

LYONIA

Occasional Papers of the Harold L. Lyon Arboretum

Volume 2, Nos. 1, 2, & 3

November 1983

Volume 2, No. 1 ----- Pages 1-16

**NEW TAXA AND NEW COMBINATIONS
IN HAWAIIAN BIDENS (ASTERACEAE)**

FRED R. GANDERS and KENNETH M. NAGATA

Volume 2, No. 2 ----- Pages 17-21

**A NEW SUBSPECIES OF BIDENS
(ASTERACEAE) FROM MAUI**

HAROLD ST. JOHN, KENNETH M. NAGATA, and FRED R. GANDERS

Volume 2, No. 3 ----- Pages 23-31

**RELATIONSHIPS AND FLORAL BIOLOGY
OF BIDENS COSMOIDES (ASTERACEAE)**

FRED R. GANDERS and KENNETH M. NAGATA

NEW TAXA AND NEW COMBINATIONS IN HAWAIIAN *BIDENS* (ASTERACEAE)¹

FRED R. GANDERS² and KENNETH M. NAGATA³

ABSTRACT. *Bidens sandvicensis* ssp. *confusa* Nagata & Ganders, *B. hillebrandiana* ssp. *polycephala* Nagata & Ganders, *B. micrantha* ssp. *kalealaha* Nagata & Ganders, and *B. forbesii* ssp. *kahiliensis* Ganders & Nagata are described as new. *Bidens campylothea* ssp. *pentamera* (Sherff) Ganders & Nagata, *B. menziesii* ssp. *filiformis* (Sherff) Ganders & Nagata, and *B. micrantha* ssp. *ctenophylla* (Sherff) Nagata & Ganders are published as new combinations at subspecific rank. A key to all taxa of *Bidens* in the Hawaiian Islands is provided.

In the course of our investigation of the genetics of adaptive radiation and evolution of *Bidens* in the Hawaiian Islands, it has been necessary to revise the group taxonomically. Here we describe four new subspecies and make three new combinations at the rank of subspecies. It will be useful to have valid names published for use in other papers before our monograph is published.

We have also included a key to all taxa of *Bidens* in the Hawaiian Islands. Presently available keys to the Hawaiian taxa do not work, and include many species unworthy of any taxonomic recognition. Our key should be useful to ecologists or others who may need to identify *Bidens* in Hawai'i. It includes introduced taxa that have been collected in the islands in the last 80 years. *Bidens laevis* is excluded. It was collected several times before 1900, but probably does not persist on the islands.

¹We thank Robert Hobdy, Bea Krauss, Ronald Nagata, and Steve Perlman for collections of seeds or cuttings, Dr. Helen Kennedy for the Latin diagnoses, Lesley Bohm for the drawings, the Natural Sciences and Engineering Research Council of Canada for financial support, and the curators at BISH, BM, F, G, GH, and HAW for loan of specimens.

²Department of Botany, University of British Columbia, Vancouver, B.C., Canada V6T 2B1.

³Harold L. Lyon Arboretum, 3860 Manoa Road, Honolulu, HI 96822.

***Bidens sandvicensis* Less. ssp. *confusa* Nagata & Ganders, ssp. nov.**

FIGURE 1.

Differt a ssp. *sandvicensis* folioliis angustioris, minus quam 8 mm latis; flosculis radiatis 5-6, (15-)18-21(-28) mm longis et (5-)6-9 mm latis.

Erect to somewhat straggling perennial, 0.5-1.0 m tall, flowering terminally as well as laterally, lateral branches ascending to nearly horizontal. Leaves pinnately or occasionally bipinnately compound, mostly 50-160 mm long including petiole; leaflets 5-9 to bipinnate, serrate, glabrous or glabrate, mostly 15-80 mm long and less than 8 mm wide, more than 5 times as long as wide. Inflorescence a compound dichasium, rather diffuse, with 6 to more than 30 heads, peduncles of heads glabrous or sparsely pubescent, (10-)15-50 mm long. Heads 25-40 mm in diameter, outer involucre bracts (2.5-)3-4(-5) mm long. Ray flowers sterile, 5-6, yellow, (15-)18-21 mm long, (5-)6-9 mm wide. Disk flowers 17-22, perfect or pistillate, some populations gynodioecious. Achenes straight, black, wingless, setose on the margins and sometimes on the faces, 5-10 mm long and 0.75-1.0 mm wide; awns 2, 1-2 mm long, or absent.

HOLOTYPE: Hawaiian Islands, Kauai, Waimea District, Kokee, along Waimea Canyon Road near Canyon Lookout, elevation about 3300'; 5 June 1982, *K. Nagata 2473* (BISH).

DISTRIBUTION: Restricted to the Koke'e region of Kaua'i, on west rim of Waimea Canyon from about 700-1100 m elevation.

SPECIMENS EXAMINED: KAUA'I: near power house, Waimea Canyon, *Degener et al. 23,981* (BISH); Kukui Trail, Waimea Canyon, *Degener et al. 27,189* (BISH); near rim of Waimea Canyon, *Gillett 1888* (HLA); Waimea Canyon rim, *Hobdy 38* (BISH); Iliau Nature Trail, *Hobdy 54* (BISH); Waimea Canyon Road, *K. Nagata 1946-1948* (HLA).

This taxon is common along the west rim of Waimea Canyon at about 1000 m elevation. It is not always easy to distinguish *Bidens sandvicensis* ssp. *confusa* from ssp. *sandvicensis* morphologically, since it differs mainly in having larger ray flowers and heads and narrower leaflets. Some specimens have nearly linear leaflets but others approach those of some plants of ssp. *sandvicensis*. The two taxa retain their differences when cultivated in the same environment, and differ in polyacetylene chemistry (Marchant *et al.*, in press) and in flavonoid chemistry (McCormick and Ganders, unpublished). Subspecies *sandvicensis* also occurs on Kaua'i, but is usually restricted to elevations below 400 m. It is possible, however, that some intergradation occurs on the walls of Waimea Canyon.

Gillett and Lim (1970) and Gillett (1975) considered this taxon to represent a natural hybrid between *Bidens menziesii* and *B. forbesii*, largely on the basis of the finely divided leaves of the specimens Gillett had in cultivation. *Bidens menziesii* does not occur on Kaua'i, and ssp. *confusa* shows little resemblance to *B. forbesii*. It is more similar to *B. cervicata*, which does occur nearby, but there is no evidence at present that it has hybridized with that taxon. The achenes of ssp. *confusa* are identical to those of ssp.

