


Hesperomannia A. Gray (Vernonieae):

Extreme rarity and conservation status of an endemic Hawaiian genus

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ABSTRACT

Hesperomannia, is a Hawaiian endemic genus of four species and is highly endangered throughout its range. The four species and their habitats are described and a conservation assessment for each species and the genus is provided. Each species is threatened by small population size, climate change, and non-native species- including rodents, ungulates, and invasive plants. Conservation measures such as ungulate fencing, weed control, rodent control, and hand pollination have proven effective but specific funding for these efforts is necessary to prevent the extinction of all four species.

Keywords: Asteraceae, Endangered species, climate change, Compositae, hand pollination, Hawaii, Hawaiian flora, invasive species.

INTRODUCTION

Hesperomannia A. Gray is endemic of the Hawaiian islands, and is comprised of four species: *H. arborescens* A. Gray, *H. lydgatei* C.N. Forbes, *H. oahuensis* (Hillebr.) O. Deg., and *H. swezeyi* O. Deg. (Morden & Ching Harbin 2013; Wagner et al. 2012). The genus was originally thought to have been most closely related to South American genus *Stiffitia* J.C.Mikan, Subfamily Stifftidoideae (formerly Tribe Mutisieae), based on morphological characters (Funk and Wagner 1995), but more recently, genetic information placed the genus in the Tribe Vernonieae with closest known relatives in *Gymnanthemum* Cass. of the East Africa and Madagascar region

(Kim et al., 1998; Keeley et al., 2007). This geographical distance is immense, 12,000 km, and is proposed as the result of dispersal via an extinct ancestor(s) (likely through Australia) to the Hawaiian Archipelago (Keely et al., 2021; Price & Wagner, 2018). Divergence from Madagascan *Gymnanthemum* is estimated at 17.19 Mya with diversification within the Hawaiian archipelago around 5.7 Mya. (Price & Clague, 2002; Keeley et al., 2007; Keeley et al., 2021). Other Hawaiian plant radiations with African origins include *Kokia* Lewt., Malvaceae (Seelanan, 1997), and all Hawaiian Campanulaceae (Givnish, 2009; Steve Hunter, pers. comm. 2022).

Hawaii's floristic endemism is unmatched by any other archipelago at ~90% for vascular plants (Wagner et al. 1990, 2012). Driven by extreme isolation of high islands with varied biomes, the evolution of the Hawaiian flora is arguably one of the most fascinating. Unfortunately, this unique flora holds another distinction: one of the most endangered floras in the world (Sakai et al., 2002; Weisenberger & Keir, 2014; Rønsted et al., 2022). The Hawaiian *Hesperomannia*, is a prime example of both extraordinary evolutionary radiation from a long-distance dispersal event (Keeley et al. 2007, Kim et al. 1998) as well as acute rarity. In this paper we aim to provide a short taxonomic overview of this interesting genus and an update of its precarious conservation status.

TAXONOMIC OVERVIEW

Hesperomannia A.Gray, Proc. Amer. Acad. Arts 6: 554, 1865. Type species: *Hesperomannia arborescens* A.Gray.

Trees; leaves alternate. Capitula solitary or in clusters of 2-10, homogamous, discoid; involucre of 4 to 8 series of phyllaries, persistent; receptacle epaleate. Florets monoclinal, corollas actinomorphic, deeply 5-lobed, yellow; anthers tailed, apical appendage acute; style branches dorsally prurulose, scarcely separated at tip when receptive, with little stigmatic tissue. Achenes costate, glabrous. Pappus of scabrid setae, arranged in 2-3 series. Pollen tricolporate, minutely spiculiferous ($n = 10$). Hawaii. Four species.

KEY TO THE SPECIES OF *Hesperomannia* A.Gray

- 1a.** Flowering heads nodding at anthesis; leaf blades glabrous; phyllaries white to pink or brown at anthesis; Kauai **H. lydgatei**
- 1b.** Flowering heads erect to ascending at anthesis; leaf blades pubescent, sparsely puberulent, tomentose, densely tomentose, sparsely pubescent, or nearly glabrous; phyllaries green and magenta, magenta, or dusty pink at anthesis; other Hawaiian Islands, not Kauai.
- 2a.** Plants with lower leaf surfaces, petioles, and apical buds densely tomentose; leaf blades ovate to elliptic-ovate, upper surface tomentose to sparsely pubescent; innermost phyllaries 2.3–2.5 cm long; phyllaries green and magenta at anthesis; O'ahu (Waianae Mountains) **H. oahuensis**
- 2b.** Plants with lower leaf surfaces, petioles, and apical buds nearly glabrous or sparsely pubescent; leaf blades oblanceolate to obovate or broadly oblanceolate (sometimes elliptic), upper surface glabrous; innermost phyllaries 2.7–3.0 cm long; phyllaries dusty pink or magenta at anthesis; Maui, Molokai and Lanai or O'ahu (Koolau Mountains)
- 3a.** Leaf blades oblanceolate to obovate, lower surface sparsely puberulent, especially along lower 1/3–1/2 portion of midrib on young leaves, upper surface glabrous; petioles 1/7–1/4 of total leaf length; peduncles 8–13 mm long; phyllaries in 3rd to 5th series 4–5 cm wide; phyllaries dusty pink at anthesis; West Maui, Molokai, Lanai **H. arborescens**
- 3b.** Leaf blades oblanceolate to broadly oblanceolate, or sometimes elliptic, both surfaces glabrous or nearly so with lower leaf blade surface of young leaves sometimes sparsely pubescent along 1/2–1/3 of midrib; petioles 1/8–1/7 of leaf total length; peduncles 4–6 mm long; phyllaries in 3rd to 5th series 3–3.5 cm wide; involucre phyllaries magenta at anthesis; O'ahu (Koolau Mountains) **H. swezeyi**

Ku'u home 'o *Hesperomannia*

In Ōlelo Hawai'i, the archipelago's native tongue, Ku'u home 'o *Hesperomannia* means "the beloved home of *Hesperomannia*". The Hawaiian archipelago is home the endemic genus *Hesperomannia* A.Gray (Vernonieae). A genus composed of four species, all are critically endangered.



