

Rediscovery of *Echinacea angustifolia* and *Cirsium undulatum* in the loess hills of Missouri, with confirmation of *Solidago jejunifolia*

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ABSTRACT. — New populations of three species — *Echinacea angustifolia*, *Cirsium undulatum*, and *Solidago jejunifolia* — are documented from xeric loess hill prairies in Missouri. *E. angustifolia* and *C. undulatum* were previously known only from historic records, while an extant population of *S. jejunifolia* is verified at the same location as a 2003 collection.

INTRODUCTION

The loess hills of Missouri and Iowa are a unique landform consisting of deep deposits of wind-blown soil (loess). These deposits, which are believed to have originated from the ancient Missouri River that drained pre-Illinoian glacial events (Rovey and McLouth 2015), reach over 100 feet deep in many places, and are composed of angular sand, calcium, and loess. In Missouri, loess hill prairies are considered a dry expression of glaciated tallgrass prairie (Nelson 2010) and occur in a narrow band of hills directly overlooking the Missouri River to the west.

Although deep loess deposits can be found along the Missouri River as far south as Van Meter State Park in Saline County, loess hill prairies have been documented only from St. Joseph northward (Bush 1895), and are today best expressed only in Atchison and Holt counties. There are currently only 173 acres of loess hill prairie left in Missouri (Missouri Natural Heritage Program, personal communication, 2021) and many of these remnants are threatened by woody intrusion and soil mining. Because larger particles of loess were deposited closer to the water source, the hills closest to the ancient Missouri River channel offer the most distinctive soil characteristics (Mutel 1989). These hills are excessively drained and feature unique plant and animal communities that are most similar to a mixed-grass prairie although loess hill prairie is often considered a xeric expression of tallgrass prairie. Today, these prairies are maintained through the use of prescribed fire, mechanical, and chemical means. Historically, regular fire and periodic drought were thought to be the primary drivers of species composition.

Twenty-one of the plant species of conservation concern tracked by the Missouri Department of Conservation (2021) occur in the loess hills; all of these typically have their main ranges west of Missouri. Characteristic species of loess hill prairies in Missouri which should be considered associates of the species discussed here include *Astragalus lotiflorus*, *Bouteloua hirsuta*, *Castilleja sessiliflora*, *Dalea enneandra*, *Liatris punctata* var. *punctata*, *Lygodesmia juncea*, *Muhlenbergia cuspidata*, *Oxytropis lambertii* var. *lambertii*, *Schizachyrium scoparium*, and *Yucca glauca* (Yatskievych 1999, 2006, 2013).

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Over the past ten years, two species have reappeared as a constituent of the Missouri loess hills flora after a long hiatus: *Echinacea angustifolia* and *Cirsium undulatum*. A third species, *Solidago jejunifolia*, was recently described and reported in Missouri from herbarium specimens. Field work has confirmed the persistence of this species in the loess hills of Missouri.

1. *Echinacea angustifolia* DC.

Echinacea angustifolia, narrow-leaved purple coneflower (**Figure 1**), is primarily a Great Plains species, distributed from Manitoba and Saskatchewan (Urbatch et al. 2006), south to northeastern New Mexico and Texas. Range-wide, the species is ranked as G4 (Apparently Secure), but is considered critically endangered (S1) in Iowa (NatureServe 2021). It is most similar to *E. pallida*, but is separated by its short (<4 cm), spreading rays and yellow pollen (Yatskievych 2006, GPFA 1986; see also **Figure 1**). It is considered a characteristic member of the Great Plains flora with the majority of occurrences found on dry, rocky prairies (GPFA 1986).

The documentation of this species in Missouri has been sporadic. It was first discovered in 1961, in a private remnant prairie near Taberville Prairie Conservation Area in St. Clair County (Tropicos 2021: MO-2109569). In 1963, Victor Muehlenbach collected a waif (Tropicos 2021: MO-2109566) in the Baden Freight Yards in St. Louis; this area was a fertile site for many exotic species prior to widespread use of herbicides (Muehlenbach 1979). In 1965 a specimen was collected from a roadside north of Cape Girardeau in Cape Girardeau County (Missouri Natural Heritage Program, personal communication, 2021). Overall, this species has been frequently reported but seldom verified within the state, and Yatskievych (2006) considered the species introduced in Missouri. For a full history of *E. pallida* and related species in Missouri see Yatskievych (2006).

