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## A New Species of *Chamaesyce* Section *Sclerophyllae* (Euphorbiaceae) from Kaua'i

David H. Lorence

National Tropical Botanical Garden, P.O. Box 340, Lawai, Hawaii 96765, U.S.A.

Warren L. Wagner

Department of Botany, Smithsonian Institution, MRC-166, National Museum of Natural History,  
Washington, D.C. 20560, U.S.A.

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**ABSTRACT.** The new species *Chamaesyce eleanoriae* is described and illustrated, and its affinities are discussed. It is restricted to the steep slopes and cliffs of northern Kaua'i, the oldest of the main Hawaiian Islands. *Chamaesyce eleanoriae* is closely related to the Kaua'i endemic *C. sparsiflora*, from which it differs by its consistently present white, glandular cyathial appendages.

***Chamaesyce eleanoriae*** Lorence & W. L. Wagner, sp. nov. TYPE: Hawaiian Islands (U.S.A.). Kaua'i: Hanalei District, Pohakuao, hanging valley between Kalalau and Hanakoa, *Metrosideros-Diospyros* lowland mesic forest, 400–600 m, collected below Pu'u Ki and Ka'a'alahina Ridge, 1 Apr. 1992, K. R. Wood, S. Perlman & J. Lau 1763 (holotype, PTBG; isotypes, BISH, F, MO, P, US). Figure 1.

Haec species *Chamaesyce sparsiflorae* (A. Heller) Koutnik affinis, sed ab ea folii petiolo breviora 0.5–1.5 mm longa, lamina elliptica, late obovato-elliptica vel subcirculari, (5–)10–20 mm longa, basi subcordata vel raro truncata vel rotundata, etiam cyathii glandibus appendices candidas 0.7–1.5 × 1.5–2.6 mm ferentibus differt.

Small shrubs (12–)20–40 cm tall, glabrous, densely branched, the branches erect-ascending, brittle, the basal stems with dark gray, longitudinally fissured bark, the leafy branches 0.6–1 mm diam., longitudinally furrowed, green or red-tinted, the internodes 6–30 mm long; stipules broadly triangular or obtuse and rounded, 0.5–1 × 1–2 mm, externally glabrous, internally villosulous, occasionally bifid, the margin brown, erose, with scattered dark colleters; leaves decussate or the pairs sometimes spirally arranged, short-petiolate or sessile, the petioles 0.5–1.5 × 0.5 mm, glabrous, the blades elliptic, broadly elliptic, broadly ovate-elliptic, broadly ovate, or rarely suborbicular, (5–)10–20 × (4–)6–14 mm, glabrous, drying dull, pale green, slightly discolorous, adaxially faintly white-punctate, often with reddish tint marginally, abax-

ially grayish green, subcoriaceous or coriaceous, the base subcordate, less commonly truncate or rounded, the apex rounded or retuse, often mucronulate, the lateral veins 5–7 pairs, with 3–4 pairs arising subpalmately from the base, the venation obscure or secondary (rarely tertiary) veins visible on both surfaces, the margin entire, usually slightly involute. Cyathia solitary and terminal at branch tips, the peduncles 1–1.5 mm long, glabrous, the involucre campanulate, 2–3 mm long, 2–2.5 mm diam., internally densely villous, externally glabrous, green or dark purple, the glands (4–)5, glabrous, purple, each with a broadly obovate to subcircular, obtuse, petaloid white appendage 0.7–1.5 mm long, 1.5–2.6 mm wide, entire or irregularly sinuate or lacerate; ovary initially erect, glabrous or rarely tomentellous, styles bifid for 1/3 of their length, dark purple, thickened; stamens 0.6–0.7 mm long, the anthers dark purple, bilobed; capsule 3-angled, 2.5–2.8 mm long, 2.3–3 mm diam., broadly ovoid, glabrous, green with margins and apex purple-red, recurved on a glabrous gynophore to 2 mm long, the styles 0.5–0.7 mm long; seeds 2.2–2.3 mm long, 1.3–1.5 mm diam., testa brownish white, smooth.

**Distribution, habitat, and ecology.** Known only from the Na Pali coast of northern Kaua'i, Hawaiian Islands, *Chamaesyce eleanoriae* ranges in elevation from 270 to 1100 m. The new species occurs most commonly on north-facing, steep, narrow ridge crests and outcrops, less commonly on steep rocky slopes and the upper portions of basalt cliffs. It is generally restricted to windswept areas where it occurs in small populations of 50 or more plants in relictual native lowland or montane diverse mesic forest and shrubland. Dominant tree species include *Metrosideros polymorpha* Gaudichaud-Beaupré, *Acacia koa* A. Gray, and *Diospyros sandwicensis* (A. DC.) Fosberg, associated with herbaceous taxa including *Eragrostis* spp., *Poa mannii* W.