Hesperomannia arborescens A.Gray, Proc. Amer. Acad. Arts 6: 554, 1865. Type: Summit of Lanai, *H. Mann & W.T. Brigham 357*, 1865 (holotype: GH! [00008996]; isotypes: BISH 1005806!, BISH 1005807!, US 00432531).

Hesperomannia arbuscula Hillebrand, Flora Hawaiian Islands, 232, 1888. Type: West Maui about 1,200 ft above Lahaina, *E. Bishop s. n.*, May 1871 (holotype: B [destroyed], fragment: BISH 1005809!; lectotype: GH 00008997!; isolectotype: BISH 1005808!).

Hesperomannia mauiensis St. John, Ann. Mo. Bot. Gard. 70:198, 1983. Type: Iao Valley, Makalaloe Stream, steep forest slope, West Maui, *Hobdy 859* (holotype: BISH 1005814!).

Trees 2–4 m tall, young stems and apical buds pubescent. Leaves with petioles 1/7–1/4 of total leaf length, sparsely puberulent; leaf blades oblanceolate to obovate, lower leaf surfaces sparsely puberulent, especially along lower 1/3–1/2 portion of midrib on young leaves, upper leaf blade surface glabrous, margins entire or slightly crenate/undulate. Heads on stout puberulent peduncles, 8–13 mm long, erect at anthesis; involucre in 6 or 7 series, phyllaries dusty pink at anthesis, inner phyllaries 2.7–2.9 cm; middle phyllaries 4–5 cm wide. Corollas 2.5–3 cm long; pappus 2.2–2.5 cm long, elements tapering towards the apex, fimbriate at the base, scabrid all along, pale pink to light brown.

Distribution and ecology: Highly endangered in wet forest on West Maui; possibly extirpated from Molokai; extirpated from Lanai.

Additional specimens examined: United States. Hawaii.

Lanai. *C.N. Forbes 322.L*, Sep 1917 (BISH1022037); *W.B. Hillebrand s.n.*, s.d. (BISH1022036); *G.C. Munro 492*, Mar 1922 (BISH1022032); *G.C. Munro 684*, Jun 1922 (BISH1022039); *G.C. Munro 936*, 01 Nov 1929 (BISH1022034); *G.C. Munro s.n.*, 1925 (BISH1022040); *G.C. Munro 492*, Mar 1922 (BISH1022033); *G.C. Munro 104*, 17 Jun 1927 (BISH1022038). **Maui.** *R.W. Hobdy 3046*, 07 Jun 1989 (BISH1022135); *R.W. Hobdy 758*, 20 Jan 1980 (BISH1022136); *J. Lau 3231*, 21 Jan 1989 (BISH1022043); *J. Lau 3230*, 21 Jan 1989 (BISH1022044); *J.S. Meidell 126*, 22 Aug 1996 (BISH1022041); *J.S. Meidell 141*, 29 Aug 1996 (BISH1022045); *H.L. Oppenheimer H90612*, 13 Sep 2006 (BISH1022042); *H.L. Oppenheimer H71302*, 24 Jul 2013 (BISH1199205); *H.L. Oppenheimer H71410*, 30 Jul 2014 (BISH1199204); *K.R. Wood 6106*, 26 Mar 1997 (BISH1022046).

Molokai. *C.N. Forbes 239.Mo*, Jul 1912 (BISH1022050); *S.L. Montgomery s.n.*, 02 Sep 1976 (BISH1022047); *S.L. Montgomery s.n.*, 02 Sep 1976 (BISH1022048); *S. Perlman 10341*, 10 Mar 1989 (BISH1022049).

Hesperomannia lydgatei C.N. Forbes, Occas. Pap. Bernice Pauahi Bishop Mus. 4: 220, 1909. Type: Wahiawā Mountains, Kaua'i, *Lydgate s. n.*, May 1908 (holotype: BISH 1005813!).

Small trees 2–3 m tall, young stems glabrous. Leaves glabrous, petiole 1/10–1/7 of total leaf length; leaf blades obovate-elliptic to broadly oblanceolate, margins entire. Heads on narrow glabrous peduncles, 23–40 mm long, nodding at anthesis; involucre in 4 or 5 series, phyllaries white to pink or brown at anthesis, inner phyllaries 3.7–4.5 cm long; middle phyllaries 2.6–3.4 cm wide. Corollas 2.3–2.5 cm long; pappus 1.5–1.7 cm long, elements tapering towards the apex, fimbriate at the base, scabrid all along, pink to light brown.

Distribution and ecology: Highly endangered in wet forest, Kauai.

Additional specimens examined: United States. Hawaii.