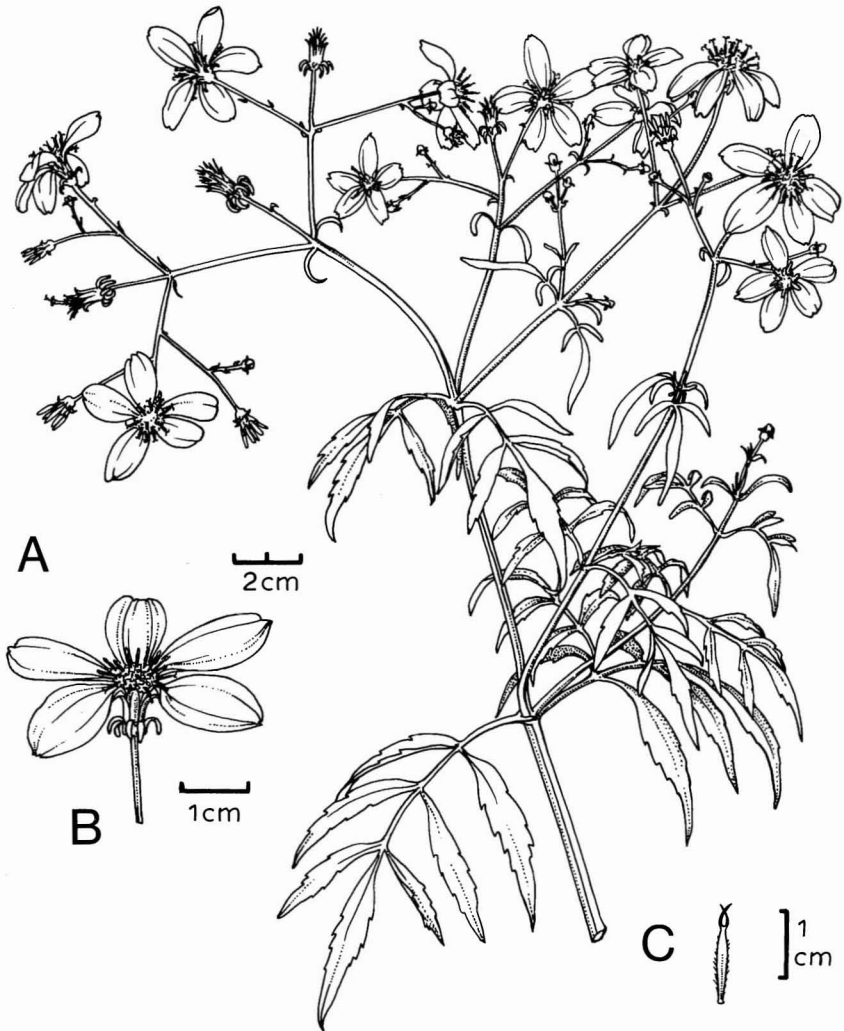


FIGURE 1. *Bidens sandvicensis* ssp. *confusa* (A) terminal inflorescence; (B) flowering head showing outer involucral bracts; (C) achene.

sandvicensis, and the narrow leaflets typical of *ssp. confusa* are found on occasional plants of *ssp. sandvicensis* from O'ahu.

Bidens hillebrandiana (Drake) Deg. ex Sherff *ssp. polycephala* Nagata & Ganders, *ssp. nov.*

FIGURE 2.

Campylotheca rutifolia H. Lev. Repert. Spec. Nov. Regni Veg. 10: 123. 1911. LECTOTYPE (here designated): Hawaiian Islands, Molokai, Wailau, June 1910, *U. Faurie 931* (BM!; isolectotype: P).

Differt a *ssp. hillebrandiana* inflorescentiae cum capitulis 4-30, pedunculus capitulorum 2-12(-20) mm longis.

Decumbent perennial herb, woody at base, less than 0.5 m tall, flowering terminally as well as on lateral branches. Leaves rarely simple, usually pinnately or bipinnately compound, mostly 35-80(-110) mm long including petiole; leaflets mostly 5-25 mm long and 2-15 mm wide, fleshy, crenately toothed or lobed, glabrous or sparsely pubescent. Inflorescence a compound dichasium; heads (4-)5-30, peduncles of heads glabrous or sparsely pubescent, 2-12(-20) mm long. Heads (14-)19-24 mm in diameter, outer involucre bracts 2-3 mm long, inner involucre bracts short, often not covering flower buds. Ray flowers sterile, 5-6, yellow, 9-12 mm long, 3-4 mm wide. Disk flowers 11-21, perfect. Achenes straight, grayish black, wingless, setose on margins and often also on the faces, 6-8 mm long and 0.8-1.2 mm wide; awns 1-2 mm long, prominently retrorsely barbed.

HOLOTYPE: Hawaiian Islands, East Maui, on ledge of sea cliffs with *Sesuvium*, *Digitaria*, and *Lycium*, west end of Maliko Bay, Makawao District, elevation 80', 5 June 1979, *K. Nagata 1897* (BISH).

DISTRIBUTION: Windward coasts of East Maui and Moloka'i, on coastal bluffs or talus exposed to ocean spray, from sea level to about 60 m elevation. On Maui it occurs from Maliko Bay east to Hana and around the east end of the island to the mouth of the Kipahulu Valley. On Moloka'i it occurs on sea cliffs from Wailau Valley to Kikipua Point.

SPECIMENS EXAMINED: MAUI: north shore of Kauiki Head, Hana, *Degener et al. 12,397* (BISH); Oheo Stream, Kipahulu Valley, *Higashino 5740* (BISH); Maliko Bay, *K. Nagata 1894 & 1895* (HLA); Maliko Bay, *K. Nagata 1896* (HLA).

MOLOKA'I: Wailau Valley, talus slope at foot of cliffs, *Fosberg 9666* (BISH, F); Kikipua Pt., *Jacobi 1724* (BISH).

