

## Resurrection of a Kaua'i *Stenogyne*: *S. kealiae*<sup>1</sup>

WARREN L. WAGNER<sup>2</sup> AND STEPHEN G. WELLER<sup>3</sup>

**ABSTRACT:** Recent discovery of a population of plants referable to *Stenogyne kealiae*, which was treated as a synonym of the widespread Kaua'i species, *S. purpurea*, has provided new information that shows that it is a distinct species. It differs from *S. purpurea* primarily by its coriaceous leaves that are weakly revolute near the margins, with the margins subentire to weakly serrate or crenate-serrate in the upper half, sometimes nearly to the base, and the lower surface glabrous. This distinctive morphology coupled with sympatric occurrence of *S. kealiae* and *S. purpurea* without evidence of hybridization indicate their distinction as separate species and that extrinsic or intrinsic barriers seem to prevent hybridization between them.

RECENT FIELD STUDIES BY Tim Flynn on Kaua'i have drawn our attention to a problem in the treatment of *Stenogyne* in the *Manual of the Flowering Plants of Hawai'i* (Weller and Sakai in Wagner et al. 1990). Specifically, *S. kealiae* was believed, based on the study of limited herbarium materials, to be a form of the widespread and relatively common Kaua'i species, *S. purpurea*. Flynn's discovery of a population of this entity, recently called to our attention, has provided ample material to show that it is indeed a distinctive species. Part of the reason that this species was subsumed under *S. purpurea* was the misleading discriminator given by Sherff (1935), based partly on leaf margin being serrate versus

subentire, a feature that is not as absolute as Sherff seemed to indicate. The other was the belief that the more coriaceous leaves in specimens referred to *S. kealiae* were, at least in part, ecologically induced. Flynn's studies and subsequent study of sympatric populations of *S. purpurea* and *S. kealiae* at one site by Weller clearly have shown that the differences between the species are maintained in the same environments. Moreover, no intermediates between these species were detected, indicating that intrinsic or extrinsic barriers prevent hybridization between *S. kealiae* and *S. purpurea*. The two species are contrasted in the following key and treatment.

### SYSTEMATIC TREATMENT

- 1. Leaves coriaceous, the margin weakly revolute, subentire to weakly serrate or crenate-serrate in the upper half, sometimes nearly to the base, lower surface glabrous; younger stems glabrous ..... ***S. kealiae***
- 1'. Leaves membranous, the margin flat, conspicuously serrate or crenate-serrate, lower surface usually at least sparsely appressed puberulent; younger stems appressed puberulent ..... ***S. purpurea***

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<sup>2</sup> Botany Department, National Museum of Natural History, Smithsonian Institution, NHB-166, Washington, D.C. 20560.

<sup>3</sup> Department of Ecology and Evolutionary Biology, University of California, Irvine, California 92717.

***Stenogyne kealiae*** Wawra, *Flora* 55: 556. 1872. *Stenogyne purpurea* H. Mann. var. *kealiae* (Wawra) Hillebr., *Fl. Hawaiian Isl.* 357. 1888. TYPE: "Hawaische Inseln. Kauai" [U.S.A., Hawaiian Islands, Kaua'i, in mountain forests of Pohakupili near

Kealia, NE Kaua'i, 1868–1871.] *H. Wawra* 2042 (w 2 sheets, holotype); seen by Sherff, Bernice P. Bishop Mus. Bull. 136:75. 1935, and by F. R. Fosberg for us in May 1990 (pers. comm.). St. John, during his studies of the genus, annotated one of the sheets as the holotype, the other as an isotype. We see no reason for this designation. Wawra's material was apparently ample enough ultimately to have been mounted on two sheets.

Trailing or scandent stiff vines; stems weakly 4-angled, glabrous. Leaves thinly to moderately coriaceous, broadly lanceolate to elliptic-lanceolate, 8–15 cm long, 2.5–4.5 cm wide, glabrous, margin weakly revolute, subentire to weakly serrate or crenate-serrate in the upper half, sometimes nearly to the base, apex acuminate, base acute, rounded, truncate, or weakly subcordate, petioles 12–35 mm long, glabrous. Flowers 3–5 per verticillaster, pedicels 4–5 mm long, moderately puberulent, sometimes sparsely so; calyx nearly radially symmetrical, narrowly campanulate, 9–12 mm long at anthesis, sparsely puberulent or subglabrous, sparsely puberulent within on the teeth, the teeth lanceolate, 2–4 mm long, 1.5–2.5 mm wide near base; corolla tube and lobes deep pinkish purple, base whitish, strigose externally, glandular pubescent within, tube straight, ca. 15–17 mm long, upper lip 8–9 mm long, lower lip 4–5 mm long. Nutlets very dark purple at maturity, ca. 7–8 mm long.

