TAXONOMY OF *HELENIUM* SECT. *AMARUM* (ASTERACEAE)

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ABSTRACT

This treatment, which takes into account all known morphologic, ecologic, cytologic, and chemical data, recognizes *Helenium* L. sect. *Amarum* Bierner with two taxa: *Helenium amarum* (Raf.) Rock var. *amarum* and *H. amarum* var. *badium* (A. Gray ex S. Wats.) Waterfall. These are the only taxa of *Helenium* in North America with leaves not decurrent along the stem.

INTRODUCTION

Helenium L. sect. *Amarum* Bierner comprises two taxa distributed mainly in the southcentral and southeastern United States (Bierner 1972, Stanford and Turner 1988). The taxa are here recognized at the varietal level as *Helenium amarum* (Raf.) Rock var. *amarum* and *H. amarum* var. *badium* (A. Gray ex S. Wats.) Waterfall. This concept follows the views of Watson (1883), Waterfall (1960), and Stanford and Turner (1988).

The specific epithet "*amarum*" was originally used by Rafinesque (1817) when he described a plant from Louisiana and Mississippi as *Galardia amara*. Nuttall's (1834) name *Helenium tenuifolium*, however, was used for many years until Rock (1957) recognized that the two were synonymous and formed the new combination *Helenium amarum*. In fact, var. *badium* was originally described as *H. tenuifolium* var. *badium*.

In 1902, Greene recognized these taxa as separate species, a concept that persisted for quite some time (Bierner 1972, Correll and Johnston 1970, Rock 1957). In this treatment, I have recognized them as varieties of one another because of the compelling ecologic evidence presented by Stanford and Turner (1988), and because such treatment is warranted when the morphologic, cytologic, and chemical data are considered.

It is hoped that this taxonomic treatment will be of value to researchers who are interested in this section because of *Helenium amarum* var. *amarum*'s well known toxicity to livestock and its ability to cause bitterness in the milk of cows that eat it (e.g., Ivie et al. 1975). This taxon also contains chemical compounds that may be efficacious as insecticides (e.g., Arnason et al. 1987) and as antineoplastic agents (e.g., Waddell et al. 1979). With

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regard to the above subjects, I have found no reports in the literature for var. *badium*.

INTERSECTIONAL RELATIONSHIPS

Section *amarum* is delimited from the four other North American sections of *Helenium* by its nondecurrent leaves (Bierner 1972). There are, however, many nondecurrent-leaved species in South America in sections *Actinea* and *Cephalophora* (Bierner 1978, 1987). In addition, *Helenium aromaticum* (Hook.) Bailey of sect. *Cephalophora* produces the sesquiterpene lactones aromaticin, helenalin, and mexicanin I (Romo et al. 1964), all of which have been isolated from *H. amarum* var. *amarum* (Seaman 1982). I was tempted at one point, therefore, to use these data to suggest that sect. *Amarum* of North America is most closely related to sect. *Cephalophora* of South America. Later, however, it was my opinion that there was better evidence (Bierner 1987) for a disjunction from sect. *Tetrodus* of North America to Chile giving rise to sect. *Cephalophora*. If this hypothesis is correct, there is no direct link between sect. *Amarum* and the South American sections.

It appears on morpholgic and cytologic grounds that sect. *Amarum* may be most closely related to sect. *Tetrodus*. In particular, both taxa of sect. *Amarum* and 12 of the 14 taxa of sect. *Tetrodus* are annuals with narrow involucral bracts that are reflexed at anthesis, while the other North American taxa are perennials with wide involucral bracts that often are only spreading at anthesis. Cytologically, the chromosome number of $n = 15$, which is found in both taxa of sect. *Amarum*, has been observed in only two other species of *Helenium*, both of which are in sect. *Tetrodus* (Bierner et al. 1977, Grashoff et al. 1972).

INTRASECTIONAL RELATIONSHIPS

Recognizing the two taxa of sect. *Amarum* as varieties of the same species is not a new idea. *Helenium amarum* var. *badium* was, in fact, originally described as a variety under the old name *H. tenuifolium*.

The two taxa are very similar morphologically, differing mainly in the color of the disc corolla lobes and the shape of lower and basal leaves (see descriptions). Based on observations of a mixed population in Austin, Texas, Stanford and Turner (1988) suggested that the section be " . . . treated as monotypic, the single species comprised of two regional intergrading varieties . . ." For approximately 10 years, Turner had noted that this population included plants with yellow discs and plants with reddish-brown discs, that the percentage of each would vary from year to year, and that this was the only character that would distinguish between them. In

addition, Stanford and Turner noted that plants in populations to the west of Austin on the Edwards Plateau become totally reddish-brown-headed and have lower leaves that are more pinnatisect, while plants in populations east of the Edwards Plateau become more robust, have all yellow heads, and have less dissected lower leaves.

