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COSMOS OCELLATUS, A *BIDENS* (ASTERACEAE, COREOPSIDEAE)

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ABSTRACT

Cosmos ocellatus Greenman is transferred to *Bidens* as **Bidens ocellatus** *comb. nov.* Illustrations and discussions (primarily of achene morphology and flavonoid chemistry) supporting this change are presented.

KEY WORDS: Asteraceae, Coreopsideae, *Bidens, Cosmos*, México, systematics

Cosmos ocellatus Greenman is endemic to a very small area in northern Morelos, México, most collections coming from the type locale (Sierra de Tepoxtlan) and the "Pedregal" (lava fields) found ca. 10 miles north of Cuernavaca. Though initially placed in the wrong genus (*Cosmos*), specific identification of this yellow rayed, diploid annual (n = 12 [Melchert 1968]) has never been a problem because it is distinguished *at a glance* by the single, bright, maroon-red anthocyanin spot located at the *center* of each of its uniquely notched ligules (Figure 1). No other Mexican *Bidens* (*Cosmos, Coreopsis*, or *Thelesperma*) species is so marked!

Both in his original monograph of *Cosmos*, and later in an updated treatment of the Coreopsidineae for the North American Flora, Sherff (1932; 1955) included this exceptionally distinctive species in *Cosmos* section *Eucosmos*, a group of annual species including *C. bipinnatus* Cav., *C. sulphureus* Cav., *C. caudatus* H.B.K., and *C. parviflorus* (Jacq.) H.B.K. Like these well known, often cultivated *Cosmos* species, *C. ocellatus* has linear-tetragonal achenes which are prolonged apically into a narrow beak that protrudes well above the seed bearing portion of the achene. Over emphasis of this particular "key" character caused Sherff to misplace *C. ocellatus*, and a number of other annual species of *Bidens* (Melchert 1975), in the genus *Cosmos*. One effect of these misplacements was to unnecessarily blur the boundaries between the two genera. That *C. ocellatus* truly belongs in *Bidens* is demonstrated by four lines of evidence: 1) *stamen morphology*; 2) *achene morphology*; 3) *floral pigmentation*; and 4) *leaf flavonoid chemistry*.

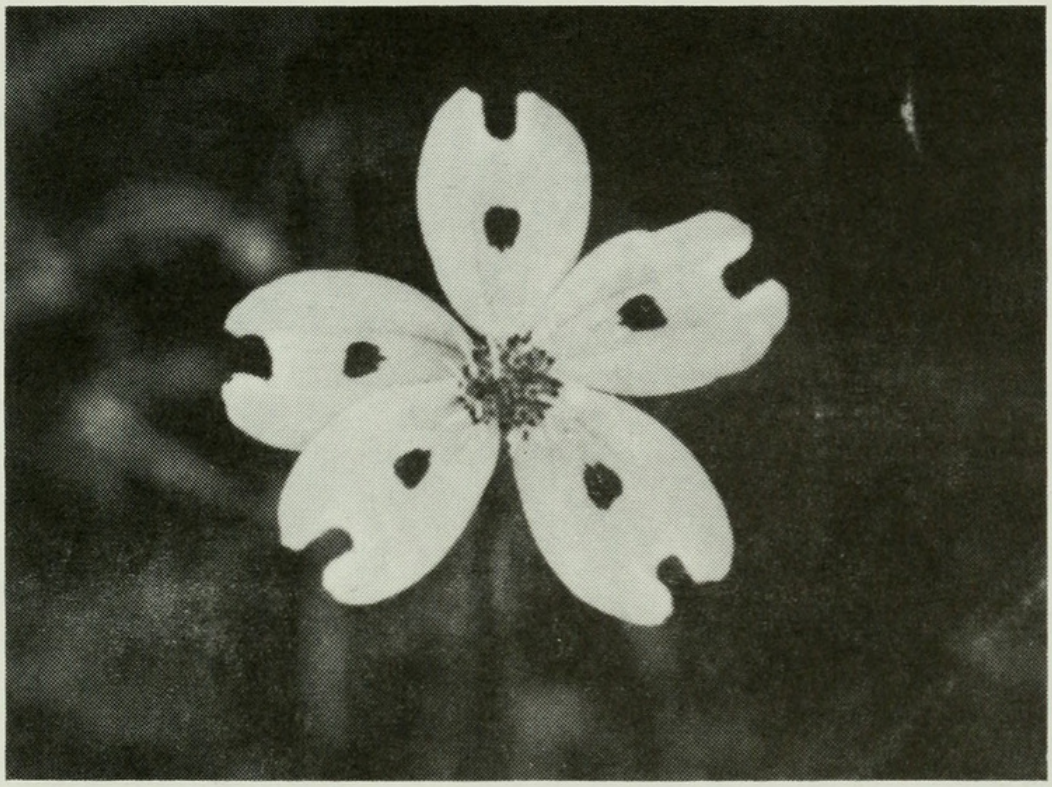


Figure 1. Head of "*Cosmos*" (now *Bidens*) *ocellatus*, note notched ligules and central anthocyanin spot. (*Melchert, Ballard & Hart* 71-222).

