.org/photos/230494603>)

scattered plants are occasionally seen. Outside of garden settings, it is usually seen as scattered plants or a small colony less than a few meters wide. *Phyllanthus leucanthus* has been observed forming dense patches in gardens and nurseries, however, and it is likely that its main impacts will be felt there (Figure 1).

The following description is from Pope (1996: 61): “A scaberulous or glabrous erect annual or perennial herb up to 90 cm tall, usually much less, monoecious or rarely dioecious; stems reddish or purplish later becoming wiry. Lead shoots angular. Lateral shoots up to 15 cm long, narrowly 2-winged, the older ones often co-axillary with secondary shoots. Short shoots sometimes developing. Scale leaves c. 1 mm long, narrowly triangular-lanceolate to subulate; stipules triangular-lanceolate, otherwise similar to scale leaves. Foliage leaves distichous; petioles 0.5–1 mm long; stipules c. 1 mm long, narrowly triangular-lanceolate, pallid. Leaf blades 0.5–3.5 × 0.4–1.5 cm, elliptic to oblong, subacute, obtuse or rounded, cuneate or rounded at the base, firmly membranaceous, light to medium green above, paler and somewhat glaucescent or purplish-tinged beneath; lateral nerves in 5–8(10) pairs, usually looped near the margin, not prominent above, slightly so beneath. Male flowers in few-flowered clusters in the lower parts of the lateral shoots, female flowers pendulous and solitary in the upper parts of the lateral shoots. Male flowers: pedicels 0.5 mm long; sepals 6, c. 1 × 1 mm, suborbicular-obovate, rounded, cream-coloured with a greenish midrib; disk glands 6, free, 0.3 mm in diameter, flat or somewhat verruculose, minutely lobulate; stamens 3, filaments connate in the lower two-thirds, 0.75 mm long, anthers 0.3 mm long, vertically



**Figure 2.** A, *Phyllanthus leucanthus*. B, *Phyllanthus urinaria*. C, *Phyllanthus debilis*. D, *Phyllanthus tenellus*. E, *Phyllanthus amarus*. Note that the male flowers are deciduous and have already fallen from this branch. F, Currently known distribution of *P. amarus*, *P. leucanthus*, & *P. urinaria*. Distribution data from iNaturalist.org observations reviewed by the author. Photos A–D were taken at the same magnification at the National Tropical Botanical Garden, where they were growing together as weeds in a garden bed, June 2022. *Phyllanthus amarus* was photographed at Kualoa, O‘ahu, and is not at the same magnification.

held, longitudinally dehiscent. Female flowers: pedicels 1 mm long, extending to 2 mm in fruit, somewhat flattened; sepals 6, in 2 whorls of 3,  $1.5 \times 1$  mm, accrescent to  $3 \times 2$  mm in fruit, the outer broadly elliptic and rounded to cordate at the base, the inner obovate and attenuate-cuneate at the base, white with a narrow green midrib; disk 0.75 mm in diameter, shallowly 6-lobed, the lobes entire; ovary 0.5 mm in diameter, shortly stipitate, 6-lobed, subglobose, smooth; styles 3, 0.67 mm long, united at the base, closely appressed



to the top of the ovary, deeply bifid, the stigmas slender, recurved. Fruit 1.8 × 2.8 mm, depressed 3-lobed to subglobose, smooth, olivaceous, enclosed by the persistent sepals. Seeds 1.5 × 1.2 × 1 mm, segmentiform, light to dark brown, with 7–9 shallow longitudinal ridges on the dorsal facet, and 6–7 concentric ridges on each ventral facet, with innumerable faint transverse striae between them.”

*Material examined.* **KAUAI:** Kalāheo, National Tropical Botanical Garden, McBryde Garden, near fern tunnel, moist, partly shaded garden bed, rare in garden, only a small patch of ca. 50 plants seen, 21.902117, -159.507042, 03 Jun 2022, *K. Faccenda & D. Lorence 2471*; Wainiha Valley, back of valley near hydroelectric plant, infrequently mowed roadside, part shade, moist, rare, only 3 plants seen, 22.196130, -159.556573, 30 May 2022, *K. Faccenda 2425*; Kaua‘i Landscape and Nursery off of Kaumuali‘i Hwy just W of Puhi, weed around garden center area, seen growing only in pots of plants for sale, ca. 50 plants seen, 100 m, 21.963308, -159.404212, 08 Jul 2022, *K. Faccenda & S. Vanapruks 2520*. **O‘AHU:** Hale‘iwa, near intersection of Kamehameha Hwy and Emerson Rd, weed in flower bed, several plants seen, 7 m, 21.590742, -158.103047, 16 Jan 2022, *K. Faccenda 2201*; Honolulu, Bishop Museum campus, weed along road behind Castle Bldg., partial sun, uncommon weed, 21.333506, -157.871972, 24 Jun 2021, *K. Faccenda 2008*; Nu‘uanu Pali Drive, above where the housing development ends, roadside, shaded, moist, infrequent along road, 21.347769, -157.823219, 29 May 2021, *K. Faccenda 1902*; Makiki Heights Drive & Mott Smith Drive, sunny, weedy areas, common, 21.312340, -157.833388, 22 May 2021, *K. Faccenda 1840*; N side of Frear Hall, UH Mānoa campus along Dole St., partly shaded flower beds, abundant weed, 21.293010, -157.813672, 19 May 2021, *K. Faccenda 1831*. **MAUI:** Hāna Hwy ca. 4 km W of Wai‘ānapanapa State Park at roadside coconut stand and restaurant, wet, shady area, growing as weed in garden bed, rare, only spot plant was observed along Hāna Hwy, 169 m, 20.794373, -156.051771, 23 Oct 2022, *K. Faccenda 2749.5*; Kahului, Wai‘inu Rd, weed in irrigated flower bed, shady area under ornamentals, common, over 50 plants, 81 m, 20.879999, -156.495534, 21 Oct 2022, *K. Faccenda 2723*. **HAWAII:** Hilo, intersection of East Kahaopea St and Kīlauea Ave, in infrequently mowed abandoned lot, uncommon, small colony of ca. 30 plants, other colonies also seen nearby, 42 m, 19.689879, -155.068077, 07 Aug 2022, *K. Faccenda 2583*;‘Imiloa Astronomy Center grounds, growing as weed in flower bed, 19.699994, -155.088556, 25 Aug 2019, *C. Warneke 315*.

KEY TO WEEDY HERBACEOUS *PHYLLANTHUS* IN HAWAII

- 1. Fruits and flowers long-pedicellate, pedicel >4 mm; stamens 5, distinct .... *P. tenellus*
- 1'. Fruits and flowers sessile or with pedicel <2 mm; stamens 3, fused
  - 2. Tepals 5; male and female flowers both borne at all flowering nodes (the male flower falling by the time the female has matured, examine branch tips) ..... *P. amarus*
  - 2'. Tepals 6; male and female flowers borne separately
    - 3. Male flowers distal, female proximal; seeds with sharp transverse ridges on the dorsal side; leaves hispidulous-margined ..... *P. urinaria*
    - 3'. Male flowers proximal, female distal; seeds striate; leaves not hispidulous-margined
      - 4. Pistillate tepals ~2 mm long, enclosing fruit at maturity; leaves widest near apex, obovate, blunt to obtuse at tip; leaves >6 mm wide ..... *P. leucanthus*
      - 4'. Pistillate tepals ~1 mm long, surpassed by fruit at maturity; leaves widest at middle, elliptic, acute at tip; leaves <6 mm wide ..... *P. debilis*

*Phyllanthus urinaria* L.

## New island records

First published as occurring on Kauaʻi (Brock *et al.* 2023), *Phyllanthus urinaria* is now known to also occur on Oʻahu, Maui, and Hawaiʻi. The first collection in the state was from a garden (*Neal s.n.*) in 1948, and this species continues to be found in nurseries and garden centers, but has also spread along roadsides and also into natural areas. *Phyllanthus urinaria* material at BISH was previously identified by Christopher Warneke and confirmed by the author.

*Material examined.* **OʻAHU:** Honolulu, 42 Coelho Way, in garden border, shaded, weed, 23 May 1948, *M.C. Neal s.n.* (BISH 664835); UH Mānoa, behind St. John Bldg., weed in flower bed, only one plant seen, 30 m, 21.302267, -157.815514, 12 Jan 2022, *K. Faccenda 2197*; Honolulu, Kakaʻako, JABSOM medical school off of Ilalo St., weed in flower bed, ca. 10 plants seen, uncommon, 21.296319, -157.863191, 08 Jun 2022, *K. Faccenda 2489*; Kāneʻohe, Valley of the Temples, weed around temple on edge of path, shady area, common, 55 m, 21.431060, -157.832469, 23 Aug 2022, *K. Faccenda & T. Chapin 2684*. **MAUI:** East Maui, Kihei, nursery, volunteer in pot on ground, naturalized, previously collected on Big Island, nursery imports from Big Island are likely source, 30 ft, 20° 43' N, 156° 26' W, 05 May 2004, *F. Starr 040505-3*. **HAWAII:** Hilo International Airport, garden beds at main terminals, weed, uncommon, 15 m, 19.714685, -155.040672, 28 Feb 2022, *K. Faccenda 2248*; North Hilo Distr., Humuʻula, near head of Wailuku River, herb growing under *Sophora* tree, 9100 ft, 10 Jul 1978, *D. Herbst 6141*; Near UH-Hilo, coming up in stream bed, erect annual herb, <10 cm tall, naturalized, common in stream bed, 60 m, 19° 42' N, 155° 05' W, 01 Aug 2001, *F. Starr 010801-7*; Keaʻau, Shipman Park, edge of wooded area on edge of park, uncommon, one plant seen, 6 m, 19.620553, -155.043178, 14 Aug 2022, *K. Faccenda & M. Murphy 2646*.

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## A survey of the hornworts and liverworts of Lāna‘i, Hawaiian Islands, including 63 new records<sup>1</sup>

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**Abstract.** A field and herbarium survey of the liverworts and hornworts of the island of Lāna‘i was conducted in 2022. Two hundred thirty-eight hornwort and liverwort specimens were collected and deposited at the Herbarium Pacificum (BISH), Bernice Pauahi Bishop Museum. Previous to the survey, only 17 species of liverworts and no hornworts were known from the island based on published records, the study of herbarium collections, and online records of specimens. Including the following four new state liverwort records: *Cephaloziella* aff. *microphylla*, *Lejeunea flava*, *Myriocoleopsis minutissima* subspecies *minutissima*, and *Telaranea nematodes*, sixty species of liverworts and three species of hornworts are added here, for a total of 80 liverwort and hornwort species now known from Lāna‘i.

Mosses have been relatively well-studied on Lāna‘i (55 species were recorded by Staples *et al.* 2004), but the liverworts and hornworts of the island have not been as well-surveyed. This survey represents the first attempt at a comprehensive inventory of the hornworts and liverworts of the island.

Staples & Imada (2006) provided a literature-based checklist of the hornworts and liverworts of Hawai‘i. They accepted 186 species as occurring in the state, but only three species were documented from the island of Lāna‘i (*Frullania sandvicensis*, *Jubula javanica*, and *Radula javanica*). Additionally, fourteen additional species of liverworts are known from other literature reports, online records, and our examination of specimens at the Herbarium Pacificum, Bernice Pauahi Bishop Museum (BISH), and the National Tropical Botanical Garden (PTBG) herbaria in 2022.

Fieldwork was conducted from 22–25 March 2022 and resulted in 238 numbered collections, also collected under all three authors’ names. On 24 June 2022, Bogner collected in Maunalei Gulch. Specimens are deposited in the Herbarium Pacificum (BISH), Bernice Pauahi Bishop Museum. Including the following four new state liverwort records: *Cephaloziella* aff. *microphylla*, *Lejeunea flava*, *Myriocoleopsis minutissima* subspecies *minutissima*, and *Telaranea nematodes*, 60 species of liverworts and three species of hornworts are added here, for a total of 80 liverwort and hornwort species now known from Lāna‘i

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1. Contribution 2023-005 to the Hawaii Biological Survey.

2. Distinguished Research Affiliate, Herbarium Pacificum, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai‘i 96817-2704, USA

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**CHECKLIST**

Taxonomic nomenclature follows Staples & Imada (2006) and Söderström *et al.* (2016), updated through February 2023 using the TROPICOS <https://www.tropicos.org/home> database. Collections made by all three of us (Freire, Judziewicz & Bogner) are cited with the prefix “22-”. Those made by Bogner alone (her numbers 442–450) are cited with her surname and number. The full names of all other collectors and the place of deposition of their collections are fully cited. Previous records from other major islands follow the checklist of Staples & Imada (2006).

**HORNWORTS (3 species)****Anthocerotaceae**

*Folioceros fuciformis* (Mont.) D.C. Bharadw. **New island record**

Common, Maunalei Gulch. Previously known from O‘ahu, Maui and Hawai‘i.

*Material examined.* LĀNA‘Ī: Maunalei Gulch, 24 Jun 2022, *Bogner 447b, 449a, 450a.*

**Dendrocerotaceae**

*Dendroceros crispus* (Sw.) Nees

**New island record**

(Fig. 1)

Occasional, in dry forest, and only seen on the bark of *Schinus terebinthifolius*. Previously known from all other major islands.

*Material examined.* LĀNA‘Ī: Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-417, 22-428* in mix; Koloiki Trail, 24 Mar 2022, *22-433*; Kunoa, rare on bark of tree, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-384a.*



**Fig. 1.** *Dendroceros crispus* (hornwort with sporophytes), and small leafy liverwort *Lejeunea pacifica* on Munro Trail 0.5 miles northwest of Pu‘u Kīlea.



Fig. 2. Hornwort *Phaeoceros* cf. *carolinianus* at Lānaʻihale summit.

### Notothyladaceae

*Phaeoceros* cf. *carolinianus* (Michx.) Prosk.      **New island record**

(Fig. 2)

Uncommon. Previously known from all other major islands except Molokaʻi.

*Material examined.* LĀNAʻI: Lānaʻihale, rare, with immature horns, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-372*; Maunalei Gulch, 24 Jun 2022, *Bogner 442a*.

### LIVERWORTS (79 species)

#### Adelanthaceae

*Cuspidatula robusta* (Austin)

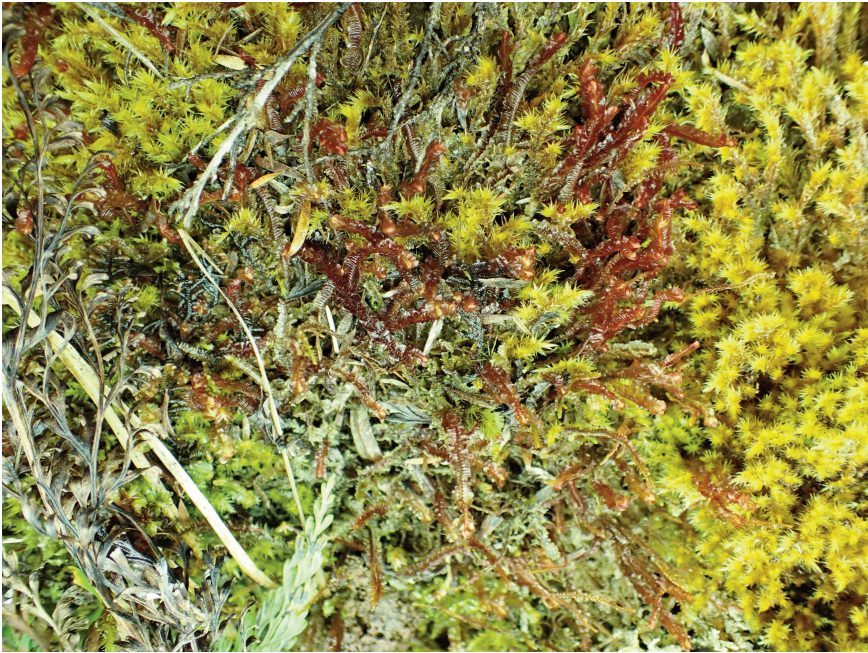
Váňa & L. Söderstr.

**New island record**

(Fig. 3)

Common, summit. Previously known from all other major islands.

*Material examined.* LĀNAʻI: Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-324, 22-325*; Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-380b*; Kunoa, same date, *Freire, Judziewicz & Bogner 22-382b, 22-392a, 22-396, 22-399a, 22-401a*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-409a*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-464a, 22-465b, 22-467a, 22-472, 22-22-485*; Haʻalealepaʻakai, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-501c*.



**Fig. 3.** Reddish leafy liverwort *Cuspidatula robusta* and yellowish moss *Acroporium fuscoflavum*, Kunoa.

### Aneuraceae

#### *Riccardia* species.

(Fig. 4)

Common, summit. At least three species appear to be present on the island.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, Freire, Judziewicz & Bogner 22-268, 22-274, 22-279a, 22-281, 22-285b, 22-286c, 22-291a, 22-294a, 22-298a, 22-299a, 22-301b; Lāna'ihale, 23 Mar 2022, Freire, Judziewicz & Bogner 22-352a, 22-354, 22-374; Kunoa, 23 Mar 2022, Freire, Judziewicz & Bogner 22-403c; Koloiki Trail, 24 Mar 2022, Freire & Judziewicz 22-441; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, Freire, Judziewicz & Bogner 22-445, 22-452; Kunoa, 25 Mar 2022, Freire, Judziewicz & Bogner 22-466c, 22-476b, 22-477, 22-479, 22-481a, 22-484, 22-487c, 22-488c, 22-489e, 22-493b. Also: Upper end of Naio Gulch, 17 Sep 1963, Degener 28438 (MU, not examined).

### Calypogeiaceae

#### *Calypogea tosana* (Steph.) Steph.

#### New island record

Common, summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, Freire, Judziewicz & Bogner 22-280b, 22-286a, 22-290, 22-294c, 22-298c, 22-299b, 22-301a, 22-333a, 22-335e, 22-337; Lāna'ihale, 23 Mar 2022, Freire, Judziewicz & Bogner 22-350b, 22-365, 22-371b, 22-375; Kunoa, 25 Mar 2022, Freire, Judziewicz & Bogner 22-466b, 22-476a, 22-481b, 22-482b, 22-486, 22-488b.



**Fig. 4.** Large thalloid liverwort *Dumortiera hirsuta* with smaller thalloid *Riccardia* species (arrow). Photo: Kari Bogner.

***Mnioloma fuscum*** (Lehm. & Lindenb.)

R.M. Schuster

**New island record**

Rare in mix at summit. Previously known from Maui and Hawai'i.

*Material examined.* LĀNA'I: Ha'alealepa'akai, 22 Mar 2022, Freire, Judziewicz & Bogner 22-305b.

**Cephaloziaceae**

***Cephalozia lucens*** (A. Evans) Steph.

**New island record**

Rare and inconspicuous at summit, mixed with *Riccardia*. Previously known only from Maui.

*Material examined.* LĀNA'I Kunoa, 25 Mar 2022, Freire, Judziewicz & Bogner 22-466a.

***Cephalozia maxima*** Steph.

Rare. Previously known only from Maui. Not seen by us, but this species is reported from Kahinahina Ridge [ca. 20°49'N, 156°51'W according to Google Earth], windswept tree trunks in fog belt, 2,500 ft [762 m], 9 Sep 1963, *Degener 28411* (MU, not examined). This specimen was determined by H.A. Miller in 2018.

***Fuscocephaloziopsis connivens* (Dicks.)**

Vána &amp; L. Söderstr. subsp.

***sandwicensis* (Mont.) Vána & L. Söderstr. New island record**

Fairly common but inconspicuous in mixes at the summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-291b, 22-298b, 22-335c*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-350c, 22-352b, 22-364b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-386b, 22-391*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-488e*.

***Odontoschisma denudatum* (Mart.) Dumort. New island record**

Fairly common, bark and embankments, summit and foothills. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-269, 22-276, 22-294b, 22-298d, 22-301c, 22-305a*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-380d*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-479b*.

**Cephaloziellaceae*****Cephaloziella heteroica* (C.M. Cooke) Douin New island record**

Rare and inconspicuous, disturbed soil. Previously known from Kaua'i, Moloka'i and Maui.

*Material examined.* **LĀNA'I:** Puhī'elelū Gulch parking pull-off, 20°48'18"N, 156°51'53"W, 992 m, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-302a*; Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-338b*.

***Cephaloziella kilohanensis* (C.M. Cooke) Douin New island record**

Rare and inconspicuous in mixes at summit. Previously known from Kaua'i and Maui.

*Material examined.* **LĀNA'I:** Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-404b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-487d*.

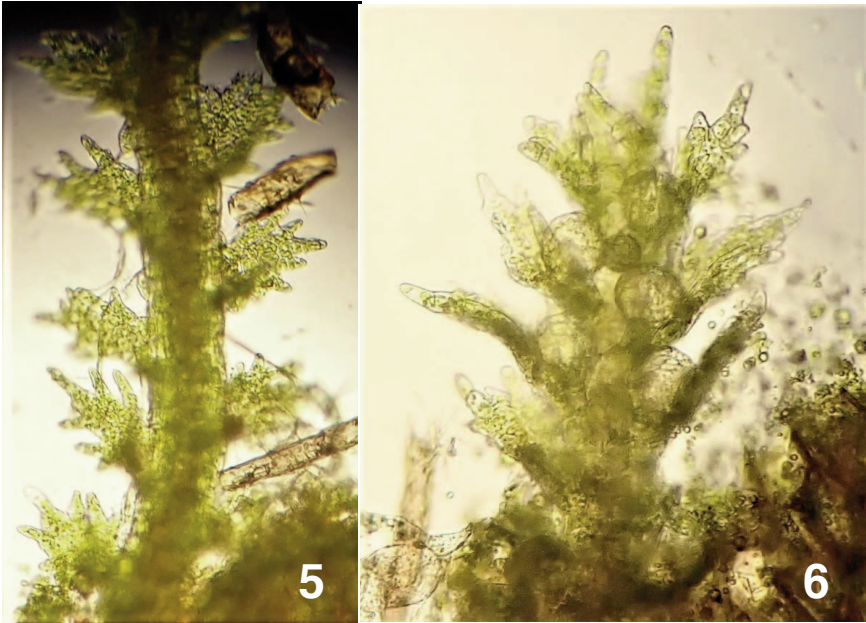
***Cephaloziella* aff. *microphylla* (Steph.) Douin New state record**

(Figs 5–6)

This is a tiny, inconspicuous species with pinnately lobed leaves only 100 μm (0.1 mm) long. It appears to very similar to *C. microphylla* (Huang & Lin, 2009) from tropical Asia, and, according to David H. Wagner, an authority on American species of *Cephaloziella* (13 April 2022 pers. comm.), it may represent an undescribed species; it is apparently indigenous. Without fertile material, we hesitate to describe this as a new species. It creeps on bark, hāpu'u stipes, can be epiphytic on hornworts, and is found on both Lāna'i and Hawai'i Islands (815–1,768 m) in wet montane forests. The stems are relatively rigid and prominent. The minute (0.1 mm long) leaves have two lobes that are pinnately divided, resembling a tiny Christmas tree. We have observed some populations with elliptical, 2-celled gemmae.

*Material examined.* **LĀNA'I:** On a wet, shaded rock wall on the south side of Munro Trail just east of Kunoa, mixed with *Symphogyna semi-involucrata*, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-403d*; Lāna'ihale, on bark, mixed with *Riccardia* sp. and *Fuscocephaloziopsis connivens* subsp. *sandwicensis*, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-352c*. **HAWAII:** Hawai'i Volcanoes National Park, East Rift Zone kīpuka, forest north of Nāpau Crater, ca. 19°22'45"N, 155°08'45"W, 815 m, 13 Apr 1984, *L.R. Pratt 1348e* (HAVO); Volcano Guest House, 19°25'31"N,





**Fig. 5–6.** *Cephaloziella* aff. *microphylla* (Freire & Judziewicz 22-403d). The leaves are approximately 0.1 mm long. **5.** Leafy stem with pinnately lobed leaf lobes. **6.** Androecial branch.

155°12'24"W, open pastured *Metrosideros polymorpha* forest, moist shaded rock, with *Fissidens elegans*, 1,045 m, 25 Dec 2020, *A.V. Freire & E.J. Judziewicz 20-1146* (BISH); same location, with *Phaeoceros carolinianus*, *Kurzia hawaica*, and *Telaranea nematodes*, 27 Oct 2021, *A.V. Freire & E.J. Judziewicz 21-945a* (BISH); Hawai'i Volcanoes National Park, trail down into Kīlauea Iki, 100-250 m west of Nāhuku Lava Tube parking lot, 19°24'46"N, 155°14'22"W, on stipes of *Cibotium glaucum*, 1,186 m, 11 Apr 2021, *A.V. Freire & E.J. Judziewicz 21-410* (HAVO); Pu'u Maka'ala N.A.R., about 1 mi [1.62 km] north of end of Amaumau Road, 19°29'N, 155°17'W, 1,340 m, 5 Feb 2022, *A.V. Freire & E.J. Judziewicz 22-215c* (BISH).

### Dumortieraceae

*Dumortiera hirsuta* (Sw.) Nees

(Fig. 4)

Occasional in shaded gulches on summit and in Maunalei Gulch.

*Material examined.* **LĀNA'I:** Puhi'elelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-307*; Maunalei Gulch, 24 Jun 2022, *Bogner 449b*. Also: *Forbes 480L* (BISH).

### Frullaniaceae

*Frullania apiculata* (Reinw. et al.) Nees

**New island record**

(Fig. 7)

Common, summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-265a*; 22-339c; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-345a*, 22-355a; Kunoa, 23



**Fig. 7.** *Frullania apiculata*, Munro Trail.

Mar 2022, *Freire, Judziewicz & Bogner 22-387a, 22-405*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-412a*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-467b, 22-491c*.

***Frullania hawaiiensis* H.A Mill.**

**New island record**

Rare, summit. Previously known from O'ahu, Moloka'i and Maui.

*Material examined. LĀNA'I:* Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-468b*.

***Frullania hypoleuca* Nees.**

Fairly common, summit.

*Material examined. LĀNA'I:* Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-270a, 22-272b, 22-289a, 22-330*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-359b*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-493c*; Maunalei Gulch, 24 Jun 2022, *Bogner 443c*. Also: Bog, 2,500 ft [762 m], 26 Nov 1960, *Doty 22316* (BISH).

***Frullania meyeniana* Lindenb.**

**New island record**

Fairly common, summit and foothills. Previously known from all other major islands.

*Material examined. LĀNA'I:* Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-287, 22-298g, 22-332*; Munro Trail, 1 km northwest of Pu'u Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-426*; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-454b, 22-459b*; Kō'ele, 24 Mar 2022, *Freire & Judziewicz 22-461*.

***Frullania oahuensis* Hampe****New island record**

Common. Previously known from all other major islands.

*Material examined.* LĀNA'I: Maunalei Gulch, 24 Jun 2022, *Bogner 442f, 443b, 444c.*

***Frullania sandvicensis* Ångstr.**

Only known from a dry forest with *Nothocestrum* in the northwestern part of the island; *Fagerlund & Skottsberg 7020* (Stockholm Herbarium, S, not examined). Not relocated by us.

**Herbertaceae*****Herbertus aduncus* (Dicks.) Gray**

Fairly common, summit.

*Material examined.* LĀNA'I: Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-323a*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-408, 22-411c*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-492*. Also: Bog, 2,500 ft [762 m], 26 Nov 1960, *Doty 22320* (BISH).

***Herbertus gracilis* (Mont.) Kuntze****New island record**

Abundant, summit. Previously known from all other major islands.

*Material examined.* LĀNA'I: Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-271a, 22-289c, 22-298f, 22-331, 22-333b, 22-334, 22-339a*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-343a, 22-358a, 22-360, 22-361b, 22-362a, 22-378b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-398b, 22-400, 22-401b*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-473, 22-478d, 22-483, 22-493a*; Ha'alealepa'akai, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-501a.*

***Herbertus herpocladoides* E.B. Scott**

& H.A. Mill.

**New island record**

Uncommon, status of species uncertain; perhaps better included in *H. gracilis*. Previously known from all major islands except O'ahu.

*Material examined.* LĀNA'I: Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-464b, 22-495a.*

**Jubulaceae*****Jubula javanica* Steph.**

Rare, seen at summit in the Restoration Area forest on the Munro Trail at the base of a tree (no voucher by us).

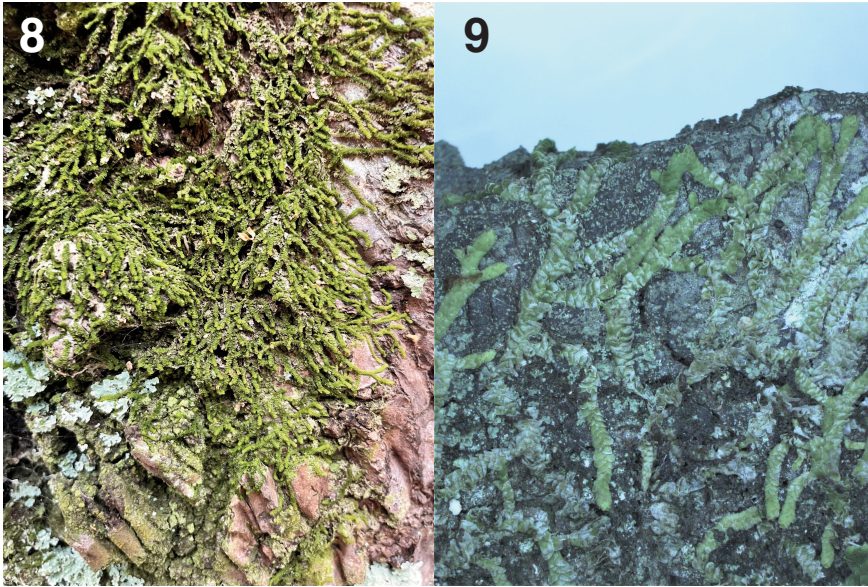
*Material examined.* LĀNA'I: Epiphytic on the fern *Vandenboschia cyrtotheca*, Sep 1917, *Forbes 485* (BISH).

**Lejeuneaceae*****Acrolejeunea sandvicensis* (Gottsche) Steph.      **New island record****

(Figs. 8, 9)

Common in Maunalei Gulch. Previously known from O'ahu and Hawai'i.

*Material examined.* LĀNA'I: Maunalei Gulch, 24 Jun 2022, *Bogner 442e, 443a, 444a.*



**Figs. 8–9.** *Acrolejeunea sandvicensis*. Maunalei Gulch. Photos: Kari Bogner.

***Cheilolejeunea decursiva*** (Sande Lac.)

R.M. Schust.

**New island record**

Uncommon at summit; inconspicuous. Previously known from all other major islands except Hawai‘i.

*Material examined.* **LĀNA‘Ī:** Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-384c*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-467a, 22-469a*.

***Cheilolejeunea intertexta*** (Lindenb.) Steph. **New island record**

Fairly common in foothill forests. Previously known from all other major islands.

*Material examined.* **LĀNA‘Ī:** Munro Trail, 1 km northwest of Pu‘u Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-427*; Pumping station on the NW side of Wai‘apa‘a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-447, 22-457, 22-459a*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-463b*; Maunalei Gulch, 24 Jun 2022, *Bogner 443e, 444b*.

***Cheilolejeunea stenoschiza*** (Ångstr.) A. Evans **New island record**

Occasional in mixes at summit. Previously known from all other major islands except Hawai‘i.

*Material examined.* **LĀNA‘Ī:** Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-272a*; Lāna‘ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-345b, 22-347* in mix.

***Cololejeunea ceatocarpa* (Ångstr.) Steph.**

Occasional, summit.

*Material examined.* **LĀNA'I:** Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-284a*; Puhī'elelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-315b, 22-321*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-489c*. Also *Forbes 479, 482-484, 490, 492, 494, 495, 496* (all at BISH).

***Cololejeunea hoana* Tixier****New island record**

Occasional, Maunalei Gulch. Previously known from O'ahu.

*Material examined.* **LĀNA'I:** Maunalei Gulch, 24 Jun 2022, *Bogner 442h, 444d*.

***Cololejeunea longistylis* A. Evans****New island record**

Rare, Maunalei Gulch. Previously known from Kaua'i and O'ahu.

*Material examined.* **LĀNA'I:** Maunalei Gulch, 24 Jun 2022, *Bogner 443d*.

***Cololejeunea planissima* (Mitt.) Abeyw.****New island record**Occasional in foothill forests (rare at summit); closely appressed to bark or leaves. Previously known from Kaua'i and O'ahu (as *C. lanciloba* Steph.).

*Material examined.* **LĀNA'I:** Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-370d*; Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-443*; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-454a*.

***Colura tenuicornis* (A. Evans) Steph.****New island record**

Occasional, summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-265c, 22-278a*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-347* in mix, *22-363b*.

***Drepanolejeunea anderssonii* (Ångstr.)**

A. Evans

**New island record**

Occasional at summit, inconspicuous. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-265b, 22-266b, 22-275b, 22-289b*, Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-363a*.

***Drepanolejeunea ungulata* (Steph.) Grolle****New island record**

Fairly common at summit, inconspicuous. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-265d, 22-271b, 22-273b, 22-275a, 22-278b, 22-279b, 22-296b*, Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-411d*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-467d*.

***Lejeunea adpressa* Nees****New island record**

Uncommon, summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-288b*.



**Fig. 10.** Exotic liverwort *Lejeunea flava* is known only from a few planted trees in the Kōʻele resort area (intersection of Kaunaʻoa Drive and Ninth Street).

*Lejeunea flava* (Sw.) Nees  
(Fig. 10)

**New naturalized state record**

We newly report this species from all major islands (0–1,340 m) except Molokaʻi, where it probably also occurs. Apparently first collected in Hawaiʻi in 1977 (from Foster Botanical Garden in Honolulu, based on a Miami University specimen that has not yet been examined), and becoming widely distributed by about 2000. This American species is now the dominant bark epiphyte in both urban and rural locations in lowland Hawaiʻi. Distinct in Hawaiian members of the genus in its large underleaves. First confirmed for Hawaiʻi in 2016 by the late Jochen Heinrichs (1969–2018) based on Kauaʻi collections annotated at both BISH and PTBG. A good description and illustration may be found in Gradstein & Ilkiu-Borges (2009: 101–102).

*Material examined.* **KAUAʻI:** Kawaihau Dist., Ca. 4.5 mi [7.3 km] up Hwy 580 between Keahou Arboretum and Wailua Experiment Station, planted *Albizia* grove along roadside, Epiphytic on trunk of *Albizia*, 13 Mar 1992, *T. Flynn 4926* (PTBG); Kealia Forest Reserve, Kahuna Valley, 174 m, 27 Jan 2018. *W. Ma, J. Shevock, T. Flynn, & A. Williams 18-9330* (PTBG). Kōloa Dist., Kalāheo, 5473C Puʻulima Road, growing on undersides of branches of *Pandanus*, 340 m, 24 Jan 2022, *T. Flynn 9279* (PTBG). Līhuʻe Dist., Terminus of road to Blue Hole, 334 m, 18 Feb 2016, *T. Flynn, J. Shevock, W. Ma & J. Game 8245, 8246, 8248, 8249* (BISH, PTBG); Agroforestry demonstration plot along Hwy 50 east of Kauaʻi Humane Society, epiphyte on lower trunk of *Macaranga tanarius*, in heavy shade, 118 m, 31 Jan 2014 (PTBG). **OʻAHU:** Waiʻanae Range, trail from Mauna

Kapu to Palikea, 811–920 m, 4 Nov 2021, *E.J. Judziewicz et al. 21-953* (BISH). Ko'olau Range, Mt. Tantalus, near Pu'u 'Ōhi'a Trail, bamboo forest, on yellowing leaves, 18 Jan 2022, *N. Walvoord NW-2022-005* (BISH). **LĀNA'I:** On exotic cultivated tree at corner of Kauna'oa Drive and 9<sup>th</sup> Street, Lāna'i City, Kō'ele, 540 m, 25 Mar 2022, *A.V. Freire & E.J. Judziewicz 22-460*. **MAUI:** Ko'olau Dist., Waiohū Bay coastline to Pa'akea to Kapā'ula, hala coastal wet forest, 0–50 m, 23 Sep 2021, *K. Severson 018* (BISH). **HAWAII:** Hilo, UH-Hilo campus, 38 m, 21 Jan 2021, *A.V. Freire & E.J. Judziewicz 21-84* (BISH); Onomea, 19°48'35"N, 155°05'40"W, on exotic trees, 30 m, 20 Nov 2019, *A.V. Freire & E.J. Judziewicz 19-150* (BISH); Niaulani Forest, Volcano, 1,158 m, 29 Sep 2020, *A.V. Freire & E.J. Judziewicz 20-720* (BISH); Volcano Guest House, Volcano, 19°25'30"N, 155°12'25"W, 1,045 m, 4 Sep 2020, *A.V. Freire & E.J. Judziewicz 20-636* (BISH); Hawai'i Volcanoes National Park, employee housing area, 19°25'37"N, 155°15'23"W, 1,210 m, 28 Nov 2020, *A.V. Freire & E.J. Judziewicz 20-1011* (HAVO); Hawai'i Volcanoes National Park, Maunaulu parking lot, 985 m, 2 Aug 2020, *A.V. Freire & E.J. Judziewicz 20-552* (HAVO); Hawai'i Volcanoes National Park, small pit in open lava on trail to Pu'u Huluhulu, 1,000 m, 28 Jan 2020, *A.V. Freire & E.J. Judziewicz 20-30a* (HAVO); Hawai'i Volcanoes National Park, 'Akihi ravine, epiphyte on *Pipturus albidus*, 760 m, 11 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-794a* (HAVO).

### *Lejeunea pacifica* Mont.

(Fig. 1)

Fairly common, summit.

*Material examined.* **LĀNA'I:** Puhi'eleeū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-314, 22-315a, 22-317*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-415 mix, 22-416*; Munro Trail, 1 km northwest of Pu'u Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-420b*, Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-434*; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-450b, 22-453*; Kauna'oa Drive and 9<sup>th</sup> Street, Kō'ele, Lāna'i City, *Freire & Judziewicz 22-463a*. Also *Forbes 487-489* (BISH).

### *Lopholejeunea nigricans* (Lindenb.) Schiffn. **New island record**

Occasional at summit. Previously known from all major islands.

*Material examined.* **LĀNA'I:** Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-264, 22-338a*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-347b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-493c* in mix.

### *Lopholejeunea* aff. *nigricans* (Lindenb.) Schiffn.

Rare at summit. This collection is smaller in all respects than *L. nigricans*.

*Material examined.* **LĀNA'I:** Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-403d*.

### *Metalejeunea cucullata* (Reinw. et al.) Grolle **New island record**

Abundant but inconspicuous, summit and foothills. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** N Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-279b, 22-273a, 22-296c, 22-304b, 22-339f*; Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-342a, 22-356b, 22-359c*; Munro Trail, 1 km northwest of Pu'u Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-420c*; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-446b, 22-456*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-491d*.

***Microlejeunea lunulatiloba*** Horik.**New island record**

Occasional but inconspicuous, at summit and foothills. Previously known from all other major islands except Kauaʻi.

*Material examined.* **LĀNAʻI:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-266a*, Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-435*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-489d*.

***Myriocoleopsis minutissima*** (Sm.) R.L. Zhu,Y. Yu & Pócs subspecies *minutissima* **New state record**

A tiny, inconspicuous pantropical bark epiphyte that can now be reported from Oʻahu, Molokaʻi, Lānaʻi, Maui, and Hawaiʻi (540–1,768 m); indigenous. In this commoner subspecies, the leaves are nearly spherical, with the subspherical lobule nearly as long as the lobe; in subspecies *myriocarpa* (Nees & Mont.) R.L. Zhu, Y. Yu & Pócs, the leaves are slightly elliptical and the lobule is narrow and elongate (Yu *et al.*, 2014).

*Material examined.* **OʻAHU:** Mānoa, Kūkaʻōʻō, 2 Feb 1903, *C.M. Cooke, Jr. s.n.* (BISH). **MOLOKAʻI:** Between Maunahui and Waikolu Canyon, 3,000–3,500 ft [914–1,067 m], Jul 1903, *C.M. Cooke, Jr. 15* (BISH). **LĀNAʻI:** Pumping station on the NW side of Waiʻapaʻa Gulch, 710 m, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-454c*; Kaunaʻoa Drive and 9<sup>th</sup> Street, Kōʻele, Lānaʻi City, 540 m, 24 Mar 2022, *Freire & Judziewicz 22-462*; Maunalei Gulch, 24 Jun 2022, *Bogner 442i*. **MAUI:** West Maui, Maunahoʻoma, Jun 1910, *C.N. Forbes s.n.* (BISH). **HAWAIʻI:** Manukā N.A.R., epiphylllic on leaves of *Ochna serrulata*, 600 m, 9 Jan 2022, *A.V. Freire & E.J. Judziewicz 22-59, 69b* (BISH); Hawaiʻi Volcanoes National Park, Kīpukapuau, on decorticate log in koa-mānele forest, 1,210 m, 27 May 2021 (HAVO); Puʻu Makaʻala N.A.R., near old Mauna Loa Boys School, south kīpuka, 19°34ʻ45″N, 155°20ʻ00-07″W, 1,760 m, 19 Aug 2021, *A.V. Freire & E.J. Judziewicz 22-655a* (BISH), north kīpuka, 19°35ʻ00-08″N, 155°21ʻ00-03″W, 1,768 m, 25 Aug 2021, *A.V. Freire & E.J. Judziewicz 22-699a* (BISH).

***Spruceanthus planiusculus*** (Mitt.) X.Q. Shi, R.L. Zhu & Gradst.

Fairly common, foothills; uncommon, summit.

*Material examined.* **LĀNAʻI:** Puhīʻelelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-309, 22-312*; Munro Trail, 1 km northwest of Puʻu Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-420a*; Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-431a*; Pumping station on the NW side of Waiʻapaʻa Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-446a, 22-448a, 22-450a*. Also East Kunoa, 8 Jan 2008, *Wood et al. 12763b* (BISH, PTBG).

***Spruceanthus polymorphus*** (Sande Lac.) Verd. **New island record**

(Fig. 11)

Fairly common, foothill. Previously known from Kauaʻi and Oʻahu.

*Material examined.* **LĀNAʻI:** Munro Trail, 1 km northwest of Puʻu Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-418, 22-425, 22-22-428*; Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-442a*.

**Lepidoziaceae*****Acromastigum integrifolium*** (Austin) A. Evans **New island record**

Common in mixes from the summit. Previously known from all other major islands except Hawaiʻi.

*Material examined.* **LĀNAʻI:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-323b, 22-339e*; Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-342b, 22-344a, 22-346a, 22-378d, 22-379, 22-380a*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-388, 22-390*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-467e*.





**Fig. 11.** *Spruceanthus polymorphus* (yellowish leafy liverwort in center) on Christmas berry, *Dendroceros crispus* (dark green hornwort on right), Munro Trail 0.5 miles north-west of Pu‘u Kīlea.

***Bazzania brighamii* (Austin) A. Evans**                      **New island record**

Occasional, summit. Previously known from all other major islands.

*Material examined.* LĀNA‘Ī: Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-291a, 22-292d.*

***Bazzania cordistipula* (Mont.) Trevis.**

Fairly common, summit.

*Material examined.* LĀNA‘Ī: Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-297, 22-300, 22-303*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-385*. Also: Kahinahina Ridge [ca. 20°49’N, 156°51’W according to Google Earth], windswept tree trunks in fog belt, 2,500 ft [762 m], 9 Sep 1963, *Degener 28411* (MU, not examined).

***Bazzania didericiana* (Steph.) Steph.**                      **New island record**

Occasional, summit. Previously known from all other major islands.

*Material examined.* LĀNA‘Ī: Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-296a*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-386a.*

***Bazzania emarginata* (Steph.) C.M. Cooke**                      **New island record**

Abundant, summit. Previously known from all other major islands.

*Material examined.* **LĀNAʻĪ:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-267, 22-292c, 22-323c, 22-339d*; Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-349, 22-353, 22-356a, 22-358b, 22-361a, 22-373, 22-378c*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-383, 22-387b, 22-392b, 22-393b, 22-394b*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-407*; Munro Trail, 1 km northwest of Puʻu Kīlea, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-419a*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-474a, 22-478a, 22-496b, 22-498*.

***Bazzania minuta* (Austin) A. Evans**

**New island record**

Rare in mix. Previously known from all other major islands except Oʻahu.

*Material examined.* **LĀNAʻĪ:** Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-343b*.

***Bazzania sandvicensis* (Steph.) Steph.**

**New island record**

Rare, summit. Previously known from all other major islands.

*Material examined.* **LĀNAʻĪ:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-306*.

***Kurzia hawaica* (C.M. Cooke) Grolle**

**New island record**

Fairly common but inconspicuous in mixes from the summit. Previously known from all other major islands.

*Material examined.* **LĀNAʻĪ:** 22-294d, 22-298e, 22-335d, 22-386c, 22-465a, 22-478c, 22-481d, 22-488d, 22-494a.

***Telaranea nematodes* (Austin) M. Howe**

**New naturalized state record**

We newly report this species as present on all major islands except Molokaʻi (0–1860 m). This tiny, filamentous looking liverwort (Gradstein & Ilkiu-Borges 2009: 28–29) had not been noted in Hawaiʻi prior to this study, even though it is now widespread and locally common in Hawaiʻi Volcanoes National Park. The plants grow in tiny, dense mats on soil or rotted bark, often associated with other leafy liverworts and in apparent association with blue-green colored cyanobacteria. The stem has an apparent hyalodermis and trifid leaves, each lobe with two paired cells at the base and tipped with a uniseriate series of 4–5 more cells. Widespread on the American mainland, Africa, and western Europe, this species apparently first appeared in Hawaiʻi about 2000; we have examined numerous liverwort mixtures from prior to 2000 and have not found this species in any of them.

*Material examined.* **KAUAI:** Nā Pali-Kona Forest Reserve, Pihea Trail, in tiny bog by trail, 1,109–1,231 m, 24 Sep 2014, *W. Ma, J. Shevock, T. Flynn 14-5912* (PTBG); Waimea Dist., Alakaʻi Wilderness Preserve, northeast of *Platanthera* bog along small tributary of Kawaiikoi Stream, *Metrosideros* dominated wet forest w/*Cibotium*, *Sticherus*, *Melicope*, *Dubautia*, and *Labordia*, 28 Apr 2016, *T. Flynn 8370* (BISH, PTBG). **OʻAHU:** Summit of Puʻu Kaʻala, 1,220 m, terrestrial on steep, moist, partially shaded roadsides, in *Metrosideros polymorpha*-dominated forest, 17 May 2022, *M.K. Thomas, S.N. Ching et al. 371b, 403b* (BISH). **LĀNAʻĪ:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-294e*; Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-358c, 22-364c*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-385* in mix; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-407* in mix, 22-410, 22-411 in mix; Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-439b*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-471* in mix, 22-478b, 22-481c, 22-482a, 22-487b, 22-488a, 22-497 in mix. **MAUI:** Hana Dist., East Maui, Koʻolau Forest Reserve, Kopiliula drainage basin, *Metrosideros/Acacia* montane wet forest, 771 m, 20 Sep 2016, *H. Oppenheimer 91264* (PTBG). **HAWAII:** Volcano Guest House, 11-3733 Ala ʻŌhiʻa Street, 19°25'31" N, 155°12'24" W, shaded moist crevice in tumulus in

pasture with scattered *Metrosideros polymorpha*, with *Cephaloziella microphylla*, *Phaeoceros carolinianus*, and *Kurzia hawaiiica*, 1,045 m, 27 Oct 2021, *A.V. Freire & E.J. Judziewicz 21-945d* (BISH); Hilo, Ka'ūmana Cave, 290 m, 17 Feb 2021, *A.V. Freire & E.J. Judziewicz 20-167b* (BISH); Niauulani Forest, Volcano, 1,160 m, 26 Dec 2020, *A.V. Freire & E.J. Judziewicz 20-1153* (BISH); Ka'ū Dist., Kaihohena Reserve, 19°10'40" N, 155°34'15" W, 820 m, 9 Dec 2020, *A.V. Freire & E.J. Judziewicz 20-1092a* (BISH); Hawai'i Volcanoes National Park, Kīpukapuauulu, 1,210 m, 27 Jan 2021, *A.V. Freire & E.J. Judziewicz 21-94* (HAVO); Hawai'i Volcanoes National Park, Kīpukakī, 1,335 m, 12 Jan 2021, *A.V. Freire & E.J. Judziewicz 21-33a* (HAVO); Hawai'i Volcanoes National Park, east of Escape Road, on *Cibotium stipe*, 1,112–1,128 m, 30 June 2020, *A.V. Freire & E.J. Judziewicz 20-409* (HAVO); Hawai'i Volcanoes National Park, Halema'uma'u Trail adjacent to Volcano House, 1,160 m, 4 Feb 2020, *A.V. Freire & E.J. Judziewicz 20-75a* (HAVO); Hawai'i Volcanoes National Park, 'Ākiki ravine, 762 m, 11 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-793a* (HAVO); Hawai'i Volcanoes National Park, Kāhuku Unit, waterholes, 19°13'36" N, 155°38'00" W, 1,860 m, 9 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-674* (HAVO).

### Lophocoleaceae

#### *Chiloscyphus laceratus* Steph.

#### **New island record**

Rare, summit. Previously known from Moloka'i, Maui, and Hawai'i.

*Material examined.* **LĀNA'I** Lāna'ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-378a*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-468a*.

#### *Cryptolophocolea ciliolata* (Nees) L. Söderstr.,

Crand.-Stotl., Stotler & Váňa

#### **New island record**

Occasional at summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I**: Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-277, 22-301d*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-411b*.

#### *Lophocolea autoica* Steph.

#### **New island record**

Occasional in foothills, uncommon at summit. Previously known from O'ahu and Hawai'i.

*Material examined.* **LĀNA'I**: Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-394b*; Koloiki Trail, 24 Mar 2022, *Freire & Judziewicz 22-436, 22-441* in mix; Pumping station on the NW side of Wai'apa'a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-455*; Ha'alealepa'akai, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-501b*.

#### *Lophocolea baldwinii* Steph.

#### **New island record**

Occasional at summit, especially at Kunoa. Previously known from all other major islands.

*Material examined.* **LĀNA'I**: Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-382a, 22-404* in mix; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner, 22-471*.

#### *Lophocolea bartlettii* H.A. Mill.

#### **New island record**

Uncommon at summit. Previously known from Moloka'i, Maui, and Hawai'i.

*Material examined.* **LĀNA'I**: Ha'alealepa'akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-285a*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-395a*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-409b*.



**Fig. 12.** Thalloid liverworts *Marchantia crenata* (large) and *Symphyogyna semiinvolucrata* (small), rock wall on Munro Trail east of Kunoa.

***Lophocolea hawaiiica* Steph.**

**New island record**

Occasional in foothills. Previously known from Kauaʻi, Molokaʻi, and Hawaiʻi.

*Material examined.* LĀNAʻI: Haʻalealepaʻakai, 22 Mar 2022, Freire, Judziewicz & Bogner 22-280, 22-286b; Puhiʻelelū Gulch, 23 Mar 2022, Freire, Judziewicz & Bogner 22-311; Koloiki Trail, 24 Mar 2022, Freire & Judziewicz 22-439.

***Lophocolea kilauensis* (Steph.) H.A. Mill.**

**New island record**

Uncommon at summit and in foothills. Previously known from Oʻahu and Hawaiʻi.

*Material examined.* LĀNAʻI: Haʻalealepaʻakai, 22 Mar 2022, Freire, Judziewicz & Bogner 22-292b; Pumping station on the NW side of Waiʻapaʻa Gulch, 24 Mar 2022, Freire, Judziewicz & Bogner 22-449.

**Marchantiaceae**

***Marchantia crenata* Austin**

**New island record**

(Fig. 12)

Occasional on wet embankments at summit. Previously known from all other major islands except Molokaʻi.

*Material examined.* LĀNAʻI: Lānaʻihale, 23 Mar 2022, Freire, Judziewicz & Bogner 22-366; Kunoa, 23 Mar 2022, Freire, Judziewicz & Bogner 22-404a.



**Fig. 13.** *Marchantia marginata*. Note gemmae cups. Maunalei Gulch. Photo: Kari Bogner.

*Marchantia marginata* Steph.

**New island record**

(Fig. 13)

Locally common in Maunalei Gulch. Previously known from all other major islands except Hawai'i.

*Material examined.* **LĀNA'I:** Maunalei Gulch, 24 Jun 2022, *Bogner 446a, 447a, 449d.*

### Metzgeriaceae

*Metzgeria furcata* (L.) Corda

**New island record**

Rare, summit. Previously known from all other major islands.

*Material examined.* **LĀNA'I:** Restoration site on Munro Trail, on exotic tree trunk, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-415.*

### Notoscyphaceae

*Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt.

Occasional, wet roadside embankments, summit, occasionally in foothills,

*Material examined.* **LĀNA'I:** 22-377, 22-397, 22-431b, 22-499a, 22-500. Also: Kaiholena Ridge, wall of irrigation tunnel, 17 Aug 1957, *Degener 24324* (MU, not examined).

**Pallaviciniaceae*****Symphyogyna semiinvoluta*** Austin**New island record**

(Fig. 12)

Occasional, wet ground, summit and Maunalei Gulch. Previously known from all other major islands.

*Material examined.* **LĀNAʻĪ:** Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-364a, 22-367*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-402, 22-403a*; Maunalei Gulch, 24 Jun 2022, *Bogner 449c*.

**Plagiochilaceae*****Chiastocaulon combinatum*** (Mitt.) S.D.F. Patzak,M.A.M. Renner, Schäf.-Verw. & Heinrichs **New island record**

Uncommon at summit. Previously known from all other major islands.

*Material examined.* **LĀNAʻĪ:** Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-381*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-398a*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-413*.

***Plagiochila conduplicata*** Steph.**New island record**

Occasional, summit. Previously known from all major islands except Maui.

*Material examined.* **LĀNAʻĪ:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-282a, 22-283a, 22-327*.

***Plagiochila convoluta*** Steph.**New island record**

Common, summit. Previously known from Kauaʻi, Oʻahu, and Hawaiʻi.

*Material examined.* **LĀNAʻĪ:** Haʻalealepaʻakai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-288a, 22-304a, 22-335e*; Lānaʻihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-341, 22-362b, 22-376b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-384b, 22-389*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-467c*.

***Plagiochila gracillima*** A. Evans.**New island record**

Rare. Trigones small for this species. Previously known Molokaʻi, Maui, and Hawaiʻi.

*Material examined.* **LĀNAʻĪ:** Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-389*.

***Plagiochila grossipina*** Steph.

Uncommon; just below summit.

*Material examined.* **LĀNAʻĪ:** Puhiʻelelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-316, 22-320*. Also Hauʻola Gulch, 800–850 m, 11 Aug 2021, *Oppenheimer H82112* (BISH).

***Plagiochila mauiensis*** Steph.

Rare. Previously known from all major islands.

*Material examined.* **LĀNAʻĪ:** Hauʻola Gulch, 800–850 m, 11 Aug 2021, *Oppenheimer H82110* (BISH).



**Fig. 14.** *Plagiochila remyana*, Puhi‘elelū Gulch.

*Plagiochila remyana* Steph.

**New island record**

(Fig. 14)

Rare, just below summit. Previously known from all major islands except Moloka‘i.

*Material examined.* **LĀNA‘Ī:** Puhi‘elelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-319*.

### **Radulaceae**

*Radula acutangula* Steph.

Occasional, foothills forest.

*Material examined.* **LĀNA‘Ī:** Puhi‘elelū Gulch, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-313, 22-322*; Pumping station on the NW side of Wai‘apa‘a Gulch, 24 Mar 2022, *Freire, Judziewicz & Bogner 22-458*. Also: Kaiholena Ridge, tree in shrubby forest, 10 Aug 1957, *Degener 24329* (MU, not examined).

*Radula cavifolia* Gottsche, Lindenb. & Nees **New island record**

Occasional, summit. Previously known from Kaua‘i, Maui, and Hawai‘i.

*Material examined.* **LĀNA‘Ī:** Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-328, 22-339g*; Lāna‘ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-343c, 22-359a, 22-378e*.

*Radula cordata* Mitt.

(Fig. 15)

Common, summit.

*Material examined.* **LĀNA‘Ī:** Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-326, 22-329*; Lāna‘ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-340, 22-368, 22-369*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-399d*; Restoration site on Munro Trail, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-411a*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-470, 22-476c*. Also: East Kunoa, 8 Jan 2008, *Wood et al. 12763a* (PTBG).



**Fig. 15.** *Radula cordata*. Lāna‘ihale summit.

*Radula gracilis* Mitt. ex Steph.

**New island record**

(Fig. 16)

Fairly common, summit. Previously known from all other major islands.





**Fig. 16.** *Radula gracilis*. Kunoa, on summit ridge.

*Material examined.* LĀNA'I: Kunoa, 23 Mar 2022, Freire, Judziewicz & Bogner 22-382c, 22-387c, 22-393a, 22-394a, 22-395b; Kunoa, 25 Mar 2022, Freire, Judziewicz & Bogner 22-474b, 22-496d.

***Radula javanica*** Gottsche

Uncommon, summit.

*Material examined.* **LĀNA‘Ī:** Lāna‘ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-347a, 22-371*. Also: Northwestern part of Munro Trail, dark gulch in rain forest, 29 Jul 1963, *Degener 28285* (MU, not examined).

**Scapaniaceae*****Anastrophyllum esenbeckii*** (Mont.) Steph. **New island record**

Occasional in mixes from the summit. Previously known from all other major islands except O‘ahu.

*Material examined.* **LĀNA‘Ī:** Ha‘alealepa‘akai, 22 Mar 2022, *Freire, Judziewicz & Bogner 22-339b*; Lāna‘ihale, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-344b, 22-346b*; Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-399c*; Kunoa, 25 Mar 2022, *Freire, Judziewicz & Bogner 22-491b, 22-496c*.

**Solenostomataceae*****Solenostoma micrantha*** (Mitt.)

Vaña, Hentschel & Heinrichs

**New island record**

Rare, summit embankments; also Maunalei Gulch. Previously known from all other major islands.

*Material examined.* **LĀNA‘Ī:** Kunoa, 23 Mar 2022, *Freire, Judziewicz & Bogner 22-403b*; Maunalei Gulch, fairly common, 24 Jun 2022, *Bogner 447c, 450d*.

**DISCUSSION**

The first hepatic collections on Lāna‘i were made by Bishop Museum botanist Charles N. Forbes (1883–1920), who collected some specimens in 1917. Otto Degener (1899–1988) collected a few from 1957 to 1963, and, in the 21st century, Kenneth R. Wood and Hank Oppenheimer collected some hepatics on the island.

Below are the liverwort species known from Lāna‘i prior to our fieldwork. Except for *Cephalozia maxima* and *Frullania sandvicensis*, all species were relocated during the current study.

*Bazzania cordistipula* (*Degener 28411*, Miami University, Ohio, MU, not examined), *Cephalozia maxima* (**not relocated in this survey**, but identification needs checking; *Degener 28411*, MU, not examined).

*Cololejeunea ceatocarpa* (*Forbes 479, 482–484, 490, 492, 494, 495, 496* in Sept. 1917, all at BISH).

*Dumortiera hirsuta* (*Forbes 486*, BISH).

*Frullania hypoleuca* (Miller, “bog” at 2,500 ft [762 m] elev., BISH; *Doty 22316*, BISH).

*Frullania sandvicensis* (reported as *F. neurota*, **not relocated in this survey**; *Fagerlund & Skottsberg 7020*, Stockholm Herbarium, S, not examined).

*Herbertus aduncus* (reported as *H. sanguineus*; *Doty 22320*, BISH; *Wood 12757*, PTBG).

*Jubula javanica* (reported as *J. hutchinsiae*; *Forbes 485*, BISH).

*Lejeunea pacifica* (*Forbes 487–489*, BISH).

*Notoscyphus lutescens* (*Degener 24324*, MU, not examined).

*Plagiochila grossipina* (Hau‘ola Gulch, 800–850 m, *Oppenheimer 82112*, BISH).

*Plagiochila maiuensis* (Hau‘ola Gulch, 800–850 m, *Oppenheimer 82110*, BISH).



**Fig. 17.** Bryologically rich site on Munro Trail at head of Kunoa Gulch, el. 3,000 ft, 25 March 2022. This is the most diverse liverwort site on Lāna‘i, with 39 species. Of 80 species of liverworts and hornworts known from Lāna‘i, 65 are known from the summit ridge at elevations 2,500 ft or higher.

*Radula acutangula* (Degener 24329, MU, not examined).

*Radula cordata* (Wood et al. 12763a, PTBG).

*Radula javanica* (Degener 28285, MU, not examined).

*Riccardia* sp. (Degener 28438, MU, not examined).

*Spruceanthus planiusculus* sp. (Wood et al. 12763b, PTBG).

Four main habitats were surveyed in 2022: The summit ridge, with remnant wet indigenous forest and indigenous fern understories; a mesic leeward gulch with indigenous trees, shrubs, and ferns; “foothills” dry-mesic to mesic forests, dominated by exotic trees but with some remnant indigenous species; and Maunalei Gulch, with lowland exotic and indigenous forest along an intermittent stream. We also explored Lāna‘i City and found just one liverwort species there, the exotic *Lejeunea flava*.

#### **Lāna‘ihale summit ridge with exotic and remnant indigenous forests and indigenous fern understories**

Approximately 4 km of the summit ridge of Lāna‘i, from about 760–1,030 m along the Munro Trail, are windswept, often rain- and mist-enshrouded open forests of Cook pine

(*Araucaria columnaris*), strawberry guava (*Psidium cattleianum*), mānukā (*Leptospermum scoparium*) and occasional indigenous small trees of ‘ōhi‘a (*Metrosideros polymorpha*) (as cloud forest; Hobdy 1993); the understory is often dominated by dense mats of the indigenous uluhe ferns *Dicranopteris linearis* and *Diplazium pinnatum*. This area has the richest liverwort and hornwort diversity on the island; of 80 species of liverworts and hornworts known from Lāna‘i, 65 are known from the summit ridge at elevations of about 750 m or higher. The richest site is at the head of Kunoa Gulch, elev. 914 m; this is the most diverse single liverwort site surveyed on Lāna‘i, with 39 species (Fig. 17). Along the ridge top from northwest to southeast (the “summit”), these sites were surveyed:

1. Restoration Site (with picnic shelter), 20°49'33"N, 156°53'26"W, 847 m: 18 species seen, but incompletely surveyed; collections *Freire, Judziewicz & Bogner 22-406 to 22-416*.
2. Head of Kunoa Gulch (Fig. 17), 20°49'15"N, 156°52'48"W, 907–925 m: 39 species (richest location on Lāna‘i); collections *Freire, Judziewicz & Bogner 22-382 to 22-395 and 22-464 to 22-500*.
3. Lāna‘ihale (summit), 20°48'45"N, 156°52'24"W, 1,020–1,030 m: 26 species; collections *Freire, Judziewicz & Bogner 22-340 to 22-381*.
4. Munro Trail, 20°48'36"N, 156°52'08"W, 1,006–1,021 m: 24 species; *Freire, Judziewicz & Bogner 22-323 to 22-339*.
5. Ha‘alealepa‘akai, 20°48'23"N, 156°51'54"W, 975–1,006 m: 30 species; *Freire, Judziewicz & Bogner 22-264 to 22-306 and 22-501*.