Kauai. *S. Carlquist s.n.*, Apr 1964 (BISH1022143); *C. Christensen 325*, 15 Oct 1977 (BISH1022156); *C.N. Forbes 190.K*, Aug 1909 (BISH1022159); *C.N. Forbes 189.K*, Aug 1909 (BISH1022158); *D.R. Herbst 2414*, 22 May 1972 (BISH1022153); *D.R. Herbst 2414*, 22 May 1972 (BISH1022154); *R.W. Hobdy 9*, Sep 1968 (BISH1022150); *R.W. Hobdy 99*, 09 Apr 1969 (BISH1022149); *C.H. Lamoureux 1512*, 25 Aug 1960 (BISH1022137); *C.H. Lamoureux 1513*, 25 Aug 1960 (BISH1022139); *C.H. Lamoureux 1511*, 25 Aug 1960 (BISH1022138); *C.R. Long 1639*, 25 Apr 1964 (BISH1022157); *J.M. Lydgate s.n.*, s.d. (BISH1022145); *S. Perlman s.n.*, 02 Jun 1979 (BISH1022142); *S. Perlman 477*, 13 Aug 1979 (BISH1022140); *S. Perlman 12448*, 30 Dec 1991 (BISH1022141); *S. Perlman 5969*, 20 Jun 1987 (BISH1022151); *S. Perlman 23081*, 31 Oct 2012 (BISH10220223); *S. Perlman 23767*, 04 Dec 2013 (BISH1199265); *S. Perlman 23861*, 25 Feb 2014 (BISH1200255); *H.U. Stauffer 5912*, 24 Apr 1964 (BISH1022155); *N. Tangalin 2924*, 15 Dec 2011 (BISH1044844); *N. Tangalin 2181*, 14 Sep 2009 (BISH1200026); *W.L. Wagner 4996*, 27 Aug 1983 (BISH1022148); *W.L. Wagner 6298*, 21 Nov 1989 (BISH1022147); *W.L. Wagner 6015*, 07 Apr 1988 (BISH1022146); *K.R. Wood 1542*, 30 Dec 1991 (BISH1022144); *K.R. Wood 2047*, 08 Aug 1992 (BISH1022152); *K.R. Wood 14349*, 14 Oct 2010 (BISH1059057); *K.R. Wood 15755.00*, 04 Dec 2013 (BISH1067937).

Hahai nō ka ua i ka ululā'au

Hahai nō ka ua i ka ululā'au means "The rain follows the forest". The intact wet forests of West Maui are essential habitat for *H. arborescens* A.Gray. Native trees, ferns, and mosses allow water to slowly percolate into the ecosystem. Non native ungulates and weeds threaten this balance.

A 'ai ka manu i luna

A 'ai ka manu i luna means "The birds feed above". An attractive person is compared to a tree laden with flowers that attracts birds. *H. lydgatei* C.N.Forbes is hypothesized to have pendant flowers to be more attractive to honey creepers (Drepanidae)

Kaua'i, O'ahu
Photo by Natalia Tangalin

Hesperomannia oahuensis (Hillebr.) O.Deg., Fl. Hawaiiensis [Degener] Fam. 344, 1938.

Hesperomannia arborescens subsp. *oahuensis* Hillebrand, Flora Hawaiian Islands, 232, 1888.

Hesperomannia arbuscula subsp. *oahuensis* (Hillebrand) Carlquist, Pac. Sci. 11:213, 1957. Type: Puakea, Mt. Kaala, Oahu, *Wawra s. n.* (lectotype (designated by Degener, 1938): B [destroyed]; syntype: Makaleka, Mt. Kaala, Oahu, *Lydgate sn.* BISH 1005805!). (See discussion by St. John [1978] on effective lectotypification by Degener.)

Hesperomannia arbuscula var. *pearsallii* St. John, Phytologia 40:241, 1978. Type: Southern Waianae, Oahu, *Pearsall 500-* (holotype: BISH 1005804!).

Small, sprawling trees/shrubs 2–3 m tall, young branches and apical buds densely tomentose. Leaves with petioles 1/4 – 1/3 of total leaf length, tomentose; leaf blades ovate to elliptic-ovate, densely tomentose on lower surface, upper surface tomentose to sparsely pubescent, margins entire or dentate. Heads on stout, puberulent peduncles, 6 – 8 mm long, erect at anthesis; involucre in 5–8 series, phyllaries green at bottom and magenta at top at anthesis; inner phyllaries 2.3–2.5 cm long; middle phyllaries 3–3.5 cm wide. Corollas 1.3 cm long; pappus 2.0–2.5 cm long, elements broadened towards the apex, fimbriate at the base and scabrid all along, pink to light purple.

Distribution and ecology: Highly endangered, restricted to mesic forests in the Waianae Mountain Range of Oahu.

Additional specimens examined: United States.

Oahu. *B. Bishop s.n.*, 03 Aug 1963(BISH1022134); *S. Carlquist 640*, 26 Aug 1961(BISH1022116); *S. Carlquist 1720*, 03 Jul 1965(BISH1022115); *S. Carlquist 1910*, 02 Jul 1966(BISH1022117); *O. Degener 11200*, 11 Apr 1937(BISH1022106); *C.N. Forbess.n.*, 26 Apr 1912(BISH1022121); *C.N. Forbes 1591.O*, 27 Apr 1910(BISH1022119); *C.N. Forbes 1591.O*, 27 Apr 1910(BISH1022118); *C.N. Forbes 1829.O*, 26 Apr 1912(BISH1022120); *G.W. Gillett 1725*, 10 Apr 1965(BISH1022132); *D.R. Herbst 5047*, 21 Sep 1974(BISH1022113); *D.R. Herbst 1416*, 02 Jun 1969(BISH1022112); *D.R. Herbst 1132*, 17 Jun 1968(BISH1022114); *P.C. Hutchison 7370*, 23 Jul 1967(BISH1022133); *J.K. Obata 77-310*, 27 Mar 1977(BISH1022127); *J.K. Obata 328*, 01 Aug 1977(BISH1022130); *J.K. Obata 77-310*, 27 Mar 1977(BISH1022129); *J.K. Obata 85-545*,

