Adenophorus ×*carsonii* hyb. nov. (Grammitidaceae): A New Endemic Hybrid from the Island of Hawaii

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ABSTRACT. A new hybrid between two species of the endemic Hawaiian genus *Adenophorus* is described. On morphological grounds it appears to be a hybrid between *A. hymenophylloides* and *A. tripinnatifidus*. That hypothesis is supported by preliminary isozyme data, which also demonstrate that different individuals were produced by separate hybridization events. The irregular size and shape of spores and lack of complete pairing of meiotic chromosomes indicate that the hybrid is infertile.

Adenophorus Gaudich. is an endemic Hawaiian genus comprising two subgenera, *Adenophorus* (6 species) and *Oligadenus* L. E. Bishop (4 species; Bishop, 1974). Most members of the genus are widespread on the main Hawaiian Islands, although *A. haalilioanus* (Brack.) K. A. Wilson is restricted to Kauai and Oahu, and *A. oahuensis* (Copel.) L. E. Bishop only occurs on Oahu. *Adenophorus periens* L. E. Bishop is known only from a few locations on Kauai, Hawaii, and Molokai. Most species are obligate epiphytes occurring in habitats ranging from montane mesic to wet forests. Although Bishop (1974) described a hybrid between *A. oahuensis* and *A. pinnatifidus* Gaudich., both in subgenus *Oligadenus*, the hybrid I present here is the first report of a naturally occurring hybrid between two species in subgenus *Adenophorus*.

Adenophorus ×carsonii Ranker, hyb. nov.

TYPE: U.S.A. Hawaii: Island of Hawaii, Puna District, Kahaualea Natural Area Reserve, 5.6 km S of Hwy. 11 at end of South Glenwood Rd., 700 m, 6 June 1990, *Ranker 1115* (holotype, BM; isotype, COLO). Figure 1.

Rhizomata breviter reptantia; paleae elongato-lanceolatae; folia 12–35 cm longa, pendula sed juvenilia erecta; lamina bipinnatifida; pinnae 5–15 cm longae; pinnulae basales et acroscopicae simplices vel pinnatifidae; sporae abortivae; planta inter *A. hymenophylloides* et *A. tripinnatifidus* intermedia.

Plants epiphytic; rhizome short-creeping, 2–4 mm diam.; rhizome scales 3–4 mm long, 0.3–0.5 mm wide, amber-colored, long-lanceolate, rounded to auriculate at base, subulate to slightly rounded at tip often bearing a glandular apical cell, occasionally branched near tip with an additional glandular cell at apex of branch; cells of rhizome scales rhomboid to fusiform, several to many times longer than wide; leaves mostly 12–25 cm long, occasionally up to 35 cm, 1.5–2.0 cm wide, erect when young but soon becoming pendulous as they mature, appearing tufted; stipe 0.3–0.5 mm diam., 1.0–2.0 cm long, slightly alate when young but not apparent on older stipes, sparsely to densely clothed with appressed glandular trichomes; blades bipinnatifid, linear, with appressed, glandular trichomes on both surfaces and rachis, tip long-tapering or abrupt; pinnae 5–15 mm long with 6–10 pinnules; pinnules mostly simple, spathulate, apex slightly rounded to acute, basal pinnules 2.0–7.0 mm long, 0.8–1.0 mm wide, becoming smaller toward tip of pinna, basal acroscopic pinnule often divided again; mature sori abaxial, about 1.0 mm diam., equaling the width of the fertile pinnule; sporangia with 12–15 annular cells; spores irregular and aborted.

Plants discovered to date only grow epiphytically on bryophyte-covered trunks of *Metrosideros polymorpha* Gaudich. (Myrtaceae) in forests dominated by a mixture of that species and the tree fern *Cibotium glaucum* (Smith) Hook. & Arn.

The epithet is in honor of Hampton L. Carson, University of Hawaii, who first recommended that I visit the Kahaualea Natural Area Reserve where the hybrid was first discovered.

Paratypes. U.S.A. HAWAII: Island of Hawaii, Puna District, same as *Ranker 1115* but collected on 27 May 1991, *Ranker 1202* (MICH, PTBG, US); forest NW of Volcano refuse transfer site and SE of Olaa tract of HVNP, 870–900 m, *Ranker (1315) & Trapp* (COLO).

