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## New island records of *Werauhia* (Bromeliaceae) on Kaua‘i and Maui

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We report range extensions for two *Werauhia* (Bromeliaceae) species in Hawai‘i: *W. gladioliflora* on Kaua‘i and *W. sanguinolenta* on Maui. *Werauhia gladioliflora* was discovered naturalizing in a disturbed forest area on the Kuilau Ridge Trail in the Līhue-Kōloa Forest Reserve, Kaua‘i. Herbarium vouchers were acquired on a return visit after ascending host trees with climbing gear, providing the first documentation for the species on Kaua‘i. *Werauhia sanguinolenta* was documented as naturalized in East Maui in two separate locations, also a new island record for that species. The taxonomy and ecological implications for these species is briefly discussed. Online public observations of visually similar bromeliads on iNaturalist suggests that there are many additional populations of this genus naturalizing on all main islands, and we hope to encourage further collection and documentation.

### Bromeliaceae

*Werauhia gladioliflora* Grant

### New island record; confirmation of naturalization

In January 2023 a colony of epiphytic bromeliads was observed to be naturalizing by one of the authors in non-native trees along both sides of the Kuilau Ridge Trail in the Līhu‘e-Kōloa Forest Reserve, East Kaua‘i. A population of thousands, ranging from seedlings to fully mature plants, was observed in the mid- to upper canopy of the secondary forest dominated by 40 m tall albizia trees (*Falcataria moluccana*), with only seedlings and immature plants accessible from the ground. Returning to the site in June 2023, an appropriate tree was selected and climbed to a height of approximately 40 ft (12 m) using rope and harness. Three mature specimens were collected for identification and herbarium records (one with infructescence [*A. M. Williams* & *J. Jablonski* AMW 799, PTBG], two with inflorescence [*J. Jablonski* 12, PTBG], and seedling establishment was observed on lower tree trunk sections along the trail and on mossy trunks throughout the tree canopies. The species was identified as *Werauhia gladioliflora* using the key in the *Manual de Plantas de Costa Rica* (Morales 2003). *Werauhia* (subf. Tillandsioideae) has a center of diversity in mountainous habitats of Costa Rica to western Panama, though the broader range extends from southern Mexico

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through Central America to the West Indies, Peru, and northeastern Brazil (Morales 2003). The genus has synapomorphies that include plants with mostly nocturnal anthesis and a lack of brilliant coloration, fleshy floral bracts, dactyloid petal appendages, a cupulate stigma, and stout, dark-colored capsules (Grant 1997). Seeds are adapted for wind dispersal, with long chalazal appendages and absent micropylar appendages (Leme *et al.* 2020). *Werauhia gladioliflora* is epiphytic or terrestrial, and has dark green, thin, waxy leaves up to 67 cm long, forming a funnelliform rosette. The inflorescence is simple, erect to 65 cm tall, with broadly ovate floral bracts and broadly elliptic and obtuse sepals. It is morphologically similar to some other species in the genus (*W. barrii*, *W. tonduziana*, *W. viridiflora*, etc.) but is differentiated from these allied species by its overall size, floral bracts that are rugose to rugulose, a simple cylindrical inflorescence, and its ecological preference in its native range for humid lowlands. It is the most common *Werauhia* species at lower elevations in Costa Rica (Morales 2003).

On Kaua'i, *W. gladioliflora* was observed at elevations ranging from 600–700 ft (182–213 m) above sea level. Plants were recorded growing epiphytically on a variety of trees, primarily on *Falcataria moluccana*, but also seen on *Persea americana*, *Psidium cattleianum*, *Eucalyptus* sp. (only on the lower trunk sections with rough bark and abundant moss), and *Sphaeropteris cooperi*. Consultation with two South American Bromeliaceae specialists, Dr. Elton Martinez Carvalho Leme and Dr. Juan Francisco Morales, proved congruous identification after reviewing photographs of the fresh plant material (E. Leme and J. F. Morales, pers. comm., Jan 2024).

*Werauhia gladioliflora* was first documented naturalizing on O'ahu in 2010 at the Lyon Arboretum (Frohlich & Lau 2012). It was described as adventive, establishing on branches of a longan tree 30 ft (9 m) from planted individuals.