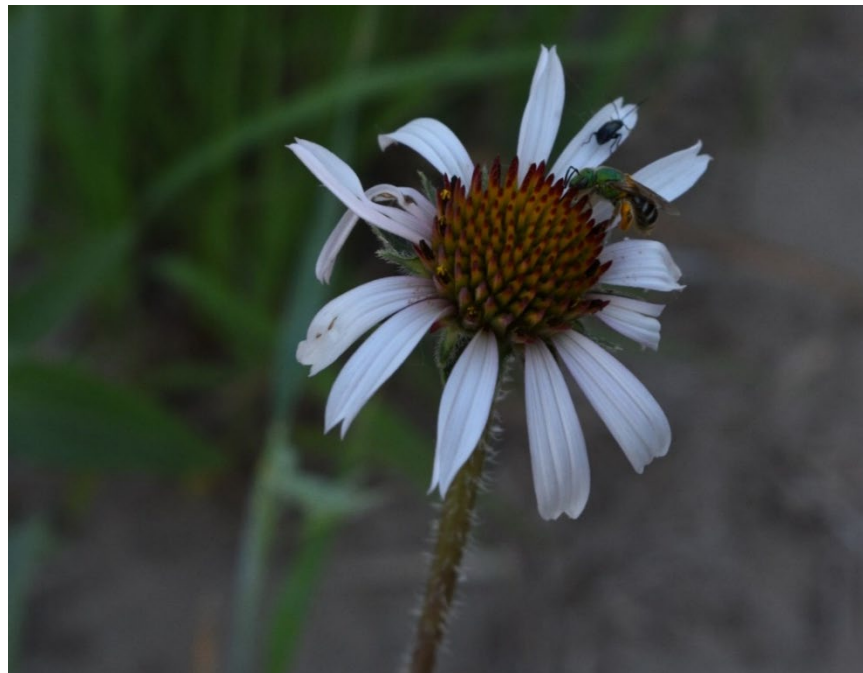


Figure 1: *Echinacea angustifolia* inflorescence, showing spreading ray florets and yellow pollen, with *Agopostemon* visitation. Star School Prairie Conservation Area. Photo by the author, 17 June 2016.

Echinacea angustifolia was first located in a native habitat in Missouri in 2014, when several flowering specimens were noted adjacent to a historic roadcut through a loess hill prairie at Star School Hill Prairie Conservation Area in Atchison County. Several botanists verified this occurrence in the following few years, including George Yatskievych and an independent discovery by Justin Thomas (Ladd and Thomas 2015). A voucher specimen was collected by the author in 2016 (*Buback 16-006, hb buback*). The species has since been noted on steep side slopes in remnant loess hill prairie at Star School Hill Prairie Conservation Area and on a separate property 1.5 km to the south, where it was discovered in 2020. These loess hill prairies are well botanized, so it is surprising that such a conspicuous species would have gone undetected until now. *Echinacea pallida* is generally not present in loess hill prairies, and pollen color and morphology clearly separate the two species. The yellow pollen and spreading rays of *E. angustifolia* are apparent in **Figure 1**, whereas *E. pallida* has white pollen and drooping rays.

One possible explanation for the occurrence of *E. angustifolia* at the site is propagule transport from extant populations in Iowa or Nebraska, which is further supported by the appearance of individuals on the south tract of Star School Hill Prairie Conservation Area in 2020. There were no known equipment movements or other vectors during this time to suggest that the migration is human-facilitated. Additionally, Bush (1895) did not mention this species in the loess hills, lending credence to the idea of a more recent establishment. No site contains more than 10 individuals, and populations should continue to be monitored and protected.

2. *Cirsium undulatum* (Nutt.) Spreng.

Cirsium undulatum, wavyleaf thistle, is a widespread species that occurs throughout the western and northern United States and adjacent western Canada (Kiel 2006). This perennial thistle has both leaf surfaces covered with a wooly pubescence (**Figure 2**). The species is secure (G5) from a rangewide perspective, although both Missouri and Iowa consider the species Critically Imperiled (S1) from a state perspective (NatureServe 2021). Throughout most of its range it is considered common, occupying habitats including dry prairies, roadsides, and open disturbed areas (GPFA 1986).

The first collector of *Cirsium undulatum* in Missouri was Benjamin Franklin Bush, who reported it as uncommon near Sheffield, Jackson County in 1894 (Bush 1895). Populations have subsequently been documented along railroad tracks in Jackson and Wayne counties and in St. Louis City, but these populations have not been relocated. These populations could have been adventive from propagules transported by the railroad or remnants of native populations. Art Christ collected a specimen at an unknown locale 3 miles south of Watson, in Atchison County, in 1932 (TROPICOS 3507456). This location is currently part of an entire section of tilled agricultural land, but in 1932 could have been bottomland prairie. Aerial photography from October 1950 shows the area to be a mix of row crop and what could be native pasture or hay prairie. Tom Toney relocated a specimen in Atchison County in 1978 but provided no detailed location information (TROPICOS 3257799). In fall of 2011, short individuals of this species were found in Atchison County along a roadside that had been sprayed with herbicide. These plants consisted of rosettes with the characteristic upper and lower leaf pubescence of the species, but herbicide use prevented flowering.