**DISTRIBUTION.** Rare in wet forest, Koke'e State Park, Waimea District, Kaua'i, from Awa'awapuhi to Kalalau valleys, ca. 1090–1250 m.

**SPECIMENS EXAMINED.** Kaua'i: Waimea District: Awa'awapuhi Trail, Koke'e [State Park], 1095 m, *Stone* 3342 (BISH), *Stone* 3347 (BISH); Awa'awapuhi Trail, Koke'e [State Park], Honopu, 1250 m, 29 December 1956, *Pearsall* s. n. (BISH); Awa'awapuhi Trail, Koke'e State Park, ca. 30 m down trail from #20, left-hand side, April 1982, *Flynn* 177 (PTBG 2 sheets); Koke'e State Park, Hwy. 550 near mile 18.3, Kalalau Valley, 1190 m, November 1985, *Flynn* 1354 (PTBG); "Hawaische Inseln,"

*Wawra* 2258 (w) [incorrectly annotated by St. John as holotype].

***Stenogyne purpurea*** H. Mann, Proc. Am. Acad. Arts 7:193. 1868. TYPE: U.S.A., Hawaiian Islands, Kaua'i, in mountains above Waimea, 2000–3000 ft, *H. Mann & W. T. Brigham* 552 (CU, holotype; BISH 2 sheets!, F 2 sheets, G-DEL, GH, MO, NY, US, isotypes).

*Stenogyne purpurea* var. *brevipedunculata* Wawra, Flora 55:555. 1872; Flora 58:286. 1875. TYPE: "Hawaische Inseln. Kauai" [Hawaiian Islands, Kaua'i, Halemanu, 1868–1871.] *H. Wawra* 2070 [corrected to 2076 by Wawra, Flora 58:286. 1875] (w 2 sheets, holotype); often cited as "*pedunculata*." Wawra's correction of his collection number was noted by Sherff (Bernice P. Bishop Mus. Bull. 136:72. 1935) and verified for us in May 1990 by F. R. Fosberg. *Wawra* 2070 is the type of *Cyrtandra paludosa* Gaud. var. *herbacea* Wawra (= *C. oenobarba* H. Mann).

*Stenogyne purpurea* H. Mann var. *forbesii* Sherff, Am. J. Bot. 21:701. 1934. *Stenogyne forbesii* (Sherff) St. John, Phytologia 63:162. 1987. TYPE: U.S.A., Hawaiian Islands, Kaua'i [specific locality unknown], 1909, *Brodie* s. n. (BISH 510657!, holotype). The specimen in BISH annotated by Sherff as the type has no label information. The only label is one of J. F. Rock's blank labels.

*Stenogyne purpurea* H. Mann var. *leptophylla* Sherff, Bot. Gaz. (Crawfordsville) 96:142. 1934. *Stenogyne leptophylla* (Sherff) St. John, Phytologia 63:164. 1987. TYPE: U.S.A., Hawaiian Islands, Kaua'i, higher plateau, Keaku Stream, 21 October 1911, *J. F. Rock* 8863 (GH, holotype, BISH 5 sheets!, isotypes).

*Stenogyne kealiae* Wawra var. *angustata* Degener & Sherff in Sherff, Am. J. Bot. 38:61. 1951. TYPE: U.S.A., Hawaiian Islands, Kaua'i, northwesternmost Kaua'i, NE of Kalalau Lookout, in forest, 1220 m, 31 January 1950, *O. Degener & W. H. Hatheway* 20430 (F, holotype, photo BISH 2 sheets!; BISH!, isotype).

*Stenogyne alakaiensis* St. John, *Phytologia* 63:159. 1987 TYPE: U.S.A., Hawaiian Islands, Kaua'i, Hanalei Dist., Alaka'i Swamp, adjacent to Wainiha Valley, 22°7' N, 159°34' W, trailing on ground adjacent to bog association, *Pelea*, *Cyrtandra*, *Scaevola kauaiensis*, *Pittosporum gayanum*, *Ilex anomala*, *Myrsine*, *Metrosideros polymorpha*, etc., 26 November 1978, *Gustafson 1061* (BISH 522999!, holotype). St. John annotated this sheet as an isotype, apparently in error.

