

FLOWERING PHENOLOGY OF SYMPATRIC *CAREX WAPONAHKIKENSIS* AND *CAREX SCOPARIA* (CYPERACEAE)

MARILEE LOVIT

P.O. Box 95

Addison, Maine 04606

mlovit9876@WUSTL.edu

ABSTRACT

Comparison of the flowering phenology of *Carex waponahkikensis* (formerly *Carex scoparia* var. *tessellata*) and sympatric *Carex scoparia* is illustrated with photographs. *Carex waponahkikensis* flowers and fruits one week to ten days earlier than sympatric *C. scoparia*, with some overlap.

Carex waponahkikensis Lovit & Haines was first named *C. scoparia* var. *tessellata* Fernald & Wiegand (Fernald et al 1910). It was elevated to species rank and given its current name in 2012 (Lovit et al. 2012). Phenological differences in flowering indicate that *C. waponahkikensis* and *C. scoparia* are reproductively isolated and support their recognition as distinct biological species. The present study documents the phenology with photographs during one growing season.

Methods

During the 2012 growing season I photographed both *Carex* species in Harrington, Washington Co., Maine. Eight individual *C. waponahkikensis* clumps and nine *C. scoparia* were tracked between May 28 and July 31, with photos taken on twelve different dates. Both species occupy a similar habitat of roadsides and often occur together. I photographed them along an unpaved road all within two miles of each other, between N 44.56090 W 067.77114 and N 44.583588 W 067.763296. Individual plants were labeled by placing a numbered rock beside each one. I took 584 photographs.

Results and discussion

The results of this study during one growing season are consistent with my observations over many years. Both species begin with staminate flowers and proceed to carpellate flowers. Staminate and carpellate flowers are present together on a spike for several days. Finally, all anthers and then all stigmas are shed, with the distalmost stigmas remaining longest, until they are also shed. *Carex waponahkikensis* does all of this slightly earlier than *C. scoparia*.

As seen in Figures 1–6 and Table 1, *Carex waponahkikensis* flowers in early to mid-June, with anthers appearing as early as May 28 and shedding by June 10–11. Stigmas are present from June 6 or earlier and are mostly withered and brown, or shed, by June 10–11, except for the distalmost stigmas, which remain fresh as late as June 17. *Carex scoparia* anthers first appear June 6 and persist through June 25. Stigmas first appear June 10 and remain present through June 25. Both species are finished flowering by late June. When the last few distal stigmas of *C. waponahkikensis* are still fresh, sympatric *Carex scoparia* has many anthers shedding pollen (Fig. 3). But when *C. scoparia* is down to its last distal stigmas, neighboring *C. waponahkikensis* has long ago shed all its anthers (Fig. 4). Perigynium color is green during the growing season for both species, with *C. waponahkikensis* perigynia beginning to turn yellow around July 7, then brown by July 16, and falling from the spike July 31. *Carex scoparia* perigynia remain green a little longer, through July 10, turn yellow by July 16, and are completely brown July 31 though not yet falling from the spike (Figs. 5 and 6).



Figure 1. *Carex waponahkikensis*. A. May 28, anthers present. B. June 6, anthers and stigmas. C. June 11, stigmas present and spikes thickening with maturing perigynia. D. June 11, anthers shed, stigmas brown or shed. E. June 17, anthers shed, stigmas brown or shed.