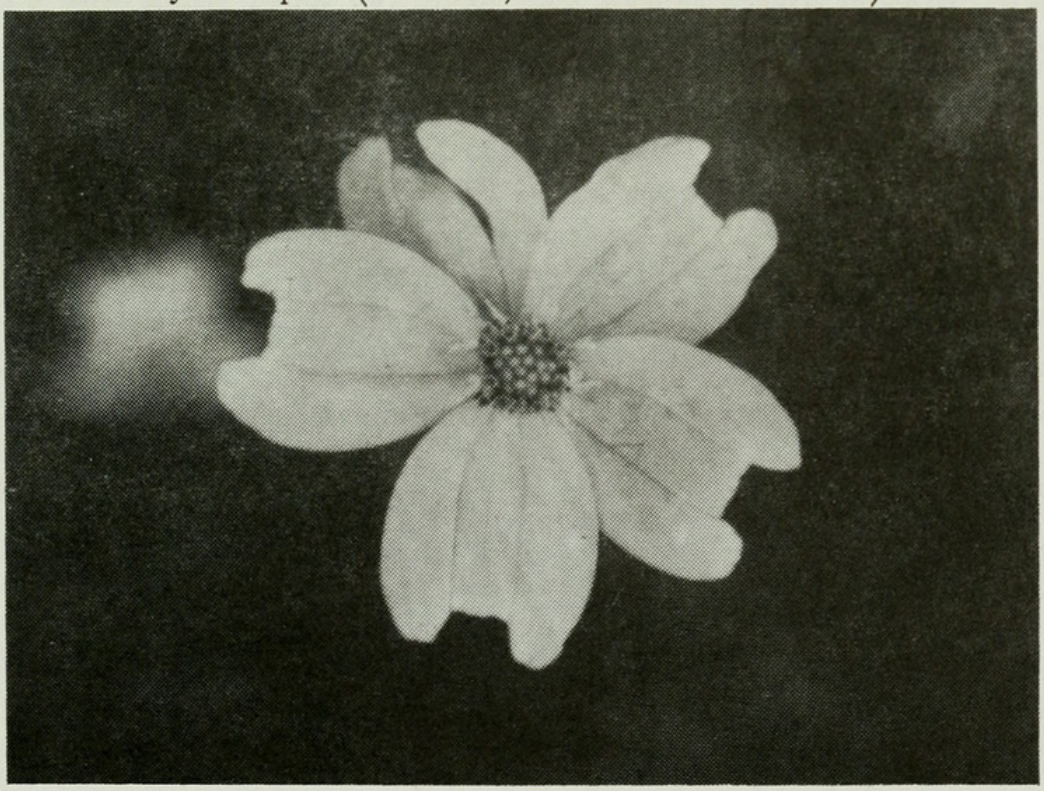


Figure 2. Head of "*Cosmos*" *ocellatus*, from individual lacking the central anthocyanin spot. (*Melchert, Ballard & Hart* 71-222).

