

Tetraplasandra lydgatei (Araliaceae): Taxonomic Recognition of a Rare, Endemic Species from O'ahu, Hawaiian Islands¹

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Abstract: *Tetraplasandra* is a genus of seven species endemic to the Hawaiian Archipelago. Recent field studies in the Ko'olau Mountains on the island of O'ahu have led to a taxonomic reevaluation of a rare species, *Tetraplasandra lydgatei*. The species, originally described in the late 1800s, was placed into the widespread, polymorphic species *T. oahuensis* in a subsequent treatment of the genus. Several morphological characters and varying ecological habitats distinguish the two species. Based on these differences *T. lydgatei* deserves formal taxonomic recognition. Furthermore, *T. lydgatei* was an uncommon species even when it was originally described. This may be due to the early human alteration of the dry and mesic Hawaiian forests for housing and agriculture and also that the species was always only an occasional component of the mesic ecosystem. Regardless of the reasons, the rarity of this species has been accelerated. Currently, only six individuals of *T. lydgatei* are known to exist, and conservation efforts to protect it are needed.

THE HAWAIIAN ENDEMIC genus *Tetraplasandra* A. Gray as currently circumscribed contains seven species (Lowry 1990, Lowry and Wood 2000). *Tetraplasandra lydgatei* (Hillebr.) Harms was first described by Hillebrand (1888) as *Triplasandra lydgatei*; the genus *Triplasandra* Seem. was later subsumed into *Tetraplasandra* (Harms, 1898). Subsequently, Lowry (1990) combined *T. lydgatei* with the polymorphic, widespread species *T. oahuensis* (A. Gray) Harms, believing that *T. lydgatei* represented simply a morphological extreme in the wide range of variation encompassed among individuals of *T. oahuensis*. The Lowry (1990) treatment represents a more concise and workable taxonomic framework for the genus based on current data and knowledge about the ranges of species variation in the Hawaiian Islands

in which many of the more than 82 species, subspecies, and varieties described in, and subsequent to, Sherff's (1955) revision of the genus were synonymized. However, extensive field investigations by botanists John Obata and Ron Fenstemacher over many years have led them to suspect that one lowland species, *T. lydgatei*, still warranted taxonomic recognition based on habitat and several morphological characteristics.

During my field investigations in 1995 and 1996 with Obata and Fenstemacher they identified the localities of two known *Tetraplasandra* individuals that they determined to be morphologically distinct from *T. oahuensis*. On revisiting the sites one of the two individuals had died since their last visit. The single living individual was found at an elevation of 335–340 m, which is typically lower than the usual range for *T. oahuensis* (>500 m) in the Ko'olau Mountain Range of O'ahu. In addition, the leaves of the individual were more membranous than the coriaceous leaves of *T. oahuensis*, but based on a single sterile individual the variation was attributed to the ecological habitat. However, in late July 1996 the plant began to flower. Even in bud the inflorescences were very distinct from those of *T. oahuensis* and it became clear that this was a unique species, morphologically

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similar to prior scientific descriptions and type specimens of *T. lydgatei*. Later, senescent flowers and fruit became available for study and supplied further characters to distinguish the taxon from the other species of *Tetraplasandra*.

The realization also struck us that the extinction of this species was imminent and the preservation of the species may require an actual resurrection rather than taxonomic resurrection. This concern spurred additional field exploration and surveys by Daniel Chun and other botanists that led to the discovery of seven additional individuals, two of which have since died. One of these flowered and fruited profusely before perishing and provided further material for this study and propagation. Currently, there are six known individuals of *T. lydgatei* in the southeastern Ko'olau Mountains; I have seen three of these.

Phylogenetic analyses of sequences from the nuclear ribosomal Internal Transcribed Spacer (ITS) and 5S nontranscribed spacer (Costello and Motley 2001) did not provide resolution among members of the *Tetraplasandra oahuensis* clade (*T. oahuensis*, *T. lydgatei* [not included in ITS], *T. waimeae* Wawra, and *T. waialealae* Rock), but this is not uncommon in closely related Hawaiian plant lineages (Ganders et al. 2000, Gemmill et al. 2002, Lindqvist and Albert 2002). The use of Amplified Fragment Length Polymorphisms (AFLP) has been useful for providing additional resolution among taxa resulting from recent and rapid species radiations (Lindqvist et al. 2003). In a recent AFLP study of the