The possible hybrid nature of *A.* ×*carsonii* was suggested on morphological grounds because of its similarity to both *A. hymenophylloides* and *A. tripinnatifidus*, its putative parents. *Adenophorus* ×*carsonii* differs from these two species in several morphological features and is usually approximately intermediate between them (Table 1, Fig. 1). The hybrid is most easily confused at first sight with *A.*

Figure 1. A–C. *Adenophorus* ×*carsonii* Ranker. —A. Entire plant. —B. Detail of abaxial surface of pinna. —C. Detail of abaxial surface of pinnule. —D. Abaxial surface of pinna of *A. hymenophylloides*. —E. Abaxial surface of pinna of *A. tripinnatifidus*.

hymenophylloides because of the pendulous habit of the leaves of both species. The broader and longer leaf blade, larger pinnae, and irregularly shaped spores of the hybrid (Table 1), however, readily allow for its distinction.

Material for chromosomal analyses was collected from the type locality. Meiotic behavior of chromosomes was observed following the methods of Haufler et al. (1985). An exact meiotic chromosome count could not be obtained because of the limited

TABLE 1. Comparison of *Adenophorus* ×*carsonii* with its putative parents, *A. hymenophylloides* and *A. tripinnatifidus*.

Character	*A. hymenophylloides*	*A.* ×*carsonii*	*A. tripinnatifidus*
Rhizome	Short	Short-creeping	Long-creeping
Rhizome scales	Sublinear	Long-lanceolate	Narrowly deltoid
Leaf length (cm)	2–15	12–35	8–50
Leaf habit	Pendulous	Erect when young, becoming pendulous	Erect, arching
Leaf blade	Sub- to deeply bipinnatifid	Bipinnatifid	Bi- to tripinnatifid
Pinnae length (mm)	2–10	5–15	10–60
Basal, acroscopic pinnule	Simple	Simple to bifid	Simple to pinnatifid, with up to 10 lobes

amount of material available and due to irregular pairing at diakinesis. Several of the chromosomes appeared to be univalents, and the total number of meiotic figures was greater than would be expected in a normally pairing diploid in this genus (i.e., 37 pairs) and fewer than would be expected in a triploid or higher polyploid. *Adenophorus* ×*carsonii* therefore appears to be an infertile diploid.

Preliminary isozyme data (following Ranker et al., 1989) were obtained from the limited amount of material collected (i.e., four individuals; Ranker, unpublished data). At 10 of the 14 loci scored, the two parental taxa and their putative hybrid were invariant for the same allele. At the remaining loci, hybrid individuals were heterozygous and shared alleles with at least one parent. At the latter group of loci, however, parental taxa were highly variable (Ranker, 1992), and alleles present in the hybrid were not always detected in the individual parental plants examined. A more detailed analysis is necessary, therefore, to attempt to sample more of the allelic variability present in the potential parental taxa. Each of the four hybrids sampled possessed a unique genotype at each of several loci, indicating that separate hybridization events were responsible for the origin of each plant.

Acknowledgments. I thank Hampton Carson, Bill Mull, and Genie Trapp for accompanying me in the field, Chrissen Gemmill, Ann Hambleton, and Kieu Tran for laboratory assistance, William A. Weber for assistance with the manuscript, and Karolyn Darrow for providing the illustrations. This work was supported by the National Science Foundation (BSR-9096282), the University of Colorado, and the University of Hawaii. Permission to collect specimens was generously granted by the Natural Area Reserves System Commission, State of Hawaii.

Literature Cited

Bishop, L. E. 1974. Revision of the genus *Adenophorus* (Grammitidaceae). Brittonia 26: 217–240.

Haufler, C. H., M. D. Windham, D. M. Britton & S. J. Robinson. 1985. Triploidy and its evolutionary significance in *Cystopteris protrusa*. Canad. J. Bot. 63: 1855–1863.

Ranker, T. A. 1992. Genetic diversity of endemic Hawaiian epiphytic ferns: Implications for conservation. Selbyana. 13: (in press).

———, C. H. Haufler, P. S. Soltis & D. E. Soltis. 1989. Genetic evidence for allopolyploidy in the neotropical fern *Hemionitis pinnatifida* (Adiantaceae) and the reconstruction of an ancestral genome. Syst. Bot. 14: 439–447.