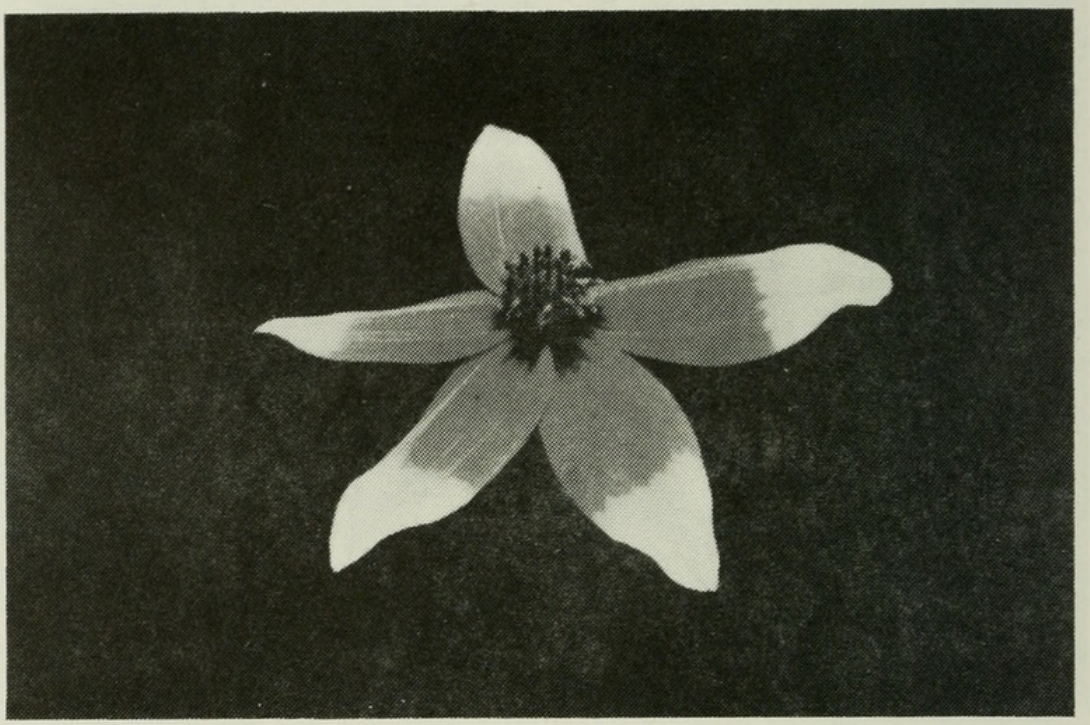


Figure 3. Head of *Bidens sharpii*, each ligule two toned yellow with a deep maroon-red anthocyanin spot.

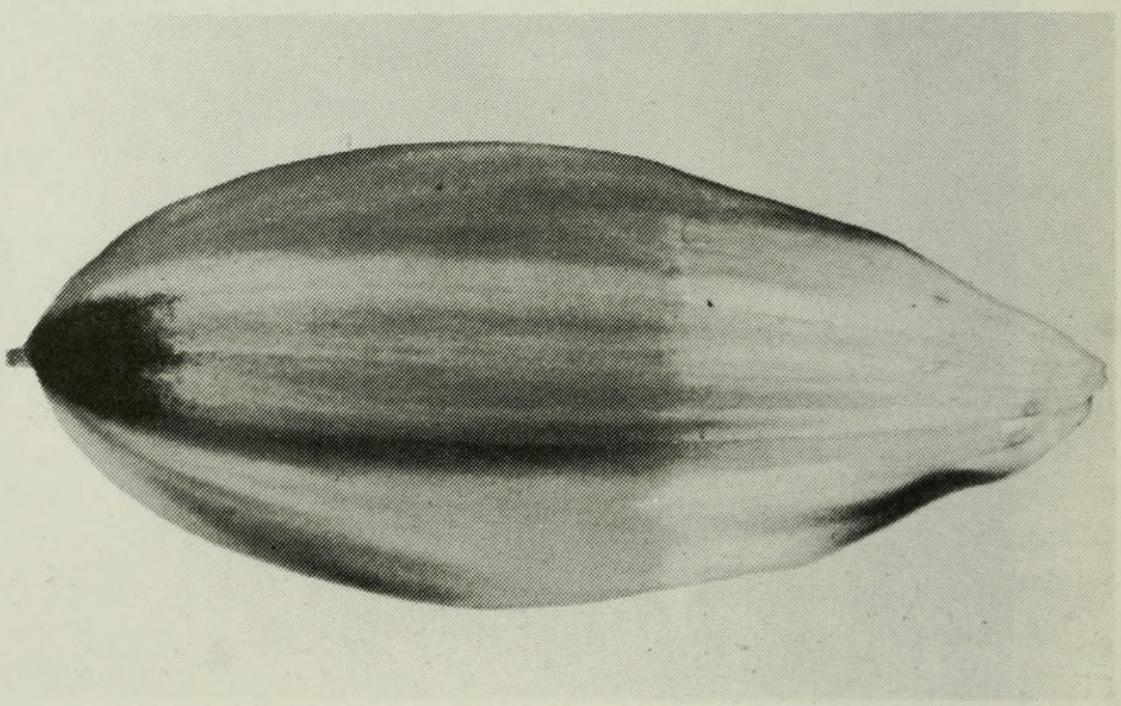
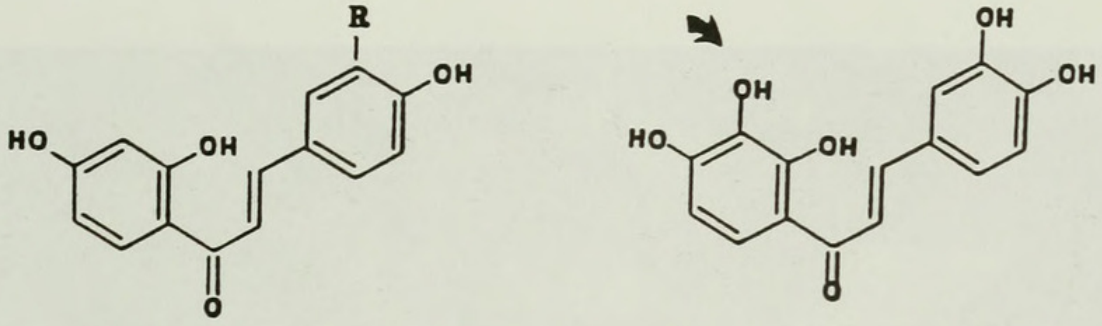