These morphologic differences are not great, but they are fairly consistent, and there is a geographic integrity to the distribution of plants that have these distinguishing characters. Plants referable to var. *badium* are found mainly from central Texas north to southcentral Oklahoma, and southwest to the states of Coahuila and Chihuahua in northcentral Mexico, while those referable to var. *amarum* are found mainly from central Texas and central Oklahoma to the east (Stanford and Turner 1988). There is some overlap in their distributions, particularly along the Balcones Escarpment in Texas. Populations containing plants with both types of morphology (e.g., *Bierner and Averett 42* & *43* TEX; the population noted by Stanford and Turner 1988) or with apparent intermediate morphology (e.g., *Bierner and Szatkowski 297* & *298* TEX) can be found in these areas.

Ecologically, both are weedy taxa that commonly grow near roadsides and in disturbed pastures and fields. However, var. *amarum* tends to grow on clay soils in areas with 30 – 60 inches annual precipitation, while var. *badium* grows mainly on calcareous soils in drier areas to the west (Stanford and Turner 1988). Furthermore, var. *amarum* behaves as a winter or summer annual and completes its life cycle predominantly during the following summer or autumn (Baskin and Baskin 1973), while var. *badium* flowers mainly during the spring and early summer. Plants of both taxa, however, can be found flowering throughout most of the year.

All plants of sect. *Amarum* that have been examined thus far have a chromosome number of $n = 15$ (Grashoff et al. 1972). In general, meiosis is very regular with 15 clear bivalents formed during diakinesis and metaphase I. In the population mentioned above as containing plants with apparent intermediate morphology, however, I was not able to obtain counts because of irregularities in the meiotic process. This combination of morphologic intermediacy and irregular meiosis suggests that the plants were hybrids and supports a hypothesis that there are two taxa that have diverged from one another to some extent.

The flavonoid chemistry of var. *amarum* and var. *badium* is almost identical (Bierner 1973), but sesquiterpene lactone chemistry is unclear at present. Several sesquiterpene lactones have been reported in var. *amarum* (Seaman 1982), while only tenulin has been identified in var. *badium* (Clark 1939). I suspect that many of the sequiterpene lactones found in var. *amarum* will be found in var. *badium* when it is thoroughly characterized.

This is a classic situation for the recognition of geographic varieties. The taxa are very similar as to their morphology, ecology, cytology, and chemistry, but they occupy different geographic areas, they are morphologically separable in areas of allopatry, and there is a zone of sympatry in which there is some morphologic intergradation with some meiotic irregularities.

TAXONOMY

HELENIUM L. sect. AMARUM Bierner, Brittonia 24(4):335. 1972.
TYPE: *Helenium amarum* (Raf.) Rock.

Taprooted annuals. Stems one to occasionally several originating at the base, unbranched to usually corymbosely branched above, sulcate below becoming striate above, glabrous below becoming sparsely pubescent above with short antrorse hairs, usually moderately dotted with sessile glands. Peduncles 3 – 11 cm long, striate, sparsely pubescent with short antrorse hairs, moderately dotted with sessile glands, broadened beneath the receptacle. Leaves sessile, not decurrent. Middle and upper leaves linear, entire, sparsely pubescent with short antrorse hairs, densely dotted with impressed glands. Lower and basal leaves often withered at anthesis, linear to ovate in outline, entire to pinnately toothed or lobed to pinnatifid, glabrous to sparsely pubescent with short antrorse hairs, densely dotted with impressed glands. Heads solitary to numerous, hemispheric to globoid to globose. Receptacle hemispheric to globoid to ovoid, alveolate, naked. Involucre of two series of free bracts, the outer exceeding the inner, reflexed at anthesis. Outer involucral bracts green, linear lanceolate, acuminate, moderately to densely pubescent with short antrorse hairs, moderately dotted with impressed and sessile glands. Inner involucral bracts yellow-brown, often green toward the tips, oblanceolate to obovate, acuminate, sparsely to moderately pubescent with short antrorse hairs, sparsely to moderately dotted with sessile glands. Ray florets 8 – 10 per head, pistillate, fertile. Ligules 3-lobed, yellow, upper surface glabrous and without glands, lower surface moderately to densely pubescent with short antrorse hairs, moderately to densely dotted with sessile glands. Disc florets bisexual and fertile. Disc corollas 5-lobed, cylindric, yellow with yellow to yellow-brown to purple lobes, sometimes purple the upper 1/4 to 3/4, sparsely to moderately dotted with sessile glands. Achenes ribbed, moderately to densely pubescent with straight hairs that are forked at the apex. Pappus scales 6 – 8, obovate, awn-tipped or acuminate into the awn. Chromosome number, $n = 15$.