The most widespread (but not necessarily the most conspicuous) liverworts found on the summit ridge sites were:

<i>Acromastigum intregrifolium</i>	<i>Herbertus gracilis</i>
<i>Bazzania cordistipula</i>	<i>Kurzia hawaica</i>
<i>Bazzania emarginata</i>	<i>Metalejeunea cucullata</i>
<i>Calypogeia tosana</i>	<i>Odontoschisma denudatum</i>
<i>Cololejeunea ceatocarpa</i>	<i>Plagiochila convoluta</i>
<i>Cuspidatula robusta</i>	<i>Radula cordata</i>
<i>Drepanolejeunea ungulata</i>	<i>Riccardia</i> species
<i>Frullania apiculata</i>	<i>Telaranea nematodes</i> (naturalized)
<i>Herbertus aduncus</i>	

### **Puhi‘elelū Gulch, a mesic leeward-facing gulch with indigenous trees, shrubs, and diverse ferns**

Puhi‘elelū Gulch (850–885 m) is a mesic gulch fenced from herbivores with a rich native vascular flora. Māmaki (*Pipturus albidus*) was dominant in the overstory and the liverworts were associated with many ferns in the understory including *Diplazium sandwichi-anum* and *Tectaria gaudichaudii*. These liverwort species were present (*Freire, Judziewicz & Bogner 22-307 to 22-322*):



**Fig. 18.** Branch of Christmas berry with diverse assemblage of lichens, liverworts, and the hornwort *Dendroceros crispus*. Munro Trail about 0.5 miles northwest of Pu‘u Kīlea.

*Bazzania cordistipula*  
*Cololejeunea ceatocarpa*  
*Dumortiera hirsuta*  
*Lejeunea pacifica*  
*Lophocolea hawaiiica*

*Plagiochila grossispina*  
*Plagiochila remyana* (only Lāna‘i site)  
*Radula acutangula*  
*Spruceanthus planiusculus*

It is likely that other mesic gulches harbor liverworts and hornworts not documented in this survey.

#### “Foothills” mesic to dry-mesic forests

Mesic to dry-mesic forests occur from approximately 530–700 m elevations on the drier leeward side of Lāna‘ihale and are composed primarily of exotic species such as *Eucalyptus* species, *Psidium cattleianum* (strawberry guava), *Schinus terebinthifolius* (Christmas berry), *Cinnamomum burmannii* (cinnamon), *Toona ciliata* (Australian red cedar) and *Casuarina glauca* (ironwood), with some indigenous species such as *Nestegis sandwicensis* (olopua). However, Christmas berry, in particular, hosts many species of indigenous liverworts as well as the hornwort *Dendroceros crispus*. We visited three sites of this type: Munro Trail, 1 km northwest of Pu‘u Kīlea (collections Freire, Judziewicz & Bogner 22-417 to 22-430) (Fig. 18); southern Koloiki Trail (Freire & Judziewicz 22-431

to 22-443); and the pumping station on the northwest side of Wai'apa'a Gulch (*Freire, Judziewicz & Bogner 22-445 to 22-459*). While far less diverse than the summit forests of Lāna'i, these forests do host the following 17 species of liverworts, mainly as bark epiphytes:

<i>Cheilolejeunea intertexta</i>	<i>Microlejeunea lunulatiloba</i>
<i>Cololejeunea planissima</i>	<i>Myriocoleopsis minutissima</i>
<i>Frullania meyeniana</i>	<i>Notoscyphus lutescens</i>
<i>Frullania sandvicensis</i> (historical)	<i>Radula acutangula</i>
<i>Lejeunea pacifica</i>	<i>Riccardia species</i>
<i>Lophocolea autoica</i>	<i>Spruceanthus planiusculus</i>
<i>Lophocolea hawaiiica</i>	<i>Spruceanthus polymorphus</i>
<i>Lophocolea kilauensis</i>	<i>Telaranea nematodes</i> (naturalized)
<i>Metalejeunea cucullata</i>	

### Maunalei Gulch

Maunalei Gulch is Lāna'i's largest and deepest gulch, and was surveyed by Bogner (numbers 442–450) on 24 June 2022, 20°49'56.2"–50°40.1"N, 156°53'27.5–42.7"W, at elevations from 300–448 m. At the beginning of the gulch where the paved Keōmuku Road ends, the habitat is dominated by kiawe (*Prosopis pallida*) that transitions to a mixed forest of wiliwili (*Erythrina sandvicensis*) and koa haole (*Leucaena leucocephala*), with Christmas berry (*Schinus terebinthifolia*) comprising much of the vegetation on the steep slopes of the gulch. The gulch then transitions towards a more mesic forest environment at the old pump house, where a lo'i is being restored by Pūlama Lāna'i's Cultural and Historic Preservation Department. Mauka of the lo'i the canopy is predominantly kukui (*Aleurites moluccanus*) mixed with tī (*Cordyline fruticosa*) and strawberry guava (*Psidium cattleianum*). At its back, the gulch opens into a small hame (*Antidesma pulvinatum*) forest with several other native plant species present (*Metrosideros polymorpha*, *Carex wahuensis*, *Pittosporum confertiflorum*, and *Boehmeria grandis*). There are several steep waterfalls in the back of Maunalei that periodically flow throughout the year. We found 12 species of liverworts and two hornworts at this site:

<i>Acrolejeunea sandvicensis</i>	<i>Marchantia marginata</i>
<i>Cheilolejeunea intertexta</i>	<i>Myriocoleopsis minutissima</i> subspecies <i>minutissima</i>
<i>Cololejeunea hoeana</i>	<i>Phaeoceros</i> cf. <i>carolinianus</i>
<i>Cololejeunea longistylis</i>	<i>Riccardia species</i>
<i>Dumortiera hirsuta</i>	<i>Solenostoma micrantha</i>
<i>Folioceros fuciformis</i>	<i>Symphyogyne semi-involucrata</i>
<i>Frullania hypoleuca</i>	
<i>Frullania oahuensis</i>	

### Lāna'i liverwort and hornwort diversity in a regional context

We added 63 species of liverworts and three species of hornworts for a total of 80 liverwort and hornwort species now known from Lāna'i, or about 43% of the 186 liverwort

and hornwort species documented from Hawai'i (Staples & Imada 2006). With the exception of a possible undescribed species of *Cephaloziella* aff. *microphylla* (discussed above), nearly all species found on Lāna'i are also found on at least three other Hawaiian islands, and none are endemic to Lāna'i.

Bryophytes are an often overlooked and poorly inventoried component of embryophyte (land plant) diversity; the Lāna'i embryophyte flora (now 497 species) consists of 362 vascular plants (Gustafson *et al.* 2014; 72%), 55 mosses (Staples *et al.* 2004; 12%), 77 liverworts (16%), and three hornworts (1%); bryophytes thus comprise 27% of the land plant diversity of the island. Based on the literature-based Staples & Imada (2006) paper, these are the total number of species of liverworts and hornworts known from each major Hawaiian Island:

Kaua'i	106
O'ahu	110
Moloka'i	86
Lāna'i (this study)	80
Maui	134
Hawai'i Island	110
Hawai'i	190

#### ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of the following organizations and people who made this study possible in various ways: Bernice Pauahi Bishop Museum personnel Clyde Imada, Barbara Kennedy, and Tim Gallaher, for connecting us with Pūlama Lāna'i and facilitating our volunteer work for the Herbarium Pacificum; and personnel at Pūlama Lāna'i (Rachel and Jonathan Sprague) for providing us with lodging and transportation while on Lāna'i.

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## New plant records for O‘ahu

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Several updates to the Hawaiian Naturalized Vascular Plants Checklist (Imada 2019) from some recent collections on O‘ahu are reported here. These collections have revealed five new island records, two range extensions, three new state records, two potential naturalizations, four new naturalizations, and one confirmation of a naturalization record. All identifications were made by the authors unless otherwise stated. All voucher specimens cited for this paper have been deposited at the Herbarium Pacificum (BISH).

### **Amaranthaceae**

#### ***Amaranthus polygonoides* L.**

#### **Range extension**

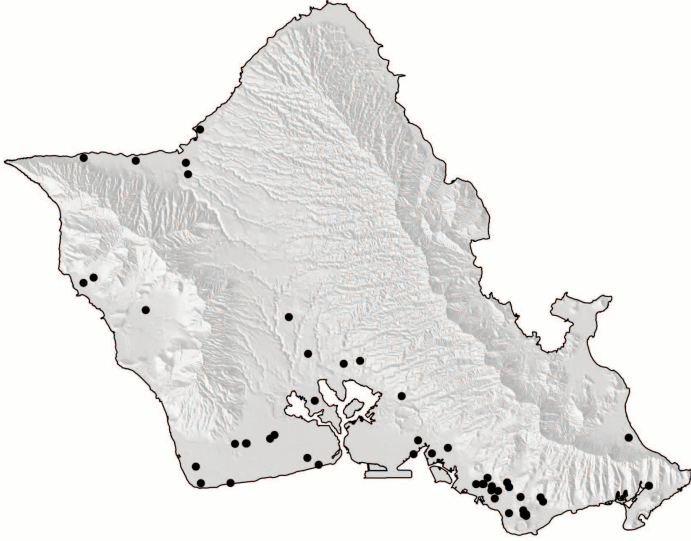
*Amaranthus polygonoides* was previously only reported from roadsides in Waikele and Wai‘anae on O‘ahu (Frohlich & Lau 2020). Recent surveys around the island have revealed that this species has spread quickly, as it has already reached Kalaniana‘ole Highway in the vicinity of Ka Iwi in southeastern O‘ahu. The species is also becoming a very common weed in lawns at parks and other disturbed roadside areas across almost all lowland leeward parts of the island (Fig. 1). *Amaranthus polygonoides* is distinguished from other species of *Amaranthus* by its axillary inflorescences and pistillate flowers with tepals fused in the proximal 1/3 (Mosyakin & Robertson 2003).

*Material examined.* O‘AHU: UH Mānoa Campus, Varney Circle, crack in asphalt between road and curb, one individual in area, 21.299934, -157.818398, 6 Jan 2021, *K. Faccenda 1702*; Ka Iwi Shoreline Trail, sparsely naturalized along the Ka Iwi trail near Kalaniana‘ole Hwy across from Hawai‘i Kai Golf Course, ca. 20–30 plants, 9 Feb 2021, *M.C. Ross 1807*; *loc. cit.*, 23 Mar 2021, *M.C. Ross 1809*; *loc. cit.*, 28 Mar 2021, *M.C. Ross 1810*; Hawai‘i Kai, Kamilo‘iki Park off of Lunalilo Home Rd, in water retention basin at NW corner of park, common only in this depression, approximately 50 plants seen in mowed area, 21.297161, -157.687860, 3 Dec 2022, *K. Faccenda 2857*.

#### ***Atriplex muelleri* Benth.**

#### **Range extension**

This species has been collected several times on O‘ahu on the western portion of the island (Imada & Kennedy 2020). *Atriplex muelleri* has since spread from the west side to most of the suitable leeward coastal areas on O‘ahu. It has been recently documented as far from the original collection sites as the southeastern portion of O‘ahu at Ka Iwi (Fig. 2). This species is similar to *A. subrecta* but can be distinguished by the fruiting bracts, which have an obtuse apex and teeth that are all more or less equal in length (Imada & Kennedy 2020). *Atriplex muelleri* is also known to be naturalized on Maui (Imada & Kennedy 2020).



**Figure 1.** Distribution of *Amaranthus polygonoides* on O'ahu based on iNaturalist.org data reviewed by the authors.



**Figure 2.** Distribution of *Atriplex muelleri* on O'ahu based on iNaturalist.org data reviewed by the authors.

*Material examined.* O‘AHU: Ka Iwi Shoreline Trail, growing along a southeast-facing sea bluff in sandy soil, abundant and weedy, 4–5 m, 21.1741, -157.3931, 28 Jan 2021, *M.C. Ross 1805*.

### Asteraceae

#### *Emilia praetermissa* Milne-Redh.

#### New state record

For the first time *Emilia praetermissa* is being reported from the Hawaiian Islands. It is known from a small population found near the easternmost lookout point at the Hanauma Ridge Trail on O‘ahu, where it grows in loamy volcanic soil with other weedy annuals. The native range for this species is tropical West Africa, but it has become naturalized in the northern part of Taiwan (Chung *et al.* 2009). The species is apparently of hybrid origin from a cross between *Emilia sonchifolia* and *E. coccinea* that underwent chromosome doubling (Olorode & Olorunfemi 1973). Interestingly, both of the parents of this hybrid cross were present at the collection site. It is unknown at this time whether this species was introduced accidentally to the collection site or formed spontaneously. The species is not known to be cultivated in Hawai‘i or elsewhere. It is at least possible that its occurrence here represents an independent origination of the species, given the presence of both parents in the area of this population. *Emilia praetermissa* can be recognized from most other species of *Emilia* by the cream or peach-colored corollas (Fig 3).

The following description is from the Flora of China (Chen *et al.* 2011:453):

“Herbs, annual. Stems erect or ascending, to 140 cm tall, glabrous or pilose. Basal and lower stem leaves petiolate; petiole 1.5–3 cm, in basal leaves unwinged and exauriculate, in lower stem leaves winged and basally auriculate; blade broadly ovate, 4–6 × 4.5–6 cm, ± pilose, base subcordate, margin dentate, apically obtuse; median and upper stem leaves sessile, pandurate to triangular, becoming smaller upward. Capitula up to 7 in lax corymbs, rarely solitary. Involucres cylindric, ca. 10 × 3–4 mm; phyllaries 9–12. Florets distinctly exceeding involucre; corollas cream, yellowish, or pallid orange, ca. 8 mm; lobes ca. 2 mm, tinged purple or orange. Achenes ca. 3 mm, pubescent. Pappus ca. 7 mm. 2n = 20.”

*Material examined.* O‘AHU: Southeast of the Hanauma Ridge Trail, east-facing peninsula, growing with *Commelina* and several other species of *Emilia*, ca. 20 plants seen, 92–93 m, 21.155209, -157.413871, 6 Mar 2023, *M.C. Ross 1906*.

#### *Florestina tripteris* DC.

#### New island record

Previously reported as naturalized only on Maui (Oppenheimer & Bartlett 2000), *Florestina tripteris* has now been found in both ‘Ewa and Wai‘anae on O‘ahu. Both populations observed consisted of less than 5 plants. It is uncertain whether there is a larger source population on the island yet to be discovered, or if this is the beginning of the species spread on O‘ahu, or if some other factor is leading to the unusually small populations of this weedy annual.

*Material examined.* O‘AHU: Wai‘anae, Pa‘akea Rd & Apana Rd, roadside weed in annual community growing on crushed coral, very sticky to touch, four plants seen, 17 m, 21.418430, -158.159054, 16 Jan 2023, *K. Faccenda & M. Ross 2993*; ‘Ewa, near Kapolei Pkwy, growing along abandoned railroad tracks in full sun, two plants observed, 12–13 m, 21.201199, -158.286700, 27 Feb 2023, *M.C. Ross 1904*.



**Figure 3.** *Emilia praetermissa*. **A**, head showing cream to peach-colored corollas; **B**, habit at Hanauma Ridge.

***Soliva sessilis* Ruiz & Pav.**

**New island record**

*Soliva sessilis* is now known to be naturalized on O‘ahu in Wahiawa, where at least two populations were found during roadside surveys. One single plant was seen at Wahiawa District Park (but the area was not searched thoroughly). Another population of over 100 plants was found on Higgins Road. *Soliva sessilis* is now known to be naturalized on Kaua‘i, O‘ahu, and Hawai‘i (Wagner & Herbst 1995; Brock *et al.* 2023).

*Material examined.* **O‘AHU:** Wahiawā, Wahiawā District Park, at base of stadium lights, mowed lawn, moist, sunny, rare, only this one plant seen, 282 m, 21.499531, -158.022974, 20 Feb 2023, *K. Faccenda & M. Ross 3047*; Wahiawā, Higgins Rd, about 300 m E of Kamehameha Hwy, moist roadside, occasionally mowed, common, over 100 plants seen in this area, inflorescence concealed below the leaves, 265 m, 21.487227, -158.024113, 18 Jan 2023, *K. Faccenda 3011*.

**Bignoniaceae**

***Markhamia zanzibarica* (Bojer ex DC.)**

K. Schum.

**New naturalized record**

While botanizing in Mākaha, 3–4 individuals of *Markhamia zanzibarica* were found growing in an undeveloped area in the middle of the valley. These trees were about 3–4 m tall; two of the trees were distant from the rest, while the other two occurred in close proximity, although it is unclear whether the latter two were distinct or if the smaller one was a root sucker. *Markhamia zanzibarica* is uncommonly cultivated in Hawai‘i (Staples & Herbst 2005), where it has been present since at least the 1990s when the first herbarium specimen was made. However, the specimen notes that the specimen came from a parent tree at Ala Moana Park. Information could not be found regarding when that tree, or any others before 1990, were planted on O‘ahu. *Markhamia zanzibarica* is native from Ethiopia south to Namibia and Angola (POWO 2023), where it grows in woodlands, savanna, and riverine forests (Diniz 1988). This is the first report of the naturalization of *M. zanzibarica*, perhaps because Hawai‘i is the only place that it has been intentionally introduced for horticultural purposes (Staples & Herbst 2005). *Markhamia zanzibarica* can be recognized by its shrub to small tree habit, alternate odd-pinnate leaves with 5–9 leaflets, and flowers with dark corolla lobes and dark splotches on the throat (Fig. 4).



**Figure 4.** *Markhamia zanzibarica*. **A**, flowers; **B**, fruits and leaves.

The following description is taken from Diniz (1988:61):

“Shrub 2–5 m. tall or a small often straggling tree up to 9 m. tall. Bark grey, smooth or rough, peeling off soon. Young branchlets minutely lepidote, sometimes with conspicuous lenticels. Leaves up to 35 cm. long (1) 2–4-jugate, size of the leaflet-pairs increasing progressively from the base; pseudostipules 0.5–1.7(2) cm. in diam., subcircular to reniform; petiole 2–7(9) cm. long, flat above, sometimes slightly winged, terete below, leaflet lamina 2–24.5(32.5) × 2–13 cm., elliptic, obovate or almost subcircular, sessile or with petiolules up to 5 mm. long, acute, acuminate to longly acuminate, rarely obtuse at the apex, tapering towards the often asymmetric base, pubescent and minutely scaly at both surfaces, with age becoming minutely and sparsely puberulous or even glabrous; lower surface with pubescent axillary domatiae more or less conspicuous and sometimes with small circular black glands near and on both sides of the midrib; lateral nerves 6–12(14), impressed above and prominent below; margins entire or finely toothed. Inflorescence a terminal or axillary panicle or raceme rather lax, 5–20(23) cm. long, scaly glabrous or puberulous; pedicels up to 1.5(2) cm. long, 2-bracteate below the middle; bracts 2–5(7) mm. long, triangular-acuminate, ciliate at the margins. Calyx 10–15(19) mm. long cuspidate or uncinately splitting at one side down to 8 mm. from the base sometimes provided with scattered glands towards the apex and opposite to the fissure. Corolla funnel-shaped to campanulate, tube (18) 20–30(43) mm. long, yellow-greenish flecked with maroon; lobes 10–15 mm. in diam., subcircular, sometimes with conspicuous small glands near the mouth. Stamen-filaments 9–14 mm. long adnate to the corolla tube up to c. 5 mm. from the base, corolla tube provided with pluricellular hairs at the insertion points of the filaments; anther-thecae c. 1.5 mm. long, divergent. Disk 1.5 mm. long and 2–3 mm. in diam. Ovary 3–5 mm. long, sometimes lepidote; style 15–27 mm. long. Capsule slender, 22–68 × 0.9–1.5 cm., straight or slightly falcate, glabrous, lenticellate. Seeds 4–6 × 20–40 mm. including the wing.”

*Material examined.* **OAHU:** Mākaha, Huipu Dr near intersection with Mākaha Valley Rd, *Leucaena* & *Megathyrus maximus*-dominated shrubland which occasionally burns, dry, sunny, right next to road, 64 m, 21.475196, -158.198576, 16 Jan 2023, *K. Faccenda* & *M. Ross* 2982.

***Tecomaria capensis* (Thunb.) Spach**

**Potentially naturalizing**

*Tecomaria capensis* (formerly known as *Tecoma capensis*), or cape-honeysuckle, is a popular ornamental shrub commonly cultivated in Hawai‘i (Staples & Herbst 2005). A collection of an apparently wild colony near the Kapālama Ridge Trail and a recent iNaturalist observation of this species growing in an empty lot in Kaimukī suggest that



**Figure 5.** *Lepidium lasiocarpum*. **A**, habit; **B**, fruit showing characteristic hairs on margins.

this species may be naturalizing on O‘ahu. *Tecomaria capensis* can be recognized by its orange-red corolla, exserted stamens, apically fused anthers, and leaflets with mostly obtuse apices (Staples & Herbst 2005). Since this species is known to root from runners, it may have the potential to spread quickly in the wild (Staples & Herbst 2005).

*Material examined.* O‘AHU: Nā Pueo Park, growing with *Casuarina*, *Asystasia*, and *Asparagus* near start of Kapālama Ridge trail, one colony, 20–30 plants observed, 199 m, 21.202126, -157.505019, 22 Nov 2022, M.C. Ross 1846.

## Brassicaceae

### *Lepidium lasiocarpum* Nutt.

### New state record

A colony of 100–150 plants of *Lepidium lasiocarpum* was found along the roadside of Rt 803 about 5 km south of Waialua next to a heavily disturbed area where people park to shop at a chocolate and honey stand. A single plant was also seen about 1 km down the road towards Wahiawā. These plants were growing from moist, rich soil in full sun. Photos of the plant were sent to Ihsan Al-Shehbaz (MO), who identified it as *Lepidium lasiocarpum*, a species from the southwestern United States and Northern Mexico (Al-Shehbaz & Gaskin 2010). In its native range, this species grows in pinyon-juniper woodlands, sagebrush, open deserts, washes, waste places, streambeds, and roadsides (Al-Shehbaz & Gaskin 2010). This is the first time *L. lasiocarpum* has been reported outside of its native range (POWO 2023). *Lepidium lasiocarpum* is relatively similar to the other weedy annual *Lepidium* in Hawai‘i, but can be identified by its pinnately divided lower leaves, fruits with hairy margins, pedicels that are flattened dorsiventrally, and hirsute leaves and stems (Fig. 5).

The following description is from Al-Shehbaz & Gaskin (2010:584):

“Annuals; hirsute or hispid, (trichomes cylindrical). Stems usually few to several, rarely simple from base, erect to ascending or (outer ones) decumbent, branched distally, (0.15–)0.6–3(–3.8) dm. Basal leaves (later withered); not rosulate; petiole (0.4–)1–3.5(–5) cm; blade spatulate to oblanceolate, lyrate-pinnatifid, pinnatisect, or 2-pinnatifid, (0.7–)1.5–4.5(–7.5) cm × (9–)12–20(–30) mm, margins rarely dentate, (lobes) entire or dentate. Cauline leaves sessile or petioles 0.8–2.2 cm, blade lanceolate to oblanceolate, (0.7–)1.2–3.3(–5) cm × (2–)4–12 mm, base cuneate, not auriculate, margins subtire to dentate. Racemes often considerably elongated in fruit; rachis hirsute or hispid, trichomes

straight, cylindrical. Fruiting pedicels divaricate-ascending to horizontal, straight or slightly curved, (often strongly flattened),  $(1.8-2-4(-4.6) \times 0.2-0.7$  mm (to 0.3 mm thick), hirsute to hispid throughout or adaxially. Flowers: sepals oblong,  $1-1.3(-1.5) \times 0.5-0.8$  mm; petals (sometimes absent), white, oblanceolate to linear,  $(0.3-0.6-1.5(-2) \times (0.1-0.2)-0.5$  mm, claw absent; stamens 2, median; filaments  $1-1.4$  mm; anthers  $0.2-0.3$  mm. Fruits ovate to ovate-orbicular,  $2.8-4(-4.6) \times 2.4-3.6(-4)$  mm, (base broadly cuneate to rounded), apically winged, apical notch  $(0.2-0.3-0.6(-0.7)$  mm deep; valves thin, smooth, not veined, hirsute to hispid (on surface or margin); style obsolete or to 0.1 mm, included in apical notch. Seeds ovate,  $1.4-2.2 \times 0.9-1.4$  mm.”

*Material examined.* **O’AHU:** Central valley, Rt 803 ca. 1 km N of its intersection with Rt 801, roadside, *Megathyrsus maximus*-dominated area, only one plant seen, 279 m, 21.527461, -158.078471, 20 Feb 2023, *K. Faccenda & M. Ross 3039*; Central valley, Kaukonahua Rd, about 5 km S of Waialua near honey & chocolate stand, roadside near driveway and very close to honey stand, sunny, moist area, about 100–150 plants seen in area in a clump about 15 m in diameter in disturbed area, 21.535851, -158.088011, 29 Mar 2023, *K. Faccenda & M. Ross 3082*.

### Caryophyllaceae

*Sagina japonica* (Sw.) Ohwi

#### New island record

*Sagina japonica* has previously been collected only once on O’ahu at the Honolulu Airport (Wagner *et al.* 1999), where it was “probably not established.” A new population was found growing in a crack in a sidewalk at the Nu’uanu Pali Lookout, along with a voucher at BISH dated 2009 from Pu’u Ka’ala confirming that the species is, in fact, established and naturalized.

*Material examined.* **O’AHU:** Pali Lookout, crack from sidewalk at the main lookout, cool, moist, common weed, only seen from cracks in concrete, 358 m, 21.366776, -157.793152, Jan 15 2022, *K. Faccenda 2198*; Ka’ala Rd, bog, small herbs < 10 cm tall 4,000 ft. [1,220 m] 10 Mar 2009, *US Army 126*.

### Euphorbiaceae

*Euphorbia serpens* Kunth

#### New island record

*Euphorbia serpens* is now known from four recent collections and several iNaturalist observations on O’ahu. The populations of this species are mostly found along the leeward coastline; however, it has also been collected in Waimānalo and observed in the North Shore (Fig. 6). This species can sometimes be confused with *E. albomarginata*, which has not been collected on O’ahu for more than 70 years (Wagner *et al.* 1997; Imada 2019). The two can be readily distinguished by the size of the involucre gland appendages, which are smaller and less conspicuous to the naked eye in *E. serpens* (Steinmann *et al.* 2016). *Euphorbia serpens* has been previously collected on Kaua’i, Maui, and Midway Atoll (Imada 2019).

*Material examined.* **O’AHU:** Waimānalo, intersection of Makakalo St and Mokulama St, growing from gravel on roadside in sunny area, rare, <10 plants seen, 28 m, 21.337001, -157.722045, 3 Aug 2022, *K. Faccenda 2574*; Ala Wai Community Park, growing near path adjacent to the canal, several patches observed, ca. 10–20 plants per patch, 2 m, 21.1708, -157.4945, 12 Nov 2022, *M.C. Ross 1837*; Honolulu, Sand Island State Recreation Area, growing in sand with *Prosopis juliflora* and *Sporobolus pyramidatus*, ca. 10–15 plants observed, <3 m, 21.185615, -157.525494, 20 Feb 2023, *M.C. Ross & K. Faccenda 1896*; ‘Ewa Beach, One’ula Beach Park, eastern end, growing ca. 5 m from a rocky shoreline in sandy soil with *Alternanthera pungens*, ca. 100 plants observed, <3 m, 21.182334, -158.123819, 13 Mar 2023, *M.C. Ross & K. Faccenda 1909*.



**Figure 6.** Distribution of *Euphorbia serpens* on O'ahu based on iNaturalist.org data reviewed by the authors.

### Fabaceae

#### *Lysiphyllum hookeri* (F. Muell.) Pedley

#### Potentially naturalizing

Formerly called *Bauhinia hookeri*, this species is well known from cultivation, where it has been used for urban landscaping in Honolulu (Staples & Herbst 2005). Several young individuals have recently been observed growing in yards and unkempt areas along University Avenue, suggesting that the species may be naturalizing. The young saplings were somewhat sprawling, ca. 45–50 cm tall, and not connected to any of the root systems of adult trees or cut stumps nearby. This species can be distinguished from other similar species by its weeping habit and bilobed leaves that are divided all the way to their bases (Staples & Herbst 2005).

*Material examined.* O'AHU: Honolulu, University Ave and Date St, growing in a weedy area near the sidewalk, two young saplings observed, 2–3 m, 21.172029, -157.492846, 18 Jan 2023, M.C. Ross 1875.

#### *Tephrosia noctiflora* Bojer ex Baker

#### New state record

During a weed survey at the University of Hawai'i Poamoho Research Station, about 300 plants of a shrubby pea were found growing in sunny areas on the edge of a dirt road. These plants were then identified using the keys in Gillett *et al.* (1971) and Forbes (1948) as *Tephrosia noctiflora*. *Tephrosia noctiflora* was imported into Hawai'i twice by the Hawai'i Agricultural Experiment Station (HAES n.d.; accession # 2346 & 4341) in 1929 and 1944. Before the Poamoho Research Station was transferred to the University of Hawai'i, it was owned by the Hawai'i Agricultural Experiment Station, so it is almost certain that the plants growing there now descend from the plants imported over 80 years ago.





**Figure 7.** *Tephrosia noctiflora*. **A**, inflorescence; **B**, fruits.

*Tephrosia noctiflora* is native to much of eastern Africa and India, but has been introduced in scattered locations across the tropics, including Brazil, China, Thailand, much of Malaysia, and Australia (POWO 2023). It can be identified by its upright, shrubby habit, and its abundant brown hairs on the fruits, sepals, leaves, and stems (Fig. 7; Gillett *et al.* 1971). In its native range it is reported in grasslands, thickets, and as a weed of cultivated areas (Gillett *et al.* 1971)

The following description is from Gillett *et al.* (1971:182):

“Annual or briefly perennial bushy herb 0.3–1.3 m. tall; stems tomentose. Leaf-rhachis up to 10 cm. long, including a petiole of up to 10 mm., prolonged up to 7 mm. beyond the lateral leaflets; stipules narrowly triangular, up to 8 mm. long; leaflets 11–15, cuneate-oblong or elliptic, up to 35 × 12 mm., densely appressed villous beneath, more sparsely so above; main nerves about 9 on each side. Flowers purple in moderately dense terminal pseudoracemes and often also in upper leaf-axils; bracts narrowly triangular; pedicels densely tomentose, 2–4 mm. long. Calyx densely tomentose, the hairs 1 mm. or more long; tube up to ± 2 mm. long; lobes long-acuminate, the lowest up to 8 mm. or more long, upper pair up to ± 7 mm. long, united for up to ± 2 mm. Standard densely fulvous tomentose outside, up to 11–15 mm. long, including a claw of ± 2 mm., up to 9–10 mm. wide; keel glabrous. Upper filament lightly attached, widened but not callous a little above the base; filament-sheath up to ± 6 mm., free parts up to 2–2.5 mm., anthers 0.5 mm. long. Style glabrous, tapering, twisted, bent sharply upward at base, penicillate, up to 3–5 mm. long. Pod strongly curved usually becoming deflexed so that the base is often parallel with the stem, bent sharply up near the tip, up to 5.4 cm. long and up to 5–6 mm. wide, densely silvery or fulvous tomentose, the hairs often up to 2 mm. long. Seeds 6–12, muricate, longitudinal, oblong, ± 4 × 2.5 mm., distance between their centres under 5 mm.; hilum central, aril small and strap-shaped or none.”

*Material examined.* **O‘AHU:** University of Hawai‘i Poamoho Experimental Station, Kaukonahua Rd, about 5 km S of Waialua, along side of dirt road inside farm, full sun areas on edge of guinea grass stand, about 250 plants seen, 21.539802, -158.089203, 29 Mar 2023, *K. Faccenda & M. Ross 3083*.

### *Trifolium repens* L. var. *repens*

### **New island record**

This species is previously known from Kaua‘i, Lāna‘i, Maui, and Hawai‘i (Imada 2019). It has now been collected on O‘ahu from several parks, and may be spreading to other areas,



**Figure 8.** Distribution of *Trifolium repens* var. *repens* on O'ahu based on iNaturalist.org data reviewed by the authors.

possibly due to lawn mowers and/or foot traffic (Fig. 8). *Trifolium repens* var. *repens* is recognized by its prostrate habit, trifoliate leaves with stipules fused to the petiole for most of their length, and white globose heads on long peduncles (Wagner *et al.* 1999).

*Material examined.* **O'AHU:** Ala Moana Beach Park, Magic Island, growing in lawn with *Axonopus*, *Eleusine*, & *Eragrostis*, several small colonies, ca. 1.5 m diam. or less, <3 m, 28 Jan 2021, *M.C. Ross 1806*; Nu'uuanu Pali Lookout, muddy lawn with *Axonopus* & *Commelina*, one colony, ca. 1 m diam., 316 m, 21.215976, -157.473572, 23 Nov 2022, *M.C. Ross 1847*; Mililani Mauka District Park, growing in lawn in full sun near restrooms with *Oxalis* & *Axonopus*, irrigated, several colonies, ca. 2 m wide, 222 m, 21.281192, -158.019248, 1 Dec 2022, *M.C. Ross 1855*; Mānoa Valley District Park, growing on a muddy slope in full shade with *Axonopus*, irrigated, large colony, ca. 6 m wide, 52 m, 21.314741, -157.808543, 6 Dec 2022, *M.C. Ross 1858*.

## Malvaceae

### *Abutilon indicum* (L.) Sweet

*Abutilon indicum* is previously known from only a single collection near Honolulu in 1960 (Wagner *et al.* 1999). A recent collection of this species from a weedy lot in Honolulu indicates that it has persisted into the present. Only one plant was observed at the time of collection. An exhaustive search of the area where the species was collected turned up no cultivated plants nearby. *Abutilon indicum* can be distinguished from the more common *A. grandifolium* by the larger petals, shorter calyx lobes, and fruits with 15–22 mericarps (Fig. 9; Wagner *et al.* 1999).

*Material examined.* **O'AHU:** Honolulu, Liona St, near intersection with Kē'eumoku St, growing in weedy area near the sidewalk, only one plant observed, 5 m, 21.175205, -157.502453, 13 Dec 2022, *M.C. Ross 1862*.

### Confirmation of naturalization



**Figure 9.** *Abutilon indicum*. **A**, flowers and fruits; note the fruits with 15–22 mericarps; **B**, calyx.

### *Corchorus olitorius* L.

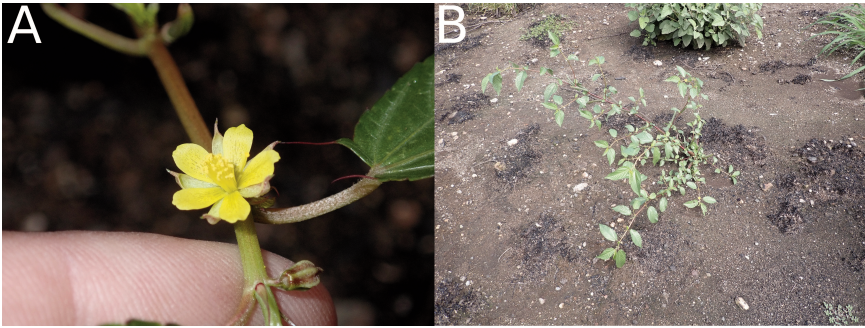
### **New naturalized record**

*Corchorus olitorius* is a widely cultivated subshrub native to India. It is often grown in Asian, Middle Eastern, and North African countries for fiber and food (Staples & Herbst 2005). In Hawai‘i, this species was once reported to have been naturalized in Lāwa‘i Valley on Kaua‘i, but was apparently eradicated there (Wagner *et al.* 1999). Another population was reported by Wagner *et al.* (1990) to be escaping near the lotus ponds in Hale‘iwa on O‘ahu; however, there is no evidence that the population persisted. A population of approximately 100 plants was recently discovered while botanizing near Renton Rd. in ‘Ewa Beach, confirming that *Corchorus olitorius* is indeed naturalized on O‘ahu. The population was observed in a dry, vacant area that had recently burned. The plants seemed to favor sprouting from charred soil and were becoming somewhat dominant in the burnt area (Fig. 10). This should raise some concerns about the potential for this species to quickly colonize new areas after fire. Other instances of *Corchorus olitorius* escaping cultivation on O‘ahu have also been documented in Kalihi and Wai‘anae Valley. This species is easily recognized by its semi-woody habit, leaf bases with long tail-like setae, yellow flowers, and 5-valved capsules.

The following is a description from the Flora of China (Wu *et al.* 2006:250):

“Herbs woody, 1–3 m tall. Stipule ovate-lanceolate, ca. 1 cm; petiole 0.8–3.5 cm, puberulent; leaf blade oblong-lanceolate, 7–10 × 2–4.5 cm, glabrous, basal veins 5, lateral veins 7–10 pairs, base rounded, margin serrulate, apex acuminate. Flowers solitary or 1–3 arranged in cymes, axillary, opposite to leaves; peduncle and pedicel short. Sepals oblong, hairy at base, apex long awned. Petals oblong, as long as or slightly shorter than sepals, stalked at base; stalk ciliate. Stamens on very short androgynophore, glabrous. Ovary 5-loculed, hairy; style glabrous; stigma disk-shaped, lobed. Capsule cylindrical, slightly curved, 10-angled, robust, 5–6-valved, 3–8 cm, apex beaked, with single awn. Seeds obconic, slightly angled, separated by septum.”

*Material examined.* **O‘AHU:** Along Halona Dr, between Halona Pl and Kohou St, weed in garden beds along road, growing apparently cultivated in one yard, but recruiting in another yard further down the road as a weed, semi-woody herb to about 80 cm, locally common in those two patches, 21.331953, -157.869389, 25 May 2021, *K. Faccenda 1894*; Wai‘anae, Lualualei Homestead Rd, at entrance to farmland about 200 m SW of Kuwale Rd, roadside weed in dry area, rare, one adult flowering plant and ca. 20 seedlings, more plants seen at *Urochloa ramosa* site growing as weeds in farmland, 16 m, 21.440685, -158.151943, 16 Jan 2023, *K. Faccenda & M.C. Ross 2992*; ‘Ewa, growing in a vacant area that had recently burned, near Renton Rd, dry, mostly *Leucaena-Cenchrus*-dominated, ca. 100 plants seen, 12–13 m, 21.195993, -158.231182, 27 Feb 2023, *M.C. Ross 1901*.



**Figure 10.** *Corchorus olitorius*. **A**, close-up of the flower and leaf base; **B**, habitat of the wild population in 'Ewa; note the charred root crowns from grasses that had burned during a recent fire.

## Moringaceae

### *Moringa oleifera* Lam.

### New naturalized record

*Moringa oleifera* is a very popular tree extensively cultivated in home gardens throughout Hawai'i. It has many uses, but is most often grown locally for its edible leaves and seeds (Staples & Herbst 2005). In cultivation, the trees are usually cut back to the trunk to keep the foliage and pods within arm's reach (Staples & Herbst 2005). During a recent survey of an overgrown vacant area adjacent to Renton Rd. in 'Ewa Beach, two mature unpol-larded *Moringa oleifera* trees, ca. 2–3 m tall, were observed. One of the trees was growing in the middle of an abandoned dirt road and the other in *Leucaena* scrub. Several saplings were also seen growing nearby in *Cenchrus ciliaris*-dominated grasslands along Koahi St. These saplings have apparently escaped from cultivated trees in the neighborhood across the street, perhaps unsurprisingly so since these trees do well in hot, dry areas at low elevations, very similar to the conditions where this population was observed (Staples & Herbst 2005). Another species of *Moringa*, *M. stenopetala*, is also known to be naturalizing at Koko Crater on O'ahu (Lau & Frohlich 2013). Although the wild populations of these two species do not currently overlap, it is still possible that they could be confused. A couplet is therefore provided below to help distinguish between them.

The following description of *Moringa oleifera* is from the Flora of North America (Olson 2010:168):

“Plants 1–10 m, to 40 cm diam. Roots tuberous when young, woody with age. Bark pale gray or tan, smooth or finely rugose. Stems often canelike, becoming pendent with age, glabrous or finely puberulent. Leaves with pungent odor of horseradish; 30–60 cm, leaflets distributed on 4–8 pairs of pinnae; pinnae largest near base of leaf, 2 or 3 pinnate; leaflets 75–150, distalmost pairs represented by pairs of single leaflets along main rachis; blades bright to dark green, (0.5–)1–2(–3) × (0.3–)0.5–1.5(–2) mm, base rounded to cuneate, apex rounded to emarginate, glands 3–5 mm (smaller at blade apex). Panicles (5–)10–25(–35) cm, each flower subtended by glandular bract. Pedicels 5–10(–20) mm; bracteoles 2. Flowers sweet-scented, 2–3 cm; sepals 10–20 × 3–4 mm, proximal ones usually reflexed, usually puberulent, distalmost pair usually largest, ± erect, enclosing banner petal, or ± reflexed; petals cream, 1–2 cm, distalmost banner petal ± erect, others usually ± reflexed; filaments and staminodes 7–10 mm, basally pubescent, adherent distally proximal to banner petal and anthers in a 3-tiered presentation; receptacle cup-shaped, 3–4

mm; gynophore 2–3 mm, appressed to banner petal; ovary 3–5 mm, with 3 ridges. Capsules tan, 10–30(–55) × 1.5–3 cm, apex beaked, 3 (or 4)-angled; valves silvery inside. Seeds pale to dark brown, globular, 3-winged; cotyledons exuding oil when compressed.”

*Material examined.* **O‘AHU:** ‘Ewa Beach, growing in middle of a dry dirt road near abandoned railroad tracks, two mature plants and several young saplings seen in nearby area, corolla white, foliage aromatic, 12–13 m, 21.208999, -158.230503, 27 Feb 2023, *M.C. Ross 1903*.

KEY TO NATURALIZED SPECIES OF *MORINGA* IN HAWAII (Adapted from Verdcourt 1985)  
 1a. Leaflets 0.5–2(–3) × 0.3–1.3(–2) cm; flowers irregular, perigynous ..... *M. oleifera*  
 1b. Leaflets 3.3–6.5 × 1.7–3.25 cm; flowers regular, hypogynous ..... *M. stenopetala*

## Portulacaceae

### *Portulaca umbraticola* Kunth ‘Wildfire Mixed’ New naturalized record

This is the first time *Portulaca umbraticola* ‘Wildfire Mixed’ is being reported as naturalized in the Hawaiian Islands. Several populations have become well established on O‘ahu in the southeastern part of the island near Hanauma Ridge and in the Ka Iwi area. The largest population (>1000 plants) is at Ka Iwi along a seasonally muddy portion of the trail that parallels a storm drainage canal. There are also unpublished reports of this taxon naturalizing on other islands. The plants are likely escaping from cultivation given that *Portulaca umbraticola* is one of only two species of *Portulaca* cultivated as an ornamental (Ocampo & Columbus 2012). The species is a common weed from the southwestern U.S. to Argentina, which should raise concerns about its potential to become invasive here in Hawai‘i (Matthews 2003; Ocampo & Columbus 2012). There are three subspecies recognized, which can be differentiated primarily based on flower color (Matthews 2003; Ocampo & Columbus 2012). The cultivar *Portulaca umbraticola* ‘Wildfire Mixed’ produces flowers of various colors (Fig. 11) and may be most closely related to the South American subsp. *umbraticola* (Ocampo & Columbus 2012). *Portulaca umbraticola* ‘Wildfire Mixed’ is almost certainly what Staples & Herbst (2005) referred to as *Portulaca* ‘Wildfire’, which they considered to be one of the most popular cultivated portulacas in Hawai‘i. The fruit contains a wing at the dehiscence line of the capsule (Fig. 11), which is diagnostic to the species (Ocampo & Columbus 2012). Unfortunately, Staples & Herbst (2005) did not describe the fruit in their treatment; however, there is little doubt that these are the same species.

The following description is from Flora of North America (Matthews 2003:501):

“Plants annual; roots fibrous. Stems prostrate to suberect; trichomes sparse at nodes and in inflorescence, stems otherwise glabrous; branches 5–20 cm. Leaf blades obovate, spatulate, or sometimes lanceolata, flattened, 10–35 × 2–15 mm, apex rounded to truncate; involucrelike leaves 4–5. Flowers 8–15 mm diam.; petals yellow or yellow tipped with red or copper, spatulate or obovate, 5–10 × 3–6 mm, apex acute or cuspidate; stamens 7–30; stigmas (3–)5–18. Capsules obovoid or turbinate, 3–5 mm diam., with encircling, expanded, membranaceous wing 0.5–1.5 mm wide proximal to suture. Seeds gray, round or elongate, flattened, 0.5–1 mm; surface cells stellate with long tubercles.”

*Material examined.* **O‘AHU:** Hanauma Ridge, locally abundant on NW-facing slopes below ridge trail, >100 plants, 10–15 m, petals yellow, 12 Jan 2022, *M.C. Ross 1812; loc. cit.*, petals yellow, 12 Jan 2022, *M.C. Ross 1813*; Ka Iwi Shoreline Trail, locally abundant in muddy disturbed areas along the trail, >1000 plants, petals reddish yellow, 12 Jan 2022, *M.C. Ross 1814; loc. cit.*, petals yellow, 12 Jan 2022, *M.C. Ross 1815; loc. cit.*, petals white, 12 Jan 2022, *M.C. Ross 1816*.



**Figure 11.** *Portulaca umbraticola* ‘Wildfire Mixed’, photographed at Ka Iwi, 12 Jan 2022. **A**, pink-flowered form; **B**, yellow-flowered form; **C**, white-flowered form, arrow showing wing at the dehiscence line of the capsule, a diagnostic feature of *P. umbraticola*; **D**, habitat.

#### ACKNOWLEDGEMENTS

Mahalo to Clyde Imada for help in identifying *Portulaca umbraticola* ‘Wildfire Mixed’ and Barbara Kennedy for encouragement in preparation of this report.

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## Preliminary annotated checklist of the moss flora of Lower Limahuli Valley

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**Abstract.** A checklist of mosses of Lower Limahuli Valley was compiled using 36 historical collections from the National Tropical Botanical Garden (PTBG) and Bishop Museum (BISH) herbariums, in addition to 168 specimens collected for this project. Field surveys were focused in areas that represented the diverse array of habitats found throughout Limahuli Valley. Forty-nine species across 35 genera and 20 families were recorded from the valley at this time. Out of these species, 46 are native (15 endemic, 31 indigenous) and 3 are nonnative.

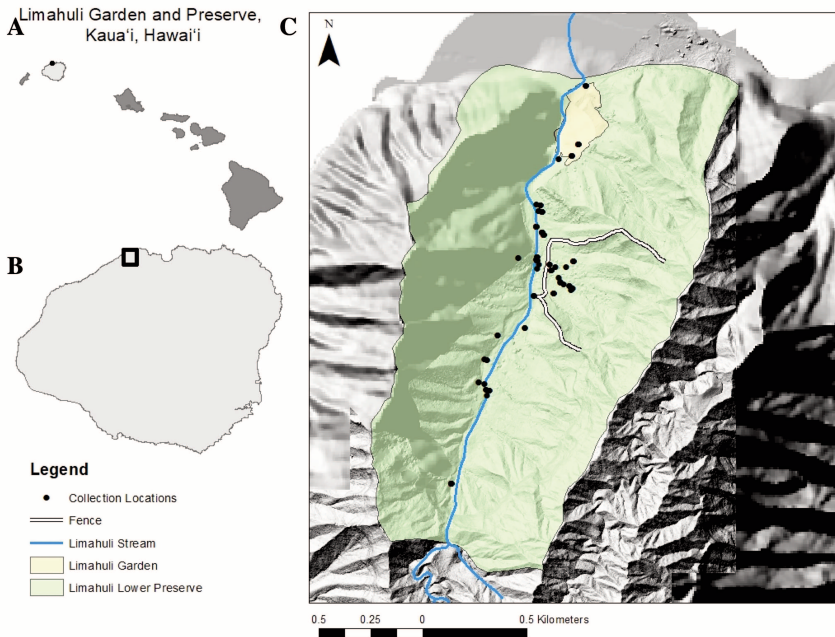
### INTRODUCTION

#### Limahuli Preserve History and Habitats

The 3.1 mile long, 1,000-acre watershed of Limahuli Valley is located in Hāʻena on the north shore of Kauaʻi (see Fig. 1A, 1B). Separated by a waterfall, it is split into two sections: the Upper Valley, which is about 356 GIS acres (1,068 surface acres), 1.5 miles long, and ranges from 1600–3330 feet (488–1,015 meters) elevation, and the Lower Valley, which is 600 acres, 1.5 miles long starting from the coast, and reaches 984 feet (300 meters) elevation (Wood 2006; Dr. Uma Nagendra, pers. comm.) (see Fig. 1C). This checklist will focus on Lower Limahuli Valley.

As with many areas across the Hawaiian Islands, the valley was utilized for its natural resources by Hawaiians of old. Currently the National Tropical Botanical Garden maintains 1640 feet (500 meters) along the stream and 67 acres of ungulate fencing for restoration purposes within Lower Limahuli Valley. Access is restricted to the public, leaving this area rarely traversed (Dr. Uma Nagendra, pers. comm.). However, Limahuli Garden is located at the very front of the valley and is open to the public (see Fig. 1C). Its 17 acres contain restored native plant forests as well as invasive forest demonstration sites. Some moss collections were taken from Limahuli Garden, as the bryoflora is surprisingly diverse.

Lower Limahuli Valley has a diverse array of habitat types from which collections have been made. It is dominated by a matrix of invasive species with remnant pockets of native vegetation and has received an average of 81 inches of rain per year over the last three years, according to the Limahuli Garden rain gauge. The first half of the valley consists of a lowland mesic mixed canopy forest. Forest types include Coastal Hala (*Pandanus tectorius*) Forest (see Fig. 2A); Mixed Kukui (*Aleurites moluccanus*) and ʻŌhiʻa ʻAi (*Syzygium malaccense*, Mountain Apple) Forest (see Fig. 2B); pockets of



**Figure 1.** A. Kaua'i, westmost of the main islands B. Limahuli Valley, located on the north shore of Kaua'i. C. Lower Limahuli Valley, Garden, Ungulate Fence Restoration Area, and location of collections sites.

bamboo (*Phyllostachys nigra*) (see Fig. 2C), guava (*Psidium guajava*) (see Fig. 2D), and hau (*Hibiscus tiliaceus*) (see Fig. 2E); and riparian zones dominated by Octopus Tree (*Heptapleurum actinophyllum*) Forest (see Fig. 2F).

Mixed native forests containing the native trees *Metrosideros polymorpha*, *Diospyros sandwicensis*, and *Ceodes umbellifera* become more abundant as one moves through the valley and towards the waterfall (see Fig. 3A). Pockets of vulnerable native species such as *Charpentiera densiflora* and *Cyrtandra confertiflora* also occur towards the back of Lower Limahuli Valley (see Fig. 3B).

Collection was mainly focused in the fenced restoration area (about 0.25–1 mile from the trailhead), due to its accessibility. This area consists of a secondary growth forest dominated by a canopy of *Aleurites moluccanus* and *Syzygium malaccense* brought by Polynesian voyagers to be used in agroforestry. It tends to have rocky slopes and lacks a diverse understory. In 2019, a large flooding event occurred on the northern shore of Kaua'i, resulting in many landslides throughout the valley. These landslides affected both riparian and mesic forest habitats, with two in particular occurring within the fenced restoration zone. Sections of these two landslides have become restoration sites that contain both wild and reintroduced native species. During the winter/rainy season, water can flow throughout these landslides, causing streamlets to form.

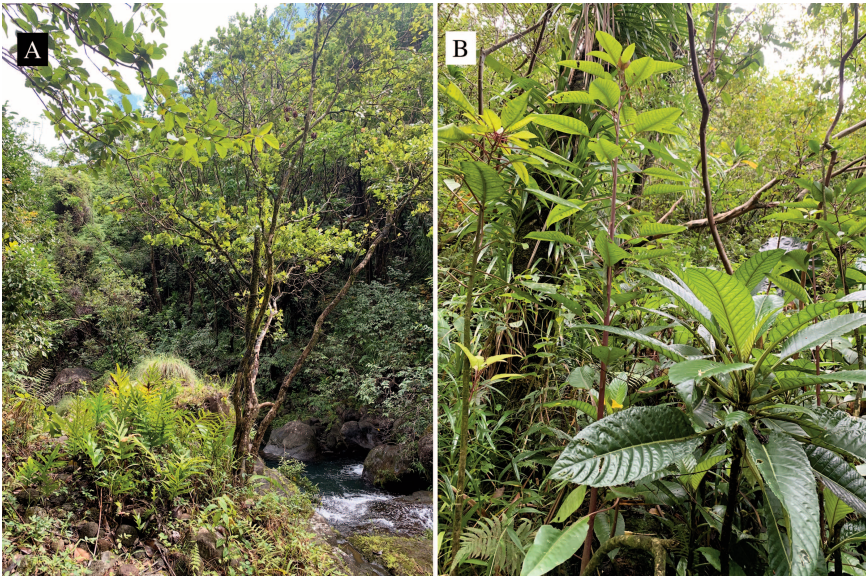


**Figure 2.** A. Streamside *Pandanus tectorius*. B. Previous agroforestry area containing *Aleurites moluccanus* and *Syzygium malaccense*. C. *Phyllostachys nigra* forest. D. *Psidium guajava*, *Coffea arabica*, *Heptapleurum actinophyllum*—all invasive plant species. E. Matrix of *Hibiscus tiliaceus*. F. Section of Limahuli Stream with *Heptapleurum actinophyllum* dominating the stream banks.

The riparian habitat stretches the full 1.5 miles of the valley and is relatively accessible. Limahuli Stream consists of shallow pools and small islands that host many native and nonnative plants. The stream bank tends to be inundated by either the invasive *Heptapleurum actinophyllum*, introduced in the early 1900s, or *Hibiscus tiliaceus*, introduced by Polynesian voyagers (Little & Skolmen 1989). Water levels change based on the season, causing streamlets to occasionally dry up. Stream flow originates both from upstream flow and numerous underground aquifer and spring sources. This results in the occurrence of many seeps near springs. Native plants grow along the stream and throughout the entire valley, but are scarce compared to nonnative plant species.

### BRYOPHYTE RESEARCH HISTORY

In the past, bryophytes have been understudied in Hawai‘i compared to vascular plants. Karl Müller produced the first major publication of Hawaiian bryophytes in 1896 (Müller



**Figure 3.** A. *Metrosideros polymorpha* beginning to mix with nonnative plants moving towards the waterfall. B. *Charpentiera densiflora* and *Cyrtandra confertiflora* thriving further back into the valley.

1896), detailing the known plants at the time and their descriptions, with additions made later by Viktor Brotherus in 1927 (Brotherus 1927). In 1933, Edwin Bartram published the first keys, including new additions to the flora (Bartram 1933). This book still remains the main resource for identifying moss species. Later on, William Hoe published a checklist of Hawaiian mosses (Hoe 1974) that was then revised and updated by Staples *et al.* (2004). Specifically for the island of Kaua‘i, James Shevock published a paper in 2019 with updated nomenclature, ranges, and new additions (Shevock *et al.* 2019). A variety of other publications have allowed for identification of moss taxa in specific families or genera, but an updated and comprehensive moss flora is sorely needed.

Today there is a resurgence of bryological study in Hawai‘i, including efforts to collect, analyze, and digitize specimens at organizations like Bishop Museum, Missouri Botanical Garden (with Dr. Si He), and the National Tropical Botanical Garden, to be stored and made available online. Private researchers like Emmet Judziewicz and Virginia Freire have been conducting much-needed studies on hepatics and anthoceroophytes, as well.

Many researchers have worked to catalog the vascular taxa found throughout Limahuli Valley, but few have assessed the bryoflora. Representation of mosses is very limited in local herbaria. According to the National Tropical Botanical Garden collections database,

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only three researchers collected 26 taxa of moss within Lower Limahuli Valley from 1990–2015. One novel (non-duplicate) collection of the species *Floribundaria floribunda* from Limahuli Valley is stored at the Bishop Museum Herbarium, collected in 2021 by Miles Thomas (*MKT190*). It is important that the entire flora of this valley is represented as efforts to restore it continue. While this is still a preliminary checklist, it can hopefully provide insight into the diversity of moss flora that exists throughout Lower Limahuli Valley.

### METHODS

Due to the terrain and large size of the valley, the majority of species examined were mainly focused in the easily accessible restoration and riparian sections. This area ranged from 30–200 meters in elevation and less than 1 mile into the valley. Collections were made over the course of two years and from a variety of habitats in order to loosely represent the valley as a whole based on elevation, light, and moisture, paying special attention to morphologically distinct specimens. On occasion, efforts were made to expand into other, less traversed areas within Limahuli Valley, extending to the waterfall and mainly staying near the stream. Species were collected, identified, and stored at PTBG. This checklist will include findings from these surveys, as well as herbarium collections from past researchers. While many of these taxa overlap, it is important to note that some species may not be currently represented in the valley.

### RESULTS

In total, 201 collections of mosses were evaluated for this checklist—165 specimens collected for this project and 36 collections from other researchers. Among these vouchers, 49 species—46 native (15 endemic, 31 indigenous), 3 nonnative—were identified, spread across 35 genera and 20 families. The accepted names listed can be referenced in *A Revised Checklist of Hawaiian Mosses* (Staples *et al.* 2004), with any scientific name changes otherwise noted. Family classifications will follow those presented on the website *Classification of the Bryophyta* (Goffinet & Buck, 2020).

### DISCUSSION

This checklist will hopefully begin to provide insight into the moss diversity of Limahuli Valley, but much more still needs to be explored. Though the terrain can make areas difficult to access, surveys should be expanded into the mid-elevation sections of the Lower Valley.

Upper Limahuli Valley should also be surveyed in depth. While invasive plants still impact the habitat of the Upper Valley, much of the forest is dominated by native species. There are considerable differences in moisture and altitude, resulting in a vastly different

bryoflora. For example, *Plagiomnium rostratum* is less abundant and rarely fertile in the Lower Valley, especially as one moves from the waterfall to the coast, while in the Upper Valley it is extremely abundant and often fertile.

Given that Limahuli Valley has a mixture of habitats, specifically native vs. non-native/Polynesian-introduced, continuing surveys that note biomass could provide insight into the relationship mosses have with colonization and the surrounding environment.

Although this checklist focuses on only a single valley on Kaua'i, it may serve as a resource for other budding bryologists to gain an understanding of what mosses they may find in similar habitats. More importantly, it shines a light on these important yet all too often overlooked plants.

### CHECKLIST

[Note: All vouchers are from "Hanalei District, Limahuli Valley," unless otherwise noted.]

#### Anomodontaceae

*Haplohymenium triste* (Ces.) Kindb.

Unknown abundance, Indigenous

Substrate(s): Tree trunk (*Syzygium malaccense*)

Habitat(s): Mesic forest

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46261* (CAS, PTBG).

#### Bartramiaceae

*Philonotis hawaïica* (Müll. Hal.) Broth.

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian/waterfall, seep

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, seep near Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ170* (PTBG).

#### Bryaceae

*Anomobryum angustirete* Broth.

Common near waterfalls, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian (waterfall)

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian basalt rock, 147 m, 17 Sep 2022, *Jensen KLJ152* (PTBG); *loc. cit.*, splash zone of Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ168* (PTBG).

***Bryum argenteum* Hedw.**

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Botanical garden/roadside

*Material examined.* **KAUA'I:** Limahuli Garden, on a rock wall along the road opposite Visitor Center, 37 m, 14 Dec 2015, *Flynn 8008* (PTBG); *loc. cit.*, volcanic rocks lining driveway near welcome sign, 34 m, 18 Feb 2021, *Jensen KLJ122* (PTBG).

***Bryum caespiticium* Hedw.****New island record**

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Botanical garden/roadside

This taxon was first collected on Kaua'i in 1988 by Dr. David Lorence (*Lorence 5773*, PTBG, COL, HOE) but was not identified until 2012 by Dr. Mashuri Waite. Therefore, Staples *et al.* (2004) does not list it as occurring on Kaua'i.

*Material examined.* **KAUA'I:** Limahuli Garden, volcanic rocks lining driveway near welcome sign, 34 m, 18 Feb 2021, *Jensen KLJ121* (PTBG).

**Brachytheciaceae*****Donrichardia bartramii* Ignatov & Huttunen**

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian, partially/fully submerged in stream

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slopes above garden toward Limahuli Falls, Limahuli Stream, 152 m, 26 Jan 2015, *Shevock 46269* (CAS, PTBG); *loc. cit.*, 201 m, 26 Jan 2015, *Shevock 46273A* (CAS, PTBG); Lower Limahuli Preserve, Limahuli Stream, underside of rock in the splash zone of a small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ145* (PTBG); *loc. cit.*, riparian basalt rock that is often submerged, 147 m, 17 Sep 2022, *Jensen KLJ153* (PTBG).

***Rhynchostegium celebicum* (Sande Lac.) A. Jaeger**

Unknown abundance, Indigenous

Substrate(s): Volcanic rock (submerged)

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4346* (AD, COLO, HOE, PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 107 m, 20 May 2021, *Jensen KLJ078* (PTBG); Lower Limahuli Preserve, hau forest after bamboo forest about 1 mile into valley, 196 m, 17 Sep 2022, *Jensen KLJ158* (PTBG).

**Dicranaceae*****Holomitrium seticalycinum* Müll. Hal.**

Abundant, Endemic

Substrate(s): Volcanic rock

Habitat(s): Mesic forest, riparian

*Material examined.* **KAUA'I:** Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4341* (AD, COLO, HOE, PTBG); Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46255* (CAS, PTBG); Lower Limahuli Preserve, mesic forest fenced restoration, 145 m, 26 Mar 2022, *Jensen KLJ022* (PTBG); Lower Limahuli Preserve, riparian restoration next to streamlet, 112 m, 1 Apr 2021, *Jensen KLJ030* (PTBG); Lower Limahuli Preserve, riparian zone, 127 m, 8 Jun 2021, *Jensen KLJ103* (PTBG); *loc. cit.*, 95 m, 27 Aug 2022, *Jensen KLJ136* (PTBG); *loc. cit.*, 126 m, 27 Aug 2022, *Jensen KLJ150* (PTBG); Lower Limahuli Preserve, Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ172* (PTBG).

### **Fissidentaceae**

#### ***Fissidens bryoides*** Hedw.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Landslide restoration (2019), riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, southernmost landslide restoration area within fenced sections, 174 m, 13 Sep 2022, *Jensen KLJ182* (PTBG); *loc. cit.*, 164 m, 27 Apr 2021, *Jensen KLJ048*; Lower Limahuli Preserve, Limahuli Stream, 140 m, 16 Oct 2022, *Jensen KLJ186* (PTBG).

#### ***Fissidens delicatulus*** Ångstr.

Unknown abundance, Endemic

Substrate(s): Volcanic rock

Habitat(s): Mesic forest

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, on trail in mesic forest fenced restoration, 184 m, 28 Aug 2022, *Jensen KLJ140* (PTBG).

#### ***Fissidens elegans*** Brid.

Unknown abundance, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Landslide restoration (2019)

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, southernmost landslide restoration area within fenced sections, 164 m, 27 Apr 2021, *Jensen KLJ048* (PTBG).

