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# Surveys of *Stylisma Pickeringii* var. *Pattersonii* (Convolvulaceae), its Associated Plant Species, and its Insect Visitors

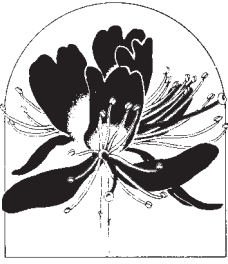
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SURVEYS OF *STYLISMA PICKERINGII* VAR.  
*PATTERSONII* (CONVOLVULACEAE), ITS ASSOCIATED  
PLANT SPECIES, AND ITS INSECT VISITORS

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**ABSTRACT.** *Stylisma pickeringii* var. *pattersonii* (Convolvulaceae) is endangered in Illinois and Iowa, and occurs in scattered populations in other states. During 1999 and 2000, two insect species previously unreported from Illinois were observed visiting its flowers. This study was undertaken to survey additional insect visitors, as well as to characterize the plant community where *S. pickeringii* occurs. The objectives were to survey: 1) floral traits (anthesis and flower density) of *S. pickeringii*, 2) associated plant species, and 3) insect visitor

characteristics. Floral traits were determined and associated plant species surveyed in Mason County (degraded hay field on private property) and Henderson County (dry sand prairie at the Big River State Forest), Illinois. Insects visiting flowers were collected at 10:00 a.m., 12:30 p.m., and 3:00 p.m. during June, July, and August in 2001 and 2002. Individual flowers lasted one day and remained open for 6–8 hours. Peak flowering occurred from early to the middle of July when *S. pickeringii* was the dominant species in flower. Henderson County contained a greater diversity of native plant species with less bare ground and fewer non-native species than the Mason County site. Forty-seven insect species were observed visiting *S. pickeringii* flowers. Most frequent visitors were *Apis mellifera* (Hymenoptera: Apidae), *Bombylius fraudulentus* (Diptera: Bombyliidae), and *Heterostylum croceum* (Diptera: Bombyliidae). The diversity of visiting insects was higher earlier than later in the day, in July and August than June, and in Henderson than Mason County.

**Key Words:** dry sand prairie, endangered plant species, *Heterostylum*, Illinois plants, Patterson bindweed, *Stylisma*

*Stylisma pickeringii* (Torr. ex M.A. Curtis) Gray var. *pattersonii* (Fernald & B.G. Schub.) Myint (Convolvulaceae—Patterson bindweed) is a perennial species listed as state-endangered in Illinois and Iowa (Illinois Endangered Species Protection Board 2005; Iowa Natural Resource Commission 2002; USDA, NRCS 2002). In Missouri, it is listed as critically imperiled (Missouri Natural Heritage Program 2007). Its natural range extends from Illinois and Iowa to Mississippi and Texas (USDA, NRCS 2002) where it exists in scattered populations.

In Illinois, *Stylisma pickeringii* occurs in open habitats in dry sand prairies and disturbed sand fields at one location in each of three counties—Cass, Henderson, and Mason (Herkert and Ebinger 2002). Currently, only the population in Henderson County is located on state-protected land (Big River State Forest). These populations vary in area from 1.5 m<sup>2</sup> (Cass) to 55,200 m<sup>2</sup> (Mason; Todd 2002). The Henderson County population is estimated to exceed 20 ha (200,000 m<sup>2</sup>). These sand deposits are located in limited areas in the northern half of Illinois and contain a unique assemblage of plant and animal species.

In 1999 and 2000, field studies led to the discovery of two insects previously unreported in Illinois—*Heterostylum croceum* Painter and *H. robustum* (Osten Sacken); Diptera: Bombyliidae—visiting *Stylisma pickeringii* flowers in Mason County. This plant/insect relationship is noteworthy, since Illinois is the most northeastern location reported for *S. pickeringii* var. *pattersonii* as well as for

these two insect species (Todd 2002; Webb 2001). Studies investigating insect visitors to other *Stylisma* species were not found and investigations of other relatives in Convolvulaceae were only found for *Calystegia*, *Ipomoea*, and *Merremia*. Insect visitors reported for other Convolvulaceae species include a wide range of nectar and pollen gatherers, such as long-tongued bees (Hymenoptera: Apidae), carpenter bees (Hymenoptera: Anthophoridae), halictid bees (Hymenoptera: Halictidae), long-tailed skippers (Lepidoptera: Hesperidae), hawk moths (Lepidoptera: Sphingidae), scarab beetles (Coleoptera: Scarabaeidae), and hummingbirds (Austin 1978; Devall and Thien 1989; Raimúndez-Urrutia et al. 2008; Stucky and Beckmann 1982; Ushimaru and Kikuzawa 1999; Willmott and Búrquez 1996). A record of insect species that are potential pollinators present at sites containing *S. pickeringii* would provide additional insight regarding this endangered plant species and its insect visitors.

