GENETIC RELATIONSHIPS BETWEEN BIDENS FORBESII AND SIX SPECIES IN THE HAWAIIAN AND THE MARQUESAS ISLANDS

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Gillett, G. W. (Department of Biology, University of California, Riverside, California). Genetic relationships between *Bidens forbesii* and six species in the Hawaiian and the Marquesas Islands. Brittonia **25**: 10–14. 1973.—A crossing program was carried out between the Kauai endemic *B. forbesii* and six other Polynesian species, five of which are Hawaiian and one Marquesan. All crosses produced vigorous F_1 hybrids, portraying a strong genetic relationship between *B. forbesii* and the other species. The results indicate a close systematic relationship among the Polynesian species of *Bidens* placed by Sherff in sect. *Campylotheca* and strengthen the argument that this group dispersed from North America to the Hawaiian Islands, then from Hawaii to the Marquesas Islands.

INTRODUCTION

Few Hawaiian genera present more difficulties to the taxonomist than does *Bidens*. The more than 40 described species of *Bidens* in Hawaii by no means portray a full account of the diversity in the genus, for there are many cases of natural hybridization (Sherff, 1937; Gillett & Lim, 1970). The evidence of widespread natural hybridization has been supported by experimental hybridizations that indicate weak to nonexistent genetic barriers between species (Gillett & Lim, 1970). Those experiments produced some 23 different interspecific hybrids, and later work has increased this figure to 41. Six of these recently secured experimental hybrids have involved the Kauai endemic *B. forbesii* Sherff. In the earlier research, attempts to cross this species with 10 other Hawaiian taxa produced only one F_1 hybrid, this between *B. forbesii* and a putative natural hybrid (*B. forbesii* × *B. menziesii*) also endemic to Kauai. These results, indicative of a very narrow genetic relationship for *B. forbesii*, have appeared questionable, so that further experimental crosses seemed to be in order. The additional crosses were carried out in 1971–72, using the greenhouse stocks indicated below. Voucher specimens are deposited at BISH and UCR.

HAWAIIAN ISLANDS:

Bidens forbesii Sherff

KAUAI: Waioli Valley, near Hanalei, 10 m, growing on a moist hillside approximately 200 m from the ocean, *Gillett 1765*. Sherff (1937) described both awned and awnless achenes for the species, but this race is characterized by awnless achenes (Fig. 1).

Bidens cuneata Sherff

OAHU: Inside the rim of Diamond Head crater, opposite the sea, on a windswept, rocky slope, 200 m, *Gillett 2319*.

Bidens molokaiensis (Hillebr.) Sherff

MOLOKAI: grassy summit of headland north of Hoolehua, 150 m, *Gillett 1807*.

Bidens mauiensis (A. Gray) Sherff var. *mauiensis*

MAUI: Manawainui Gulch, S coast of east Maui, 60 m, *Gillett 1872*.

Bidens menziesii (A. Gray) Sherff var. *filiformis* Sherff

HAWAII: S slopes of Mauna Kea, near the Saddle Road, 1800 m, *Gillett 1756*.

