

Rediscovery of *Melicope quadrangularis* (Rutaceae) and other notable plant records for the island of Kauaʻi, Hawaiʻi¹

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Although several previously funded surveys by the U.S. Fish and Wildlife Service (USFWS) and the National Tropical Botanical Garden (NTBG) between 1993 and present had failed to relocate any living individuals of the Kauaʻi endemic *Melicope quadrangularis* (Rutaceae), a recent USFWS-funded survey has brought about its rediscovery and is reported here. In addition, *Bidens hillebrandiana* subsp. *polycephala* (Asteraceae) has been documented on Kauaʻi for the first time, possibly indicating a recent inter-island introduction; and a single individual of *Lysimachia filifolia* (Primulaceae) was discovered within the remote upper headwater drainages of Wainiha, representing the only known living individual on Kauaʻi.

Asteraceae

Bidens hillebrandiana (Drake) O. Deg. ex Sherff

subsp. *polycephala* Nagata & Ganders

New island record

Previously recorded from the islands of Molokaʻi and Maui, *Bidens hillebrandiana* subsp. *polycephala* has now been documented along the coastal strand of Kalalau, Kauaʻi. Although all Hawaiian *Bidens* have evolved with reduced dispersal ability (Carlquist 1974) and are predominantly single-island endemics (Wagner *et al.* 1990; Knope *et al.* 2012), *B. hillebrandiana* subsp. *polycephala* has retained some ancestral mechanisms for dispersal by birds (i.e., setose achenes with spreading awns) and is usually associated with near-shore bluffs and cliffs that are frequented by sea birds. In 2013, ca. 50 plants of this *Bidens* species were discovered around a Kalalau coastal bluff site that had been botanically surveyed by the senior author numerous times in the past without being previously detected. The presence of *B. hillebrandiana* subsp. *polycephala* on Kauaʻi may possibly be an example of a recent natural inter-island introduction by sea birds, which are often seen in the general region. Plants are being cultivated by the NTBG.

Material examined. **KAUAʻI:** Hanalei Distr., Kalalau, coastline around river mouth, *Scaevola taccada* coastal shrubland, with *Chenopodium oahuense*, *Artemisia australis*, *Vigna marina*, *Capparis sandwichiana*, *Panicum fauriei* var. *latius*, *Lysimachia mauritiana*, *Adiantum capillus-veneris*, threatened by goats, landslides, *Digitaria ciliaris*, 3 m elev., herb, decumbent, 25–35 cm tall, several older plants dried up, a few with flowering left, some achenes, ca. 50 plants, observed mostly on north side of Kalalau Stream, a few on south side of stream near *heiau*, 26 Jul 2013, Wood, Kirkpatrick & Clark 15589 (PTBG).

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Primulaceae***Lysimachia filifolia* C.N. Forbes & Lydgate Range rediscovery**

The extremely rare Hawaiian primrose *Lysimachia filifolia* has been recorded on Kaua'i and O'ahu. In 1912 John Lydgate made the holotype collection in upper Olokele, Kaua'i below the Kawaikini summit (Wagner *et al.* 1990; Marr & Bohm 1997; Wood 2012), and subsequently, up till now, the only other reported collection from Kaua'i was made in 2008 in the Waikoko headwater region, below Kamanu Ridge (Wood 2012). Plants of *L. filifolia* on Kaua'i can be erect shrubs up to 1.5 m tall as compared to the O'ahu plants, which are smaller, more delicate, and only known to be pendulous (Wood 2012). Within the Ko'olau Mountain Range of O'ahu several colonies still remain around waterfall sites of Uwao, Waianu, and Wai'āhole Streams. Recent research around the only known Kaua'i colony of *L. filifolia* (i.e., Waikoko) revealed that a large landslide had destroyed the plants, causing a regional extinction from a singular stochastic event (Wood, pers. obs.). Fortunately, in October 2013 a single plant was documented on the northwestern side of Kaua'i, within the upper headwaters of Wainiha Valley. The Kaua'i Plant Extinction Prevention (PEP) Program and NTBG are planning for additional surveys to attempt conservation collections and to search for additional plants around this last known individual on Kaua'i. There is also potential for additional colonies around the holotype locality of Olokele, Kaua'i, which is privately owned and historically off-limits for biotic surveys.