The holotype of *Bidens hillebrandiana* is from the island of Hawai'i and has heads solitary on long peduncles, or rarely inflorescences of 2-4 heads on long peduncles. Subspecies *hillebrandiana* is known only from the windward Kohala coast and has been only rarely collected. The plants resemble hybrids of *B. hillebrandiana* *ssp. polycephala* and *B. mauianensis*, and some

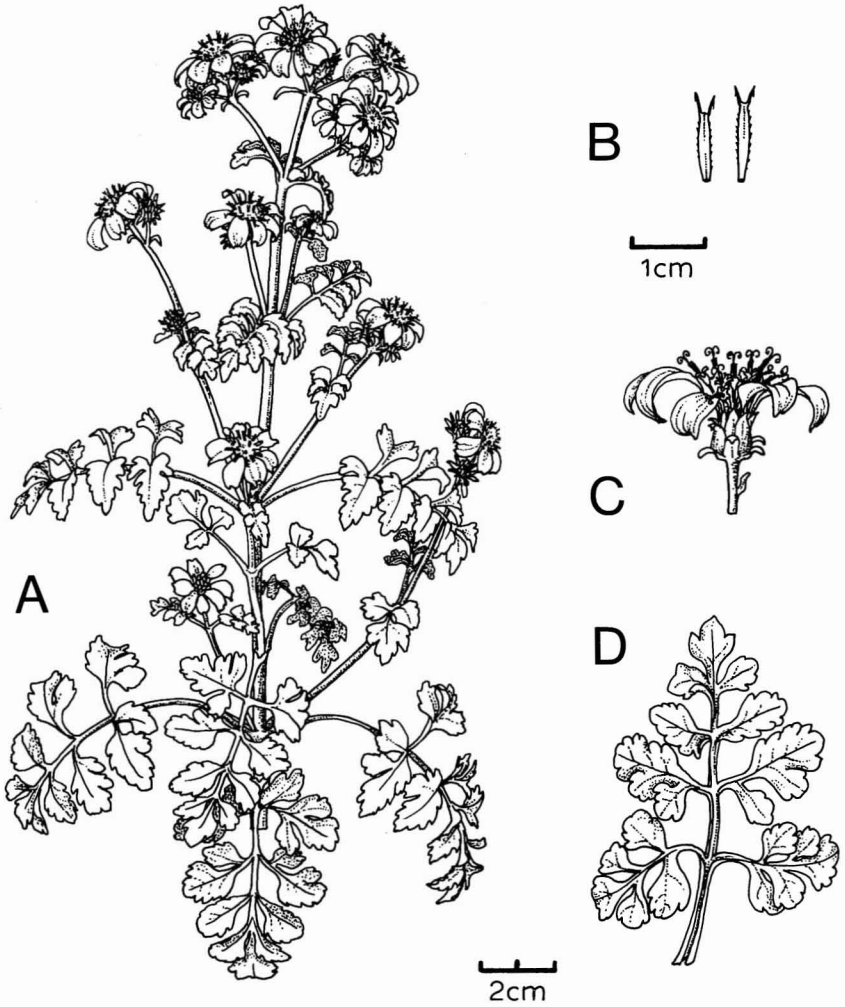


FIGURE 2. *Bidens hillebrandiana* ssp. *polycephala* (A) terminal inflorescence; (B) achenes; (C) flowering head showing outer involucre bracts; (D) stem leaf.

specimens at BISH were annotated as such by Gillett. Subspecies *hillebrandiana* is reasonably constant and the achenes show no evidence of hybridization with *B. mauiensis*, which does not occur on the island of Hawai'i in any case.

Bidens hillebrandiana is more common on east Maui and Moloka'i, but plants from these islands have branching inflorescences and heads on short peduncles. They are best considered a distinct subspecies.

In describing *Campylotheca rutifolia* Leveille cited two numbers, *Faurie 931* and *965*. *Faurie 931* is from Moloka'i and is here designated as the lectotype. It is a synonym of *B. hillebrandiana* ssp. *polycephala*. *Faurie 965* was not selected because the locality is given only as Hawaiian Islands. It appears to be *B. hillebrandiana* ssp. *hillebrandiana* and would therefore have been collected on the Kohala coast on the island of Hawai'i.

***Bidens micrantha* Gaud. ssp. *kalealaha* Nagata & Ganders, ssp. nov.**

FIGURE 3.

Bidens distans Sherff, Bot. Gaz. (Crawfordsville) 89:362. 1930. HOLOTYPE: Hawaiian Islands, Lanai, at Gay's (Ranch) on mountains near Koele, June 1918, *C.N. Forbes 148L* (F!; isotype: BISH!).

Bidens micrantha Gaud. var. *rudimentifera* Sherff, Bot. Leaflet 3:7. 1951. HOLOTYPE: Hawaiian Islands, East Maui, Kahua crater, south Haleakala, 7000', 24 Nov. 1950, *W.H. Hatheway & A. Greenwell 465* (F!).

Differt a ssp. *micrantha* *achaeneis* rectis, aristatis; foliolis plerumque ad marginem ciliatis; flosculis radiatis 5, 15-27 mm longis; inflorescentiae diffusis. Differt a ssp. *ctenophylla* foliolis (3-)5-7(-9); pedunculis capitulorum glabris vel glabratis; inflorescentiae diffusis.

Erect perennial, 0.5-1.5 m tall, with ascending branches, flowering terminally as well as on lateral branches, stems not prominently quadrangular. Leaves pinnately compound, occasionally some but not all simple, mostly 60-190 mm long including petiole; leaflets 3-7(-9), lanceolate to narrowly lanceolate, serrate, usually ciliate on margins, mostly 25-100 mm long and 5-30 mm wide. Inflorescence a much branched compound dichasium with 15-50 heads, moderately diffuse, peduncles of heads glabrous or glabrate, (3-)25-40 mm long. Heads 25-45 mm in diameter, outer involucre bracts 1-2.5 mm long. Ray flowers sterile, 5, yellow, 15-27 mm long, 5-7 mm wide. Disk flowers 9-15, perfect. Achenes straight, black, wingless, glabrous, 8-14 mm long and 0.75-1.5 mm wide; awns 2, 0.5-2.5 mm long.

HOLOTYPE: Hawaiian Islands, East Maui, Kahikinui, on sheer cliff in Manawainui Gulch out of the reach of goats, elevation 6300', 18 Dec. 1980, *R. Hobdy 959* (BISH).

DISTRIBUTION: Leeward slopes and inner crater walls of Haleakala, East Maui, from 750-2300 m elevation, and at least formerly on leeward Lana'i.

SPECIMENS EXAMINED: MAUI: 200 yards w. of Kahua Crater, *Hatheway and Greenwell 470* (BISH); Kahikinui, *R. Hobdy 654* (HLA); Haleakala crater, south side, inner wall, *R. Nagata 81-2* (HLA).

LANA'I: Waipaa, *Munro 122* and *Munro 136* (BISH); Hi'i, *Munro 482* (BISH).