*Material examined.* KAUA'I: Lihue District, Lihue-Kōloa Forest Reserve, along Kuilau Trail, disturbed lowland wet forest, epiphytic on albizia, 1.2 m tall (incl. infructescence), leaves medium green top and bottom, inflorescence green, single mature flower observed at anthesis barely poking out past floral bract, petals and sepals green, mature-looking fruits (undehisced) hard, bright reddish purple, oriented slightly downward, 182–213 m, 20 Jun 2023, A. M. Williams & J. Jablonski AMW 799 (PTBG); same location and date, epiphytic bromeliad growing on many different species with suitable substrate, 1.5 m tall (incl. inflorescence), 4 ft (1.2 m) diam, inflorescence goopy, leaking clear slime, J. Jablonski 12 (PTBG).

### *Werauhia sanguinolenta* Grant      New island record

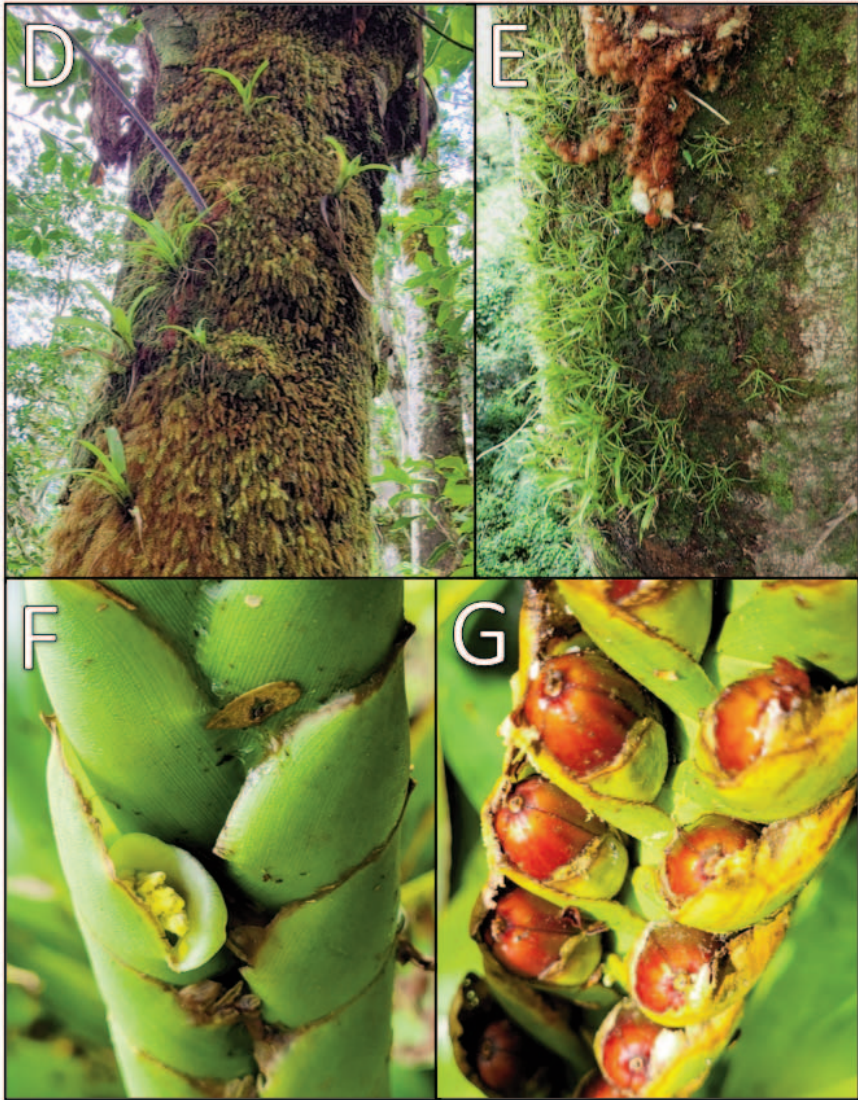
In January 2023, two separate specimens of *W. sanguinolenta* were collected on East Maui, one with green leaves and another with purple leaves (see Figure 3). It was unclear at the time if the green-leaved plants were of the same species as the purple-leaved plants, as they both seemed identical in all other characteristics when fruiting. No flowers were observed. They may be two cultivars, or a reversion to phenotype due to feralization. Their naturalized ranges in Hana District, East Maui, overlap from east of Ke'anae Valley to at least Nāhiku, which seems to be the densest occurrence. Neither form appears to have a host species preference and are found epiphytically on both native (e.g., *Metrosideros polymorpha*), Polynesian-introduced (e.g., *Aleurites moluccana*), and invasive (e.g., *Spathodea campanulata*) trees. Plants have been observed on mossy tree trunks as well as precariously perched on secondary branches wherever there is an appropriate substrate, such as bryophytes or accumulated leaf litter and soil. Seeds were sown from the specimens cited but the two leaf-color forms were not separated. Germination began