KEY TO THE TAXA OF *HELENIUM* SECT. *AMARUM*

A. Disc corollas yellow with yellow to yellow-brown lobes; lower and basal leaves usually withered at anthesis; lower leaves usually entire, occasionally pinnately toothed; basal leaves entire to pinnately toothed to occasionally pinnatifid. . . . . 1a. *H. amarum* var. *amarum*

A. Disc corollas usually yellow with purple lobes, but sometimes yellow at the base and purple in the upper 1/4 to 3/4; lower and basal leaves sometimes withered at anthesis, but often persistent; lower leaves linear to ovate in outline, entire to pinnately toothed or lobed to pinnatifid; basal leaves pinnatifid. . . . . 1b. *H. amarum* var. *badium*

1a. HELENIUM AMARUM (Raf.) Rock var. AMARUM, Rhodora 59:131. 1957. BASIONYM: *Galardia amara* Raf., Fl. Ludov. 69. 1817. TYPE: U.S.A. LOUISIANA. Rapides Parish: Alexandria, 6 Sep 1898, *C.R. Ball 182* (NEOTYPE: US!).

Helenium tenuifolium Nutt., J. Acad. Nat. Sci. Philadelphia 7:66. 1834. TYPE: ALABAMA. *Beck s.n.* (LECTOTYPE: PH!). *Heleniastrum tenuifolium* (Nutt.) Kuntze, Rev. Gen. Pl. 1:342. 1891.

Plants (1)2 – 6(10) dm tall. Lower and basal leaves usually withered at anthesis. Basal leaves linear to ovate in outline, entire to pinnately toothed to occasionally pinnatifid. Lower cauline leaves usually linear, usually entire, but occasionally pinnately toothed. Heads 5 – 9 mm high, 6 – 10 mm wide. Receptacle 1.2 – 2.1 mm high, 1.4 – 3.5 mm wide. Ligules 6.5 – 14 mm long, 4 – 10 mm wide. Disc corollas yellow with yellow to yellow-brown lobes, 2.0 – 2.7 mm long, 0.8 – 1.2 mm wide. Achenes 0.9 – 1.3 mm long, 0.6 – 0.8 mm wide. Pappus scales 6 – 8, 1.2 – 1.8 mm long including the awn, 0.4 – 0.6 mm wide, the awn 0.7 – 1.1 mm long. Chromosome number, $n = 15$.

Flowering February to December, mainly July to October. From central Texas and central Oklahoma eastward throughout the southeastern United States and northeast as far as Connecticut.

1b. HELENIUM AMARUM (Raf.) Rock var. BADIUM (A. Gray ex S. Wats.) Waterfall, Rhodora 62:321. 1960. BASIONYM: *Helenium tenuifolium* Nutt. var. *badium* A. Gray ex S. Wats., Proc. Amer. Acad. Arts 18:108. 1883. TYPE: TEXAS. Travis Co.: "Bottoms," Austin, 20 May 1872, *E. Hall 364* (LECTOTYPE: here designated GH!; ISOLECTOTYPES: NY!, PH!, US!). ≡ *Helenium badium* (A. Gray ex S. Wats.) Greene, Pittonia 5:55 – 56. 1902.

Plants 1 – 5(8) dm tall. Lower and basal leaves sometimes withered at anthesis, but often persistent. Basal leaves pinnatifid. Lower cauline leaves linear to ovate in outline, entire to pinnately toothed or lobed to pinnatifid. Heads 5 – 8 mm high, 6 – 9 mm wide. Receptacle 1.1 – 2.0 mm

high, 1.3 – 3.1 mm wide. Ligules 4.5 – 14 mm long, 2 – 9 mm wide. Disc corollas usually yellow with purple lobes, but sometimes yellow at the base and purple in the upper 1/4 to 3/4, 1.6 – 2.5 mm long, 0.8 – 1.2 mm wide. Achenes 0.7 – 1.0 mm long, 0.5 – 0.7 mm wide. Pappus scales usually 6, 1.0 – 1.5 mm long including the awn, 0.4 – 0.5 mm wide, the awn 0.4 – 0.8 mm long. Chromosome number, $n = 15$.

Flowering March to November, mainly April to July. The Edwards Plateau of central Texas north to north Texas and southcentral Oklahoma, and west and southwest to Trans-Pecos Texas and adjacent Mexico.

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