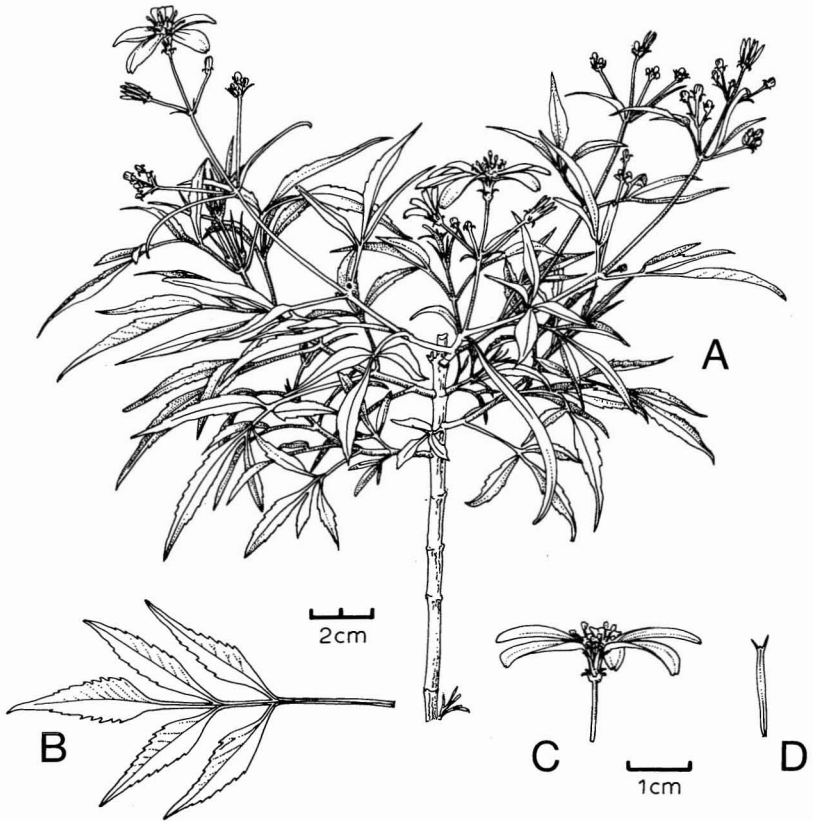


FIGURE 3. *Bidens micrantha* ssp. *kalealaha* (A) portion of flowering plant; (B) stem leaf; (C) flowering head showing outer involucral bracts; (D) achene.

Bidens micrantha is a variable species, particularly in leaf shape, achene length, curvature, and presence or absence of awns, head size, ray flower number and length, and the compactness of the inflorescence. Some of these characters show clinal variation, particularly on West Maui. Many of the variable characters occur in all possible combinations in different populations, making a biologically meaningful taxonomic subdivision of the species difficult. However, three mostly allopatric subspecies are reasonably distinct and deserve recognition. *Bidens micrantha* ssp. *micrantha* is restricted to West Maui, with one early Hillebrand collection reportedly from Moloka'i and another from Kula on East Maui. *Bidens micrantha* ssp. *ctenophylla* is restricted to the Kona coast of Hawai'i. *Bidens micrantha* ssp. *kalealaha* is found on East Maui, and at least formerly on Lana'i, where it has not been seen for about 20 years, and is known from one locality on West Maui. Achenes of ssp. *micrantha* are always at least slightly curved, and are coiled and twisted in populations north and east of Lahaina. They usually lack awns. Inflorescences are usually dense with small heads with 3-5 ray flowers and 5-9 disk flowers, although populations in the vicinity of Iao Valley have rather diffuse inflorescences. Peduncles of the heads are glabrous or glabrate. Leaves may be simple or pinnately compound with up to 9 leaflets, and they are not ciliate on the margins. Subspecies *ctenophylla* has dense inflorescences with small heads with 5-9 ray flowers and 11-18 disk flowers, peduncles of the heads are pubescent, and achenes are straight and awned, but rather variable, some bearing two pairs of awns, decurrent awns, or even narrow marginal wings. Leaves are simple or rarely trifoliate. Subspecies *kalealaha* has diffuse inflorescences with larger heads, 5 ray flowers, usually longer than the other two subspecies, and 9-15 disk flowers, glabrous or glabrate peduncles, and straight, wingless, awned achenes. Plants from East Maui have pinnately compound leaves with 5-9 leaflets which are ciliate margined. Plants from Lana'i lack cilia on the leaflet margins and may have some simple leaves as well as pinnately compound ones on the same plant, but are indistinguishable from the East Maui plants in achenes, heads, and inflorescence. These plants from Lana'i have previously been called *B. distans* but cannot be considered specifically distinct from *B. micrantha*. The taxon has apparently not been collected on Lana'i for over 50 years, although Robert Hobdy (pers. comm.) remembers seeing what must have been this taxon about 20 years ago near Pu'u 'Ula'ula in dry scrub near the edge of pineapple fields and on cliffs above the pumphouse in Maunalei Gulch. We were unable to find this species on Lana'i on a short visit in August 1982.

Bidens micrantha var. *rudimentifera* Sherff was based on a plant of ssp. *kalealaha* with abnormal achenes which was apparently collected along with normal plants (*Hatheway and Greenwell 470*; BISH). Because Sherff's inappropriate epithet was based on a monstrosity we are not transferring it to subspecies rank.

Bidens forbesii Sherff ssp. **kahiliensis** Ganders & Nagata, ssp. nov.

FIGURE 4.

Differt a ssp. *forbesii* foliis coriaceis, foliolis 3-7, lanceolatis; achaeneis 1.0-1.5 mm latis, paxillum angustatis ad 0.5-0.75(0.9) mm latis prope apicem.

Erect woody perennial, 0.75-1.5 m tall, with horizontal or ascending lateral branches, flowering only on lateral branches. Young stems inconspicuously quadrangular. Leaves pinnately compound, mostly 110-200 mm long including petiole; leaflets 3-7, lanceolate to ovate lanceolate, serrate, glabrous, dark green, coriaceous, mostly 50-120 mm long and 20-45 mm wide. Inflorescence a much branched compound dichasium with more than 50 heads, peduncles of heads glabrous, (2-)10-25 mm long. Heads 20-25 mm in diameter, outer involucre bracts 1.5-3.5 mm long. Ray flowers sterile, 5, yellow, 8-13 mm long, 3-5 mm wide. Disk flowers 10-20, perfect or pistillate, some populations gynodioecious. Achenes straight or curved or usually twisted about one revolution, black, wingless, setose near the base and occasionally above, tapering only slightly at apex, 7-14 mm long, 1.0-1.5 mm wide tapering to 0.5-0.75(-0.9) mm wide just below apex; awns minute or none.

HOLOTYPE: Hawaiian Islands, Kauai, ridge SW of Mt. Kahili, elevation ca. 680 m, June 1980, *B. Krauss s.n.* (BISH).

DISTRIBUTION: Vicinity of Kapalaoa and Mt. Kahili in south central Kaua'i, at elevations of 600-1100 m.