#### ***Fissidens lancifolius*** E.B. Bartram

Unknown abundance, Endemic

Substrate(s): Volcanic rock

Habitat(s): Landslide restoration (2019)

*Material examined.* **KAUA'I:** Limahuli Garden, invasive forest demonstration site, 73 m, 18 May 2021, *Jensen KLJ058* (PTBG).

#### ***Fissidens nothotaxifolius*** Pursell & Hoe

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian (splashed by small waterfall)



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*Material examined.* **KAUA'I:** Lower Limahuli Preserve, Limahuli Stream, splash zone of small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ143* (PTBG).

### Funariaceae

#### *Funaria hygrometrica* Hedw.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Mesic forest

*Material examined.* **KAUA'I:** Limahuli Garden, fenced restoration, secondary mesic forest, section is seasonally inundated, 140 m, 31 Aug 2022, *Jensen KLJ181* (PTBG).

### Hylocomiaceae

#### *Ctenidium stellulatum* Mitt.

Abundance unknown, Naturalized?

Substrate(s): Volcanic rock, branch hanging over stream

Habitat(s): Riparian

According to Nishimura (1985), this species was originally reported from the Society Islands. It is not mentioned by Bartram (1933). It was later collected by William Hoe between the 1970s and 1980s in Mānoa Valley, O'ahu (*Hoe 2712.0*, NICH), which is highly susceptible to invasive species due to its dense human population and frequently traversed trails. Because of its late discovery and initial geographical location, it is likely that this is a naturalized species.

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slopes above garden toward Limahuli Falls, Limahuli Stream, 196 m, 26 Jan 2015, *Shevock 46272* (CAS, PTBG); Lower Limahuli Preserve, Limahuli Stream, 212 m, 17 Sep 2022, *Jensen KLJ159* (PTBG).

### Hypnaceae

#### *Ectropothecium decurrens* (Sull.) N.Nishim.

Unknown abundance, Endemic

Substrate(s): Tree trunk (*Hibiscus tiliaceus*)

Habitat(s): Mesic forest/secondary forest

*Material examined.* **KAUA'I:** Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4343a, 4345* (AD, COLO, HOE, PTBG).

#### *Ectropothecium sandvicense* (Hook. & Arn.) Mitt.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian (in splash zones of small waterfalls), Lower Limahuli waterfall

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, Limahuli Stream, underside of rock in the splash zone of a small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ147* (PTBG); *loc. cit.*, 216 m, 17 Sep 2022, *Jensen KLJ163* (PTBG); Lower Limahuli Preserve, splash zone of Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ169* (PTBG).

***Ectropothecium zollingeri*** (Müll. Hal.) A. Jaeger

Unknown abundance, Indigenous

Substrate(s): Volcanic rock (in stream)

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 244 m, 26 Jan 2015, *Shevock 46277* (CAS, PTBG).

***Phyllodon lingulatus*** (Cardot) W.R. Buck[Syn. *Glossadelphus baldwinii* Broth.] (see Shevock *et al.* 2019)

Common, Indigenous

Substrate(s): Wet volcanic rock

Habitat(s): Riparian (in splash zone of streamlet), bamboo forest, mesic forest

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 152 m, 26 Jan 2015, *Shevock 46268* (CAS, PTBG); Lower Limahuli Preserve, first patch of bamboo forest on trail, 190 m, 17 Sep 2022, *Jensen KLJ179* (PTBG).

***Vesicularia inflectens*** (Brid.) Müll. Hal.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian on stream banks and near streamlets

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration near streamlet, 112 m, 31 Aug 2022, *Jensen KLJ139* (PTBG); *loc. cit.*, riparian zone, likely becomes submerged in heavy rains, 227 m, 17 Sep 2022, *Jensen KLJ178* (PTBG).

***Vesicularia perviridis*** (Ångstr.) Müll. Hal.

Unknown abundance, Endemic

Substrate(s): Volcanic rock

Habitat(s): Mesic forest

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46263* (CAS, PTBG).

**Leskeaceae*****Claopodium whippleanum*** (Sull.) Renauld & Cardot

Uncommon, Indigenous

Substrate(s): Volcanic rock, tree branch (*Psidium guajava*)

Habitat(s): Mesic forest, riparian

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 152 m, 26 Jan 2015, *Shevock 46265* (CAS, PTBG); Lower Limahuli Preserve, mesic forest restoration, 145 m, 26 Mar 2021, *Jensen KLJ021* (PTBG); *loc. cit.*, 173 m, 27 Apr 2021, *Jensen KLJ044* (PTBG); *loc. cit.*, 170 m, 27 Aug 2022, *Jensen KLJ142* (PTBG); Lower Limahuli Preserve, secondary mesic forest, 138 m, 31 Aug 2022, *Jensen KLJ151* (PTBG).

**Leucobryaceae*****Campylopus umbellatus*** (Arn.) Paris var. *umbellatus*

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, lowland mesic forest, 97 m, 3 Dec 2020, *Jensen KLJ004* (PTBG); *loc. cit.*, riparian restoration zone next to streamlet, 112 m, 26 Mar 2021, *Jensen KLJ029* (PTBG).

***Campylopus wheeleri*** (Müll. Hal.) Paris

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration, 104 m, 20 May 2021, *Jensen KLJ070* (PTBG); Lower Limahuli Preserve, Limahuli Stream, 123 m, 8 Jun 2021, *Jensen KLJ112* (PTBG).

***Dicranodontium porodictyon*** Cardot & Thér.

Uncommon, Indigenous

Substrate(s): Volcanic rock, tree trunk (*Heptapleurum actinophyllum*)

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, island within Limahuli Stream, 147 m, 21 Oct 2022, *Jensen KLJ189* (PTBG).

***Leucobryum gracile*** Sull.

Common, Endemic

Substrate(s): Volcanic rock, tree roots and trunk (*Heptapleurum actinophyllum*)

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration 500 ft from trailhead, 95 m, 15 Mar 2021, *Jensen KLJ124* (PTBG); Lower Limahuli Preserve, riparian restoration near streamlet, 112 m, 26 Mar 2021, *Jensen KLJ028* (PTBG); Lower Limahuli Preserve, slope/ridge behind Limahuli Garden, 6 Jan 2021, *Jensen KLJ190* (PTBG).

***Leucobryum seemannii*** Mitt. var. *seemannii*

Common, Endemic

Substrate(s): Volcanic rock, tree roots and trunk (*Heptapleurum actinophyllum*)

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slope/ridge behind Limahuli Garden, 6 Jan 2021, *Jensen KLJ191* (PTBG); Lower Limahuli Preserve, riparian restoration, 127 m, 8 Jun 2021, *Jensen KLJ088, KLJ090, KLJ096* (PTBG); Lower Limahuli Preserve, riparian zone 35 ft from stream, 123 m, 8 Jun 2021, *Jensen KLJ105, KLJ113* (PTBG).

**Meteoriaceae*****Aerobryopsis longissima*** (Brid.) M. Fleisch.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian

Specimens of *Aerobryopsis longissima* have been placed under the name *Pseudotrachypus wallichii* (Brid.) W.R. Buck in PTBG records. However, following Buck (1994), the former may be a more accurate name for this species.

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slopes above garden toward Limahuli Falls, Limahuli Stream, 76 m, 26 Jan 2015, *Shevock 46254, 46279* (CAS, PTBG); Lower Limahuli Preserve, riparian restoration, 107 m, 20 May 2021, *Jensen KLJ071, KLJ079* (PTBG); *loc. cit.*, 127 m, 6 Jun 2021, *Jensen KLJ099* (PTBG); *loc. cit.*, 127 m, 27 Aug 2022, *Jensen KLJ138* (PTBG); Lower Limahuli Preserve, lowland mesic forest, 104 m, 3 Dec 2020, *Jensen KLJ002* (PTBG).

***Aerobryopsis subdivergens*** (Broth.) Broth. subsp. *scariosa* (E.B. Bartram) Nog.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration zone next to streamlet, 126 m, 7 Jan 2021, *Jensen KLJ052* (PTBG); *loc. cit.*, 126 m, 26 Mar 2021, *Jensen KLJ027* (PTBG).

***Floribundaria floribunda*** (Dozy & Molk.) M. Fleisch.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Landslide restoration (2019), riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, southern landslide within fenced restoration, 176 m, 5 Apr 2021, *Jensen KLJ053* (PTBG); *loc. cit.*, 179 m, 5 Apr 2021, *Jensen KLJ056* (PTBG); *loc. cit.*, 183 m, 27 Aug 2022, *Jensen KLJ141* (PTBG); Lower Limahuli Preserve, bamboo forest, 200 m, 17 Sep 2022, *Jensen KLJ155* (PTBG).

***Trachypus bicolor*** Reinw. & Hornsch.

Very abundant, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, Limahuli stream, riparian restoration, 107 m, 20 May 2021, *Jensen KLJ081* (PTBG); *loc. cit.*, in splash zone of small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ192* (PTBG).

**Mniaceae*****Plagiomnium rostratum*** (Schrad.) T.J. Kop.

Uncommon, Indigenous

Substrate(s): Volcanic rock, silt

Habitat(s): Riparian

*Material examined.* **KAUAʻI:** Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4343, 4357* (AD, COLO, HOE, PTBG); Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 201 m, 26 Jan 2015, *Shevock 46274* (PTBG); Lower Limahuli Preserve, riparian zone, halfway to the waterfall, 215 m, 26 Mar 2021, *Jensen KLJ055* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 140 m, 3 May 2021, *Jensen KLJ119* (PTBG); Lower Limahuli Preserve, Limahuli Stream, in the splash zone of a small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ146* (PTBG); Lower Limahuli Preserve, riparian zone, 214 m, 17 Sep 2022, *Jensen KLJ161* (PTBG); Lower Limahuli Preserve, Limahuli waterfall, in splash zones of main waterfall and several waterfalls, 300 m, 17 Sep 2022, *Jensen KLJ177* (PTBG).

### Neckeraceae

***Baldwiniella kealeensis*** (Reichardt) E.B.Bartram

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian, bamboo forest

*Material examined.* **KAUAʻI:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 152 m, 26 Jan 2015, *Shevock 46267* (CAS, PTBG); Lower Limahuli Preserve, Limahuli Stream, underside of rock in the splash zone of a small waterfall, 125 m, 27 Aug 2022, *Jensen KLJ144* (PTBG); Lower Limahuli Preserve, Limahuli Stream, 214 m, 17 Sep 2022, *Jensen KLJ162* (PTBG); Lower Limahuli Preserve, Limahuli streambank in a section that is seasonally inundated, 212 m, 17 Sep 2022, *Jensen KLJ160* (PTBG); Lower Limahuli Preserve, bamboo forest, newly cut trail, 185 m, 21 Oct 2022, *Jensen KLJ188* (PTBG).

***Homaliodendron flabellatum*** (Sm.) M. Fleisch.

Very abundant, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Mesic forest, riparian

*Material examined.* **KAUAʻI:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46262* (CAS, PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 95 m, 23 Nov 2020, *Jensen KLJ005, KLJ006* (PTBG); Lower Limahuli Preserve, Limahuli Stream, wet forest fenced restoration, 165 m, 26 Mar 2021, *Jensen KLJ017* (PTBG); Lower Limahuli Preserve, Limahuli Stream, mesic forest fenced restoration, 145 m, 5 Apr 2021, *Jensen KLJ025* (PTBG); *loc. cit.*, 173 m, 27 Apr 2021, *Jensen KLJ037* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration near streamlet, 107 m, 20 May 2021, *Jensen KLJ076* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 112 m, 1 Apr 2021, *Jensen KLJ032* (PTBG); *loc. cit.*, 107 m, 20 May 2021, *Jensen KLJ080* (PTBG); *loc. cit.*, 127 m, 8 Jun 2021, *Jensen KLJ087* (PTBG); *loc. cit.*, 123 m, 8 Jun 2021, *Jensen KLJ107* (PTBG).

***Neckeropsis obtusata*** (Mont.) M. Fleisch.

Unknown abundance, Indigenous?

Substrate(s): Volcanic rock

Habitat(s): Landslide restoration (2019)

Olson (1999) postulated that this taxon is introduced due to its small range, proximity to horticultural development and transplanting zones, and confinement to Kauaʻi. It is listed

in the Staples *et al.* (2004) checklist as naturalized. I feel that this may be incorrect, as it has also been found on O‘ahu in a privately accessed native forest, with no transplants, by Miles Thomas (*MKT 455*, BISH).

*Material examined.* **KAUA‘I:** Lower Limahuli Preserve fenced restoration, northern landslide within fence, restoration zone, 175 m, 28 Sep 2022, *Jensen KLJ185* (PTBG).

### **Octoblepharaceae**

***Octoblepharum albidum*** Hedw.

Uncommon, Indigenous

Substrate(s): Tree roots and trunk (*Pandanus tectorius*)

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA‘I:** Lower Limahuli Preserve, riparian restoration west bank, 102 m, 6 May 2021, *Jensen KLJ046* (PTBG).

### **Orthotrichaceae**

***Macromitrium brevisetum*** Mitt.

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Botanical Garden (invasive forest), mesic forest

*Material examined.* **KAUA‘I:** Limahuli Garden, invasive forest demonstration site, 73 m, 18 May 2021, *Jensen KLJ064* (PTBG).

***Macromitrium incurvifolium*** (Hook. & Grev.) Schwägr.

Unknown abundance, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Botanical garden, open grassy slope

*Material examined.* **KAUA‘I:** Limahuli Garden, 46 m, 6 Nov 1995, *Flynn 5864* (COLO, PTBG).

***Macromitrium microstomum*** (Hook. & Grev.) Schwägr.

Abundant, Indigenous

Substrate(s): Volcanic rock, tree trunk (*Heptapleurum actinophyllum*)

Habitat(s): Riparian

*Material examined.* **KAUA‘I:** Limahuli Garden, Limahuli stream, riparian restoration next to streamlet, 112 m, 1 Apr 2021, *Jensen KLJ035* (PTBG); Limahuli Garden, riparian zone, 127 m, 8 Jun 2021, *Jensen KLJ100* (PTBG); Limahuli Garden, Limahuli Stream, riparian restoration, 125 m, 27 Aug 2022, *Jensen KLJ148* (PTBG).

***Macromitrium piliferum*** Schwägr.

Abundant, Endemic

Substrate(s): Tree trunk and roots (*Pandanus tectorius*)

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA'I:** Limahuli Garden, lower Limahuli Preserve, slopes above garden toward Limahuli Falls, Limahuli Stream, 76 m, 26 Jan 2015, *Shevock 46258* (CAS, PTBG); Lower Limahuli Preserve, on trail in fenced restoration section, 145 m, 26 Mar 2021, *Jensen KLJ019* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration near streamlet, 112 m, 1 Apr 2021, *Jensen KLJ036, KLJ051* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian, 127 m, 8 Jun 2021, *Jensen KLJ094* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 123 m, 8 Jun 2021, *Jensen KLJ110* (PTBG); Lower Limahuli Preserve, 30 feet from trailhead on trail, 68 m, 27 Aug 2022, *Jensen KLJ133* (PTBG); Lower Limahuli Preserve, on trail 30 feet uphill from stream, 92 m, 27 Aug 2022, *Jensen KLJ134* (PTBG); Lower Limahuli Preserve, fenced restoration section, 140 m, 27 Aug 2022, *Jensen KLJ137* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 126 m, 27 Aug 2022, *Jensen KLJ149* (PTBG).

### Pottiaceae

*Barbula indica* (Willd. ex Schrad.) Spreng.

Uncommon, Naturalized

Substrate(s): Volcanic rock

Habitat(s): Riparian/waterfall

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, splash zone of Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ171* (PTBG).

*Chionoloma angustatum* (Mitt.) M. Menzel

[Syn. *Pseudosymblypharis angustata* (Mitt.) Hilp.] (see Alonso *et al.* 2019)

Common, Endemic

Substrate(s): Volcanic rock

Habitat(s): Riparian (waterfall)

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ167* (PTBG); Lower Limahuli Preserve, Limahuli Stream, 140 m, 16 Oct 2022, *Jensen KLJ187* (PTBG).

*Hyophila involuta* (Hook.) A. Jaeger

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian, roadside

*Material examined.* **KAUA'I:** Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46281* (CAS, PTBG); Limahuli Garden, volcanic rocks lining driveway near welcome sign, 34 m, 18 Feb 2021, *Jensen KLJ120* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian restoration, 244 m, 20 May 2021, *Jensen KLJ069* (PTBG); Lower Limahuli Preserve, southernmost landslide restoration area within fenced sections, 164 m, 1 Sep 2022, *Jensen KLJ183* (PTBG); Lower Limahuli Preserve, Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ166* (PTBG); Lower Limahuli Preserve, splash zone of Limahuli waterfall, 300 m, 17 Sep 2022, *Jensen KLJ175* (PTBG); Lower Limahuli Preserve, southernmost landslide restoration area within fenced sections, 163 m, 22 Sep 2022, *Jensen KLJ184* (PTBG).

**Pylaisiadelphaceae*****Taxithelium mundulum*** (Sull.) E.B. Bartram

Unknown abundance, Indigenous

Substrate(s): Tree branch (*Hibiscus tiliaceus*)

Habitat(s): Secondary mesic forest

*Material examined.* **KAUA'I:** Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4354* (AD, COLO, HOE, PTBG).**Racopilaceae*****Racopilum cuspidigerum*** (Schwägr.) Ångstr.

Very abundant, Naturalized?

Substrate(s): Volcanic rock, soil (clay &amp; silt), tree trunk/branch/roots, fallen logs

Habitat(s): Mesic forest, riparian, wet forest

The status of this taxon is uncertain and may be a Polynesian introduction (Staples et al, 2004).

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slopes above garden toward Limahuli Falls and Limahuli Stream, 76 m, 26 Jan 2015, *Shevock 46256* (CAS, PTBG); Lower Limahuli Preserve, fenced restoration, 173 m, 27 Apr 2021, *Jensen KLJ045* (PTBG); Lower Limahuli Preserve, mesic forest restoration, 104 m, 3 Dec 2020, *Jensen KLJ001* (PTBG); Limahuli Garden native forest walk and loulu feature, 82 m, 15 Mar 2021, *Jensen KLJ010, KLJ011* (PTBG); Lower Limahuli Preserve, fenced restoration, 165 m, 26 Mar 2015, *Jensen KLJ015* (PTBG); *loc. cit.*, 145 m, 4 Apr 2021, *Jensen KLJ024* (PTBG); *loc. cit.*, 173 m, 27 Apr 2021, *Jensen KLJ038, KLJ040* (PTBG); Lower Limahuli Preserve, riparian restoration near streamlet, 112 m, 1 Apr 2021, *Jensen KLJ031, KLJ034* (PTBG); Limahuli Garden invasive forest demonstration site, 73 m, 18 May 2021, *Jensen KLJ057* (PTBG); Lower Limahuli Preserve, riparian restoration, 107 m, 20 May 2021, *Jensen KLJ072, KLJ073, KLJ074* (PTBG); Lower Limahuli Preserve, riparian zone, 127 m, 8 Jun 2021, *Jensen KLJ091* (PTBG); *loc. cit.*, 123 m, 8 Jun 2021, *Jensen KLJ106, KLJ109* (PTBG).**Rhizogoniaceae*****Pyrrhobryum spiniforme*** (Hedw.) Mitt.

Abundant, Indigenous

Substrate(s): Volcanic rock, tree trunks/roots, fallen trees, and logs

Habitat(s): Riparian, mesic forest

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration near streamlet, 112 m, 26 Mar 2021, *Jensen KLJ026* (PTBG); Lower Limahuli Preserve, mesic forest fenced restoration, 173 m, 27 Apr 2021, *Jensen KLJ041* (PTBG); Lower Limahuli Preserve, riparian restoration west bank, 107 m, 20 May 2021, *Jensen KLJ067* (PTBG); Lower Limahuli Preserve, riparian zone, 127 m, 8 Jun 2021, *Jensen KLJ092* (PTBG); *loc. cit.*, 123 m, 8 Jun 2021, *Jensen KLJ114* (PTBG).



**Sematophyllaceae*****Sematophyllum hawaiiense*** (Broth.) Broth.

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian, botanical garden (invasive forest)

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, riparian restoration, 112 m, 7 Jan 2021, *Jensen KLJ050* (PTBG); Limahuli Garden invasive forest demonstration site, 73 m, 18 May 2021, *Jensen KLJ066* (PTBG); Lower Limahuli Preserve, Limahuli Stream, riparian basalt rock that is often submerged, 147 m, 17 Sep 2022, *Jensen KLJ154* (PTBG); Lower Limahuli Preserve, riparian zone that is submerged in rainy season, 216 m, 17 Sep 2022, *Jensen KLJ164* (PTBG).

***Sematophyllum subpinnatum*** (Brid.) E. Britton

Common, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Riparian

*Material examined.* **KAUA'I:** Lower Limahuli Preserve, slopes above garden toward Limahuli Falls and Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46259* (CAS, PTBG); Lower Limahuli Preserve, riparian restoration, 95 m, 5 Mar 2021, *Jensen KLJ123* (PTBG).

**Thuidiaceae*****Thuidium cymbifolium*** (Dozy & Molk.) Dozy & Molk.

Very abundant, Indigenous

Substrate(s): Volcanic rock

Habitat(s): Secondary mesic forest, riparian, bamboo forest

*Material examined.* **KAUA'I:** Limahuli Valley, Limahuli Valley, in valley bottom, 76–82 m, 28 Dec 1990, *Flynn 4358* (AD, COLO, HOE, PTBG); Lower Limahuli Preserve, eastern side-gulch, 195 m, 22 Mar 2010, *Wood 14143* (PTBG); Limahuli Garden, slopes above garden toward Limahuli Falls, Limahuli Stream, 107 m, 26 Jan 2015, *Shevock 46264* (CAS, PTBG); Lower Limahuli Preserve, ungulate proof fence zone, 165 m, 26 Mar 2021, *Jensen KLJ014* (PTBG); Lower Limahuli Preserve, mesic forest fenced restoration, 145 m, 5 Apr 2021, *Jensen KLJ023* (PTBG); *loc. cit.*, 173 m, 27 Apr 2021, *Jensen KLJ039* (PTBG); Lower Limahuli Preserve, riparian restoration near streamlet, 112 m, 1 Apr 2021, *Jensen KLJ033* (PTBG); Lower Limahuli Preserve, riparian restoration zone, 107 m, 20 May 2021, *Jensen KLJ068* (PTBG); *loc. cit.*, 127 m, 8 Jun 2021, *Jensen KLJ097* (PTBG); *loc. cit.*, 123 m, 8 Jun 2021, *Jensen KLJ108* (PTBG); Lower Limahuli Preserve, second patch of bamboo forest on trail, 200 m, 17 Sep 2022, *Jensen KLJ156* (PTBG).

**ACKNOWLEDGMENTS**

Thank you to Tim Flynn (PTBG Herbarium Curator) and Dr. Uma Nagendra (Limahuli Preserve Operations Manager) for nurturing the early interests in bryophytes in Limahuli Valley, assisting with project design, and helping to identify specimens. Thank you to Miles Thomas for plant identification help and project advice. Thank you to the entire Limahuli staff for continuously being excited to learn about mosses and keeping the momentum on this project going.

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## New records of Cyperaceae from Hawai‘i

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New records of Cyperaceae were found across several islands during both casual botanizing and roadside grass surveys. Six new island records, five new state records, three corrections, and one questionable naturalization are reported. All identifications were made by the author, unless otherwise noted. Voucher collections mentioned are housed in Bishop Museum’s Herbarium Pacificum (BISH), Honolulu, Hawai‘i.

### *Cyperus aggregatus* (Willd.) Endl.

#### New island record

*Cyperus aggregatus* was found during roadside surveys on Moloka‘i, where a small patch of less than 10 plants was found along the road entering Hālawā Valley. *Cyperus aggregatus* is now known to be naturalized on Moloka‘i and Maui (Starr & Starr 2015).

*Material examined.* **MOLOKA‘I:** Rt 450 at the first switchback as the road enters Hālawā Valley, from roadside gravel in dry, partly sunny area under guard rail, rare, only one small patch seen in this area, 129 m, 21.155263, -156.733633, 29 Dec 2022, *K. Faccenda 2956*.

### *Cyperus croceus* Vahl

#### New state record

*Cyperus croceus* is now known from O‘ahu and Hawai‘i, where it has been present since at least 2004, except that, until recently, the specimens were misidentified. These misidentified specimens were brought to the attention of Mark Strong (US) who correctly identified them. The population size of the colony on O‘ahu is unclear, but on Hawai‘i Island about 20–30 plants were seen during roadside surveys in Hawaii Volcanoes National Park in the Volcano Unit. Only scattered plants were seen and the largest population of about a dozen plants was seen at tree molds at the base of Mauna Loa Strip Road. *Cyperus croceus* is native from the United States through Ecuador (POWO 2023). It has also been reported as naturalized in Spain, where it was likely introduced with contaminated grass seed (Verloove & Gullón 2010). It is unclear by what mechanism this species arrived in Hawai‘i. *Cyperus croceus* can be identified by its perennial habit; rather dense, hemispherical or subglobose heads (Figure 1); affinity for drier areas than most other *Cyperus* in Hawai‘i; and 2–4 flowers per spikelet.

The following description is from Flora of North America Editorial Committee (1993:149):

“Herbs perennial, cespitose. Culms trigonous, (4–)14–45 cm × 1–2 mm, glabrous. Leaves yellow-green, flat, 18–44 cm × 3–4.5 mm. Inflorescences: spikes densely to loosely globose to ovoid, 10–20 mm wide; rays (3–)5–9(–14), 1–15(–26) cm; rachis 3–6(–9) mm; bracts (4–)6–9(–11), horizontal to ascending at 45°, flat, 1–30 cm × 0.5–4 mm; rachilla deciduous, wings persistent, 0.3–0.5(–0.8) mm wide. Spikelets (10–)30–50, oblong to lanceoloid, quadrangular to subterete, compressed, 4–8 × 1–1.3 mm; distal spikelet spreading or ascending; floral scales persistent, (1–)2–4(–6), appressed, whitish with red speckles, laterally 2–4-ribbed, ovate, 2.3–3.6 × 1.8–2.2 mm. Flowers: anthers 0.5 mm; styles 0.6–1.3 mm; stigmas 1.2–2.6 mm. Achenes reddish brown to nearly black, sessile, oblong, ellipsoid, 2–2.4 × 0.4–0.5(–0.7) mm, apex ± truncate-emarginate, apiculate, surfaces punctulate.”



**Figure 1.** *Cyperus croceus* growing near the backcountry office at Hawaii Volcanoes National Park.

*Material examined.* **O‘AHU:** Lualualei, back of valley, across from 59th St, southern ridges of Kaua, occasional along ridge, 405 m, 19 Feb 2004, *K.R. Wood 10580*. **HAWAI‘I:** Hawaii Volcanoes National Park, offices near the Visitor Center, moist, sunny roadside, rare in this area, only one clump, achene 1.7 mm, oblong, trigonous, 1207 m, 19.424418, -155.255987, 19 Aug 2022, *K. Faccenda 2676*; Hawaii Volcanoes National Park, along closed road leading to lava viewing area by the park headquarters and area with housing, weedy area, one plant seen, caespitose, 1209 m, 19.425986, -155.257546, 10 Aug 2022, *K. Faccenda 2609*.

***Cyperus cyperinus* (Retz.) Valck.Sur.**

**Correction**

*Cyperus cyperinus* is no longer known from O‘ahu, as the sole specimen was reidentified as *Cyperus croceus*. See further notes above.

***Cyperus cyperoides* (L.) Kuntze**

**New island record**

*Cyperus cyperoides* is now known from Lāna‘i from one collection of a single plant at Kapukaloa. This species has also been reported from Hawai‘i Island, where it is considered a questionable naturalization (Strong & Wagner 1997).

*Material examined.* **LĀNA‘I:** Ka‘ā, vicinity of Kapukaloa, single plant, 540 m, northing 2308690, easting 709073, 11 Oct 2013, *H. Oppenheimer et al. H101809*.

***Cyperus flavescens* L.**

**New state record**

*Cyperus flavescens*, a globally widespread species, has now made an appearance in Hawai‘i, where it has been found during roadside surveys on Kaua‘i and Hawai‘i. On Kaua‘i, a colony was collected on a roadside in the back of Kapa‘a Valley near the Keāhūa



**Figure 2.** *Cyperus flavescens*, photographed at Keāhua Arboretum.

Arboretum; because it was not recognized at the time as a new record, its population size was not recorded, but it was relatively common. Further populations were observed but not vouchered at Hanalei Valley (22.187725, -159.467229) and Kahiliholo Rd. near Kīlauea (22.205877, -159.429997). Another single plant was found on the side of the road in Honolū‘i on Hawai‘i Island. Examination of the *Cyperus* collection at BISH revealed another specimen—22 years old—documenting *C. flavescens* as naturalized and common on the University of Hawai‘i Hilo campus. This species is an annual and grows on moist to saturated soil, generally in sunny locations. *Cyperus flavescens* can be identified by its annual habit, yellow spikes arranged umbellately (Figure 2), black fruits 1–1.2 mm long, and <30 cm tall habit.

The following description is from Flora of North America Editorial Committee (1993:142):

“Herbs, annual, cespitose. Culms trigonous, (2–)4–30 cm × 0.4–2 mm, glabrous. Leaves 1–5, (blades often absent, base of culm with 1 reddish sheath bearing minute blade tooth 1–2 mm), (3–)10–18 cm × (0.5–)1.5–2(–2.6) mm. Inflorescences: spikes 1–3, ovoid or ± digitate, 10–30 × 8–26 mm; rays 1–4(–6), 0.5–3(–9) cm; bracts 2–3, approximately horizontal, 1–12 cm × 0.5–2.5 mm. Spikelets 1–6, compressed, oblong-lanceoloid, 5–15 × (2–)2.3–2.8 mm; floral scales (4–)8–24, closely imbricate, laterally yellow to yellowish brown, margins light brown to clear, medially green, laterally ribless, medially 2–3-ribbed, 2-keeled basally, ovate, (1.5–)1.8–2.2 × 1.8 mm, apex obtuse. Flowers: stamens 3; anthers 0.4 mm, connectives not prolonged; styles 0.5–1 mm; stigmas 0.5–0.8 mm. Achenes jet black to reddish brown, slightly stipitate, obovoid, 1–1.2 × 0.8 mm, apex apiculate, surface with network of rectangular longitudinally elongate cells and transverse undulations.”

*Material examined.* **KAUAI:** Kapa'a Valley, Keāhua Arboretum, roadside in the arboretum, from saturated soil of roadside ditch, partly shaded area before crossing over Kāwī Stream, common, 158 m, 22.071789, -159.417147, 29 May 2022, *K. Faccenda 2388*. **HAWAII:** Honoli'i, Kahoa St along Honoli'i Stream, weed on roadside, wet, shady forest, one plant seen, caespitose, 33 m, 19.757840, -155.093914, 14 Aug 2022, *K. Faccenda & M. Murphy 2645*; near UH-Hilo, coming up in waste areas, relatively common, 60 m, 19° 42' N. 155° 05' W, 01 Aug 2001, *F. Starr & K. Martz 010801-12*.

***Cyperus meyenianus* Kunth**

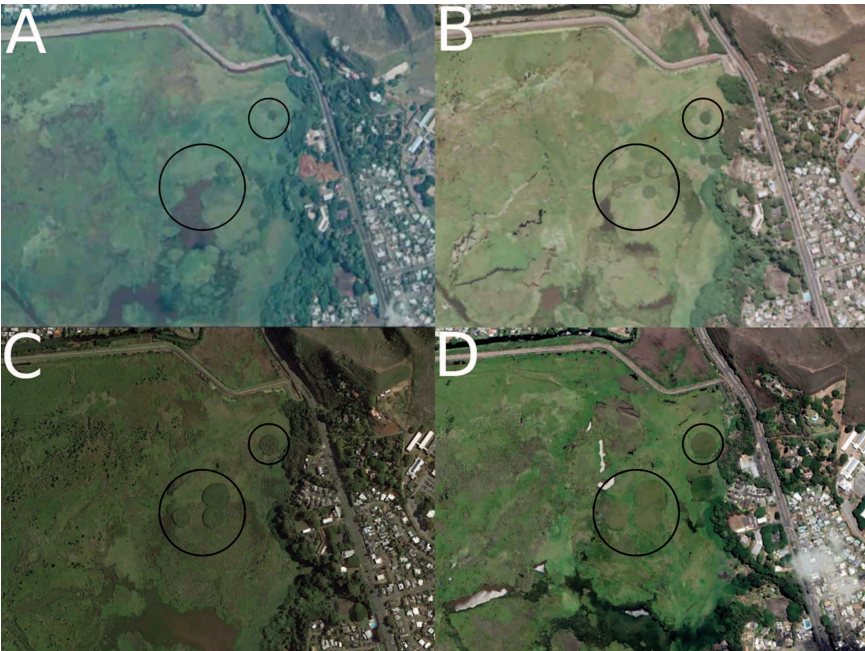
**Correction**

*Cyperus meyenianus* is no longer known from Lāna'i, as the sole specimen cited by Oppenheimer & Bogner (2019) has been reidentified as *C. cyperoides*.

***Cyperus papyrus* L.**

**New island record**

*Cyperus papyrus*, commonly known as papyrus, has long been naturalized on O'ahu at Kawainui Marsh, but has only recently been collected. Examining historical aerial photographs, it appears that these colonies have existed since before 1990, and have slowly expanded over time (Figure 3), until the largest has reached its current diameter of 84 meters. There are at least 5 colonies in the marsh currently visible from aerial photographs, although not all are visible in Figure 3. Another population exists in a reservoir off of Old Nu'uuanu Pali Rd. *Cyperus papyrus* is now known to be naturalized on Kaua'i, O'ahu, and Hawai'i (Wagner *et al.* 1990; Staples *et al.* 2003).



**Figure 3.** Aerial photographs of four colonies of *Cyperus papyrus* at Kawainui Marsh over 30 years. One colony is present in the smaller circle and three in the larger circle. **A**, two colonies visible in 1993, photo courtesy of NOAA. **B**, three colonies visible in 2000, photo courtesy of NOAA. **C**, four colonies visible in 2013, photo courtesy of Google Earth & Maxar Technologies. **D**, four colonies visible in 2022, photo courtesy of Google Earth & Maxar Technologies.

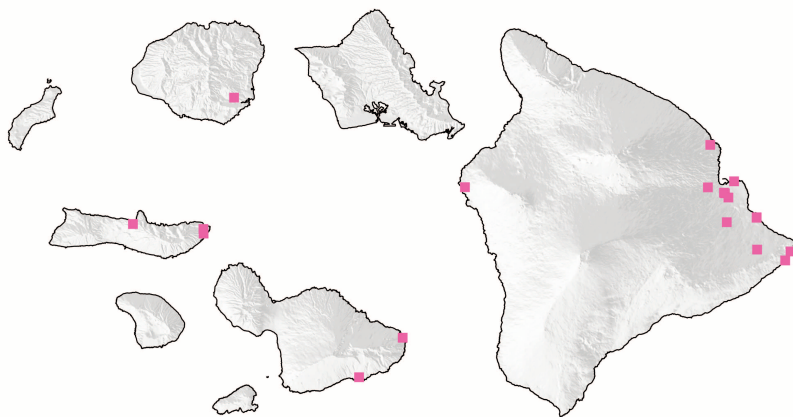
*Material examined.* **O‘AHU:** Reservoir off of Old Nu‘uanu Pali Rd near Bureau of Water Supply Pump Station, emergent from mucky silt on reservoir edge, culms triangular, spongy inside, to 3 m tall, very large colony present, 246 m, 21.350226, 157.818772, 09 Jan 2022, *K. Faccenda 2186*; Kawainui Marsh, far east portion of marsh, forming large monocultures in marsh, spreading rhizomatously, these clumps up to ca. 50 m wide, 2 m, 21.390034, -157.749991, 09 Jan 2022, *K. Faccenda 2189*.

### *Cyperus sphacelatus* Rottb.

### New island records

*Cyperus sphacelatus* was found naturalized during roadside surveys on Maui and Hawai‘i. On Maui, one individual was found near the Hāna landfill and a population of about 50 plants were found near Kaupō. While botanizing in Hilo, this sedge was found abundantly on roadsides where many thousands of plants were seen, especially around Waiākea. The current distribution of this species on the islands is shown in Figure 4. *Cyperus sphacelatus* was previously reported as naturalized only on Moloka‘i (Oppenheimer 2008).

During a nursery survey at Kauai Nursery & Landscaping, a single individual of *C. sphacelatus* was found growing as a weed in a pot. Given that no individuals were found growing in the ground, it cannot be reported as naturalized on the island, but likely is already, or will be soon.



**Figure 4.** Distribution of *Cyperus sphacelatus* in Hawai‘i, based on iNaturalist.org data and the specimens examined below.

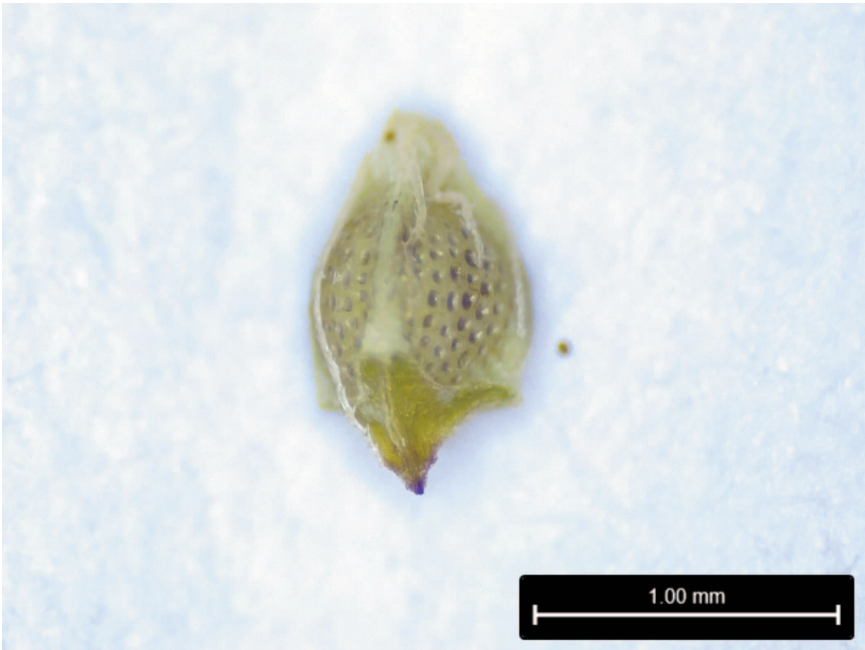
*Material examined.* **KAUAI:** Kauai Nursery & Landscaping off of Kaunualii Hwy just W of Puhi, weed around garden center area, seen growing only in pots of plants for sale, rare, only one plant seen, 102 m, 21.963138, -159.405639, 08 Jul 2022, *K. Faccenda & S. Vanaprucks 2523*. **MAUI:** Hāna, Waikoloa Rd leading to landfill, outside landfill entrance, wet, sunny roadside dominated by weeds, rare, only one plant seen along this road, 23 m, 20.769506, -155.991996, 23 Oct 2022, *K. Faccenda 2776*; Kaupō, Pi‘ilani Hwy, ca. 2 km W of Kaupō town, roadside weed along edge of pasture, small patch of ca. 50 plants growing from gravel where water runs in a small ditch along the road, spikelets with reddish marking running along their middle, 93 m, 20.631221, -156.154641, 26 Oct 2022, *K. Faccenda 2797; loc. cit.*, 15 Mar 2023, *F. Starr & K. Starr 230315-01*. **HAWAII:** Hilo, shopping center at Mamalahoa Hwy and E. Kahaopea St, on edge of parking lot, infrequently mowed area, dominant weed in this area, 34 m, 19.692410, -155.066914, 07 Aug 2022, *K. Faccenda 2589*.

*Eleocharis retroflexa* (Poir.) Urb.

**New state record**

While making a collection of *Fimbristylis schoenoides* near Kea'au, on Hawai'i Island, two small plants of *Eleocharis retroflexa* were accidentally collected and only noticed after the specimen was made. As this was collected accidentally, the population size is unknown. The specimen was first identified as *Eleocharis retroflexa* by the author using the key in Flora of North America Editorial Committee (1993) and confirmed by Mark Strong (US).

*Eleocharis retroflexa* has a pantropical distribution (POWO 2023); in China, it is found in generally moist areas, often in fields (Dai *et al.* 2010). Flora of North America Editorial Committee (1993) states that it is found along streambanks, ponds, marshes, and other wet sites. It can be distinguished from other *Eleocharis* in Hawai'i by its trigonous achenes with a cancellate surface and decurrent style bases (Figure 5), along with sessile spikelets often occurring at the base of the plant.



**Figure 5.** Photograph of the achene of the *Eleocharis retroflexa* plant collected near Kea'au.

The following description is from Flora of North America Editorial Committee (1993:98):

“Plants annual, tufted, mat-forming, often stoloniferous, sometimes entirely vegetative; rhizomes absent. Culms erect, ascending or arching, pentagonal, sulcate, 1.5–10 cm × 0.2–0.3 mm [larger], soft. Leaves: distal leaf sheaths persistent or disintegrating, pale brown to green, red-spotted [mostly red-brown], membranous; apex acuminate. Spikelets: basal spikelets usually present, bisexual; often proliferous, ellipsoid or obovoid, laterally compressed, 1.7–3.9 × 1.2–2 mm, apex acute; proximal



scale empty or with a flower, deciduous, amplexicaulous, similar to floral scales (sometimes 2.4–2.9 mm); subproximal scale with a flower; floral scales clearly distichous, 2–6 [or more], 4–6 per mm of rachilla, pale brown [marked red-brown], ovate or elliptic, 1.8–2.5 × 0.8–1.4 mm, membranous, apex rounded to obtuse, midribs green, keeled. Flowers: perianth bristles 6, colorless or pale brown, shorter than achenes; spinules not evident at 45×; stamens 3; anthers (0.55–)0.7 mm; styles 3-fid. Achenes stramineous (to cream), obovoid, trigonous or subterete, not compressed, angles prominent, 0.8 × 0.5–0.55 mm, apex not constricted proximal to tubercle, coarsely cancellate or honeycomb-reticulate at 10–15×. Tubercles red-brown, pyramidal, trigonous, proximally clearly to obscurely 3-lobed, lobes decurrent on achene angles, 0.3–0.35 × 0.3–0.4 mm.”

*Material examined.* **HAWAII:** Hwy 11 about halfway between Kea‘au and Kurtistown, near Kamehameha School, mowed roadside, sunny, moist, accidental collection with *Fimbristylis schoenoides*, 177 m, 19.606066, -155.050018, 14 Aug 2022, *K. Faccenda & M. Murphy 2649*.

***Fimbristylis aestivalis* (Retz.) Vahl**

**New island record**

*Fimbristylis aestivalis* is now known to occur on O‘ahu, where a single individual was found in the Nu‘uanu Stream bed. *Fimbristylis aestivalis* was previously reported as naturalized on Kaua‘i and Hawai‘i (Imada 2019).

*Material examined.* **O‘AHU:** Honolulu, Lili‘uokalani Botanical Garden, Nu‘uanu Stream bed, partly sunny, moist, gravel substrate, only one individual seen, 21.319622, -157.855725, 12 Jun 2021, *K. Faccenda 1983*.

***Fimbristylis squarrosa* Vahl**

**New state record**

A single plant of *Fimbristylis squarrosa* was found during a roadside survey at the end of ‘Āma‘uma‘u Rd. in Volcano on Hawai‘i Island growing in a wet, sunny area on a disturbed roadside habitat. *Fimbristylis squarrosa* is native to the Old World tropics and Australia but has become widely naturalized in the Americas (POWO 2023). It is generally a weed of seasonally wet areas (Gordon-Gray & Browning 2020). *Fimbristylis squarrosa* is unique among *Fimbristylis* as it has long, pendant hairs that descend from the style base and partially cover the top of the fruit (Gordon-Gray & Browning 2020). The plant is generally similar to *F. aestivalis* but differs in having fertile scales with recurved (squarrose) awns, while *F. aestivalis* has unawned to mucronate fertile scales, in addition to lacking hairs at the base of its style.

The following description is from Flora of North America Editorial Committee (1993:127):

“Plants annual, caespitose, delicate, to 30(–40) cm, bases soft; rhizomes absent. Leaves polystichous, spreading to ascending, to 1/2 length of culms or longer; sheaths entire or ciliate distally, backs hirtellous; ligule absent; blades linear-filiform, 0.5 mm wide, flat or involute, scabrid ciliate, often abaxially hirtellous. Inflorescences: anthelae simple or compound, mostly open, ascending-branched, mostly longer than broad; scapes filiform, 0.5 mm wide, distally compressed, mostly glabrous; longer involucre bracts leafy, equaling or exceeded by anthela. Spikelets greenish brown or brownish, lanceoloid or narrowly ellipsoid-cylindric, 4–5 mm; fertile scales ovate, acute, glabrous, midrib excurrent as slender, excurved cusp. Flowers: stamens 1; styles 2-fid, slender, base flat, long-fimbriate, hairs recurved over achene summit. Achenes pale brown, lenticular, obovoid, 0.9 mm, smooth or very finely reticulate.”

*Material examined.* **HAWAI‘I:** Volcano, end of ‘Āma‘uma‘u Rd., sunny, wet roadside, rare, only one plant seen, base of style with hairs recurved and covering achene, style widest at base and triangular tapering, leaves and sheaths hairy, 1284 m, 19.482087, -155.267645, 13 Aug 2022, *K. Faccenda 2630*.

***Scleria gaertneri* Raddi**

**New state record**

*Scleria gaertneri* was found during roadside surveys on Maui, where one patch of about 30–40 plants at the beginning of the road to Hāna was seen. Examination of *Scleria* material at BISH revealed that the exact population observed by the author was collected 14 years prior by Forest Starr et al.. Furthermore, the specimen previously published as *S. testacea* from Moloka‘i by Oppenheimer (2008) was found by Mark Strong (US) to be misidentified and truly to be *S. gaertneri*. *Scleria gaertneri* is native to Africa and Central and South America and has previously been reported as naturalized in Florida (Franck et al. 2016). *Scleria gaertneri* has a plethora of synonyms, and older literature often refers to it as *S. melaleuca*, *S. pterota*, or *S. latifolia* (Galán Díaz et al. 2019). *Scleria gaertneri* can be distinguished from *S. testacea* by its 3-lobed hypogynium, fruits as long as wide, and mature fruits ranging from gray to white, whereas *S. testacea* has a cup-shaped hypogynium, and fruits longer than wide and consistently white fruits.



**Figure 6.** Flowers and fruits on *Scleria gaertneri* from the Maui population.

The following description is taken from Galán Díaz et al. (2019:210):

“Perennial, tufted with well-developed rhizome. Culm 35–80 cm by 1.3–1.6 mm. Leaves 10–30 cm by 5–8 mm, generally glabrous but central vein ciliate, some basal leaves with few but conspicuous hairs, margins scabrid; spine-like hairs present along the distal part of the leaves, antrorse, sheaths slightly winged; contraligule

triangular, glabrous, sometimes puberulous, strongly ciliate along the margin. Inflorescence with panicles spiciform, little branched, rachilla reddish, flattened, completely glabrous; one or two terminal panicles, up to 5 cm long; laterals solitary, generally two or three, distal panicle close to the terminal, basal much shorter than the internode; peduncles up to 5 cm. Spikelets unisexual, mostly 3/4 female; glumes bearing male flowers 2.5–3.5 mm long, female 3–3.5 mm, both straw-coloured with reddish margin and green midrib. Nutlets globose, 2–3 mm diam, smooth, hairy underneath, shiny, white; hypogynium deeply trilobed, margin revolute.”

*Material examined.* **MOLOKA‘I:** S of Pōhakupili Gulch, naturalized in pasture but localized, 385 m, 25 Nov 2007, *Oppenheimer H110738*. **MAUI:** Road to Hāna where it crosses over Waipi‘o Stream, wet, shady roadside, clump-forming sedge to 50 cm tall, perennial, fruits green or black when immature, drying bone white, glossy and smooth, hypogynium 3-lobed, achene 2.5 mm long with minute hairs present only at achene base, sheaths weakly winged, ca. 5 plants seen, 171 m, 20.904421, -156.233364, 23 Oct 2022, *K. Faccenda 2743; loc.cit.*, side of road under railguard, occasional in spray patches along highway, 600 ft [182 m], 231414N, 7880834E, 13 Feb 2009, *F. Starr et al. 090213-01*.

### *Scleria testacea* Nees

### Correction

*Scleria testacea* was published as occurring on Moloka‘i by Oppenheimer (2008), but this specimen has since been reidentified as *S. gaertneri* by Mark Strong (US). Therefore, *Scleria testacea* is now only known to occur on Hawai‘i Island, and potentially West Maui, where it was reported by Hillebrand in 1888, but has not been collected since (Wagner *et al.* 1990).

### ACKNOWLEDGMENTS

Thank you to BISH staff, including Barb Kennedy & Clyde Imada, for assistance in the herbarium, and Mark Strong for assistance with identifications. Mahalo to Clyde Imada for reviewing this manuscript.

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## Updates to the Hawaiian grass flora and selected keys to species: Part 2

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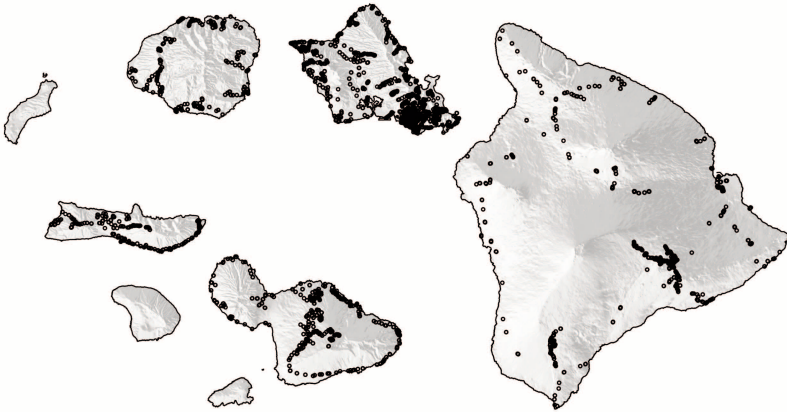
This paper continues work by Faccenda (2022) to revise the introduced grass flora of Hawai'i and expands upon it by visiting and critically reviewing specimens from the remainder of the herbaria located in Hawai'i, including HALE, HAVO, and PTBG. The US herbarium was not visited, but all photographed specimens of Hawaiian grasses at US were examined, and selected specimens were loaned and examined in Hawai'i.

As part of this work, a database of all Poaceae specimens from Hawai'i was created by combining digitized collection data from BISH, HALE, HAVO, PTBG, US, and various herbaria that have contributed data to GBIF (gbif.org 2022). This database was compared to the published island distribution of all grasses to identify any specimens that would constitute new state or island records. Each of these potential new records were examined to determine if they were misidentified, cultivated, or correctly identified material representing new records. The inverse was also done, looking for any published records lacking a supporting voucher. Many new records were found using this methodology. Several published records lacking naturalized voucher specimens were also found and are retracted from the checklist herein.

New keys have been prepared for *Bothriochloa/Capillipedium/Dichanthium* (combined key), *Cenchrus*, *Chloris*, *Digitaria* (with photos), *Paspalum*, *Saccharum*, *Schizachyrium/Andropogon* (combined key) and *Setaria*. The following species are reported for the first time in the United States: *Bothriochloa macra*, *Chloris pycnothrix*, *Dichanthium caricosum*, *Digitaria henryi*, *D. mollicoma*, *D. scalarum*, *D. velutina*, *Dinebra retroflexa* var. *retroflexa*, *Echinochloa haploclada*, *Paspalum jesuiticum*, *Saccharum* × *sinense*, and *Sporobolus coromandelianus*. Of these, *Chloris pycnothrix*, *Digitaria henryi*, *D. mollicoma*, *Paspalum jesuiticum*, *Schizachyrium sanguineum* and *Sporobolus domingensis* are reported for the first time outside of their native range. *Eriochloa acuminata* var. *acuminata* and *Paspalum langei* are native to the continental United States and are also reported for the first time outside of their native range. The following names have been misapplied in Hawai'i and correct names are reported herein: *Gastridium ventricosum*, *Hordeum brachyantherum*, *Schizachyrium condensatum*, *Schizachyrium scoparium*, and *Setaria verticillata*.

Fieldwork across Kaua'i, O'ahu, Maui, Moloka'i, and Hawai'i was conducted over 2022–2023 which discovered many new records of grasses across the archipelago. A total of 6 days were spent on Kaua'i, 13 days on O'ahu (supplemented by additional opportunistic surveys), 5 days on Moloka'i, 11 days on Maui, and 16 days on Hawai'i Island. This fieldwork consisted largely of roadside surveys where stops were made along public roads at approximately 1–5 mile intervals. During these stops I walked about 100–200 meters along the road margins on both sides of the road and examined every species of grass. If an unrecognized plant was seen out the window while driving, it was also investigated if it was safe to pull over.

If an unknown species or new distribution record was found, a herbarium specimen was made. Sometimes, extra time was able to be spent attempting to determine the extent of the population of some new state records, but in most cases this was not assessed. Approximately 700 vouchers were made during these surveys and were deposited principally at BISH, with some duplicates going to PTBG, HAW, HAVO, and US. Most of these specimens were not new records but were instead uncommon or common species collected to fill in gaps in the herbarium record. At each stop, each species of grass seen was photographed and the coordinates recorded; in total, ~9,300 data points were recorded (Fig. 1). This full dataset was uploaded to *inaturalist.org* and is also available upon request. These surveys covered a woeful volume of each island, yet identified 17 new state records and 59 new island records of grasses. Not all of these new records are published herein; some will be published in part three. Many non-grass records were also found and will be published separately. This underscores the fact that introduced grasses are under-collected and it is certain, in the author's opinion, that further effort would reveal even more species, especially on Hawai'i Island, where survey coverage was poorer than on other islands. In total, 174 species of non-native grasses were seen during this fieldwork, out of 239 species currently documented as naturalized on the islands.



**Figure 1.** Areas covered by roadside surveys and other surveys during 2021–2023. Each black circle represents an area where grasses were surveyed.

All identifications were made by the author, unless otherwise noted. This work documents 126 new island records, 45 island level corrections, 34 new state records, 9 species deleted from the state checklist, 8 new questionable naturalizations, 8 confirmations of species previously reported as questionable naturalizations, and contributes several notes. A breakdown of these records by island is reported in Table 1. All herbarium specimens cited are deposited at BISH, unless otherwise noted.

**Table 1. Summary of new grass records presented here, broken down by island.**

\* Including one native species.

Island	NIR	Corrections	Total spp.	TNQ
Kure Atoll	2	2	13	13
Midway	3	1	35	33
Pearl And Hermes Reef	1	1	3	3
French Frigate	2	2	7	7
Nihoa	1	1	2	2
Ka'ula Rock	1	1	5	5
Lehua	1	1	8	7
Ni'ihau	2	2	16	15
Kaua'i	17	6*	124	120
O'ahu	28	7	184	163
Moloka'i	15	3	106	97
Lāna'i	3	3	72	68
Maui	19	6	168	156
Kaho'olawe	4	3	35	34
Hawai'i	27	7	181	160
Total	126	45	273	239

Abbreviations: NIR = New Island Records; TNQ = Total non questionable

***Avena barbata* Pott ex Link****New island record**

*Avena barbata*, formerly known from O'ahu and Hawai'i (Imada 2019), is now known from several collections on East Maui, where it has been present since 1937.

*Material examined.* MAUI: East Maui, Makawao Distr, Kalialinui, south gulch along road near edge of pasture, 2 m tall grass, locally common, 878 m, 20.792098, -156.308096, 16 Feb 2006, *H. Oppenheimer H20611* (PTBG); On roadside going to Makawao from Kahului, local patches, 500 ft [152 m], 20 Jan 1937, *E.Y. Hosaka 1708*; Kula, Crater Rd heading to Haleakalā, weed from yard of residence just before road enters Haleakalā Ranch, wet, sunny area, 5 plants seen, only this one colony seen, 20.767529, -156.294802, 27 Oct 2022, *K. Faccenda 2809*.

***Bothriochloa bladhii* (Retz.) S.T. Blake****New island record; Correction**

*Bothriochloa bladhii*, previously reported as questionably naturalized on Hawai'i Island (O'Connor 1990), is now fully naturalized and is widespread on the island. It was found both in the Kahuku and Volcano Units of the Hawaii Volcanoes National Park, as well as along the belt road south of Waimea. In one area visited by the author (intersection of the Hawai'i Belt Road and Waikoloa Rd.), recently affected by a fire, this species was dominant, regenerating from large clumps in the burned area, indicating that *B. bladhii* is both flammable and fire adapted.

Examination of the only vouchered specimen (*Starr 030730-1*, BISH) identified as *B. bladhii* from Kaho'olawe revealed it to be a misidentified specimen of *Dichanthium annulatum* var. *annulatum*. No other specimens have been collected from the island, so it must be removed from the checklist for Kaho'olawe.

*Material examined.* **HAWAII:** Hawaii Volcanoes National Park, Kahuku Unit, in grounds of ranch house, few scattered grasses seen on edge of lawn of ranch house, ca. 0.6 m tall, 650 m, 11 Oct 2005, *L.W. Pratt 3545* (HAVO); Junction of Waikoloa Rd and Hwy 190, recently burned area, open, dry, sunny area, strongly regenerating after the fire with *Hyparrhenia rufa*, dominant in many areas and therefore likely this species was one of the main fuels for the fire, 770 m, 19.877252, -155.722274, 03 Mar 2022, *K. Faccenda 2288*; Saddle Rd, about 1 km away from its intersection with Rt 190, dry roadside, full sun, uncommon, mixed with the dominant *Cenchrus setaceus* and the less common *C. ciliaris*, 828 m, 19.926750, -155.678760, 04 Mar 2022, *K. Faccenda 2311*; Rt 190 about 2 km S of Waimea near the airport, pastures and roadsides in sunny dry areas, locally dominant in some areas, uncommon in others, 797 m, 20.002103, -155.677323, 05 Mar 2022, *K. Faccenda 2326*; Hawaii Volcanoes National Park, Chain of Craters Rd, near Hi'iaka Crater, roadside, sunny, dry area, rare, only 2 plants seen along road, 1003 m, 19.371192, -155.225656, 19 Aug 2022, *K. Faccenda 2681*.

***Bothriochloa ischaemum* (L.) Keng**

**New island records**

*Bothriochloa ischaemum* is now known from O'ahu and Moloka'i. This species was formerly known only from Hawai'i Island (Faccenda 2022). A single individual was found growing along King St. in urban Honolulu from dry, compressed soil adjacent to a sidewalk. Another individual was found along Rt. 72 and Kalani'iki St. between Honolulu and Hawai'i Kai. Over the course of this fieldwork only two plants were observed, making this grass apparently quite rare on O'ahu. A population on Moloka'i also exists at Lā'au Point.

*Material examined.* **O'AHU:** Honolulu, along Kalākaua Ave near King St, dry area between road and sidewalk, near *Bothriochloa pertusa*, 21.297625, -157.838172, 22 Jun 2021, *K. Faccenda 2000*; Between Honolulu and Hawai'i Kai, just W of Kalani'iki St along Rt 72, dry, sunny soil on edge of sidewalk, irregularly mowed area, rare, only one patch of this grass seen, but not every clump was examined in great detail in this area, all inflorescences lacked pits, clump-forming, 21.277837, -157.777651, 14 May 2022, *K. Faccenda 2373*. **MOLOKA'I:** West end of Lā'au Point, in coastal *Cressa* hermland, locally common, 21.101292, 157.309075, 15 m, *H. Oppenheimer H50632*.

***Bothriochloa macra* (Steud.) S.T. Blake**

**New state record**

Critical examination of the specimens filed as *Bothriochloa pertusa* at BISH revealed two distinct types of plants, one with smaller florets and a pitted pedicellate floret, and another with larger florets and a pedicellate floret lacking a pit (Fig. 2). This second type with the larger florets is actually *Bothriochloa macra* from Australia, commonly called Redleg Grass (Blake 1944). *Bothriochloa macra* may also lack glands on its glumes (Blake 1944), but all Hawaiian specimens collected to date do have glands. See the combined key to *Bothriochloa*, *Capillipedium*, and *Dichanthium* below to identify this species.

*Bothriochloa macra* was actually published as occurring on the islands in 1954 (Hosaka & Thistle 1954; cited as *B. ambigua*), but despite publication of this as a naturalization in 1954, no specimens could be found in any herbaria annotated with that name. This species has supposedly existed on the islands since 1916 (Hosaka & Thistle 1954), but the earliest specimen is from 1936, where it was first collected on O'ahu. *Bothriochloa macra* is currently known to occur on Ni'ihau, O'ahu, Moloka'i, Maui, Kaho'olawe, and Hawai'i from 15–1300 m elevation.

This grass has previously only been recorded as naturalized in New Zealand (Edgar & Shand 1987), but little information could be found regarding its weed potential or ecology in New Zealand. In Australia it is associated with disturbance in grassy woodlands (Prober *et al.* 2002), can handle drought and thrives on low fertility soils (Blake 1944), and can be a dominant species in grazed areas (Mitchell *et al.* 2021).





**Figure 2.** *Bothriochloa macra*. **A**, close-up of florets photographed at Pu'uwa'awa'a; **B**, inflorescences photographed at Ho'olehua.