Material examined. **KAUAI:** Līhu'e Distr., upper Olokele Valley, Jan. 1912, *Lydgate 2* (holotype, BISH); Līhu'e Distr., Waikoko headwaters, below Kamanu Ridge, S of Wailua River and above Wailua Ditch, associated with *Cheirodendron*, *Pipturus* spp., *Dubautia*, *Cyrtandra*, *Kadua centranthoides*, *K. elatior*, *K. foggiana*, *Psychotria*, *Melicope*, *Machaerina*, *Isachne*, with ferns of *Microlepia*, *Asplenium*, *Cyclosorus*, *Deparia*, terrestrial in *Diplazium* with *Boehmeria grandis*, threats include pigs, landslides, *Buddleia asiatica*, and *Erigeron karvinskianus*, 732 m elev., 1.5 m tall with erect stems brown-red, pendent corolla light purple, terrestrial near land slide and on wet cliff, ca 30 plants, 12 Jan 2008, *Wood 12774* (BISH, PTBG); Hanalei Distr., Wainiha, upper northeastern fork, closed *Metrosideros* lowland wet forest, 8–12 m canopy, surrounded by steep valley walls with *Dicranopteris* and mixed shrubs, understory dominated by *Antidesma* with *Syzygium*, *Broussaia*, *Perrottetia*, *Cyrtandra* spp., *Psychotria* spp., *Dubautia* spp., *Labordia* spp., *Coprosma waimeae*, *Cheirodendron* spp., *Polyscias kawaiensis*, and *P. oahuensis*, rich fern and bryophyte understory, threatened by pigs, rats, slugs, *Sphaeropteris cooperi*, *Buddleia asiatica*, *Clidemia hirta*, *Hedychium gardnerianum*, *Juncus planifolius*, *Erigeron karvinskianus*, *Psidium guajava*, *Cyperus meyenianus*, and *Rubus rosifolius*, 845 m elev., herb, 30 cm tall, unbranched young plant, vegetative, single plant seen, 10 Oct 2013, *Wood & Kishida 15697* (PTBG).

Rutaceae***Melicope quadrangularis* (H. St. John &**

E.P. Hume) T.G. Hartley & B.C. Stone **Rediscovery**

Melicope quadrangularis is a Kaua'i endemic tree known from the holotype collection made by Charles Forbes in 1909, and rediscovered in the same general region of Wahiawa in May 1991 (Lorence *et al.* 1995; Lorence & Flynn 1997). The rediscovered population, consisting of 13 trees in close proximity, was subsequently destroyed by Hurricane 'Iniki in September 1992 (Wood 2000, 2009, 2011) and reported as possibly extinct, as no living individuals were known (Wood 2012). Recent field research funded by the USFWS has rediscovered four individuals of this taxon in the headwater region of Wai'āhi Stream, ca. 2 km to the north of the holotype locality. Fruit capsules were present and seeds are actively being monitored for collection by PEP and NTBG. *Melicope quadrangularis* can

be easily distinguished from other *Melicope* species on Kaua'i by its large, 12–14 mm long \times 19–22 mm wide, cube-shaped capsules that have an unusual central depression at their apex, yet can be very difficult to recognize when not in fruit (Wood 2012). The extreme vulnerability of these last known individuals of *M. quadrangularis* cannot be overstated, especially being a wet forest understory species susceptible to the severe storms that frequent Kaua'i. Continued botanical surveys are encouraged in order to discover more individuals and prevent the extinction of this taxon. Recommended regions for survey include the prime *Metrosideros* wet forests of Wahiawa and adjacent drainages to its north, including Kamo'oloa, Wai'ahi, 'Iole, and 'Ili'ilu'ula.