SPECIMENS EXAMINED: KAUA'I: bank of small stream below ditch trail W of Wahiawa Bog, *Fay 295* (BISH); 1 mi SW of Mt. Kahili, *Nagata 2094* (HLA); cultivated plant grown from cuttings collected on steep slope below microwave tower on Mt. Kahili, *Ganders 81-10* (UBC); cultivated plant grown from seed collected by B. Krauss, 1 mi N of Mt. Kahili near Kapalaoa, *Ganders 82-01* (UBC).

Populations of *Bidens forbesii* from elevations over 600 m near Mt. Kahili in south central Kaua'i differ from ssp. *forbesii* in several vegetative characters and also in achenes. The stems are only obscurely quadrangular, the leaves are 3-7 foliolate, with at least some leaves with 5 leaflets, the leaflets are narrower, usually lanceolate, and are dark green and coriaceous. In ssp. *forbesii* stems are conspicuously square in cross section, leaves are simple or trifoliate, only rarely with 5 leaflets, leaflets are ovate, bright green or yellowish green, and soft and slightly succulent. Achenes of ssp. *kahiliensis* are wider and less conspicuously tapered apically than those of ssp. *forbesii*, which are only 0.5-0.75(-1) mm wide and taper to about 0.3 mm wide just below the apex. All of the differences are maintained when plants of the two subspecies are cultivated under the same environmental conditions. At least some populations of both ssp. *kahiliensis* and ssp. *forbesii* are gynodioecious.

Bidens cervicata Sherff is closely related to *B. forbesii*, especially ssp. *forbesii*. Both have square stems and conspicuously tapered narrow achenes. *Bidens cervicata* differs in having 5-11(-13) leaflets, which are soft, yellowish green, lanceolate, more coarsely serrate with teeth at least 1 mm

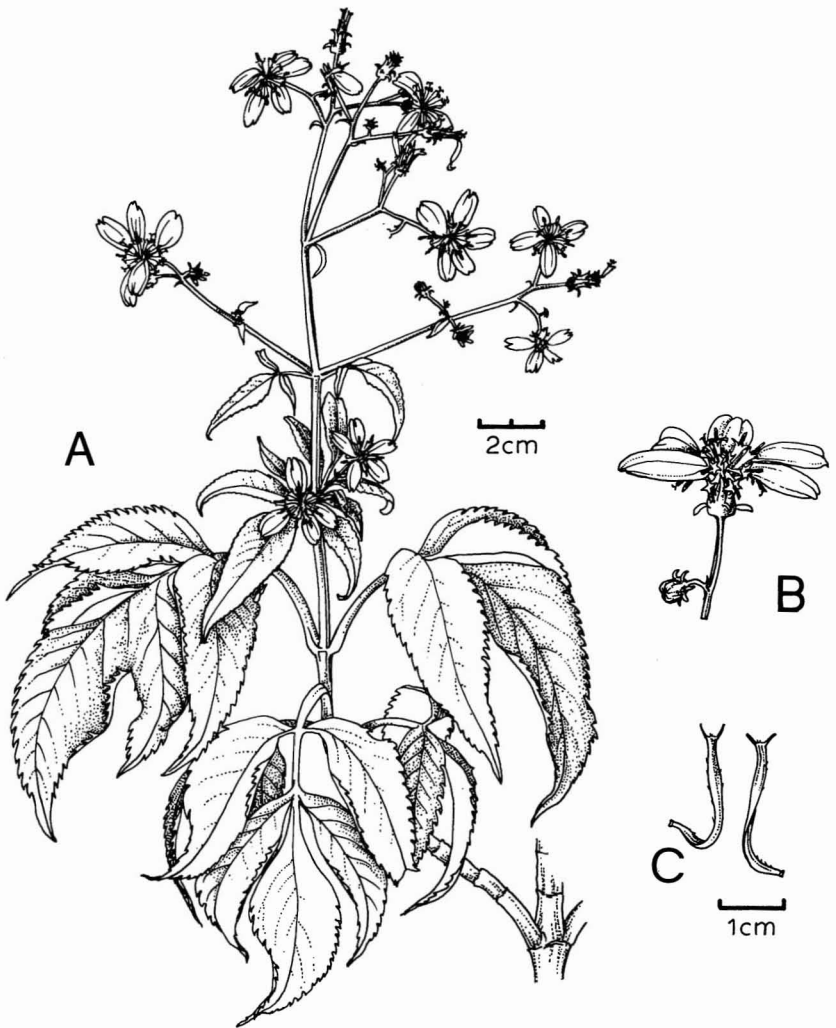


FIGURE 4. *Bidens forbesii* ssp. *kahiliensis* (A) inflorescence on lateral branch; (B) flowering head showing outer involucre bracts; (C) achenes.

long, and has larger heads 25-50 mm wide including ray flowers, ray flowers 12-25 mm long, disk flowers 18-21, outer involucral bracts 1.5-5.5 mm long. *Bidens cervicata* flowers terminally as well as on lateral branches. Most populations of *B. cervicata* also appear to be gynodioecious.

Bidens asymmetrica var. *subocculta* Deg. & Sherff and *B. napaliensis* Sherff are synonyms of *B. forbesii* ssp. *forbesii*. All specimens from Kaua'i determined as *B. conjuncta* by Sherff are also *B. forbesii* ssp. *forbesii*.

***Bidens campylothea* Schz. Bip. ssp. *pentamera* (Sherff) Ganders & Nagata, comb. nov.**

Bidens campylothea var. *pentamera* Sherff, Bot. Gaz. (Crawfordsville) 85: 4. 1928. *Bidens pentamera* (Sherff) Deg. & Sherff, Amer. J. Bot. 28: 31. 1941. HOLOTYPE: Hawaiian Islands, Maui, Koolau Gap, Haleakala Crater, 11 Aug. 1927, O. Degener & H. Wiebke 2163 (F!; isotypes: BM, F, HAW!, K, P).

Bidens campylothea f. *filicifolia* Sherff, Bot. Gaz. (Crawfordsville) 85: 4. 1928. HOLOTYPE: Hawaiian Islands, Maui, Koolau Gap, Haleakala Crater, 11 Aug. 1927, O. Degener & H. Wiebke 2177 in part (F!; isotype: HAW!).

***Bidens menziesii* (A. Gray) Sherff ssp. *filiformis* (Sherff) Ganders & Nagata, comb. nov.**

Bidens menziesii var. *filiformis* Sherff, Bot. Gaz. (Crawfordsville) 85: 9. 1928. LECTOTYPE (here designated): Hawaiian Islands, Hawaii, central plateau, W. Hillebrand 30 (K).