The following description is taken from Blake (1944: 29; cited as *B. ambigua*):

“Loosely to densely tufted, green or brownish, 30–100 cm high; innovations extravaginal or mixed. Culms geniculately ascending, glabrous, smooth, shining, finely striate, 2–8 (usually 3–7)-noded, branched from many of the nodes with erect branches, the internodes (uppermost excepted) with one side furrowed. Leaf-sheaths soon gaping, keeled, striate, smooth, glabrous or the nodes sometimes puberulent or pubescent, shorter than the internodes except for the lowermost; ligules membranous, truncate, 1.5–2.5 mm. long, minutely and sparsely ciliolate at apex; blades at length more or less flat or revolute, up to 30 cm. long, about 2.5–5.5 mm. wide, margins scaberulous, asperulous on the upper surface, smooth beneath, both sides (particularly at the auricles) sparsely hairy with long tubercle-based hairs, primary nerves 9–11, narrowly keeled beneath. Inflorescence of 3–6 subdigitate racemes; common axis terete, somewhat bearded at the nodes otherwise glabrous, 0.7–2 cm. long; peduncles solitary or opposite, erect, rigid, terete and glabrous or the upper ones similar to the joints of the racemes, 4–7 or up to 9 mm. long. Racemes erect, appressed or somewhat flabellate, 5–10 cm. long, white-villous; joints and pedicels, 4–4.5 mm. long, the hyaline middle line sometimes becoming opaque and disappearing, the margins ciliate with hairs up to 4.5 mm. long. Sessile spikelet lanceolate-linear, narrowed upwards from about the middle to the lower third, narrowly rounded. at the tip, 5–7 mm. long, green or pallid, rarely purplish; callus about  $\frac{3}{4}$  mm. long, densely

bearded with hairs up to 1 mm. long. Glumes thinly coriaceous; upper narrowly rounded at the tip, with 5–7 intracarinial nerves, loosely hairy in the lower  $\frac{1}{3}$  or rarely glabrous, the keels spinulose-scabrous above the middle, the back above the middle punctate or smooth, sometimes with a more or less circular small pit; upper glume slightly smaller, spinulose-scabrous on the keel, otherwise smooth. Lower lemma lanceolate-oblong or ovate-lanceolate, jagged at the apex, 4–5 mm. long, about as long as the glumes. Upper lemma stipe-like, 2.5–2.75 mm. long; awn with stipe 20–23 mm. long, the brown scabrous column about as long as the scaberulous fulvous bristle, palea absent. Stamens 3; anthers 1.35–1.75 mm. long. Grain 3–3.25 mm. long, about 1 mm. wide. pedicelled spikelet neuter, lanceolate acute, 4.5–6 mm. long; lower glume scaberulous with the keels scabrous in the upper part and with 11 intracarinial nerves; upper glume much shorter, 3-nerved, ciliate; remainder absent.“

*Material examined.* **NI‘IHAU:** [no specific location], tall grass, 02 Nov 1939, *Anonymous s.n.* (BISH 117913); Ki‘eki‘e, cult. pasture grass, 50 ft [15 m], 16 Aug 1947, *H. St. John 22845*; Pānī‘au, introduced range grass, 1100 ft [335 m], 30 Mar 1949, *H. St. John 22385*. **O‘AHU:** Honolulu, University of Hawai‘i campus, weed in lawn behind Miller Hall, by *Euphorbia neriifolia*, 80 ft [24 m], 29 Apr 1966, *D. Herbst 85*; University of Hawai‘i Mānoa campus, outside Bilger Hall, mowed lawn, moist, sunny, seemingly irrigated, over 100 plants seen in area, with *Bothriochloa pertusa*, *Cynodon dactylon*, 23 m, 21.299817, -157.816904, 19 Apr 2023, *K. Faccenda 3098*; Waiawa, 500 ft [152 m], 31 Aug 1936, *A.F. Judd s.n.* (BISH 117914); Honolulu, Judd St., residence of A.F. Judd, transplanted from Waiawa, 26 Oct 1936, *A.F. Judd s.n.* (BISH 117911). **MOLOKA‘I:** Waiakoa, Dr. Cooke’s place, 13 Apr 1939, *Anonymous s.n.* (BISH 786589); Maunaloa town, intersection of Maunaloa Rd and North Wai‘eli St, in mowed lawns around town, rather dry, sunny areas, common in town, over 100 plants seen but not dominant, 309 m, 21.132911, -157.212683, 26 Dec 2022, *K. Faccenda 2903*; Rt 450 ca. 1 km S of the Pu‘u o Hoku Ranch headquarters (as the ‘alalā flies), along edge of large pasture spanning both sides of road, 192 m, 21.134650, -156.730070, 29 Dec 2022, *K. Faccenda 2955*. **MAUI:** Makawao, ‘Ulupalakua, occasional in pasture (local patch), growing nicely, 1800 ft [548 m], 08 Apr 1937, *E.Y. Hosaka 1794*; ‘Ulupalakua, bunch grass ca. 2.5 ft [76 cm] in height in pasture above Kula Hwy, 2000 ft [609 m], 08 Jan 1976, *J. Resnick 213* (HAW); Kanaio, above Kula Hwy, on ‘a‘ā lava, bunch grass, 1800 ft [548 m], 16 Jan 1976, *J. Resnick 294* (HAW); ‘Ulupalakua, grassland near Mākena Rd, bunch grass ca. 1 ft [30 cm] tall, 1600 ft [487 m], 18 Jan 1976, *J. Resnick 348* (HAW); Ahuwai [Auwahi], near boundary with Kanaio, bunch grass to 1 ft [30 cm] in height, 2400 ft [731 m], 16 Jan 1976, *J. Resnick 270* (HAW); ‘Ulupalakua, on slopes of Pu‘u o Kanaloa, above La Perouse Bay, steep slope, cindery soil, dry conditions, 150 ft [45 m], 27 Aug 1975, *J. Resnick 112* (HAW); Pā‘ia, Holomua Rd, Old Maui High School, MISC Baseyard, mowed lawn, full sun, unirrigated, common in lawn, with *Cynodon* and *Bothriochloa pertusa*, 20.915056, -156.347798, 22 Oct 2022, *K. Faccenda 2784*. **KAHO‘OLAWA:** Bordering west side of LZ-1, UTM 752300-2275800, 09 Apr 1987, *S. Warren K-7*. **HAWAI‘I:** Mauna Loa Strip Road about 4 miles from intersection with Kona-Hilo Hwy, drive through Kīpuka Kī, just before the roadside pulloff at left of road (plot 40), 1340 m, 13 Jul 1966, *C.L. Newell 56, 57, 58*; Pu‘u Wa‘awa‘a, roadside, dry, open area dominated by *Cenchrus setaceus*, 659 m, 19.800794, -155.839116, 03 Mar 2022, *K. Faccenda 2283*; Ka‘ū, Pākini Iki, Ka‘alu‘alu Ranch, pasture, occasional in local patch, 1000 ft [304 m], *E.Y. Hosaka s.n.* (BISH 786739); Saddle Rd, ca. 1 km away from its intersection with Rt 190, dry roadside, 968 m, 19.905982, -155.674917, 04 Mar 2022, *K. Faccenda 2312*; Hawai‘i National Park, between Keauhou Trail and Kīpuka Nēnē on jeep road, open exotic grasslands, Sept 1987 burn area, 24 Nov 1987, *P.K. Higashino 10618* (HAVO); South Kohala Distr, Pōhakuloa, Ke‘āmuku Unit, old substrate near MSR Rd., uncommon in shrubland with alien grasses, bunchgrass, 1300 m, 08 May 2013, *L.W. Pratt 3949* (HAVO).

### *Bothriochloa pertusa* (L.) A. Camus

### Correction

*Bothriochloa pertusa* is no longer known from Ni‘ihau, as all specimens have been reidentified as *Bothriochloa macra*. It is likely that *B. pertusa* does occur on the island, but no vouchers exist, as the island is largely inaccessible.



**Figure 3.** *Bouteloua dactyloides* male inflorescence from the Hale‘iwa.

***Bouteloua dactyloides* (Nutt.) Columbus      New state record**

During roadside surveys on O‘ahu, a small population of *Bouteloua dactyloides* was found growing in a mowed roadside along the Kamehameha Hwy. near Hale‘iwa Beach Park. This colony covered approximately 20 square meters of ground and was mixed with *Cynodon dactylon* and *Bothriochloa pertusa*. *Bouteloua dactyloides* is a dioecious species (Barkworth *et al.* 2003) and all inflorescences observed were staminate (Fig. 3), making it possible that this population was all only one staminate clone. However, when I was examining this grass in the field, I did not know that the male and female inflorescences were dimorphic and did not examine below the leaves for female flowers.

*Bouteloua dactyloides* is commonly called American Buffalo Grass and is native to short grass prairies of the central United States, where it is one of the most dominant species. This plant is adapted to fire, providing both flammable fuels and regenerating after fire (Howard 1995). In some areas, it has value as a turf grass (Wu 2000). It has previously been reported as naturalized in China, Spain, and Greece (POWO 2023). *Bouteloua dactyloides* is considered a valuable forage grass (Barkworth *et al.* 2003) and has previously been intentionally introduced into Hawai‘i for trial as a forage grass at least 5 times (von Tempisky 1905; HAES n.d.), making it very likely that this population descends from material intentionally imported into the islands. American buffalo grass can be identified by its stoloniferous habit, short stature, dioecious habit, and <3 mm wide hairy leaves.

The following description is taken from Barkworth *et al.* (2003: 270; cited as *Buchloë*, a monotypic genus):

“Plants perennial; usually dioecious; strongly stoloniferous, sometimes mat-forming. Culms 1–30 cm, erect, solid, mostly unbranched, those of the pistillate inflorescences much shorter than those of the staminate inflorescences; nodes mostly glabrous.

Leaves basally tufted, not clustered or strongly distichous; sheaths open, rounded, often sparsely pilose near the collar; ligules membranous or of hairs; blades usually flat basally, curling when dry, glabrous or sparsely pilose, apices involute. Staminate inflorescences terminal, usually exceeding the upper leaves, panicles of 1–3(4) racemously arranged, unilateral, pectinate branches; branches not enclosed at maturity, spikelets densely crowded in 2 rows. Staminate spikelets with 2 florets; glumes unequal, glabrous, 1- or 2-veined; lemmas 3-veined, glabrous, unawned; anthers brownish to red or orange. Pistillate inflorescences terminal, panicles, partially hidden within bracteate leaf sheaths; branches 2–3(4), 2.5–4.5 mm, burlike, with 3–5(7) spikelets; disarticulation at the base of the panicle branches. Pistillate spikelets with 1 floret, almost completely enclosed by the upper glumes; lower glumes irregular and reduced; branch axes and lower portion of upper glumes globose, white, indurate, terminating in 3 awnlike teeth; lemmas firmly membranous, glabrous, 3-veined, unawned or shortly 3-awned.  $x = 10$ .”

*Material examined.* **O‘AHU:** Hale‘iwa, along main highway just N of Hale‘iwa Beach Park near intersection of Kamehameha Hwy and Rt 83, mowed roadside on E side of road, only patch encountered during roadside surveys in this area, stoloniferous grass which was mostly sterile, but a limited number of flowers could be found, covering over 20 sq. meters with *Cynodon* and *Bothriochloa*, forming a dense turf, 2 m, 21.604326, -158.099059, 22 Dec 2022, K. Faccenda 2882.

***Bromus diandrus* Roth**

**Correction**

*Bromus diandrus* is no longer known to be naturalized on Lāna‘i, as the specimen published by Oppenheimer (2008) has been redetermined to *B. madritensis*. *Bromus diandrus* is now known to be naturalized on Kaua‘i, O‘ahu, Moloka‘i (questionable), Maui, and Hawai‘i (Imada 2019; Imada & Kennedy 2020; Faccenda 2022).

***Bromus hordeaceus* L.**

**Correction**

*Bromus hordeaceus* was previously reported on Moloka‘i by Wyszong *et al.* (2007); however, the specimen cited was a misidentification of *Bromus madritensis*. As there are no other specimens documenting *B. hordeaceus* from Moloka‘i, the record is herein retracted. *Bromus hordeaceus* is now known to occur only on Kaua‘i, O‘ahu, Maui, and Hawai‘i (Imada 2019).

***Bromus tectorum* L.**

**New island record**

*Bromus tectorum*, formerly known only from Maui, is now known on Hawai‘i Island from the Saddle area. This collection from the Rock Herbarium at the University of Hawai‘i was only recently identified as *B. tectorum*.

*Material examined.* **HAWAII:** In forest near pu‘u at mile 30 of Saddle Rd, 6000 ft [1828 m], 15 May 1995, C. Morden 1342 (HAW).

***Cenchrus ciliaris* L.**

**Note**

Fieldwork on Hawai‘i Island discovered a rhizomatous form of *Cenchrus ciliaris* with glaucous leaves. These differences were so striking that it was initially thought to be a different species, based on its rhizomatous habit and larger, glaucous leaves without hairs. However, after fruitless attempts to identify it, and keys repeatedly keying it as *C. ciliaris*, it was realized that these plants are likely escaped cultivars (Hosaka & Carlson 1957; Marshall *et al.* 2012). This cultivar was also found naturalized on Kaua‘i, O‘ahu, Moloka‘i, and Hawai‘i. Little information could be found on this cultivar and how it could differ

ecologically from the wild type *C. ciliaris*, although it has been noted that the rhizomatous form can tolerate heavier soils (Marshall *et al.* 2012).

*Material examined.* **KAUAI:** Rt 50, ca. 5 km NW of Kekaha, roadside weed, sunny dry area, leaves glaucous, rhizomatous, typical form of this grass occurring right next to it, this is apparently a cultivar, 4 m, 21.998607, -159.756583, 04 Jun 2022, *K. Faccenda 2480*. **O'AHU:** Kapolei, Kualakai Pkwy about 500 m N of its intersection with Kapolei Pkwy, roadside along bike trail, full sun, area dominated by *Cenchrus ciliaris* rare, only this one clump seen in area, all other plants had green leaves, 22 m, 21.339635, -158.052806, 19 Feb 2023, *K. Faccenda 3036*. **MOLOKA'I:** Ho'olehua, end of pavement on W end of Mo'omomi Ave, disturbed roadside, dry sunny area, rhizomatous blue-leaved form, common in this area along 100s of meters of road, aside from this patch the green-leaved caespitose form dominant, 117 m, 21.168326, -157.114454, 27 Dec 2022, *K. Faccenda & C. Daehler 2919*. **HAWAI'I:** Rt 190 about 6 km S of Waimea, dry sunny roadside, rhizomatous grass with glaucous blue leaves and culms, uncommon in area, 760 m, 19.959988, -155.680848, 05 Mar 2022, *K. Faccenda 2322*; South Point, South Point Rd about 200 m N of final "Y" in road, roadside ditch, seemingly slightly moister than nearby areas as this grass was green whereas all other vegetation was dry and brown at this time, forming monoculture along road for about 20–30 m, 28 m, 18.925054, -155.681573, 02 Mar 2022, *K. Faccenda 2271*.

***Cenchrus longisetus* M.C. Johnston.**

**Correction**

*Cenchrus longisetus* is no longer known to be naturalized on Hawai'i Island, as the specimen cited by Herbst & Clayton (1998) was apparently cultivated next to a house. *Cenchrus longisetus* is not currently known to be naturalized on any Hawaiian island, although it has been recorded in cultivation on most of the islands.

***Cenchrus setigerus* Vahl**

**New island record**

*Cenchrus setigerus* was found during roadside surveys on Moloka'i, where two populations were noted in the vicinity of Kaunakakai. One population was found in the housing development mauka of downtown Kaunakakai and consisted of over 100 plants, while the other was a small clump of around 10 plants at the intersection of Hoawa Rd. and Rt. 460. *Cenchrus setigerus* was reported as adventive on Moloka'i by O'Connor (1990) and is now clearly naturalized. *Cenchrus setigerus* is now known to be naturalized on Kaua'i and Moloka'i (Imada 2019).

*Material examined.* **MOLOKA'I:** Kaunakakai, Kupa Place and along other roads in subdivision, from cracks in sidewalks and strips of dirt between sidewalks and road along with yards, rather dry, sunny area in residential area, uncommon, over 100 plants seen in this area and also further W, mixed with *Cenchrus ciliaris*, 37 m, 21.092738, -157.012177, 30 Dec 2022, *K. Faccenda 2979*.

***Cenchrus setosus* Sw.**

**Corrections; taxonomic note**

It has recently been revealed that the name *Cenchrus polystachios* has been widely misapplied, as in 1917 the name was lectotypified to be *Setaria flava*, an entirely different species (Turner *et al.* 2019). Therefore, the correct name for *Cenchrus polystachios* as it has been applied in Hawai'i (as well as most places in the world) is *Cenchrus setosus*.

*Cenchrus setosus* is also no longer known to be naturalized from Kaua'i or Maui, as the records published by Starr *et al.* (2002, 2003, 2004) and Starr & Starr (2011) were based on misidentifications of *Cenchrus ciliaris*. However, during roadside surveys on Maui, a *C. setosus* plant was photographed in Kaupō (Fig. 4), but was not vouchered; as no voucher was made, it must be considered a **questionable naturalization**. *Cenchrus setosus* is currently known to be naturalized on O'ahu, Lāna'i, and Hawai'i, and questionably naturalized but unvouchered on Maui.



**Figure 4.** *Cenchrus setosus* photographed at Kaupō, Maui, 20.631154, -156.154758, 26 Oct 2022.

#### KEY TO *CENCHRUS* IN HAWAII

*Cenchrus* is part of the bristle clade of Paniceae, and all species have bristles subtending the florets. *Setaria* is also a member of this clade, and the two genera can be distinguished by whether the spikelets fall with or without the bristles. The bristles are persistent on the inflorescence in *Setaria* but fall with the spikelet in *Cenchrus*. *Cenchrus americanus* is an exception to this rule and is also found in the key to *Setaria* in this paper. The genus *Pennisetum* is now included in *Cenchrus* based on molecular evidence; if the name dramatically changed when it was moved to *Cenchrus*, the former *Pennisetum* name is also provided below.

1. Leaves consistently pink to red; cultivated or uncommonly escaped plants [also compare to *Cenchrus americanus* × *purpureus* (bana grass), a sterile, cane-like grass resembling *C. purpureus* vegetatively, but with purple leaves and occurring only in cultivation]
  2. Leaves >20 mm wide; all bristles scabrous ... *C. elegans* [*Pennisetum macrostachys*]
  - 2'. Leaves <11 mm wide; at least one of innermost bristles plumose .....  
..... *C. ×cupreus* [*Pennisetum advena*] (in part)
- 1'. Leaves green, occasionally reddish when stressed; wild or cultivated plants
  3. Plants rhizomatous or stoloniferous
    4. Plants decumbent, long creeping, stoloniferous; conspicuously hairy; inflorescence concealed in leaf sheaths ..... *C. clandestinus*
    - 4'. Plants erect, rhizomatous; glabrous or inconspicuously hairy; inflorescence prominently exserted ..... *C. ciliaris* (in part; uncommon glaucous-leaved cultivar)

- 3'. Plants clump-forming (caespitose)
  - 5. Spikelets enclosed in a spiny burr composed of stiff, flattened bristles
    - 6. Spines hooked at tip [potentially mistaken for *Cenchrus*] .....  
 ..... *Tragus berteronianus*
    - 6'. Spines never hooked at tip
      - 7. Burs with spines in two distinct series, the outer <3 mm and terete; the inner stiff and flattened
        - 8. Burr 8–18 mm long; burr with conspicuous flaring pedicel ~2 mm long [endemic] ..... *C. agrimonioides*
        - 8'. Burr 4–7 mm long; burr with pedicel <1 mm ..... *C. echinatus*
      - 7'. Burs with only one series of stiff spines
        - 9. Spines grooved; burs 5–7 mm long; burrs scabrous ..... *C. setigerus*
        - 9'. Spines not grooved; burs >1 cm long; burrs conspicuously hairy .....  
 ..... *C. tribuloides*
  - 5'. Spikelets subtended by relatively soft, terete bristles (or bristles slightly flattened in *C. ciliaris* but not spiny)
    - 10. Bristles glabrous, scabrous, or with very sparse hairs
      - 11. Annual; bristles persistent after spikelets fall; bristles <1 cm long; waif occurrences from birdseed or use as soil stabilization .....  
 ..... *C. americanus* [*Pennisetum glaucum*] (in part)
      - 11'. Perennial; bristles deciduous; bristles >1 cm; naturalized
        - 12. Canelike plants up to 4 m tall (but may flower before appearing canelike); inflorescence axis conspicuously hispid pubescent; bristles golden yellow ..... *C. purpureus*
        - 12'. Not canelike; inflorescence axis scabrous or minutely pubescent; bristles typically brownish purple ..... *C. complanatus*
    - 10'. Most bristles conspicuously ciliate
      - 13. Fascicle of spikelets sessile or on pedicel <0.5 mm long
        - 14. Inner whorl of bristles fused at base into minute cup 0.2–1 mm tall; inner whorl of bristles flattened and grooved longitudinally, weakly ciliate, cilia generally not obscuring spikelets; bristles generally wavy ..... *C. ciliaris*
        - 14'. Inner whorl of bristles not fused for any length; inner whorl of bristles terete and without groove, densely ciliate, cilia generally entirely obscuring spikelets; bristles generally straight .....  
 ..... *C. setosus* [*Pennisetum polystachion*]
      - 13'. Fascicle of spikelets borne on a pubescent pedicel >1 mm long
        - 15. Leaves stiff, V-shaped, <3.5 mm wide ..... *C. setaceus*
        - 15'. Leaf soft, flat, >4 mm wide
          - 16. Panicle <15 cm long
            - 17. Panicle partially inserted into subtending leaf sheath .....  
 ..... *C. clandestinus* × *C. setaceus*
            - 17'. Panicle long-exserted from subtending leaf [not yet naturalized]  
 ..... *C. longisetus* [*Pennisetum villosum*]

- 16'. Panicle longer  
 18. Annual; bristles persistent, <1 cm long; waif occurrences from  
 birdseed or soil stabilization .....  
 ..... *C. americanus* [*Pennisetum glaucum*] (in part)  
 18'. Perennial; bristles deciduous, >1 cm; cultivated or naturalized ...  
 ..... *C. ×cupreus* [*Pennisetum advena*] (in part)

***Chloris divaricata* R. Br.****Nomenclatural note; new island record**

*Chloris divaricata* was formerly treated as having two varieties in Hawai'i (*C. d. var. divaricata* and *C. d. var. cynodontioides*) following the treatment *Chloris* by Lazarides (1972). However, recent fieldwork has shown that these varieties entirely intergrade in Hawai'i. An identical conclusion was reached by Anderson (1974) who also chose not to recognize these varieties. As such, they are no longer recognized in the Hawaiian flora.

*Chloris divaricata* is now known to be naturalized on Moloka'i at Waihānau, Ho'olehua, and 'Ualapu'e. It is also known from a single old collection from Kahuku, Hawai'i. Persistence of this record from Hawai'i Island should be considered questionable, as this species has not been observed in the past 70 years. *Chloris divaricata* is now known to be naturalized on Midway, Ni'ihau Kaua'i, O'ahu, Moloka'i, Lāna'i, and Maui, Kaho'olawe, and Hawai'i (Imada 2019).

*Material examined. MOLOKA'I:* Waihānau, 02 Dec 2004, G.D. Hughes 1105; Rt 450, ca. 8 km E of 'Ualapu'e, roadside weed in dry sunny area, common in this area along the compressed soil along the road, 13 m, 21.094306, -156.762759, 29 Dec 2022, *K. Faccenda 2953*; Ho'olehua, intersection of Rt 482 and Ala Elua St, partly shady, moist roadside, common in sunny and partially shaded locations in this area, weakly stoloniferous grass in mowed areas, 245 m, 21.172906, -157.056016, 27 Dec 2022, *K. Faccenda & C. Daehler 2930. HAWAI'I (Questionable record):* Ka'ū, Kahuku, Kahuku Ranch, rare local patch in dry pasture, 1500 ft [457 m], 29 Sep 1950, *E.Y. Hosaka 3615*.

***Chloris gayana* Kunth****New island record**

*Chloris gayana*, previously reported on Ni'ihau, O'ahu, Moloka'i, Lāna'i, Maui, and Hawai'i (Imada 2019), is now also known from Kaua'i. It was found in two spots around Kalāheo in weedy situations.

*Material examined. KAUA'I:* Kalāheo, National Tropical Botanical Garden off of Papalina Rd, weedy area near powerline outside of headquarters building, full sun, rare, only 2–3 plants seen, 113 m, 21.906012, -159.511124, 29 May 2022, *K. Faccenda 2384*; Kalāheo, Pu'u Rd about 0.5 km S of Pu'u Lani Pl., roadside weed, sunny dry area on poor soil on side of road, small colony seen only in this area, 187 m, 21.916021, -159.535793, 02 Jun 2022, *K. Faccenda 2452*.

***Chloris pycnothrix* Trin.****New state record**

An unusual *Chloris* was found by Mike Ross (Kapi'olani Community College) growing out of the gutter on the side of the road while botanizing at the Mililani Mauka Park. He then uploaded photos of the grass to inaturalist.org, where they struck the author as strange due to their inflorescence with two whorls of inflorescence branches (Fig. 5), a character not seen on the common *Chloris divaricata*. Subsequently, a specimen was made and the floret anatomy proved that it could not be *Chloris divaricata*, as the sterile lemma was too short and not bilobed. Using the keys in Pope (1999) and Clayton *et al.* (1974), this grass was identified as *Chloris pycnothrix*. All material at BISH and HAW was examined and no



further material was found. Further populations were found on Kunia Rd. and Wahiawa District Park; each population was rather small, consisting of less than 30 plants.

*Chloris pycnothrix* is native to Africa (Pope 1999) and South America (Molina & Agrasar 2004) and has previously been introduced in Central America, India, China, and Japan (POWO 2023). It is a common weed of disturbed ground in its native range (Pope 1999). It is very similar to *Chloris divaricata*, but can be distinguished by the sterile lemma being <0.7 mm and very shallowly bilobed (compared to >1 mm and strongly bilobed in *C. divaricata*). These two species are not distinguishable without microscopic examination of the sterile lemmas. A key to *Chloris* in Hawai‘i has been prepared to aid in the identification of this grass.



**Figure 5.** *Chloris pycnothrix* seen at Mililani Mauka Park. The two-whorled inflorescence is atypical as most plants only have one whorl.

The following description is from Flora Zambesiaca (Pope 1999: 210):

“Annual up to 45 cm tall, erect or geniculately ascending, often rooting from the nodes; leaf sheaths keeled; leaf laminas 3–11 cm × 3–5 mm, abruptly obtuse at the apex. Inflorescence of 3–12 digitate or subdigitate racemes 1.5–7 cm long. Spikelets 2-flowered, 1–2-awned; inferior glume 1.3–1.4 mm long; superior glume 2–2.4 mm long; floret callus rounded; fertile lemma 2.4–2.8 mm long, narrowly elliptic in profile, pallid, scabrid on the margins, keel and flanks, the awn 11–27 mm long; 2nd lemma 0.1–1 mm long, borne upon an internode 2–3 mm long, awnless or with an awn up to 8 mm long.”

*Material examined.* O‘AHU: Kunia Rd, about 500 m S of NSA facility, roadside in sunny dry area, common in area, 309 m, 21.471126, -158.053058, 18 Jan 2023, *K. Faccenda 3007*; Mililani, Ukuwai St on E side of Mililani Mauka Park, from accumulated leaves and detritus next to curb, on road in moist sunny area, 231 m, 21.470629, -158.005759, 08 Dec 2022, *K. Faccenda & M.C. Ross 2865*; Wahiawā, Wahiawā District Park, at base of stadium lights, weed in mowed lawn, sunny, moist, uncommon, only one clump of ca. 30 plants seen, leaves blunt at tip, stoloniferous, 282 m, 21.499531, -158.022974, 20 Feb 2023, *K. Faccenda & M.C. Ross 3045*.

KEY TO *CHLORIS* IN HAWAII

*Eustachys petraea* has been reported on Midway Island and is easily confused with *Chloris*, and is therefore also included in this key.

1. Florets with 3 awns approximately equal in length, these awns all pointing in different directions; sterile florets inflated ..... *C. barbata*
- 1'. Florets with 0–3 awns, progressively reduced in length, these awns aligned with the axis of the inflorescence branch; sterile florets not inflated
  2. Florets lacking awns or with awns up to 6 mm; florets 2–3; rather robust perennials up to 300 cm tall
    3. Upper glume acute; awns up to 6 mm or absent ..... *C. gayana*
    - 3'. Upper glume bilobed; awns up to 1.2 mm or absent [easily confused with *Chloris*, currently only known from Midway] ..... *Eustachys petraea*
  - 2'. Florets with awns 4–25 mm long; florets 2; annual or perennial, rarely surpassing 50 cm tall
    4. Lowest lemma with dense tuft of hairs 2–3 mm long at its apex; panicle branches usually held closely together and erect ..... *C. virgata*
    - 4'. Lowest lemma with short hairs <1 mm or glabrous; panicle branches usually spreading
      5. First sterile lemma truncate ..... *C. truncata*
      - 5'. First sterile lemma not truncate
        6. First sterile lemma >1 mm long, bilobed for ¼–½ its length; panicle with 3–9 branches, all branches typically from one whorl, rarely plants are seen with a single branch arising below the main whorl ..... *C. divaricata*
        - 6'. First sterile lemma minute, <0.7 mm, scarcely bilobed; panicle with 3–15 branches, branches from 1–4 whorls
          7. Panicle branches 3–12, divergent, from 1 or 2 whorls; fertile lemma 2–2.5 mm long, lacking tuft of hairs ..... *C. pycnothrix*
          - 7'. Panicle branches 5–15, ascending, from 2–4 whorls; fertile lemma 2.5–3.3 mm long, often with a tuft of hairs at its apex ..... *C. radiata*

***Cortaderia selloana*** (Schult. & Schult. f.)

Asch. &amp; Graebn.

**New island record**

*Cortaderia selloana* was previously reported as naturalized on Maui by Loope & Medeiros (1992); however, they did not cite a voucher, leading to their report being considered unconfirmed by Imada (2019). However, specimens had been made and stored at PTBG. Vouchers are reported below, confirming that the species is naturalized on Maui. This species is an eradication target of the Maui Invasive Species Committee (MISC), and all wild plants should be reported to them for control. Over the past 20 years, 144 wild plants have been killed by MISC (Brooke Mahnken, pers. comm.).

*Material examined.* MAUI: Crater Rd, through Haleakalā Ranch on road embankment (vertical cliff of dirt), plants about 9 ft tall, sparingly naturalized, 1676 m, 19 Oct 1989, *B. Gagne & R. Hart s.n.* (PTBG 006659); Kula [precise locality redacted], cultivated and spreading into adjacent feral lands, soon to be killed by MISC, grass to 3 m tall, clumps up to 2 m wide, leaves sharp on margins, 1020 m, 24 Oct 2022, *K. Faccenda 2780*.

*Cynodon aethiopicus* Clayton &

J.R. Harlan

**Correction**

*Cynodon aethiopicus* is no longer known from O‘ahu as the specimens published by Herbst & Clayton (1998) have been redetermined to be *Cynodon dactylon*. *Cynodon aethiopicus* is now known to be naturalized only on Maui, Kaho‘olawe and Hawai‘i (Imada 2019; Faccenda 2022).

*Dichanthium annulatum* (Forssk.) Stapfvar. *annulatum***New state record**

No infraspecific taxa of *Dichanthium annulatum* have previously been recognized as occurring in Hawai‘i, but examination of specimens at BISH showed two distinct forms of this grass exist on the islands, one with acutely tipped, lanceolate lower glumes (*D. annulatum* var. *annulatum*) and another with bluntly tipped, obovate to oblong glumes (*D. annulatum* var. *papillosum*). These varieties also differ in their pubescence, as var. *papillosum* has papillose-based hairs on its lower glume, whereas var. *annulatum* lacks papillose-based hairs on its glumes.

These two varieties of *D. annulatum* have been extensively studied in cytological and breeding studies (e.g., Singh *et al.* 1962; Mehra 1964; Singh & Mehra 1965). The varieties form a polyploid series, with var. *annulatum* (referred to as both the Mediterranean and tropical type) having 20 or 40 chromosomes, whereas var. *papillosum* (referred to as the South African type) has 60 (Mehra 1964). Breeding studies have shown that *D. a.* var. *papillosum* can be created artificially via crosses of plants that would be classified as *D. a.* var. *annulatum*, and that the two varieties can hybridize (Mehra 1964).

It is unclear how *D. a.* var. *annulatum* arrived in Hawai‘i, as there are no records of its importation, nor specimens made from introduction gardens. As there is no evidence of intentional introduction, it may have been of accidental introduction. Ecological studies rarely report which variety of *D. annulatum* was encountered, making it difficult to compare the ecology of the two varieties.

*Material examined.* **KAUA‘I:** Port Allen, Waialo Rd just S of Rt 50, roadside, dry sunny area, several plants seen, generally uncommon in this area, 17 m, 21.903582, -159.585211, 03 Jun 2022, *K. Faccenda 2475*; Ninini Point road running along edge of Līhu‘e Airport, roadside weed, sunny dry area, common, also seen inside airport, 45 m, 21.971297, -159.352440, 29 May 2022, *K. Faccenda 2418*. **O‘AHU:** Honolulu, Ko‘olau summit, Air Defense Nike Site 3-4 Kamehame Ridge, growing in lawns and along sides of buildings at lower installation, 1100 ft [335 m], 08 Nov 1976, *K.M. Nagata 1409*; Honolulu, Pi‘ikoi St and Kinau St, roadside weed from crack in sidewalk, abundant weed in urban Honolulu from cracks in sidewalks, 7 m, 21.302409, -157.842954, 08 Apr 2022, *K. Faccenda 2357*; Lunalilo St and Ke‘eaumoku St, weedy roadside in area not recently mowed or sprayed, common in sunny areas, 21.302643, -157.838358, 01 Dec 2020, *K. Faccenda 1698*. **MOLOKA‘I:** Ho‘olehua Airport, mixed grassland or open field, ascending perennial grass 0.5 m tall, naturalized in lawns, fields, roadsides, occasional, 24 Feb 1992, *G.D. Hughes 24*; Airport, edge of wetland on side of airport road, perennial grass, frequent along roadside, 08 Feb 2005, *M.L. Wysong 608*; near airport, Apr 1977, *R.W. Hobdy s.n.* (BISH 768175). **MAUI:** East Maui, ‘Ulupalakua, 1500 ft [457 m], 18 Jan 1976, *J. Resnick 346* (HAW); West Maui, Wailuku Distr, Kahului, weed in roadway medial strip, 20 ft [6 m], 20°53’17”N, 156°28’02”W, 02 July 2001, *H. Oppenheimer H70101* (PTBG); East Maui, S side of Kahului Airport, roadside, 01 Dec 1995, *R. Hobdy 3911*. **KAHO‘OLAWA:** Lua Makika, N rim, side of road, windswept shrub/grassland, hardpan substrate, 20°33’N, 156°34’W, 1450 ft [440 m], 30 Jul 2003, *F. Starr 030730-1*. **HAWAI‘I:** Ka‘ū, Kahuku, Kahuku Ranch, rare, local patch in dry pasture, 1800 ft [548 m], 29 Sep 1950, *E.Y. Hosaka 3614*.

***Dichanthium annulatum* var. *papillosum***

(A. Rich.) de Wet &amp; Harlan

**New state record**

*Dichanthium annulatum* var. *papillosum* is now known in Hawai'i from O'ahu, Moloka'i, Maui, and Hawai'i. It was an intentional introduction, as the first specimen was collected at an agricultural experiment station. See further discussion under *Dichanthium annulatum* var. *annulatum*.

*Material examined.* **O'AHU:** Honolulu, Pensacola St, along roadside near Experiment Station, 06 Jun 1940, *E.Y. Hosaka 2525*; Honolulu, Pensacola St, Hawaii Agri[cultural] experimental station, weed in cultivated field, 23 Oct 1940, *R. Wong s.n.* (BISH 785796); H.A.E.S. [Hawaii Agricultural Experimental Station], Pensacola St, 24 Jul 1931, *W.C. Davis s.n.* (BISH 785797); Honolulu, Pi'ikoi St and Kinau St, roadside weed from crack in sidewalk, uncommon, in close proximity to the much more common *Dichanthium annulatum* var. *annulatum*, 8 m, 21.302901, -157.842723, 08 Apr 2022, *K. Faccenda 2356*; Between Honolulu and Hawai'i Kai, intersection of Rt 72 and Laukani St, strip of grass between road and sidewalk, seemingly irrigated area, one patch seen, 5 m, 21.277287, -157.772162, 14 May 2022, *K. Faccenda 2368*. **MOLOKA'I:** Moloka'i Ranch, Mo'omomi, 200 m, 23 Mar 1992, *G. Hughes 317* (US); Mākoaleau, *Bidens menziesii*-*Dodonaea* shrublands, occasional grass growing in small tufts, naturalized weed in pastures as shrublands, 750 m, 16 Mar 1992, *G.D. Hughes 31*; Western end of island, Ahiu Rd about 1 km from Kalua Ko'i Rd, roadside weed, very sunny and dry area, one flowering culm seen in this area, 58 m, 21.163777, -157.246504, 26 Dec 2022, *K. Faccenda 2898*; Rt 450, ca. 7 km E of Kaunakakai near intersection with 'Uluunui Rd, roadside weed in sunny, dry area, rare, only 10 plants seen in this area, 20 m, 21.066772, -156.953600, 30 Dec 2022, *K. Faccenda 2974*. **MAUI:** West Maui, Lāhainā Distr, Hanaka'ō'ō, near old Ka'anapali Airport, 20°56'N, -156°41'W, ca. sea level, 29 May 2000, *H. Oppenheimer H40028*. **HAWAII:** Ka'ū, Pakini Iki, Ka'alu'alu Ranch, occasional in local patch in pasture, good growth, 1000 ft [304 m], 24 Feb 1950, *E.Y. Hosaka s.n.* (BISH 786738).

***Dichanthium caricosum* (L.) A. Camus****New state record**

*Dichanthium caricosum* was found by Mike Ross growing at the Ka Iwi shoreline, where approximately 200 plants were found growing along a trail in an area otherwise dominated by *Cenchrus ciliaris*. This grass is morphologically identical to *Dichanthium aristatum* except that the latter has a hairy peduncle, while *D. caricosum* has a glabrous peduncle. A colony of *Dichanthium aristatum* was also seen within 300 m of the *D. caricosum* colony at Ka Iwi, but the two colonies did not overlap geographically. Some authors have suggested that *D. aristatum* is simply a hairy form of *D. caricosum* (Lakshminarasimhan 1996; Wu *et al.* 2006), but cytological and hybridization experiments by de Wet & Harlan (1968) suggest they are distinct species. *Dichanthium caricosum* is native from India through Southeast Asia but has been introduced in scattered areas across the tropics (POWO 2023).

*Material examined.* **O'AHU:** Ka Iwi Shoreline Trail, growing in full sun in a very dry, open grassy area dominated by *Cenchrus ciliaris*, ca. 50–60 plants seen, <3m, 21.175404, -157.392386, 09 Feb 2023, *M.C. Ross 1887*; Ka Iwi shoreline, about 100 m E of the small beach, ca. 200 plants, 1 m, 21.298514, -157.656283, 07 Apr 2023, *K. Faccenda & M. Ross 3093*

***Dichanthium tenue* (R. Br.) A. Camus****New island record**

*Dichanthium tenue* is now known to be naturalized on Hawai'i Island based on specimens from HAVO collected south of the park along Hwy 11. *Dichanthium tenue* was formerly known to be adventive on Hawai'i Island (O'Connor 1990). It is now known from O'ahu, Maui, Hawai'i, and questionable on Ni'ihau (Imada 2019).

*Material examined.* **HAWAII:** Hawaii Volcanoes National Park, Ka'ū Distr, Ke'āmuku Lava Flow near Hwy 11, bunchgrass scattered on ash in *Metrosideros*/native

shrub scrub, ca. 3200 ft [957 m], 03 Jun 1985, *L.W. Cuddihy 1993* (HAVO); Hwy 11 west of Hawaii Volcanoes National Park on edge of Kapāpala Ranch, Ka'ū Distr (mile 43–44), disturbed area on side of highway, bunchgrass with dark brown awns, 700 m, 29 May 2001, *K. Bio 1-10-02* (HAVO).

COMBINED KEY TO *BOTHRIOCHLOA*, *CAPILLIPEDIUM*, AND *DICHANTHIUM* IN HAWAI'I

This key is designed to minimize reliance on one specific, difficult characteristic: the translucent medial groove of the pedicel. The presence of this groove defines the difference between *Dichanthium* and the other genera. The groove is present in *Bothriochloa* and *Capillipedium*, but not *Dichanthium*. Examining plants for this character can be very difficult and postponing its use until late in the key should help to make this group more approachable. Molecular evidence also suggests that these genera are artificial and further justifies inclusion of all these genera in one key (Sumadijaya 2015).

Examination of a specimen for a translucent medial groove is best done using a dried specimen as it tends to make the groove more visible, but can still be done on fresh material. The specimen should be placed under strong magnification, ideally dissecting scope at 20–40×. It is sometimes possible to locate the groove using a 10× hand lens, but is *very* difficult, in the author's experience. The easiest way to find the groove is to use forceps and tear away a pedicellate spikelet, taking care to grab it at the base of the pedicel. Once it is extracted, the groove (if present) will be visible running through the middle. The groove may not be truly translucent and it is often more red or purple than the edges of the pedicel. The groove will be visible from both faces of the pedicel. If a very fine needle is at hand (the author uses a 1RL tattoo needle for this task), it is possible to puncture the translucent medial line and easily split the pedicel in two down its length (at least in all specimens examined by the author). The groove can also be seen on the rame internodes (axis of the raceme of spikelets; the structures that connect the spikelet pairs) but is easiest to observe on the pedicels of the pedicellate spikelets. In *Dichanthium* the pedicels and rame internodes are typically convex with no groove, but in *Bothriochloa* and *Capillipedium* they tend to be shaped more like a compressed serifed "I" in cross section, since the groove acts as a depression on both sides.

- 1. Racemes of spikelets with less than 8 spikelets each; panicle loosely branched with many secondary branches ..... *Capillipedium spicigerum*
- 1'. Racemes of spikelets with >8 spikelets each; panicle uncommonly with secondary branches
  - 2. Glumes pitted
    - 3. Axis of inflorescence longer than or equalling length of lowest panicle branch ..... *Bothriochloa bladhii* (in part)
    - 3'. Axis of inflorescence shorter than lowest panicle branch
      - 4. Pedicellate spikelets reduced in width compared to sessile spikelets; pedicellate spikelets lacking a pit; sessile florets 4.75–7.00 mm long; panicle branches usually held stiffly erect and parallel to inflorescence axis ..... *Bothriochloa macra* (in part)
      - 4'. Pedicellate spikelets generally similar to sessile spikelets, occasionally slightly reduced; pedicellate spikelets with or without a pit; sessile florets 3–4 mm long; panicle branches usually held weakly erect to strongly divergent from inflorescence axis ..... *Bothriochloa pertusa*

- 2'. Glumes not pitted
5. Pedicellate spikelets reduced in width compared to sessile spikelets
6. Hairs of inflorescence <2 mm, not obscuring florets; panicles reddish or whitish when mature
7. Spikelets 4.75–7.00 mm long; axis of inflorescence shorter than lowest panicle branch ..... *Bothriochloa macra* (in part)
- 7'. Spikelets 3.0–4.5 mm long; axis of inflorescence longer than or equalling length of lowest panicle branch ..... *Bothriochloa bladhii* (in part)
- 6'. Hairs of inflorescence >4 mm long, obscuring florets; panicles whitish when mature
8. Sessile spikelets 4.5–7.3 mm long; nodes pubescent .....  
..... *Bothriochloa barbinodis*
- 8'. Sessile spikelets 2.5–4.5 mm long; nodes glabrous [questionably naturalized as of 2023] ..... *Bothriochloa laguroides*
- 5'. Pedicellate spikelets similar in width compared to sessile spikelets
9. Lower glume apex blunt, obtuse, or rounded; lower glume typically oblong or obovate
10. Peduncle of inflorescence pubescent just below inflorescence .....  
..... *Dichanthium aristatum*
- 10'. Peduncle of inflorescence glabrous
11. Glumes nearly glabrous to shortly pubescent, hairs <1 mm, uniformly covering glumes ..... *Dichanthium caricosum*
- 11'. Glumes with hairs 1–4 mm long, concentrated towards edges
12. Hairs of glumes 4 mm or longer, partially obscuring florets, hairs not papillose-based; inflorescence branches umbellate or with inconspicuous internodes ..... *Dichanthium sericeum*
- 12'. Hairs of glumes 2 mm or less, not obscuring florets, hairs usually papillose-based around edge of glume; inflorescence branches separated .....  
..... *Dichanthium annulatum* var. *papillosum*
- 9'. Lower glume apex acute; lower glume typically lanceolate, elliptic, or obovate
13. Glumes entirely glabrous ..... *Dichanthium tenue*
- 13'. Glumes with at least some hairs
14. Pedicles of pedicellate spikelets lacking a translucent medial line (see key caption) ..... *Dichanthium annulatum* var. *annulatum*
- 14'. Pedicles of pedicellate spikelets with a translucent medial line
15. Axis of inflorescence longer than or equalling length of lowest panicle branch ..... *Bothriochloa bladhii* (in part)
- 15'. Axis of inflorescence shorter than lowest panicle branch .....  
..... *Bothriochloa ischaemum*

***Digitaria abyssinica*** (Hochst.)

ex A. Rich.) Stapf

**Correction**

Most specimens of *Digitaria abyssinica* from the Hawaiian Islands have been redetermined to *Digitaria scalarum* (see notes under that species). As such, *Digitaria abyssinica* is now known to occur only on Maui in the vicinity of Olinda at Waihou Spring

Forest Reserve, and a small colony on Kauaʻi at Kōkeʻe. No populations are currently known from Oʻahu.

***Digitaria bicornis* (Lam.) Roem. & Schult.      New island records**

During roadside surveys on Molokaʻi, a single plant of *Digitaria bicornis* was found on Mahalo Pl. in Kaunakakai growing as a weed in the yard of a residence. A population of between 100–200 plants was also found on Oʻahu on the edge of the University of Hawaiʻi West Oʻahu campus. *Digitaria bicornis* is now known to be naturalized on Lehua, Kauaʻi, Oʻahu, Molokaʻi, and Maui (Faccenda 2022).

*Material examined.* OʻAHU: E end of University of Hawaiʻi West Oʻahu campus, open, weedy, undeveloped area, full sun, dry, 100–200 plants here, population about 10 m diam., 21.358237, -158.054490, 13 Mar 2023, K. Faccenda & M.C. Ross 3068. MOLOKAʻI: Kaunakakai, Mahalo Pl. at end of road, outside house in unmaintained area, rather sunny and somewhat moist, only one plant seen in this area, but area only surveyed very briefly, 21 m, 21.096027, -157.023016, 30 Dec 2022, K. Faccenda 2977.

***Digitaria ciliaris* (Retz.) Koeler      Correction**

*Digitaria ciliaris* is no longer known to occur on French Frigate Shoals or Kure Atoll, as all specimens formerly identified as *D. ciliaris* from those islands have been reidentified to *Digitaria henryi*. *Digitaria ciliaris* is now known from all the main islands and Midway (Imada 2019).

***Digitaria didactyla* Willd.      New state record**

*Digitaria didactyla* is now known to be naturalized in Hawaiʻi, where it has appeared as a weed in mowed lawns on both Kauaʻi and Hawaiʻi. The population on Hawaiʻi Island was found growing in a narrow strip of grass along the edge of a parking lot in Waiākea, along with another population outside of Waiākea Elementary School. Another population was also discovered by a turf manager at the Kukuiula and Puakea golf courses on Kauaʻi, where it was growing as an unsightly weed in a putting green planted with *Paspalum distichum*.

*Digitaria didactyla* was intentionally introduced to Hawaiʻi at least four times between 1916 and 1964, according to the Hawaiʻi Agricultural Experiment Station accession list (HAES n.d.), presumably to be trialed as a forage species. *Digitaria didactyla* is native to Madagascar, Mozambique, and other islands in the Indian Ocean (POWO 2023). It has been introduced to scattered localities across the tropics for use as both a lawn grass and pasture grass (Loch *et al.* 2013).

The common name for this species is Blue Couch, due to the bluish tinge often present in its leaves. This grass typically has two or three inflorescence branches, but does not have any easy single characters to differentiate it from other Hawaiian *Digitaria* species; identification is best done using the key below. This species may also be confused with *Paspalum distichum*, as they both typically have two inflorescence branches and similar stoloniferous habit, but differ in spikelet size, along with *P. distichum* lacking a lower glume and *D. didactyla* having one.

The following description is taken from Barkworth *et al.* (2003: 376):

“Plants perennial; stoloniferous and rhizomatous, mat-forming. Culms 15–40(63) cm, rooting and branching from the lower nodes. Sheaths densely to sparsely hairy, with 3–5 mm papillose-based hairs; ligules 1–1.5 mm; blades 2.5–7 cm long, 1–3

mm wide, flat or folded, usually glabrous, green to bluish-green. Panicles with 2–4 spikelike primary branches digitately arranged; primary branches 2–7 cm, axes wing-margined, wings at least 1/2 as wide as the midribs, spikelets somewhat imbricate, in unequally pedicellate pairs; secondary branches rarely present; pedicels not adnate to the branches; shorter pedicels 1–1.5 mm; longer pedicels 2–3 mm; axillary panicles not present. Spikelets homomorphic, 2–2.8 mm long, about 0.8 mm wide. Lower glumes to 0.3 mm, triangular; upper glumes from 1/2–3/4 as long as the spikelets, 3-veined, pilose on the margins and sometimes between the veins; upper lemmas equaling the spikelets, prominently 7-veined, veins equally spaced, margins and sometimes the intercostal regions pilose, hairs 0.3–0.5 mm; upper lemmas slightly shorter than the lower lemmas, almost smooth, gray, sometimes purple-tinged, at maturity. 2n = unknown.”

*Material examined.* **KAUAI:** Koloa, The Club at Kukui‘ula, weed in ‘Seadwarf’ seashore *Paspalum* turf, 18 Aug 2022, *G. Araki s.n.* (BISH 788657). **HAWAII:** Hilo, shopping center at Mamalahoa Hwy and East Kahaopea St, weed in mowed grass on edge of parking lot, leaves bluish glaucous, glabrous, stoloniferous, two small patches observed about 1 m wide each in a lawn otherwise consisting of *Axonopus* sp., 35 m, 19.692136, -155.066703, 07 Aug 2022, *K. Faccenda 2590.*

### *Digitaria henryi* Rendle

### New state record

*Digitaria henryi* was synonymized with *D. ciliaris* by Veldkamp (1973), who stated: “Another small form [of *Digitaria ciliaris*] with a  $\pm$ persistently contracted panicle has been described as *D. henryi* (but the racemes may become spreading!). Except for this feature I can not find any other morphological difference.”

However, during my fieldwork and examination of the Hawaiian *Digitaria* I was unable to reach the same conclusions as Veldkamp and found many features reliably separating these species. The species differ in spikelet length, panicle branch length, and presence of hairs on the leaf sheaths. Photographs of the type specimens of both species were also examined to confirm that they matched Hawaiian material. Furthermore, no material was found during the course of this work that could be considered intermediate between the two species. Based on this I am treating *D. henryi* as a valid species and following the taxonomy of authors from the native range of *Digitaria henryi* who never accepted its synonymization (Huang 2000; Wu *et al.* 2006).

The differences observed between *D. ciliaris* and *D. henryi* include a difference in leaf sheath pubescence, spikelet lengths, panicle lengths, and panicle structure. All information recorded below was based on observation of material from Hawai‘i. Approximately 20 measurements were made per trait per species; variation is reported in units of standard deviation. *Digitaria ciliaris* has consistently ciliate leaf sheaths, spikelets ranging from 2.5–3.5 mm long (average  $2.85 \pm 0.31$ ), panicles ranging from 5–17 cm long (average  $10 \pm 3.2$ ), panicle branches held perpendicularly or slightly ascending, and pubescent lowest node of the panicle. *Digitaria henryi* has consistently glabrous sheaths, spikelets ranging from 2.1–2.7 mm long (average  $2.48 \pm 0.12$ ), panicles ranging from 2–9 cm long (average  $5 \pm 1.8$ ), panicle branches strongly ascending and held closely together, and glabrous lowest node of the panicle.

*Digitaria henryi* was first collected in Hawai‘i in 1923 on Maui and has since been documented on Kure, Midway, French Frigate Shoals, Kaua‘i, O‘ahu, Moloka‘i, Lāna‘i, Maui, Kaho‘olawe, and Hawai‘i. At the time of its introduction in Hawai‘i, it was immediately recognized as a different species from *D. ciliaris* (Whitney 1937) and was



synonymized only after the publication of Veldkamp's 1973 treatment of *Digitaria*. As over 70 specimens of this grass exist from Hawai'i, only the earliest record for each island is cited below. Recent fieldwork has shown that *D. henryi* is currently widespread on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i at low elevations and is expected to be similarly widespread on the other islands.

The following description is from the Flora of China (Wu *et al.* 2006: 543):

“Perennial. Culms tufted, slender, prostrate, often rooting at lower nodes, 20–50 cm tall. Leaf sheaths glabrous; leaf blades narrowly lanceolate, 3–8 × 0.2–0.5 cm, glabrous or sparingly hispid near base, apex acute; ligule 1–2 mm. Inflorescence subdigitate, axis short; racemes 3–9, erect and clustered, never divergent, 4–8 cm; spikelets paired; rachis flat, winged ca. 0.5 mm broad, margins scaberulous. Spikelets lanceolate, 2.2–2.8 mm, acuminate; lower glume ca. 0.2 mm; upper glume lanceolate, 1/2 as long as spikelet, 3-veined, pilose; lower lemma slightly longer than upper lemma, 7-veined with broader intervein spaces flanking the midvein, pilose along lateral intervein spaces and margins; upper lemma yellowish green to gray, apex acute. Fl. and fr. summer–autumn.  $2n = 36$ .”

*Material examined.* **KURE:** Green Island, used as lawn around quarters, also in a few open places throughout island, on beach near pier, 14 Aug 1964, *C.H. Lamoureux 2777*. **MIDWAY:** Sand Island, common roadside weed, 19 Jun 1980, *D. Herbst 6346*. **FRENCH FRIGATE SHOALS:** Tern Island, common, especially along edges of runway, 31 Aug 1968, *D. Herbst 1211*. **KAUAI:** PTBG [Pacific Tropical Botanical Garden], Lāwa'i Valley, occasional in valley, 26 Jan 1972, *D. Herbst 2335*. **O'AHU:** East Mānoa Rd, 25 Feb 1930, *O.H. Swezey s.n.* (BISH 118607). **MOLOKA'I:** Top of Mauna Loa, 03 Sep 1936, *L.D. Whitney 4228*. **LĀNA'I:** Lālākoa, 13 Apr 1928, *G.C. Munro 314a*. **MAUI:** Hiku, 1923, *G.C. Munro 516*. **KAHO'OLAWA:** Northeastern part of island between Lua Makika and Lua Keālia Luna, 1300 ft [396 m], 24 Apr 1980, *L.W. Cuddihy 397*. **HAWAI'I:** north of Ka'ahola Lighthouse, Hāwī, growing on soil near ocean, 08 Feb 1952, *O. Degener 21807*.

### *Digitaria longiflora* (Retz.) Pers.

### New state record

*Digitaria longiflora* was found during roadside surveys on O'ahu, where only a single plant was found growing in Whitmore Village. This area we resurveyed several months after the original collection and no more plants were found, suggesting there is no population established at Whitmore. This species is still published as a full naturalization as it is possible that this was a satellite population of a yet-undiscovered source population. *Digitaria longiflora* has previously been erroneously reported to occur in Hawai'i by Hitchcock (1922), Rotar (1968), & St. John (1973), but these were based on misidentifications of *D. violascens*. *Digitaria longiflora* has stolons and light brown fertile lemmas at maturity, whereas *D. violascens* is caespitose and has fertile lemmas that are very dark purple and sometimes approaching black.

*Digitaria longiflora* is native to Africa, Southeast Asia, and Malesia, and has become naturalized in Florida and much of South and Central America (POWO 2023). In its introduced range it grows in grasslands, field margins, and weedy places (Wu *et al.* 2006). *Digitaria longiflora* is very similar to *D. fuscescens*, as the species differ only based on presence of hairs on the floret (present in *D. longiflora*, absent in *D. fuscescens*). It is possible they could be considered the same species (Wu *et al.* 2006; Cope 1982), but most authors currently consider them distinct (Veldkamp 1973; Wu *et al.* 2006; Boonsuk *et al.* 2016).

The following description is taken from Barkworth *et al.* (2003: 370):

“Plants of indefinite duration; stoloniferous, stolons long and branching. Culms 10–60 cm, occasionally branching from the lower nodes. Leaves 3–4, clustered near the base; sheaths usually glabrous; ligules 0.5–1 mm; blades 1.5–4 cm long, 3–5 mm wide, mostly glabrous, bases subcordate and ciliate, with 0.6–1 mm papillose-based hairs. Panicles with 2(–4) spike-like primary branches, digitate; primary branches 2–5 cm, strongly divergent; branch axes about 1 mm wide, wing-margined, wings wider than the central midribs, bearing spikelets in unequally pedicellate groups of 3; secondary branches rarely present; shortest pedicels about 0.3 mm; middle pedicels about 1 mm; longest pedicels 1.5–2 mm, adnate to the branch axes basally; axillary panicles not present. Spikelets 1.2–1.5 mm, elliptic or slightly obovate, acute. Lower glumes absent; upper glumes equaling or almost equaling the spikelets, 5-veined, minutely pubescent between the veins and on the margins; lower lemmas subequal to the upper glumes, 7-veined, usually pubescent on the margins and lateral veins, occasionally glabrous, hairs, if present, 0.2–0.4 mm; upper lemmas about 1.2 mm, pale brown or pale gray, becoming light brown at maturity, acute; anthers 0.8–0.8 mm.  $2n = 18$ .”

*Material examined.* OAHU: Whitmore Village, Ahae Ave and Ehoeho Ave, from crack in pavement in shady area, only one plant seen, with stolons, mature lemmas yellow, 309 m, 21.511494, -158.020323, 18 Jan 2023, K. Faccenda 3008.

***Digitaria mollicoma* (Kunth) Henrard**

**New state record**

*Digitaria mollicoma* is now known from Hawai‘i Island, where it was found naturalized on the edge of a parking lot in Waiākea. Only one small colony less than one meter wide was seen mixed with *Axonopus compressus*, *Cynodon dactylon*, *Digitaria didactyla*, and *D. fuscescens*. It is likely this grass is more widespread around Hilo, but it is very easily overlooked due to its small size.

*Digitaria mollicoma* is native to Southeast Asia including most countries between China, Indonesia, and the Philippines (Boonsuk *et al.* 2016). This is the first report of this species outside of its native range. *Digitaria mollicoma* is most similar to *D. fuscescens* but has visibly hairy florets and sheaths, whereas these structures on *D. fuscescens* are glabrous or nearly so (Boonsuk *et al.* 2016). It is also similar to *D. longiflora*, but differs as *D. longiflora* has glabrous leaf sheaths and smaller florets.

The following description is taken from Boonsuk *et al.* (2016: 262):

“Annual or perennial. Culms decumbent and creeping, 30–40 cm high; nodes pilose. Sheaths 1.2–3 cm long, densely pilose. Ligules 1–1.2 mm long. Blades linear to lanceolate, 2–5.5 cm by 3–5 mm, chartaceous, both surfaces densely pilose, apex acute. Inflorescences composed of racemes; peduncles glabrous; common axis absent. Racemes 2–3, longest 5–7.5 cm long, digitate; rachis ribbon-like, winged, margins serrulate, 0.7–0.8 mm wide. Pedicels terete to trigonous, glabrous; abscission discoid to cupuliform. Spikelets ternate, homomorphous, lanceolate, 2.1–2.3 long, apex acute; hairs smooth or verrucose with acute apex. Lower glume 0.1–0.2 mm long, membranous. Upper glume elliptic to slightly lanceolate, 1.9–2 mm long, chartaceous, apex acute, pubescent between nerves but with glabrous interspaces beside the midnerve or pubescent only on the margins, nerves 3. Lower lemma lanceolate, as long as the spikelet, chartaceous, apex acute, pubescent with glabrous interspaces beside the midnerve or pubescent only on the margins, nerves 7, equidistant. Upper lemma lanceolate, 2–2.1 mm long, coriaceous, apex acute or apiculate, yellowish. Anthers 0.6–0.8 mm long, yellowish. Caryopsis ellipsoid, 0.9–1 mm long, yellowish.”

*Material examined.* **HAWAII:** Hilo, shopping center at Mamalahoa Hwy and East Kahaopea St, weed in mowed grass on edge of parking lot, 34 m, 19.692284, -155.066719, 07 Aug 2022, K. Faccenda 2591.

***Digitaria nuda*** Schumach.

**Questionable new island record**

A single individual of *Digitaria nuda* was found growing in a flower bed at the Wavecrest Resort on Moloka'i, where it was likely introduced as a contaminant in nursery stock. As only a single plant was found, and it was a weed in a flower bed, this record should be treated as a questionable naturalization until *D. nuda* can be found growing in a more natural context or as part of a larger population. *Digitaria nuda* is now known to be naturalized on Kure Atoll, Kaua'i, O'ahu, Lāna'i, Maui, Kaho'olawe, and Hawai'i (Faccenda 2022), and questionably naturalized on Moloka'i.

*Material examined.* **MOLOKA'I:** 'Ualapu'e, Wavecrest Resort, weed in garden bed at resort on edge of parking lot, one plant seen in shady, irrigated area, 11 m, 21.054531, -156.840664, 30 Dec 2022, K. Faccenda 2969.

***Digitaria radicata*** (J. Presl) Miq.

**New island record**

*Digitaria radicata* is now known to be naturalized on Moloka'i, where a small colony of ca. 5 plants was found on a roadside near 'Ualapu'e. *Digitaria radicata* is now known from Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i (Imada & Kennedy 2020).

*Material examined.* **MOLOKA'I:** Rt 450, ca. 1 km E of 'Ualapu'e, roadside weed in partly sunny, moist area, rare along the road, only this one colony seen, about 1 m in diam. mixed with *Axonopus* and other weeds, 11 m, 21.065705, -156.822280, 29 Dec 2022, K. Faccenda 2944.

***Digitaria scalarum*** (Schweinf.) Chiov.

**New state record**

Critical examination of herbarium specimens identified as *Digitaria abyssinica* has revealed two distinct phenotypes: one with wide, hairy leaves, and another with narrow, largely glabrous leaves. Further research into the African *Digitaria* literature revealed that the narrow-leaved plants are best treated as *D. scalarum*. *Digitaria scalarum* was formerly synonymized with *D. abyssinica* based on the similarity of their florets (Clayton & Renvoize 1982), but more recent work supports them being treated as separate species that do not overlap in their morphology (Goetghebeur & Van der Veken 1989; Fish *et al.* 2015). During this work I examined photographed types of both species and confirmed that Hawaiian material matches each of them.

*Digitaria scalarum* was intentionally introduced by the agricultural experimental stations in the 1940s and planted on O'ahu, Maui, and Hawai'i. Most of the specimens formerly treated as *D. abyssinica* in Hawai'i are actually *D. scalarum*, and as such *D. scalarum* is now known to be naturalized on Kaua'i, O'ahu, Maui, and Hawai'i. The record for Hawai'i Island, where large colonies were found during surveys of the 'Ainahou Ranch in the Hawaii Volcanoes National Park, is reported for the first time. This species is an aggressive weed in Hawai'i, where it has been observed forming thick mats and seems to be more aggressive than *D. abyssinica*. *Digitaria scalarum* is also listed as a federal noxious weed (USDA 2010).

*Digitaria scalarum* is one of the most easily identified species of *Digitaria*, as no other grasses from the islands have a similar growth habit of rhizomatous and stoloniferous growth in combination with narrow leaves (3–6 mm wide), which are held



**Figure 6.** *Digitaria scalarum* climbing up to 2 m tall when supported by vegetation. Note the dense thatch of dead culms. Photo taken in Ha'ikū, Maui.

ectly. *Digitaria scalarum* is almost always observed forming monotypic or nearly monotypic stands and is also frequently observed climbing fences, trees, and other vegetation (Fig. 6). The mats formed by this grass are, at times, thick enough that I was able to stand on top of one and not touch the ground, as the stems were supporting my entire weight.