Due to lack of reproductive information regarding many sand prairie species, including *Stylisma pickeringii*, management and reintroduction efforts are limited. A better understanding of ecological interactions and reproduction in this species is needed to make informed management and conservation decisions. The objectives of this study were to survey 1) floral traits (anthesis and flower density), 2) associated plant species at the Mason and Henderson County sites, and 3) insect species visiting these two populations of *S. pickeringii*.

#### MATERIALS AND METHODS

**Description of study sites.** The two larger populations of *Stylisma pickeringii* known in Illinois, including one in Mason County and one in Henderson County, were studied. The Mason County population is located on private land in a degraded (i.e., mowed occasionally) hay field and adjacent fallow field about one kilometer southwest of Snicarte (SW1/4 Section 4, T19N R10W). The Henderson County population is on state-protected land in a dry sand prairie at Big River State Forest, eight kilometers north of Oquawka (NW1/4 Section 36, T12N R5W).

**Anthesis.** Twenty fully open *Stylisma pickeringii* flowers *in situ* at Mason County were tagged at 9:00 a.m. on July 17, 2001 and observed continuously until the corolla closed and detached from

the plant. In addition, 20 flower buds were tagged at 9:00 a.m. on July 18, 2001 and observed over the course of four days between 6:30 a.m. and 6:00 p.m. to determine flower opening. Flower development was recorded daily for each tagged flower as closed bud, bud with petals starting to show, bud just before opening (petals exposed), open, closed with corolla attached, and closed with corolla detached. From these data, the duration (number of hours) that *S. pickeringii* flowers remain open was determined.

**Flower density.** In 1999, 2000, and 2001, flower density of *Stylisma pickeringii* was determined at Mason County during single field visits in June, July, and August. In 2002, flower density was determined at Henderson County in July. Flower density (flowers/m<sup>2</sup>) was estimated using a 50 m transect that was placed where *S. pickeringii* was present. Along the transect, 0.25 m<sup>2</sup> quadrats were placed on alternating sides of the transect at 1 m intervals ( $n = 50/\text{transect}$ ), odd-numbered quadrats on one side of the transect line, even-numbered on the other side. A random number table was used to determine the placement in meters (0 to 9) of each quadrat away from the transect line. Numbers of open flowers were counted in each quadrat and multiplied by four to yield an estimate of density per m<sup>2</sup>.

**Associated plant species.** Vegetation associated with *Stylisma pickeringii* populations at Mason (July 17, 2003) and Henderson (July 18, 2003) counties was surveyed using two 25 m transects at each site, with each transect located within the *S. pickeringii* populations. Along each transect, 1 m<sup>2</sup> quadrats were placed at 1 m intervals ( $n = 25/\text{transect}$ ). Odd-numbered quadrats were placed on one side of the transect line and even-numbered ones on the other side. A random number table was used to determine the placement in meters (0 to 9) of each quadrat away from the transect line.

Species cover, as well as bare ground and litter, were determined using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968). From these data, the frequency (%), mean cover (% total cover), relative frequency, relative cover, and importance value were determined for each species present in the plots. Importance value (I.V.) was determined by summing relative frequency and relative cover. Plant species nomenclature follows Mohlenbrock (2002). Plant voucher specimens were deposited in the Stover-Ebinger Herbarium at Eastern Illinois University, Charleston, Illinois (EIU).

**Diversity of visiting insect species.** Insects visiting flowers of *Stylisma pickeringii* were collected at the Mason County site in the summers of 2001 and 2002. In 2001, all insects visiting flowers within a 1 m<sup>2</sup> plot during a one-hour time interval were collected starting at 10:00 a.m. (July 17 and 20), 12:30 p.m. (June 20; July 5, 16, 17, and 20; and August 21), and 3:00 p.m. (July 18 and 20). For time-of-day comparisons, two sampling dates in mid-July were used for each time interval. In 2002, insect collections were made from three 1 m<sup>2</sup> plots for one hour starting at 10:00 a.m., 12:30 p.m., and 3:00 p.m. on July 9 (Henderson Co.) and on July 10 (Mason Co.). On August 21, 2002, three new plots were established to have sufficient numbers of flowers in the plots, because flowers persisted only in scattered patches this late in the season. This August collection was made for one hour starting at 12:30 p.m. (Mason Co. only).