Figure 4. Single ligule of *Bidens sharpii*.



R = OH, Butein

R = H, Isoliquiritigenin

Okanin

(=3′OH Butein)

Fig. 5, chemical formulae contrasting Butein and Isoliquiritigenin with Okanin; note, Okanin differs from Butein only by the addition of a 3′OH group (arrow).

1. *Stamen Morphology*: All "true" *Cosmos* species have a moderate to dense tomentum of multicellular hairs on their filaments (Figure 6). The filaments of *Cosmos ocellatus*, by contrast, are glabrous and rather elastic, as are those of all other *Bidens* species known to me.

2. *Achene Morphology*: The achenes of *Cosmos* are typically fusiform-tetragonal. Whether beaked or not, each of their four faces exhibit two main sections separated by a distinct, median, longitudinal sulcus (Figure 7). In sharp contrast, Mexican *Bidens* species of section *Psilocarpaea* (the group to which all the Mexican annuals belong) typically show three nearly equal ribs per achene face (e.g., *B. sharpii* (Sherff) T. Melchert, Figure 8). Additionally, when observed under high magnification, the surface of most *Bidens* achenes show a black stippled texture never seen in *Cosmos*. As shown in Figure 9, the achenes of *Cosmos ocellatus* are three nerved on each face and stippled in texture, i.e., are essentially identical to those of *B. sharpii* (cf. Figures 8 & 9).

Though not noted in either Sherff's or Greenman's descriptions of *Cosmos ocellatus*, the latter has achenes which are decidedly dimorphic; several short, subclavate, yellow brown to rubrocastaneous achenes occurring at the peri- phery of each fruiting head, these differing abruptly from the blackish, linear-tetragonal achenes found to the interior. Such achene dimorphism, while common in *Bidens* section *Psilocarpaea* (occurring in *B. serrulata* (Poir.) Desf., *B. sharpii*, *B. bicolor*, *B. ferulaefolia* (Jacq.) DC., *B. pueblensis* (Sherff) T. Melchert, *B. triplinervia* H.B.K., etc.), is unknown in *Cosmos*.

3. *Ray Pigmentation*: The vast majority of yellow rayed Mexican *Bidens* species have two toned yellow ligules. Typically, the proximal 1/2 to 2/3 of each ligule is deep golden yellow and the distal portion pale yellow (the