**Figure 1.** *Werauhia gladioliflora*. A, population growing epiphytically in *Falcataria moluccana* on Kauaʻi. B, mature fruiting plant size for comparison. C, leaves and inflorescence of mature plant.

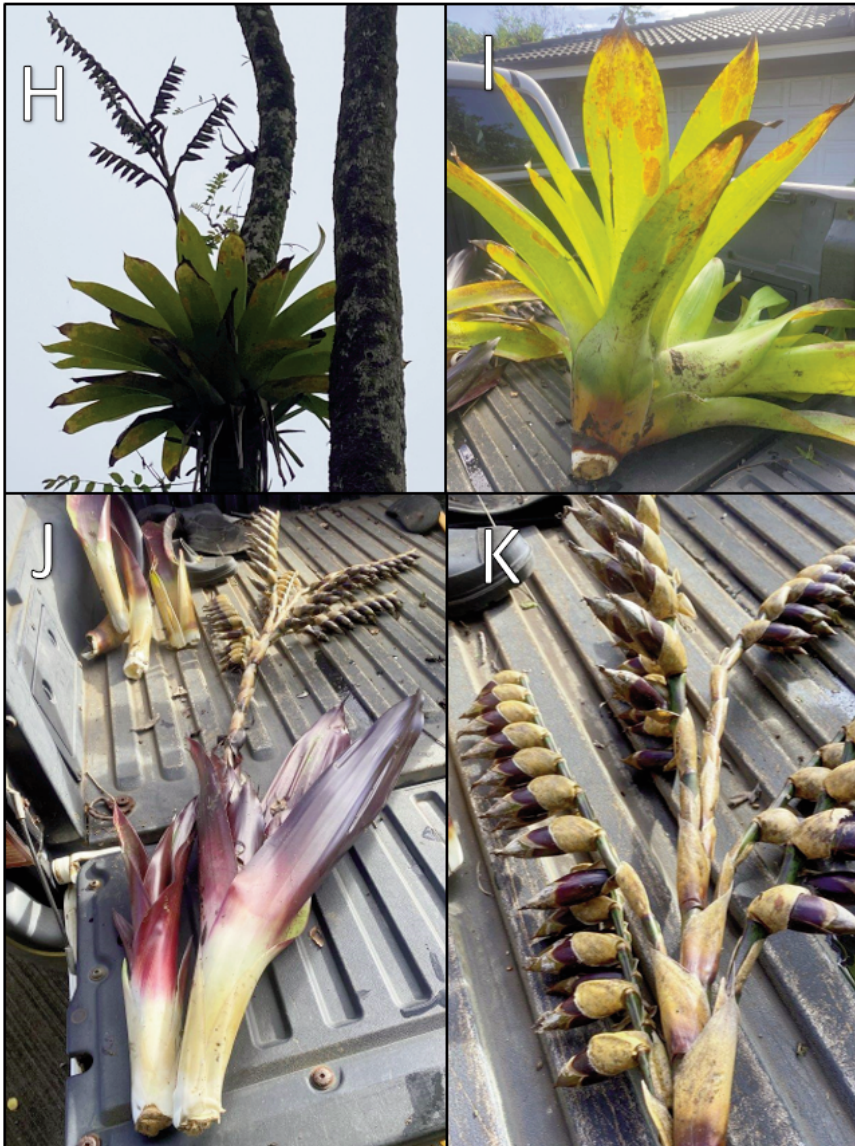
in approximately 30 days. The species was identified as *Werauhia sanguinolenta* using the key in the *Manual de Plantas de Costa Rica* (Morales 2003), and photographs of the fresh material were reviewed and the species determination confirmed by Dr. Elton Martinez Carvalho Leme (E. Leme, pers. comm., 9 Apr 2024). *Werauhia sanguinolenta* was first documented naturalizing in East Oʻahu in 2009, where it was collected growing epiphytically on streamside vegetation several hundred meters from the nearest homesite (Lau & Frohlich 2012). That specimen was also described as having burgundy red leaves.