1985(BISH1022126); *J.K. Obata 375*, Apr 1978(BISH1022131); *G.A. Pearsall s.n.*, 26 Mar 1960(BISH1022105); *S. Perlman 5466*, 24 Mar 1987(BISH1022107); *J. Rohrer s.n.*, 18 Oct 2007(BISH1199614); *John, H. St. John 13005*, 29 Mar 1933(BISH1022003); *B.C. Stone 2788*, 04 May 1959(BISH1022053); *B.C. Stone 3660*, Sep 1961(BISH1022052); *B.C. Stone 3450*, 30 Apr 1960(BISH1022110); *B.C. Stone 3293*, 26 Mar 1960(BISH1022111); *W.N. Takeuchi 2118*, 31 Mar 1985(BISH1022122); *W.N. Takeuchi 2186*, May 1985(BISH1022125); *B. Tate 2*, May 1987(BISH1022108); *P. Welton 749*, 17 Jul 1991(BISH1022109).

Hesperomannia swezeyi O.Deg., Fl. Hawaiiensis [Degener] Fam. 344, 1935. *Hesperomannia arborescens* subsp. *swezeyi* (Degener) Carlquist, Pac. Sci. 11:214, 1957. Type: Pupukea-Kahuku region on Kahuku side, Oahu, in rain forest at crest just south of trail, O.Degener & O.Swezey 4398 (holotype: BISH 1005815!; isotypes: B †, NY 00007532).

Hesperomannia bushiana Degener, Flora Hawaiiensis, 1933. *Hesperomannia arborescens* subsp. *bushiana* (Degener) Carlquist, Pac. Sci. 11:214, 1957. Type: Along crest of middle Hawala Ridge about 2.5 mi. above makai boundary of Forest Reserve, Oahu, *O. Degener, W. Bush, C. Potter, K. Park 9981* (holotype: BISH 005810!; isotype: B 10 0088463 [3 sheets; ex GH], BISH 1005811!, M 0031144, MICH 1107453!, NY 00007529 [2 sheets], WIS 0256899WIS);

Hesperomannia bushiana var. *fosbergii* Degener, 1933, Flora Hawaiiensis. Type: Kalawao Ridge, Koolau Mountains, Oahu, alt. 540 m, *Fosberg 9470* (holotype: BISH 1005812!; isotype: NY 00007531).

Trees 2–5 m tall, young stems and apical buds pubescent. Leaves with petioles 1/8–1/7 of total leaf length; leaf blades broadly oblanceolate to obovate, sometimes elliptic, glabrous or nearly so, with lower leaf surface of young leaves sometimes being sparsely pubescent along 1/2–1/3 of midrib, margins entire or sometimes crenate. Heads on stout sparsely puberulent peduncles 4 – 6 mm long, erect at anthesis; involucre in 5–8 series of phyllaries, phyllaries magenta at anthesis, inner phyllaries 2.7– 3.0 cm long; middle phyllaries 3.0 – 3.5 cm wide. Corollas 2.0 cm long; pappus 2.5–3.0 cm long, elements tapering towards the apex, fimbriate at the base and scabrid all along, pink.

Distribution and ecology: Highly endangered in wet forest, mainly on the leeward side of the Koolau

He pua laha 'ole

He pua laha 'ole means "A rare flower". The multiseriate involucre of *H. lydgatei* C.N.Forbes has pale whitish pink phyllaries at anthesis. These flowering heads are conspicuous in the dark green wet forest of Kaua'i.

Kaua'i, Hawai'i
Photo by Scott Heintzman

Somewhere over the Rainbow

Although down to just 3 wild individuals, *H. oahuensis* (Hillebr.) O.Deg. is starting to rebound through efforts by the Army Natural Resources Program, O'ahu. Their hand pollination efforts saved this species from extinction.

Wai'anae Mountains, O'ahu
Photo by Ane Bakutis

The Law of Attraction

Open flowering heads of *H. swezeyi* O.Deg. produce copious nectar, and are pollinated by native honey creeper birds such as 'apapane (*Himatone sanguinea*) and 'amakihi (*Chlorodrepanis flavā*). This species flowers synchronously with the dominant forest tree 'Ōhi'a lehua (*Metrosideros polymorpha* Gaudich., Myrtaceae) which is also visited by these bird species for nectar.

Ko'olau Mountains, O'ahu
Photo by Susan Ching Harbin

Mountain Range, Oahu. One population documented as extirpated from the windward Waianae Range, Oahu.

Additional specimens examined: United States.