Tetraplasandra group (Costello and Motley 2003) the members of the *T. oahuensis* clade (plus, on the recommendation of Timothy Flynn, National Tropical Botanical Garden, an individual thought to represent *T. bisattenuata* Sherff [= *T. oahuensis*]) formed a polytomy. One clade contained three individuals of *T. lydgatei* that were resolved as sister to *T. waimeae* and *T. waialealae*. A second clade included eight individuals of *T. oahuensis* sampled from throughout the Hawaiian Islands. The *T. bisattenuata* individual and a *T. oahuensis* individual from the Wai'anae Mountains, O'ahu, were unresolved. This AFLP evidence provides further support for the segregation of *T. lydgatei* from *T. oahuensis*.

Morphologically it is difficult to find diagnostic characters to separate species of this clade from the polymorphic *T. oahuensis* without using overlapping or continuous characters. *Tetraplasandra waimeae* and *T. waialealae* are separated dichotomously from *T. oahuensis* in the key of the recent treatment (Lowry 1990) by their larger fruit size and inflorescences without bract scars (which occasionally do occur in *T. waimeae*).

In the taxonomic key in the *Manual of the Flowering Plants of Hawai'i*, *T. lydgatei* can be segregated from the other species of the genus (including *T. flynnii*, which was not treated) by: inflorescences strictly compound umbellate (second choice in couplet 1); rays of inflorescence with 1 to several bract scars (couplet 5[1]). This keys the species as *T. oahuensis*. These two species can be separated by the following couplet.

- Fruit cylindrical, occasionally ovoid, 7–15 mm long; leaves coriaceous; flower petals pinkish red to yellow green; nectary disk pinkish red, peduncles 3.5–10 mm wide, pedicels ≥ 1.5 mm wide; terminal umbellules of flowers flat-topped to convex, with outer pedicels progressively longer than inner ones *T. oahuensis*
 Fruit globose, 4–5 mm long; leaves chartaceous; flower petals always yellow to yellow green (never pink or red); nectary disk yellow; peduncles ≤ 2 mm wide; pedicels ≤ 1 mm wide; terminal umbellules of flowers spherical, with pedicels being nearly equal in length *T. lydgatei*

Tetraplasandra lydgatei (Hillebr.) Harms
 Harms, 1898, in Engl. & Prantl, Pflanzenfam. III, 8:20; *Triplaspandra lydgatei* Hillebr., 1888, Fl. Hawaiian Isl., p. 153. Type: "Wailupe, Isl. Oahu," *Rev. John M. Lydgate s.n.*

(holotype, formerly at B [destroyed]; isotype, BISH 488665! [fragment]; possible isotype, "Niu or Wailupe," Isl. Oahu, W. Hillebrand & J. M. Lydgate s.n. BISH 488664!).

SYNONYMY: *Tetraplasandra lydgatei* var.

brachypoda Sherff, 1952, Bot. Leaflet 6:19. Type: "Niu valley, wooded valley, tree 30–40 tall," Isl. Oahu, 3 Dec. 1933, *D. L. Topping & W. Bush* 3,701 (NY 00217978!, holotype; MO, NY [three sheets]!, isotypes); *T. l.* var. *coriacea* Sherff, 1952, Bot. Leaflet 6:21. Type: "Halawa Valley Ridge Trail, 1800 ft., Koolau Range, Southeastern Oahu," 2 Mar. 1947, *S. Cowan* 563 (BISH 488744! holotype; BISH 488745! isotype); *T. l.* var. *forbesii* Sherff, 1952, Bot. Leaflet 6:20. Type: "tree about 20 ft. tall, darkish bark, leaves with 7 leaflets ... turning yellow with age ... ridge west of Waialae Valley, near the top, rather dry locality," Isl. Oahu, 15 Oct. 1914, *C. N. Forbes* 1942-O (US, holotype; BISH 488743!, 488748!, isotypes); *T. l.* var. *leptorhachis* Degener & Sherff, 1952, Bot. Leaflet 6:20. Type: "open, windy rain-forest, slope north-east of Nuuanu Valley," Isl. Oahu, 20 Nov. 1926, *Degener* 17, 796 (US, holotype; MO, NY [three sheets]!, isotypes); *Triplasarandra lydgatei* Hillebr.