In both years, general collections of insects visiting *Stylisma pickeringii* flowers were made outside of plots at random times throughout sampling days. Insects were collected with nets, placed in killing jars containing cyanide, and stored in a plastic tackle box lined with an absorbent material. Insects were pinned and identified at a later date. Insect voucher specimens were deposited in the insect collection of the Illinois Natural History Survey, Champaign, Illinois and of the Spooner-Riegel-Goodrich Insect Collection at Eastern Illinois University, Charleston, Illinois. A species list, along with the number of individuals collected, was compiled for each collection time. The number of Patterson bindweed flowers in each plot where insects were collected ranged from 54 on July 16, 2001 to 384 on July 10, 2002, but generally ranged between 90 to 150 flowers. Cloud cover ranged from sunny to cloudy, air temperature ranged from 28–39°C, soil temperature at 10 cm ranged from 25–34°C, relative air humidity ranged from 32–100%, and wind speed ranged from 0.0–2.6 m/sec. No obvious associations were found between weather conditions and visiting insect diversity. Collections were not made during times of rain.

## RESULTS

**Anthesis.** Flowers opened mid-morning and closed by mid-afternoon. Once *Stylisma pickeringii* flower buds were fully opened, all 20 flowers remained open for just 6–8 hours. All fully opened flowers closed and the corollas detached by the end of that same day.

Table 1. *Stylisma pickeringii* var. *pattersonii* flower density in Mason County, Illinois throughout the summers of 1999, 2000, and 2001. <sup>a</sup>Dates surveyed in 1999 (July 9); in 2000 (July 7, 28; August 25); in 2001 (June 20; July 5, 16; August 21). <sup>b</sup>Mean  $\pm$  SE; n = 50.

Month <sup>a</sup>	Flower Density <sup>b</sup> (flowers/m <sup>2</sup> )		
	1999	2000	2001
Mid-June	—	—	1 $\pm$ 0
Early July	56 $\pm$ 8	59 $\pm$ 7	31 $\pm$ 4
Mid-July	—	—	21 $\pm$ 3
Late July	—	4 $\pm$ 1	—
Late August	—	0 $\pm$ 0	0 $\pm$ 0

**Flower density.** Early to mid-July was the peak flowering time of *Stylisma pickeringii*, with the greatest number of open flowers/m<sup>2</sup> recorded in early July (Table 1). Fewer flowers were present in June and late July. No flowers were present within the August transects. However, some plants outside these transects were observed with flowers. From 1999 to 2001, flower density for Mason County ranged from 0  $\pm$  0 to 59  $\pm$  7 (Table 1). In 2002, flower density in Mason County was 131  $\pm$  17 on July 10, while flower density in Henderson County was 15  $\pm$  4 on July 9.

**Associated plant species.** The *Stylisma pickeringii* population at Big River State Forest (Henderson County) was associated with a mature, good quality dry sand prairie, in terms of species diversity. In the area surveyed, *S. pickeringii* was the dominant species with a mean cover of 22.4% and an importance value (I.V.) of 31.1 (Table 2). *Schizachyrium scoparium* (little bluestem) was the dominant grass, while the most common forbs were *Tephrosia virginiana* (goat's rue), *Ambrosia psilostachya* (western ragweed), *Opuntia macrorhiza* (plains prickly pear) and *Commelina erecta* (day-flower), all with importance values greater than 10, and all common, dry sand prairie species. Bare ground and litter cover was low, with an average of 5.7%. In contrast, the Mason County population was located in a poor quality hay field that was occasionally mowed. At Mason County, *S. pickeringii* dominated with a mean cover of 19.4% and an I.V. of 58.8 (Table 2). A few important, native, dry sand prairie species [*S. scoparium*, *A. psilostachya*, and *O. humifusa* (common prickly pear)] were present, but all with importance values below 15. The dominant grasses at this site were *Bromus inermis* (awnless brome) with an I.V. of 17.3,



Table 2. Frequency (Freq.; %), mean cover (% of total cover), and importance value (I.V.) of the plant species surveyed in Mason and Henderson counties, Illinois, in July 2003. \*Non-native (introduced or adventive species).  
<sup>a</sup>Species with I.V. of 1.5 or less for both locations.