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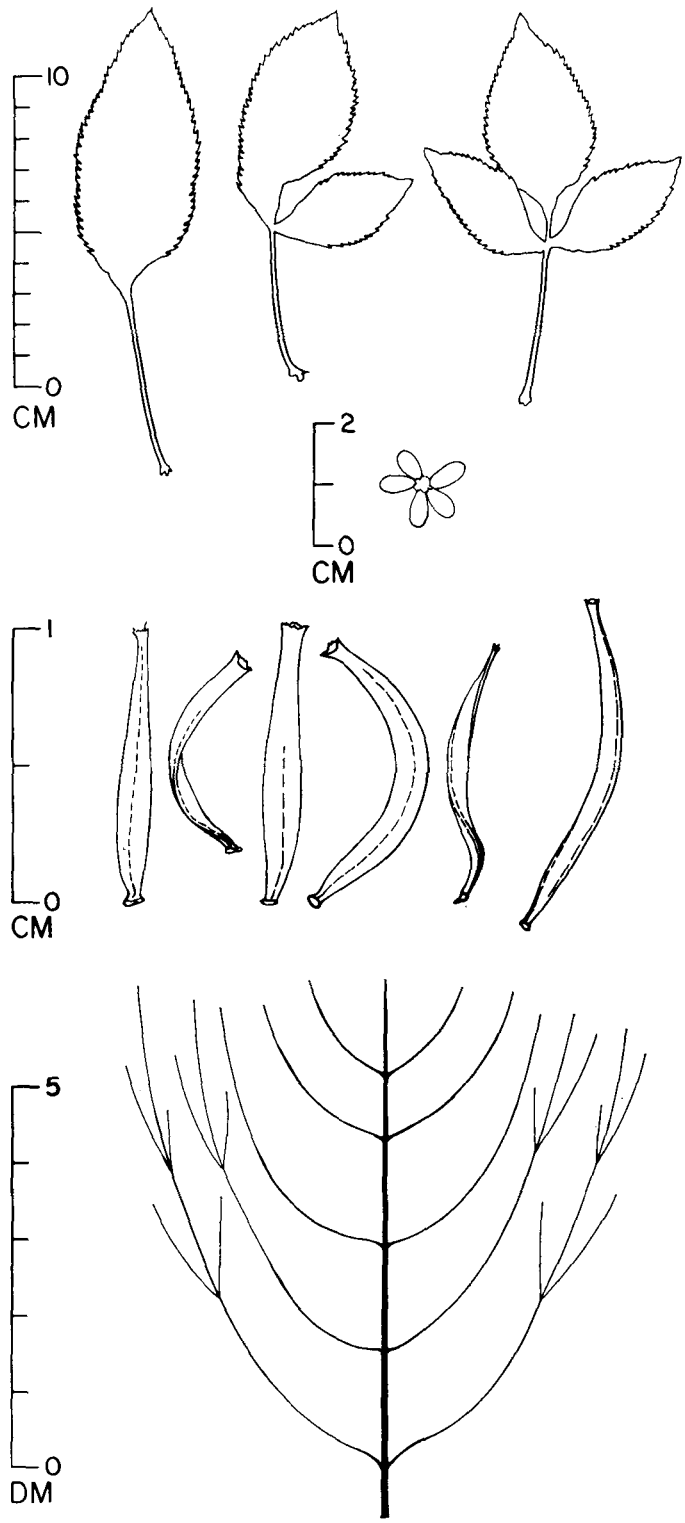

FIG. 1. Leaf form, capitulum, achene form, and growth form of *Bidens forbesii* (top to bottom).