Figure 1. *Chamaesyce eleanoriae* Lorence & W. L. Wagner. —a. Habit. —b. Detail of cyathium with capsule and white petaloid appendages on the glands. —c. Detail of leaf. Scale: bar equals 1 cm. (Based on Wood *et al.* 1763.)

Munro ex Hillebrand, *Stenogyne campanulata* S. Weller & A. Sakai, and shrubby taxa including *Coprosma* sp., *Dubautia* sp., *Lepidium serra* H. Mann, *Lobelia niihauensis* H. St. John, *Lysimachia glutinosa* Rock, *Nototrichium divaricatum* Lorence, *Hibiscus kokio* Hillebrand ex Wawra subsp. *saintjohnianus* (M. J. Roe) D. M. Bates, *Styphelia tameiameiae* (Chamisso & Schlechtendal) F. v. Mueller, *Chamaesyce celastroides* (Boissier) Croizat & O. Degener var. *hanapepensis* (Sherff) O. Degener & I. Degener, *Bidens sandvicensis* Lessing subsp. *sandvicensis*, *Hedyotis* sp. nov., and *Vaccinium* spp. (K. R. Wood, pers. obs., 1995).

The major threats to *Chamaesyce eleanoriae* are browsing and the resulting erosion, habitat degradation, and landslides provoked by the large feral goat populations in Kalalau Valley and adjacent areas on the Na Pali coast. In addition, invasion by alien plant species, primarily *Erigeron karvinskianus* DC., *Kalanchoe pinnata* (Lamarck) Persoon, and *Lantana camara* L., also threatens this species.

**Affinities.** The endemic Hawaiian species of *Chamaesyce* are members of section *Sclerophyllae* (Boissier) Hurusawa (Webster, 1967; Koutnik, 1987), a pantropical group of about 30 insular or maritime species. This section is characterized by subshrubby or woody habit, articulate stems, subcoriaceous entire to occasionally serrate leaves, and glandular cyathial appendages that are reduced or absent (Webster, 1967; Lin et al., 1991). All but the Hawaiian species have been placed in subsection *Sclerophyllae*, which comprises about 16 distichous-leaved species, usually with glandular cyathial appendages. The Hawaiian species have been segregated in the endemic subsection *Gymnadeniae* (Boissier) Koutnik, based primarily on the absence of glandular cyathial appendages (Boissier, 1862; Koutnik, 1987). Koutnik stated that there is little to consistently separate these two subsections, and that detailed revision of the entire section is needed. Despite this, Koutnik made the combination bringing this subsection into the genus *Chamaesyce* from *Euphorbia* L. He noted that glandular appendages occasionally occur in several Hawaiian species, including *C. atrococca* (A. Heller) Croizat & O. Degener, *C. sparsiflora*, and *C. herbstii* W. L. Wagner, thus blurring the distinction between the subsections (Koutnik, 1987). To complicate the situation, study of collections at BISH, PTBG, and US of the Pacific island *C. atoto* (G. Forster) Croizat complex, a member of subsection *Sclerophyllae* and likely to be the closest sister species to the Hawaiian lineage, has shown that the occurrence of cyathial appendages is also variable in this group. The presence of appendages may vary in popula-

tions of the same species from different islands within an archipelago or even the same island (e.g., on Viti Levu, Fiji). Moreover, a new, as-yet-unpublished species from the Marquesas Islands related to *C. atoto* does not have appendages at all (J. Florence, pers. comm., 1994). Although this character is nearly fixed within the Hawaiian lineage (except in *C. eleanoriae* and the occurrences reported by Koutnik, 1987), we think it is too variable to use as the primary basis for division of section *Sclerophyllae* into two subsections. We therefore recognize all Pacific island species as members of one section without further subdivision. This is a more natural classification because segregation of the Hawaiian species obscures their relationship to *C. atoto* and creates a paraphyletic group, subsection *Sclerophyllae*.