DESCRIPTION: Trees 7–10 m tall. Leaves 34–40 (50) cm long, leaflets (7) 9–11, broadly elliptic or ovate to oblong-elliptic, lateral ones often slightly falcate, 7–9 cm long, 3–3.5 cm wide (lower pair often smaller), glabrous, apex rounded, base rounded to attenuate, margins slightly revolute, petiolules 1–2 mm long. Flowers in erect, 2 times compound umbel, primary axis 0.6 cm, 9–12 secondary axes, 8–10 cm long with one to several bract scars, each with a terminal, spherical umbellule of 26–47 flowers, pedicels 1.5–3 cm long, becoming slightly curved in fruit; calyx lobes undulating, becoming acute in fruit, <1 mm; petals six, ovate, 2 mm long, 1 mm wide, yellow to yellow green; stamens 12 or 18 (two to three times as many as petals), in a single whorl; ovary fully inferior, (3)–4 celled. Fruit 1 cm long, 0.5–0.7 cm wide, globose to ovoid with stylopodium forming small (1 mm) beak, fruit wall becoming longitudinally ridged when dry. Seeds globose, 4–5 mm long.

DISTRIBUTION: Rare, in mesic forest of the Ko'olau Mountain Range, southeastern O'ahu. Formerly, ranging from Niu Valley to the Halawa Ridge trail, 335–548 m; the distribution currently appears to be limited to the eastern slopes of Hawai'i Loa and Kūlepeamo Ridges, 335–378 m.

PHENOLOGY: The phenological data are limited, but it appears that the reproduction of the species is not on an annual cycle. Flowering tends to occur in the summer months as early as June and peaking July–September. Fruit remains on the tree from September to January, with records extending until March; maturation takes 3–4 months.

SPECIMENS EXAMINED: Hawaiian Islands, island of O'ahu: "Western slope of central ridge of Niu Valley, moderately open, dry summit," 4 June 1932, *O. Degener* 18,244 (NY); "Wahiawa," 25 Nov. 1926, *O. Degener s.n.* (NY); "Hawaii Loa Ridge, E. facing slope, 335 m." 15 Dec. 1997, *T. Motley* 1809 (NY); "same individual 1809," 18 Aug. 1997, *T. Motley & R. Fenstemacher* 1798.5 (NY); "same individual 1809," 1 Oct. 1998, *T. Motley & R. Fenstemacher* 2025 (NY); "Hawaii Loa Ridge, down in Pia Gulch, by wire on trail, small tree," 3 Oct. 1998, *T. Motley, R. Fenstemacher & J. Obata* 2032 (NY); "same locality 2032, large tree farther down slope," 3 Oct. 1998, *T. Motley, R. Fenstemacher & J. Obata* 2033 (NY); "Palolo-Waialae ridge," 27 Jan. 1927, *L. H. MacDaniels* 466 (BISH); "Koolau Range, Hawaii Loa Ridge, 335 m, off ridgetop in subgulch, 1 km from beginning of trail, E-facing, w/Psidium; trunk erect, narrow, no branching before 2.5 m; leaflets ... chlorotic-looking turns green when drying, ... stamen 18–21," 27 Sept. 1992, *J. Obata & R. Fenstemacher s.n.* (BISH, two sheets), "Koolau Range, Aina Haina, Kului-Wailupe Ridge, 335 m elev., along ridgetop, growing under Psidium sp. (waiawi) in drier steep habitat. Inflorescences in bud, leaves atypical *T. lydgatei*, more leaflets, possibly *T. oahuensis*," 2 Aug. 1992, *J. Obata & R. Fenstemacher s.n.* (BISH); "Ridge between Niu and Wailupe," 11 Apr. 1917, *C. N. Forbes & J. C. Bidwell* 2461-O (BISH); "Wailupe Valley," 4 May 1917, *C. N. Forbes* 2511-O (BISH); "Niu Valley, in moderately dry open woods on side of the trail on western slope of central ridge of Niu, same tree as Topping Bush No. 3701," 4 June 1932, *O. Degener, O. Sweeney, K. Parks & Y. Nitta* 6099 (BISH), "Hawaii Loa ridge, same place as 14-June-2000 collection," 30 July 2000, *D. Chun s.n.* (BISH, two sheets and alcohol collection).