**Figure 2.** *Werauhia gladioliflora*. **D**, seedlings visible from the ground in moss on lower tree trunks. **E**, seedlings present at voucher location, ca. 40 ft. off the ground in *Falcataria moluccana* canopy. **F**, inflorescence with flower. **G**, infructescence with maturing fruit.

*Material examined.* MAUI: East Maui, Hanawā Stream, on makai side of Hana Hwy, degraded lowland *Metrosideros-Acacia-Dicranopteris* wet forest, 317 m, naturalized, epiphytic, 7 m high in *Spathodea campanulata*, leaves light green, similar to *Asplenium nidus*, shiny, fibrous, fleshy but not succulent, 04 Jan 2023, *Oppenheimer & K. Bustamente H12302* (BISH, PTBG); East Maui, Kapā‘ūla



**Figure 3.** *Werauhia sanguinolenta*. **H**, fructing specimen growing epiphytically in *Spathodea campanulata*, Maui. **I**, green variant. **J**, inflorescence on purple variant. **K**, inflorescence with maturing fruit.

Stream, on makai side of Hana Hwy, degraded lowland *Metrosideros-Acacia-Dicranopteris* wet forest, naturalized, epiphytic, 3 m high in *Metrosideros polymorpha*, leaves purple, shiny, fibrous, fleshy but not succulent, 04 Jan 2023, *Oppenheimer & K. Bustamente H12304* (BISH, PTBG).

In its native range, *Werauhia gladioliflora* has a pollination method associated with bats (Tschapka & Helverson 2007). However, there is evidence that despite adaptations to chiropterophily, *W. gladioliflora* has a flexible breeding system, with both autogamy and cross-pollination occurring. Cascante-Marín *et al.* (2004) report up to 90% fruit set following spontaneous-selfing tests, with no significant difference in the number of seeds compared to naturally pollinated fruits. Estimated seed output for the sampled population was nearly one million seeds in a given reproductive season. Interestingly, at one pre-montane Costa Rican study site, a florivorous eurytomid wasp (*Eurytoma werauhia*) reduced fruit set in *W. gladioliflora* by as much as 70% (Cascante-Marín *et al.* 2009). Although naturalized populations of *W. gladioliflora* in Hawai‘i are lacking bat pollinators, they are likely also missing parasites or predators that could potentially check their population growth.

*Werauhia* belongs to a group of bromeliads often referred to as “tank” bromeliads. This is due to their capacity to retain considerable amounts of water within a rosette of overlapping leaves. The additional weight on tree limbs from mature, water-retaining tank bromeliads may exacerbate damage to infrastructure and property, especially in stands of invasive albizia trees (*Falcataria moluccana*), a species already infamous for sudden limb shear (Watson 2018). Additional negative effects of *Werauhia* establishment across the landscape could include an increase in breeding habitat for invasive animal species, like coqui frogs (*Eleutherodactylus coqui*) (Hara & Niino-DuPonte 2016), and arthropods such as mosquitos. One study on Kaua‘i (Yang *et al.* 2003) documented *Vriesea* aff. *regina*, a tank bromeliad in a genus closely allied to *Werauhia*, to be a significant breeding site for three noxious mosquito species: *Wyeomyia mitchellii* (Theobald), *Aedes albopictus* (Skuse), and *Culex quinquefasciatus* (Say). One of these mosquitos, *C. quinquefasciatus*, is considered to be a grave threat to Hawaiian forest birds as a vector of avian malaria, which is already menacing the last surviving endemic honeycreeper populations of several species on both Kaua‘i and Maui (Glad & Crampton 2015; Pratt *et al.* 2009). Given that the native range of these bromeliads includes observations well over 1200 m above sea level, we suspect no elevational barrier for their proliferation on Kaua‘i, and that only diminishing rainfall may inhibit their spread into the uppermost forests of Maui.