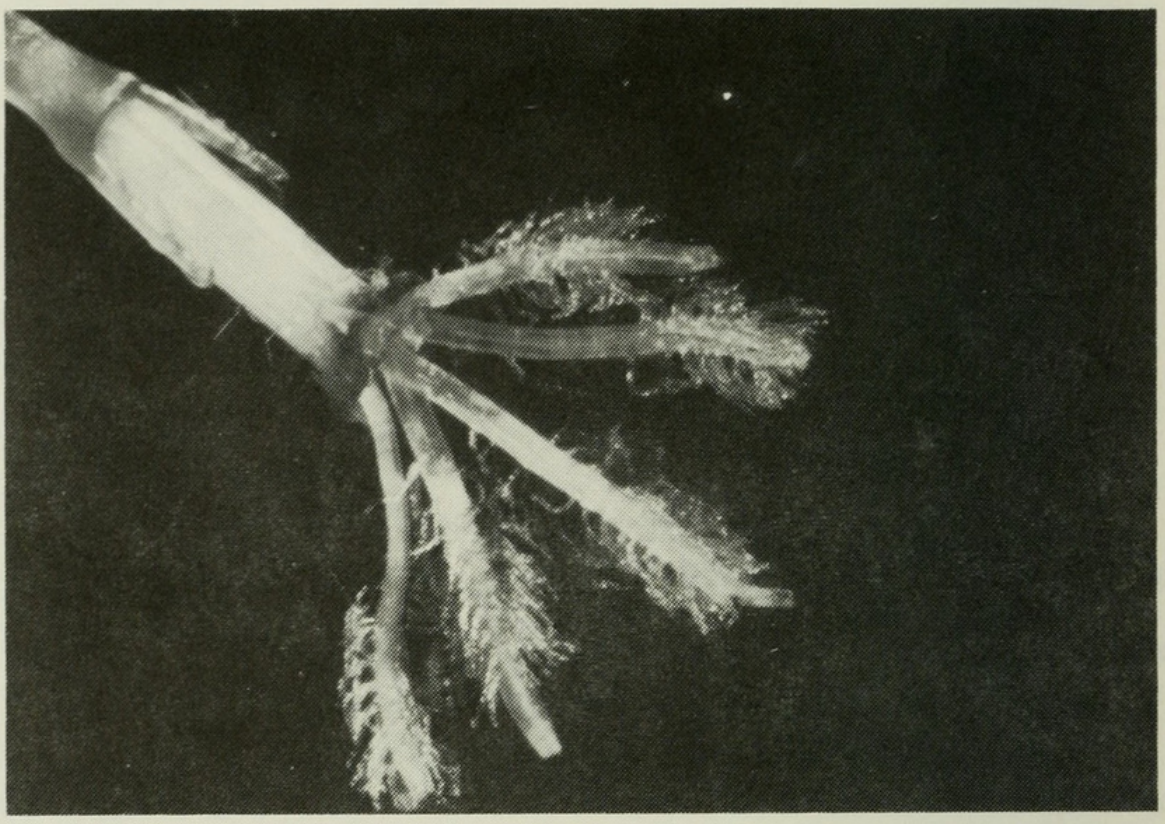


Figure 6. Filaments of *Cosmos* species (connate anthers removed).