Further searching led to the discovery of basal rosettes of the species on the loess hill prairie at the north end of Brickyard Hill Conservation Area in Atchison County, where a single individual bloomed in the fall of 2011. Here the basal rosettes all appeared to be infested with *Trichosirocalus horridus*, a weevil introduced for the biological control of musk thistle (*Carduus nutans*). Over the last ten years, the population has persisted on the loess hill prairies but generally only 10% of the rosettes bloom in any given year. As a drought-tolerant perennial, the species may be able to persist without flowering for some time due to its “deeply seated runner roots that produce adventitious buds” (Keil 2006). Bush (1895) noted that this species was found about halfway up the sides of several loess mounds, as are the current plants.

In the field, individuals of *Cirsium undulatum* were very distinct from other native and exotic thistles, with dense pubescence on abaxial and adaxial surfaces. Plants were most noticeable as basal rosettes, which were widely separated (~1 m) from each other, and only flowering sporadically. Flowering plants were typically short (<0.5 m), blooming from May to August over the last 10 years. Counts of rosettes peaked at 26 in 2020, so the population is still precarious. Typical management has allowed the species to persist at the site, but additional monitoring is needed to ensure this species remains a part of the Missouri flora.



Figure 2. *Cirsium undulatum*. **A.** Inflorescence; **B.** Leaves and stem. Brickyard Hill Conservation Area. Photos by the author, 30 July 2017.

3. *Solidago jejunifolia* E.S. Steele

Solidago jejunifolia, sometimes called long-petioled showy goldenrod, is a recently resurrected species in the section *Squarrosae* (Semple et al. 2017). *Solidago jejunifolia* is most similar to *S. speciosa*, from which it differs in having long, thin petioles, especially on basal leaves

(Semple et al. 2017). In their Flora of North America treatment for the genus, Semple and Cook (2006) treated the species as a synonym of *S. speciosa* var. *speciosa*. Yatskievych (2006) notes that the taxon is not known from Missouri. It was first documented from the state in 2017 when Semple redetermined a specimen collected by the late Jack Harris in Atchison County from Star School Hill Prairie Conservation Area in 2003 (Semple 2017), but no further specimens from Missouri were identified. Occurrences have also been documented (Semple 2017, Semple et al. 2017) in Nemaha County, Nebraska, directly across the Missouri River from Atchison County, and in eastern Iowa from Muscatine County, so additional populations could be anticipated in northern Missouri. The bulk of the populations of *S. jejunifolia* are documented from western Wisconsin and central Minnesota on sandy sites (Semple et al. 2017).

During an October 2019 visit to the loess hills with Aaron Floden and Meg Englehardt, Aaron brought the newly described species to my attention. We located the species on the crest of hills at Star School Hill Prairie Conservation Area in Atchison County, and I subsequently found specimens on loess hill prairies at Brickyard Hill Conservation Area in Atchison County. We were unable to locate any *S. speciosa* sensu stricto at these sites, so it is possible that previous reports of *S. speciosa* from the area include or consist of *S. jejunifolia*. I have not located *S. jejunifolia* outside of these two loess hills prairies, so it is possible that the species could be considered a loess hill specialist in Missouri.

In the loess hills, the species is relatively common and populations on most publicly-owned loess hill prairies likely number in the dozens, although no population estimations were made. The Missouri populations occur on substantially different substrates than populations elsewhere in the range, and it is recommended that future searches should focus on sandy areas along the Mississippi River in northeastern Missouri. Interested parties should also note the presence of *S. rigidiuscula* in Missouri, where it is purported to inhabit drier areas than typical *S. speciosa*. A modified key to the *S. speciosa* complex from Semple (2017) is presented below. Note that late-season flowering or fruiting material is required for accurate identification.

KEY TO THE *SOLIDAGO SPECIOSA* COMPLEX IN MISSOURI

- 1 Petioles of basal rosette and lower stem leaves often comprising half or more of total leaf length; lower stem leaves present at flowering; ovaries and achenes with sparse pubescence; currently known only from loess hill prairies in northwest Missouri..... *Solidago jejunifolia*
- 1 Petioles of basal rosette and lower stem leaves comprising less than one-third of total leaf length; ovaries and achenes glabrous to sparsely pubescent; habitat and distribution various.
 - 2 Lower stem leaves absent at flowering; middle and upper stem leaves relatively numerous and overlapping; ovaries and achenes sparsely pubescent*Solidago rigidiuscula*
 - 2 Lower stem leaves usually present at flowering; middle and upper stem leaves less numerous and not overlapping; ovaries and achenes glabrous..... *Solidago speciosa*

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