As of May 2024, online observations on the citizen science platform iNaturalist indicate wild populations of *Werauhia* spp. on the islands of Hawai‘i, Maui, O‘ahu, and Kaua‘i (iNaturalist 2024). Given the documented life history traits of *Werauhia* spp. in their native range and the observed quantity of propagules on Kaua‘i, we expect that *Werauhia* spp. are likely to continue range expansion into natural areas across the state, including both degraded and native forests. We strongly encourage all botanists and nature enthusiasts to report naturalized instances of these species, and especially to make herbarium records for confirmation and proper documentation of these troubling invasive pests that are so quickly establishing across the archipelago. These are, unfortunately, just two more examples in a long line of intentional horticultural introductions accidentally escaping to become part of the growing non-native flora, with untold impacts on the many threatened endemic species of Hawai‘i.

## REFERENCES

- Cascante-Marín, A, Oostermeijer, J.G.B., Wolf, J.H.D. & Nijs, J.C.M. den 2004. Reproductive biology of the epiphytic bromeliad *Werauhia gladioliflora* in a pre-montane tropical forest. *Plant Biology* 7: 203–209.



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- Cascante-Marín, A., Wolf, J.H.D. & Oostermeijer, J.G.B.** 2009. Wasp florivory decreases reproductive success in an epiphytic bromeliad. *Plant Ecology* **203**(1): 149–153. [🔗](#)
- Frohlich, D. & Lau, A.** 2012. New plant records from O‘ahu for 2010–2011. *Bishop Museum Occasional Papers* **113**: 27–54.
- Glad, A. & Crampton, L.** 2015. Local prevalence and transmission of avian malaria in the Alakai Plateau of Kauai, Hawaii, U.S.A. *Journal of Vector Ecology* **40**(2): 221–229.
- Grant, J. R.** 1997. Sinopse do genero *Werauhia*. *Bromélia: Revista da Sociedade Brasileira de Bromélias* **4**(1): 28–38.
- Hara, A. & Niino-DuPonte, R.** 2016. Coqui frog control for homeowners. University of Hawai‘i at Mānoa, CTAHR. <https://www.ctahr.hawaii.edu/oc/freepubs/pdf/MP-5.pdf>. (Accessed 15 May 2024).
- iNaturalist.** 2024. Available at: <https://www.inaturalist.org>. (Accessed 15 May 2024).
- Lau, A. & Frohlich, D.** 2012. New plant records from O‘ahu for 2009. *Bishop Museum Occasional Papers* **113**: 7–26.
- Leme, E.M.C., Valsko, J.J., Krahl, A.H. & Grant, J.** 2020. A new species of *Werauhia* (Bromeliaceae: Tillandsioideae) from the Brazilian “Hylaea.” *Phytotaxa* **471**(1): 29–37. [🔗](#)
- Morales, J.F.** 2003. Bromeliaceae. In: Hammel, B.E., Grayum, M.H., Herrera, C. & Zamora, N. (eds.), *Manual de Plantas de Costa Rica*. Vol. II: Monocotiledóneas (Agavaceae-Musaceae). *Monographs in Systematic Botany from the Missouri Botanical Garden* **92**: 297–375.
- Pratt, T. K., Atkinson, C.T., Banko, P.C., Jacobi, J.D. & Woodward, B.L.** (eds.) 2009. *Conservation biology of Hawaiian forest birds: implications for island avifauna*. Yale University Press, New Haven, Connecticut. 707 pp.
- Tschapka, M. & Helversen, O.** 2007. Phenology, nectar production and visitation behaviour of bats on the flowers of the bromeliad *Werauhia gladioliflora* in a Costa Rican lowland rain forest. *Journal of Tropical Ecology* **23**: 385–395.
- Watson, J-C.** 2018. Strategic plan for the control and management of *Albizia* in Hawaii. Available at: <https://dlnr.hawaii.gov/hisc/files/2018/01/Strategic-Plan-for-the-Control-and-Management-of-Albizia-In-Hawaii.pdf> (Accessed 15 May 2024)
- Yang, P., Furumizo, R., Tangalin, L., Takekuma, C. & Hall, K.** 2003. Mosquito species breeding in bromeliad axils on the island of Kauai, Hawaii. *Proceedings of the Hawaiian Entomological Society* **36**: 95–101.