Species	Mason County			Henderson County		
	Freq. (%)	Mean Cover (%)	I.V.	Freq. (%)	Mean Cover (%)	I.V.
<i>Stylisma pickeringii</i> (Torr.) Gray	94	19.4	58.8	90	22.4	31.1
<i>Tephrosia virginiana</i> (L.) Pers.	—	—	—	92	17.8	26.7
<i>Schizachyrium scoparium</i> (Michx.) Nash	14	1.1	4.9	94	11.6	20.8
<i>Ambrosia psilostachya</i> DC.	44	3.3	14.9	82	12.7	20.7
<i>Opuntia macrorhiza</i> Engelm.	—	—	—	62	8.2	14.3
<i>Commelina erecta</i> L.	—	—	—	82	2.4	10.3
<i>Euphorbia corollata</i> L.	—	—	—	48	3.6	8.3
<i>Dichanthelium villosissimum</i> (Nash) Freckm.	—	—	—	44	3.7	8.0
* <i>Chenopodium album</i> L.	4	0.0	0.7	60	1.8	7.6
<i>Heterostipa spartea</i> (Trin.) Barkworth	—	—	—	44	2.1	6.5
<i>Cyperus schweinitzii</i> Torr.	34	0.8	7.6	52	1.1	6.1
<i>Physalis subglabrata</i> Mack. & Bush	—	—	—	50	1.1	5.9
<i>Koeleria macrantha</i> (Ledeb.) Spreng.	—	—	—	36	1.7	5.2
<i>Rhus aromatica</i> Aiton	—	—	—	14	3.3	4.7
<i>Carex muehlenbergii</i> Schkuhr	2	0.3	1.0	30	0.2	3.1
* <i>Poa pratensis</i> L.	—	—	—	28	0.4	3.1
<i>Lespedeza capitata</i> Michx.	—	—	—	18	1.3	3.0
<i>Brickellia eupatorioides</i> (L.) Shinnery	—	—	—	14	1.4	2.8
<i>Helianthus strumosus</i> L.	—	—	—	16	1.2	2.8
<i>Paspalum bushii</i> Nash	22	0.8	5.6	12	0.2	1.4
<i>Chrysopsis camporum</i> Greene	72	9.4	33.1	—	—	—
<i>Croton glandulosus</i> L.	92	1.2	18.3	—	—	—
* <i>Bromus inermis</i> Leyss.	46	4.3	17.3	—	—	—
* <i>Bromus tectorum</i> L.	44	1.9	11.8	—	—	—
<i>Eragrostis trichodes</i> (Nutt.) Wood	28	0.9	6.7	—	—	—
<i>Sorghastrum nutans</i> (L.) Nash	10	0.7	3.3	—	—	—
<i>Conyza canadensis</i> (L.) Cronquist	12	0.2	2.5	—	—	—
<i>Solanum carolinense</i> L.	12	0.2	2.5	—	—	—
* <i>Mollugo verticillata</i> L.	12	0.1	2.2	—	—	—
<i>Opuntia humifusa</i> (Raf.) Raf.	8	0.4	2.2	—	—	—
<i>Monarda fistulosa</i> L.	10	0.1	1.9	—	—	—
Others <sup>a</sup>	—	0.5	4.7	—	1.3	7.6
TOTALS	—	45.5	200.0	—	99.5	200.0
Average bare ground and litter	—	53.2	—	—	5.7	—

and *B. tectorum* (downy chess) with an I.V. of 11.8. Most of the remaining species were exotics, or prairie species commonly associated with disturbances. At this site, average bare ground and litter cover was 53.2% (Table 2).

Species with importance values less than 1.5 were not listed in Table 2. For Mason County, these plant species included *Froelichia gracilis* (Hook.) Moq., *Oenothera clelandii* W. Dietr., Raven & W.L. Wagner, \**Bromus commutatus* Schrad., and \**Saponaria officinalis* L. (in order of importance; \* = non-native). For Henderson County, these species included: *Dichanthelium oligosanthes* (Schult.) Gould, *Monarda punctata* L., *Tradescantia ohimensis* Raf., *Viola pedata* L., *Calamovilfa longifolia* (Hook.) Scribn., *Solidago speciosa* Nutt., *Oenothera clelandii*, *Sisyrinchium albidum* Raf., *Asclepias viridiflora* Raf., and *Leptoloma cognatum* (Schult.) Chase (in order of importance).

**Diversity of visiting insect species.** In 2001, eighteen species of insects visiting *Stylisma pickeringii* flowers were collected during one-hour collection periods in Mason County (Table 3). *Apis mellifera* (honeybee) and *Heterostylum croceum* (a bee fly; Figure 1) were the most frequent visitors. More insect species visited flowers at 10:00 a.m. than at 12:30 p.m. or 3:00 p.m. (Table 4). In addition, in 2001, three genera of insects were collected outside of the designated plots, including the syrphid fly, *Allograpta oblique* (Diptera: Syrphidae), the mayfly, *Isonychia* sp. (Ephemeroptera: Oligoneuriidae), and tangle-veined fly, *Neorhyncocephalus volaticus* (Diptera: Nemestrinidae). However, only one specimen of each of these insects was observed and collected on flowers. General weather conditions were similar throughout the different collection times. Within marked plots and outside of plots, visiting insects were observed in July and August, but not in June.