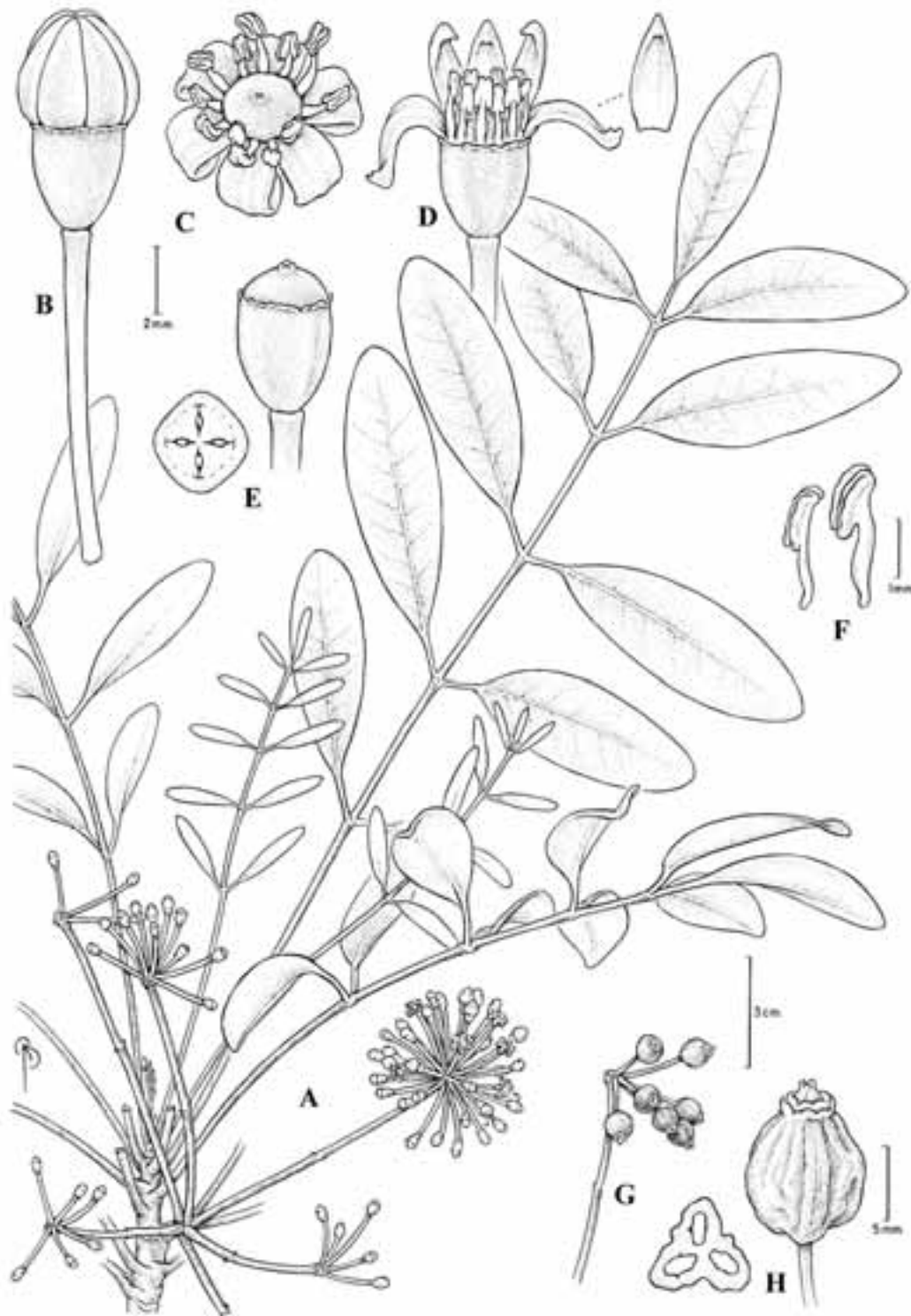


FIGURE 1. *Tetraplasandra hydgatei* (Hillebr.) Harms. *A*, Terminal branch with inflorescence; *B*, individual flower bud; *C*, dorsal view of flower at anthesis; *D*, lateral view of flower with sepal removed; *E*, immature fruit and cross section; *F*, stamen; *G*, infructescence; *H*, mature fruit and cross section.