Oahu. A.M. Adamson s.n., 29 Mar 1933 (BISH1022082); H. Akiyama s.n., 13 May 1951 (BISH1022058); B. Bishop s.n., 29 Apr 1962 (BISH1022062); E. H. Bryan Jr. 860, 20 Nov 1934 (BISH1022063); E.L. Caum s.n., 12 Aug 1930 (BISH1022026); E.L. Caum s.n., 14 Aug 1930 (BISH1022025); A.K. Chock 231, 13 May 1951 (BISH1022008); A.K. Chock 231, 13 May 1951 (BISH1022009); A.K. Chock 230, 13 May 1951 (BISH1022010); O. Degener 7447, 27 Mar 1933 (BISH1022066); O. Degener 75482, 19 Sep 1950 (BISH1022067); O. Degener 10080, 02 Jun 1935 (BISH1022074); O. Degener 10081, 29 Jul 1935 (BISH1022073); O. Degener 10079, 16 Jun 1935 (BISH1022065); O. Degener 7445, 31 Mar 1929 (BISH1022069); O. Degener 3397, 15 Feb 1928 (BISH1022068); O. Degener 10007, 02 Jun 1935 (BISH1022072); O. Degener 7446, 06 Dec 1931 (BISH1022070); O. Degener 10079, 16 Jun 1935 (BISH1022064); O. Degener 10008, 25 Apr 1935 (BISH1022075); O. Degener 10007, 02 Jun 1935 (BISH1022071); C.N. Forbes 2035.O, 10 Feb 1915 (BISH1022088); C.N. Forbes 1703.O, 09 Apr 1911 (BISH1022089); C.N. Forbes 2035.O, 10 Feb 1913 (BISH1022087); C.N. Forbes 2035.O, 10 Feb 1913 (BISH1022086); C.N. Forbes 2035.O, 10 Feb 1913 (BISH1022090); F.R. Fosberg 9820, 08 Aug 1933 (BISH1022101); F.R. Fosberg 9791, 08 Aug 1933 (BISH1022102); F.R. Fosberg 9419, 15 Apr 1933 (BISH1022060); D.W. Garber 283, 07 Mar 1920 (BISH1022103); D.W. Garber 202, 01 Feb 1920 (BISH1022104); M.L. Grant 7251, 08 Aug 1934 (BISH1022023); M.L. Grant 7251, 08 Aug 1934 (BISH1022024); M.L. Grant 7251, 08 Aug 1934 (BISH1022022); M.L. Grant 7251, 08 Aug 1934 (BISH1022020); M.L. Grant 7146, 01 Aug 1934 (BISH1022021); D.R. Herbst 1169, 22 Jun 1968 (BISH1022059); E.Y. Hosaka 619, 04 Jul 1932 (BISH1022011); E.Y. Hosaka 2036, 08 May 1938 (BISH1022012); Jr., A.F. Judd Jr. 1244, 06 Jun 1925 (BISH1022081); Jr., A.F. Judd Jr. 1244, 06 Jun 1925 (BISH1022083); H.L. Lyon s.n., 15 Sep 1926 (BISH1022030); H.L. Lyon s.n., 20 Apr 1934 (BISH1022029); H.L. Lyon s.n., 15 Sep 1926 (BISH1022031); S. Miyake 97, 1950 (BISH1022085); J.K. Obata s.n., 20 Apr 1952 (BISH1022057); J.K. Obata s.n., Apr 1989 (BISH1022076); G.A. Pearsall s.n., 25 Apr 1948 (BISH1022014); G.A. Pearsall s.n., 05 Jul 1958 (BISH1022015); G.A. Pearsall s.n., 30 Oct 1949 (BISH1022013); S. Perlman 6197, 19 Jul 1987 (BISH1022078); S. Perlman 6197, 19 Jul 1987 (BISH1022077); S. Perlman 23654, 22 Aug 2013 (BISH1099539); J.F.C. Rock 10301, s.d. (BISH1022093); J.F.C. Rock 25766, 03 Apr 1957 (BISH1022095); J.F.C. Rock 16019, Sep 1917 (BISH1022094); J.F.C. Rock 10301, s.d. (BISH1022091); J.F.C. Rock 10301, s.d. (BISH1022092); C.J.F. Skottsberg s.n., 23 Oct 1922 (BISH1022027); C.J.F. Skottsberg

890, 25 Oct 1922 (BISH1022028); John, H. St. John 11570, 06 Mar 1932 (BISH1022002); John, H. St. John 20188, 16 Feb 1941 (BISH1022006); John, H. St. John 13005, 29 Mar 1933 (BISH1022004); John, H. St. John 20270, 19 Oct 1941 (BISH1022016); John, H. St. John 11570, 06 Mar 1932 (BISH1022000); John, H. St. John 13005, 29 Mar 1933 (BISH1022005); John, H. St. John 11547, 14 Feb 1932 (BISH1022056); John, H. St. John 11570, 06 Mar 1932 (BISH1022001); John, H. St. John 13116, 30 Apr 1933 (BISH1022007); John, H. St. John 20270, 19 Oct 1941 (BISH1022018); A. Suehiro s.n., Sep 1933 (BISH1022054); O.H.



Figure 1. Dried inflorescences of *Hesperomannia lydgatei* C.N.Forbes in wet forest habitat of Kauai, Hawaii. The dried achenes with pappus of scabrid setae are wind dispersed short distances within populations.

He ali'i ka 'āina; he kauwā ke kanaka

He ali'i ka 'āina; he kauwā ke kanaka means "The land is chief; man is its servant"

The upland wet forest of Kaua'i is home to *H. lydgatei* C.N.Forbes. Due to introduced species, development, and climate change, the Hawaiian islands have less than 50% of native forest habitat remaining. In addition to direct work to preserve rare flora, the State of Hawaii with partners such as watershed partnerships are working to protect and restore essential habitat.