The following description is taken from (Goetghebeur & Van der Veken 1989: 161):

“A rhizomatous perennial, rhizome conspicuously well developed, growing deeply, straight with vertically growing offshoots, much branched at groundlevel, sometimes stoloniferous. Culms (10)20–40 cm., ascending from a creeping base, glabrous, nodes dark, glabrous or hairy. Leaf sheaths often with many bulbous based bristles, sometimes scaberulous. Ligule 1–3 mm. long, truncate, erose or subentire. Leaf laminae 5–10 × 0.3–0.6 cm., linear, flat or involute, glabrous or sometimes loosely hairy on both surfaces, scaberulous along the crisped margin. Inflorescence composed of (2)4–10(12) racemes, (1)3–10 cm. long, erect to patent, sometimes branched at the base, solitary along a well developed common axis. Rhachis triquetrous, narrowly winged, up to 0.4 mm. broad, smooth to scaberulous, with scaberulous margins. Pedicels 2 nate, 0.5–2.5 mm. long, subterete to triangular, scaberulous, scarcely broadened at the apex. Spikelets (1.6)1.7–2.2(2.4) mm. long, oblong-ovate, swollen. Inferior glume 1/10–1/4 of the spikelet, conspicuously heteromorphic, often erose or truncate, nerveless, glabrous, hyaline, sometimes purplish. Superior glume c.4/5 of to as long as the spikelet, ovate to oblong, 5(7)-nerved, glabrous or with some short, fine

hairs in a marginal row, pale green, often purplish tinged. Inferior lemma as long as the spikelet, ovate-oblong with recurved margins, 7-nerved, glabrous or with a marginal row of short, fine hairs, pale green, often purplish tinged. Superior lemma as long as the spikelet, ovate-oblong, apiculate, swollen, bluish green to dark brown. Habitat: Sandy flood plains, wet spots in disturbed sandy soils, weed in gardens.”

*Material examined.* **KAUAI:** Kapaka St about 1 km S of Rt 56 (Kūhiō Hwy), roadside, sunny, moist-dry area, only one patch seen on this road, but abundant on Kahilihōlo Rd, 114 m, 22.200358, -159.459839, 30 May 2022, *K. Faccenda 2431*; Kapa'a Valley, Waiakea Rd, roadside weed, sunny, moist, occasionally mowed area, only one patch seen in this area, 122 m, 22.100174, -159.374390, 29 May 2022, *K. Faccenda 2399*; W of Puhi, ca. 1.7 W of Kaumuali'i Hwy intersection with Kipu Rd, 0.4 mi N of Halfway Bridge, mixed planted pasture of alien grasses, 12 Apr 2012, *W.C. Fleming s.n.* (BISH 764509). **O'AHU:** Kawailoa, Drum Rd, mesic roadside setting, naturalized, 09 Mar 2016, *US Army 427*. **MAUI:** Ha'ikū, Kaupakalua Rd, near Ulumalu & Calassas, 'Ōpaepilau Gulch, carpet-forming grass, 20°53'N, -156°17'W, *F. Starr & K. Martz 020130-2*; East Maui, Makawao Distr, Honokalā, roadside and pasture, 20°47'N, 156°04'W, 14 Jun 2002, *H. Oppenheimer H70205*; East Maui, Kokomo, very common wet pasture grass between Makawao and Hāna, 1 or 2 ft tall in open areas, but when supported by fences or vegetation can go to over 10 ft [3 m], Nov 1995, *R.W. Hobdy 3888*. **HAWAII:** Hawaii Volcanoes National Park, 'Āinahou area, about 2 km S of Chain of Craters Rd, dry, partly sunny area along road, abundant, forming large monocultures along road and going over 10 m away from road, with *Digitaria eriantha* and *Cenchrus clandestinus*, 925 m, 19.347653, -155.226526, 17 Aug 2022, *K. Faccenda & J. Gross 2667*.

*Digitaria velutina* (Forssk.) P. Beauv.

#### New state record

*Digitaria velutina*, a federal noxious weed (USDA 2010), is now known from Maui, where it is widespread and abundant on roadsides between Makawao and 'Ulupalakua. At this point, it is certainly too widespread to be controlled on Maui. *Digitaria velutina* is native to Africa and has formed naturalized populations scattered throughout the tropics.

*Digitaria velutina* is similar in habit to other annual weedy species such as *D. abyssinica*, *D. ciliaris*, and *D. nuda*, but differs in often bearing secondary branches coming from the base of the lowest inflorescence branches. These secondary branches, when present, are a unique feature among Hawaiian *Digitaria*. Although not all inflorescences have them, when multiple inflorescences across a plant/population are examined they are very likely to be found. It also tends to have more inflorescence branches and smaller florets than the other annual *Digitaria* species found in Hawai'i. *Digitaria velutina* populations on Maui displayed two phenotypes in terms of their inflorescence structure: some had inflorescences where the branches were held nearly perpendicular to the main axis, but other populations had all their inflorescence branches held ascendant and parallel to the inflorescence axis (Fig. 7). Those populations with ascendent branches also have secondary branches, but they are also held ascendent, and are thus hidden within all the other branches. Both of these forms were also observed in herbarium material from this species' native range.

The following description is taken from Barkworth *et al.* (2003: 378) but the duration was edited as they erroneously report it as having indefinite duration:

“Plants annual; loosely caespitose to straggling. Culms 15–80 m, decumbent, rooting and branching at the lower nodes. Sheaths pilose, with papillose-based hairs; ligules 1.8–2 mm; blades 4–15 cm long, 3–10 mm wide, pilose, with papillose-based hairs. Panicles with 5–18 spikelike primary branches on 2.5–5 cm rachises, lower branches usually verticillate; primary branches 3.5–10 cm long, 0.3–0.5 mm wide, narrowly



**Figure 7.** *Digitaria velutina* photographed on Maui. **A**, open panicle form with conspicuously divergent secondary branches; **B**, closed panicle form where secondary branches are appressed to primary branches.

wing-margined, wings less than 1/2 as wide as the midribs, bearing spikelets in unequally pedicellate pairs; secondary branches often present, often highly divergent; shorter pedicels 0.2–0.5 mm; longer pedicels 0.8–1.1 mm. Spikelets 1.5–2 mm long, about 0.5 mm wide, elliptic-lanceolate. Lower glumes absent or to 0.2 mm; upper glumes 1.5–1.7 mm, usually to 3/4 as long as the spikelets, 3-veined, villous between the veins, hairs tapering or parallel-sided; lower lemmas about as long as the spikelets, 7-veined, veins unequally spaced, 2 veins crowded together near each margin, 3 inner veins well-separated, pubescent on the margins and between the inner lateral veins, hairs about 0.2 mm, sometimes sparse, lateral veins smooth throughout or scabridulous only on the distal 1/3; upper lemmas 1.5–1.7 mm, usually gray at maturity, sometimes brown; anthers about 0.5 mm.  $2n = 18$ .”

*Material examined.* **MAUI:** ‘Ulupalakua, main highway ca. 8 km S of Kēōkea, roadside weed in disturbed areas in full sun, 515 m, 20.627955, -156.393667, 26 Oct 2022, *K. Faccenda 2798*; Kēōkea, along main highway, roadside weed in moist sunny areas, 809 m, 20.700420, -156.366421, 26 Oct 2022, *K. Faccenda 2804*; Kula, Kekaulike Ave near Puanani Pl., roadside in sunny area, 1068 m, 20.765807, -156.306126, 29 Oct 2022, *K. Faccenda & S. Vanaprüks 2835*; Olinda, Hawea Pl., side of road in gulch, mesic mid-elevation, semi-shade, growing with *Persea*, *Ipomoea indica*, *Melinis minutiflora*, scattered clumps, semi-erect, furry leaves, some plants in area with secondary branching on inflorescence, naturalized, 2700 m, 20.823854, -156.293584, 05 Nov 2022, *F. Starr et al. 221105-01*.

KEY TO *DIGITARIA* IN HAWAII

The inflorescence of *Digitaria* consists of a panicle of 2 to many branches arranged digitately or paniculately. The flowers are needed to identify these with certainty, but with practice, the majority can be differentiated based on largely vegetative characters and inflorescence structure. If an identification of a *Digitaria* needs to be made with certainty, a pressed specimen should be made, as identification using only a hand lens in the field is not possible for all species. Florets of all species naturalized in Hawai'i are photographed in Figs. 8–11 for reference.

1. Spikelets ternately arranged (in groups of 3) at least in lower part of panicle branches; rachis with 2 wings; spikelets <2.5 mm long
  2. Fertile lemma whitish, straw, or light tan; plants decumbent with stolons; inflorescence branches typically 2–3, rarely up to 5
    3. Spikelets 1.7–2.5 mm long; sheaths conspicuously pubescent; spikelets hairy (look at mature spikelets) ..... *D. mollicoma*
    - 3'. Spikelets 1.2–1.6 mm long; sheaths largely glabrous; spikelets entirely glabrous or hairy
      4. Florets entirely glabrous ..... *D. fuscescens*
      - 4'. Florets with hairs ..... *D. longiflora*
  - 2'. Fertile lemma dark brown to violet, occasionally lighter colored when immature; plants upright, caespitose; inflorescence branches 2–9
    5. Apex of pedicel without any hairs; florets with pilose hairs or appearing nearly glabrous ..... *D. violascens*
    - 5'. Apex of pedicel with a corona of hairs surpassing tip of pedicel; sterile lemma with conspicuous clavate hairs (use >20× to view hairs) .... *D. stricta* var. *stricta*
- 1'. Spikelets paired; rachis usually 3-winged or triangular and lacking wings; spikelets typically >2 mm long (<2 mm in *D. orbata* & *D. velutina*)
  6. Perennials; caespitose, culms upright, without rhizomes or stolons, rarely rooting at nodes
    7. Spikelets long-hairy with brown and white hairs clearly visible to naked eye ... ..... *D. insularis*
    - 7'. Spikelets glabrous to pubescent, lacking brown hairs
      8. Lower glume absent; spikelets <2 mm long ..... *D. orbata*
      - 8'. Lower glume present; spikelets >3 mm long
        9. Panicle branches barren on lower 1/4–1/3 of their length; spikelets remotely spaced above and typically not overlapping ..... *D. divaricatissima*
        - 9'. Panicle branches with spikelets uniformly distributed from base to apex; spikelets typically close and overlapping ..... *D. eriantha* (in part)
  - 6'. Perennials or annuals; culms decumbent, with rhizomes, stolons, or rooting at nodes
    10. Panicle branches triangular, lacking wings of green tissue on edges (Fig. 11d–e)
      11. Spikelets entirely glabrous, with distinct lower glume
        12. Lower glume without a hyaline margin; upper glume 3 (rarely 5)-nerved; leaves 5–12 mm wide, hairy; panicle branches generally held horizontally or weakly ascending ..... *D. abyssinica*
        - 12'. Lower glume with a hyaline margin; upper glume 5 (rarely 7)-nerved; leaves 2–6 mm wide, glabrous or sparsely hairy; panicle branches strongly ascending ..... *D. scalarum*

- 11'. Spikelets with white hairs, with or without lower glume
13. Inflorescence branches 2–4; leaves 1–6 mm wide, often bluish; densely stoloniferous and/or rhizomatous, forming a tightly matted turf .....  
..... *D. didactyla*
- 13'. Inflorescence branches >4; leaves 2–17 mm wide; stoloniferous or not, not forming a tight turf
14. Annual; sometimes rooting at nodes but not stoloniferous; lower inflorescence branches usually compound at their base .....  
..... *D. velutina* (in part)
- 14'. Perennial; strongly stoloniferous; inflorescence branches always simple ..... *D. eriostachya*
- 10'. Panicle branches triangular, with wings of green tissue coming from the three edges
15. Sessile and pedicellate spikelets dimorphic (check middle to apex of panicle branches), sessile spikelet with nerves equally spaced, and pedicellate spikelet with nerves close to margins; pedicellate spikelets often with dense, spreading hairs when mature, these hairs not present on immature material (Fig. 9a–b) ..... *D. bicornis*
- 15'. Not as above (florets of *D. ciliaris* occasionally dimorphic in pubescence but not venation)
16. Panicle branches held strongly ascending and parallel from inflorescence axis, diverging from axis by 20° at most
17. Upper glume up to 1/3 as long as floret; lower glume always absent .....  
..... *D. setigera* (in part)
- 17'. Upper glume >1/2 as long as floret; lower glume present or absent
18. Sheaths & leaf blades glabrous; spikelets 2.1–2.7 mm long .....  
..... *D. henryi*
- 18'. Sheaths & leaf blades hairy; spikelets 1.5–2.0 mm long .....  
..... *D. velutina* (in part)
- 16'. Panicle branches strongly divergent from inflorescence axis, diverging by at least 30°
19. Veins of sterile lemma unequally spaced with a large area between midvein and adjacent vein compared to spacing between marginal veins (e.g. Fig. 9e)
20. Lower glume absent; upper glume up to 1/3 as long as spikelet ....  
..... *D. setigera* (in part)
- 20'. Lower glume present or absent; upper glume >1/2 as long as spikelet
21. Panicle branches scabrous on margins; lower glume always present; delicate or coarse grasses with culms 1–2 mm diam. at base .....  
..... *D. ciliaris*
- 21'. Panicle branches smooth on margins; lower glume absent or present; delicate grasses with culms ~1 mm diam. at base .....  
..... *D. radicata*



- 19'. Veins of sterile lemma equally spaced (e.g. Fig. 10d)
- 22. Spikelets 2.8–3.5 mm long; stoloniferous perennial; inflorescence branches without cilia ..... *D. eriantha* (in part)
- 22'. Spikelets <2.4 mm long; annual; inflorescence branches sometimes with 1–4 mm long cilia
- 23. Panicle with secondary branches from base of lower panicle branches; florets <2 mm long; upper glume >3/4 as long as floret ..... *D. velutina* (in part)
- 23'. Panicle without secondary branches; florets 1.7–2.4 mm long; upper glume 1/3–4/5 as long as floret
- 24. Upper leaf surface glabrous or with a few hairs near base; upper glume 2/5–4/5 as long as floret; lower glume usually absent on most florets ..... *D. nuda*
- 24'. Upper leaf surface usually hairy; upper glume 1/3–1/2 as long as floret; lower glume usually present on most florets ..... *D. horizontalis*

***Dinebra retroflexa* (Vahl) Panz.**

var. *retroflexa*

**New state record**

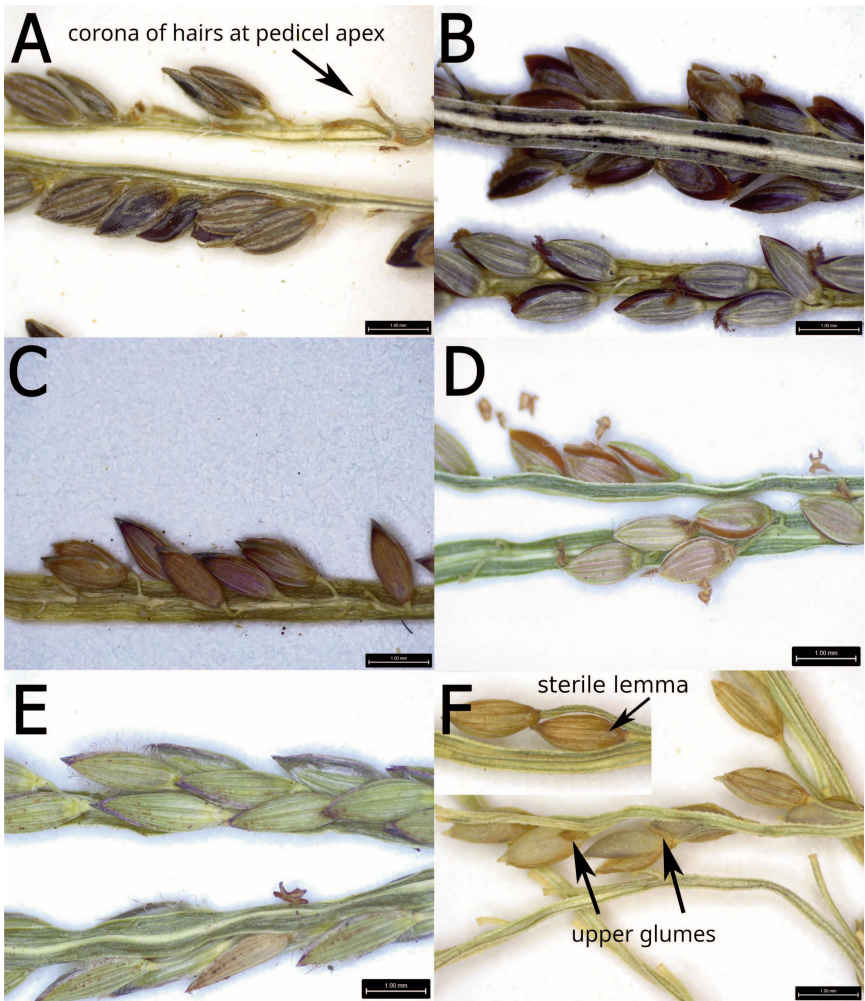
*Dinebra retroflexa* var. *retroflexa* was found during roadside surveys on O‘ahu in ‘Āhuimanu, where one patch approximately 20 m long was found, running along the edge of Ahilama Road. Only this one colony was located during roadside surveys. *Dinebra retroflexa* most closely resembles *Oplismenus hirtellus*, but *D. retroflexa* is distinguished by its annual habit, lack of stolons, and deciduous inflorescence branches (Fig. 12).

This species is native from Africa through the Middle East to India and Pakistan (Barkworth *et al.* 2003). *Dinebra retroflexa* has also been introduced to the continental United States, China, Japan, Australia, and several other countries (POWO 2023). Throughout its range, this species has been recognized as an aggressive weed of agriculture (Tanji 2020). For example, in the Nile Delta region, *D. retroflexa* is such a common weed it was used to name a weed community (Shaltout *et al.* 1992). In India, it is a dominant weed in soybean fields (Panda *et al.* 2015).

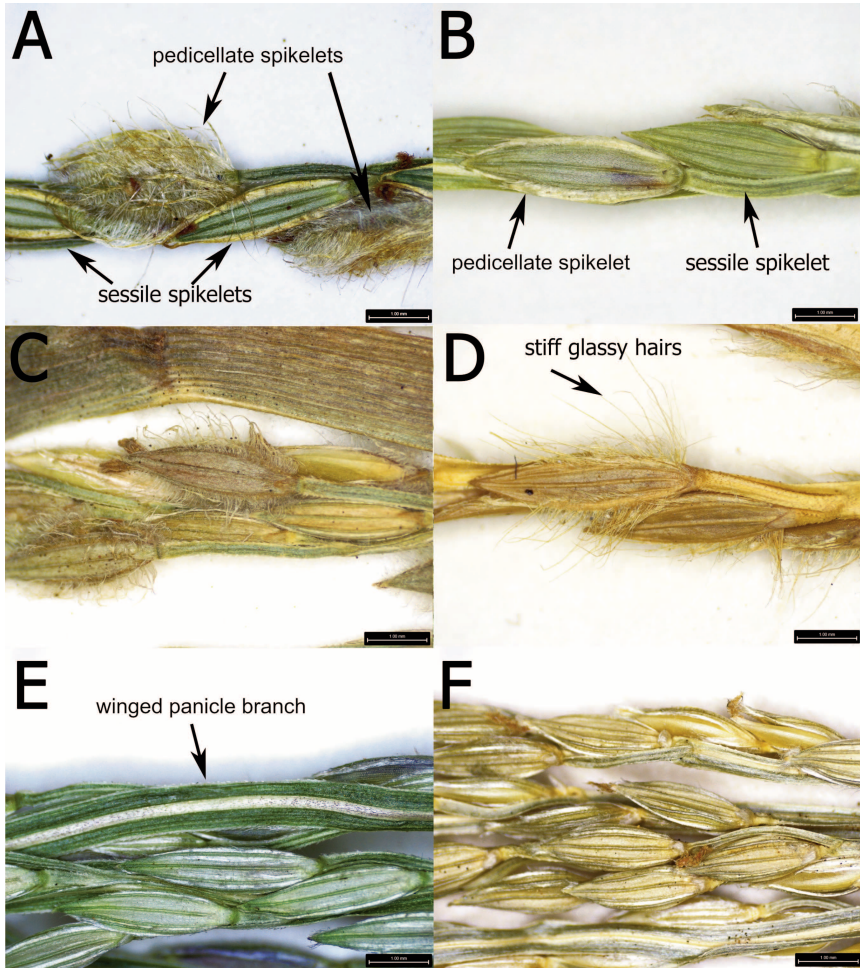
The following description is taken from Barkworth *et al.* (2003: 64):

“Plants loosely tufted. Culms 13–120 cm, decumbent, straggling, often rooting at the lower nodes. Leaves sometimes glandular, particularly on the sheaths; blades 4.5–28 cm long, 4–8 mm wide, finely pointed. Panicles 8–34 cm; branches 0.6–5(7) cm, stiff, initially ascending, reflexed at maturity; disarticulation at the base of the branches. Spikelets 5.7–9 mm, with 1–3 florets. Glumes 5.7–9 mm, asymmetric, coriaceous, keels glandular, apices caudate-curving; lemmas 2.1–2.9 mm, narrowly ovate, appressed pubescent on the lateral veins and adjacent to the lower 1/2 of the central vein; paleas appressed pubescent on the flaps adjacent to the keels. 2n = 20.”

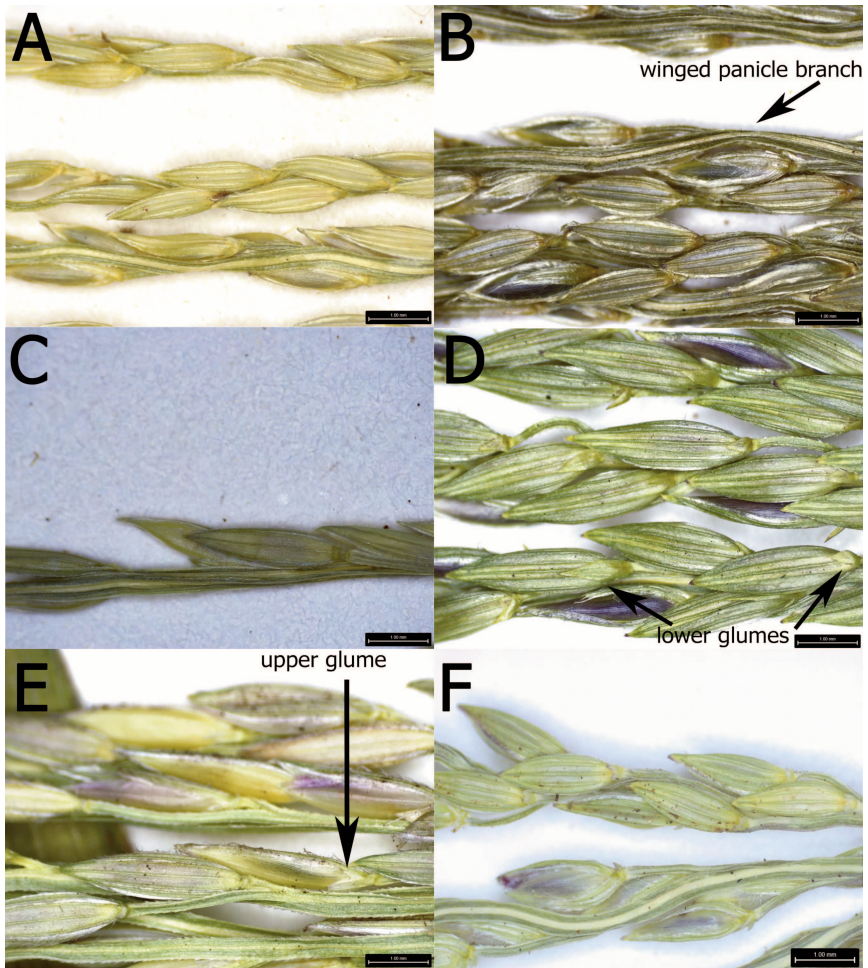
*Material examined.* O‘AHU: ‘Āhuimanu, 300 m N of intersection of Ahilama Rd and Waihe‘e Rd, roadside weed from irregularly mowed area, in sun, rather dry, dominated by invasive grasses, patch extended around 20 m long along road, hundreds of plants, 10 m, 21.460071, -157.847848, 20 Sep 2022, K. Faccenda 2707.



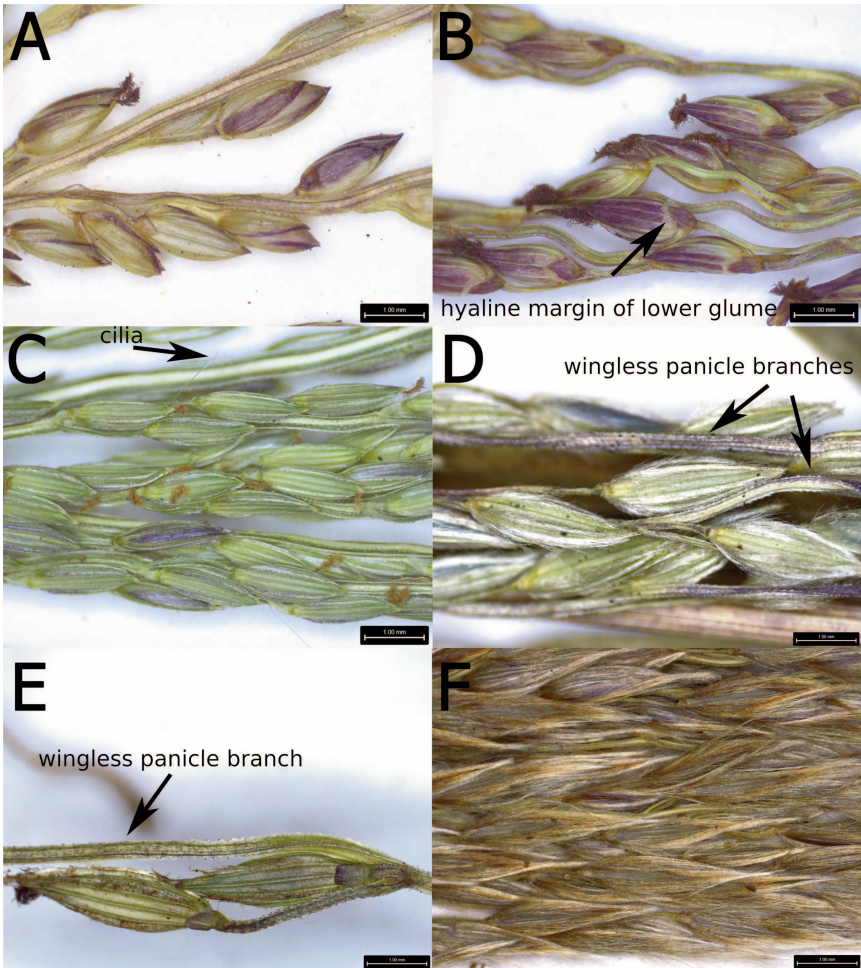
**Figure 8.** *Digitaria* spikelets. **A**, *D. stricta* var. *stricta* (Kawelo s.n., BISH 704712). **B**, *D. violascens* (T. Flynn 2720). **C**, *D. fuscescens* (D.R. Herbst 248). **D**, *D. longiflora* (K. Faccenda 3008). **E**, *D. mollicoma* (K. Faccenda 2591). **F**, *D. orbata* (R.W. Hobdy s.n., BISH 767427). All scale bars are 1 mm long. All photos were taken at BISH at 20 $\times$ .



**Figure 9.** *Digitaria* spikelets. **A–B**, *D. bicornis*: **A**, spikelets at maturity with fimbriate hairs (Starr 020112-1); **B**, spikelets not yet mature (T. Flynn 2701). **C–E**, *D. ciliaris*: **C**, mature spikelets resembling *D. bicornis* (Starr 05334-18); **D**, form with glassy hairs on the florets, which is only found in the NW islands (Cornelison s.n., BISH 118638); **E**, most often encountered form (A. Ainsworth WNR005). **F**, *D. henryi* (Stone 1241). All scale bars are 1 mm long. All photos were taken at BISH at 20 $\times$ .



**Figure 10.** *Digitaria* spikelets. **A.** *D. horizontalis* (D.R. Herbst 696). **B.** *D. nuda* (D.R. Herbst 4027). **C.** *D. radicata* (T. Flynn 625). **D.** *D. eriantha* (T. Flynn 6134). **E.** *D. setigera* (K.M. Nagata 3854). **F.** *D. didactyla* (K. Faccenda 2590). All scale bars are 1 mm long. All photos were taken at BISH at 20 $\times$ .



**Figure 11.** *Digitaria* spikelets. **A**, *D. abyssinica* (R.W. Hobdy 434). **B**, *D. scalarum* (W.C. Fleming 764509). **C**, *D. velutina* (K. Faccenda 2799). **D**, *D. eriostachya* (K.F. Bio 03-0016-01). **E**, *D. divaricatissima* (C. Imada 2002-39). **F**, *D. insularis* (F.R. Fosberg 29542). All scale bars are 1 mm long. All photos were taken at BISH at 20 $\times$ .



**Figure 12.** *Dinebra retroflexa* var. *retroflexa* inflorescence from the Ahilama Rd. population.

***Echinochloa haploclada* (Stapf) Stapf                      New state record**

*Echinochloa haploclada* was found growing in the Wāwāmalu channel at Ka Iwi, O‘ahu, where over 200 plants were seen growing in a concrete-lined portion of the channel (Fig. 13). It was identified as *E. haploclada* using the keys in Barkworth *et al.* (2003) and Clayton & Renvoize (1982). *Echinochloa haploclada* can be identified by its perennial habit and 1–2 m tall height. All other naturalized *Echinochloa* in Hawai‘i are annual and rarely surpass 1 m height.

In its native range of Eastern Africa, *E. haploclada* occurs in stream banks, dry river beds, and floodplains (Launert & Pope 1989). This is the second time this species has been reported outside of its native range, with the first being Trinidad and Tobago (POWO 2023). There are no records of intentional importation of the grass, nor any other obvious introduction mechanisms, making it unclear how this grass arrived in Hawai‘i.

The following description is from Launert & Pope (1989: 56):

“Tussocky perennial. Culms 30–300 cm. high, arising from a short oblique rhizome, often wiry; ligule absent or a line of hairs; leaf laminae occasionally marked with purple bars. Inflorescence 7–25 cm. long, lanceolate (occasionally linear); racemes 1–5 cm. long, densely crowded with appressed spikelets. Spikelets small, 1.5–2.5(3) mm. long, subglobose to elliptic, ± hispid. Inferior floret male, its lemma acute or with a short curved awn up to 5(15) mm. long. Superior lemma 1.5–2.3 mm. long.”

*Material examined.* **O‘AHU:** Ka Iwi area, Wāwāmalu channel, where it goes under the road, in the concrete channelized streambed and area where the concrete disappears and a paragrass-filled streambed appears, over 200 plants seen, caespitose perennial, almost 2 m tall, inflorescence reddish purple, from saturated soil in full sun, 5 m, 21.297434, -157.662533, 07 Apr 2023, *K. Faccenda & M. Ross 3092*.



Figure 13. *Echinochloa haploclada* habit in the Wāwāmalu channel.

***Ehrharta erecta* Lam.**

**New island record**

Formerly known to be naturalized only on Maui (Imada 2019), *Ehrharta erecta* is now known on Hawai‘i Island from one collection made on the side of Rt. 250 in Kohala. It is likely that this plant came from a seed transported by vehicles, as the habitat was unlike where this was seen on Maui. The source population on Hawai‘i Island has yet to be discovered.

*Material examined.* **HAWAI‘I:** Kohala, Rt 250, about 8 km away from Rt 19, edge of road, sunny dry area, rare, one plant seen, 1047 m, 20.072859, -155.760952, 05 Mar 2022, K. Faccenda 2331.

***Enneapogon cenchroides* (Licht.)**

C.E. Hubb.

**New state record**

*Enneapogon cenchroides* is now known from O‘ahu, where it was found growing in Mākaha Valley about 600 m makai of the resort along the roadside. Over 500 plants were seen. This grass was growing in an area otherwise dominated by *Cenchrus ciliaris*. *Enneapogon cenchroides* was largely confined to infrequently mowed areas along the roadside, as it apparently could not compete with *C. ciliaris*; however, a few unmowed areas where the soil was shallow and rocky were dominated by *E. cenchroides* rather than *C. ciliaris*. Based on this behavior of growing from shallow and rocky soils, it is likely that this grass will spread up the ridge separating Mākaha and Mākua-Kea‘au valleys, if it has not done so already, as the ridge was not surveyed.

*Enneapogon cenchroides* is native to Africa through the Middle East and India, but has become naturalized in Brazil and Arizona (POWO 2023). It is found in woodlands, grasslands, and disturbed areas, where it usually grows from poor, rocky or sandy soils (Fernandes *et al.* 1971). *Enneapogon cenchroides* can be identified by its annual habit, spicate to racemose inflorescence (Fig. 14), and lemmas with nine awns that are plumose at maturity



**Figure 14.** Inflorescences of *Enneapogon cenchroides* from the Mākaha population. Note that while most inflorescences were panicleate, other plants in the population had more spikelike inflorescences.

The following description is taken from Fernandes *et al.* (1971: 148):

“A loosely caespitose annual or rarely shortly lived perennial, densely glandular-pubescent all over. Culms 15–100 cm. tall, 2–5-noded, rather stout, geniculately ascending, seldom erect, sometimes decumbent, simple or branched below. Leaf-sheaths relatively tight, usually slightly shorter than the internodes, striate, smooth or somewhat asperulous towards the mouth. Leaf-laminae 3–25 × (0.1)0.3–0.7(1) cm., linear to lanceolate-linear, long-tapering to a fine point, expanded or convolute (often only towards the apex), rigid to subflaccid, scaberulous on the upper surface and along the margins. Panicle 3–15(20) cm. long, spike-like, usually dense and contracted, rarely somewhat open below, compact, rarely interrupted. Spikelets 3–5 mm. long, usually crowded, 3-flowered. Glumes slightly unequal, light to dark grey or grey-green; the inferior 2.8–4(5.1) mm. long, 5–7-nerved, ovate; the superior 3.2–5.5(6.8) mm. long, 3-nerved, oblong, often with the apex somewhat truncate. Fertile lemma (the inferior) 1.5–2 mm. long (excluding the awn), dorsally shortly villous; awns 3–4.25 mm. long, plumose up to or beyond the middle. Palea 2–2.25 mm. long, with the keels ciliolate. Anthers 0.8–1.8(2.3) mm. long.”



*Material examined.* **O'AHU:** Mākaha, Kili Dr, about 600 m SW of the resort, dry, occasionally mowed roadside area, full sun, 38 m, 21.479400, -158.208981, 16 Jan 2023, *K. Faccenda & M.C. Ross 2983*.

***Eragrostis atropioides* Hillebr.**

**Note**

A large colony of *Eragrostis atropioides* was observed on Saddle Road at about 1680 m growing vigorously from a recently burned area. In this area the grass was forming a near monoculture. On the burned side of the road, the number of flowering culms appeared greater than on the unburned side, suggesting that the growth of this species is promoted by fire, a trait not commonly observed in Hawaiian species. Promotion of this species by fire has also been reported by Banko & Farmer (2014). Shaw (1995) also reported *E. atropioides* regenerating after fire. Invasive grasses such as *Cenchrus setaceus* were also observed in this area, and the *E. atropioides* was successfully competing with them. *Dactylis glomerata* was growing mixed with *E. atropioides*, although it was uncommon.

***Eragrostis barrelieri* Daveau**

**New island records**

*Eragrostis barrelieri* is now also known to occur on Kaua'i, where it was found in the vicinity of Waimea. *Eragrostis barrelieri* was also very frequently encountered during roadside surveys on Moloka'i, where it was a dominant component of the annual communities of dry areas around the island. Given that millions of individuals were estimated to be germinating from the seedbank across the island during recent rains, it is likely that this grass has been present on the island for at least 20 years. The populations seen on Moloka'i were much more extensive than any seen during roadside surveys on any other island. It was often seen with other annuals, including *Lepidium didymum*, *Malva parviflora*, and *Dysphania carinata*. *Eragrostis barrelieri* is now known to be naturalized on Kaua'i, O'ahu, Moloka'i, Maui, and Kaho'olawe (Faccenda 2022).

*Material examined.* **KAUA'I:** Waimea, Russian Fort Elizabeth, at recently installed statue of Kaumuali'i, irrigated area around statue in otherwise very dry, sunny landscape, about 15 plants seen, 4 m, 21.952671, -159.663661, 07 Jul 2022, *K. Faccenda 2512*. **MOLOKA'I:** western end of island, Papapa Rd off of Kalua Ko'i Rd, roadside weed in shoulder, very dry, sunny area, annual popping up and flowering after only about 1 week since the first winter rains, hundreds of plants in this area, very common across the island, 34 m, 21.159249, -157.264829, 26 Dec 2022, *K. Faccenda 2895*; Ho'olehua, Moloka'i Airport, long-term parking lot, weedy area around parked cars, rarely mowed, sunny, 138 m, 21.156067, -157.094023, 26 Dec 2022, *K. Faccenda 2886*.

***Eragrostis curvula* (Schrad.) Nees**

**New island records**

*Eragrostis curvula* is now known to be naturalized on Moloka'i, Lāna'i, and Hawai'i. This species was previously reported only on O'ahu, Maui, and Kaho'olawe (Imada 2019).

*Material examined.* **MOLOKA'I:** W-facing slopes at Mākoelau, numerous plants present, 530 m, 18 Mar 1992, *J.K. Normann s.n.* (US 1052776). **LĀNA'I:** Hi'i Flats, along unimproved road in waste area, 20.813223, -156.895002, 600 m, 11 May 2006, *H. Oppenheimer H50618* (PTBG); Manele Rd ca. 700 m S of intersection with Kaumalapau Hwy, roadside, moist sunny, occasionally mowed area, 6 plants seen, rare, only patch observed on entire island, 20.810132, -156.913167, 20 Jun 2023, *K. Faccenda & J. Sprague 3144*. **HAWAI'I:** Hawaii Volcanoes National Park, 'Āinahou area, about 4 km S of Chain of Craters Rd, dry open area on roadside, about a dozen plants seen along road, 858 m, 19.338004, -155.224522, 17 Aug 2022, *K. Faccenda & J. Gross 2668*.

***Eragrostis multicaulis* Steud.****New state record**

Previously reported as questionably naturalized on Hawai'i Island by Faccenda (2022) based on a specimen from 1943, *Eragrostis multicaulis* is now known to have persisted, as a specimen was found from 1973.

*Material examined.* **HAWAI'I:** Volcano, Wright Rd, naturalized in bulldozed area, 23 Aug 1973, *O. Degener & I. Degener 33429* (NY).

***Eragrostis pilosa* (L.) P. Beauv. var. *pilosa*****New island records**

*Eragrostis pilosa*, an easily overlooked annual weed, was found naturalized on Moloka'i, Maui, and Hawai'i during roadside surveys. On Hawai'i Island, it has been found growing as a weed in Hilo and Captain Cook, growing from cracks or edges of pavement. Another population was also collected in the vicinity of Pu'u Wa'awa'a along the roadside, and was seen along the trail to the crater. On Maui it was found along Hāna Highway and in Ha'ikū. On Moloka'i, a population of many hundreds of plants was found along Rt. 460. *Eragrostis pilosa* is now known from Kaua'i, O'ahu, Moloka'i Maui, and Hawai'i (Imada 2019; Faccenda 2022).

*Material examined.* **MOLOKA'I:** Maunaloa, 3 km E of intersection of Rt 460 and Kalua Ko'i Rd, mowed roadside, sunny, rather dry area, large colony in this area composed of hundreds of plants, one other colony seen about 1 km down the road of similar size, these two colonies the only ones encountered on the island, 333 m, 21.148147, -157.163256, 27 Dec 2022, *K. Faccenda & C. Daehler 2914*. **MAUI:** Hāna Hwy ca. 200 m E of Wai'ānapanapa State Park, wet, sunny roadside dominated by weeds, 53 m, 20.781917, -156.007264, 23 Oct 2022, *K. Faccenda 2773*; Ha'ikū, Hog Back Rd, weed from crack in pavement in moist, sunny area, 252 m, 20.903950, -156.310079, 30 Oct 2022, *K. Faccenda & S. Vanaprucks 2839*. **HAWAI'I:** Captain Cook, along Hwy 11, weed from crack in pavement of parking lot, 19.499973, -155.919894, 03 Mar 2022, *K. Faccenda 2290*; Hilo, Kīlauea Ave N of East Kahaopea St, on edge of parking lot, 36 m, 19.692374, -155.068099, 07 Aug 2022, *K. Faccenda 2587*; Pu'u Wa'awa'a, roadside of Hwy 190, dry, sunny area from roadside gravel, common locally, 585 m, 19.796586, -155.862398, 03 Mar 2022, *K. Faccenda 2287*.

***Eragrostis tenuifolia* (A. Rich.)**

Hochst. ex Steud.

**New island record**

Roadside surveys on Moloka'i found that *Eragrostis tenuifolia* was widespread and common as a roadside weed across most of the island. This grass has surely been present on the island for many years given how widespread it is and must have been overlooked by past botanists. *Eragrostis tenuifolia* is now known to be naturalized on Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, and Hawai'i (Imada 2019).

*Material examined.* **MOLOKA'I:** Ho'olehua, Moloka'i Airport long-term parking lot at airport, weedy area around parked cars, rarely mowed, sunny, abundant from compressed soil on edges of roads, very common across entire island, 138 m, 21.156214, -157.094385, 26 Dec 2022, *K. Faccenda 2888*.

***Eragrostis unioides* (Retz.) Nees ex Steud.****New island record**

*Eragrostis unioides* was previously reported as naturalized on Hawai'i Island (Herbst & Wagner 1999), and was erroneously reported on Maui (Oppenheimer 2008; Faccenda 2022). Now *Eragrostis unioides* is known from Maui, where it was found along the Hāna Highway. Only two plants were seen during roadside surveys, making the plant currently rather rare on the island.

*Material examined.* MAUI: Hāna Hwy ca. 4 km W of Wai‘ānapanapa State Park at roadside coconut stand and restaurant, 170 m, 20.794499, -156.052268, 23 Oct 2022, K. Faccenda 2753.

***Eremochloa ophiuroides* (Munro) Hack.                      New state record**

Previously reported as a questionable naturalization on O‘ahu, where it may have been planted (Faccenda 2022). *Eremochloa ophiuroides* has now been documented as naturalized on Kaua‘i and Hawai‘i, where it was found on roadsides and in pastures.

*Material examined.* KAUA‘I: Wailua Game Reserve, above Wailua, vegetation on plots stripmined for bauxite in 1958–60, Jul 1983, *S. Lum* 72 (PTBG); Kalāheo, National Tropical Botanical Garden off of Papalina Rd, along main road heading down valley into garden, before road starts heading steeply downhill, on exposed steep soil of roadcut where no other vegetation is growing, sunny, several colonies along road, not seen growing in mowed areas nearby but only on roadbank slopes, suggesting that this is a naturalized population, 112 m, 21.905595, -159.511015, 29 May 2022, K. Faccenda 2385. HAWAI‘I: Kahuku Unit of Hawaii Volcanoes National Park, near main parking lot and toilet, in both compressed soil of parking area and spreading into nearby scrubby area, growing over 10 m from edge of parking area, naturalized and spreading, strongly stoloniferous, 651 m, 19.063700, -155.678216, 08 Aug 2022, K. Faccenda 2598; Hawaii Volcanoes National Park, old horse pastures about 200 m N of Tree Molds Rd at base of Mauna Loa Strip Rd, old pasture land, now mostly dominated by *Cenchrus clandestinus*, one colony, about 5 m wide in sunny, dry area, 1218 m, 19.435196, -155.284374, 16 Aug 2022, K. Faccenda 2659; Hawaii Volcanoes National Park, ‘Āinahou area, about 4 km S of Chain of Craters Rd, dry open area on roadside, one patch seen along road, about 50 m long, growing into shrubby areas away from road as well as from the dirt road itself, 860 m, 19.338351, -155.224088, 17 Aug 2022, K. Faccenda 2669.

***Eriochloa acuminata* (J. Presl) Kunth**

var. *acuminata*

**New state record**

*Eriochloa acuminata* var. *acuminata* is now known to occur on West Maui, where it was collected once in 2000 at Lāhainā. *Eriochloa acuminata* can be identified by the small beadlike structure subtending the floret, annual habit, and acute (never acuminate) spikelets 3.8–5 mm long. *Eriochloa acuminata* is native to the southern United States and northern Mexico (Barkworth *et al.* 2003). This is the first time this species has been reported outside of its native range. Shaw & Webster (1987) note that *E. acuminata* is a noxious weed in the southwestern U.S., and often infests field crops.

The following description is from the Flora of North America (Barkworth *et al.* 2003: 515):

“Plants annual; caespitose. Culms 30–120 cm, erect or decumbent, sometimes rooting at the lower nodes; internodes glabrous or with scattered hairs; nodes glabrous or pilose. Sheaths sometimes conspicuously inflated, glabrous or pubescent; ligules 0.2–1.2 mm; blades 5–12(18) cm long, (2)5–12(16) mm wide, linear, flat or folded, straight or lax, glabrous or sparsely pubescent adaxially. Panicles 7–16 cm long, 1–6 cm wide, loosely contracted; rachises scabrous or hairy; branches 5–20, 1–5 cm long, 0.4–0.6 mm wide, appressed to divergent, pubescent, sometimes setose, not winged, with 20–36 spikelets, spikelets mostly in unequally pedicellate pairs, solitary distally; pedicels 0.1–1 mm, hairy. Spikelets 3.8–5(6) mm long, 1.1–1.4 mm wide, lanceolate to ovate. Lower glumes absent; upper glumes equaling the lower lemmas, lanceolate to ovate, hairy, 5(7)-veined, acuminate to acute, unawned or awned, awns to 1.2 mm; lower lemmas 3.6–5 mm long, 1.1–1.4 mm wide, lanceolate to ovate, setose, 5(7)-veined, acuminate to acute, unawned; lower paleas absent; anthers absent; upper lemmas 2.3–3.3 mm, 0.7–0.9 times as long as the lower lemmas, indurate, elliptic, rounded, 5-veined, awned, the awns 0.1–0.3 mm; upper paleas indurate, blunt, rugose.  $2n = 36$ .”

*Material examined.* **MAUI:** West Maui, Lāhainā Town, roadside waste area, 20 ft [6 m], 20°52'N, 156°40'W, 25 Jun 2000, *H. Oppenheimer H90002*.

***Festuca rubra* L.**

**New island record; Note**

*Festuca rubra* is now known to be naturalized on O'ahu, where it was found at the Ka'ala summit along the road. The colony extends along approximately 10 m of roadside and is at least 2–3 m deep. It is unclear how many plants were in this population, as this species spreads extensively via rhizomes, but it is clear that this population had been there for quite some time. *Festuca rubra* is now known to be naturalized on O'ahu, Maui, and Hawai'i (O'Connor 1990).

*Material examined.* **O'AHU:** Pu'u Ka'ala summit, roadside at summit, colony covering at least 20 m square of disturbed roadside, 1,213 m, 21.507916, -158.144288, 06 May 2023, *K. Faccenda & T. Chambers 3099*.

During recent fieldwork on Hawai'i in August 2022, two populations of *Festuca rubra* were found producing viviparous inflorescences in Hawaii Volcanoes National Park, one in Volcano at 1217 m and another in the Kahuku Unit at 1392 m. Further viviparous plants were found on the slopes of Haleakalā but were outnumbered by seminiferous plants. This is the first time vivipary has been observed in this species in Hawai'i, as all 45 prior collections produced seminiferous flowers. Viviparous inflorescences on *Festuca rubra* have been well documented and can be caused by both environmental conditions, or in plants with abnormal chromosome counts (Aiken *et al.* 1988). In *Festuca rubra*, links have been made between vivipary and high temperatures (Heide 1990) and even the presence of endophytes (Gundel *et al.* 2014). It is currently unknown what the underlying cause of vivipary is in these plants, or if they are capable of producing seminiferous flowers.

***Gastridium phleoides* (Nees & Meyen)**

C.E. Hubb.

**New state record**

*Gastridium ventricosum* was first published as naturalized in Hawai'i by Hitchcock (1922). However, the name has been misapplied in Hawai'i; after critical examination of specimens and consulting the keys in Barkworth *et al.* (1993) and Tutin *et al.* (1980), it was determined that all the Hawaiian material is a better match to *Gastridium phleoides*. This is not the first time these species have been confused, as an identical misapplication happened across the continental United States, as well (Barkworth *et al.* 1993).

This species was published as occurring on O'ahu by Hitchcock (1922) but never synthesized into modern checklists. As this species has not been recollected in the past 100 years it must be treated as a questionable naturalization. *Gastridium phleoides* is/was known to occur on Kaua'i, O'ahu (as questionable), Moloka'i, Maui, and Hawai'i. Only the first collection on each island is cited below.

*Material examined.* **KAUA'I:** Kahōluamano, 21 Oct 1916, *A.S. Hitchcock 15435*. **O'AHU:** Schofield Bar[racks] - parade grounds, 12 Jul 1916, *A.S. Hitchcock 14048* (US). **MOLOKA'I:** Waiakoa, 13 Apr 1937, *L.D. Whitney 4479*. **MAUI:** Haleakalā, 2500 ft [762 m], Aug 1909, *U. Faurie 1356*. **HAWAI'I:** Mauna Loa, open pasture, 01 Apr 1936, *L.D. Whitney 4107*.

***Gastridium ventricosum* (Gouan)**

Schinz & Thell.

**Correction**

*Gastridium ventricosum* is no longer known to occur in Hawai'i, as all specimens have been redetermined to *G. phleoides*. See note above.

***Hordeum brachyantherum* Nevski****Correction**

*Hordeum brachyantherum* is no longer known to occur in Hawai'i, as the specimen has been reidentified as *Hordeum depressum*. See further notes under that species.

***Hordeum depressum* (Scribn. &**

J.G. Sm.) Rydb.

**Questionable new state record**

*Hordeum brachyantherum* was first published in Hawai'i by Herbst & Clayton (1998). However, this identification was erroneous, as a duplicate specimen at US was annotated by Wray M. Browden, a Triticeae expert, as *H. depressum*. There is only one specimen of *H. depressum*, collected last in 1936 on Hawai'i Island; therefore, this species must be considered a questionable naturalization.

*Material examined.* **HAWAII:** Waiki'i, South Kohala, rare in open pasture, 1,219 m, 18 Sep 1936, *E.Y. Hosaka 1623*.

***Hyparrhenia hirta* (L.) Stapf****New island record**

*Hyparrhenia hirta* is now known from Hawai'i Island, where it has occurred since at least 1963 at an ambiguous location on Mauna Loa. A recent collection from Pu'u Ke'eke'e in 2013 confirms that the species is still established on Hawai'i Island. Fieldwork on Maui also found this species naturalized on Copp Rd. on East Maui in Kula. This species is now known to be naturalized on Moloka'i, Lāna'i, Maui, and Hawai'i (Imada 2019).

*Material examined.* **MAUI:** Kula, Copp Rd & Holomakani Dr, roadside weed in occasionally mowed area, two clumps seen, leaves blueish, perennial, 944 m, 20.752984, -156.323601, 29 Oct 2022, *K. Faccenda & S. Vanaprucks 2824*. **HAWAII:** South Kohala Distr, Pōhakuloa Training Area, Ke'āmuku Unit on Pu'u Ke'eke'e, alien grassland with native shrubs, perennial bunchgrass with pubescent inflorescence, 1,700 m, 23 Jul 2013, *L.W. Pratt 3968* (HAVO 20688a); Mauna Loa, 26 Apr 1962, *S. Uehara s.n.* (US 00425709).

***Lolium arundinaceum* (Schreb.) Darbysh.****New island record**

During creation of a database of all grass records in Hawai'i it was realized that *Lolium arundinaceum* has only been treated as an adventive record on Hawai'i Island (O'Connor 1990). However, this species is naturalized at mid-elevations on Hawai'i Island. Six recent specimens exist of this grass from the Kahuku Unit of Hawaii Volcanoes National Park (HVNP), and one from Hakalau National Wildlife Refuge; it was also observed (but not vouchered) during roadside surveys in the HVNP Volcano Unit. *Lolium arundinaceum* is now known to be naturalized on Kaua'i, O'ahu, Maui, and Hawai'i.

*Material examined.* **HAWAII:** Ka'ū Distr, Hawaii Volcanoes National Park, Kahuku Unit, east of main road in pasture, 1000 m, 02 Feb 2004, *L.W. Pratt 3362* (HAVO); Hakalau NWR, near koa plantings, 6500 ft [1981 m], 16 May 2003, *L.W. Pratt 3313*.

***Lolium perenne* L.****New island record**

*Lolium perenne*, recorded as naturalized on O'ahu, Maui, and Hawai'i (Imada 2019), has now been found naturalized on Kaua'i at the National Tropical Botanical Garden, where it was collected in 1984.

*Material examined.* **KAUAI:** Lāwa'i Valley, PTBG [Pacific Tropical Botanical Garden], Pump Six, lawn grass, 31 Jul 1984, *T. Flynn 903* (PTBG).

***Lolium pratense* (Huds.) Darbysh.****Correction**

Critical examination of the specimen published as *Lolium pratense* by Snow (2008) found that the specimen has scabrous lemmas, awns on the lemmas up to 4 mm long, and short and wide auricles, all characters of *Lolium arundinaceum* (Terrell 1979; Tutin *et al.* 1980; Barkworth *et al.* 1993), and was therefore identified erroneously. As this was the only specimen of *L. pratense* known from Hawai'i, this species should be removed from the Hawai'i checklist.

***Lolium temulentum* L.****Questionable new island record**

An old specimen of *Lolium temulentum* was discovered in the US herbarium collection documenting it on Hawai'i Island. As it has not been recollected in the past 100 years, it should be considered a questionable naturalization. *Lolium temulentum* is now known to be questionably naturalized on Kaua'i, O'ahu, Maui, and Hawai'i.

*Material examined.* HAWAI'I: Near Hilo, 1917, *Bro. Matthias s.n.*<sup>1</sup>. (US 1039015).

***Melinis scabrida* (K. Schum.) Hack.****New island record**

*Melinis scabrida*, previously reported on O'ahu by Faccenda (2022), is now known on Maui, where one collection had been made in Haleakalā National Park at Kaupō Gap. This plant had glumes and a sterile lemma that were nearly glabrous, but were otherwise a perfect match with the material found on O'ahu.

*Material examined.* MAUI: Kaupō, under *Schinus*, 5000 ft [1524 m], 12 Dec 2005, *P. Welton s.n.* (HALE 3151).

***Microlaena stipoides* (Labill.) R. Br.****Correction**

*Microlaena stipoides* was published as occurring on Kaho'olawe by Herbst & Clayton (1998); however, the specimen cited (*Ellshoff 196*, BISH) represents *Flaveria trinervia*. There are no specimens of *M. stipoides* known from Kaho'olawe; therefore, the species should not be treated as occurring on the island.

***Moorochloa eruciformis* (Sm.) Veldkamp****New state record**

An unusual grass was located and brought to my attention by Allen Allison, which turned out to be *Moorochloa eruciformis*, a new state record, after using the keys in Barkworth *et al.* (2003) and Clayton & Renvoize (1982). This species is monotypic in its genus and is native from the Mediterranean to South Africa and east to China and has become naturalized in scattered localities on all other continents (POWO 2023). In Australia, *M. eruciformis* is a noxious weed of agriculture, especially in unirrigated systems (Salgotra & Chauhan 2021).

*Moorochloa eruciformis* was found naturalized next to a driveway on Alaeloa St. on Wai'alae Ridge above Kahala. Only about a dozen plants were found in a small patch and no other patches were reported by Allen Allison as occurring nearby. *Moorochloa eruciformis* most closely resembles *Urochloa*, based on its inflorescence (Fig. 15), but can be recognized as distinct from all other naturalized *Urochloa* by its annual habit, creeping growth form rooting at the nodes, densely hairy florets, and shiny fertile lemma.

<sup>1</sup> Brother Matthias Newell (1854–1939) was the government Agricultural Inspector in Hilo from 1896–1923; hence, this could have been an interception from material deriving from elsewhere. — Editor



Figure 15. *Moorochloa eruciformis* inflorescence.

The following description is from Barkworth *et al.* (2003: 28):

“Plants mat-forming. Culms (10)19–60 cm, decumbent, rooting at the lower nodes before geniculate ascending, sometimes branching from the upper nodes; nodes pubescent; internodes glabrous. Sheaths glabrous or pubescent; ligules to 1 mm; blades 2–6(12) cm long, 3–6 mm wide, pubescent (rarely pilose) on both surfaces, bases subcordate. Panicles 4–9 cm long, 0.5–1 cm wide, exserted, with 3–15 erect to appressed branches; branches 1–2 cm, hispidulous; pedicels 0.1–0.5 mm, pubescent. Spikelets (1.6)2–2.6 mm long, 0.8–1 mm wide, ovate. Lower glumes 0.3–0.5 mm, to 1/5 the spikelet length; upper glumes (1.6)2–2.5 mm; lower lemmas longer than the paleas, 5-veined, without cross-venation; upper lemmas (1.4)1.7–1.8 mm long, 0.6–0.9 mm wide; anthers 0.5–1 mm, reddish. Caryopses 1–1.5 mm.  $2n = 18, 36$ .”

*Material examined.* O‘AHU: Honolulu, Alaeloa St near its intersection with Halekoa Dr, in weedy area next to driveway in front of house, sunny, rather dry area, stoloniferous annual to around 15 cm tall, small patch of around a dozen plants, area, 216 m, 21.288733, -157.778489, 24 Mar 2023, K. Faccenda & B. Najarin 3080.

***Muhlenbergia paniculata* (Nutt.)**

P.M. Peterson

**Correction**

*Muhlenbergia paniculata* was initially published based on a specimen from an agricultural experiment station (O’Connor 1990; cited as *Schedonnardus paniculatus*). While the label does not explicitly state that it was cultivated, Poamoho is also listed as the sole description on many other specimens from grass introduction gardens. Therefore, this species should not be listed as naturalized or even questionably naturalized in Hawai‘i.

***Oplismenus hirtellus* (L.) P. Beauv.**subsp. ***undulatifolius* (Ard.) U. Scholz**      **Correction**

*Oplismenus hirtellus* subsp. *undulatifolius* was published as occurring in Hawai'i by Snow & Lau (2010), where they had delimited *O. hirtellus* subsp. *undulatifolius* from the typical variety by the presence of hairs on the sheaths, as described by Barkworth *et al.* (2003). However, the sheath pubescence is not considered diagnostic by Davey & Clayton (1977), Scholz (1981), Clayton & Renvoize (1982), Launert & Pope (1989), or Peterson *et al.* (1999). These authors all diagnose the subspecies based on the inflorescence structure, and using that character, all specimens formerly annotated as *O. hirtellus* subsp. *undulatifolius* have been redetermined to *O. hirtellus* var. *hirtellus*. As such, *O. hirtellus* subsp. *undulatifolius* should be deleted from the Hawai'i checklist.

***Panicum coloratum* L.****Correction**

*Panicum coloratum* was first reported as naturalized on Maui by O'Connor (1990) based on *Hosaka 2448*; however, the label of that specimen states that it was grown at an experimental farm in Makawao. As this species was not naturalized at the time of the Hosaka collection, and has no present evidence of naturalization, it should be removed from the checklist for Maui.

***Panicum dichotomiflorum* Michx.****Correction**

Similar to the two entries above, *Panicum dichotomiflorum* is only known on O'ahu from one collection at the Poamoho Experiment Station, where it was almost certainly cultivated. Therefore, it should not be considered naturalized on O'ahu.

***Panicum pygmaeum* R. Br.****New state record**

*Panicum pygmaeum*, an Australian species, is recorded for the first time outside of its native range on Hawai'i Island in 'Ola'a at Hawaii Volcanoes National Park, where it was found near houses. Its introduction method is unclear but was likely an accidental introduction. Emmet Judziewicz (University of Wisconsin-Stevens Point) initially identified this grass and his identification was confirmed by the author.

*Panicum pygmaeum* can be identified by its decumbent stoloniferous habit <30 cm tall, and small "*Panicum*-type" panicles 2–8 cm long. It is most similar to *Cyrtococcum patens* but differs in its spikelets, as the spikelets on *P. pygmaeum* are dorsoventrally compressed, whereas *C. patens* has laterally compressed florets.

The following description is taken from Simon & Alfonso (2011):

"Perennial. Rhizomes absent. Stolons present. Culms decumbent, stature slender to delicate, 8–29 cm tall, 2–5-noded. Mid-culm internodes glabrous. Mid-culm nodes glabrous or pubescent. Lateral branches sparsely branched. Leaf-sheaths hairy. Leaf-sheath auricles absent. Ligule a fringe of hairs, 0.5 mm long. Leaf-blades spreading, linear or lanceolate, 1–4.5 cm long, 1–6 mm wide. Leaf-blade surface smooth or scabrous, indumented. Inflorescence compound, a panicle. Panicle ovate, 2–8 cm long, evenly furnished. Spikelets: spikelets pedicelled. Fertile spikelets 2-flowered, the lower floret barren (rarely male), the upper fertile, comprising 1 basal sterile florets, comprising 1 fertile floret(s), without rachilla extension, lanceolate or elliptic or ovate, dorsally compressed, 1.7–2.3 mm long. Rhachilla internodes brief up to lowest fertile floret. Glumes thinner than fertile lemma. Lower glume ovate,



membranous, without keels, 0-nerved. Lower glume apex mucinous. Upper glume elliptic or ovate, 1.7–1.9 mm long, membranous, without keels, 5(–7)-nerved. Upper glume surface smooth or asperulous. Basal sterile florets 1, barren, without significant palea. Lemma of lower sterile floret 100 % of length of spikelet, membranous, 5-nerved, mucronate. Fertile lemma 1.5–1.9 mm long, without keel. Lemma apex mucronate. Anthers 3”.

*Material examined.* **HAWAII:** Puna Distr, Hawaii Volcanoes National Park, ‘Ōla’a Forest, small tract fenced unit, patch near fence line adjacent to house and garden, stoloniferous grass, 1180 m, 07 Aug 1989, *L.W. Pratt 2282* (HAVO).

***Panicum repens* L.**

**New island record**

*Panicum repens* is now known from Moloka‘i, where it was found along Rt. 450 4–7 km west of ‘Ualapu‘e. Several large colonies were found, the largest of them being over 10 m long paralleling the road. It was surprising to see this species occurring on the coastal plain in a leeward area, when all other populations seen by the author on other islands have been from windward or otherwise much moister sites. It appears that this population must instead be getting its moisture from groundwater. *Panicum repens* is now known from O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i (Imada 2019).

*Material examined.* **MOLOKA‘I:** Rt 450, ca. 7 km W of ‘Ualapu‘e, roadside weed in wet, sunny area, colony about 5 m long along road, from moist ditch and not seen in drier areas in this location, rhizomatous, 7 m, 21.056070, -156.900483, 29 Dec 2022, *K. Faccenda 2966*; Rt 450, ca. 4 km W of ‘Ualapu‘e, roadside weed from rather dry, sunny area, large colonies present in this area extending over 20 m along road, 12 m, 21.047704, -156.874559, 29 Dec 2022, *K. Faccenda 2959*.