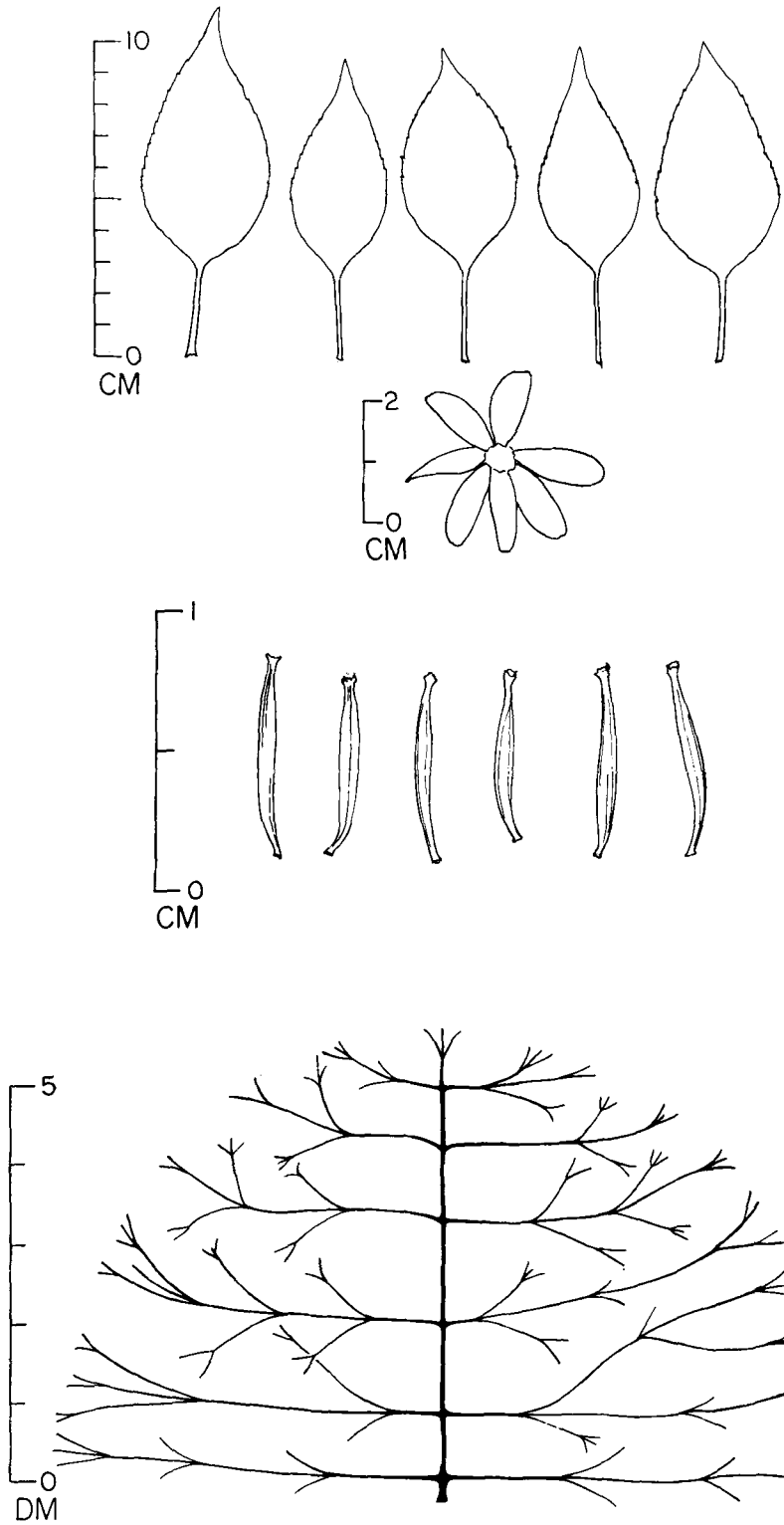

FIG. 2. Leaf form, capitulum, achene form, and growth form of *Bidens ahnnei* (top to bottom).

Bidens skottsbergii Sherff

HAWAII: S slope of Mauna Loa, on the 1750 lava flow, 12 m, near Black Sand Beach, *Gillett 1753*.

MARQUESAS ISLANDS:

Bidens ahnnei Sherff

NUKUHIVA: in rain forest vegetation on an east spur of the summit ridge, 1100 m, about 5 km S of the Tapuaooa shelter, *Gillett 2194*.

Bidens forbesii (Fig. 1) is one of several Polynesian species of *Bidens* with awnless achenes. It has an erect growth form, simple to dissected leaves, and a gynodioecious habit. However, its flowering response in the greenhouse appears to be delayed for 3 to 4 years, as compared with that of most other species that flower less than a year after germination.

Bidens cuneata is a decumbent herb with awnless achenes. This only known population consists of perhaps 40 individuals. The species has been postulated (Gillett & Lim, 1970) to be of hybrid origin, derived from natural crossing between *B. molokaiensis* and *B. mauiensis*.

Bidens ahnnei is an herbaceous to suffrutescent rain forest species with simple leaves and awnless achenes (Fig. 2). It is endemic to Nukuhiva, restricted to the upland rain forest.

The morphology and habitat relationships of the remaining four species were related by Gillett & Lim (1970). They portray a growth form that ranges from creeping herbs to erect, woody plants 4 m high, strongly awned to awnless achenes, and simple to strongly dissected leaves. They are related to a broad range of habitats from the rain forest to arid, exposed slopes, and from tropical to subtropical climates.

RESULTS

Vigorous F_1 hybrids were secured between *Bidens forbesii* and each of the other six species, indicating close genetic relationships. These crosses show that *B. forbesii* is an integral part of a complex of interrelated Polynesian species that comprise what Sherff (1937) has formally recognized as *Bidens* sect. *Campylotheca*.

DISCUSSION

It is clear that a portion of the genetic resources of sect. *Campylotheca* has been accessible to populations of *Bidens forbesii* and that this species probably was involved in the relatively broad expression of natural hybridization and gene flow in Hawaiian *Bidens* (Gillett, 1972a). The gynodioecious habit of *B. forbesii* assures "open" populations, which would greatly facilitate gene flow. The extensive variability of *Bidens* on Kauai, a subject that I prefer to defer to a later paper, very likely derives partly from this species. The hybrid *B. forbesii* × *B. menziesii* has now been synthesized in the greenhouse, and there is a strong similarity between the putative natural and experimental hybrids.

The experimental hybrid between *Bidens forbesii* and the Marquesan *B. ahnnei* lends added emphasis to earlier experiments (Gillett, 1972b) showing a strong genetic relationship between the species of Hawaii and of southeastern Polynesia. Together, these results emphasize the strong unity of sect. *Campylotheca* and strengthen the earlier stated hypothesis (Gillett, 1972b) that the initial ingression of *Bidens* into Polynesia occurred from North America to Hawaii, where maximum adaptive radiation was accomplished. This probably was followed by the entry of the stock to southeastern Polynesia (the Marquesas, Society, Gambier, Pitcairn, and Bass Islands), where far less morphological and ecological diversity is found.

LITERATURE CITED

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