Bidens menziesii var. *leptodonta* Sherff, Bot. Gaz. (Crawfordsville) 85: 9. 1928. LECTOTYPE: (Sherff, Field Mus. Nat. Hist., Bot. Ser. 16: 151): Hawaiian Islands, Maui, W. Hillebrand s.n. (BM!).

Despite Sherff's description and key, the type specimen of *Bidens menziesii* var. *leptodonta* is indistinguishable from *B. menziesii* ssp. *filiformis*, and the ultimate divisions of its leaves are no wider than those of ssp. *filiformis*. The type of var. *leptodonta* is supposedly from Maui, but it is the only known specimen of ssp. *filiformis* from Maui, and we suspect that the locality on the label is wrong. All the other specimens that Sherff (1937) cited for his var. *leptodonta* are from Hawai'i, and are ssp. *filiformis*.

***Bidens micrantha* Gaud. ssp. *ctenophylla* (Sherff) Nagata & Ganders, comb. nov.**

Bidens ctenophylla Sherff, Bot. Gaz. (Crawfordsville) 85: 5. 1928. HOLOTYPE: Hawaiian Islands, Hawaii, arid weed covered aa slopes between Puu Waa Waa and Huehue, 22 Aug. 1926, O. Degener & H. Wiebke 2128 (F!; isotypes: BM, F, HAW!, K).

Bidens sandvicensis var. *heterophylla* A. Gray, Proc. Amer. Acad. Arts 5:128. 1861. *Bidens remyi* Drake, Ill. Fl. Ins. Pacif. pl. 39. 1888. *Coreopsis remyi* (Drake) Drake, Ill. Fl. Ins. Pacif. 210. 1890. *Bidens micrantha* var. *heterophylla* (A. Gray) Sherff, Brittonia 6:339. 1948. HOLOTYPE: Hawaiian Islands, Hawaii, 1851-1855, *J. Remy 281* (GH!).

Bidens schizoglossa Sherff, Bot. Gaz. (Crawfordsville) 88: 288. 1929. HOLOTYPE: Hawaiian Islands, Hawaii, near Huehue, 24 June 1924, *W.A. & C.B. Setchell s.n.* (UC!).

Not *Campylotheca remyi* Hillebr. Fl. Haw. Is. 211, 212. 1888. *Bidens remyi* (Hillebr.) Sherff, Bot. Gaz. (Crawfordsville) 70: 97. 1920. which are based on *J. Remy 287* (GH!) and are synonyms of *B. hillebrandiana* (Drake) Deg. ex Sherff.

This taxon has been known for more than 50 years as *Bidens ctenophylla*. Sherff (1920, 1937) regarded the type specimen of *B. sandvicensis* var. *heterophylla* as just a form of *B. micrantha* ssp. *micrantha*, but it is in fact the same taxon as his *B. ctenophylla*. When Sherff (1948) made the new combination *B. micrantha* var. *heterophylla* he intended this name, based on the type of *B. sandvicensis* var. *heterophylla*, to apply to the nomenclaturally typical variety of *B. micrantha*. Recognizing infraspecific taxa of Hawaiian *Bidens* at the rank of subspecies allows the familiar epithet *ctenophylla* to be preserved.

A satisfactory key to Hawaiian *Bidens* is difficult to produce, because of the variability of many characters and the occurrence of hybrids. Interspecific hybrids or populations that appear to show evidence of hybridization have not been included in the key. The hybrids most commonly encountered are listed below:

1. Hybrid swarms between *Bidens amplexans* and *B. torta* occur on the northwest end of the Wai'anae Range, O'ahu, from Ka'ena Point to the head of the Makua Valley. Achenes may be straight or twisted, inner involucre bracts partially fused, ray flowers intermediate in number and size, or any combination of the parental characters. Possible hybrids between *B. cervicata* and *B. torta* and *B. cervicata* and *B. sandvicensis* ssp. *sandvicensis* may also be found here at low to medium elevations.
2. Hybrid swarms between *B. menziesii* ssp. *filiformis* and *B. micrantha* ssp. *ctenophylla* occur near Pu'u Wa'aWa'a, Hawai'i. Hybrids usually have leaves trifoliolate or pinnately, but not bipinnately, compound with narrow leaflets more than 5 mm wide or with leaflets with long pectinate teeth. Anomalous plants of *B. menziesii* ssp. *filiformis* from Kohala, Hawai'i also resemble these hybrids.
3. Populations somewhat intermediate between *B. asymmetrica* and *B. sandvicensis* ssp. *sandvicensis* occur from Tantalus to Nu'uuanu Pali in the Ko'olau Range on O'ahu. Populations we somewhat arbitrarily assign to *B. asymmetrica* may have twisted achenes slightly setose on the margins,

and flower only on lateral branches. Populations we assign to *B. sandvicensis* may have slightly twisted achenes, conspicuously setose on the margins, and have terminal inflorescences as well as lateral ones.

4. On West Maui hybrids between *B. mauiensis* and *B. micrantha* ssp. *micrantha* are occasionally collected. Some more perplexing hybrids seem to involve *B. menziesii* ssp. *menziesii* and either *B. mauiensis* or *B. micrantha*, or possibly both.

In the following key measurement of ray flower size is based on live material. Dried material may shrink considerably depending on how well it was pressed, and no reliable conversion ratio can be given. If heads are not completely flattened ray flowers may shrink more than fifty percent. For measurements they should be soaked and stretched to maximum length and width.

Most species produce a few simple leaves near the inflorescence where typical stem leaves grade into bracts. These have been ignored in descriptions and measurements of leaves. Even so, leaves of many species are exceedingly variable and rather unreliable as taxonomic characters.

One character that is often useful, but frequently indeterminable from herbarium specimens, is whether the growth habit is determinate or indeterminate. Some species never produce inflorescences terminating the main stem, but only on lateral branches. Others produce terminal inflorescences first, then lateral branches flower. (Inflorescence is used here to mean the inflorescence of heads, sometimes called a synflorescence.)

The distribution, by island, is given for the indigenous taxa as an aid in identification. The introduced taxa are rather widespread, sometimes even in relatively undisturbed habitats, with the exception of *B. alba* var. *radiata*. It is established near Waimea Bay on O'ahu and has recently become quite common on O'ahu, Hawai'i, Midway, and Kure (D. Herbst, pers. comm.).