Swezey s.n., 26 Mar 1933 (BISH1022080); O.H. Swezey s.n., 22 Aug 1920 (BISH1022055); W.N. Takeuchi 2206, 19 May 1985 (BISH1022019); W.N. Takeuchi 2738, Aug 1986 (BISH1022017); G.L. Webster 1558, 25 Apr 1948 (BISH1022079); K.A. Wilson 124, 06 Apr 1952 (BISH1022084)

CURRENT CONSERVATION STATUS

The current conservation status of the genus is reflective of Hawaii's overall ecosystem crises. All currently accepted species are listed by the IUCN as Critically Endangered, CR (World Conservation Monitoring Centre, 1998; Bruegmann & Caraway, 2003; Walsh et al., 2020) as well as listed as Endangered by the USFWS (USFWS 1991a, 1991b, 1994 ONLY ONE OF 1991 CITED). Causes for this are numerous and include: feral ungulates, rats, mice, invasive plants, climate change, and over visitation by humans (Price & Toonen, 2017; Rønsted et al. 2022). Furthermore, with reduced abundance these species are now affected simply by small population sizes consisting of just 1-3 individuals (Kawelo et al. 2012). Low genetic diversity is evident in all four species (Ching Harbin, 2003).

Hesperommania is presumably bird pollinated, with large, brightly colored flowering heads that produce copious amounts of nectar at anthesis. The genus is also protandrous and assumed to be strongly self-incompatible. With the continued decline of Hawaiian nectivorous

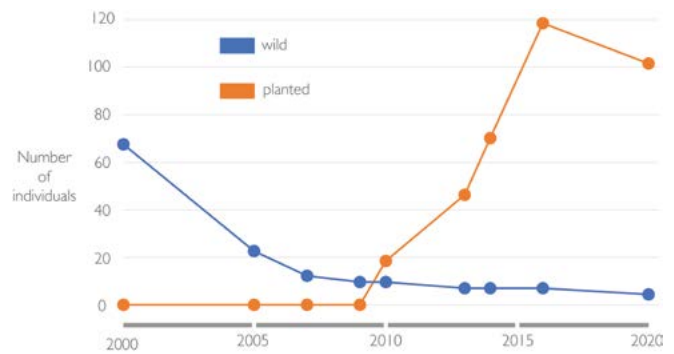


Figure 2. Evolution of populations of *Hesperommania oahuensis* (Hillebr.) O.Deg., wild mature individuals and restoration plantings (ANRPO 2021 data).

birds (Paxton et al. 2018), small populations of bird pollinator dependent plant species could be effectively experiencing an Allee effect, where small populations are not attracting enough floral visitors to successfully move pollen amongst individuals. Forsyth (2003) found that in the Haleakala Silversword (*Argyroxiphium sandwicense* D.C. subsp. *macrocephalum* (A. Gray) Meyrat, Tribe Madieae) - a self-incompatible insect pollinated species - percent seed set was significantly correlated with the number of flowering plants in a population.

The floral morphology and pollination syndrome of this genus is also similar to the most common mesic and wet forest tree in Hawaii, Ohia lehua, *Metrosideros polymorpha* Gaudich. (Myrtaceae). Generalist nectivorous bird pollinators would visit both *Metrosideros* Banks ex Gaertn. and

Table 1. Conservation status of the endemic Hawaiian genus, *Hesperommania* A.Gray. #s given as mature (immature) (S. Heintzman, H. Oppenheimer, A. Bakutis, S. Ching Harbin PEPP; T. Chambers Army Natural Resources Program, Oahu (ANRPO, pers. comm)).

Species	# Wild populations	# Wild individuals	# Conservation planting	Ex situ representation
<i>H. arborescens</i> A.Gray	8	88	0	<25 seeds (from 1 pop.)
<i>H. lydgatei</i> C.N.Forbes	1 (+ outlier individuals)	<30	1	<25 seeds (from 1 pop.)
<i>H. oahuensis</i> (Hillebr.) O.Deg	1	3	38 (64)	246 seeds (from 3 pops.)
<i>H. swezeyi</i> O.Deg	20	200 (181)	0	<50 seeds (from 4 pops.)

Ola I Ka Wai

Ola I Ka Wai means "Water is Life". *H. arborescens* A.Gray occurs in the steep, wet gulches of West Maui. This species once occurred on Lana'i and has not been seen on Moloka'i in recent years. This species is in need of seed collections representing all remaining populations and large scale ungulate fences.



West Maui, Hawaii
Photo by Hank Oppenheimer

Table 2. Threat control summary by *Hesperomannia* A.Gray species.

Species	Ungulate fence	Rat Control	Slug control
<i>H. arborescens</i> A.Gray	1 population	0	0
<i>H. lydgatei</i> C.N.Forbes	0	0	0
<i>H. oahuensis</i> (Hillebr.) O.Deg	All wild/reintroduced fenced	100%	100%
<i>H. swezeyi</i> O.Deg	<10 individuals in 3 populations	1 pop	0

Hesperomannia, which generally have overlapping flowering times in the spring (Ching Harbin pers. Obs.). *Hesperomannia oahuensis* is known from mesic forest in the Waianae mountains of Oahu. The *Metrosideros* canopy cover in the mesic habitat unique to *H. oahuensis* has been reduced due to invasive species and climate change. Perhaps, as remaining *Hesperomannia* exist only as scattered populations of a few individuals, pollinators are no longer attracted in sufficient numbers to effectively cross pollinate individuals causing the observed low to absent seed set observed in wild populations of *H. oahuensis* (ANRPO, 2021). In contrast, medium sized populations of *H. swezeyi* have more demographic structure with seedlings and immatures and occurs in more intact *Metrosideros* forest on Oahu. This suggests that this species, although declining, continues to be successfully pollinated as a benefit from being within an Ohia dominated forest.