***Panicum tenuifolium* Hook. & Arn.**

**Correction**

As in part one of this series (Faccenda 2022), only one distributional change was accidentally found for a native grass. *Panicum tenuifolium* was published as occurring on Kaua‘i by Herbst & Clayton (1998) based on only one specimen (*Henrickson 4060*). However, this specimen is simply an aberrant *P. nephelophilum* with narrower leaves than typical; the duplicate specimen at US has wider leaves than the BISH specimen and is a match for *P. nephelophilum*. *Panicum tenuifolium* is now known to occur on O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i (O’Connor 1990).

***Paspalum distichum* L.**

**New island record**

*Paspalum distichum*, a stoloniferous grass from coastal areas, is now known to be naturalized on Hawai‘i Island, where it was collected on Coconut Island in Hilo. *Paspalum distichum* is now known from Kaua‘i, O‘ahu, and Hawai‘i (Imada 2019).

*Material examined.* **HAWAII:** Hilo, Coconut Island, mowed grass and spreading onto rocks in salt spray area, dominant grass on lawn and edge of ocean of islet, growing from lava and sand, naturalized from lawn and many unique individuals seen, with *Paspalum vaginatum*, 19.729708, -155.068245, 06 Mar 2022, *K. Faccenda 2338*.

***Paspalum jesuiticum* Parodi**

**New state record**

*Paspalum jesuiticum* is now known to be naturalized in Hawai‘i, having been naturalized since at least 2003 when it was first collected in Volcano on Hawai‘i Island; roadside surveys in 2022 showed that the species is widespread and abundant (1000s–10000s of plants seen) in the Volcano area, with a smaller number of plants seen at Ke‘eau. The

second known observation of the species was on Kauaʻi in 2018 at by iNaturalist user seakangaroo (<https://www.inaturalist.org/observations/17392613>) at Keāhua Arboretum, which alerted the author to its presence on Kauaʻi and led to a specimen being made from the same location where it was first reported in 2018. Further populations were found on the north side of Kauaʻi. During roadside surveys on Maui, only one colony was found on Hāna Hwy. One single plant was also found in the rear of Pālolo Valley on Oʻahu.

*Paspalum jesuiticum* is native to southern Brazil and Argentina and no records were found indicating that it was intentionally imported into Hawaiʻi. Its introduction mechanism is unclear; it may have been introduced as material misidentified as *Paspalum lividum*, a morphologically similar species that was intentionally imported for forage purposes. It is a well regarded forage species in Brazil (Descamps & Tcacenco 2000; Boldrini 2011) and may have also been introduced as a forage grass. This is the first time *P. jesuiticum* has been reported outside of its native range. There is limited information about the ecology of this grass available, but in Hawaiʻi, this grass was found most often in wet, sunny to partly shady areas that are often mowed, but was also seen in unmowed areas, where it was less common.

*Paspalum jesuiticum* is best identified using the new key to *Paspalum* below, but its unique features are 4–8 inflorescence branches, a strongly stoloniferous habit, and glabrous, acute spikelets (Fig. 16). The leaf sheaths on this species are variable; on most plants seen in Hawaiʻi, they are glabrous, but plants with strongly hirsute sheaths are also frequently seen, even in the same population.

The following description is from Parodi & Nicora (1969: 104) and was translated from Spanish:

“Perennial, creeping, with vigorous intravaginal innovations that arise from the rooted nodes; flowering culms ascending, 2–3-noded, 40–60 cm tall; blackish and glabrous nodes. Sheaths shorter than the internodes, grooved, hairy; ligule membranous, ochraceous, glabrous, 2–3 mm long; leaf blades flat, linear-lanceolate, 6–12 cm long by 6–10 mm wide, glabrous, with long, white, papillose based hairs scattered on both sides, usually with partially wavy edges. Panicles 7–8 cm long, formed by 7–8 greenish branches 3–6 cm long, divergent when fruiting, with a pubescent axis endowed with a few long hairs in the axils. Rachis mostly glabrous, dorsoventrally compressed, 1.6–1.8 mm wide, bearing 4 series of briefly pedicellate spikelets; pedicels compressed, glabrous with denticulate-scabrous sides. more or less than 0.5 mm on one spikelet, somewhat less on the other. Spikelets paired, ovate-lanceolate, 2.8 mm long by 1.5 mm wide, flat on the front face, convex on the back; lower (front) glume absent, upper 3-veined, barely mucronate, glabrous, similar in size to the spikelet; sterile lemma similar, 3-veined, as long as glume, without palea; fertile lemma ovate-lanceolate, 2.5 mm long, with a greenish or straw-colored back, finely dotted; palea embraced within. Bisexual flower with three yellow-orange anthers of 1–1.4 mm; lodicules 2, cuneiform, 0.4 mm.”

*Material examined.* **KAUAI:** Kapaʻa Valley, Keāhua Arboretum, roadside in the arboretum, 158 m, 22.071795, -159.417195, 29 May 2022, *K. Faccenda 2387*; Hanalei Valley, roadside at parking lot for ʻŌkolehao Trail, sunny moist roadside, 9 m, 22.201184, -159.472378, 30 May 2022, *K. Faccenda 2434.5*. **OʻAHU:** Pālolo Valley, rear of valley where road enters agricultural lots, at mailboxes, roadside weed in wet, partly sunny area on road shoulder, one plant seen, only two inflorescences, rare in area, 21.312048, -157.785706, 04 Mar 2023, *K. Faccenda 3051*. **MAUI:** Hāna Hwy, ca. 2 km E of Wailua, wet, shady roadside dominated by weeds, 368 m, 20.820957, -156.134018, 23 Oct 2022, *K. Faccenda 2767*. **HAWAII:** Puna Distr, Wright Rd, 3–4 mile marker,



**Figure 16.** Inflorescence and spikelets (inset) of *Paspalum jesuiticum*.

along roadside, wet open disturbed area, rhizomatous, 4,000 ft [1,220 m], 06 Oct 2003, *K.F. Bio 03-0015*; Puna Distr, Hwy 11 near Kurtistown, mile 14, disturbed roadside, 1,500 ft [457 m], 12 Jun 2003, *L.W. Pratt 3321*; Hawaii Volcanoes National Park, roadside near the Volcano House, wet, frequently mowed area, 1209 m, 19.428054, -155.257711, 10 Aug 2022, *K. Faccenda 2608*.

***Paspalum langei*** (E. Fourn.) Nash

**New state record**

Roadside surveys on O‘ahu at Pūpūkea found that *Paspalum langei* is naturalized in the subdevelopment above Pūpūkea, where thousands of plants were seen along roadsides. *Paspalum langei* is native from the southern United States through Central America (POWO 2023). Discovery of this population in Hawai‘i marks the first time it has been found outside of its native range (POWO 2023). In its native range, this grass is found in tropical, deciduous, or subevergreen forests, along paths, on floodplains, and as a weed associated with agriculture (Denham 2005). It has also been reported as useful as a forage species (Denham 2005).

*Paspalum langei* is similar to *P. botterii* (E. Fourn.) Chase and was synonymized by Denham (2005); however, the two species are now largely regarded as distinct (POWO 2023). *Paspalum botterii* differs from *P. langei* in lacking a lower glume on the lower floret of the lower spikelet in the pair (Davidse *et al.* 1994).

*Paspalum langei* is identified by its annual habit, inflorescence with 1–3 (usually 2) branches, frequent presence of axillary inflorescences, and presence of dimorphic lower glumes between its paired florets (Fig. 17). Look-alike species include *P. pilosum*, which differs in having only one inflorescence branch and a perennial habit. *Paspalum setaceum* is also similar, but differs in having no lower glumes on any spikelets.



**Figure 17.** *Paspalum langei* inflorescences and spikelets (inset) from the Pūpūkea population. Inset photo courtesy of Mike Ross.

The following description is from the Flora of North America (Barkworth *et al.* 2003: 588):

“Plants perennial; cespitose. Culms 23–125 cm, erect; nodes glabrous or pubescent. Sheaths glabrous or pubescent; ligules 0.6–1.9 mm; blades to 38 cm long, 4–18 mm wide, flat, glabrous or pubescent, dark green. Panicles terminal, with 1–3(4) racemously arranged branches; branches 2.3–13.4 cm, erect to divergent, terminating in a spikelet; branch axes 0.2–1 mm wide, glabrous, margins scabrous. Spikelets 2.1–3.3 mm long, 1.3–1.6 mm wide, paired, imbricate, appressed to the branch axes, elliptic to obovate, stramineous to brown. Lower glumes 0.4–1.2(1.8) mm, stramineous to brown; upper glumes with papillose-based short pubescence, 3- or 5-veined, margins entire, lower lemmas with papillose-based short pubescence, lacking ribs over the veins, 3-veined, margins entire; upper florets light stramineous. Caryopses 1.3–1.5 mm, light to dark brown.  $2n = 40, 60$ .”

*Material examined.* O‘AHU: Pūpūkea, Pu‘u o Mahuka Rd leading to heiau, about halfway along road, moist, partly shaded roadside, 93 m, 21.642699, -158.057310, 08 Dec 2022, *K. Faccenda & M.C. Ross 2861*; Pūpūkea, Pūpūkea Rd and Alapio Rd, roadside, near to top of a driveway, sunny moist area, uncommon in subdivision, only a few colonies seen above heiau, 171 m, 21.646187, -158.047419, 08 Dec 2022, *K. Faccenda & M.C. Ross 2866*.

***Paspalum mandiocanum* Trin.**

var. *mandiocanum*

**New island record**

*Paspalum mandiocanum* was encountered during recent fieldwork on Hawai‘i Island at Kalōpā State Recreation Area, where it was found near the parking lot in moist woods. This species has now been documented on Kaua‘i, O‘ahu, Moloka‘i, Maui, and Hawai‘i (Imada 2019; Faccenda 2022).

*Material examined.* HAWAII: Kalōpā State Recreation area, near parking lot, disturbed forest, stoloniferous, colony ca. 5 m wide, shady forest, moist, 20.038153, -155.435370, 06 Mar 2022, K. Faccenda 2344.

***Paspalum minus* E. Fourn.**

**New state record**

Roadside surveys around Hilo found *Paspalum minus* growing abundantly from mowed roadsides and lawns moist areas. The population along Railroad Ave. was the largest seen, spanning over 1 km of mowed roadside. *Paspalum minus* is native to the Americas and is found in the southeastern United States through Central America to Paraguay (Barkworth *et al.* 2003), and has been previously introduced to Japan (POWO 2023).

This species is most similar to *Paspalum notatum* and *Axonopus compressus*, and these three species were seen growing sympatrically in some areas around Hilo. *Paspalum minus* differs from each of these in spikelet size, being intermediate between *P. notatum* and *A. compressus* (Fig. 18).

The following description is from the Flora of North America (Barkworth *et al.* 2003: 577):

“Plants perennial; shortly rhizomatous. Culms 3–60 cm, erect; nodes glabrous. Sheaths glabrous or pubescent; ligules 0.2–0.7 mm; blades 8–18 cm long, 2–7.1 mm wide, flat, glabrous or pubescent. Panicles terminal, usually composed of a digitate pair of branches, a third branch sometimes present below the terminal pair; branches 1.8–6.4 cm, diverging to erect; branch axes 0.5–1.3 mm wide, narrowly winged, glabrous, margins scabrous, terminating in a spikelet. Spikelets 1.9–2.3 mm long, 1.2–2 mm wide, solitary, appressed to the branch axes, broadly elliptic to ovate to obovate, glabrous, stramineous, apices obtuse. Lower glumes absent; upper glumes 3-veined, lower lemmas faintly 3-veined; upper florets stramineous. Caryopses 1.8–2.2 mm, white.  $2n = 20, 40, 50$ .”



**Figure 18.** *Paspalum notatum* on left, *P. minus* on right, both plants collected in Hilo.

*Material examined.* **HAWAII:** Hilo, Railroad Ave though Hawaiian Homeland Agricultural lots, 42 m, 19.687861, -155.053947, 07 Aug 2022, *K. Faccenda 2579*; Hilo, intersection of East Kahaopea St and Kīlauea Ave, in infrequently mowed abandoned lot, along edge of road, 44 m, 19.689748, -155.068712, 07 Aug 2022, *K. Faccenda 2584*.

***Paspalum plicatum* Michx.**

**New island record**

Reported as occurring on Kaua'i by Faccenda (2022), another specimen of *Paspalum plicatum* was identified from Hawai'i Island, where it was collected near Kurtistown in 2003. Roadside surveys on Maui also found that it is naturalized at the beginning of the road to Hāna. The Maui population extended for about one kilometer along the road, where it was common but not abundant on the roadside. *Paspalum plicatum* is now known from Kaua'i, Maui, and Hawai'i.

*Material examined.* **MAUI:** Hāna Hwy heading towards Hāna, ca. 1 km after the road loses its shoulder and becomes windy with blind curves, roadside in sunny, wet, infrequently mowed areas, 221 m, 20.892643, -156.216742, 28 Oct 2022, *K. Faccenda 2821*. **HAWAII:** Puna Distr, Hwy 11 near Kurtistown, grass growing on disturbed areas on roadside, 650 ft [200 m], 12 Jun 2003, *L.W. Pratt 3322*.

KEY TO *PASPALUM* IN HAWAII

The inflorescence of *Paspalum* is a panicle composed of one to many spikelike branches, simply referred to as branches in this key. *Paspalum* is closely related to, and similar to, *Axonopus*, which is also included in this key.

1. Inflorescences both terminal and axillary on same culm (sometimes manifesting as 2 inflorescences that appear to arise terminally since they arise out of the same leaf sheath, but are not united at the base); each panicle composed of 1–2 (rarely 3–6) branches
  2. Lower glumes present and dimorphic between paired spikelets
    3. Panicle branch single; rachis of panicle branch usually with scattered setae; spikelets 2.6–3.2 mm long; spikelets glabrous; lower glume of lower spikelet the larger of the pair ..... *P. pilosum*
    - 3'. Panicle with 1–2 (rarely 3–4) branches; rachis of panicle branch without setae; spikelets 2.2–2.6 mm long; spikelets minutely pubescent, at least on upper glume; lower glume of upper spikelet the larger of the pair ..... *P. langei* (in part)
  - 2'. Lower glumes absent on all spikelets
    4. Plant caespitose or rhizomatous; spikelets round, blunt at apex [only known from Midway as of 2023] ..... *P. setaceum*
    - 4'. Plant stoloniferous; spikelets ovate to lanceolate, acute at apex . *Axonopus* spp.
- 1'. Inflorescence terminal, never axillary; each panicle composed of 2–70 branches
  5. Plants stoloniferous
    6. Panicle branches alternately arranged; panicle with  $\geq 3$  branches
      7. Florets with obtuse apex; plant erect or decumbent and rooting at nodes ..... *P. mandiocanum* var. *mandiocanum* (in part)
      - 7'. Florets acute; plant strongly stoloniferous ..... *P. jesuiticum*
    - 6'. Panicle branches paired (or approximately so) at apex of inflorescence; panicle with 2 branches on most individuals (uncommonly with a 3rd lower branch)
      8. Spikelets 1–2 mm long; upper glume pilose around edges .... *P. conjugatum*

- 
- 8'. Spikelets >2 mm long; upper glume without hairs concentrated on edges
  - 9. Stolons 3–8 mm diam. with internodes <1 cm; leaves concentrated at tip of stolon; spikelets elliptic to ovate, obtuse at apex; not found in saline situations and not growing aquatically
    - 10. Florets >2.5 mm long; leaves flat or folded ..... *P. notatum*
    - 10'. Florets <2.3 mm long; leaves flat ..... *P. minus*
  - 9'. Stolons 1–3 mm diam. with internodes typically >1 cm; leaves evenly distributed along stolon; spikelets elliptic-lanceolate, acute at apex; often (but not always) found in saline situations or growing as an emergent aquatic
    - 11. Spikelets 2.4–3.2 mm long; upper glume obscurely hairy .....  
..... *P. distichum*
    - 11'. Spikelets 3.0–4.5 mm long; upper glume glabrous ..... *P. vaginatum*
  - 5'. Plants caespitose, rarely rooting at lower nodes
  - 12. Panicle with 1–10 branches
    - 13. Upper glume fringed with hairs or a lacerate wing
      - 14. Upper glume fringed with a lacerate, papery wing ..... *P. fimbriatum*
      - 14'. Upper glume fringed with hairs
        - 15. Upper glume fringed with stiff, spreading hairs; spikelets 2.5–2.8 mm long ..... *P. humboldtianum*
        - 15'. Upper glume fringed with soft hairs; spikelets 1.8–4.5 mm long
          - 16. Hairs on florets minute, usually not visible without magnification ' ..... *P. virgatum* (in part)
          - 16'. Hairs on florets long and wispy (at least some 1 mm long), visible without magnification
            - 17. Panicle branches <7, held widely spreading from panicle axis; florets 2.5–4.5 mm long ..... *P. dilatatum*
            - 17'. Panicle branches >7, ascending, loosely appressed to panicle axis; florets <2.8 mm long ..... *P. urvillei* (in part)
    - 13'. Upper glume without fringe of hairs or lacerate wing around its edge
      - 18. Spikelets borne singly, rarely with some spikelets paired, if so, these are the minority of florets in an inflorescence [native?] ..... *P. scrobiculatum*
      - 18'. Spikelets borne in pairs, all florets consistently paired, although the lower of the pair may be aborted in some parts of the inflorescence
        - 19. Florets with lower glumes present, these glumes dimorphic between the spikelets of the pair ..... *P. langei* (in part)
        - 19'. Florets with lower glumes absent
          - 20. Leaves linear, their width uniform or tapering from base; fertile lemma dark glossy brown; leaves <9 mm wide ... *P. plicatum* (in part)
          - 20'. Leaves lanceolate, their width greatest above the base; fertile lemma pale; at least some leaves >10 mm wide
            - 21. Leaf margins scabrous or smooth, without cilia; spikelets glabrous or with limited hairs on edge of glume; leaves appressed pilose .....  
..... *P. mandiocanum* var. *mandiocanum* (in part)
            - 21'. Leaf margin ciliate; spikelets evenly pubescent on glume; leaves glabrous or pubescent ..... *P. macrophyllum*

- 12'. Panicle with >10 branches (occasionally with <10 branches if mowed or grazed)
22. Spikelets ~1 mm thick, with a noticeable bulge in central portion; spikelets of dried material often bicolored with a brown center portion and green rims ..... *P. plicatum* (in part)
- 22'. Spikelets ~0.5 mm thick, relatively uniform in thickness, or hemispherical in *P. paniculatum*; color uniform when dried
23. Spikelets entirely glabrous
24. Sterile lemma ribbed over veins; both glumes lacking; weaker grasses with culms typically <6 mm diam. at base ..... *P. malacophyllum*
- 24'. Sterile lemma smooth; upper glume present; robust grasses with culms ~1 cm diam. at base ..... *P. arundinaceum*
- 23'. Spikelets with at least some hairs visible under 10× magnification
25. Spikelets evenly pubescent; spikelets 1.00–1.3 mm long .. *P. paniculatum*
- 25'. Spikelets with hairs concentrated on glume edge; spikelets 2–3 mm long
26. Glume with a long-ciliate fringe around their edge, this obvious without magnification ..... *P. urvillei* (in part)
- 26'. Glume with a short-ciliate fringe around the edge, the hairs only visible under magnification ..... *P. virgatum* (in part)

***Phalaris canariensis* L.****Correction**

*Phalaris canariensis* was noted as occurring on Hawai'i and Maui by O'Connor (1990); however, the labels on the material cited indicate the plant was cultivated on these islands. *Phalaris canariensis* is now only known as a questionable naturalization on O'ahu, where it was only collected once as a volunteer in a Nu'uaniu garden and is likely extirpated.

***Phalaris paradoxa* L.****Questionable new island record**

*Phalaris paradoxa* was first published as occurring on O'ahu by Hitchcock (1922), but the specimen and citation have been overlooked by recent authors. As the species has not been seen in the past 100 years, it is considered a questionable naturalization.

*Material examined.* O'AHU: Nu'uaniu Pali, 17 Jun 1916, *A.S. Hitchcock 13780* (US).

***Phleum pratense* L.****Questionable new island record**

Previously reported as naturalized on Kaua'i, O'ahu, and Maui (Imada 2019), *Phleum pratense* is now known from an old collection on Hawai'i Island. As the collection is 80 years old and has not been recollected since, it is considered questionably naturalized.

*Material examined.* HAWAII: Hawaii Volcanoes National Park, park residence street, few plants only, along roadside, 06 Jun 1943, *G.O. Fagerlund & A.L. Mitchell 667* (HAVO).

***Saccharum ×sinense* Roxb.****New state record**

A curious species of cane was found while reviewing photos from inaturalist.org; it was subsequently visited in the field and determined to be *Saccharum ×sinense* using the key to *Saccharum* in Wu *et al.* (2006) and Backer & van den Brink (1968). *Saccharum ×sinense* has been naturalized on Hawai'i Island along the Hāmākua coast since at least



2019, when it was first photographed by iNaturalist user csk (<https://www.inaturalist.org/observations/19581157>). Hundreds of plants were observed by the author along the road leading to ‘Akaka Falls.

*Saccharum* × *sinense*, (commonly called Uba Cane) has been variously treated as a hybrid or full species depending on the author, but it is likely of hybrid origin, perhaps derived from *S. spontaneum* and *S. barberi* as parents (Amalraj & Balasundaram 2006). *Saccharum* × *sinense* is closely related to domestic sugarcane and is likely an ancestor of modern hybrid cultivars (Wu *et al.* 2006). *Saccharum* × *sinense* was intentionally imported to Hawai‘i for sugarcane breeding experiments as early as 1905 (Rotar 1968).

*Material examined.* HAWAI‘I: Outside ‘Akaka Falls State Park, roadside, common along the road for over 1 km leading to park, cane to 3 m tall, dominant in area along road, naturalized, 378 m, 19.851510, -155.150403, 06 Mar 2022, K. Faccenda 2350.

### Key to *Saccharum* in Hawai‘i

1. Inflorescence axis glabrous (pilose in some hybrid cultivars); cultivated and not currently known to naturalize ..... *S. officinarum*
- 1'. Inflorescence axis densely pilose; naturalized
  2. Plant rhizomatous; leaf blades 0.2–0.8 cm wide ..... *S. spontaneum*
  - 2'. Plant clump-forming; leaf blades 1–6 cm wide ..... *S. × sinense*

### *Schizachyrium condensatum* (Kunth) Nees      **Correction**

*Schizachyrium condensatum* was first published as occurring in Hawai‘i by O’Connor (1990). However, this identification was erroneous, as all specimens and populations previously referred to as *S. condensatum* in Hawai‘i have now been reidentified as *S. microstachyum*. True *S. condensatum* is not known to occur in Hawai‘i. See further comments under *S. microstachyum*.

### *Schizachyrium microstachyum* (Desv.)

Roseng., B.R. Arrill. & Izag.

### **New state record**

After a critical review of the collections at BISH, PTBG, US, and HAW, all specimens formerly identified as *Schizachyrium condensatum* from Hawai‘i have been reidentified as *S. microstachyum*, based on a recent revision of the group showing that the name *S. condensatum* has been widely misapplied to a complex of closely related, but unique, species (Welker & Peichoto 2015). In Hawai‘i, *S. microstachyum* is often and easily confused with *Andropogon bicornis* and *A. tenuispatheus*. A new key is provided below to help with their identification.

The plants now called *Schizachyrium microstachyum* have had a frustratingly tortuous nomenclatural history in Hawai‘i: they were first recognized as *Andropogon glomeratus* (Degener & Degener 1983) until O’Connor (1990) placed them in the correct genus as *Schizachyrium condensatum*, but now the name must change again, as *S. condensatum* was misapplied in Hawai‘i as well as throughout much of the species native range. It must also be noted that true *Andropogon glomeratus* var. *pumilus* (now *Andropogon tenuispatheus*) is also naturalized in Hawai‘i and is an entirely different species from *S. microstachyum*.

According to Degener & Degener (1983), which was then cited by O’Connor (1990), *S. microstachyum* was first introduced in O‘ahu in 1932. However, neither source

provides evidence to support this date, and I have found no evidence to support it as the first collection from O‘ahu is dated 2012. It is almost certain that the Degeners were confusing *S. microstachyum* with *Andropogon virginicus*, as there are several specimens of *A. virginicus* from O‘ahu dated as 1932. The first reliable evidence of *S. microstachyum* occurring in Hawai‘i is from herbarium material dated 1961. According to *O. Degener 35273* (BISH), it was apparently imported into the islands with hay for mule feed after WWII, contradicting their supposed 1932 introduction date.

During roadside surveys on Maui, the first population of this grass was found on the island in the Ha‘ikū area, consisting of approximately 500 plants. *Schizachyrium microstachyum* is abundant on Hawai‘i Island, with most of the population centered between Hilo and Kahuku, with very large stands of this grass occurring in the Volcano area; smaller populations are found on Kaua‘i, where this grass is widespread but relatively uncommon. Small populations also exist on O‘ahu and Maui. Only the first record from each island is cited below.

*Material examined.* **KAUA‘I:** Summit of Mt. [Mauna] Kapu, Kalepa Ridge, 207 m, 19 Aug 1989, *L. Hume 411* (PTBG). **O‘AHU:** Schofield Barracks East Range, on road that loops up to Schofield-Waikāne Trail, 1,400 ft [426 m], 21.498107, -157.968028, 27 Feb 2012, *US Army 268*. **MAUI:** Ha‘ikū, ‘Awalau Rd about 700 m away from Kaupakalua Rd, 393 m, 20.884063, -156.288203, 30 Oct 2022, *K. Faccenda & S. Vanaprucks 2837*. **HAWAI‘I:** Ka‘ū, Kapāpala Ranch, [occasional] in dry pasture, 2000 ft [609 m], 29 Apr 1961, *E.Y. Hosaka s.n.* (BISH 786575).

### *Schizachyrium sanguineum* (Retz.) Alston **New state record**

During roadside surveys on Moloka‘i a population of at least several hundred individuals of *Schizachyrium sanguineum* was found on Rt 450 about 1 km south of the Pu‘u O Hoku Ranch headquarters (Fig. 19). After this population was seen, naturalized specimens from O‘ahu and Kaua‘i previously identified as the morphologically similar species, *S. scoparium*, were critically examined and all were found to be *S. sanguineum*. *Schizachyrium sanguineum* can be identified by its fertile lemma being bilobed  $\frac{2}{3}$ – $\frac{7}{8}$  of its length and having pubescent or glabrous glumes, whereas *S. scoparium* has a fertile lemma that is bilobed up to  $\frac{1}{2}$  its length, and glumes that are always glabrous (Barkworth *et al.* 2003). As such, *S. sanguineum* is now known to be naturalized on Kaua‘i, O‘ahu, and Moloka‘i.

There are no records of *S. sanguineum* being intentionally imported to Hawai‘i, making it likely that this was an accidental introduction. This species was first collected in Hawai‘i on O‘ahu in 1987. *Schizachyrium sanguineum* is native from the southern United States through Central and most of South America, as well as most of Africa and India through most of Southeast Asia (POWO 2023). It has never before been reported outside of its native range (POWO 2023). In its native range, *S. sanguineum* occupies many habitat types, including meadows, cerrado, and forest edges and interiors, but is generally restricted to dry and sunny areas on rocky soils (Peichoto 2010; Cope 2002). *Schizachyrium sanguineum* is a fire-tolerant species, as it occurs in fire-prone cerrado vegetation in South America (Peichoto 2010) and is associated with annually burned firebreaks in South Africa (Bachinger *et al.* 2016).

The following description is taken from Barkworth *et al.* (2003: 674):

“Plants caespitose. Culms 40–120 cm, erect, not rooting or branching at the lower nodes, glabrous. Sheaths glabrous, rounded; ligules 0.7–2 mm; blades 7–20 cm long, 1–6 mm wide, usually with long, papillose-based hairs basally, glabrous elsewhere,

sometimes scabrous, without a longitudinal stripe of white, spongy tissue. Peduncles 4–6 cm; rames 4–15 cm, not open, usually almost fully exerted at maturity; internodes 4–6 mm, straight, from mostly glabrous with a tuft of hairs at the base to densely hirsute all over. Sessile spikelets 5–9 mm; calluses 0.5–1 mm, hairs to 2 mm; lower glumes glabrous or densely pubescent; upper lemmas cleft for  $(2/3)3/4$ – $7/8$  of their length; awns 15–25 mm. Pedicels 3–6 mm long, 0.3–0.5 mm wide at the base, gradually widening to about 0.6–0.8 mm at the top, straight. Pedicellate spikelets 3–5 mm, usually evidently shorter than the sessile spikelets, sterile or staminate, awned, awns 0.3–6 mm.”



**Figure 19.** Inflorescence of *Schizachyrium sanguineum* from the Moloka‘i population.

*Material examined.* **KAUAI:** Hanalei Distr, Waipā, ahupua‘a on SW of Waipā Stream, pasture land and secondary forest giving way to *Metrosideros*-dominated forest near base of ridge that forms natural boundary of area, dominant grass in heavily grazed pasture lands, 150–960 ft [46–292 m], 02 Dec 1988, *T. Flynn & L. Hume* 3220. **O‘AHU:** Ko‘olauloa, Pūpūkea-Paumalū, uncommon in periphery of *Casuarina* forest in sunny sites, 600 ft [183 m], 05 Dec 1987, *K.M. Nagata & W. Takeuchi* 3743. **MOLOKA‘I:** Rt 450 ca. 1 km S of Pu‘u o Hoku Ranch headquarters (as the ‘alalā flies), about 400 m W of a large pasture spanning both sides of road, growing on steep slopes of poor soil on roadcut in rather dry, exposed, sunny location with assorted invasive weeds, over 100 individuals present, 168 m, 21.134355, -156.734510, 29 Dec 2022, *K. Faccenda* 2957.

***Schizachyrium scoparium* (Michx.) Nash      Correction**

*Schizachyrium scoparium* is now known only from old, cultivated collections from grass gardens in 1939 & 1941 (*Hosaka* 2459, 2612) and is not known to be naturalized in Hawai‘i. The specimens previously published as naturalized by Herbst & Clayton (1998) and Lorence *et al.* (1995) have been redetermined as *Schizachyrium sanguineum*. See further discussion under that species.

COMBINED KEY TO NATURALIZED *SCHIZACHYRIUM* AND *ANDROPOGON* IN HAWAII

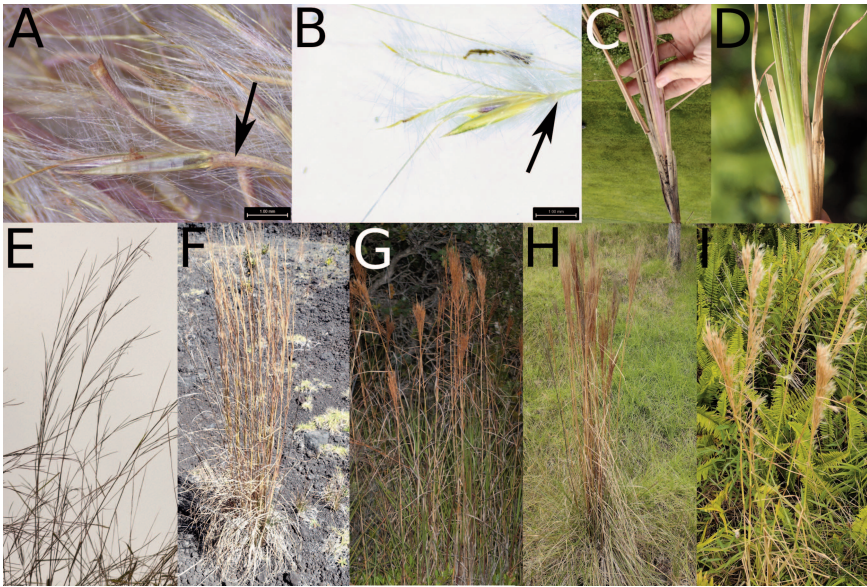
The genera *Schizachyrium* and *Andropogon* are most reliably distinguished by the tip of the rame internodes having a concave cuplike structure at their apex on *Schizachyrium* and no such structure existing on *Andropogon* (Fig. 20a–b). However, that character is difficult to use in the field and this key was designed to avoid using it. The grasses in these genera in Hawai‘i have a history of misidentification; hopefully, this key will help towards reducing misidentifications in the future.

1. Inflorescence uniformly narrow (Fig. 20e–f)
  2. Florets fluffy and with conspicuous hairs; racemes paired, 3–5 cm long and <0.5 mm diam. .... *Andropogon virginicus* var. *virginicus*
  - 2'. Florets with minute hairs, these not visible to the naked eye; racemes single, 4–15 cm long and 0.8–1.5 mm diam. .... *Schizachyrium sanguineum*
- 1'. Inflorescence narrow at base and expanding in width towards tip with profuse branching (Fig. 20g–i)
  3. Leaves stiff and strongly scabrous on margins; culms circular at base (Fig. 20c); flowering culms 1.5–2.5 m tall ..... *Andropogon bicornis*
  - 3'. Leaves usually rather soft, weakly scabrous or smooth-margined; culms circular or strongly laterally compressed at base; flowering culms rarely surpassing 1.5 m tall
  4. Base of culms circular; inflorescence held stiffly upright, rarely drooping; plants often with strong brick-red coloration on leaf sheaths; leaves evenly distributed along culm at flowering time ... *Schizachyrium microstachyum* [formerly *S. condensatum*]
  - 4'. Base of culms strongly laterally compressed due to distichously arranged leaf sheaths (Fig. 20d); inflorescence often drooping (Fig. 20i); plants typically without reddish coloration on leaves or sheath; leaves basally disposed on culms at flowering time ..... *Andropogon tenuispathus* [formerly *A. glomeratus* var. *pumilus*]

***Setaria adhaerens* (Forssk.) Chiov.****New state record**

The species *Setaria verticillata* and *S. adhaerens* have long been considered closely related and synonymized by many authors, including Clayton & Renvoize (1982) and Morrone *et al.* (2014). Other authors, such as Barkworth *et al.* (2003) and more recently Crespo *et al.* (2020), accept the name *S. adhaerens* as distinct from *S. verticillata* and their treatment is followed here. *Setaria adhaerens* is a  $2n = 18$  species with glabrous leaf sheaths and margins, whereas *Setaria verticillata* is a  $2n = 36$  species with hairy leaf sheaths and margins (Crespo *et al.* 2020). The species also differ in their distribution, with *S. adhaerens* being tropical and *S. verticillata* being temperate.

All herbarium specimens at BISH and HAW (approximately 150 (BISH) + 40 (HAW) in total) were examined and all were found to have glabrous leaf sheaths, indicating that all Hawaiian material formerly called *Setaria verticillata* should now be referred to as *S. adhaerens*. *Setaria adhaerens* is known from all islands where *S. verticillata* was previously reported, including Kure Atoll, Midway, Pearl and Hermes, French Frigate Shoals, Nihoa, Ka'ula Rock, Lehua, Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, Kaho'olawe, and Hawai'i (Imada 2019). As numerous specimens of this grass exist from Hawai'i, only the earliest record for each island is cited below.



**Figure 20.** Comparison of *Schizachyrium* spp. and *Andropogon* spp. in Hawai'i. **A**, *Schizachyrium microstachyum* floret, arrow indicating rami internode (Illis 132). **B**, *Andropogon tenuispatheus* floret, arrow indicating rami internode (Lau OISC002). **C**, *A. bicornis* culm base. **D**, *A. virginicus* culm base, the culm base is very similar in shape to *A. tenuispatheus*. **E**, *Schizachyrium sanguineum* habit. **F**, *Andropogon virginicus* habit. **G**, *Schizachyrium microstachyum* habit. **H**, *Andropogon bicornis* habit. **I**, *A. tenuispatheus* habit.

*Material examined.* **KURE:** Under the tower on east side of island, 14 Sep 1964, C.R. Long 2246. **MIDWAY:** Eastern Island, also found on Sand Island, Nov 1954, J.A. Neff & P.A. DuMunt 7. **PEARLAND HERMES REEF:** Common on east portion of island (Southeast Island), 16 Sep 1964, C.R. Long 2269. **FRENCH FRIGATE SHOALS:** Tern Islet, H.I. Rainwater s.n. (BISH 120406). **NIHOA:** Near S coast, May 1969, D.E. Yen 1012. **KA'ULA ROCK:** Ka'ula Rock, 21 Jan 1976, R. Daehler 6. **LEHUA:** Lehua Rock, 19 Apr 1931, E.L. Caum 20. **NI'HAU:** Ni'ihau, Jan 1912, J.F.G. Stokes s.n. (BISH 120389). **KAUA'I:** Makaweli, Apr 1903, A. Robinson 3. **O'AHU:** Honolulu, Waikiki, 20 Mar 1895, A.A. Heller 1961. **MOLOKA'I:** Near Kaunakakai, in cultivated field, 03 Sep 1936, L.D. Whitney 4456. **LĀNA'I:** Kō'ele, 02 Feb 1916, G.C. Munro 513. **MAUI:** Kanahā Pond, near S side adjacent to the parking area & observation point, 22 Jun 1962, C.H. Lamoureux 2035. **KAHO'OLAWA:** Transect c4 along secondary road to area above lighthouse, 25 Nov 1978, W.P. Char 78.06. **HAWAI'I:** Kohala, 12 Sep 1924, C.C. Barnum 59.

### *Setaria distans* (Trin.) Veldkamp

### New island record

Formerly reported on Ni'ihau and Moloka'i (Faccenda 2022), *Setaria distans* is now known on Kaua'i.

*Material examined.* **KAUA'I:** Awa'awapuhi, Nā Pali Valley, lowland dry secondary forest, very common, 200 ft [61 m], 23 Aug 2004, K.R. Wood 10921 (PTBG).

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

*Setaria verticillata* is no longer known to occur in Hawai'i. All material from all islands of Hawai'i formerly identified as this have been reidentified as *Setaria adhaerens*; see further comments above.

***Setaria viridis* (L.) P. Beauv.****Questionable new state record**

A single plant of *Setaria viridis* was recently found growing from the strip of dirt between sidewalk and road in urban Honolulu. Nearby, *Panicum miliaceum* and a new state record dioecious *Amaranthus* were found, suggesting that the species may have been imported with bird seed. Given that urban Honolulu has been relatively heavily botanized recently by both the author and M. Ross, and no other populations have been seen, this should be considered a questionable naturalization unless more plants are found.

*Setaria viridis* is native to much of Afroeurasia and has become widely naturalized across much of the Americas, where it is an aggressive weed of agriculture (Barkworth *et al.* 2003). *Setaria viridis* can be identified by its annual habit, spikelets with only a faintly transversely rugose fertile lemma, and 1–5 bristles below each spikelet, or by using the key below.

The following description is from Barkworth *et al.* (2003: 554):

“Plants annual. Culms 20–250 cm; nodes glabrous. Sheaths glabrous, sometimes scabridulous, margins ciliate distally; ligules 1–2 mm, ciliate; blades to 20 cm long, 4–25 mm wide, flat, scabrous or smooth, glabrous. Panicles 3–20 cm, densely spicate, nodding only from near the apices; rachises hispid and villous; bristles 1–3, 5–10 mm, antrorsely scabrous, usually green, rarely purple. Spikelets 1.8–2.2 mm. Lower glumes about as long as the spikelets, triangular-ovate, 3-veined; upper glumes nearly equaling the upper lemmas, elliptical, 5–6-veined; lower lemmas slightly exceeding the upper lemmas, 5-veined; lower paleas about as long as the lower lemmas, hyaline; upper lemmas very finely and transversely rugose, pale green, 5–6-veined; upper paleas similar to the upper lemmas.  $2n = 18$ .”

*Material examined.* O'AHU: Algaroba St, near intersection with Makahiki Way, growing in dirt near sidewalk, 21.173503, -157.494117, M. Ross 1861.

KEY TO *SETARIA* IN HAWAII

1. Only one (or sometimes zero) bristle(s) subtending each spikelet
  2. Leaves strongly plicate (resembling a palm seedling), >15 mm wide ..... *S. palmifolia*
  - 2'. Leaves flat, <10 mm wide
    3. Bristles inconspicuous; inflorescence of racemes ..... *S. distans*
    - 3'. Bristles conspicuous; inflorescence spikelike [this is currently treated as an endemic genus but is likely instead a member of *Setaria*] ..... *Dissochondrus biflorus*
- 1'. Multiple bristles subtending each spikelet
  4. Bristles retrorsely barbed, sticky to touch ..... *S. adhaerens*
  - 4'. Bristles antrorsely barbed, not sticky to touch
    5. Spikelets fascicled, fascicle subtended by >30 bristles [potentially confused with *Setaria*] ..... *Cenchrus americanus*
    - 5'. Spikelets not fascicled (but may have fused pedicles), subtended by <12 bristles

6. Fertile lemma smooth or minutely rugose; annual; bristles green  
 7. Fertile lemma smooth and shiny; inflorescence with secondary branches  
 ..... *S. italica*  
 7'. Fertile lemma dull, finely rugose; inflorescence without secondary  
 branches [questionably naturalized as of 2023] ..... *S. viridis*  
 6'. Fertile lemma conspicuously rugose; perennial; bristles yellow, orange,  
 green, or purple  
 8. Inflorescence >10 cm; bristles typically yellow, orange, or purple;  
 rhizomes stout ..... *S. sphacelata*  
 8'. Inflorescence <10 cm; bristles typically yellow to green; rhizomes knotty  
 ..... *S. parviflora*

***Sorghum arundinaceum* (Desv.) Stapf                      Correction**

Examination of the specimens of *S. arundinaceum* published by Snow & Lau (2010) shows that it is no different than *Sorghum × drummondii*. True *Sorghum arundinaceum* can be identified by its leaves >2 cm wide and readily disarticulating racemes, and deciduous pedicelled florets (Barkworth *et al.* 2003; Fish *et al.* 2015). As these vouchers were the only record of the species in Hawai'i, *S. arundinaceum* should be removed from the Hawai'i checklist and be considered a misapplied name in Hawai'i.

***Sorghum × drummondii* (Nees  
 ex Steud.) Millsp. & Chase                      New island records**

*Sorghum × drummondii* was previously reported as questionably naturalized on Hawai'i Island (Herbst & Clayton 1998), but is now known to be established in the Puna District based on herbarium material and populations found during roadside surveys. It was also found on Kaua'i at Kalāheo during roadside surveys. This species is now known to be naturalized on Kaua'i, O'ahu, Lāna'i, and Hawai'i (Imada 2019).

*Material examined.* **KAUAI:** Kalāheo, National Tropical Botanical Garden, weed in native plant section of garden, only 4 plants seen in small clump, 49 m, 21.904084, -159.508360, 01 Jun 2022, *K. Faccenda 2444*; Kalāheo, intersection 200 m S of Rt 540 and 50, roadside, dry sunny area, associated with other weeds including *Panicum maximum*, rare, only one patch seen, 197 m, 21.922522, -159.536588, 03 Jun 2022, *K. Faccenda 2479*; Līhu'e, 14 Oct 1916, *C.N. Forbes 591.K* (US). **HAWAII:** Puna Distr, Hwy 130, 14–15 mile marker, 19 May 2005, *K.F. Bio 05-0002*; Ka'ū Distr, Hwy 11, 49–50 mile marker, 04 Jun 2001, *K.F. Bio 01-0029-01*; Hwy 11 about halfway between Kea'au and Kurtistown, near Kamehameha School, overgrown grassy roadside, full sun, moist, lacking rhizome, about 10 plants seen, 173 m, 19.608643, -155.048779, 14 Aug 2022, *K. Faccenda & M. Murphy 2647*.

***Sporobolus coromandelianus* (Retz.) Kunth                      New state record**

*Sporobolus coromandelianus* is now known from O'ahu and Maui, where it was found during roadside surveys only at Lāhainā on Maui and is widespread on O'ahu, where five locations were found between Wai'anae and Kalihi on O'ahu. On Maui, about 20 plants were seen; on O'ahu, each of the populations found consisted of between 10 and 1000 plants.

*Sporobolus coromandelianus* is native to Africa through the Middle East, Asia, and into Malesia (POWO 2023). It has previously been reported as introduced only in Australia (Simon & Jacobs 1999), making this the second time this species has been found

outside of its native range. In its native range it is associated with calcareous or saline conditions in seasonally dry areas (Baaijens & Veldkamp 1991). In Australia, this species is associated with gardens and roadsides (Simon & Jacobs 1999).

*Sporobolus coromandelianus* is morphologically similar to and may be confused with *S. pyramidatus*, as they are both found in dry, low-elevation areas. However, based on the populations seen by the author, *S. pyramidatus* prefers more coastal saline habitats, whereas *S. coromandelianus* was generally found further inland. Morphologically, *S. pyramidatus* has glabrous leaves with scabrous margins, and tightly closed inflorescences that are almost linear when immature; *S. coromandelianus* has leaves often with papillose-based hairs on their upper surface, spines on the margins of its leaves, and usually open-paniculate immature inflorescences (Fig. 21).



**Figure 21.** *Sporobolus coromandelianus* inflorescence & spikelets (inset) from the Lāhainā population.

The following description is taken from Pope (1999: 172):

“Caespitose annual; culms up to 25 cm tall, erect or ascending, branched or unbranched; leaf sheaths chartaceous, usually glabrous, sometimes with tubercle-based hairs near the margins above, lightly compressed; leaf laminas 2–10 cm × 2–4 mm, flat, glabrous or scattered tuberculate-pilose on the surface, scabrid on the margins or with a few long stiff tubercle-based hairs below, acute or subacute at the apex. Panicle 2–8 cm long, ovate; branches in a succession of whorls, smooth, with numerous elongated viscid glandular patches, the spikelets 2–3 on secondary branchlets, these ± confined to the distal part of the primary branches. Spikelets (1)1.2–1.4(1.6) mm long, greyish-green; inferior glume 1/4–1/3 the length of the



spikelet, oblong, nerveless, glabrous, obtuse at the apex; superior glume as long as the spikelet, oblong-elliptic, 1-nerved, glabrous to scaberulous or minutely asperulous, acute at the apex; lemma as long as the spikelet or almost so, oblong-elliptic; anthers 3, (0.2)0.3–0.55 mm long. Grain obovate, 0.7–0.8 mm long, terete or lightly laterally compressed.”

*Material examined.* **O‘AHU:** Waipahu, Waipi‘o Point Access Rd where it crosses over canal at base of peninsula, common annual weed in area, 2 m, 21.383181, -157.992487, 20 Jan 2023, *K. Faccenda 3017*; Wai‘anae, intersection of Government Rd and Kuwale Rd, roadside weed in dry area, rare, panicle rather reddish purple, 28 m, 21.454998, -158.152484, 16 Jan 2023, *K. Faccenda & M.C. Ross 2990*; Kapolei Community Park, near baseball dugout in shade with *Euphorbia, Eleusine*, and *Sida*, ca. 20–30 plants observed, 21 m, 21.195764, -158.467380, 25 Nov 2022, *M.C. Ross 1850*; Sand Island Beach, Honolulu, growing near main parking lot in full sun, not irrigated, ca. 50 plants seen, <3m, 21.181398, -157.521789, 28 Jan 2023, *M.C. Ross 1883*; ‘Ewa Beach, ‘Ewa Mahiko District Park, growing near parking lot in mowed lawn, soil compact, full sun, not irrigated, several colonies, ca. >100 plants seen, 13–14 m, 21.201366, -158.212822, 06 Feb 2023, *M.C. Ross 1884*. **MAUI:** Lāhainā, Lāhainā Recreation Center off of Shaw St, southern end of park along closed dirt road, from edge of dirt road, 5 m, 20.867175, -156.669034, 22 Oct 2022, *K. Faccenda 2735*.

***Sporobolus diandrus* (Retz.) P. Beauv.**

**Correction**

*Sporobolus diandrus* is no longer known to be naturalized on Lāna‘i, as the only specimen has been reidentified as *S. elongatus*. *Sporobolus diandrus* is now known to be naturalized on Kaua‘i, O‘ahu, and Hawai‘i (Imada 2019).

***Sporobolus domingensis* (Trin.) Kunth**

**New state record**

*Sporobolus domingensis* is now known from Midway and O‘ahu. On O‘ahu, it has been present for at least 31 years and is now widespread, having been vouchered from around the Honolulu Harbor, Pearl Harbor, Barbers Point, and photographed, but unvouchered, at the Marine Corps Base in Kāne‘ohe (<https://www.inaturalist.org/observations/119164683>) and at Moanalua Bay Beach Park (<https://www.inaturalist.org/observations/151105654>).

*Sporobolus domingensis* is commonly called Coral Dropseed (Barkworth *et al.* 2003), a fitting name given that all the locations it has been found at in Hawai‘i have coral or limestone substrate. This grass is native to the Gulf of Mexico and Caribbean, where it occurs on sandy, rocky, or alkaline soils below 20 m in elevation (Barkworth *et al.* 2003; POWO 2023), and this is the first time it has been reported outside of its native range. *Sporobolus domingensis* can be identified by its perennial habit, affinity for saline coral or calcareous situations, and nonwhorled lower inflorescence node (Fig. 22).

The following description is from the Flora of North America (Barkworth *et al.* 2003: 126):

“Plants perennial; caespitose, not rhizomatous. Culms 20–100 cm. Sheaths rounded below, distal margins and apices hairy, hairs to 3 mm; ligules 0.2–1.2 mm; blades 5–20 cm long, 3–8 mm wide, flat to loosely involute, glabrous abaxially, scabridulous adaxially, margins scabridulous. Panicles 10–25(35) cm long, 1–5 cm wide, usually some-what contracted, sometimes spikelike, often interrupted below; primary branches 0.7–7 cm, appressed or spreading to 30° from the rachis, spikelet-bearing to the base; secondary branches appressed; pedicels 0.2–1.4 mm, appressed. Spikelets 1.6–2 mm, yellowish-green to grayish. Glumes unequal, linear-lanceolate to ovate, membranous; lower glumes 0.5–1.1 mm, usually without veins; upper glumes 1.1–2



**Figure 22.** *Sporobolus domingensis* habit along Lagoon Rd. & closeup of florets (inset).

mm, subequal to the lemmas; lemmas 1.1–2 mm, ovate, membranous, glabrous (occasionally minutely pubescent), acute; paleas 1–2 mm, ovate, membranous; anthers 2 or 3, 0.5–1 mm, yellowish or purplish. Fruits 0.7–1.1 mm, ellipsoid, laterally flattened, light brownish.  $2n =$  unknown.”

*Material examined.* **MIDWAY:** Sand Island, in large field along road to Cargo Pier, perhaps a few dozen clumps, naturalized, coastal grass and herbland with *Scaevola*, *Cynodon*, and *Lobularia*, 28.216400, -77.369703, 10 ft [3 m], 27 Jun 2022, *F. Starr & K. Starr 220627-01*. **O’AHU:** Lagoon Rd near the Honolulu airport, end of road, dry, sandy substrate on edge of harbor, obviously perennial, lower inflorescence node not whorled, common, hundreds of plants seen along this road and up to Ke’ehi Beach Park. *Sporobolus pyramidatus* also seen here and a bit more common than *S. domingensis*, 2 m, 21.312213, -157.919749, 20 Jan 2023, *K. Faccenda 3015*; former Naval Air Station Barbers Point, Northern Trap & Skeet Range, on bare scraped limestone, 21.314234, -158.049024, 04 May 2021, *BISH staff BP046*; Fort Kamehameha [east side of entrance to Pearl Harbor], 07 Feb 1992, *E. Funk s.n.* (BISH 767442).

***Sporobolus tenuissimus* (Mart.**

ex Schrank) Kuntze

**New state record**

A new, annual, weedy species of *Sporobolus* was found during roadside surveys on O’ahu, where it is well naturalized around Waimānalo on roadsides. Surveys on Maui found it in Lāhainā as a weed in a flower bed. It was also collected at Kaua’i Nursery & Landscaping (KNL) in Līhu’ē, Kaua’i, growing as a weed in pots and from soil around the nursery. Given that it was growing in many of the potted plants for sale, it is certainly distributed around the island at this point. Given that it was found in the nursery at KNL, a garden bed in Maui, and that there are dozens of nurseries in Waimānalo, it is almost certain that

this was introduced as a contaminant in potted plants. This species is also often found as a garden weed in other regions (Barkworth *et al.* 2003). While it has yet to be observed on Hawai‘i Island, it is likely present and overlooked.

*Sporobolus tenuissimus* is easily differentiated from most other *Sporobolus* in Hawai‘i, as it is both an annual and does not have a spikelike inflorescences like the other weedy *Sporobolus* (Fig. 23). It is similar to *S. pyramidatus*, but differs in not have whorled panicle branches. It is most similar to *Eragrostis amabilis*, as they are similar-sized plants with a similar inflorescence structure; however, *Sporobolus* has only one floret per spikelet, whereas *E. amabilis* has at least three. *Sporobolus tenuissimus* is native to Central and South America and has previously been introduced widely across the tropics. As it is a small annual, it seems unlikely to have major environmental impacts in Hawai‘i.



**Figure 23.** *Sporobolus tenuissimus* inflorescence and florets (inset) photographed at KNL on Kaua‘i.

The following description is from the Flora of North America (Barkworth *et al.* 2003: 118):

“Plants annual; tufted. Culms 30–100 cm. Sheaths glabrous, including the apices; ligules 0.2–0.3 mm; blades 5–23 cm long, 2–4 mm wide, flat or folded, glabrous on both surfaces, margins glabrous. Panicles (8)15–30 cm long, 3.5–8 cm wide, open, diffuse, cylindrical; lower nodes with 1–2(3) branches; primary branches 0.6–5 cm, capillary, spreading 30–70° from the rachises, without spikelets on the lower 1/2; secondary branches spreading; pedicels 0.5–5 mm. Spikelets 0.7–1.1 mm, plumbeous to purplish. Glumes unequal, obovate to ovate, membranous; lower glumes 0.1–0.4 mm, occasionally absent; upper glumes 0.2–0.5 mm; lemmas 0.7–1.1 mm, elliptic, membranous, glabrous, acute to obtuse; paleas 0.7–1.1 mm, elliptic, membranous; anthers 0.2–0.3 mm, yellowish. Fruits 0.4–0.7 mm, pyriform or quadroid, somewhat laterally flattened, light brownish to whitish.  $2n = 12$ .”

*Material examined.* **KAUAI:** Kaua'i Nursery & Landscaping off of Kaunuaui'i Hwy just W of Puhi, weed around garden center area, seen growing in both pots of plants for sale as well as from the ground, common, annual, hundreds of plants seen, 102 m, 21.963143, -159.405698, 08 Jul 2022, *K. Faccenda & S. Vanapruks 2516*. **O'AHU:** Waimānalo, at end of Mahailua St, moist, shady roadside, common, hundreds of plants seen, small annual, 67 m, 21.332724, -157.736100, 02 Aug 2022, *K. Faccenda & E. Peterson 2562*; Waimānalo, at end of Kakaina St, moist, shady roadside, common, 78 m, 21.335615, -157.742117, 02 Aug 2022, *K. Faccenda & E. Peterson 2565*; Waimānalo, Mahiku Pl., shady roadside, common weed along roadside, 36 m, 21.346756, -157.737971, 02 Aug 2022, *K. Faccenda & E. Peterson 2569*. **MAUI:** Lāhainā, Dickenson St & Waine'e St, weed in irrigated flower bed in shady area, 1 m, 20.874477, -156.676776, 22 Oct 2022, *K. Faccenda 2736*.

***Themeda quadrivalvis* (L.) Kuntze**

**Questionable new state record**

A specimen of *Themeda quadrivalvis* from Honolulu has been on deposit at BISH for over 70 years and has never been mentioned or published by any previous grass researchers. That omission is herein corrected by publication of it as a questionable naturalization on O'ahu. Seed of *Themeda quadrivalvis* was imported for trial as a forage grass from New Guinea in 1939 (Acc # 3954; HAES n.d.) and may have spread from that original planting to a yard in Kaimuki where it was collected in 1951. It is likely extinct on O'ahu, as it has not been recollected in the past 70 years despite urban Honolulu being relatively well studied botanically. Pukulani St and surrounding roads were also visited in Feb 2023 specifically to search for this grass, but it was not found. Publication of this record, regardless of its status, is largely in case the species is not extinct, as most grasses are undercollected in Hawai'i, making the herbarium record incomplete and field surveys rarely thorough enough to determine whether it is extinct.

*Themeda quadrivalvis* is native to India and Southeast Asia, but has been introduced to many tropical regions (Keir & Vogler 2006). It has also become a major weed in overgrown or disturbed regions of Australia (Keir & Vogler 2006). It is best recognized by its annual habit, long bracts 1.7–5 cm long subtending the florets, and awns 4–5 cm long.

The following description is from the Flora of North America (Barkworth *et al.* 2003: 684):

“Plants annual. Culms to 2 m, glabrous. Sheaths glabrous, flattened at the base; ligules 1–2.5 mm; blades to 60 cm long, 1–6 mm wide, usually folded. False panicles to 130 cm; sheaths subtending the rame clusters 17–50 mm, distal sheaths shorter and more strongly keeled, margins tuberculate; rames 1–3 per cluster, 8–10 mm, with 1–2 heterogamous spikelet pairs. Homogamous spikelets 4–7 mm; lower glumes many-veined, hairy distally, hairs papillose-based; upper glumes subequal to the lower glumes, 3-veined. Sessile heterogamous spikelets 4–6 mm; calluses 0.5–3 mm; lower glumes glabrous or sparsely hirsute; upper glumes 4.5–5.5 mm; awns 4–5 cm; pedicellate spikelets 4.5–5.5 mm, sterile.  $2n = 18$ .”

*Material examined.* **O'AHU:** Honolulu, Kaimuki, in yard, A. Suehiro's home [likely 3746 Pukulani St], 29 Nov 1951, *A. Suehiro s.n.* (BISH 120541).

*Urochloa arrecta* (Hack.)

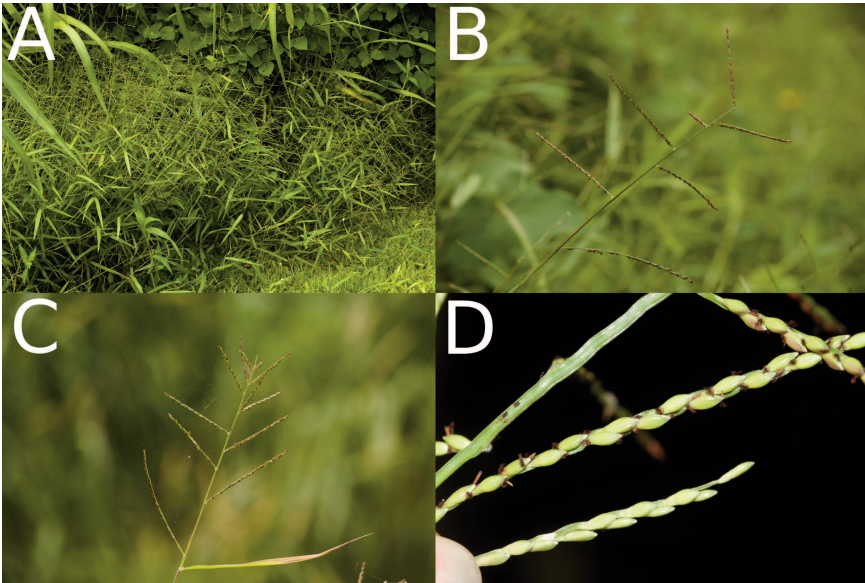
Morrone &amp; Zuloaga

**New state record**

*Urochloa arrecta* was found during roadside surveys growing at Pa‘ani Mini Park in Hāna on Maui. The colony was about 5 m long, growing along the road, and was likely only one plant as the species is aggressively stoloniferous and rather similar in growth habit to *Urochloa mutica* (Fig. 24). The area was not surveyed rigorously so the true extent of the population is likely greater. It has been used as a forage grass in other regions of the tropics (Barkworth *et al.* 2003) and could have potentially been introduced for forage purposes. However, no reports could be located stating that this species was intentionally imported.

*Urochloa arrecta* is native to tropical Africa and has also been reported as naturalized in Florida and South and Central America (POWO 2023). In Brazil, it is considered an aggressive invasive weed, where it grows as an emergent aquatic from margins of water bodies and forms dense monotypic stands that outcompete nearly all native vegetation (Fernandes *et al.* 2013; Fares *et al.* 2020). In Hawai‘i, *Urochloa mutica* fills an identical niche and it is unclear which will be most competitive if they are both growing at the same site.

*Urochloa arrecta* can be differentiated from *U. mutica* by its glabrous sheaths and leaf blades. It is also similar to *U. plantaginea*, but *U. arrecta* is distinguished by its stoloniferous habit and lack of internode between the glumes, while *U. plantaginea* is caespitose and has a conspicuous internode 0.3–0.5 mm long between the glumes. *Urochloa plantaginea* also has a sterile lower floret, whereas *U. arrecta* has a staminate lower floret.



**Figure 24.** *Urochloa arrecta* photographed at Hāna. A, habit; B–C, inflorescence; D, florets.

The following description is from the Flora of North America (Barkworth *et al.* 2003: 505):

“Plants perennial; stoloniferous. Culms 50–120 cm, branching and rooting at the lower nodes; nodes glabrous. Sheaths glabrous, margins ciliate; ligules about 1 mm; blades 5–15 cm long, 7–15 mm wide, glabrous, bases subcordate, margins scabrous. Panicles (5)9–18(25) cm long, 3–4 cm wide, with 4–10(15) spike-like primary branches in 2 ranks; primary branches (1)2–5(10) cm, axes 0.5–2 mm wide, glabrous, margins scabrous; secondary branches rarely present, pedicels shorter than the spikelets, mostly scabrous, apices with hairs. Spikelets (3)3.3–4.4 mm long, 1.4–1.7 mm wide, ellipsoid, solitary, imbricate, in 2 rows, appressed to the branches. Glumes scarcely separated; lower glumes 1.5–1.8 mm, glabrous, 5-veined, not clasping the base of the spikelets; upper glumes 3.4–4.1 mm, glabrous, 7-veined; lower florets staminate; lower lemmas 3.4–4.1 mm, glabrous, 5-veined; upper lemmas 2.7–3.5 mm long, 1.3–1.6 mm wide, apices rounded, incurved; anthers 1.6–1.8 mm.  $2n =$  unknown.”

*Material examined.* MAUI: Hāna, Pa‘ani Mini Park, wet, sunny roadside dominated by weeds, stoloniferous grass to 1 m tall, colony ca. 10 m wide, only observed at this one locality, 40 m, 20.758727, -155.991200, 23 Oct 2022, K. Faccenda 2777.

***Urochloa distachya* (L.) T.Q. Nguyen**

**New island record**

*Urochloa distachya* was published by O’Connor (1990) as occurring on Moloka‘i, but there were no herbarium specimens to support this, so the record was withdrawn by Faccenda (2022). However, recent fieldwork on Moloka‘i has shown that this grass is widely naturalized in disturbed areas across the island. *Urochloa distachya* is now known from Kaua‘i, O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i (Imada 2019; Oppenheimer & Bogner 2019; Faccenda 2022).