Key to *Bidens* in the Hawaiian Islands

- 1a. Achenes with 4(-6) barbed awns; ray flowers 3-4, yellow, less than 8 mm long, or rarely absent; at least some leaves bipinnately or tripinnately compound; introduced weed *B. cynapiifolia* H.B.K.
- 1b. Achenes with 0-3 barbed or barbless awns 2.
- 2a. Ray flowers white or absent (rarely yellowish, but if so, they have degenerate or abortive stamens); awns 2-3, barbed; outer involucre bracts usually spatulate-tipped; leaves simple and pinnately compound with 3-7 leaflets; introduced weeds 3.
- 2b. Ray flowers bright yellow, lacking any trace of a style or stamens; awns 0-2, barbed or barbless; outer involucre bracts never spatulate-tipped; endemic species 5.
- 3a. Ray flowers 6-10, white, 10-25 mm long, lacking any trace of a style or stamens; awns 2 *B. alba* L. var. *radiata* (Schz. Bip.) Ballard ex Melchert.
- 3b. Ray flowers 4-7 or absent, white or rarely yellowish, less than 8 mm long, with degenerate or abortive stamens; awns 2-3 4.
- 4a. Ray flowers absent or minute (2-3 mm long); achenes with 3(-5) awns *B. pilosa* L. var. *pilosa*
- 4b. Ray flowers 5-8 mm long; achenes with 2 or 3 awns *B. pilosa* var. *minor* (Blume) Sherff

- 5a. Styles exerted beyond anthers more than 10 mm; mature achenes enveloped by subtending chaffy bracts of the receptacle; heads pendant, campanulate, 50-90 mm wide; outer involucre bracts 10-25 mm long (Kaua'i) *B. cosmoides* (A. Gray) Sherff
- 5b. Styles exerted beyond anthers less than 5 mm; mature achenes not enveloped by chaffy bracts of the receptacle 6.
- 6a. Heads all solitary on long terminal peduncles (20-)40-250 mm long; plants decumbent, low and spreading, less than 0.3 m tall 7.
- 6b. Heads 2-many on branched inflorescences; plants usually erect, more than 0.3 m tall (except *B. hillebrandiana*) 9.
- 7a. Outer involucre bracts less than 3 mm long; ray flowers 9-12 mm long; peduncles 20-85 mm long; achenes setose on margins, wingless, armed with 2 prominently barbed awns (Hawai'i) *B. hillebrandiana* (Drake) Deg. ex Sherff ssp. *hillebrandiana*
- 7b. Outer involucre bracts more than 4 mm long; ray flowers 15-30 mm long; peduncles 50-250 mm long; achenes glabrous or sparsely setose on margins, awned or awless 8.
- 8a. Achenes winged, 1.5-3.8 mm wide, brown; leaves simple, pinnately, or bipinnately compound, if simple, the blade more than 1.5 times as long as wide (Maui and Lana'i) *B. mauiensis* (A. Gray) Sherff
- 8b. Achenes wingless, 1-1.5 mm wide, grayish black; leaves simple or trifoliate, if simple, the blade less than 1.5 times as long as wide (Moloka'i and O'ahu) *B. molokaensis* (Hillebr.) Sherff
- 9a. Inner involucre bracts completely fused, splitting irregularly at anthesis; heads large, 50-70 mm wide (O'ahu) *B. amplexans* Sherff
- 9b. Inner involucre bracts separate 10.
- 10a. Disk flowers more than 25 per head; ray flowers 5-7, less than 17 mm long; heads few (5-20) on widely divergent peduncles 30-190 mm long, borne only on long lateral branches 11.
- 10b. Disk flowers either fewer than 25 per head or ray flowers more than 17 mm long; heads few to many, usually on peduncles 2-30(-45) mm long, if peduncles are longer, then ray flowers 8-13, more than 18 mm long 13.
- 11a. Leaves pinnately compound, leaflets (1-)3(-5), serrate; achenes glabrous, wingless, irregularly curved or twisted (O'ahu, Lana'i and Hawai'i) *B. campylothea* Schz. Bip. ssp. *campylothea*
- 11b. Leaves bipinnatifid or pinnatifid, leaflets 5 or more, crenate or lobed or divided 12.
- 12a. Achenes glabrous, wingless, awless, irregularly curved or twisted (Maui) *B. campylothea* ssp. *pentamera* (Sherff) Ganders & Nagata
- 12b. Achenes setose on margins, with undulate marginal wings, awned, often undulate but not usually twisted (Maui) *B. campylothea* ssp. *waihoiensis* St. John
- 13a. Achenes undulate winged, usually somewhat twisted; inflorescences only on lateral branches; leaves compound with 3-7 serrate leaflets (Moloka'i) *B. wiebkei* Sherff
- 13b. Achenes not undulate winged (if plants are from Moloka'i, then inflorescences terminal as well as lateral, leaves compound with crenate lobed leaflets or bipinnately divided into linear segments) 14.
- 14a. Achenes 12-20 mm long, 1.5-2.8 mm wide, brown, awned or with irregular subapical teeth or awns that are decurrent into flattened margins or wings; inflorescences only on long, lateral, horizontal branches; outer involucre bracts 4-8 mm long (O'ahu) *B. macrocarpa* (A. Gray) Sherff
- 14b. Achenes shorter or narrower or both, grayish or black, usually wingless (if winged, then plants with terminal inflorescences) 15.
- 15a. Ray flowers (7-)8-11(-13), 18-38 mm long; outer involucre bracts more than 4 mm long; achenes straight 16.
- 15b. Ray flowers 3-6 (rarely 7-9, but then outer involucre bracts less than 3 mm long); outer involucre bracts and achenes various 18.
- 16a. Leaves compound with 3-7 leaflets; outer involucre bracts foliaceous, 8-18 mm long; inflorescences only on lateral branches (Kaua'i) *B. valida* Sherff
- 16b. Leaves simple; outer involucre bracts less than 10 mm long; inflorescences terminal as well as lateral 17.