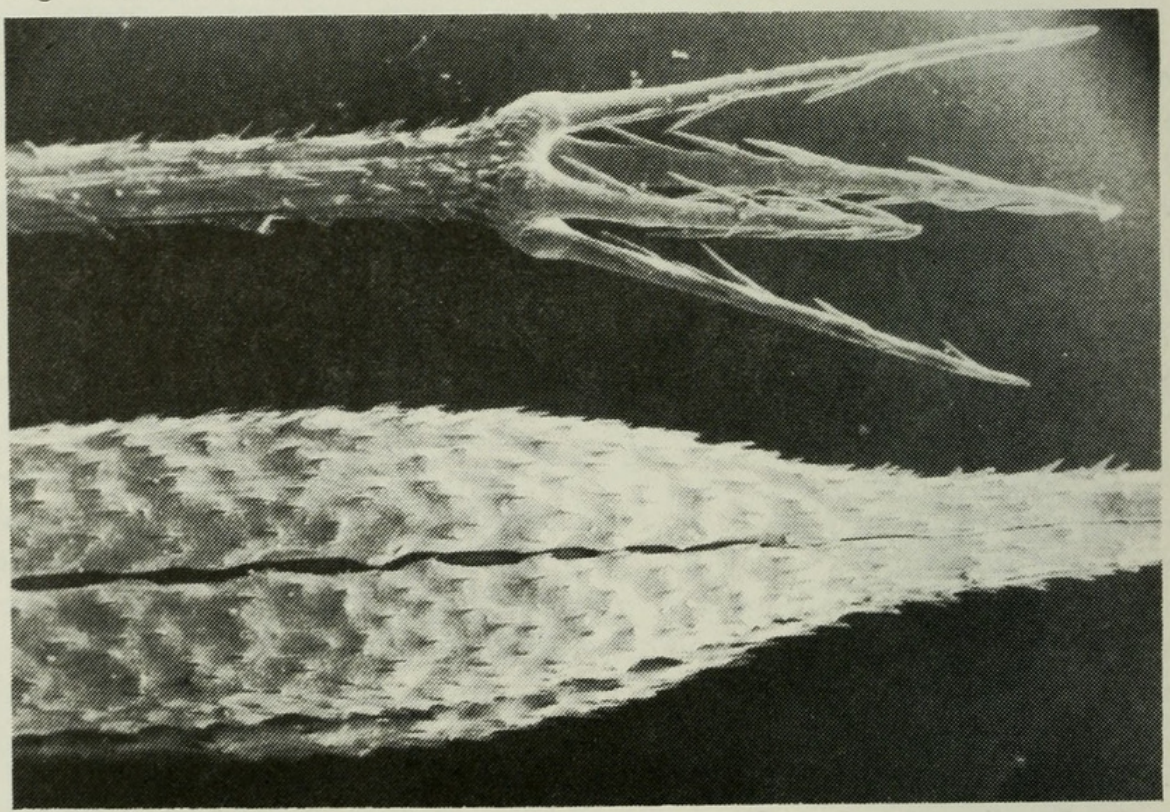


Figure 7. Achene of *Cosmos parviflorus*, showing one of four similar faces.

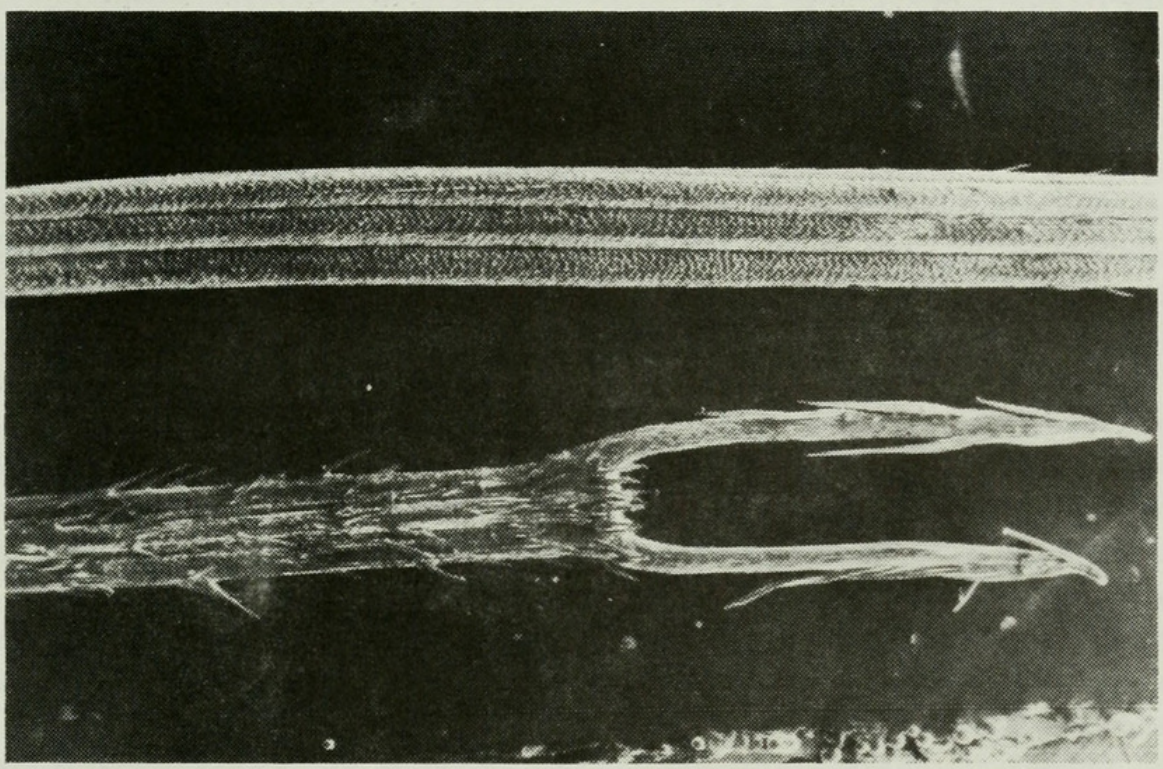


Figure 8. Achene of *Bidens sharpii*, showing one of four similar faces.