In 2002, 35 insect species visited *Stylisma pickeringii* flowers at the Mason and Henderson county sites. *Apis mellifera* accounted for 74.2% and 7.7% of insect visits in Mason and Henderson counties, respectively. *Apis mellifera* was the most frequent visitor to flowers in Mason County, while *Bombylius fraudulentus* (a bee fly) was the most frequent visitor at Henderson County (Table 3). The total number of insect visits/m<sup>2</sup>/hr were about the same for Mason and for Henderson counties, although diversity of insect visitors was lower in Mason (12 species) than in Henderson (28 species; Table 3). Also in 2002, at both sites, the diversity of insect visitors was greater earlier in the day than later in the day (Table 4).

Table 3. Insect species observed on, and frequency and total insect visits to, *Stylisma pickeringii* var. *pattersonii* flowers within 1 m<sup>2</sup> plots for one-hour intervals throughout summer 2001 and 2002 in Mason and Henderson counties, Illinois. <sup>a</sup>Avg. = average insect visits/m<sup>2</sup>/hr.; <sup>b</sup>% = percent of total visits.

Insect Species	Mason County				Henderson County	
	2001		2002		2002	
	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>
<i>Bombylius fraudulentus</i> Johnson, 1907;						
Diptera: Bombyliidae	—	—	—	—	1.9	18.7
<i>Villa lateralis</i> (Say, 1823); Diptera:						
Bombyliidae	—	—	—	—	1.2	12.1
<i>Dialictus vierecki</i> (Crawford, 1904);						
Hymenoptera: Halictidae	—	—	—	—	0.9	8.8
<i>Apis mellifera</i> Linnaeus, 1758;						
Hymenoptera: Apidae	2.8	34.6	7.7	74.2	0.8	7.7
<i>Chrysanthrax edititia</i> (Say, 1829);						
Diptera: Bombyliidae	—	—	—	—	0.8	7.7
<i>Agapostemon splendens</i> (Lepeletier, 1841);						
Hymenoptera: Halictidae	0.7	8.6	0.1	1.1	0.4	4.4
<i>Chrysanthrax cypris</i> (Meigen, 1820);						
Diptera: Bombyliidae	0.1	1.2	—	—	0.4	4.4
<i>Augochlorella striata</i> (Provancher, 1888);						
Hymenoptera: Halictidae	—	—	0.3	3.2	0.3	3.3
<i>Heterostylum croceum</i> Painter, 1930;						
Diptera: Bombyliidae	1.3	16.0	0.2	2.2	0.3	3.3
<i>Copestylum vittatum</i> Thompson, 1976;						
Diptera: Syrphidae	0.1	1.2	—	—	0.3	3.3
<i>Strigoderma arboricola</i> (Fabricius, 1792);						
Coleoptera: Scarabaeidae	—	—	—	—	0.2	2.2
<i>Polistes fuscatus</i> (Fabricius, 1793);						
Hymenoptera: Vespidae	—	—	—	—	0.2	2.2
<i>Hemipenthes sinuosa</i> (Wiedemann, 1821);						
Diptera: Bombyliidae	—	—	—	—	0.2	2.2
<i>Geraeus</i> sp.; Coleoptera: Curculionidae	—	—	—	—	0.2	2.2
<i>Collops</i> sp.; Coleoptera: Melyridae	—	—	—	—	0.2	2.2
<i>Campsomeris plumipes confluenta</i> (Say, 1823);						
Hymenoptera: Sphecidae	—	—	—	—	0.2	2.2
Orthoptera (identified to order only)	—	—	1.1	10.8	0.1	1.1
<i>Toxomerus marginatus</i> (Say, 1823);						
Diptera: Syrphidae	0.5	6.2	—	—	0.1	1.1
<i>Syritta pipiens</i> (Linnaeus, 1758);						
Diptera: Syrphidae	—	—	—	—	0.1	1.1
<i>Prionyx thomae</i> (Fabricius, 1775);						
Hymenoptera: Sphecidae	—	—	—	—	0.1	1.1

Table 3. Continued.