Material examined. **KAUA'I:** Līhu'e Distr., vicinity of Wahiawa Swamp, Aug 1909, *C. N. Forbes 273.K* (holotype, BISH); Līhu'e Distr., Wahiawa, drainage between Hulua and Kapalaoa, *Metrosideros-Dicranopteris* lowland wet forest with *Syzygium*, *Polyscias oahuensis* & *P. waialealae*, *Labordia*, *Perrottetia*, area rich with bryophytes, threats include severe storms, pigs, rats, *Psidium cattleianum* & *P. rosifolius*, *Melastoma candidum*, 820 m, 2 m tall, branches ascending, 13 trees in general area, 20 May 1991, *Wood, Flynn & Lorence 0859* (PTBG); *loc. cit.*, with *Broussaia*, *Eurya*, *Cyanea coriacea*, *Labordia hirtella*, *Syzygium*, 850 m, 4 m tall tree, 13 trees in general area, single tree in fruit, 13 cm diameter at base, vigorous, east aspect, 20 May 1991, *Wood, Flynn & Lorence 0858* (PTBG); Līhu'e Distr., Wai'ahi, upper southern headwaters, *Metrosideros-Cheirodendron* mixed wet forest with dissecting drainages and matting ferns of *Diplopterygium* & *Dicranopteris*, with *Broussaia arguta*, *Perrottetia sandwicensis*, *Touchardia latifolia*, *Pipturus albidus*, *P. ruber*, *Psychotria marianiana*, *P. hexandra*, *Antidesma platyphylla* var. *hillebrandii*, *Polyscias oahuensis*, *Kadua affinis*, *Melicope wawraeana*, *Vaccinium calycinum*, *Coprosma kauaense*, *Dubautia laxa*, *D. paleata*, *D. imbricata* subsp. *acronaea*, *Sadleria* spp., *Cyanea hirtella*, *C. recta*, *C. kahiliensis*, *C. fissa*, *Machaerina angustifolia*, *M. mariscoides*, *Cyrtandra pickeringii*, *C. paludosa*, *C. heinrichii*, *C. longifolia*, and *C. kealiae*, immediate threats include rats, goats, pigs, slugs, *Clidemia hirta*, *Rubus rosifolius*, *Axonopus fissifolius*, *Juncus planifolius*, *Cyperus meyenianus*, *Paspalum conjugatum*, *Psidium cattleianum*, *Melastoma candidum*, *Rhodomyrtus tomentosa*, *Sphaeropteris cooperi*, *Sacciolepis indica*, 830 m elev, tree, 3 m tall, moderately branched, stems covered in moss, immature fruit cauliflorous, tree 10 m above small side gulch, west aspect, single individual, 19 Nov 2013, *Wood, Kirkpatrick & Perlman 15728* (PTBG); Līhu'e Distr., Wai'ahi, upper central headwaters, 820 m elev, tree 2.5 m tall, few-branched, trunk 7 cm diameter near base, stems gray-brown, with fruit, 5–7 m above gulch bottom, 30 Dec 2013, *Wood, Kirkpatrick & Perlman 15773* (PTBG); *loc. cit.*, 823 m elev, tree, 3 m tall, moderately branched, gray-brown, base of trunk 10 cm diameter, female, immature fruit, on slope just above south side of stream lowermost of 2 trees, 30 Dec 2013, *Wood, Kirkpatrick & Perlman 15780* (PTBG); *loc. cit.*, 823 m elev, tree, 3 m tall, moderately branched, gray-brown, base of trunk 8 cm diameter, cf male, on slope just above south side of stream uppermost of 2 trees, female immediately below, 30 Dec 2013, *Wood, Kirkpatrick & Perlman 15781* (PTBG).

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Melicope quadrangularis © Earth.com Melicope quadrangularis NatureServe Explorer Species Reports -- NatureServe Explorer. It is endemic to the Hawaiian Islands, where it is known only from the island of Kauai. Melicope quadrangularis : Source: Rutaceae of North America Update, database (version 2011) Acquired: 2011 : Notes: Updated for ITIS by the Flora of North America Expertise Network, in connection with an update for USDA PLANTS (2007-2010) Reference for: Melicope quadrangularis : Source: The PLANTS Database, database (version. Hawaiian Melicope are one of the major adaptive radiations of the Hawaiian Islands comprising 54 endemic species. The lineage is monophyletic with an estimated crown age predating the rise of the current high islands. Phylogenetic inference based on Sanger sequencing has not been sufficient to resolve species or deeper level relationships. Here, we apply restriction site-associated DNA sequencing (RAD-seq) to the lineage to infer phylogenetic relationships. Our new results drastically improved resolution of relationships within Hawaiian Melicope. The lineage is divided into five fully supported main clades, two of which correspond to morphologically circumscribed infrageneric groups. We provide evidence for both ancestral and current hybridization events. Rediscovery, conservation status and taxonomic assessment of Melicope degeneri (Rutaceae), Kauai, Hawaii. Kenneth R. Wood. Published: 6 May 2011. by Inter-Research Science Center. in Endangered Species Research. Endangered Species Research, Volume 14, pp 61-68; doi:10.3354/esr00345. Publisher Website. Kauai, Hawaii 96741, USA; email: kwood@ntbg.org. Eleven possible new extinctions are reported for the Hawaiian flora, in addition to 5 island records, 3 range rediscoveries, 1 rediscovery, and 1 new naturalized record. The remark Rutaceae. Melicope macropus (Hillebr.) T.G. Hartley. & B.C. Stone Possibly extinct. A Kauai endemic, Melicope macropus was historically known from the Kahaluamano. Bishop museum occasional papers: no. 113, 2012. 98.