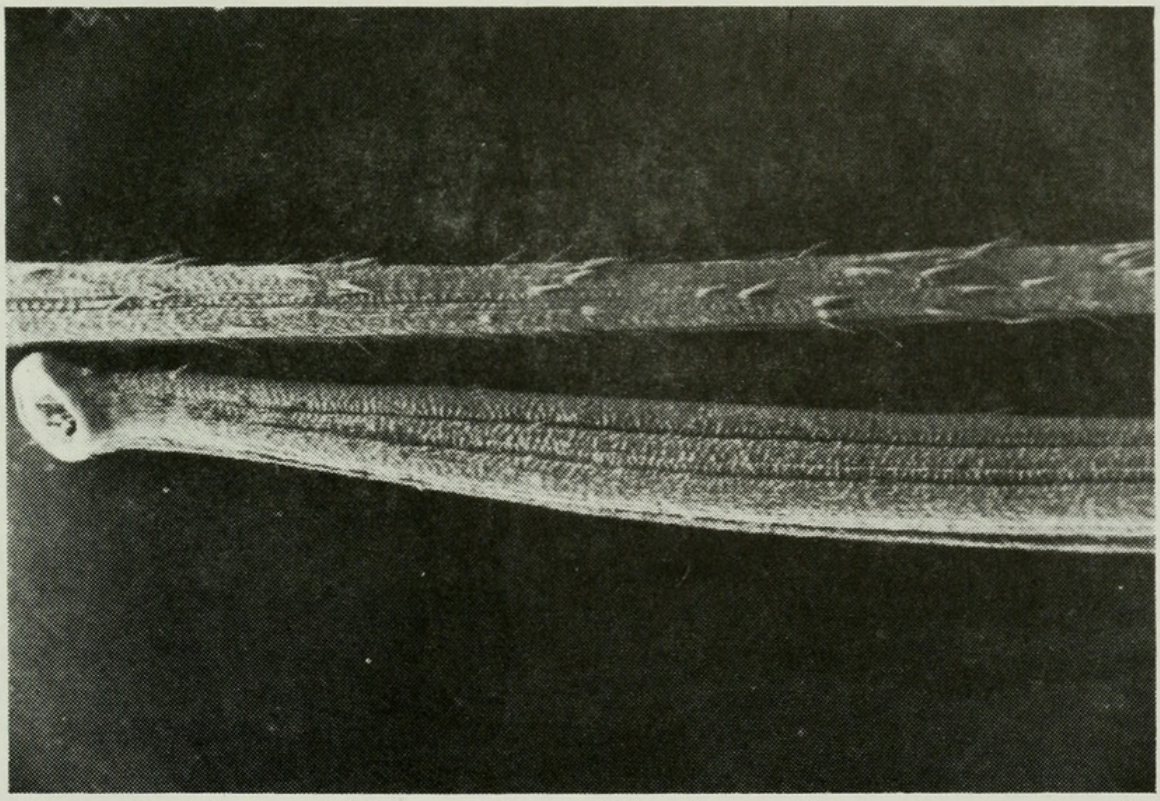


Figure 9. Achene of "*Cosmos*" (now *Bidens*) *parviflorus*, showing one of four similar faces.

latter often turning whitish with age or when pressed and dried). As shown in Figures 3 & 4, the boundary between these zones is quite abrupt. Furthermore, several of the annual species (*B. sharpii*, *B. bicolor* Greenman, *B. pueblensis*) have a red-brown anthocyanin spot *at the base* of each ligule (Figures 3 & 4), a condition which Sherff (1955) described as *bicolored.* Whether bicolored or not, both yellow (chalcone/aurone bearing) portions of their ligules include a *mix* of (1) okanin based and (2) butien-/isoliquiritigenin based chalcone/aurone pairs (Figure 5); simple 4-O-mono- and di-glycosides of *okanin* usually being the dominant compounds in the ray and disc florets of most yellow rayed *Bidens* species (Hart 1979; Roseman 1986; Melchert unpublished).

In sharp contrast to *Bidens*, yellow rays are rare in *Cosmos*, occurring in only two distantly related species, the diploid annual *C. sulphureus* ($n = 12$, section *Eucosmos*) and the tetraploid rhizomatous perennial, *C. landii* Sherff ($n = 22$, section *Mesenenia*). Neither of these taxa has two toned rays, nor are they, or any other *Cosmos* species, bicolored. More importantly, the chalcone portion of their flavonoid complements include only butein and isoliquiritigenin based compounds (4′-O- mono- and di-glycosides usually being the dominant compounds [Melchert unpublished]). In short, okanin based chalcones are not known to occur in *Cosmos.*

Though not shown in Figures 1 & 2, the ligules of *Cosmos ocellatus* are definitely two toned (the lighter portion being confined to the area of the notch); and are pigmented with a mix of *okanin* and *butein* based chalcone glycosides; i.e., are unquestionably *Bidens*-like.