*Stenogyne leptophylla* (Sherff) St. John var. *retrorsa* St. John, *Phytologia* 63:164. 1987. TYPE: U.S.A., Hawaiian Islands, Kaua'i, central plateau, back of Kaholuamanu, 4200 ft, trailing on the ground, September 1909, *J. F. Rock 5744* (BISH 54158!, holotype; BISH!, US!, isotypes).

*Stenogyne linearis* St. John, *Phytologia* 63:165. 1987. TYPE: U.S.A., Hawaiian Islands, Kaua'i, top of hill behind Koke'e Museum, 10- to 15-m *Acacia* stand, canopy and shrub layers open, from a large spreading colony growing over bare forest litter, 15 August 1983, *W. Takeuchi 2100* (BISH 513071!, holotype).

Trailing or scandent vines, occasionally forming large mats; stems weakly 4-angled, younger stems appressed puberulent, soon glabrate. Leaves membranous, lanceolate, elliptic-lanceolate or sometimes ovate, 3.5–13 cm long, 1.2–4.9 cm wide, upper surface glabrous or sparsely puberulent, especially along the midrib, lower surface sparsely to moderately appressed puberulent, sometimes subglabrous, margins serrate to serrulate, apex acuminate, acute or attenuate, base truncate-rounded or sometimes broadly cuneate, petioles (4–)7–19 mm long, puberulent. Flowers (1–)2–6(–16) per verticillaster, pedicels 4–5 mm long, puberulent; calyx nearly radially symmetrical, narrowly campanulate, 7–12(–15) mm long at anthesis, puberulent, the teeth lanceolate, 2–5.5 mm long, 1.5–2.5 mm wide at base; corolla tube and lobes pinkish purple or rarely white externally, throat whitish, strigose externally, glandular pubescent within, tube straight, 15–25 mm long, upper lip 8–9 mm long, lower lip 4–5 mm long. Nutlets dark purple at matu-

rity, 7–11 mm long;  $2n = 64$ . One individual collected by T. Flynn from the Pihea Trail is self-compatible in cultivation.

DISTRIBUTION. Occurring in diverse mesic forest to wet forest and bog margins, 600–1300 m, Kaua'i, from the Koke'e area, including Halemanu north and west to the western half of the Alaka'i Swamp in Waimea District and from two collections from Namolokama Mountain, Hanalei District and two collections from the Wahiawa Mountains, Koloa District.

REPRESENTATIVE SPECIMENS EXAMINED. Kaua'i: Hanalei District: Halelea Forest Reserve, summit of Namolokama Mountain, *Flynn & Lorence 3029* (PTBG), *Lorence et al. 6035* (PTBG). Koloa District: Wahiawa Mountains, *Forbes 191.K* (BISH); windswept knife-edge behind TV relay station, Kahili Ridge Trail, *Fay 178* (PTBG). Waimea District: Koke'e Waimeke Swamp, *Degener 5461* (BISH); E rim of Kalalau Valley, *Degener 21475* (BISH, US 2 sheets), *Degener & Cadenheads 27163* (BISH, US); Halemanu, stream near brink of Waimea Canyon, *Degener & Greenwell 21540* (BISH); Koke'e region, Kapiwai Stream, *Degener & Greenwell 21584* (BISH); along Koke'e Stream, *Degener 21476* (BISH, US); Kohua Ridge, *Degener et al. 23907* (BISH, US 3 sheets); Koke'e, Kumuwela Road, *Flynn 648* (BISH, PTBG); Koke'e, Pihea Trail, *Flynn 354* (PTBG); Waimea drainage basin, W side, Koke'e, *Forbes 821.K* (BISH); Waimea drainage basin, W. side, Koke'e, *Forbes 859.K* (BISH, US); Waimea drainage basin, W side, Nualolo Trail, *Forbes 866.K* (BISH); Kumuwela Ridge and into Waimea Canyon, Waimea drainage basin, west side, *Forbes 975.K* (BISH); NW side of Kumuwela Ridge above Koke'e, *Fosberg 12641* (BISH 2 sheets, US); Koke'e State Park, at end of Kalalau-Kaena Road, *Herbst 1042* (BISH); Kaholuamano, *Hitchcock 15396* (US), *Hitchcock 15434* (BISH, US), *Lydgate s. n.* (BISH); Kauluweli Swamp near Kaholuamano, *Hitchcock 15521* (US); Pu'u O Kila Lookout, S rim of Kalalau Valley, *Lorence et al. 5756* (PTBG); trail to Kilohana Lookout, Alaka'i Swamp, *Lorence et al. 5697* (PTBG); Halemanu, *Rock 2101* (BISH); Waimea, Koke'e, Na Pali-Kona Forest Reserve, *St. John et al.*