Hesperomannia oahuensis underwent a steep decline from 67 mature individuals in 2000 to just 3 remaining wild individuals in 2022. The Army Natural Resources Program Oahu (ANRPO) has been actively managing this species for the past 20+ years. A large effort to cross pollinate by hand was made to secure seed from the remaining plants beginning in 2007, with 12 wild matures in 6 populations. The efforts have been extremely successful with over 250 progeny planted into wild sites to date (Figure 2). ANRPO has shown that larger planted stands of mature *H. oahuensis* combined with synchronous flowering of the Ohia canopy are beginning to attract native honeycreeper pollinators such as the Oahu Amakihi, *Chlorodrepanis flava* A. Bloxam (Fringillidae). This has resulted in the observance of viable seeds and seedlings being

produced without human pollination assistance, something that hasn't been seen in over 10 years (Figure 1).

The other three species *Hesperomannia arborescens*, *H. lydgatei*, and *H. swezeyi* have received much less in situ conservation work. All *H. oahuensis* are protected from feral ungulates and rats, while only a handful of individuals of *H. swezeyi* and *H. arborescens* are within ungulate fences. There is minimal rodent control for *H. swezeyi* and no ungulate or rodent control for *H. lydgatei* (Table 2). Recent work with a population of *H. swezeyi* showed, 90% of the flowering heads were eaten by rats until a rodent control grid was set up. With the continued decline of all of these species, unprotected populations face eventual extinction due to ungulate damage, reduced or no pollinations, and minimal recruitment potential.

Not only are all of the four species declining precipitously in the wild, the genus has little to no ex situ conservation collections to preserve these species from extinction. Fewer than 400 mature individuals exist in the entire genus and fewer than 100 seeds in storage (Table 1). A handful of seeds have been stored from *H. lydgatei* on Kauai (S. Heinzman PEPP, 2022 pers. comm.), *H. swezeyi* on Oahu (T. Chambers ANRPO, 2022 pers. comm.), and *H. arborescens* Maui only (H. Oppenheimer PEPP, 2022 pers. comm.). A few seedlings have been rescued from *H. arborescens* on Maui and Molokai, none are currently alive ex situ (H. Oppenheimer, A. Bakutis, PEPP 2022 pers. comm.). *Hesperomannia* seeds are orthodox, can withstand drying and cold storage conditions, with a storage life expectancy of at least 25+years (T. Chambers/M. Akiona, ANRPO pers. comm.). However, with the lack of refined storage and propagation techniques for the

genus, and few seeds available for germination, it is likely to result in fewer live plants than seeds, given the age of the collections and the varying degrees of seed viability.

LOOKING AHEAD

In situ threat control at every population and wild collections of each species in the genus need to begin immediately. As environmental conditions continue to deteriorate and change rapidly, each species and population are expected to continue contracting. Ex situ storage is needed to represent each species for long term preservation against extinction. Without immediate threat control for ungulates and rodents as well as hand pollination for some populations, the four species may not survive the next 100 years.

The Plant Extinction Prevention Program <http://www.pepphi.org/> partnered with The State of Hawaii's Department of Land and Natural Resources <https://dlnr.hawaii.gov/ecosystems/rare-plants/>; The Army Natural Resources Program Oahu <https://oanrp.weebly.com/>; and National Tropical Botanical Gardens <https://ntbg.org/>, and The Hawaii Rare Plant Program <https://manoa.hawaii.edu/lyon/research/hrpp/> are working together towards these goals (Werden et al., 2020).

For continued positive progress, funding specific to these species is necessary. Aside from ANRPO, the programs listed above do not receive funding directly for these taxa. Most of the sites are accessed by helicopter, ungulate fences are needed, and rodent control needs to be targeted during flowering/fruiting (Table 2). Many remaining populations are too small to attract sufficient pollinators. Therefore, hand pollination will be necessary in most cases. Propagation and wild introductions of all species is essential, and a task largely not begun. The cost of these actions is sometimes prohibitive. However, the efforts made to date prove this work can be successful if given these opportunities. The time to act is now before there is not enough habitat remaining or genetic variation available to successfully prevent extinction of this extraordinary example of long distance dispersal, adaptive radiation, and island evolution.

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LITERATURE CITED

- ANRPO (Army Natural Resources, O'ahu).** 2021. Status Report for the Makua and Oahu Implementation Plans.
- Bruegmann, M.M. & Caraway, V.** 2003. *Hesperomannia arbuscula*. The IUCN Red List of Threatened Species.
- Ching Harbin, S.** 2003. Measures of fitness and genetic variation in the endangered Hawaiian genus *Hesperomannia*. M.S. Thesis, University of Hawaii.
- Degener, O.** 1932–1980. Flora Hawaiiensis or New illustrated flora of the Hawaiian Islands. Publ. privately, Honolulu.
- Funk, V. A. & Wagner, W. L.** 1995. Biogeography of seven ancient Hawaiian plant lineages. In *Hawaiian biogeography: evolution on a hotspot archipelago* (ed. W. L. Wagner & V. A. Funk), pp. 160–194. Washington, DC: Smithsonian Institution Press.
- Forsyth, S.A.** 2003. "Density-dependent seed set in the Haleakala Silversword: evidence for an Allee effect." *Oecologia* 136.4 (2003): 551-557.
- Givnish T. J., Millam K. C., Mast A. R., Paterson T. B., Theim T. J., Hipp A. L., Henss J. M., Smith J. F., Wood K. R. & Sytsma K. J.** 2009. Origin, adaptive radiation and diversification of the Hawaiian lobeliads (Asterales: Campanulaceae). *Proc. Roy. Soc. London, Ser. B, Biol. Sci.* 276: 407–416.
- Kawelo, H.K., Ching Harbin, S., Joe, S.M., Keir, M.J. & L. Weisenberger.** 2012. Unique Reintroduction Considerations in Hawaii: Case Studies from a Decade of Rare Plant Restoration at the Oahu Army Natural Resource Rare Plant Program. Pp. 209-226. In: Maschinski, J., Haskins, K.E., Raven, P.H. (eds) Plant Reintroduction in a Changing Climate. The Science and Practice of Ecological Restoration. Island Press, Washington, DC. https://doi.org/10.5822/978-1-61091-183-2_12