4. *Leaf flavonoids*: The leaves (stems and outer involucral bracts) of *Cosmos* species contain a series of *flavones* and *flavonols* (various 3-O-glycosides of quercitin and kaempferol being the dominant compounds). Chalcones and aurones, however, are not found in the vegetative tissues of any *Cosmos* species (Melchert unpublished). In sharp contrast, leaf chromatograms of *Bidens* species typically exhibit a host of chalcone/aurone pairs, with *okanin based* compounds usually being the dominant "spots" in the profile. Interestingly, many of the "okanins" found in the leaves of *Bidens* species are structurally complex chalcones that are *unknown elsewhere* (e.g., methylated okanins, 3-O-substituted okanin glycosides, acylated okanin aglycones, etc. [Hart 1979; Ballard 1986; Roseman 1986; Melchert unpublished]).

The leaf profiles of *Cosmos ocellatus* contain four dominant flavonoids, *all anthochlors*, (three chalcones and one aurone), the major spot in the profile being a *3-O-monoglucoside of 4-O-Me-okanin* (Melchert unpublished), a chalcone reported previously only from the *Bidens pilosa* L. species complex (Ballard 1986).

In view of the above discussion, the following nomenclatural change is necessary.

Bidens ocellatus (Greenman) T. Melchert, *comb. nov.* BASIONYM: *Cosmos ocellatus* Greenman, Proc. Amer. Acad. Arts 41:265. 1905. TYPE: MÉXICO. Morelos: 7500 feet, in thin soil on knobs of the Sierra de Tepoxtlan, 14 Oct 1900, *C.G. Pringle 8386, pro parte* (HOLOTYPE: GH!; Isotypes: F!, MO!, NY!, POM!, UC!).

Cosmos ocellatus Greenman var. *greenmanii* Sherff, Bot. Gaz. (Crawfordsville) 88:305. 1929. TYPE: MÉXICO. Morelos: 7500 feet, in thin soil on knobs of the Sierra de Tepoxtlan, 14 Oct 1900, *C.G. Pringle 8386, pro parte* with type of the species (HOLOTYPE: F!; Isotype: MO!).

ADDITIONAL SPECIMENS EXAMINED: MÉXICO. Morelos: Alrededros de la Estación El Parque, Municipio de Tepoxtlan, bosque con dominancia de *pino, encino*, leguminosas e *Ipomoea*, 10 Jun 1967, *Crespo 219* (MSC); Teposteco, 22 Sep 1938, *Lyonnet 2551* (US); Slope of Tepozeteco, N of Tepozeteco, 21 Nov 1948, *Langman 3689* (US); 6 km SE de Cuajomulco, sobre la autopista México-Cuernavaca, 2100 m, 17 Oct 1965, *J. Rzedowski 21469* (TEX); Tollway 95D, 9.1 mi N of Cuernavaca, 18 Sep 1967, *Melchert, Averett, & Crawford 67-131* (IA); Tollway 95D, 9 mi N of jct with route 25D to Tapotozan, 22 Oct 1971, *Melchert, Ballard, & Hart 71-222* (IA).

The size and intensity of the diagnostic spot on the ligule varies considerably within single populations. Although most individuals in the population sampled by *Melchert, et al.* (*67-131, 71-222*) displayed a very conspicuous anthocyanin spot at the center of each ligule (Figure 2), in a few individuals, this spot was *either* reduced to a mere trace *or* absent entirely (Figure 2). Identification of such "atypical" specimens poses no problem however, because no other terete stemmed, yellow rayed, annual *Bidens* has copiously (nearly silver) pubescent outer involucral bracts or terminally truncated, deeply notched ligules.

As is common in many species of *Bidens*, the leaves of *B. ocellatus* are highly heteromorphic. Within single populations, some plants have 3-5 partite leaves with lance-ovate segments, while others (usually the vast majority) have 2-3 pinnatisect leaves with narrower divisions. The two varieties recognized by Sherff (1955) are clearly only leaf forms of a single species.

According to Pringle's field notes, the type specimen of *Cosmos ocellatus* (*Pringle 8386*) was collected 14 Oct 1900 on Sierra Tepoxtlan *in the state of Morelos* (Davis 1936). Unfortunately, the label on the type specimen erroneously lists this site as being in Guerrero; and, in the original description of this species, Greenman (1905) gives the collection date as 4 Oct 1900 (not 14 Oct 1900, as correctly noted on the label).

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