*Material examined.* MOLOKA‘I: Ho‘olehua, Moloka‘i Airport, long-term parking lot at airport, weedy area around parked cars, rarely mowed, sunny, uncommon across the island in disturbed areas, 138 m, 21.156223, -157.094359, 26 Dec 2022, K. Faccenda 2892.

***Urochloa eminii* (Mez) Davidse**

**New island record**

Formerly reported on Kaua‘i, O‘ahu, Moloka‘i, Kaho‘olawe, and Hawai‘i (Imada 2019), *Urochloa eminii* is now known from Maui, where it was found in Ha‘ikū, Makawao, and Kula.

*Material examined.* MAUI: Pukalani, ca. 1.2 km N of King Kekaulike High School along Rt 337, roadside weed in infrequently mowed area, sunny, rather dry, 695 m, 20.821225, -156.311528, 27 Oct 2022, K. Faccenda 2811; Kula, Kekaulike Ave near Puanani Pl, roadside in sunny area, 1066 m, 20.766022, -156.306194, 29 Oct 2022, K. Faccenda & S. Vanaprucks 2834; Ha‘ikū, Hog Back Rd, edge of road in weedy area, 252 m, 20.903991, -156.309865, 30 Oct 2022, K. Faccenda & S. Vanaprucks 2840.

***Urochloa ramosa* (L.) T.Q. Nguyen**

**New state record**

Another new species of *Urochloa* was found during roadside surveys in Wai‘anae, where over 500 plants were seen along Kuwale Rd., where the main population ran along the roadside for about 20 m. Some plants were found on the roadside itself, while many hundreds of others were growing in irrigated farmland adjacent to the road. Some scattered plants were also found along Lualualei Homestead Rd. about 500 m away from the main population. After consultation with Barkworth (2003), Wu *et al.* (2006), and

Clayton & Renvoize (1982), the plant was identified as *Urochloa ramosa*. This species can be identified by its annual habit, spikelets in pairs, racemose panicle, and setae on the pedicel of the florets (Fig. 25).

*Urochloa ramosa* is native from Africa through Asia (POWO 2023). It has become naturalized rather widely across the tropics (POWO 2023) and has previously been reported as weedy (Barkworth *et al.* 2003). It is fast growing, reaching maturity in ~90 days, and is tolerant of semi-arid areas (Kingwell-Banham & Fuller 2014). In India, it is cultivated as a grain and forage crop (Kingwell-Banham & Fuller 2014), and cultivation as a forage crop also occurs in the United States. The grain is also sometimes used as birdseed (Barkworth *et al.* 2003); however, it is unclear how it arrived in Hawai'i.



**Figure 25.** *Urochloa ramosa* inflorescence and spikelets (inset) from the Kuwale Rd. population.

The following description is taken from Barkworth *et al.* (2003: 497):

“Plants annual; tufted. Culms 10–65 cm, decumbent, rooting or not at the lower nodes; nodes pubescent. Sheaths usually puberulous, sometimes glabrous or sparsely pilose, margins ciliate; ligules 0.8–1.7 mm; blades 2–25 cm long, 4–14 mm wide, glabrous, margins scabrous. Panicles 3–13 cm, simple, with 3–15 spikelike primary branches; primary branches 1–8 cm, divergent, axils glabrous, axes 0.4–0.6 mm wide, triquetrous, glabrous, scabrous, or pubescent, with or without some papillose-based hairs; secondary branches, if present, confined to the lower branches; pedicels shorter than the spikelets, scabrous or pubescent. Spikelets 2.5–3.4 mm long, 1.3–2 mm wide, ellipsoid, apices broadly acute to acute, paired, appressed to the branches. Glumes scarcely separated, rachilla internode between the glumes not pronounced; lower glumes 1–1.5 mm, 1/3 – 1/2 as long as the spikelets, glabrous, 3–5-veined; upper glumes 2.5–3.4 mm, usually puberulent, sometimes glabrous, margins

sometimes somewhat pubescent, 7–9-veined, without evident cross venation; lower florets sterile, lower lemmas 2.4–3.3 mm, usually puberulent or occasionally glabrous, margins not ciliate, without cross venation, 5-veined; upper lemmas 2.3–3.3 mm, acute, mucronate; anthers 0.7–1.2 mm. Caryopses 1.2–2.3 mm; hila punctiform.  $2n = 36$  (usually); also 14, 28, 32, 42, 46, 72.”

*Material examined.* **O‘AHU:** Wai‘anae, Kuwale Rd, ca. 200 m S of intersection with Pu‘uhulu Rd, from unmaintained roadside and farmland along road, very common for about 20 m of the roadside in both the unirrigated roadside, and the irrigated farmland., 24 m, 21.446452, -158.150683, 16 Jan 2023, *K. Faccenda & M.C. Ross 2988*.

***Zoysia matrella* (L.) Merr.**

**New state record**

Previously reported as a questionable naturalization on O‘ahu (Faccenda 2022), more populations have been found, demonstrating that this is truly naturalized. *Zoysia matrella* was also recently found growing on a beach near Kapa‘a on Kaua‘i, where it is unlikely to have been planted. The colony was over 10 m long, growing on sand along a footpath and not in proximity to any structures or roads. It seems that *Z. matrella* germinates best in coastal situations, as most of the colonies seen that appear most certain to be wild were all found near beaches.

*Material examined.* **KAUA‘I:** Kapa‘a, beach where Kapa‘a Stream empties into ocean, sand on beach, full sun, strongly rhizomatous plant forming a turf from sand as its substrate, 6 m, 22.091604, -159.306712, 29 May 2022, *K. Faccenda 2410*. **O‘AHU:** ‘Ewa, One‘ula Beach Park, growing on sand about 20 m from waterline, dry, full sun area, one colony about 5 m wide × 10 m long, no cultivated *Zoysia* seen nearby, 21.306672, -158.026639, 13 Mar 2023, *K. Faccenda & M.C. Ross 3071*; Kualoa Ranch, Ka‘a‘awa Valley, near rear of valley, moist pasture land, full sun, mixed with assorted weeds, colony over 50 m wide, movie set structure nearby a possible source, but not centered around structure, also seen on both sides of road, possibly planted (Julia Lee, pers. comm.), 21.520058, -157.863130, 07 Mar 2023, *K. Faccenda & J. Lee 3061*; 4WD road to Poamoho Trail, about 4 km from start of road, wet area on side of road, near large gravel pile, potentially moved with the gravel along with other weeds growing near the gravel pile not encountered on other areas of the trail, colony about 3 m wide by about 1 m deep, climbing up to 50 cm tall into some weeds, 467 m, 21.535792, -157.982027, 23 Dec 2022, *K. Faccenda 2884*; He‘eia, just outside of state park, sandy coastal site within 5 m of ocean, small colony about 1 m wide growing on sand and rubble on coast, obviously not planted given its location, 1 m, 21.440176, -157.809038, 20 Sep 2022, *K. Faccenda 2702*.

***Zoysia pacifica* (Goudsw.)**

M. Hotta & Kuroki

**New island record**

*Zoysia pacifica* has been observed growing wild in the Kahuku Unit of Hawaii Volcanoes National Park, where it appeared far from any planted patches (Linda Pratt, pers. comm.). This species is now known to be naturalized on Kaua‘i, O‘ahu, and Hawai‘i (Faccenda 2022).

*Material examined.* **HAWAI‘I:** Ka‘ū Distr, Hawaii Volcanoes National Park, Kahuku Unit, upslope of Hawai‘i Ocean View, on cinder in open area with low native shrubs, one patch of dry stoloniferous grass, 1500 m, 19 Dec 2008, *F. Duvall s.n.* (HAVO 14706).

**ACKNOWLEDGMENTS**

Mahalo to Curt Daehler for encouraging me to undertake this work and providing comments on the manuscript. Thank you to Barbara Kennedy, Tim Gallaher, Clyde Imada,



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Nick Walvoord, Tim Flynn, Linda Pratt, Coquelicot Shirey, and Katie Mathews for assistance and access to the herbarium collections visited during this research. Thank you to Warren Wagner, Nancy Khan, Matthew Pace, and Leanna McMillin for assistance with loans and accessing the photographed herbarium holdings of US and NY. Thank you to Mike Ross, Selena Vanapruks, and Kyhl Austin for assistance during fieldwork. Thank you to Jake Gross, and Kathryn Akamine for arranging for me to stay and help survey grasses at HAVO for two weeks. Thank you to Mike Ade, Forest & Kim Starr, Woody Mallinson, and Paul Krushelnycky for assistance during fieldwork and with lodging on Maui.

This is publication #202 from the School of Life Sciences, University of Hawai'i at Mānoa. This research was funded in part by the Department of the Interior Pacific Islands Climate Adaptation Science Center. The project described in this publication was supported by Grant or Cooperative Agreement No. G20AC00073 to Curtis Daehler from the United States Geological Survey. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Geological Survey. Mention of trade names or commercial products does not constitute their endorsement by the Pacific Islands Climate Adaptation Science Center or the National Climate Adaptation Science Center or the U.S. Geological Survey. This manuscript is submitted for publication with the understanding that the United States Government is authorized to reproduce and distribute reprints for Governmental purposes.

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# Updates to the Hawaiian hornwort (Antheroцерotophyta) and liverwort (Marchantiophyta) floras: species new to Hawai‘i and name changes<sup>1</sup>

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## INTRODUCTION

Since Staples & Imada’s (2006) literature-based checklist of the hornworts (Antheroцерotophyta) and liverworts (Marchantiophyta) of Hawai‘i, our field, herbarium, and literature review work has disclosed 20 species new for Hawai‘i, including two hornworts. In addition, 35 species and one subspecies have name changes; these include the proposed new combinations *Cryptolophocolea bartlettii*, *Cuspidatula labrifolia*, *Leptoscyphus baldwinii*, and *Vitalianthus pseudoneurus*. Two species are here confirmed for Hawai‘i (*Lophocolea pusilla* and *Nothoceros vincentianus*), and nomenclature is corrected for two species (*Frullania sandvicensis* and *Scapania ornithopoides*).

This paper is based on seven visits (totaling about 30 days of herbarium work there) to the Herbarium Pacificum, Bernice Pauahi Bishop Museum (BISH), the National Tropical Botanical Garden herbarium (PTBG) on Kaua‘i (one six-day visit), and the Hawaii Volcanoes National Park herbarium (HAVO) in Volcano, Hawai‘i numerous times (approximately 30 days of work); extensive field work on the islands of Hawai‘i and Lāna‘i and some field work on O‘ahu, Maui, and Kaua‘i, collecting over 3,000 hornwort and liverwort specimens; and extensive literature research aided by Interlibrary Loan services at the University of Wisconsin-Stevens Point.

It is important to note that this paper does not deal with numerous new island records for species already known to occur in Hawai‘i. The island occurrences listed for “name change” species are only those given in Staples & Imada (2006); many more island records will be added in a subsequent paper. “All major islands” denote Kaua‘i, O‘ahu, Moloka‘i, Maui, and Hawai‘i.

There are also about 15 species of liverworts new to science, all Hawaiian endemics, and these will also be treated in a subsequent paper.

We follow the synonymy of Staples & Imada (2006), updated through the Söderström *et al.* (2016) checklist of world liverworts and the current version of Tropicos.org (<https://www.tropicos.org/home>) through September 2023.

## RESULTS

Twenty species and one subspecies are newly reported for Hawai‘i, including two hornworts (one indigenous and one naturalized) and 18 leafy liverworts (17 indigenous and one naturalized species). Of these, five species are similar but not identical to species from

1. Contribution 2023-007 to the Hawaii Biological Survey.

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Asia or America; they require more research to find their proper specific epithet. In addition, 35 species and one subspecies in the Staples & Imada (2006) list have name changes; we propose the new combinations *Cryptolophocolea bartlettii*, *Cuspidatula labrifolia*, *Leptoscyphus baldwinii*, and *Vitalianthus pseudoneurus*. Two species are confirmed for Hawai‘i (*Lophocolea pusilla* and *Nothoceros vincentianus*), and nomenclature is corrected for two species (*Frullania sandvicensis* and *Scapania ornithopoides*).

## ANTHOCEROTOPHYTA (hornworts)

### Anthocerotaceae

#### *Anthoceros angustus* Steph.

#### New state record

Indigenous; found on Haleakalā, Maui and both ranges on O‘ahu (610–1220 m). In 2006, a BISH specimen from Mt Ka‘ala, O‘ahu, made by Paul Higashino in 1975, was annotated as *A. formosae* Steph. by D. Christine Cargill (Australian National Herbarium), a hornwort authority. That name is now a synonym of *A. angustus* (Peng & Zhu 2013; Lee & Gradstein 2021: 112; Lee *et al.* 2022). We were able to verify its continued existence on Mt Ka‘ala in 2022.

*Material examined.* O‘AHU: Wai‘anae Range, Mt Ka‘ala, along roadside on embankment, 4,000 ft [1,219 m], 22 Feb 1975, *P. Higashino s.n.* (BISH 684456); same day and place, *E.J. Funk s.n.* (BISH 684459); at and near summit of Mt Ka‘ala, 17 May 2022, 1,219 m, *M.K. Thomas, S.N. Ching et al.* (including the authors) 363a (BISH); Ko‘olau Range, central ridge adjacent to Niu Valley, 9 Feb 1911, *C.N. Forbes 1910.O* (BISH); Tantalus, 11 Aug 1935, *R.D. Svihla 35-204* (BISH). MAUI: Haleakalā, Waikamoi, rainforest, 2,000 ft [610 m], 3 Jan 1956, *R.D. Svihla 1886* (BISH); Waikamoi Preserve, 1,830 m, 23 Feb 2023, *A.V. Freire & E.J. Judziewicz 23-98* (BISH).

#### *Anthoceros punctatus* L.

#### New naturalized record

A cosmopolitan species (Gradstein 2021: 643–644); rare, Hawai‘i Island (1,205 m), clearly naturalized. This hornwort grows on soil in disturbed and exposed areas that are often mown.

*Material examined.* HAWAII: Hawaii Volcanoes National Park, Kīpukapuauulu, mowed picnic area lawn and trailside, moist bare packed soil, 1,205 m, 7 Feb 2020, *A.V. Freire & E.J. Judziewicz 20-92* (HAVO); same location, 19 Mar 2021, *A.V. Freire & E.J. Judziewicz 21-346* (HAVO); Nāmakaniapaio Campground, lawn, 1,205 m, 30 Nov 2022, *A.V. Freire & E.J. Judziewicz 22-962* (HAVO).

### Dendrocerotaceae

#### *Nothoceros vincentianus* (Lehm. & Lindenb.)

#### Confirmation of a previous tentative record

J.C. Villarreal

Indigenous; this neotropical species was long treated as *Megaceros vincentianus* (Lehm. & Lindenb.) Campb., but molecular evidence suggests that the two genera are distinct (Villarreal *et al.* 2010). It grows on logs and bark of trees, in deep rain forest; it is not common but can be found on Kaua‘i and Hawai‘i Island in Hawaii Volcanoes National Park (Nāhuku Lava Tube area, ‘Ōla‘a Tract), and the Pu‘u Maka‘ala Natural Area Reserve from 853–1,478 m. We suspect a much broader Hawai‘i distribution; we have not examined the specimens tentatively cited as this species (as “*Megaceros ? vincentianus*”) by Miller (1963: 530). Miller *et al.* (1983) again cited this species as occurring in Hawai‘i, but Staples & Imada (2006: 22) list it as a dubious species. We can confirm its occurrence in Hawai‘i; it differs from *Megaceros flagellaris* (Mitt.) Steph. in its lack of gemmae on the completely smooth dorsal surface of the thallus.



*Material examined.* **KAUAI:** Kōke'e Camps, near Kōke'e Stream, ca. 3,500 ft [1,067 m], 18 Feb 1956, *R.D. Svihla 2101* (BISH). **HAWAII:** Pu'u Maka'ala N.A.R., 1,340 m, 16 Jun 2022, *A.V. Freire & E.J. Judziewicz 22-620* (BISH); Hawaii Volcanoes National Park, Nāhuku Lava Tube, 1,190 m, 26 May 2022, *A.V. Freire & E.J. Judziewicz 22-564* (HAVO); Hawaii Volcanoes National Park, 'Ōla'a Tract, 1 km from first bend, 1,150 m, 28 Mar 1979, *P.J. Burton 405* (BISH); Kūlani Prison Road to Forestry Camp, 4,850 ft [1,478 m], 19 Dec 1954, *E.T. Ozaki 1178* (BISH); South Kona Distr, Hōnaunau Forest Reserve, on 'a'ā in open wet *Fraxinus uhdei* plantation, 2,800 ft [853 m], 18 Sep 1975, *D.R. Herbst & S. Ishikawa 5456* (BISH).

## MARCHANTIOPHYTA (liverworts)

### Acrobolbaceae

*Acrobolbus integrifolius* (A. Evans) Briscoe **Name change**

Treated as *Tylimanthus integrifolius* A. Evans by Staples & Imada (2006). See Briscoe *et al.* (2015: 59) and Söderström *et al.* (2016: 94). Endemic; an uncommon species of wet forests on Moloka'i and Maui.

### Adelanthaceae

*Cuspidatula labrifolia* (H.A. Mill.) A.V. Freire & Judz., **comb. nov.**

**Basionym:** *Jamesoniella labrifolia* H.A. Mill., *J. Hattori Bot. Lab.* 30: 275. 1967, and treated as that species by Staples & Imada (2006).

The type locality is Mile 15 on the Saddle Road on Hawai'i Island (Miller 1967), and it is also found on Moloka'i and Maui (610–2,790 m). These are large plants, usually red or with some red coloration, with rounded, imbricate, erect, and markedly pouched or concave leaves unlike the plane or slightly concave leaves of *C. robusta*.

*Cuspidatula robusta* (Austin)

Váňa & L. Söderstr.

**Name change**

Treated as *Jamesoniella robusta* (Austin) Steph. by Staples & Imada (2006). See Váňa *et al.* 2013a. Endemic; one of the larger, showier leafy liverworts in Hawai'i; found on all major islands and Lāna'i (Judziewicz *et al.* 2023), from 305–2,460 m, and on other islands in Oceania.

### Aneuraceae

*Aneura pinguis* (L.) Dumort.

**New state record**

These are the first records of this cosmopolitan genus and species in Hawai'i. It is indigenous.

*Material examined.* **KAUAI:** Lihu'e Distr, Blue Hole, headwaters North Fork Wailua River, 22.065332°N, 159.491517°W, low-statured wet shrubland over rubble, thallus bright green, mat-forming on rocks, 600 m, 16 Feb 2016, *T. Flynn 8272* (PTBG). **O'AHU:** Mt Ka'ala, 21°30'18–30"N, 158°08'36–45"W, dripping rocks of roadside embankment below the summit, common, 1,200 m, 9 Nov 2022, *M.K. Thomas et al. 499, 503b, 520a, 523, 539* (BISH).

### Aytoniaceae

*Mannia californica* (Gottsche ex Underw.)

L. C. Wheeler

**New state record**

This sub-cosmopolitan species (United States, Canada, Europe, Asia and Africa; Schill 2007) is a new report for Hawai'i.

*Material examined.* **KAUAI:** Po'omau Canyon, on dripping wet face in full sun, secondary forest dominated by *Aleurites*, understory of *Triumfetta*, *Plumbago*, and *Lantana*, in an area heavily grazed by goats; thallus dull medium green, 427–549 m [1,400–1,800 ft], 19 Jan 1993, T. Flynn, S. Perlman & K. Wood 5208 (PTBG).

### Calypogeiaceae

#### *Asperifolia arguta* (Nees & Mont.)

A.V. Troitsky, Bakalin & Maltseva

#### **Name change**

Treated as *Calypogeia arguta* Nees & Mont. by Staples & Imada (2006). Indigenous; found on all major islands (244–1,219 m). Bakalin *et al.* (2022: 26, 34–35) present convincing molecular evidence that this species and its relatives are basal to *Calypogeia* and should be transferred to the new segregate genus *Asperifolia*. Furthermore, they present molecular evidence that *A. arguta* is a strictly European species that does not occur in Asia (and presumably Oceania). They propose the new species *A. indosinica* Bakalin & A.V. Troitsky to accommodate Asian collections with smaller cells and smaller underleaves, and it seems possible that Hawaiian material may pertain to this species rather than to *A. arguta*. Previous to the Bakalin *et al.* papers (2020, 2022), Sun *et al.* (2018: 160) give the range of *A. arguta* (as *Calypogeia arguta*) as eastern Asia and Malesia, disjunct in Hawai'i.

### Cephaloziaceae

#### *Cephalozia lucens* (A. Evans) Steph.

#### **Name change**

Treated as *Metahygrobiella lucens* (A. Evans) H.A. Mill. by Staples & Imada (2006). See Söderström *et al.* (2016: 58) and Vána *et al.* (2013d). Endemic; Maui (Kīpahulu and Pu'u Ni'ani'au) and Lāna'i (Judziewicz *et al.* 2023), from 914–2,438 m. Wet rocks and montane forests; perhaps not distinct from *C. maxima*, in which case this older name would apply.

#### *Cephalozia maxima* Steph.

#### **Name change**

Treated as *Metahygrobiella maxima* (Steph.) N. Kitag. by Staples & Imada (2006). See Söderström *et al.* (2016: 58). Endemic; Maui (686–914 m) and reportedly Lāna'i (Judziewicz *et al.* 2023).

#### *Fuscocephaloziopsis baldwinii* (C.M. Cooke)

Vána & L. Söderstr.

#### **Name change**

Treated as *Cephaloziella baldwinii* (C.M. Cooke) H.A. Mill. by Staples & Imada (2006). Endemic; this is a tiny creeping species found on Kaua'i, Moloka'i, Maui, and Hawai'i (914–1,768 m), but is not common.

#### *Fuscocephaloziopsis connivens* (Dicks.)

Vána & L. Söderstr. subsp. *sandwicensis*

(Mont.) Vána & L. Söderstr.

#### **Name change**

Treated as *Cephalozia sandwicensis* (Mont.) Spruce by Staples & Imada (2006). See Vána *et al.* (2013d). Indigenous; the subspecies is also indigenous (it is also reportedly found in French Polynesia; Bardat *et al.* 2021: 81). This is a common species of wet forests on all major islands and Lāna'i (Judziewicz *et al.* 2023), 183–2,012 m.

***Odontoschisma denudatum* (Mart.) Dumort.**subsp. *denudatum***Name change**

Treated as *Odontoschisma subjulaceum* Austin by Staples & Imada (2006). See Aranda *et al.* 2014: 1008–1025; Gradstein & Ilkiu-Borges (2015). Indigenous; often in drier, sunnier locations and less common than the next subspecies; on all major islands.

***Odontoschisma denudatum* subsp. *sandvicense***(Ångstr.) Gradst., S.C. Aranda & Vanderp. **Name change**

Treated as *Odontoschisma sandvicense* (Ångstr.) A. Evans by Staples & Imada (2006). See Aranda *et al.* (2014: 1019) and Gradstein & Ilkiu-Borges (2015). Endemic; this commoner subspecies tends to prefer shadier, moister locations than the typical subspecies; on all major islands and Lānaʻi (Judziewicz *et al.* 2023).

**Cephaloziellaceae*****Cephaloziella kiaeri* (Austin) Douin****Name change**

Treated as *Cephaloziella lilae* (C.M. Cooke) Douin by Staples & Imada (2006). Almost pantropical; indigenous. Uncommon; Kauaʻi and Oʻahu (600–1,219 m); treated as *Cylindrocolea kiaeri* (Austin) Váňa by Váňa *et al.* (2013c), as *Cephaloziella lilae* in Staples & Imada (2006), and more recently as *Cephaloziella kiaeri* by Lee & Gradstein (2021: 52).

***Cylindrocolea* cf. *planifolia* (Steph.)**

R.M. Schust.

**New state record**

Indigenous; this bright green, montane mesic or wet forest species, appears similar to the widespread American *C. planifolia* (Gradstein & Costa 2003). It is found on Hawaiʻi Island (1,280–1,760 m) in Kīpukakī, Hawaii Volcanoes National Park and in the Puʻu Makaʻala N.A.R.

*Material examined.* HAWAII: Hawaii Volcanoes National Park, Kīpukakī, 1,345 m, 7 Mar 2021, A.V. Freire & E.J. Judziewicz 21-334 (HAVO); same location, 7 Apr 2023, A.V. Freire & E.J. Judziewicz 23-330 (HAVO); Puʻu Makaʻala N.A.R., near old Mauna Loa Boys School, *Metrosideros-Cibotium* kīpuka, 1,760 m, 19 Aug 2021, A.V. Freire & E.J. Judziewicz 21-664 (BISH).

**Frullaniaceae*****Frullania sandvicensis* Ångstr.,**[*Frullania ericoides* (Nees) Mont., misidentification

(see So &amp; Wang 2006: 428–429)].

**Correction*****Frullania sandvicensis* Ångstr.,**[*Frullania neurota* Taylor, misidentifications]

(see So &amp; Wang 2006: 428–429).

**Correction****Geocalycaceae*****Geocalyx lancistipulus* (Steph.) S. Hatt.****New state record**

Indigenous; rare, an otherwise Asian species (Asthana & Murti 2009) known from one 2021 collection from Hawaiʻi Island: Nāmakanipaio Campground, Hawaii Volcanoes National Park. Only one other species of *Geocalyx* occurs in Hawaiʻi, the Holarctic *G. graveolens* (Schrad.) Nees, known from one collection on Hawaiʻi Island; it differs from *G. lancistipulus* in lacking gemmiparous shoots and in its more deeply lobed leaves.

*Material examined.* **HAWAII:** Hawaii Volcanoes National Park, Nāmakanipaio Campground, in deep shaded rock cleft, 1,205 m, 27 Oct 2021, *A.V. Freire & E.J. Judziewicz 21-943* (HAVO).

### Gymnomitriaceae

#### *Gymnomitrium* cf. *laceratum* (Steph.) Horik. **New state record**

Indigenous; first report for Hawai‘i. This species is known in Hawai‘i only from Kīpahulu Ridge, Haleakalā, made by Marko Lewis in 1981. *Gymnomitrium* is an easy genus to identify based on its dense, cushiony habit, gray color, and wormlike, very densely leafy stems only about 0.6 mm wide. The leaves are bifid and strongly concave. Closely related to *Marsupella*. Norton G. Miller (1942–2011) annotated both specimens as *Gymnomitrium laceratum*, a species with a scattered cosmopolitan distribution. However, in 2017, Yuri Mamontov annotated them as “similar to” *G. mucrophorum* R.M. Schust., an Alaskan endemic, noting the shoots without rhizoids, leaves with crenulate margins, and verruculose cuticle. We consulted the papers of Schuster (1974, 1995), Mamontov *et al.* (2019), as well as the provisional Flora of North America treatment (FNA Editors 2020; <http://www.mobot.org/plantscience/bfna/V3/Gymnomitriaceae.html>), and we tentatively concur with N.G. Miller’s initial determination. The plants have leaves that have 2–3 rows of roundish silvery marginal cells differing from the colored, rectangular median cells; the leaf margins are slightly crenulate; and each lobe apex is mucronate. However, the leaves are bifid only about 1/3 of their length and rhizoids were not evident.

*Material examined.* **MAUI:** Haleakalā, Kīpahulu Ridge, Haleakalā, on a dirt bank above tree line, 2,408 m, 4 Oct 1981, *M. Lewis 81-388b, 81-397* (BISH, F).

#### *Marsupella emarginata* (Ehrh.) Dumort. **New state record**

Indigenous; a cosmopolitan (but mainly Holarctic) species found rarely in wet montane forests on Kaua‘i (1,250 m) and on both ranges on Maui (1,372–1,524 m). This species is unique among bifid Hawaiian liverworts in that the leaf lobes apices are quite rounded and are not at all acute. See Lee & Gradstein (2021: 61–62, 173).

*Material examined.* **MAUI:** without locality, anno 1875, *D.D. Baldwin 65* (BISH) [mixed with *Sphenobolus minutus*]; West Maui, ‘Eke Bog, 4,500 ft [1,372 m], *R.L. Stemmermann 7034* (HAVO); Haleakalā, ‘Ukulele, up Pipe Trail, Jul 1919, *C.N. Forbes 1462* (BISH). **KAUA‘I:** Hanalei Distr, Halele‘a Forest Reserve, Nāmolo-kama Mt., 17 Jun 1988, central plateau bog, with *Metrosideros*, *Pelea*, *Labordia*, and *Juncus planifolius*, 4,100 ft [1,250 m], *T. Flynn 3021* (BISH) [incidental to *Rhynchospora chinensis* (Cyperaceae)].

### Herbertaceae

#### *Herbertus aduncus* (Dicks.) Gray **Name change**

Treated as *Herbertus sanguineus* (Mont.) Austin by Staples & Imada (2006). Juslén (2006) treats *H. sanguineus* as a synonym of *H. dicranus* (Gottsche, Lindenb. & Nees) Trevis.; in turn, Sun & He (2019) present molecular evidence that *H. dicranus* is a synonym of *H. aduncus*. Found on all major islands and Lāna‘i (Judziewicz *et al.* 2023).

### Jubulaceae

#### *Jubula javanica* Steph. **Name change**

Treated as *Jubula hutchinsiae* (Hook.) Dumort. subsp. *javanica* (Steph.) Verd. by Staples & Imada (2006). See Lee & Gradstein (2021: 89). An indigenous, mostly Asian species that is found on all major islands and Lāna‘i (Judziewicz *et al.* 2023), 762–1,890 m. It is rare; we have only seen it twice. It is often terrestrial on perennially wet organic soil, or

at the base of trees. See Lee & Gradstein (2021: 89) and our discussion under *J. pennsylvanica* (below). A key to distinguish the two Hawaiian species is presented below.

1. Leaves narrowly ovate, their apices long-acuminate; leaf margin with (0–)1–3 teeth; female bracts and bracteoles with irregularly toothed or spinose margins .. ***J. javanica***  
 1'. Leaves broadly ovate, their apices shortly-apiculate; leaf margin entire, without teeth; female bracts and bracteoles with entire margins ..... ***J. pennsylvanica***

***Jubula pennsylvanica*** (Steph.) A. Evans      **New state record**

Indigenous; Maui (1,524–1,890 m). *Jubula* collections from Hawai‘i need more attention. So far, all specimens are reported as *J. javanica* (formerly *J. hutchinsiae* subsp. *javanica*; see above), but this species, known from North America and Asia (Dey *et al.* 2011) is also present. While *J. javanica* has narrowly ovate leaves with long-acuminate apices, leaf margin with (0–)1–3 teeth, and female bracts and bracteoles with irregularly toothed or spinose margins; *J. pennsylvanica* has broadly ovate leaves with short-apiculate apices, entire leaf margins, and female bracts and bracteoles with entire margins. These key differences are based on Guerke (1978), Dey *et al.* (2011), and Sukkharak (2013); however, inconsistencies are found between the latter two papers regarding the circumscription of *J. javanica*. Our specimens fit the description by Dey *et al.* (2011), except for having cylindrical rather than galeate lobules.

*Material examined.* MAUI: Haleakalā, Ko‘olau-Hāna Distr, Helele‘ike‘oha, *Metrosideros* montane wet forest and bogs, 6,200 ft [1,890 m], 4 Nov 2021, K. Severson 051 (BISH); West Maui, ravines, 4,000 ft [1,219 m], anno 1875, D.D. Baldwin 147 (BISH).

**Lejeuneaceae**

***Acrolejeunea sandvicensis*** (Gottsche) Steph.      **Name change**

Treated as *Trocholejeunea sandvicensis* (Gottsche) Mizut. by Staples & Imada (2006). See Wang *et al.* (2016) and Söderström *et al.* (2016: 399). Indigenous; found on all major islands and Lāna‘i (Judziewicz *et al.* 2023), 0–1,160 m, but mostly below 600 m); it is disjunct from subtropical eastern Asia and previous reports from other Pacific Islands are erroneous (Sun *et al.* 2018). This is a wet forest, low elevation species that is a common epiphyte on both exotic and indigenous trees, but it can also grow on rocks.

***Cololejeunea planissima*** (Mitt.) Abeyw.      **Name change**

Treated as *Cololejeunea lanciloba* Steph. by Staples & Imada (2006). See Gradstein (2021: 452). Indigenous; found on Kaua‘i, O‘ahu, and Lāna‘i (Judziewicz *et al.* 2023), 0–610 m; also in Asia, Australia and Oceania. Common, typically very closely appressed to bark in lowland forests, on both indigenous and exotic trees.

***Drepanolejeunea pentadactyla*** (Mont.) Steph.      **New state record**

Ko‘olau Range, O‘ahu (610 m); indigenous; also occurring in tropical Asia (Lee & Gradstein 2021: 230), Australasia, and New Caledonia. This species resembles *D. unguilata* (Steph.) Grolle, but has much larger and more irregular leaf teeth, the leaves often appearing almost randomly lobed. Mentioned in passing (as the synonym *D. micholitzii* Steph.) by Smith *et al.* (1997), but without a specimen citation.

*Material examined.* O‘AHU: Kīpapa Gulch, 2,000 ft [610 m], twining on *Herbertus gracilis*, 2 Apr 1933, E.Y. Hosaka 951b (BISH); Wa‘ahila Ridge Trail, growing on trunk of *Metrosideros*, 11 May 1979, C.S. Futa 48 (BISH).

***Lejeunea adpressa* Nees****Name change**

Treated as *Lejeunea anisophylla* Mont. by Staples & Imada (2006). Indigenous; found on all major islands and Lānaʻi (Judziewicz *et al.* 2023), 0–1,860 m; common. Cosmopolitan; see Gradstein (2021: 514). According to Gaik Ee Lee (pers. comm.), authority on tropical Asian species of *Lejeunea*, the *L. adpressa* complex is not a natural group.

***Lejeunea laetevirens* Nees & Mont.****New naturalized record**

An American species found in Hoʻomaluhia Botanical Garden on windward Oʻahu and at Onomea on Hawaiʻi Island, at elevations of less than 40 m. This is a minute bark epiphyte or leaf epiphyll in urban areas and botanical gardens, first noted in 2019. A good description and illustration may be found in Gradstein & Ilkiu-Borges (2009: 101–102).

*Material examined.* OʻAHU: Hoʻomaluhia Botanical Garden, on tree trunks, 30 m, 5 Nov 2021, E.J. Judziewicz 21-986 (BISH). HAWAII: Onomea, 19°48′35″N, 155°05′40″W, locally dominant on exotic trees, 20–40 m, 20 Nov 2019, A.V. Freire & E.J. Judziewicz 19-154b (BISH); same locality, 20 May 2021, A.V. Freire & E.J. Judziewicz 21-512 (BISH).

***Lopholejeunea* cf. *eulopha* (Taylor) Schiffn.****New state record**

A pantropical species new to Hawaiʻi; apparently indigenous. Tentative identification by S. Robbert Gradstein, who writes (pers. comm., 7 July 2022): “The hyalodermis, the ovate-oblong leaves with rounded, entire (flat) apex, the thin-walled leaf cells, the apparently homogeneous oil bodies, the small lobule attached at the end of the keel by a single cell to the leaf lobe, the obscure lobule teeth (1–2), the rather large underleaves with rounded bases and arched insertion, all these features point to *L. eulopha*.” Perianths will be required for a positive identification (Zhu & Gradstein 2005: 18–19).

*Material examined.* HAWAII: Manukā N.A.R., 19°06′32–54″N, 155°48′50″–49′33″W, on southeast part of loop trail from wayside, on moist shaded rocks, 600 m, 9 Jan 2022, A.V. Freire & E.J. Judziewicz 22-57 (BISH); same population, 29 Sep 2022, A.V. Freire & E.J. Judziewicz 22-859 (BISH); on northwest part of same loop trail, 29 Sep 2022, A.V. Freire & E.J. Judziewicz 22-845c (BISH).

***Marchesinia brachiata* (Sw.) Schiffn.****Name change**

Treated as *Marchesinia mittenii* A. Evans by Staples & Imada (2006). See Gradstein (2012: 73). Rare, collected by Hillebrand in the 19th century somewhere in Hawaiʻi on trees and mixed with *Lopholejeunea nigricans*. The Miami University (MU) database also lists collections from Kauaʻi (Hanakoa Valley, Nā Pali coast), Oʻahu (Kiapapau [sic] Valley, Koʻolau Range), and Hawaiʻi (Hakalau, Hāmākua coast) at elevations from 244–457 m; we have not examined them. The very deeply arched insertion of the underleaves is diagnostic. This is a common tropical American species. It should be sought in lowland rain forest.

***Myriocoleopsis minutissima* subsp. *myriocarpa***

(Nees & Mont.) R.L. Zhu, Y. Yu & Pócs

**Name change; new synonym**

*Cololejeunea cookei* A. Evans (Staples & Imada 2006) is a synonym of this subspecies. Indigenous, found at least on Kauaʻi, Maui and Hawaiʻi. Two subspecies of *Myriocoleopsis minutissima* occur in Hawaiʻi; see Judziewicz *et al.* (2023:22) for the new state record of *M. m.* subsp. *minutissima*, and the key below that separates the two taxa. Both subspecies (Yu *et al.* 2014) are almost cosmopolitan (Gradstein 2021: 579; Lee &

Gradstein 2021: 104). A tiny, easily overlooked bark epiphyte found in mesic to wet forests, even on exotic trees; related to *Cololejeunea*, but the lobules are much longer, near as long as the lobe.

*Material examined.* **KAUAI:** Lihu'e Distr, Hā'upu Ridge, secondary forest dominated by *Aleurites*, *Pandanus*, and *Psidium* with scattered *Cyrtandra*, *Hedyotis*, and *Cibotium*, east flank below Omoe, epiphytic on leaves of *Syzygium malaccense*, 520–680 m, 17 Sep 1990, T. Flynn & M. Kiehn 4243b (PTBG).

KEY TO HAWAIIAN SUBSPECIES OF *MYRIOCOLEOPSIS MINUTISSIMA*

1. Lobules broad, almost as large as the lobe, with a distinct tooth .....  
 ..... *M. minutissima* subsp. *minutissima*  
 1'. Lobules narrow, an elongate enfolding of the lower lobe margins, with or without  
 a tooth ..... *M. minutissima* subsp. *myriocarpa*

*Spruceanthus planiusculus* (Mitt.)

X.Q. Shi, R.L. Zhu & Gradst.

**Name change**

Treated as *Archilejeunea planiuscula* (Mitt.) Steph. by Staples & Imada (2006). Indigenous; found on all major islands and Lāna'i (Judziewicz *et al.* 2023), 0–1067 m, but mostly below 600 m; see Shi *et al.* (2015: 889) and Wang *et al.* (2016).

*Vitalianthus pseudoneurus* (A. Evans) Judz. & A.V. Freire, **comb. nov.**

**Basionym:** *Harpalejeunea pseudoneura* A. Evans, *Trans. Connecticut Acad. Arts* 10: 427. 1900.

Treated as *Drepanolejeunea pseudoneura* (A. Evans) Grolle by Staples & Imada (2006).

Endemic; O'ahu (several places in both the Wai'anae and Ko'olau Ranges), Maui (Pu'u Kukui), and Hawai'i (Kūlani Road) (152–1,737 m). A distinctive species with golden brown ocelli forming a false "midvein" on the leaf. Tiny, epiphytic or epiphyllous plants appressed to the substrate, the pointed lobes with a line of golden brown ocelli running down the center. The aspect of the leaves and ocelli suggest a tiny "jester's cap." Grolle (1988: 405) postulated that its closest relative is the South American *Drepanolejeunea bischleriana* (now *Vitalianthus bischlerianus* (K.C. Pörto & Grolle) R.M. Schust. & Giancotti. See also Gradstein (2018: 8–9). Based on the key to species in Zhu *et al.* (2018), the Hawaiian species appears to be most closely related to the tropical American species *V. aphanellus* (Spruce) Bechteler, G.E. Lee, Schäf.-Verw. & Heinrichs and *V. bischlerianus* than to the tropical Asian species *V. lamyii* R.L. Zhu, L. Shu & H. Mohamed and *V. guangxianus* R.L. Zhu, Qiong He & Y.M. Wei. The Asian species have underleaves with lobes 3–4 cells wide at the base, and each lobe has a lateral tooth. The American species have underleaves with lobes two cells wide at the base and lack lateral teeth. *Vitalianthus pseudoneurus* is distinctive in the genus in its attenuate, recurved lobes (versus bluntly acute and only slightly recurved), large lobules 0.55–0.65 times as long as the lobes (versus only 0.3–0.5 times as long), and ocelli in a line 6–10 cells long (versus 3–6 cells long). The oil bodies are small (0.1 the diameter of each cell) and only 2–3 per cell.

*Material examined.* **O'AHU:** Wai'anae Range, trail from Mauna Kapu to Palikea, on bark of *Cryptomeria japonica*, 811–920 m, 4 Nov 2021, E.J. Judziewicz *et al.* 21-960 (BISH); Ko'olau Range, Lanihuli, anno 1902, C.M. Cooke, Jr. 27, 32 (BISH); Kalihi Valley, 9 Mar 1916, C.N. Forbes 2307.O (BISH); Mānoa Falls Trail, on spongy bark of *Eucalyptus*, 500 ft [152 m], 18 Mar 1977, Stemmermann 2023 (BISH). Also reported from Maui (Pu'u Kukui) by Miller (1963) based on L. Cranwell & C. Skottsberg 5438 (S, Stockholm herbarium, not seen), and from Hawai'i Island (Grolle 1988) from the Stainback Hwy., H.A. Miller & A. Lamberton 5198 (MU, Miami University herbarium, not seen).

KEY TO SPECIES OF *VITALIANTHUS* OF THE WORLD  
(modified from Zhu *et al.* (2018) to add *V. pseudoneurus*)

1. Underleaf lobe (2–)3–4 cells wide at base; outer lateral margins of underleaf lobes toothed; tropical Asia
  2. Shoots 0.4–0.7 mm wide; leaves oblong-ovate, obliquely spreading; leaf lobules 1/3–2/5 as long as the lobes; outer lateral margin of underleaf lobes with a distinct tooth 1–2 cells long; Borneo ..... *V. lamyii*
  2. Shoots 0.2–0.3(–0.4) mm wide; leaves ovate, almost erect; leaf lobules usually 1/2–3/4 as long as the lobes; outer lateral margin of underleaf lobes entire to angular; China ..... *V. guangxianus*
- 1'. Underleaf lobe mostly 2(–3) cells wide at base; outer lateral margins of underleaf lobes entire or weakly angular; tropical South America and Hawai'i
  3. Leaf lobe ocelli in a row of 5–10 cells; lobule 0.55–0.65 times as long as the lobe; lobes acute-acuminate, strongly recurved; Hawai'i ..... *V. pseudoneurus*
  - 3'. Leaf lobe ocelli in a row of 3–6 cells; lobule 0.3–0.5 times as long as the lobe; lobes obtuse to acute, divergent and only slightly if at all recurved; tropical South America
    4. Ventral margin of leaf usually arched; leaves oblong, erect to suberect, usually remote; Brazil, French Guiana, and Colombia ..... *V. aphanellus*
    - 4'. Ventral margin of leaf usually weakly curved; leaves mostly oblong-ovate, obliquely to widely spreading, imbricate; Brazil ... *V. bischlerianus*

### Lepidoziaceae

*Bazzania hookeri* (Lindenb.) Trevis.

#### New state record

Indigenous; so far known only from near the summit of Mt Ka'ala, O'ahu. The auriculate underleaves and leaves (characters found in no other Hawaiian congeners) are distinctive and match the widespread tropical American species *Bazzania hookeri* (Gradstein & Ilkiu-Borges 2009: 26–27, with illustration; Gradstein 2017, 2021: 213), but with broader triangular leaves that are about as long as wide at their base.

*Material examined.* O'AHU: wet embankment near the summit of Mt Ka'ala, 1,205 m, 9 Nov 2022, M.K. Thomas *et al.* 524a (BISH).

### Lophocoleaceae

*Cryptolophocolea bartlettii* (H.A. Mill.) Judz. & A.V. Freire, **comb. nov.**

**Basionym:** *Lophocolea bartlettii* H.A. Mill., *Ark. Bot.*, n.s., 5: 506. 1963. Treated as *Chiloscyphus bartlettii* (H.A. Mill.) J.J. Engel & R.M. Schust. by Staples & Imada (2006).

Endemic; found on Moloka'i, Maui, and Hawai'i (1,067–1,829 m). An uncommon small species creeping on bark. Leaves are opposite to nearly so, rectangular, and slightly inrolled, apices may be variable, from round, truncate to slightly emarginate but with some leaves per plant with two small teeth at truncate apices. The small underleaves are bifid, with small lateral teeth or elbows, clearly connate to both adjacent leaves, “batlike”; the median leaf cells have conspicuous trigones. Miller (1963) illustrated *Lophocolea bartlettii* with a keeled perianth. Keeled perianths are not present in *Chiloscyphus* but occur in *Cryptolophocolea* and *Lophocolea*. The presence of trigones; opposite, inrolled leaves; underleaves strongly connate to adjacent leaves; and keeled perianth support the placement of this species in the genus *Cryptolophocolea*. Indeed, Miller (1963) noticed the similarity of this species to *Lophocolea gaudichaudii* (a synonym for *Cryptolophocolea ciliolata*).



***Cryptolophocolea ciliolata*** (Nees) L. Söderstr.,

Crand.-Stotl., Stotler &amp; Våña

**Name change**

Treated as *Chiloscyphus ciliolatus* (Nees) J.J. Engel & R.M. Schust. by Staples & Imada (2006). See Söderström *et al.* (2013: 39, 2016: 193), and Lee & Gradstein (2021: 72). Indigenous; a variable eastern Asian species, disjunct in Hawai'i (Sun *et al.* 2018: 160) and commonly found in wet forests on all major islands and Lāna'i (Judziewicz *et al.* 2023), 457–1,860 m.

***Leptoscyphus baldwinii*** (Steph.) Judz. & A.V. Freire, **comb. nov.**

**Basionym:** *Lophocolea baldwinii* Steph., *Bull. Herb. Boissier*, sér. 2, 6: 950. 1906. Treated as *Chiloscyphus baldwinii* (Steph.) J.J. Engel & R.M. Schust. by Staples & Imada (2006).

Endemic; a common species on all major islands and Lāna'i (Judziewicz *et al.* 2023), 610–1,830 m; on bark, rotted wood, and moist shaded soil in wet forests. The leaves are round to squarish and the leaf margins are fringed with 8–12 spreading cilia. With age or upon drying, the plants, especially the stem, become reddish brown. The leaves usually have large trigones. The numerous leaf marginal cilia and golden brown color (with age) indicate that this species belongs to *Leptoscyphus* rather than *Chiloscyphus* or *Lophocolea*. It appears to be mostly closely related to the tropical American species *Leptoscyphus trapezoides* (Mont.) L. Söderstr. See Gradstein (2021: 251, 258–260) for a description of the latter species.

***Lophocolea autoica*** Steph.**Name change**

Treated as *Chiloscyphus autoicus* (Steph.) J.J. Engel & R.M. Schust. by Staples & Imada (2006). See Söderström *et al.* (2016: 209). Indigenous; supposedly also found in New Caledonia (Miller *et al.* 1983). Found on O'ahu, Lāna'i (Judziewicz *et al.* 2023), and Hawai'i, 550–1,980 m; often in mesic rather than wet forests. This species is unusual in the genus in that the leaves are often variable on the same plant. Some or all can be entire, slightly retuse, or with one or two inconspicuous teeth.

***Lophocolea bicuspidata*** Steph.**Name change**

Treated as *Chiloscyphus bicuspidatus* (Steph.) J.J. Engel & R.M. Schust. by Staples & Imada (2006). See Söderström *et al.* (2016: 209). Endemic; locally common in wet forests on Maui and Hawai'i (640–1,860 m).

***Lophocolea hawaica*** Steph.**Name change**

Treated as *Chiloscyphus hawaicus* (Steph.) J.J. Engel & R.M. Schust. by Staples & Imada (2006). See Söderström *et al.* (2016: 211). Endemic; a common species found Kaua'i, Moloka'i, Lāna'i (Judziewicz *et al.* 2023), and Hawai'i, 488–2,133 m.

***Lophocolea kilauensis*** (Steph.) H.A. Mill.**Name change**

Treated as *Chiloscyphus kilauensis* Steph. by Staples & Imada (2006). See Söderström *et al.* (2016: 190). Endemic; uncommon on O'ahu, Lāna'i (Judziewicz *et al.* 2023), and Hawai'i, 914–1,890 m.

***Lophocolea muricata*** (Lehm.) Nees**Name change**

Treated as *Chiloscyphus muricatus* (Lehm.) J.J. Engel & R.M. Schust. by Staples & Imada (2006). See Söderström *et al.* (2016: 213). Indigenous; rare; known in Hawai'i from just a single collection made at Mile 23 (ca. 600–900 m) on the Hilo-Volcano Road, Hawai'i Island, in 1938 (*C. Skottsberg 5030*, Stockholm Herbarium, not examined; Miller 1963). We have unsuccessfully searched for it in the Volcano area. It may occur as a tiny epiphyte on fern fronds. It is mainly a species of tropical mountains and temperate areas of the Southern Hemisphere, with some records in warm temperate eastern Asia and North America.

***Lophocolea pusilla*** Steph.**Confirmation of a previous tentative record**

Rare endemic, Hawai'i Island. The complete absence of leaf teeth is unusual in Hawaiian species of *Lophocolea*. Very small leaf trigones may be present. It seems possible that this species may be conspecific with *L. autoica* Steph.; if so, we suggest that it be placed in synonymy under that species. Cited as an accepted species for Hawai'i by Miller (1963) but listed as a dubious record by Staples & Imada (2006: 38) because Miller *et al.* (1983: 202) failed to cite an island locality; however, the Hawai'i Island specimen below was annotated by Miller in 1960.

*Material examined.* **HAWAI'I:** Haleloulu, 3 Jun 1915, *C.N. Forbes 672b* (BISH).

***Lophocolea spinosa*** Gottsche**Name change**

Treated as *Chiloscyphus spinosus* (Gottsche) J.J. Engel & R.M. Schust. by Staples & Imada (2006). Endemic; an uncommon and inconspicuous small species found in bryophyte mixtures on O'ahu, Maui, and Hawai'i (914–1,768 m). Exquisitely delicate and often twining on other liverworts such as *Bazzania* and *Herbertus* and resembling tiny "snowflakes on a string."

**Marchantiaceae*****Marchantia polymorpha*** L.**New state record**

This cosmopolitan, weedy species, often found in greenhouses and nurseries, has been collected in several places in Hawai'i, but has never been reported. It is found from sea level to over 1,700 m.

*Material examined.* **KAUAI'I:** Puhī, Kauai Nursery and Landscaping, 3-1550 Kaumuali'i Hwy, moist soil in pots of plants imported from Florida, 109 m, 9 June 2003, *D. Lorence & C. Kaneshige 9080* (BISH, PTBG); same locality, mat-forming at base of concrete pillar, growing mixed with *Philonotis*, 100 m, 30 Aug 2016, *T. Flynn 8673* (BISH, PTBG). **O'AHU:** Honolulu Distr, Sand Island, Kilgo's Nursery on Sand Island Access Rd, growing on damp medium in a pot with variegated *Osmanthus heterophyllus*, 27 Mar 2007, *G. Staples 1301* (BISH). **MAUI:** West Maui, valleys, damp ground, 800 ft [244 m], 1875, *D.D. Baldwin 88, 90* (BISH); East Maui, Makawao Distr, Kēōkea, Kula Forest Reserve, 5,600 ft [1,707 m], in dense shade on cinder/ash substrate, under forestry plantings of conifers, recently burned, 1 Sep 2009, *H.K. Oppenheimer H90202* (BISH). **HAWAI'I:** Up 1880 lava flow to Kaūmana Caves, 21 May 1915, *C.N. Forbes 596H* (BISH); Volcano, 11-3733 Ala 'Ōhi'a St, Volcano Guest House, 19°25'53"N, 155°16'49"W, cracks in paving stones near house, 1,045 m, 5 Nov 2019, *A.V. Freire & E.J. Judziewicz 19-113* (BISH); South Hilo Distr, Waiākea Uka, 142-A Mala'ai Rd, in Novelty Greens nursery, in shade beneath tree ferns, growing on wet black weed block cloth spread on ground, 300 m, 17 Jan 2007, *G. Staples & E. Wilson 1239* (BISH).

**Plagiochilaceae*****Chiastocaulon combinatum* (Mitt.)**

S.D.F. Patzak, M.A.M. Renner,

Schäf.-Verw. &amp; Heinrichs

**Name change**

Treated as *Plagiochilon combinatum* (Mitt.) Inoue by Staples & Imada (2006). See Patzak *et al.* (2016: 492) and Söderström *et al.* (2016: 252). Endemic; found on all major islands and Lānaʻi (Judziewicz *et al.* 2023), 213–1,676 m, in wet forests.

***Plagiochila caduciloba* H.L. Blomq.****New state record**

Indigenous; apparently found only on Hawaiʻi Island, where we collected it recently in a wet montane forest in the Kāhuku Unit of Hawaii Volcanoes National Park. This is the first report of this southern Appalachian, U.S. species from Hawaiʻi. Other disjuncts with this Appalachians-Hawaiʻi disjunct pattern are known, for example *Radula sullivantii* (So 2005) and the moss *Plagiomnium rhynchophorum* (Harv.) T.J. Kop. (Wyatt *et al.* 2021). In its lack of trigones, caducous leaves, and large teeth this species resembles *P. remyana* (this paper), but the leaves of *P. caduciloba* are more deeply lobed than in the former species, and the plant lacks top-heavy branching. Not treated by Inoue (1976) in his revision of Hawaiian species of *Plagiochila*.

*Material examined.* **HAWAII:** Hawaii Volcanoes National Park, Kāhuku Unit, kīpuka near CCC/TMA cabin, 19°14'46–52"N, 155°36'02–22"W, 1,860 m, 10 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-720a* (HAVO).

***Plagiochila cf. corticola* Steph.****New state record**

A collection from a wet, exotic, lowland forest closely resembles this tropical Asian species (Grolle & So 2000: 9). We are not certain whether it is indigenous or naturalized. The leaves are nearly all consistently bifid (a few trifid) and have no trigones. Tiny underleaves are present. Not treated by Inoue (1976) in his revision of Hawaiian species of *Plagiochila*.

*Material examined.* **HAWAII:** Onomea, 19°48'35"N, 155°05'40"W, on exotic trees, 23–46 m, 20 May 2021, *A.V. Freire & E.J. Judziewicz 21-515* (BISH).

**Scapaniaceae*****Isopaches bicrenatus* (Schmidel ex Hoffm.)**

H. Buch

**New state record**

Indigenous; this is a drought-tolerant leafy liverwort, often found with *Cephaloziella heteroica* from 762–2,133 m and possibly higher. First collected (and long filed as a *Cephaloziella*) by J. Sorenson (*Sorenson H-18*) on 10 May 1979 at the Puhimau Hot Spot [ca. 1,100 m] in Hawaii Volcanoes National Park (BISH). This is the first record of this Holarctic genus (and species) between the Americas and New Zealand; there are also scattered records from South America (Gradstein 2021: 330–331). The plants have a distinctive and penetrating odor of cedar oil. Gemmae are sometimes observed at tips of plants; they are, brown, quadrate to star-shaped. In addition to numerous sites on Mauna Loa, we have also found it on Mauna Kea and Maui, where found at 2,400 m elevation.

*Material examined.* **MAUI:** Haleakalā National Park, Halemāuʻu Trail, 20°45'15"N, 156°13'30"W, 2,400 m, in *Leptecophyllum* shrubland, 24 Feb 2023, sight record by *A.V. Freire, E.J. Judziewicz, and Z. Pezzillo* (see Fig. 1). **HAWAII:** Kaʻū Desert, 19°21'05"N, 155°22'00"W, shaded embankment, on moist ash, 880 m, 12 Jan 2020, *A.V. Freire & E.J. Judziewicz 20-13* (HAVO); Lava Molds spur, 19°25'53"N,

155°17'03"W, shaded embankment, on moist ash, 1,233 m, 13 Jan 2020, *A.V. Freire & E.J. Judziewicz 20-15* (HAVO); same location, 9 Sep 2020, *A.V. Freire & E.J. Judziewicz 20-644* (HAVO); Hilina Pali Rd ca 0.6 mi SW of Kīpuka Nēnē, 19°19'22"N, 155°17'04"W, moist cracks in rocks, 870 m, *A.V. Freire & E.J. Judziewicz 20-38, 20-39, 20-40, 20-41* (HAVO); Maunaulu parking lot, 19°21'57"N, 155°13'08"W, soil-filled roadside crevice, 988 m, 6 Mar 2021, *A.V. Freire & E.J. Judziewicz 21-308a* (HAVO); summit of Mauna Loa Rd, 19°29'46"N, 155°23'01"W, locally abundant on ashy soil in partial shade, 2,050 m, 4 Apr 2021, *A.V. Freire & E.J. Judziewicz 21-392* (HAVO); 50 m E of Volcano House, 19°25'40"N, 155°15'40"W, in rainforest on trailside ash embankment, 1,210 m, 7 Apr 2021, *A.V. Freire & E.J. Judziewicz 21-402, 21-406* (HAVO); Kāhuku Unit, from Upper Palm trailhead north towards pit crater, trailside soil, 19°06'13"N, 155°41'17"W, 960 m, *A.V. Freire & E.J. Judziewicz 21-218* (HAVO); Kāhuku Unit, base of sedges at edges of small waterholes, 19°13'36"N, 155°38'00"W, 1,875 m, *A.V. Freire & E.J. Judziewicz 22-675* (HAVO); Kāhuku Unit, moist ash soil at edge of gulch 300 m NE of Nēnē Cabin, in open *Leptecophyllum* scrub, 19°15'30"N, 155°36'43"W, 2,000 m, *A.V. Freire & E.J. Judziewicz 22-690c, 22-691a* (HAVO); Hwy 11 roadside at Mile 40, 19°20'50"N, 155°23'14"W, tiny soil pocket in basalt, 860 m, 10 Mar 2021, *A.V. Freire & E.J. Judziewicz 21-335* (BISH); Mauna Kea, Mānā Rd at Wailuku River crossing, 19°46'12"N, 155°21'50"W, 2,085 m, 26 Mar 2023, *A.V. Freire & E.J. Judziewicz 23-328* (BISH); Hakalau Forest National Wildlife Refuge, embankment on entrance road, near Honohina Gulch, 19°49'12"N, 155°19'57"W, 1,965 m, 24 Mar 2023, *A.V. Freire & E.J. Judziewicz 23-213* (BISH); Hakalau Forest National Wildlife Refuge, near 'Āwehi Gulch, in full sun on rock at old quarry site, 19°47'15"N, 155°19'15"W, 1,815 m, 26 Mar 2023, *A.V. Freire & E.J. Judziewicz 23-235* (BISH).



**Figure 1.** *Isopaches bicrenatus*. Maui, Haleakalā National Park, Halemau'u Trail, 24 February 2023. Photo: Zachary Pezzillo.

***Lophozia silvicola* H. Buch****New state record**

Identification of this widespread Eurasian and North American species by authority Nadezhda A. Konstantinova (pers. comm.). Indigenous; usually terrestrial in moist high elevation forests on Maui and Hawai'i. On the latter it occurs from Mauna Loa from the Saddle Road to the Upper Kāhuku Unit of Hawaii Volcanoes National Park, (1,672–2,445 m), and also on the eastern slopes of Mauna Kea. Often growing with *Tritomaria exsecta*; both species are dispersed by gemmae, suggesting long-distance dispersal by birds from northern Eurasia or North America.

*Material examined.* **MAUI:** Haleakalā, N slope of Kalapawili Ridge, E of Lau'ulu Trail in *Deschampsia* grassland with scattered *Hypochaeris*, on shaded base of grass clump, 8,020 ft [2,445 m], 8 Jun 1977, *Hoe 4554.0* [mixed with *Symphygyna* and *Calypogeia tosona*] (BISH). **HAWAI'I:** Hawaii Volcanoes National Park, Upper Kāhuku Unit, 19°11'34"N, 155°39'35"W, kīpuka on south side of road, 1,672 m, 9 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-655a, 667* (HAVO); near waterholes, shaded rock crevice, 19°13'36"N, 155°38'00"W, 1,864 m, 9 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-676, 686<sup>a</sup>* (HAVO); kīpuka near CCC/TMA cabin, 19°14'46–52"N, 155°36'02–22"W, 1,852–1,885 m, 10 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-715a, 723c, 728a, 763a* (HAVO); Hakalau Forest National Wildlife Refuge, 'Āwehi Gulch, 19°47'15"N, 19°47'15"W, 1,830 m, 26 Mar 2023, *A.V. Freire & E.J. Judziewicz 23-238* (BISH).

***Protolophozia perssoniana* (H.A. Mill.)**

Váňa &amp; L. Söderstr.

**Name change**

Treated as *Lophozia perssoniana* H.A. Mill. by Staples & Imada (2006). See Váňa *et al.* (2013b: 52). One of the few endemic liverworts of Maui Nui, it is rarely found in montane bogs on Moloka'i and Maui (1,220–1,737 m), where it grows mixed with the sedge *Oreobolus furcatus* H. Mann (Miller 1963). The genus has both boreal and austral affinities.

***Scapania ciliata* Sande Lac. subsp. *hawaiiica***

(Müll. Frib.) Potemkin

**Name change**

Treated as *Scapania hawaiiica* Müll. Frib. (Scapaniaceae) by Staples & Imada (2006). See Potemkin (2002: 321) and Söderström *et al.* (2016: 88). An endemic subspecies found on Kaua'i and Maui (762–2,435 m).

***Scapania javanica* Gottsche****Name change**

Treated as *Scapania paucidens* Steph. by Staples & Imada (2006). See Potemkin (2002) and Söderström *et al.* (2016: 92). Indigenous; pantropical; found on Moloka'i and Hawai'i (610–1,768 m).

***Scapania ornithopoides* (With.) Waddell****Correction**

Treated as *Scapania ornithopodioides* (With.) Waddell by Staples & Imada (2006). Indigenous; rare, Maui (both West Maui and Haleakalā; 1,128–2,255 m). An Asian and Malesian species that is disjunct in Hawai'i (Sun *et al.* 2018: 160). The specific epithet is sometimes spelled as *ornithopodioides*, but that spelling was not conserved (Klazenga 2017).

***Scapania verrucosa* Heeg****Name change**

Treated as *Scapania mauiana* [as *mauina*] Steph. by Staples & Imada (2006). See Potemkin (2002) and Söderström *et al.* (2016: 92). Indigenous; found on Maui (914–1,830 m); otherwise Eurasian.

***Sphenolobus minutus* (D. Crantz) Berggr.      New state record**

Indigenous; in Hawai‘i, only on Haleakalā, Maui (2,362–2,444 m). First collected there by D.D. Baldwin (*Baldwin 65*, in 1875); then in 1977 by William J. Hoe in *Deschampsia* grassland on Kalapawili Ridge, Haleakalā, Maui; then on damp dirt beneath boulders on the Halemau‘u Trail by Marko Lewis in 1981. This is a common Holarctic species that is also present at scattered locations in tropical regions. It is a small plant resembling *Anastrophyllum* but is greenish in color; has more distant, cupped, almost tubular leaves; and lacks large trigones (Lee & Gradstein 2021: 82–83, 189). It grows in dense mats and can reproduce by leaf gemmae, suggesting long-distance dispersal by migratory birds.