Collection originally identified as *T. lydgatei* is a misdetermined *T. oahuensis*: "Waialae Nui Ridge, single large tree in rainforest, alt. 2,200 ft," 2 Oct. 1949, O. Degener & C. Nihei 20,222 (BISH, NY).

DISCUSSION

Tetraplasandra lydgatei is a distinct species inhabiting the mesic Hawaiian forest remnants of the southeastern Ko'olau Mountains. The compound umbels and presence of bract scars on the inflorescence rays distinguish this taxon from most other members of the genus (Figure 1), excluding the widespread, polymorphic species *T. oahuensis*. The two species are very closely related (Costello and Motley 2001), but a combination of floral and fruit characters distinguishes the taxa (Table 1). Furthermore, the taxa seem to share different elevation habitats, with *T. lydgatei* typically occupying forest below 500 m and *T. oahuensis* inhabiting the higher, wet forest.

The mesic forest habitat of *T. lydgatei*, unfortunately, is now dominated by two invasive weed species, *Psidium cattleianum* Sabine (strawberry guava) and *Schinus terebinthifolius* Raddi (Christmas berry), which form dense stands that outcompete native species and shade out understory growth. Native trees occasional in the habitat include *Santalum freycinetianum* var. *freycinetianum*

Gaud., *Acacia koa* A. Gray, *Pouteria sandwicensis* (A. Gray) Baehni & Degener, *Bohea sandwicensis* (A. Gray) Hillebr., *Pittosporum confertiflorum* A. Gray, *Eugenia reinwardtiana* (Blume) DC, *Psydrax odorata* (Forst. f.) A. C. Smith & S. Darwin, *Myrsine sandwicensis* A. DC, *Nesoluma polynesicum* (Hillebr.) Baill., *Sapindus oahuensis* Hillebr. ex. Radlk., and *Diospyros sandwicensis* (A. DC) Fosb. Understory species are *Alyxia oliviformis* Gaud., *Chamaesyce arnottiana* (Endl.) Degener & I. Degener, and the federally endangered fern *Diellia erecta* Brack. Regeneration of the native species in this area seems very limited. No saplings or seedlings have been seen of *T. lydgatei* or the other native tree species in the area, with the exception of *A. koa*. The Hawaiian mesic forest species, particularly in the Ko'olau Mountain Range, are quickly disappearing.

Conservation measures to protect *T. lydgatei* are needed because the current, known population is reduced to six individuals. However, it seems that even in the 1930s this taxon was not common. Degener noted on several of the specimens cited here that the plant was "extremely rare." Indeed it appears that many of the collections were made from the same individual during separate collecting trips, and very few herbarium collections of the species exist. Seeds from the trees germinate readily; however, the seedlings require specific treatment for survival. Young plants

TABLE 1
Comparison of Morphological Characters between *T. lydgatei* and *T. oahuensis*

Character	<i>Tetraplasandra lydgatei</i>	<i>Tetraplasandra oahuensis</i>
Leaves	Chartaceous	Coriaceous
Petals	6, yellow to yellow green	5–7(8), pinkish red to yellow green
Nectary disks	Yellow	Pinkish red
Stamens	12 or 18	5–25–(30)
Carpels	(3)–4	3–8
Fruits	Globose, 4–5 mm long	Cylindrical to ovoid, 7–15 mm long
Inflorescences	Compound umbel, 2x compound	Compound umbel or racemose umellate, 2–3x compound
Peduncles	Slender, ≤2 mm wide, 8–10 cm long	Slender to robust, 3.5–10 mm wide, 7–15–(18) cm long
Pedicels	Slender, ≤1 mm wide, 15–30 mm long	Slender to robust, ≥1.5 mm wide, 6–18–(22) mm long
Umbellules	Spherical	Mostly flat-topped or convex, rarely spherical

must be kept in full shade if the soil is kept moist, or if kept in partial sun the soil should not be moist. Seedlings placed in the sun with moist soil quickly die, perhaps due to the creation of conditions promoting soil pathogens (Daniel Chun, pers. comm.). In addition, plants have been propagated through micropropagation at the Lyon Arboretum, but plants transplanted out of media culture have not survived perhaps due to the wet conditions in Mānoa Valley (Nellie Sugii and Elizabeth Huppman, pers. comm.). It is possible that cultivation and outplanting will be a successful way to preserve the species; however, reforestation efforts and the success of offspring among the dense stands of *Psidium cattleianum* seem bleak without active management.

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