- 17a. Achenes glabrous on margins and faces; leaves oblong-ovate, base wide cuneate (Hawai'i) *B. hawaiiensis* A. Gray
- 17b. Achenes setose at least on the margin; leaves ovate-cordate, base subcordate to obliquely truncate (O'ahu) *B. populifolia* Sherff
- 18a. Achenes setose on the margins, at least a few setae near the base 19.
- 18b. Achenes glabrous on margins and faces (awns or terminal seta may be present) 25.
- 19a. Leaves and leaflets crenately lobed, fleshy, leaves pinnately or bipinnately compound; plants low, less than 0.3 m tall; inner involucre bracts not covering flower buds 20.
- 19b. Leaves variously divided but not crenately lobed; plants normally more than 0.3 m tall; inner involucre bracts covering flower buds in immature heads 21.
- 20a. Heads 1-3(-5) per inflorescence; peduncles (9)20-85 mm long (Hawai'i)
..... *B. hillebrandiana* (Drake) Deg. ex Sherff ssp. *hillebrandiana*
- 20b. Heads (4)-6-20(-30) per inflorescence; peduncles 2-12 (rarely a few 20-30) mm long (Maui and Moloka'i) *B. hillebrandiana* ssp. *polycephala* Nagata & Ganders
- 21a. Achenes setose all along the margins, not conspicuously long tapered apically, 0.75-1.3 mm wide at widest point, at least 0.5 mm wide just below apex; inflorescences terminal as well as lateral; leaves pinnately compound with 3-7 leaflets or rarely bipinnate 22.
- 21b. Achenes either setose at base only or narrow and conspicuously long tapered apically, 0.5-0.75(-1) mm wide at widest point, tapering to 0.3-0.5 mm wide just below the apex ... 23.
- 22a. Leaflets more than 8 mm wide, less than 5 times as long as wide; ray flowers usually 5, 11-15 mm long (O'ahu and below 400 m elevation on Kaua'i)
..... *B. sandvicensis* Less. ssp. *sandvicensis*
- 22b. Leaflets less than 8 mm wide, more than 5 times as long as wide; ray flowers 5-6, 15-21 mm long (Kaua'i above 600 m elevation)
..... *B. sandvicensis* ssp. *confusa* Nagata & Ganders
- 23a. Achenes 1.0-1.25 mm wide at widest point, not conspicuously long tapered apically, about 0.5 mm wide just below apex, usually twisted; young stems not conspicuously square in cross section; leaflets 3-7, coriaceous; inflorescences on lateral branches only (Kaua'i)
..... *B. forbesii* ssp. *kahiliensis* Ganders & Nagata
- 23b. Achenes 0.5-0.75(-1.0) mm wide at widest point, usually conspicuously long tapered apically to 0.3-0.5 mm wide just below apex; young stems conspicuously square in cross section with sharp angles, leaflets semi-succulent or membranous but not coriaceous 24.
- 24a. Leaflets 1-3(-5), ovate, semi-succulent, terminal leaflet more than 30 mm wide; inflorescences usually only on lateral branches; ray flowers 8-13 mm long (Kaua'i) ..
..... *B. forbesii* Sherff ssp. *forbesii*
- 24b. Leaflets 5-11(-13), lanceolate, membranous, terminal leaflet less than 25 mm wide; inflorescences terminal as well as on lateral branches; ray flowers 15-21(-25) mm long (Kaua'i, Ni'ihau and O'ahu) *B. cervicata* Sherff
- 25a. Leaves bipinnately divided into long, entire, linear or filiform divisions less than 5 mm wide; achenes straight 26.
- 25b. Leaves simple or pinnately compound with serrate leaflets over 5 mm wide, or achenes coiled or twisted 27.
- 26a. Peduncles of heads glabrous; leaves glabrous, (70-)120-220 mm long including petiole, ultimate segments 2-3(-4) mm wide; plants branching only on the upper half of the stem (Maui and Moloka'i) *B. menziesii* (A. Gray) Sherff ssp. *menziesii*
- 26b. Peduncles of heads pubescent; leaves usually pubescent, especially when young, 35-90(-110) mm long including petiole, ultimate segments 1-2(-3) mm wide; plants with erect or virgate branches from below the middle of the stem (Hawai'i, Moloka'i?) ..
..... *B. menziesii* ssp. *filiformis* (Sherff) Ganders & Nagata
- 27a. Achenes straight or slightly curved, but not twisted or coiled 28.
- 27b. Achenes coiled, twisted, or irregularly contorted 31.
- 28a. Achenes 14-20 mm long; outer involucre bracts 2.5-5.0 mm long; inflorescences only on lateral branches (Maui) *B. conjuncta* Sherff
- 28b. Achenes less than 15 mm long; outer involucre bracts less than 2.5 mm long; inflorescences terminal as well as on lateral branches 29.

- 29a. Peduncles of heads pubescent; achenes awned, straight or rarely slightly curved; ray flowers 5-9; inflorescences compact; leaves simple, acuminate, or some trifoliolate (Hawai'i) *B. micrantha* ssp. *ctenophylla* (Sherff) Nagata & Ganders
- 29b. Peduncles of heads glabrous or glabrate; achenes various; ray flowers 3-5(-6); inflorescences diffuse or compact; leaves simple or pinnately compound, if simple, not acuminate . . . 30.
- 30a. Achenes straight, awned, ray flowers 5(-6); inflorescences diffuse; leaves pinnately compound with 3-7 leaflets (a few simple ones on some plants), leaflets usually with ciliate margins (Maui and Lana'i) *B. micrantha* ssp. *kalealaha* Nagata & Ganders
- 30b. Achenes slightly curved to coiled or twisted; usually awnless; ray flowers 3-5; inflorescences usually compact; leaves simple or pinnately compound with 3-7 leaflets, margins of leaflets not ciliate (Maui) *B. micrantha* Gaud. ssp. *micrantha*
- 31a. Disk flowers fewer than 10 per head; inflorescences terminal as well as on lateral branches; outer involucre bracts less than 2.5 mm long (Maui) . . . *B. micrantha* Gaud. ssp. *micrantha*
- 31b. Disk flowers more than 10 per head; inflorescences only on lateral branches; outer involucre bracts often over 2.5 mm long 32.
- 32a. Achenes usually awned, twisted about 1 revolution or less; outer involucre bracts 3-6 mm long; peduncles and leaves glabrous (O'ahu) . . . *B. asymmetrica* (H. Lev.) Sherff
- 32b. Achenes awnless or with minute remnants of awns, twisted or coiled 1-4 revolutions or irregularly contorted; outer involucre bracts 1.5-4 (-6) mm long; peduncles and young leaves usually pubescent with white to golden hairs (O'ahu) *B. torta* Sherff

LITERATURE CITED

- GILLET, G. W. 1975. The diversity and history of Polynesian *Bidens* section *Campylotheca*. Univ. of Hawaii, Harold L. Lyon Arboretum Lecture No. 6: 1-32.
- _____, and E.K.S. LIM. 1970. An experimental study of the genus *Bidens* in the Hawaiian Islands. Univ. Calif. Publ. Bot. 56: 1-63.
- MARCHANT, Y.Y., F.R. GANDERS, C.-K. WAT, and G.H.N. TOWERS. in press. Polyacetylenes in Hawaiian *Bidens* (Asteraceae). Biochemical Syst. and Ecol.
- SHERFF, E.E. 1920. Studies in the genus *Bidens*. V. Bot. Gaz. (Crawfordsville) 70: 89-109.
- _____. 1937. The genus *Bidens*. Field Mus. Nat. Hist., Bot. Ser. 16: 1-709.