Insect Species	Mason County				Henderson County	
	2001		2002		2002	
	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>
<i>Nomia heteropoda</i> (Say, 1824);						
Hymenoptera: Halictidae	—	—	—	—	0.1	1.1
<i>Nomada</i> sp.; Hymenoptera:						
Anthophoridae	—	—	—	—	0.1	1.1
<i>Megachile</i> sp.; Hymenoptera:						
Megachilidae	—	—	—	—	0.1	1.1
<i>Lasioglossum coriaceum</i> (Smith, 1853);						
Hymenoptera: Halictidae	—	—	—	—	0.1	1.1
<i>Everes comyntas</i> (Godart, 1824);						
Lepidoptera: Lycaenidae	—	—	—	—	0.1	1.1
<i>Dialictus</i> sp.; Hymenoptera: Halictidae	—	—	—	—	0.1	1.1
<i>Chauliognathus pennsylvanicus</i> (De						
Geer); Coleoptera: Cantharidae	—	—	—	—	0.1	1.1
<i>Bicyrtes quadrifasciatus</i> (Say, 1824);						
Hymenoptera: Sphecidae	—	—	—	—	0.1	1.1
<i>Dialictus</i> sp.; Hymenoptera: Halictidae	0.5	6.2	—	—	—	—
<i>Perdita</i> sp.; Hymenoptera: Andrenidae	0.5	6.2	—	—	—	—
<i>Heterostylum robustum</i> (Osten Sacken,						
1877); Diptera: Bombyliidae	0.2	2.5	—	—	—	—
<i>Eristalinus aeneus</i> (Scopoli, 1763);						
Diptera: Syrphidae	0.2	2.5	0.1	1.1	—	—
<i>Anthrax albofasciatus</i> Macquart, 1840;						
Diptera: Bombyliidae	0.2	2.5	—	—	—	—
<i>Halictus</i> sp.; Hymenoptera: Halictidae	0.2	2.5	—	—	—	—
<i>Odontocorynus</i> sp.; Coleoptera:						
Curculionidae	0.2	2.5	—	—	—	—
<i>Systoechus vulgaris</i> Loew, 1863;						
Diptera: Bombyliidae	0.2	2.5	—	—	—	—
<i>Chauliognathus pennsylvanicus</i> (De						
Geer); Coleoptera: Cantharidae	0.1	1.2	0.2	2.2	—	—
<i>Augochlorella</i> sp.; Hymenoptera:						
Halictidae	0.1	1.2	—	—	—	—
<i>Melissodes</i> sp.; Hymenoptera:						
Anthophoridae	0.1	1.2	—	—	—	—
<i>Tropidia albistylum</i> Macquart, 1847;						
Diptera: Syrphidae	0.1	1.2	—	—	—	—
<i>Melissodes communis communis</i>						
Cresson, 1878; Hymenoptera:						
Anthophoridae	—	—	0.1	1.1	—	—
<i>Bembix spinolae</i> Lepeletier, 1845;						
Hymenoptera: Sphecidae	—	—	0.1	1.1	—	—

Table 3. Continued.

Insect Species	Mason County				Henderson County	
	2001		2002		2002	
	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>	Avg. <sup>a</sup>	% <sup>b</sup>
Diptera (identified to order only)	—	—	0.1	1.1	—	—
<i>Neorhynchocephalus volaticus</i> Williston, 1883; Diptera: Nemestrinidae	—	—	0.1	1.1	—	—
<i>Trachyrhachys kiowa</i> (Thomas, C., 1872); Orthoptera: Acrididae	—	—	0.1	1.1	—	—
TOTAL	8.1	100	10.3	100	10.0	100

DISCUSSION

Several characteristics of *Stylisma pickeringii* flowers could affect insect visitation. Features such as the duration of anthesis, flower density, and length of the blooming period may select for certain insects. Flowers of *S. pickeringii* are only available to insect visitors for 6–8 hours, opening mid-morning and closing by late afternoon. This brief anthesis provides a narrow window of opportunity. More insects visited flowers earlier in the day when irradiance and temperatures typically were lower. The nectar reward also may be higher when



Figure 1. *Heterostylum croceum* visiting a flower of *Stylisma pickeringii* var. *pattersonii*.

Table 4. Number and diversity of insects visiting per square meter by time of day in different collection years for Mason and Henderson counties, Illinois. All data expressed as mean  $\pm$  SE. <sup>a</sup>No. insect visits = total number of insect visits in given time period; <sup>b</sup>No. spp. = number of different visiting insect species in given time period.

Collection Time	Mason County						Henderson County		
	July 2001			July 2002			August 2002		
	No. Insect Visits <sup>a</sup>	No. Spp. <sup>b</sup>	No. Insect Visits	No. Insect Visits	No. Spp.	No. Spp.	No. Insect Visits	No. Insect Visits	No. Spp.
10:00–11:00 a.m.	13.0 $\pm$ 3.0	7.5 $\pm$ 0.5	6.7 $\pm$ 1.4	3.3 $\pm$ 0.9	–	–	12.0 $\pm$ 4.0	9.6 $\pm$ 2.8	–
12:30–1:30 p.m.	7.0 $\pm$ 3.0	4.0 $\pm$ 1.0	8.3 $\pm$ 0.7	2.7 $\pm$ 0.7	7.7 $\pm$ 2.6	–	12.7 $\pm$ 4.8	6.7 $\pm$ 1.6	–
3:00–4:00 p.m.	8.5 $\pm$ 4.5	4.0 $\pm$ 2.0	13.0 $\pm$ 0.6	1.0 $\pm$ 0.0	–	–	5.7 $\pm$ 1.2	3.7 $\pm$ 1.2	–

flowers have just opened; however, nectar was not collected. While anthesis of individual flowers lasted less than one day, the entire population produced an abundance of flowers available during peak bloom in July. Flower visitors would find open flowers of *S. pickeringii* starting in June and peaking in early to mid-July.