- Keeley, S. C., J. T. Cantley, & T. J. Gallaheer.** 2021. The “evil tribe” spreads across the land: A dated molecular phylogeny provides insight into dispersal, expansion, and biogeographic relationships within one of the largest tribes of the sunflower family (Vernoniaeae: Compositae). *Amer. J. Bot.* 108(3): 505–519. doi:10.1002/ajb2.1614
- Keeley, S.C., Forsman Z.H. & Chan, R.** 2007. A phylogeny of the “evil tribe” (Vernoniaeae: Compositae) reveals Old/New World long distance dispersal: Support from separate and combined congruent datasets (trnL-F, ndhF, ITS). *Molec. Phylog. Evol.* 44: 89–103.
- Kim, H. G., Keeley, S. C., Vroom, P. S. & Jansen, R. K.** 1998. Molecular evidence for an African origin of the Hawaiian endemic *Hesperomannia* (Asteraceae). *Proc. Natl Acad. Sci. USA* 95: 15440–15445.
- Morden, C. W. & S. Ching Harbin.** 2013. Evolution and Biogeographic Origins of the Endemic Hawaiian Genus *Hesperomannia* (Asteraceae) I. *Pacific Sci.* 67(2): 219-235.
- Paxton, E.H., Laut, M., Vetter, J.P. & Kendall, S.J.** 2018. Research and management priorities for Hawaiian forest birds. *The Condor* 120(3): 557–565. <https://doi.org/10.1650/CONDOR-18-25.1>
- Price, J. P. & D. A. Clague.** 2002. How old is the Hawaiian biota? Geology and phylogeny suggest recent divergence. *Proc. Roy. Soc. London, Ser. B, Biol. Sci.* 269 (1508): 2429-2435.
- Price, M. R. & R. J. Toonen.** 2017. Scaling up restoration efforts in the Pacific Islands: a call for clear management objectives, targeted research to minimize uncertainty, and innovative solutions to a wicked problem. *Pacific Sci.* 71(4): 391-399.
- Price, J. P., & W. L. Wagner.** 2018. Origins of the Hawaiian flora: Phylogenies and biogeography reveal patterns of long-distance dispersal. *J. Syst. Evol.* 56: 600-620.
- Rønsted, N., Walsh, S. K., Clark, M., Edmonds, M., Flynn, T., Heintzman, S., Loomis, A., Lorence, D., Nagendra, U., Nyberg, B., Opgenorth, M., Weisenberger, L., Williams, A., Wolkis, D., Wood, K. R., & Keir, M.** 2022. Extinction risk of the endemic vascular flora of Kauai, Hawaii, based on IUCN assessments. *Conserv. Biol.* 36(4): e13896. <https://doi.org/10.1111/cobi.13896>
- Sakai, A. K., W. L. Wagner & L. A. Mehrhoff.** 2002. Patterns of endangerment in the Hawaiian flora. *Syst. Biol.* 51(2): 276-302.
- Seelanan, T, A. Schnabel & J. F. Wendel.** 1997. Congruence and consensus in the cotton tribe (Malvaceae). *Syst. Bot.*: 259-290.
- USFWS.** 1991. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for 26 plants from the Waianae Mountains, Island of Oahu, Hawaii. *Federal Register* 56(209): 55770-55786.
- Wagner, W. L., D. R. Herbst & S. H. Sohmer.** 1990. Manual of the flowering plants of Hawai'i. University of Hawai'i Press and Bishop Museum Press, Honolulu.
- Wagner, W. L., D. R. Herbst, N. Khan & T. Flynn.** 2012. Hawaiian vascular plant updates: a supplement to the Manual of the Flowering Plants of Hawai'i and Hawai'i's ferns and fern allies. *Washington, DC: Smithsonian National Museum of Natural History.* Version 1.3 [12 April 2012].
- Walsh, S., Nyberg, B. & Wood, K.** 2020. *Hesperomannia lydgatei*. *The IUCN Red List of Threatened Species* 2020.
- Weisenberger, L. & M. J. Keir.** 2014. Assessing Status, Capacity, and Needs for the Ex Situ Conservation of the Hawaiian Flora I. *Pacific Sci.* 68.4 (2014): 525-536.
- Werden, L.K., Sugii, N.C., Weisenberger, L., Keir, M.J., Koob, G. & R. Zahawi.** 2020. Ex situ conservation of threatened plant species in island biodiversity hotspots: A case study from Hawai'i. *Biol. Conservation* 243: 108435.
- World Conservation Monitoring Centre.** 1998. *Hesperomannia arborescens*. *The IUCN Red List of Threatened Species* 1998.