*Material examined.* MAUI: Haleakalā, anno 1875, *D. Baldwin 65* (BISH); N slope of Kalapawili Ridge, E of Lau‘ulu Trail in *Deschampsia* grassland with scattered *Hypochaeris*, on shaded base of grass clump, 8,020 ft [2,444 m], 8 Jun 1977, *Hoe 4555.0* (BISH) [mixed with *Lophozia silvicola*]; Halemau‘u Trail, on damp dirt beneath boulders, 7,750 ft [2,362 m], 4 Oct 1981, *M. Lewis 81-247* (BISH, F).

***Tritomaria exsecta* (Schmidel) Loeske      New state record**

Indigenous; rare, usually terrestrial in moist high elevation forests on Mauna Loa on Hawai‘i Island (1,646–1,890 m), from the Saddle Road kīpuka (including Pu‘u Maka‘ala N.A.R., where collected in 1978 by *Murakami s.n.*, BISH 706366) clockwise to the Upper Kāhuku Unit of Hawaii Volcanoes National Park. Widespread on the mainland in Russia, Alaska, Canada, and the northern United States (Lee & Gradstein 2021: 84, 190). A distinctive small terrestrial species with 3-lobed leaves and elliptical gemmae; often associated with *Lophozia silvicola*.

*Material examined.* HAWAII: Kīlauea Forest Reserve [now Pu‘u Maka‘ala N.A.R.], on fallen log, with *Scapania javanica*, 1,646 m, 18 Aug 1978, *G. Murakami s.n.* (BISH 706366); Hawaii Volcanoes National Park, Kāhuku Unit, 19°11′34″N, 155°39′35″W, kīpuka on south side of road, 1,672 m, 9 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-645a, 653* (HAVO); near waterholes, shaded rock crevice, 19°13′36″N, 155°38′00″W, 1,864 m, 9 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-683* (HAVO); kīpuka near CCC/TMA cabin, 19°14′46–52″N, 155°36′02–22″W, 1,831–1,885 m, 10 Aug 2022, *A.V. Freire & E.J. Judziewicz 22-698b, 715b, 729a, 730a* (HAVO).

**Schistochilaceae*****Schistochila cookei* (H.A. Mill.) R.M. Schust.      Name change**

Treated as *Fulfordistria cookei* H.A. Mill. by Staples & Imada (2006). See Miller (1970: 320) and Schuster (1971: 628). Endemic; collected once on (apparently) Moloka‘i in September 1903 by C.M. Cooke, Jr. (perhaps in the Pēpē‘ōpae bog, ca. 1,000 m?). There is reportedly a specimen at BISH but we have not seen it. It is a striking liverwort: large (5–7 mm wide) and with numerous raised, toothed ridges (lamellae) running lengthwise along the conduplicate leaves. *Schistochila* is an Austral and tropical Asian genus. Possible affinity (Miller 1970): *S. lamellata* (Hook.) A. Evans, Chile.

**Solenostomataceae*****Solenostoma exsertum* (A. Evans) Steph.      Name change**

Treated as *Jungermannia hawaïica* (H.A. Mill.) Váňa by Staples & Imada (2006). See Söderström *et al.* (2016). Endemic; occasional; found on all major islands (305–1,859 m). Miller (1963) treated it as *Solenostoma hawaïicum* H.A. Mill.

***Solenostoma micranthum* (Mitt.)**

Váña, Hentschel &amp; Heinrichs

**Name change**

Treated as *Jungermannia micrantha* (Mitt.) Steph. by Staples & Imada (2006). See Váña *et al.* (2010). Indigenous; this variable, medium-sized leafy liverwort grows on all major islands and Lānaʻi (Judziewicz *et al.* 2023), 0–2,591 m, and is also found in Sāmoa.

**Southbyaceae*****Southbya organensis* Herzog****Name change**

Treated as *Southbya grollei* N. Kitag. by Staples & Imada (2006). See Váña *et al.* (2012) and Lee & Gradstein (2021: 85). Indigenous; rare, Kahālāwai, Maui; H.A. Miller (unpublished) also reports it from Kauaʻi, Oʻahu, and Molokaʻi (1,097–1,737 m). Gradstein (2018: 8) maps it as occurring in Brazil, Peru, Sri Lanka, Hawaiʻi, Southeast Asia, and New Guinea.

**ACKNOWLEDGMENTS**

Bishop P. Museum personnel Barbara Kennedy, Tim Gallaher, Clyde Imada, and Miles K. Thomas supported us during five (and continuing) visits to the Herbarium Pacificum beginning in May 2021. Bishop Museum also facilitated our Lānaʻi field work with Kari K. Bogner. Miles and DOFAW botanist Susan N. Ching-Harbin organized three forays to the Waiʻanae Range on Oʻahu: Palikea (November 2021) and Mt Kaʻala (May and November 2022). Nick Walvoord, William Bleecker, and Suhaila Ng also provided help at Bishop Museum. Clyde's 2006 checklist of Hawaiian hornworts and liverworts, co-authored with George Staples, was of inestimable value in getting our work started. Timothy W. Flynn and Kenneth R. Wood facilitated our visit to the National Tropical Botanical Garden herbarium (PTBG) in Kalāheo, Kauaʻi in April 2022, including a collecting foray to Kōkeʻe State Park with Tim. Many bryologists have graciously assisted us in attempting to identify our mystery liverworts and hornworts: S. Robbert Gradstein, D. Christine Cargill, James Shevock, Matt von Konrat, and Nadezhda Konstantinova. Matt von Konrat of the Field Museum kindly expedited a loan of *Gymnomitrium* and *Sphenobolus* to Bishop Museum. Copies of the unpublished camera lucida drawings and specimen annotations by Harvey A. Miller, housed at the Herbarium Pacificum, have been invaluable.

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## New naturalized record of *Paullinia fuscescens* on O‘ahu (Sapindaceae)

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*Paullinia fuscescens* was accidentally discovered as naturalized on O‘ahu when it naturally dispersed and germinated in the garden of the first author. The likely source population was found naturalized in Mau‘umae Nature Park nearby, indicating that this species is established on O‘ahu. All material cited below is stored at the Herbarium Pacificum (BISH) and was identified by both authors.

### Sapindaceae

#### *Paullinia fuscescens* Kunth

#### New state record

In 2021 an unusual liana germinated on the property of the first author in Kaimukī, Honolulu, and was watered and cared for until it flowered and fruited. It reached a height of over 2.5 m, growing on a *Euphorbia tirucalli*. It was later discovered that two small colonies of this liana, covering approximately 5 m<sup>2</sup> each, are naturalized at Mau‘umae Nature Park, also in Kaimukī. The Mau‘umae population is likely the source population for the seed that germinated in the author’s yard. These were identified as *Paullinia fuscescens* using the key in the *Flora of the Guianas* (Acevedo-Rodríguez 2012).

*Paullinia fuscescens* is an ornamental liana native to Mexico through Central America and northern South America (Acevedo-Rodríguez 2012). It is very likely that this was introduced as an ornamental, but it is not mentioned in Staples & Herbst (2005), nor are there any specimens of this in cultivation at BISH. One observation has been posted to iNaturalist, where it was cultivated in Wai‘anae (<https://www.inaturalist.org/observations/147276054>). *Paullinia fuscescens* has dark green, tomentose to tomentulose, biternate leaves with a narrowly winged rachis. The leaflets are chartaceous with serrate margins, the adaxial surface shiny with a sparsely pubescent midvein, and the abaxial surface dull with prominent venation. It is presently cultivated for its bright red, 3-winged capsular fruit that contains one black, persistent seed per locule, measuring ca. 6 mm in length (Figure 1). On O‘ahu, *P. fuscescens* has so far been found in elevations ranging from 150–360 ft (45–110 m) above sea level. Plants also grew in various soil types, including vertisols, ultisols, and entisols (Deenik 2014).

Historically, the plant stems were used as a lashing to bind framework in housing, fencing, and huts (Beck 1990). The plant also contains saponin and is used ethnobotanically by indigenous peoples to stun fish (Williams 1981). The flowers produce a faint, musky-sweet smell, giving these lianas the common name “moldy bread and cheese.” The oblong black, arillate seeds (Chery *et al.* 2019) are dispersed by unspecialized frugivores, including birds (Snow 1981), although other vectors, such as rodents, may play an important role (Weckerle & Rutishauser 2005).



**Figure 1.** *Paullinia fuscescens*. **A**, leaves, tendrils, and immature inflorescences. **B**, fruit partially dehiscent, showing the black seed with a white sarcotesta. **C**, flower.

*Paullinia fuscescens* is morphologically most similar to *Cardiospermum grandiflorum* (Sapindaceae), which is widely naturalized across O‘ahu, as they have similar leaves. They can be differentiated easily, as *C. grandiflorum* has inflated, papery fruits and long-hispid stems, whereas *P. fuscescens* has dehiscent, fleshy fruits and minutely tomentose stems (Figure 1).

The following description is from Acevedo-Rodríguez (2012:74):

“Woody vine 3–7 m long. Stems cylindrical, tomentose or tomentulose, to 5 mm in diameter, producing scanty watery latex; cross section with a single vascular cylinder. Stipules triangular, ca. 1 mm long. Leaves biternate; petioles unwinged, 7–12 mm long; rachis narrowly winged, 1–1.6 cm long; leaflets chartaceous, with serrate, revolute margins, adaxial surface shiny, sparsely pubescent on the midvein, abaxial surface dull, with glandular papillae, the venation prominent and puberulent, with a tuft of hairs in the secondary vein axils; distal leaflet lanceolate, 4–6 × 1.5–2.5 cm, the apex acuminate, the acumens obtuse, the base long-attenuate; lateral leaflets almost elliptical, 1–2 × 0.7–1 cm, the apex obtuse, the base acute or obtuse. Thyrses axillary, racemiform, solitary, with tomentose axis; flowers sessile, in lateral cincinni. Calyx whitish green, with 5 sepals, 2–2.5 mm long; petals white, oblancoolate, cuneate at the base, 2–3 mm long; appendages slightly shorter than the petals, fleshy and yellow at the crest; disc of two obtuse-triangular lobes; stamens with unequal puberulent filaments; ovary trilocular. Capsule three-winged, red, 1–1.5 cm long. Seeds one per locule, black, obovoid, slightly laterally compressed, ca. 6 mm long, with a white and emarginate sarcotesta on lower half.”

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*Material examined.* O'AHU: Honolulu, Mau'umae Nature Park, trail though upper portion of park, dry, sunny, scrubby area along trail, climbing vine via tendrils, 2 large patches seen in park, no flowers could be found, 120 m, 21.288244, -157.789014, 14 May 2022, K. Faccenda 2362; Kaimukī, residence along Sierra Dr, liana with tendrils, climbing up to 3 m tall, this was not planted and appeared in the garden around 2021 and was left to grow, 21 Apr 2023, B. Najarian s.n.

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## Two new occurrence records for the Hawaiian Islands of invasive octocorals (Cnidaria: Anthozoa: Octocorallia: Malacalcyonacea) reported in Pearl Harbor: *Unomia stolonifera* (Gohar, 1938) and *Capnella* cf. *spicata* (May, 1899)<sup>1</sup>

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In 2020, an unidentified xeniid octocoral was reported in Pearl Harbor by contractor divers doing routine survey work. In 2022, coordination between several organizations and government agencies, including Bishop Museum, led to the visual identification of the xeniid coral as *Unomia stolonifera* (Gohar, 1938) followed by genetic confirmation in 2023 as well as the detection and identification of an additional octocoral species found growing in an adjacent patch as *Capnella* cf. *spicata* (May, 1899). Neither species have been previously reported in Pearl Harbor surveys (Coles *et al.* 1997, 2009; Coles, 2006) and represent two new occurrence records for the greater Hawaiian Islands.

Both species are regarded as invasive. *Unomia stolonifera* is of particular concern due to the rapidity and destructiveness of its spread on Venezuelan coral reefs following its introduction there in the early 2000s (Ruiz-Allais *et al.* 2014, 2021). The Hawai‘i Invasive Octocorals Working Group, including the Bishop Museum, was formed with the mission to support developing, implementing, and maintaining a collaborative, inter-agency action plan guided through adaptive management, with the goal of eradicating or containing invasive octocorals in Pearl Harbor and creating a long-term, accessible record for future use. The octocorals currently remain confined to Pearl Harbor and have not yet been reported beyond the harbor entrance (Hawai‘i Invasive Octocorals Working Group, pers. comm., 15 June 2023).

Both *U. stolonifera* and *C. spicata* are common aquarium species. *Unomia stolonifera* is commonly referred to as “Pulsing Xenia” and *Capnella spicata* is known as the “Kenya Tree Coral” (Cleveland Metroparks Zoo; Gay 2023; Ulrich III). The illegal aquarium trade was the vector of introduction for *U. stolonifera* to Venezuela (Ruiz-Allais *et al.* 2021). Since both species were found growing together *in situ* close to shore in Pearl Harbor (Fig. 1), it is most likely that the source of introduction here was likely similar, in this case aquarium release.

### Xeniidae

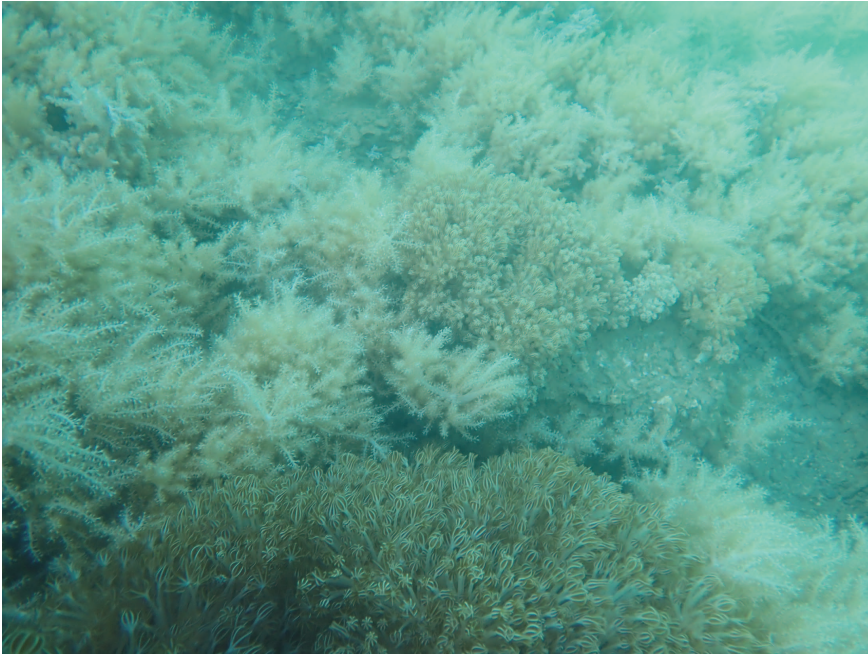
#### *Unomia stolonifera* (Gohar, 1938)

#### New state record

*Cespitularia stolonifera* Gohar, 1938: 483–485

*Unomia stolonifera* has been confirmed as a new record for the Hawaiian Islands. While it was first reported to the U.S. Navy in 2020 following marine biological surveys of Pearl Harbor, anecdotal evidence from regular users of the area suggests a presence as early as

1. Contribution No. 2023-008 to the Hawaii Biological Survey.



**Fig. 1.** Two invasive octocorals, *Unomia stolonifera* and *Capnella cf. spicata* growing on hard substrate less than 1 meter depth in Pearl Harbor, south of Bishop Point, 16 May 2023.

2017 (Hawai'i Invasive Octocorals Working Group, pers. comm., 15 June 2023). Six samples were collected by Pearl Harbor Naval Shipyard Dive Locker divers and were identified through examination of sclerite morphology and molecular analysis (ZMTAU Co38081, Accession# MT482554.1).

*Unomia stolonifera* was initially described by Gohar in 1938 and assigned the name *Cespitularia stolonifera*. In 2021, Beneyahu *et al.* revisited the species and moved it to the new genus *Unomia* after phylogenetic analysis and examination of microstructures with scanning electron microscopy. In the aquarium trade, the species is often conflated with *Xenia elongata* Dana (Gay 2023).

*Unomia stolonifera* occurs natively in the western Indo-Pacific around Indonesia (Beneyahu *et al.* 2021, GBIF). It has not been previously recorded in Hawai'i and its distinctive appearance as well as its abundance immediately set it apart to surveyors.

Material examined was preserved in 95% ethanol and deposited at the Bernice Pauahi Bishop Museum (BPBM). Prior to these specimens, neither *U. stolonifera* nor its synonyms had been catalogued in the Bishop Museum collection from Hawai'i, or any other region.

*Material examined:* HAWAIIAN ISLANDS: **O'ahu:** Pearl Harbor, south of Bishop Point, hard substrate, 1 colony: 2 Feb 2022, hand collected, PHNSY Dive Locker divers (BPBM D2844). As above (BPBM D1845-D2849).

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**Capnellidae*****Capnella* cf. *spicata*** (May, 1899)**New state record***Eunephthya spicata* (May, 1899)*Ammothea spicata* May 1899: 140

Found growing in a smaller patch adjacent to *U. stolonifera* in Pearl Harbor, *Capnella* cf. *spicata* represents another new state record. The species was detected as distinct from the neighboring *U. stolonifera* colonies initially through gross morphology before confirmation via molecular analysis in early 2023 (NCBI JX124371.1).

*Capnella spicata* was originally described as *Ammothea spicata* by May in 1899 before a generic revision in 1904 placed it in *Capnella* (Kükenthal). The genus *Capnella* was previously in the family Nephtheidae (Gray 1862) but was revised and placed in the new family Capnellidae by McFadden, van Ofwegen & Quattrini (2022).

*Capnella spicata* is native to the Indo-Pacific, its range extending from the tropics of the east coast of Africa to the Western Pacific, but was not previously known to occur within the Hawaiian Islands (GBIF). Due to the taxonomic revisions (past and future) involving this species (Utinomi 1960; McFadden & Ofwegen 2012), a more specific geographic distribution is difficult to confirm.

Six samples from Pearl Harbor were collected for analysis, preserved in 95% ethanol and deposited at BPBM. Prior to this collection, this species was not represented in Bishop Museum's collection.

*Material examined:* HAWAIIAN ISLANDS: **O'ahu:** Pearl Harbor, south of Bishop Point, hard substrate, 1 colony: 16 May 2023, hand collected, Navy PHNSY divers (BPBM D2935). As above (BPBM D2936-D2940).

**ACKNOWLEDGEMENTS**

Thank you to PHNSY Dive Locker divers for collecting specimens of both octocorals; to Kevin Lino (NAVFAC Pacific) and the U.S. Navy for facilitating the collections and site visit to Pearl Harbor; to Nicholas Walvoord for processing samples at Bishop Museum; to Rob Toonen and the HIMB ToBo lab for sequencing the specimens; to Les Watling for doing SEMs of the samples; and to Cathy McFadden for her help with identifying the specimens. And special thanks to Christy Martin at CGAPS who facilitates the Hawai'i Invasive Octocoral Working Group, and all the state, federal, and academic members of the group for their combined efforts to record, monitor, and coordinate control efforts for these invasive marine species.

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## A New Species of *Spelaeorchestia* (Crustacea: Amphipoda: Talitroidea) from Lava Tube Caves on the Island of Hawai‘i in the Hawaiian Archipelago

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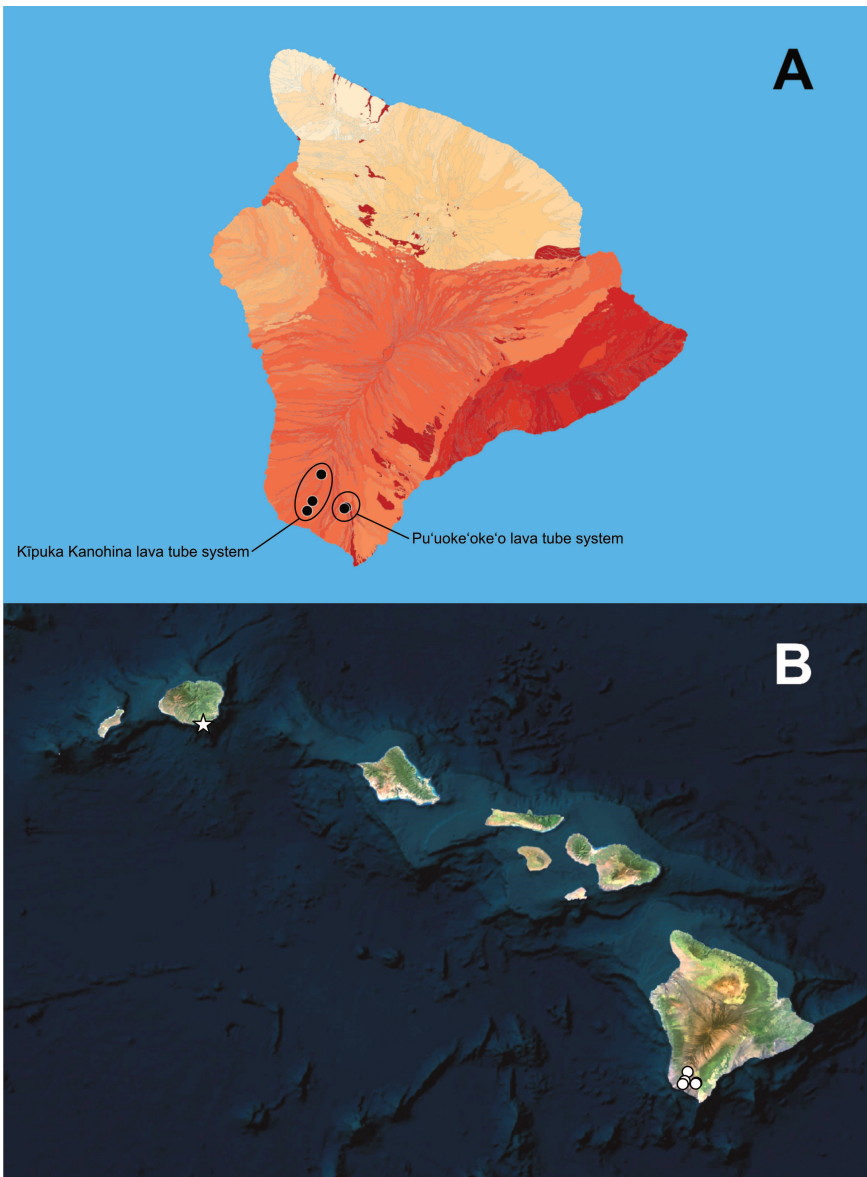
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**Abstract.** The Hawaiian islands are recognized as a hotspot of biodiversity, including both surface and subsurface habitats. Recent studies of Hawaiian lava tube fauna have continued to reveal new species. Here, a new species of cave dwelling talitroid amphipod in the genus *Spelaeorchestia* is described from lava tubes on the island of Hawai‘i. It is compared with the only other known cave amphipod from the Hawaiian archipelago and with a closely related cave talitroid from Japan in the genus *Minamitalitrus*.

### INTRODUCTION

The superfamily Talitroidea is comprised of eight amphipod families (Myers & Lowry 2020) occupying habitats ranging from supralittoral/intertidal beaches, mangrove swamps, salt marshes, coastal meadows, freshwater riparian zones, forest leaf-litter and soils, and even moss-covered tree trunks (Lowry & Myers 2019). Obligate cave-dwelling ‘cave-hoppers’, however, are rare, with only four previously described species, each of which is in a separate genus: *Houlia bousfieldi* (Hou & Li 2003); *Minamitalitrus zoltani* White, Lowry & Morino 2013; *Palmorchestia hypogaea* Stock & Martin, 1988; and *Spelaeorchestia koloana* Bousfield & Howarth, 1976. With the exception of *H. bousfieldi*, for which precise collection locality and habitat information from within China is unknown (Hou & Li 2003), the remaining three species were all described from geograph-

<sup>†</sup> Deceased 4 November 2021.



**Figure 1.** (A, B) Known distribution of *Spelaeorchestia pahoehoe* sp. nov. on the island of Hawai'i (black or white circles) and (B) area where *Spelaeorchestia koloana* occurs on the island of Kaua'i (white star). Darker red units on the island of Hawai'i, correspond to younger lava flows (0.0 to 0.4 ka), while the lightest units on the island correspond to the oldest deposits (up to 12.4 ka) (Trusdell *et al.*, 2006).

ically distant insular cave habitats: *M. zoltani* from limestone caves on an uplifted coralline atoll in the Philippine Sea (White *et al.* 2013); *P. hypogaea* from volcanic lava tubes on the Canary Islands (Stock & Martin, 1988) and *S. koloana* from volcanic lava tubes on the Hawaiian island of Kaua'i (Bousfield & Howarth 1976).

The Hawaiian Islands contain extensive subterranean habitats consisting of fractures, fissures, and human-accessible lava tubes. These lava tubes and associated habitats harbor diverse subterranean arthropod communities, with the best known obligate cavernicolous fauna including plant hoppers of the genus *Oliarus* Stål, 1862 (Hoch & Howarth 1999), the federally endangered Kaua'i cave wolf spider *Adelocosa anops* Gertsch, 1973 (pe'e pe'e maka 'ole spider) and the federally endangered Kaua'i cave amphipod *Spelaeorchestia koloana* Bousfield & Howarth, 1976 (uku noho ana).

In 2015, bioinventory investigations were initiated in the Kīpuka Kanohina lava tube system on the southern flank of Mauna Loa, Hawai'i Island (Fig. 1). These studies have resulted in the discovery of many undescribed species of cave-adapted arthropods (Liebherr, 2021; Hoch, H. *et al.*, *in litt.*), including a new species of *Spelaeorchestia* described here (Fig. 2). This recent work has built upon the foundational studies of Howarth (1973) and colleagues, who described communities from lava tubes in Kīlauea and northeastern Mauna Loa flows. Based on this work, Stone & Howarth (2005) estimated that over 44 species of cave species occur on Hawai'i island. The new amphipod species described here demonstrates the potential that exists for further significant species discoveries from Hawaiian lava tubes.

*Spelaeorchestia* is now known to include two Hawaiian species and the new species described here extends the documented range of the genus in Hawai'i to a second island. The new species brings the world total of 'cave-hopper' talitrids to five species.

## MATERIAL AND METHODS

*Collecting and preservation.* Talitroid specimens were collected by hand from lava tubes found in two flows on the southern flank of Mauna Loa volcano (Fig. 1) and transported to field stations for identification and preservation using 70–75% ethanol for specimens designated for morphological work and 95–100% ethanol for specimens used for molecular work. Specimen collections were made under official permits from the Hawaii State Department of Land and Natural Resources (numbers FHM16-405; I1005; I1063) and Hawaii Volcanoes National Park (HAVO-2019-SCI-0050), as well as permission from all individual private landowners.

*Specimen dissection, visualization, and permanent storage.* The amphipods were dissected, and body parts were mounted on microscope slides using glycerine. Specimens were examined under a Zeiss Optiphot interference contrast microscope with an attached drawing tube. Material is deposited in the Bernice P. Bishop Museum, Honolulu (BPBM).

Abbreviations used in figures: A1, 2 = antenna 1, 2; Ep 1–3 = epimera 1–3; M = male; F = female; G1, 2 = gnathopods 1, 2; L = left; Md = mandible; Mx1, 2 = maxilla 1, 2; Mxp = maxilliped; P4–7 = pereopods 4–7; Plp 1–3 = pleopods 1–3; U1–3 = uropods 1–3; T = telson.

*Mitochondrial COI sequencing and phylogenetic analysis.* In order to provide a genetic barcode for the newly described species, one specimen from each lava flow where *S. pahoehoe* was collected (designated as CKM\_1747A from the type locality, and

KKC\_1168) were DNA-extracted using a Qiagen DNEasy Blood and Tissue kit following manufacturer's protocols. Polymerase chain reactions were performed using NEB Quick-Load® Taq 2x master mix (M0271L), in 20 µL reactions using 0.4 mM Folmer primers (LCO1490: 5'-GGTCAACAAATCATAAAGATATTGG-3' and HCO2198: 5-TAAACTTCAGGGTGACCAAAAAATCA-3') and 1–12 ng DNA (Folmer *et al.*, 1994). A thermocycling protocol with a 2-min initial denaturation at 94 °C was followed by 50 cycles of 94 °C denaturation for 20 sec, 46 °C annealing for 10 sec, and 65 °C elongation for 1 min, and completed with a 7 min final extension at 65 °C. Sequences were cleaned using five units of Exonuclease I and 0.5 units of Shrimp Alkaline Phosphatase (ExoSAP) at 37 °C for 30 min, followed by inactivation at 80 °C for 15 min. Cleaned products were submitted to the University of Hawai'i Advanced Studies in Genomics, Proteomics and Bioinformatics facility for sequencing of both strands.

Sequences from *Spelaeorchestia pahoehoe* (GenBank accession numbers OR195527-OR195528) were assembled using Geneious (v10.1.3) de-novo assembly software and were aligned using the MAFFT algorithm (v7.4.50; Katoh & Standley 2013) to published sequences from a representative set of amphipod species from within the Talitridae and Brevitalitridae. A maximum likelihood phylogeny was generated from the nucleotide alignment using the IQ-tree web server (Nguyen *et al.* 2015; Trifinopoulos *et al.* 2016) with default search parameters, allowing the software to determine the best-fit model of evolution with rate heterogeneity, and estimating branch support using both ultrafast bootstrap and SH-aLRT analyses (Guindon *et al.* 2010), each from 1,000 replicates.

## SYSTEMATICS

**Suborder Senticaudata** Lowry & Myers, 2013

**Infraorder Talitrida** Serejo, 2004

**Parvorder Talitridira** Lowry & Myers, 2013

**Superfamily Talitroidea** Rafinesque, 1815

**Family Brevitalitridae** Myers & Lowry, 2020

### *Spelaeorchestia* Bousfield & Howarth, 1976

*Spelaeorchestia* Bousfield & Howarth, 1976: 143.

**Type species.** *Spelaeorchestia koloana* Bousfield & Howarth, 1976, by original designation.

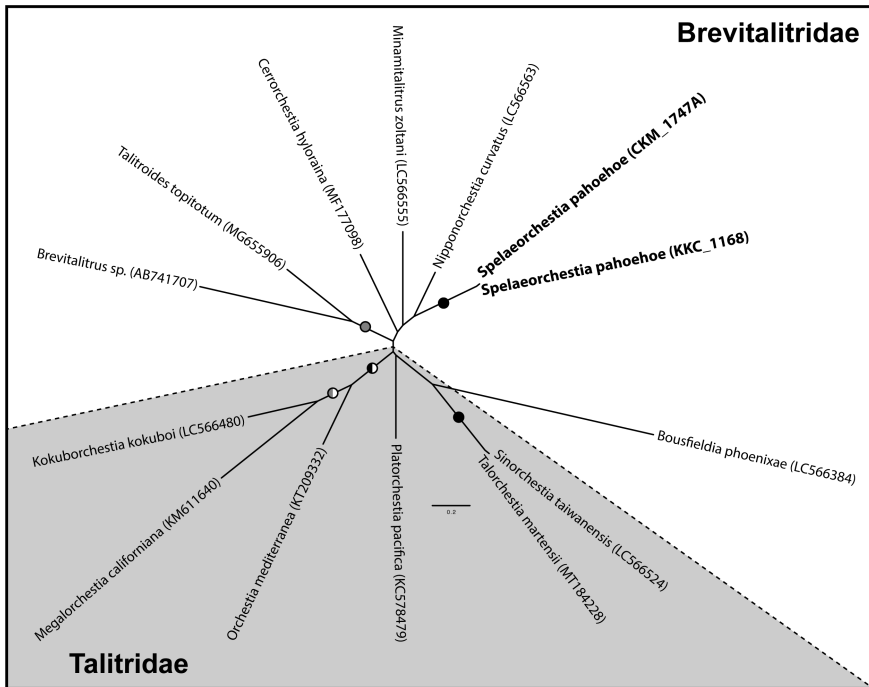
**Included species.** *S. koloana* Bousfield & Howarth, 1976 and *S. pahoehoe* sp. nov.

**Diagnostic description.** Head lacking eyes. *Antenna 1* short, reaching less than halfway along article 4 of antenna 2. *Antenna 2* about one third body length; *Mandible* left lacinia mobilis 2-3 cuspidate; maxilliped palp article 2 with or without distomedial lobe; palp with distinct, button-shaped article 4. *Gnathopod 1* palmate setae absent on merus, carpus and propodus *Gnathopod 2* mitten-like, merus with postero-distal lobe bearing palmate setae; carpus posterior margin with large patch of palmate setae; propodus with large posterodistal lobe bearing palmate setae. *Pereopods 3–7* cuspidactylate. *Pereopod 4* dactylus similar to that of pereopod 3. *Pleopods* biramous, uniramous or without rami. *Uropod 1* exopod without marginal setae. *Uropod 3* uniramous. *Telson* each lobe with single long marginal setae and a few terminal setae.



**Figure 2.** *Spelaeorchestia pahoehoe* **sp. nov.**, Kīpuka Kanohina lava tube system, CKM entrance, Hawai‘i A. Female, Holotype, (161G); B. Live animal of unknown sex; image by M.E. Slay.

**Remarks.** According to White *et al.* (2013), *Spelaeorchestia* is similar to *Minamitalitrus*, with the principal difference between these two genera being that the pleopods remain biramous in *Minamitalitrus* but are uniramous, vestigial or absent in *Spelaeorchestia*. This distinction was true at the time when only *S. koloana* was known. *Spelaeorchestia pahoehoe* **sp. nov.**, described here, has biramous pleopods and so this distinction no longer applies. However, *Minamitalitrus* also differs from *Spelaeorchestia* in its very short antenna 1 and 2 and in the weak development of palmate setae on the merus and carpus



**Figure 3.** Unrooted maximum likelihood phylogeny of cytochrome oxidase I sequences from representative Talitridae and Brevitalitridae amphipod species to provide context for newly generated *Spelaeorchestia pahoehoe* sp. nov. sequences (in bold). GenBank accession numbers are provided in parentheses for each species. Branch support values are shown on corresponding branches as circles, with the left half of the circle indicating support from bootstrap analyses, and the right half of the circle representing support from SH-aLRT branch tests. The color of each half of the circle indicates the level of support, with black indicating support values  $\geq 90\%$ , grey values from 80.0–89.9%, and white circles values from 70.0–79.9%; support values less than 70% in one or both metrics not shown.

of gnathopod 2. There is also a significant geographic distance between the occurrence of *Spelaeorchestia* in Hawai'i and that of *Minamitalitrus* in Japan. Given the recovered COI phylogenetic relationships (Fig. 3), these taxa are still considered to be separate genera.

***Spelaeorchestia pahoehoe* Myers & Lowry, sp. nov.**

(Figs. 2, 4–6)

**Type Material.** Holotype female (BPBM 2008035027) and 4 female paratypes from HAWAIIAN ISLANDS: **Hawai'i I:** Kīpuka Kanohina lava tube system, CKM entrance (HI 00161G), 1,096 m a.s.l., 24 Nov 2016, M.E. Slay, C.A.M. Slay, M.L. Porter coll.

**Other material.** There are 31 individuals from 13 sites collected for study including juveniles and eggs documenting reproduction in *S. pahoehoe*: HAWAIIAN ISLANDS: **Hawai'i I:** Pu'ūoke'oke'o lava tube system: 2 individuals, HHB entrance (HI 00030), 613 m a.s.l., 2 Dec 2015, M.E. Slay, C.A.M. Slay, M.L. Porter coll.; 1 individual, ECC entrance (HI 00035), 613 m a.s.l., 2 Dec 2015,

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M.E. Slay, C.A.M. Slay, M.L. Porter coll. Kīpuka Kanohina lava tube system: 1 individual, SRF entrance (HI 00075), 1,355 m a.s.l., 21 Nov 2016, M.E. Slay, C.A.M. Slay, M.L. Porter coll.; 7 individuals, CKM entrance (HI 00162), 1,096 m a.s.l., 24 Nov 2016, M.E. Slay, C.A.M. Slay, M.L. Porter coll.; 4 individuals, ELI entrance (HI 00296), 288 m a.s.l., 25 Nov 2017, M.E. Slay, S. Engel, M.L. Porter coll.; 2 individuals, HLC entrance (HI 00330), 539 m a.s.l., 25 Mar 2018, M.E. Slay, A.S. Engel, S. Engel, V. Hackell, T. Gracanin coll.; 3 individuals, ELI entrance (HI 00398), 288 m a.s.l., 27 Mar 2018, A.S. Engel, S. Engel coll.; 2 individuals, HLC entrance (HI 00523), 539 m a.s.l., 19 Nov 2018, R.A. Chong, A.S. Engel, M.L. Porter coll.; 2 individuals (1 adult, 1 juvenile), CWD entrance (HI 00655), 318 m a.s.l., 20 Nov 2018, C.A.M. Slay, A.G. Hudson, V. Hackell, M.L. Porter coll.; 1 individual, CWD entrance (HI 00659), 318 m a.s.l., 20 Nov 2018, C.A.M. Slay, A.G. Hudson, V. Hackell, M.L. Porter coll.; 2 individuals, CWD entrance (HI 00660), 660 m a.s.l., 20 Nov 2018, C.A.M. Slay, A.G. Hudson, V. Hackell, M.L. Porter coll.; 2 individuals, BGV entrance (HI 00847), 556 m a.s.l., 24 Nov 2018, M.L. Porter, A.S. Engel, A.G. Hudson, V. Hackell coll.; 2 individuals (one female with embryos), BGV entrance (HI 00855), 556 m a.s.l., 24 Nov 2018, M.L. Porter, A.S. Engel, A.G. Hudson, V. Hackell coll. (all BPBM).

**Type locality.** The type locality is an upper elevation section of the Kīpuka Kanohina lava tube system, although it is not directly connected by humanly-accessible passages to any other caves in the same flow. The lava tube has just over 2.9 km of passage with multiple entrances. There are numerous, dense patches of roots throughout the extent of the lava tube that serve as habitat for cave-adapted species; *Spelaeorchestia pahoehoe* **sp. nov.** were often found in wet but bare rock in the vicinity of roots.

**Etymology.** A pāhoehoe is a smooth, unbroken type of lava in ‘Ōlelo Hawai‘i

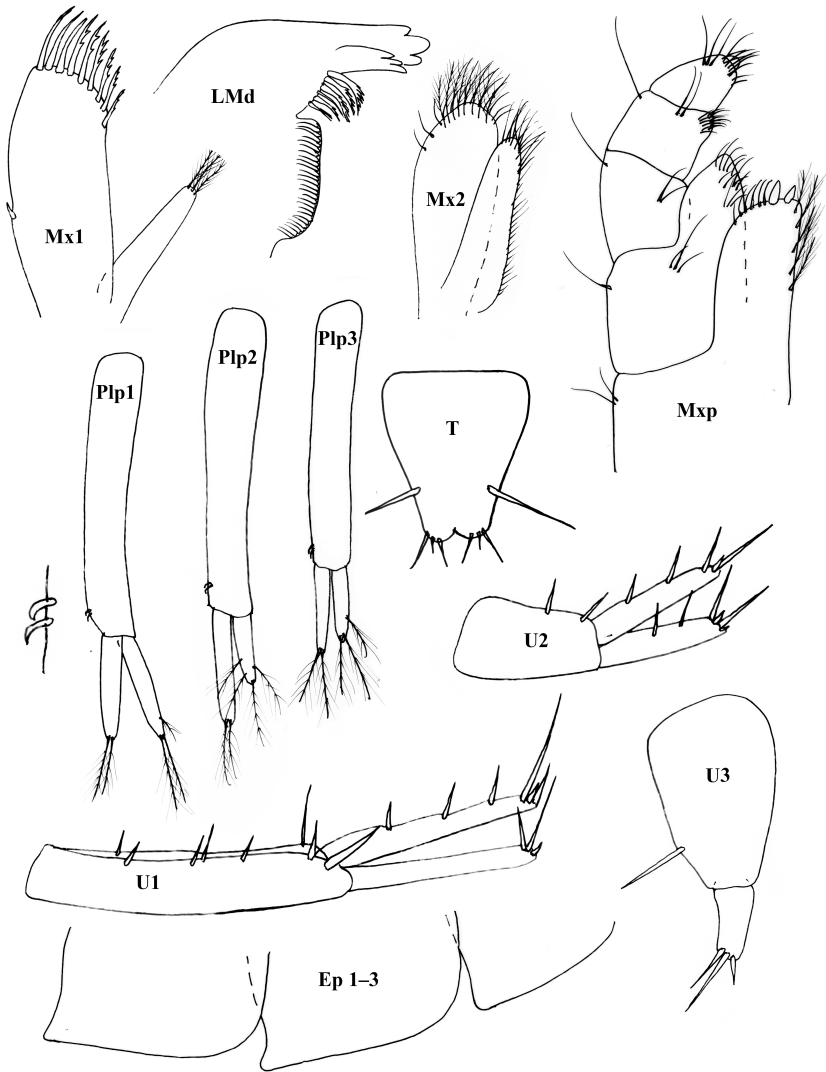
**Description.** (based on female 9.7 mm)

**Head.** Lacking eyes. *Antenna 1* short, reaching less than halfway along article 4 of antenna 2; peduncular articles 2 and 3 subequal in length; flagellum a little longer than combined length of articles 2 and 3 with 4 articles. *Antenna 2* about one third body length; peduncular article 5 a little longer than article 4; article 3 about one third length of article 5; flagellum longer than peduncle with 13 articles, the terminal article with apical cluster of imbricated setae. *Mandible* left lacinia mobilis 3-cuspidate; maxilla 1 inner plate slender with 3 terminal pectinate setae; maxilla 2 without oblique setal row; maxilliped palp article 2 with small distal lobe; palp with distinct, button-shaped article 4.

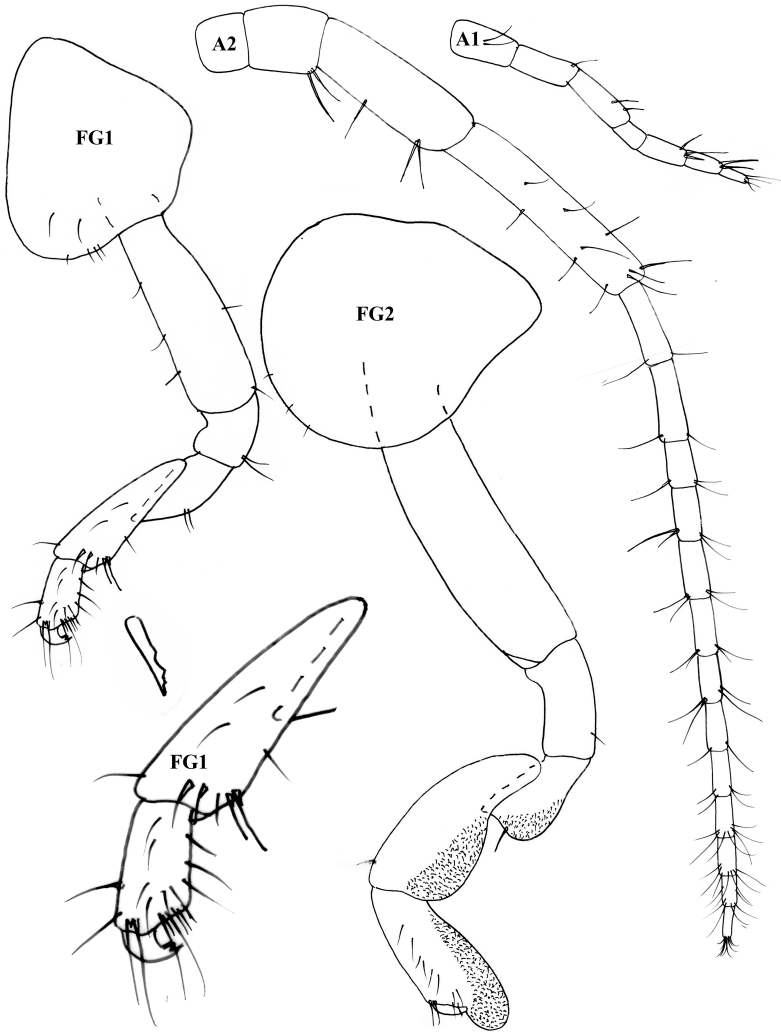
**Pereon.** *Gnathopod 1* palmate setae absent on merus, carpus and propodus; basis slender, uniform width, about 3 times as long as broad; carpus wedge shaped, about 4x as long as broad; propodus subrectangular half the length of the carpus; palm substraight; dactylus short, fitting palm, posterodistal margin with strong spines. *Gnathopod 2* larger than gnathopod 1, merus with postero-distal lobe bearing palmate setae; carpus and propodus subequal length; carpus posterior margin with large patch of palmate setae; propodus with large posterodistal lobe bearing palmate setae. *Pereopods 3–7* cuspidately-late. *Pereopod 4* dactylus similar to that of pereopod 3. *Pereopods 5–7* becoming progressively longer; *Pereopod 7* basis subovoid with distinct posterodistal flange.

**Pleon.** *Epimera 1–3* posterodistally acute. *Pleopods* biramous, peduncles each with 2 retinaculæ (coupling hooks), each ramus consisting of single article. *Pleopod 1* rami subequal in length; *Pleopods 2, 3*, with inner ramus the longer. *Uropod 1* peduncle a little longer than rami, with distal robust seta; endopod a little longer than exopod, exopod without marginal setae. *Uropod 2* rami longer than peduncle. Both rami with marginal

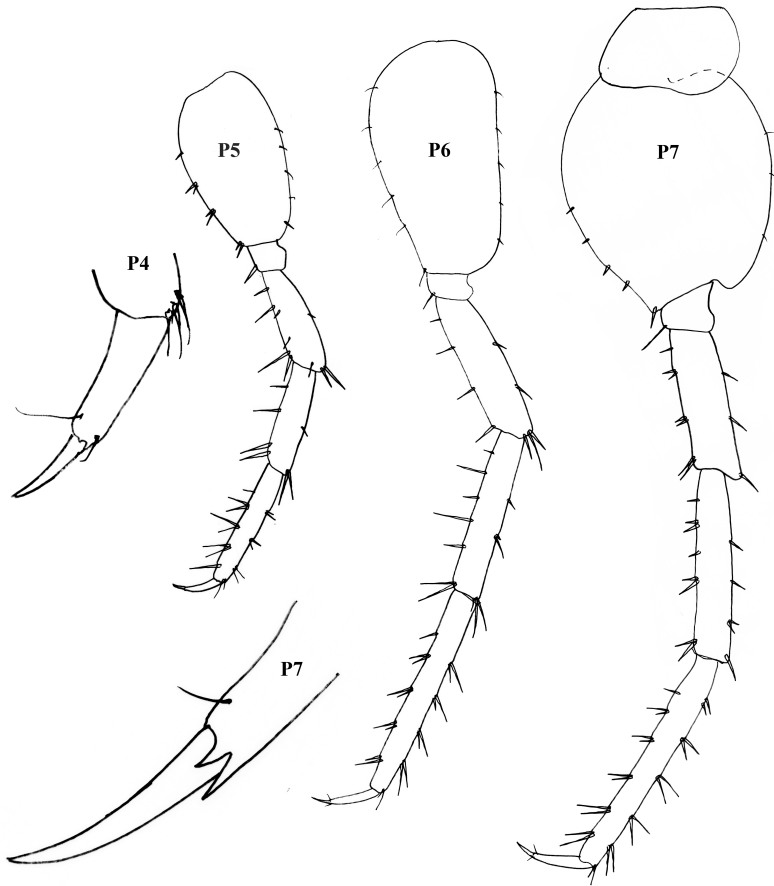




**Figure 4.** *Spelaeorchestia pahoehoe* sp. nov., Kīpuka Kanohina lava tube system, BGV entrance, Hawai'i. Female paratype, (855C), mouthparts, pleopods, uropods, telson, and epimera.



**Figure 5.** *Spelaeorchestia pahoehoe* sp. nov., Kīpuka Kanohina lava tube system, CKM entrance, Hawai‘i. Female paratype, antennae and gnathopods.



**Figure 6.** *Spelaeorchestia pahoehoe* sp. nov., Kīpuka Kanohina lava tube system, CKM entrance, Hawai‘i. Female paratype, pereopods 4–7.

robust setae. *Uropod 3* uniramus, peduncle much longer than ramus, inner margin with long robust seta, ramus without marginal setae and with 3 terminal setae. *Telson* each lobe with single long marginal setae and 3 terminal setae.

**Male.** No significant sexual dimorphism.

**Remarks.** *Spelaeorchestia pahoehoe* sp. nov. is morphologically very similar to *S. koloana* Bousfield & Howarth. The primary difference is in the pleopods that are fully biramous in *S. pahoehoe* but variously reduced in *S. koloana*. In other respects, the difference is mainly in the relative proportions of podomeres. The carpus of gnathopod 1 is more slender in *S. pahoehoe* than in *S. koloana* and gnathopod 2 is less elongate in *S. pahoehoe* than in *S. koloana*.

Myers & Lowry (2020) tentatively placed *Spelaeorchestia* in the Brevitalitridae stating that the relationship remained uncertain; this tentative placement is now supported by our molecular results (Fig. 3). Takahashi *et al.* (2021), on the basis of a molecular study, placed *Minamitalitrus zoltani* (White, Lowry & Morino, 2013) as a sister taxon to species of the forest litter talitrid genus *Nipponorchestia* Morino & Miyamoto, 2015 (Talitridae). This relationship is also supported in the present molecular results (Fig. 3). The molecular results cluster *Minamitalitrus* and *Nipponorchestia* within the family Brevitalitridae although they have previously been considered to be members of the Talitridae (Myers & Lowry 2020). The allocation of *Nipponorchestia* to the family Talitridae has rested on the presence in that taxon of a distomedial lobe on article 2 of the maxilliped palp. In other character states such as the setation of the telson and form of the uropods, *Nipponorchestia* aligns well with members of the Brevitalitridae. The distomedial lobe on the maxilliped palp is likely to be a homoplasy. According to Morino & Miyamoto (2015), *Nipponorchestia* is allied to *Bousfieldia* Chou & Lee, 1996, which is a member of the family Brevitalitridae (Fig. 3). Additionally, the morphological cladistic analysis of Myers & Lowry (2020) supports the close relationship of *Minamitalitrus* to both *Nipponorchestia* and *Spelaeorchestia*. We therefore transfer both *Minamitalitrus* and *Nipponorchestia* from the family Talitridae to the family Brevitalitridae.

**Distribution of *Spelaeorchestia* in Hawai'i.** *Spelaeorchestia pahoehoe* **sp. nov.** are found on the southern slopes of Mauna Loa volcano in lava tubes formed in at least two different flows, Kipuka Kanohina and Pu'u'oke'oke'o (Fig. 1A), ranging in age from 750 to 1800 yr (Sherrod *et al.* 2021). This expands the distribution of the genus to a second Hawaiian island, with the first described species, *Spelaeorchestia koloana* **sp. nov.**, distributed across five populations from a small geographic region on southern Kaua'i when it was federally listed as endangered (U.S. Fish and Wildlife Service, 2000).

**COI sequencing.** The interpretation of phylogenetic relationships from CO1 barcoding is not straightforward. Since mitochondrial genes are inherited entirely from the female line, it has been assumed that phylogenetic relationships will not have been obscured by the recombination that occurs in nuclear genes. However, the degree of homoplasy that may occur in genes has not been established and Rodriguez-Pena *et al.* (2020) have demonstrated a high incidence of mitochondrial gene heteroplasmy in a natural population of spider crabs. In the present analysis the close relationship between *Spelaeorchestia*, *Minamitalitrus* and *Nipponorchestia* revealed by morphological cladistic analysis (Myers & Lowry 2020) is supported by the CO1 sequencing (Fig. 3).

**Evolution of *Spelaeorchestia* in Hawai'i.** The two species of *Spelaeorchestia* on the Hawaiian islands are divergent in unexpected ways. Biramous pleopods with long peduncles, each ramus with multiple articles is the plesiomorphic state in the Amphipoda. Reduction in pleopod size, reduction in article number on rami or elimination of one or more rami is therefore the apomorphic condition. In Hawai'i, *Spelaeorchestia koloana* from Kaua'i has pleopods with rudimentary rami and is therefore a more derived lineage than *S. pahoehoe* **sp. nov.** from Hawai'i, which has pleopods that are biramous. This would appear to be counter to the generally recognised progression rule, that would predict colonisation from the older Kaua'i (4.7 my), to the younger Hawai'i (0.5 my) (Clague 1996). However, when the islands of Hawai'i were first colonised, the ancestral *Spelaeorchestia* may have possessed biramous pleopods. During the following period of isolation between the populations on Kaua'i and Hawai'i, the two populations would then have diverged, with *S. koloana* undergoing pleopod reduction, while *S. pahoehoe* experienced stabilising selection with little pleopod modification from the ancestral form.

With this description, there are two species of *Spelaeorchestia* that are now known to occur on two islands that are nearly 500 km apart in the Hawaiian archipelago. While there are several possible hypotheses that may explain this distribution, the detailed morphological descriptions of these two species does not alone provide sufficient information to be able to formulate the evolutionary route leading to the distribution of the observed species. The addition of more in-depth molecular data, including comparative sequence data from *Spelaeorchestia koloana* and other Hawaiian talitrids, will be required before further speculation can be made on the most likely scenarios for the occurrence of cave-inhabiting *Spelaeorchestia* on two widely separated islands within the Hawaiian archipelago.

**Biogeography of *Spelaeorchestia*.** The closest known sister taxon to the two Hawaiian *Spelaeorchestia* species lives in caves on the Daito Islands of Japan in the Northwestern Pacific Ocean. Both morphological and molecular studies have suggested a close phylogenetic relationship between the Japanese forest inhabiting *Nipponorchestia* and the cavernicolous *Minamitalitrus* from Japan and *Spelaeorchestia* from Hawai'i. A surface living ancestor of *Nipponorchestia* may have colonized the Hawaiian islands and entered the hypogeum giving rise to *Spelaeorchestia*. While no explanation has yet been hypothesised to explain the existence of similar taxa between Japan and Hawai'i, a relationship between these two regions has been reported previously. Myers (1991) demonstrated that two species of endemic Hawaiian marine amphipods had their closest sister taxon in Japan. Similarly, a molecular phylogeny and biogeography of Hawaiian endemic land snails of the family Succineidae (Rundell *et al.* 2004), has suggested that these endemic land snails may have had a Japanese, or at least Asian origin, while *Nesoprosopis*, a Hawaiian endemic subgenus of *Hylaeus* bees, otherwise known primarily from Japan, is also known from China and one species extends into Europe (Cowie & Holland 2008).

**Conservation Implications.** The island of Hawai'i as the youngest island in the chain has the highest concentration of lava tubes, and correspondingly the largest recorded number of cavernicolous species (Stone & Howarth 2005). Given that the only other species of *Spelaeorchestia* in Hawai'i is listed as federally endangered due to limited range and significant threats from development (U.S. Fish and Wildlife Service 2000), the discovery of a second species on the island of Hawai'i has significant conservation implications for this genus. At a minimum, further inventories of *S. pahoehoe* are needed to delineate fully its distribution and general abundance across the island of Hawai'i. The Kīpuka Kanohina system in which *S. pahoehoe* is found has faced increased threats from residential development in the form of clearing of native forest on the surface, replacement of native vegetation by non-native invasive species, as well as increased impacts from pollution in the form of pesticide use and potential septic system leaks. Because of the significant impacts and recent potential loss of habitat experienced by *S. koloana* from development (Gutierrez 2022), a full conservation assessment of *S. pahoehoe* is also warranted to determine the habitat stability and potential threats it also may face across its distribution.

#### ACKNOWLEDGMENTS

Mahalo nui to to Peter and Ann Bosted, Tomislav Gracanin, Veda Hackell, and the HICAVES research team for their dedication and support during field work, and to Sophia

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Hanscom for sequencing support. Funding was provided by the Cave Conservancy Foundation, The Subterranean Ecology Institute, The Nature Conservancy, the University of Hawai‘i at Mānoa, and the National Science Foundation (DEB 2204670 to M.L.P.). This is publication #211 from the School of Life Sciences, University of Hawai‘i at Mānoa.

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## New records and corrections of *Chenopodium* sensu lato in the Hawaiian Islands

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*Chenopodium* sensu lato is a genus of ca. 150 species of mostly annual herbs found primarily in arid to semi-arid regions nearly worldwide (Fuentes-Bazan *et al.* 2012a). Recent phylogenetic analyses of *Chenopodium* s.l. have split off several segregate genera (Fuentes-Bazan *et al.* 2012b), including *Chenopodiastrum* and *Dysphania*. Some updates to the Hawaiian naturalized *Chenopodium* s.l. are reviewed here in light of these taxonomic changes. One nomenclatural note, one new island record, and two corrections are reported. Considering the many changes since the last time the genus was treated in Hawai'i (Wagner *et al.* 1999), as well as a newly described subspecies of *Chenopodium oahuense* from Moloka'i (Cantley *et al.* 2020), an updated key for all Hawaiian *Chenopodium* s.l. (*Chenopodiastrum*, *Chenopodium* sensu stricto, and *Dysphania*) is provided. All identifications were made by the authors unless otherwise stated. All voucher specimens cited for this paper have been deposited at the Herbarium Pacificum (BISH).

### Amaranthaceae

#### *Chenopodiastrum murale* (L.)

S. Fuentes, Uotila & Borsch

#### Nomenclatural note

Formerly known as *Chenopodium murale*, this taxon was transferred to a new genus, *Chenopodiastrum*, largely based on molecular phylogenetic analyses (Fuentes-Bazan *et al.* 2012b). Morphological differences between *Chenopodiastrum* and *Chenopodium* s.s. are discussed below.

#### *Chenopodium album* L.

#### New island record

Previously only known from Maui and Hawai'i, *Chenopodium album* is reported for the first time as naturalized on O'ahu following several recent collections. The plants from O'ahu show some odd variation that initially keyed out to *Chenopodium strictum* Roth in the Flora of North America (Clemants & Mosyakin 2003a). The leaf apices are more obtuse than typical *C. album* and the perianth segments are also reflexed at maturity, exposing the fruit. However, Mosyakin (2017) has shown that there are major problems with the name *C. strictum* and its taxonomic history. The name is no longer considered valid, but rather a synonym of *C. album* var. *album* (POWO 2023). Given that *C. album*

is a well known birdseed contaminant (Oseland *et al.* 2020), it is likely that this species is being spread in part by birdseed since at least one collection site is near an area where birdseed is frequently cast.

*Material examined.* **O‘AHU:** Honolulu, Kahuna Ln, near intersection with Kuilei St, growing from dirt near parked cars, partial shade, only one plant observed, 4 m, 21.172578, -157.491993, 29 Dec 2022, *M.C. Ross 1863*; Honolulu, Kapi‘olani Community College, near NW corner of Koa Building, growing with *Alternanthera pungens* in a disturbed area, regularly weed whacked, feral chickens present, 4 plants seen, 66 m, 21.161996, -157.485837, 19 May 2023, *M.C. Ross 1944*; *loc. cit.*, one additional plant seen, 7 June 2023, *M.C. Ross 1948*.

***Chenopodium berlandieri* Moq. Correction**

*Chenopodium berlandieri* was noted by Wagner *et al.* (1999:536), who wrote: “*Chenopodium berlandieri* Moq. was collected once in 1914 in a vegetable garden in Kaimukī, Honolulu, O‘ahu (*Forbes 1938.O*); it does not appear to have ever become established.” This species was then listed as questionably naturalized by Imada (2019). Given that *Chenopodium berlandieri* has not been seen or collected again in more than 100 years it is now almost certain that it did not become naturalized. It should therefore be entirely removed from the checklist.

***Chenopodium hircinum* Schrad. Correction**

*Chenopodium hircinum* was previously considered to be naturalized on Maui and Hawai‘i Wagner *et al.* (1999:538). However, the species is no longer known from Maui, as the single specimen (*Faurie 1059*, collected in 1909) has been redetermined as *C. oahuense* subsp. *oahuense*. *Chenopodium hircinum* is therefore only known from a single collection in 1982 from Hawai‘i Island in the area near Parker Ranch. A recent [iNaturalist observation](#) by kphilley confirms that the species is still naturalized in the area.

COMBINED KEY FOR CHENOPODIASTRUM, CHENOPODIUM S.S., & DYSPHANIA IN HAWAI‘I

Several keys for *Chenopodium* s.l. were consulted in the development of this combined key (Aellen & Just 1943; Wagner *et al.* 1999; Clemants & Mosyakin 2003a, 2003b; Fuentes-Bazan *et al.* 2012b; Cantley *et al.* 2020). The genera *Chenopodiastrum* and *Dysphania* were formerly included in *Chenopodium* s.l. but have been separated from *Chenopodium* s.s., based on molecular and morphological evidence (Fuentes-Bazan *et al.* 2012b; Clemants & Mosyakin 2003a, 2003b). Given the similarity between the three genera, they are included together in this combined key. *Dysphania* are typically aromatic herbs with glandular hairs on the leaves and perianth segments, whereas *Chenopodium* s.s. and *Chenopodiastrum* are usually non-aromatic herbs with vesicular (farinose) hairs, at least when young. These hairs are effectively spherical and usually whitish in color. The hairs in *Chenopodium* s.s. become cup-shaped when dry and are mostly persistent at maturity (Fuentes-Bazan *et al.* 2012b). In *Chenopodiastrum* the hairs totally collapse when dry and rarely persist at maturity (Fuentes-Bazan *et al.* 2012b). Furthermore, the perianth segments in *Chenopodiastrum* have a prominent midvein visible inside, while in *Chenopodium* s.s. the midvein is not especially prominent (Uotila 2017).

1. Plants with glandular hairs; not farinose
  2. Seeds vertical; leaf blade glandular-hairy on veins; rarely surpassing 40 cm tall ....  
..... *Dysphania carinata*
  - 2'. Seeds mostly horizontal; leaf blade copiously gland-dotted on lower surface;  
reaching up to 100 cm tall ..... *Dysphania ambrosioides*
- 1'. Plants lacking glandular hairs; farinose, at least when young
  3. Leaves generally glabrescent, irregularly toothed; perianth segments with prom-  
inent midrib visible on inner surface ..... *Chenopodiastrum murale*
  - 3'. Leaves farinose, variously lobed or toothed; perianth segments with midrib barely  
visible or absent (*Chenopodium* s.s.)
  4. Annual or short-lived perennial herbs; leaves usually thin, not especially fleshy  
or succulent
    5. Plants fetid; leaves usually lobed, median lobe linear; seeds alveolate .....  
..... *Chenopodium hircinum*
    - 5'. Plants nonaromatic; if leaves lobed, median lobe not linear; seeds smooth or  
nearly so ..... *Chenopodium album*
  - 4'. Shrubs; leaves thick and somewhat fleshy or succulent [endemic]
    6. Prostrate or scandent shrubs; leaves succulent, marginal lobes few and  
generally not prominent [Moloka'i] ... *Chenopodium oahuense* subsp. *ilioense*
    - 6'. Erect shrubs; leaves somewhat fleshy, marginal lobes sinuate-dentate to  
weakly prominent [all main islands, NWHI] .....  
..... *Chenopodium oahuense* subsp. *oahuense*

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