Not only is the availability of *Stylisma pickeringii* flowers important to insect visitors, but the availability of flowers from other plant species also may be an important factor for generalist pollinators. However, insects visiting other plant species were not observed or collected in this study. Insect species richness is thought to increase with increasing plant species richness because a greater diversity of species provides a greater diversity of resources for insects (Haddad et al. 2001; Murdoch et al. 1972). When comparing the study sites, Henderson County had more native plant species, fewer introduced species, a lower percentage of bare ground, importance values that were more evenly distributed among plant species (i.e. less dominated by *S. pickeringii*), and a higher diversity of insect species found visiting *S. pickeringii* flowers than Mason County. This suggests that the Henderson County site was more attractive to a larger variety of “generalist” insects that visit a variety of plant species. In both sites, *S. pickeringii* was growing with other plant species commonly associated with sand deposits of the Illinois River and Mississippi River Sand Areas Division (Schwegman 1973), so insect visitors to *S. pickeringii* also could be attracted to the diversity of other plant species of this habitat. However, both sites had insect visitors that were at only one site, so other factors may be contributing to the preference of insects visiting *S. pickeringii*.

This study showed some spatial and temporal differences in insect activity. Sampling one day apart at Mason and Henderson County sites in 2002 demonstrated spatial differences in insect diversity and most common visitors to *Stylisma pickeringii* between sites. In general, our findings on visiting insect species are supported by other studies that found species of Hymenoptera (wasps, ants, bees) and Coleoptera (beetles) visiting flowers of other Convolvulaceae species (Austin 1978; Raimúndez-Urrutia et al. 2008; Stucky and Beckmann 1982; Willmott and Búrquez 1996). Some insect species were present at both sites, suggesting that key species may be linked to the success of *S. pickeringii*. *Heterostylum croceum*, an insect previously unrecorded in Illinois, was present at both sites and it was a frequent visitor at the Mason County site. A temporal difference was found between collections made through-

out the day at both counties, where a greater diversity of insect species visited earlier in the day than later in the day. Varying seasonal conditions and general weather conditions also may relate to different insect species found in 2002 compared to 2001.

The diversity of plant and insect species found at *Stylisma pickeringii* sites may be important to the management of these areas. Management practices that promote biodiversity and limit habitat fragmentation, disturbance, and pesticide application could aid in the reproductive success of a species by providing a diversity of attractants to insects and promoting pollinator populations (Johansen 1977; Johansen et al. 1983; Kearns and Inouye 1997; Nabhan and Buchmann 1997; Simberloff 1988; Steffan-Dewenter et al. 2006). Henderson County, the sand prairie with the greater plant diversity and greater insect diversity, is a contiguous piece of land protected from development and major disturbance in a State Forest. A wider variety of insect visitors were attracted to sites with greater visiting possibilities. In Mason County, where plant and insect diversity was lower, *S. pickeringii* grows in an agricultural setting. A lower diversity of insect visitors would be attracted to single-species row crops and activities associated with agricultural settings (i.e., tilling, more fragmented landscapes, and pesticide application). Flower density varies at different *S. pickeringii* sites, which may affect their relative attractiveness to the insects. By surveying the plant and insect species associated with an endangered plant species, new information describing insect visitors in a sand prairie habitat has been provided.

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#### LITERATURE CITED

- AUSTIN, D. 1978. Morning glory bees and the *Ipomoea pandurata* complex (Hymenoptera: Anthophoridae). Proc. Entomol. Soc. Wash. 80: 398–402.