10686 (BISH, US); Waimea, between Koke'e and Kilohana, *Skottsberg 928* (BISH), *Skottsberg 929* (BISH); vicinity of Koke'e Museum, *Takeuchi Nualolo-4c* (BISH); Kumu[w]jeia, ridge trail, above Koke'e, *Yunker 3496* (US); Alaka'i Swamp, Kalaaupapaaola, *Chock et al. 1176* (PTBG), *Chock et al. 1179* (BISH); Alaka'i Swamp, Kilohana, *Cranwell & Skottsberg 2947* (BISH); Alaka'i Swamp, near Lehua Maka Noe, *Fosberg 12754* (BISH); Alaka'i Swamp, S of Wainiha Pali, *Higashino & Crivellone 9658* (BISH); Alaka'i Swamp, ridge trail past Koaie Stream, *Davis & Kores 154* (BISH); Alaka'i Swamp, Pihea Trail, from Pihea Lookout S along W edge of swamp, *Lorence et al. 5161* (BISH, PTBG); Alaka'i Swamp, Mohihi-Waiialae Trail, *van Royen et al. 11695* (BISH); Alaka'i Swamp, NW end, *St. John et al. 10739* (BISH); Alaka'i Swamp, ridge SW of Pihea, *St. John et al. 22925* (BISH); Alaka'i Swamp, along Pihea Trail, from the section between Pihea and Lehua Maka Noe, *Takeuchi & Paguin Alakai-23b* (BISH); Alaka'i Swamp, section where Pihea Trail turns away from Kalalau Valley, *Takeuchi Alakai-156b* (BISH); Alaka'i Swamp, where the crescent series of bogs diverges from the Swamp Trail, *Takeuchi Alakai-87* (BISH); Alaka'i Swamp, Kohua Ridge Trail, *Warshauer & McEldowney 3358* (BISH); Alaka'i Swamp, [without specific locality], *Degener & Greenwell 21654* (BISH), *Forbes 898.K* (BISH), *Herbst 2174* (BISH, PTBG), *Higashino & Crivellone 9680* (BISH); [without specific locality], *Hillebrand s. n.* (BISH); mountains [without specific locality], *U.S. Expl. Exped. s.n.* (US).

#### DISCUSSION

The occurrence of *Stenogyne kealiae* and *S. purpurea* within a few meters of one another represents the third instance of sympatry detected for *Stenogyne*. The absence of hybrids between the species may result from differences in flowering time: individuals of *S. kealiae* were in young fruit when collected in mid-March 1990 by Weller, whereas *S. purpurea* was vegetative. All species of *Stenogyne* that have been tested (six, including *S. purpurea*) are self-compatible (Weller and Sakai 1990), but fail to set fruit in the greenhouse

unless hand-pollinated. Under field conditions it seems likely that pollinators are required for successful reproduction. This could lead to interspecific hybridization for sympatric species with overlapping flowering periods. Differences in floral morphology between *S. kealiae* and *S. purpurea* are minimal, and it is difficult to imagine that pollinator discrimination would lead to isolation for these species.

By contrast, similar floral morphology and overlapping flowering periods seem to have promoted hybridization between *S. rugosa* and *S. microphylla*, which occur sympatrically at Halepohaku on Mauna Kea, Hawai'i Island. In that area, apparent hybrids, backcrosses, and F<sub>2</sub> hybrids outnumber typical representatives of the parental species (Weller and Sakai 1990).

The third case of sympatry represents yet another pattern. *Stenogyne macrantha* and *S. scrophularioides* occur together at the Ola'a tract, Puna District, Hawai'i Island, and flower at the same time without any evidence of hybridization. Hybridization between these two species may be prevented by the significant floral differences between them: *S. scrophularioides* has corollas 8–19(–24) mm long with a straight tube, while *S. macrantha* has corollas 12–28 mm long with a strongly falcate tube. These important floral differences may result in the attraction of different pollinators or prevent transfer of pollen between the stigmas if the same pollinator visits both species.

In summary, then, it seems that in *Stenogyne* a variety of mechanisms may prevent hybridization, including allopatry, temporal differences in flowering, and differences in floral morphology. It would be of interest to check for the presence of intrinsic mechanisms preventing the formation of hybrids among sympatric species that remain distinct under field conditions.

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