Because of its large, petaloid white cyathial appendages *Chamaesyce eleanoriae* is distinct from all other Hawaiian *Chamaesyce*. It closely resembles *C. sparsiflora* and somewhat resembles *C. atrococca* in having dull, decussate leaves or the pairs occasionally spirally arranged, and inflorescences with cyathia solitary or in cymes of 1–3. Using the key of Koutnik and Huft (1990), *C. eleanoriae* keys out to *C. sparsiflora* by merit of its small leaves and low, shrubby habit. However, *C. sparsiflora* is a narrowly endemic bog species restricted to the Wahiawa Drainage on southern Kaua'i that differs by its shortly petiolate leaves with a narrower, elliptic to obovate, oblanceolate or rarely spatulate lamina and purple cyathial glands usually without appendages. *Chamaesyce atrococca* differs conspicuously in being a small tree 1–3 m tall with larger elliptic, oblanceolate, or obovate petiolate leaves, more highly branched inflorescences with (1–)3–9 cyathia, green to purple cyathial glands usually without appendages, and frequently tomentellous capsules. This latter species is widespread in western Kaua'i, where it occurs in mesic forests dominated by *Acacia koa* and *Metrosideros polymorpha*. Although *C. atrococca* is usually restricted to mesic forests, at one Kalalau Valley site it was observed growing sympatrically with *C. eleanoriae* in cliff vegetation (K. Wood, pers. comm., 1995). *Chamaesyce eleanoriae* commonly grows sympatrically with *C. celastroides* (Boissier) Croizat & O. Degener var. *hanapepensis* (Sherff) O. Degener & I. Degener, a dominant component of cliff vegetation in Kalalau Valley (K. Wood, pers. comm., 1995).

All material seen of *Chamaesyce eleanoriae* has the relatively conspicuous white cyathial appendages representing retention of a plesiomorphic character within the Hawaiian species based on outgroup comparisons to other sections of the genus

and to *C. atoto*. Its decussate leaves (or the pairs sometimes spirally arranged), however, appear to represent a derived character shared with several other Hawaiian species. Wagner (1988) pointed out that there are several lines of diversification within the Hawaiian lineage. One of the more distinctive is the decussate-leaved group, which according to Koutnik (1987) includes *C. atrococca*, *C. halemanui* (Sherff) Croizat & O. Degener, *C. remyi* (A. Gray ex Boissier) Croizat & O. Degener, and *C. sparsiflora*. Wagner (1988), in his evaluation of what had been commonly known as the *C. clusiifolia* complex for three O'ahu species, pointed out that *C. clusiifolia* (Hooker & Arnott) Arthur can have the leaf pairs decussate or spirally arranged. The leaf arrangement is apparently more variable than stated by Wagner in that it can also be distichous, as shown by Koutnik (1987). Thus, it is equivocal if *C. clusiifolia* is also a member of this group or has acquired this phyllotaxy independently. Based on recent study of cultivated plants at the National Tropical Botanical Garden (from *Perlman 14087*, PTBG), this also appears to be the case for *C. kuwaleana* (O. Degener & Sherff) O. Degener & I. Degener, also from O'ahu (D. Lorence, pers. obs., 1995). The discovery of *C. eleanoriae* possibly adds one more species to the decussate-leaved group. Determination whether this group represents a monophyletic lineage, and if so resolution of the relationships among the species within it, awaits further studies. Based on present information, *C. eleanoriae* appears to be most closely related to the Wahiawa Bog endemic, *C. sparsiflora*.

**Etymology.** We are pleased to name this new species for NTBG trustee Eleanor Crum, steadfast supporter of our research program, dedicated volunteer, and plant enthusiast.

**Paratypes.** HAWAIIAN ISLANDS (U.S.A.). **Kaua'i:** Hanalei District, Kalalau [Valley] rim, N of Kahuama'a Flat, steep diverse lowland mesic forest, in cliff area collected with ropes, 990–1020 m, 3 Mar. 1991, *Wood et al.*

635 (AD, PTBG), 800 m, 4 July 1991, *Wood & Query 1019* (PTBG); Kalalau Rim, N–S running ridge below and E of first Kalalau lookout, 960–1100 m, 18 Sep. 1991, *Wood 1244* (PTBG, US); Kalalau Rim, NE below Pu'u-o-Kila, and down to Peach Tree Ridge, 1100–1200 m, 9 May 1991, *Wood et al. 795* (PTBG), 3000–2800 ft. (914–853 m), 5 Oct. 1994, *Wood & Perlman 3613* (BISH, MO, NY, PTBG); Kalalau Valley, below Alealau, on cliffs, 3100 ft. (945 m), 17 Feb. 1993, *Perlman & Wood 13348* (BISH, F, K, P, PTBG, US), 790–900 m, 17 Feb. 1993, *Wood & Perlman 2392* (HAST, PTBG, UC, US); Na Pali Kona Forest Reserve, steep, rocky slopes below S rim of Kalalau Valley, N of Kahuama'a Flat and Highway 550, narrow rocky ridge, 900 m, 6 Mar. 1991, *Lorence et al. 6717* (PTBG); Kalalau Valley, below Puu-o-kila lookout, 3400 ft. (1036 m), 23 Sep. 1989, *Montgomery s.n.* (BISH); ridge between Kalalau and Honopu valleys, 2000 ft. (607 m), 11 July 1985, *Montgomery s.n.* (BISH); Pohakuao [Valley], diverse lowland mesic forest, 270 m, 8 June 1990, *Wood & Perlman 364* (BISH, PTBG, US).

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