- BAILEY, A. W. AND C. E. POULTON. 1968. Plant communities and environmental relationships in a portion of the Tillamook burn, northwest Oregon. *Ecology* 49: 1–13.
- DAUBENMIRE, R. 1959. A canopy coverage method of vegetation analysis. *NorthW. Sci.* 33: 43–64.
- DEVALL, M. S. AND L. B. THIEN. 1989. Factors influencing the reproductive success of *Ipomoea pes-caprae* (Convolvulaceae) around the Gulf of Mexico. *Amer. J. Bot.* 76: 1821–1831.
- HADDAD, N. M., D. TILMAN, J. HAARSTAD, M. RITCHIE, AND J. M. KNOPS. 2001. Contrasting effects of plant richness and composition on insect communities: A field experiment. *Amer. Naturalist* 158: 17–35.
- HERKERT, J. R. AND J. E. EBINGER. 2002. Endangered and Threatened Species of Illinois: Status and Distribution. Vol. 1. Plants. Illinois Endangered Species Protection Board, Springfield, IL.
- ILLINOIS ENDANGERED SPECIES PROTECTION BOARD. 2005. Checklist of Endangered and Threatened Animals and Plants of Illinois. Illinois Endangered Species Protection Board, Springfield, IL.
- IOWA NATURAL RESOURCE COMMISSION, Cha. 77. 2002. Endangered and threatened plant and animal species. *In*: Iowa Administrative Code [571]. Iowa Dept. Natural Resources, Des Moines, IA.
- JOHANSEN, C. A. 1977. Pesticides and pollinators. *Annual Rev. Entomol.* 22: 177–192.
- , D. F. MAYER, J. D. EVES, AND C. W. ISIOUS. 1983. Pesticides and bees. *Environm. Entomol.* 12: 1513–1518.
- KEARNS, C. A. AND D. W. INOUE. 1997. Pollinators, flowering plants, and conservation biology: Much remains to be learned about pollinators and plants. *BioScience* 47: 297–307.
- MISSOURI NATURAL HERITAGE PROGRAM. 2007. Missouri Species and Communities of Conservation Concern Checklist. Missouri Natural Heritage Program, Jefferson City, MO.
- MOHLENBROCK, R. H. 2002. Guide to Vascular Flora of Illinois. Revis. and enlarged ed. Southern Illinois Univ. Press, Carbondale, IL.
- MURDOCH, W., F. EVANS, AND C. PETERSON. 1972. Diversity and pattern in plants and insects. *Ecology* 53: 819–829.
- NABHAN, G. P. AND S. L. BUCHMANN. 1997. Services provided by pollinators, pp. 133–150. *In*: G. C. Daily, ed., *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, DC.
- RAIMÚNDEZ-URRUTIA, E., L. AVENDAÑO, AND D. VELÁZQUEZ. 2008. Reproductive biology of the morning glory *Merrenia macrocalyx* (Ruiz & Pavon) O'Donnell (Convolvulaceae). *J. Torrey Bot. Soc.* 135: 299–308.
- SCHWEGMAN, J. E. 1973. Comprehensive Plan for the Illinois Nature Preserves System. Part 2. The Natural Divisions of Illinois. Illinois Nature Preserves Commission, Rockford, IL.
- SIMBERLOFF, D. 1988. The contribution of population and community biology to conservation science. *Annual Rev. Ecol. Syst.* 19: 473–511.
- STEFFAN-DEWENTER, I., A. KLEIN, V. GAEBELE, T. ALFERT, AND T. TSCHARNTKE. 2006. Bee diversity and plant-pollinator interactions in fragmented

- landscapes, pp. 387–407. *In*: N. M. Waser and J. Ollerton, eds., *Plant Pollinator Interactions: From Specialization to Generalization*. Univ. Chicago Press, Chicago, IL.
- STUCKY, J. M. AND R. L. BECKMANN. 1982. Pollination biology, self-incompatibility, and sterility in *Ipomoea pandurata* (L.) G.F.W. Meyer (Convolvulaceae). *Amer. J. Bot.* 69: 1022–1031.
- TODD, B. L. 2002. Reproductive biology of *Stylisma pickeringii* (Convolvulaceae), an endangered plant of Illinois sand prairies. M.S. thesis, Eastern Illinois Univ., Charleston, IL.
- USDA, NRCS. 2002. The PLANTS Database, version 3.5. National Plants Data Center, Baton Rouge, LA, Website (<http://plants.usda.gov>). Accessed 12 Mar 2009.
- USHIMARU, A. AND K. KIKUZAWA. 1999. Variation of breeding system, floral rewards, and reproductive success in clonal *Calystegia* species (Convolvulaceae). *Amer. J. Bot.* 86: 436–446.
- WEBB, D. W. 2001. *Heterostylum* in Illinois (Diptera: Bombyliidae: Bombyliinae). *J. Kansas Entomol. Soc.* 74: 110–111.
- WILLMOTT, A. P. AND A. BÚRQUEZ. 1996. The pollination of *Merremia palmeri* (Convolvulaceae): Can hawk moths be trusted? *Amer. J. Bot.* 83: 1050–1056.