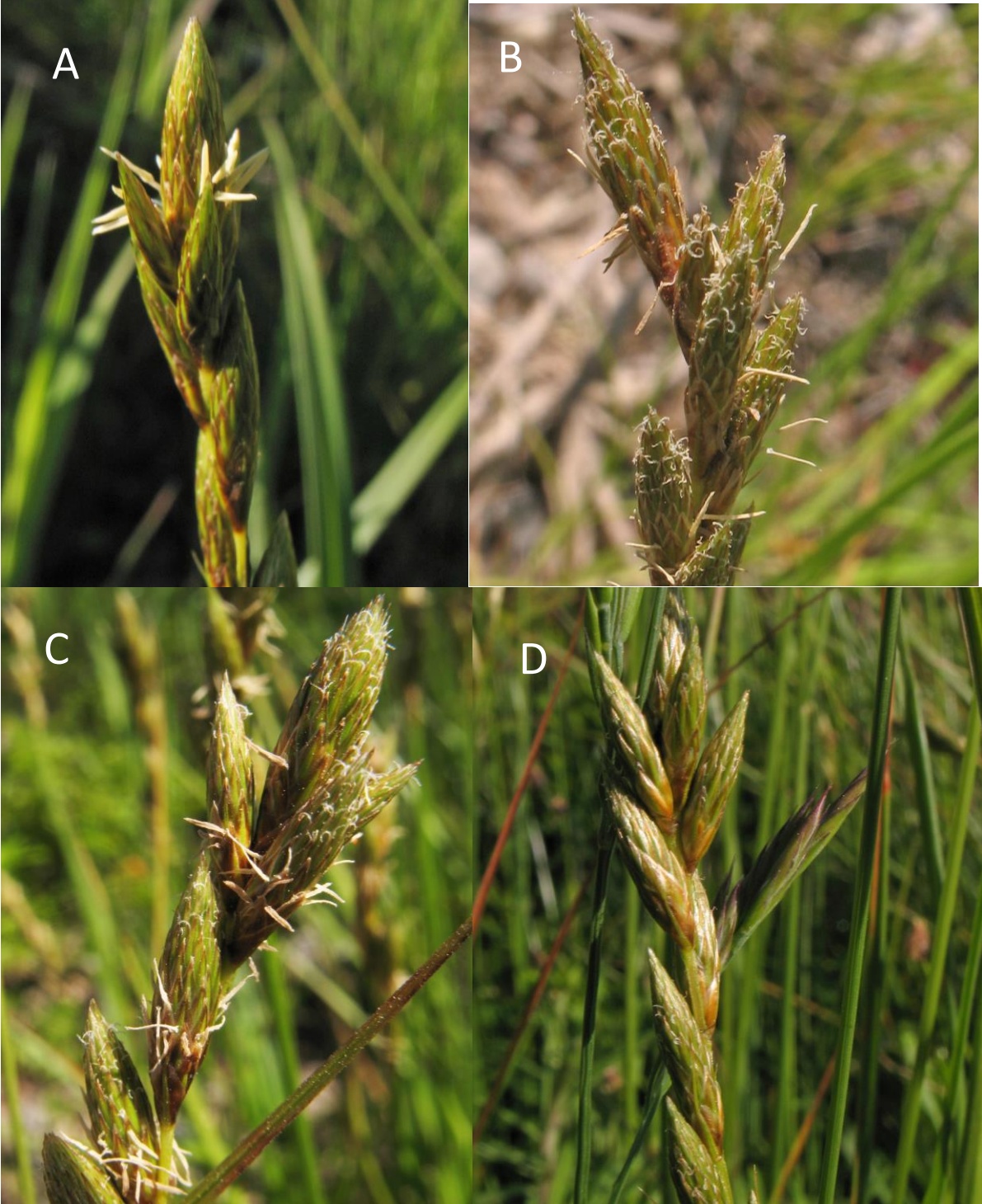


Figure 2. *Carex scoparia*. A. June 11, early example of anthers. B. June 11, anthers and stigmas present. C. June 16, anthers and stigmas present. D. June 17, this individual just beginning to flower.



Figure 3. Both species, June 16. *Carex scoparia* on the left in flower with many anthers, and *C. waponahkikensis* on the right with no anthers and only a few fresh distal stigmas. *Carex waponahkikensis* spikes are thickened with maturing perigynia; *C. scoparia* spikes are thinner, with perigynia less mature and many stigmas just emerging.



Figure 4. A. *Carex waponahkikensis*, June 25, no anthers or stigmas. Note dark perigynium beak tips and contrast between brown scales and green perigynia. B. *Carex scoparia*, June 25, distal stigmas and a few anthers still present, very little color contrast between scales and perigynia.



Figure 5. A. *Carex scoparia* July 7. B. *Carex waponahkikensis* July 7. Both species are finished flowering and have green to yellow perigynia. These photos were taken one calendar date earlier than Fernald and Wiegand's type collection of *C. scoparia* var. *tessellata* in Pembroke, Maine, on July 8 1909. Around that date the brown scales of *C. waponahkikensis* contrast with the green perigynia, creating a patterned or tessellated appearance.



Figure 6. A. Both species July 16. B. *Carex waponahkikensis* July 31. This species sheds perigynia by late July and into August. Its perigynia have turned brown but the beak tips are still noticeably darker than the rest of the perigynia. C. *Carex scoparia* July 31. This species has turned brown, perigynia and scales are mostly the same color and lack the dark perigynia beak tips of *C. waponahkikensis*.

One problem with data interpretation in this photo study is variability among the individual plants, perhaps especially *Carex scoparia*. Individual *C. scoparia* plants may show widely different states at the same time. For example, on June 11 different *C. scoparia* individuals showed either no flowering yet at all, a few anthers just beginning to emerge, anthers more fully out, or both anthers and stigmas present. *Carex waponahkikensis* had shed all anthers in all photos starting June 10, except one individual out of seven photographed on June 11, which still had anthers present. Table 1 shows the dates by which, and through which, each species presented flowering stages. Figures 1–6 illustrate the flowering stages with photographs.

Photo dates in this study have a gap between May 29 and June 6, missing the earliest days of *Carex waponahkikensis* flowering. Stigmas must first appear earlier than the June 6 date captured in photos and as shown in Table 1. Additional gaps are June 28–July 6 and July 16–31, when both species have finished flowering. Multiple photos were taken each day, but only one flower status was recorded

for each individual, except for six *Carex waponahkikensis* and five *C. scoparia* individuals, each scored twice because they showed two flowering states. For example, on June 16 one *C. waponahkikensis* individual had an inflorescence with all stigmas shed, and another with distalmost stigmas still fresh; I included both states for June 16 for that individual.

Table 1. Flowering phenology for *Carex waponahkikensis* and *Carex scoparia* from photographs

Flowering status	<i>Carex waponahkikensis</i>	<i>Carex scoparia</i>
Anthers first appear	May 28 N = 1	June 6, 10 (1 anther emerging) N = 2
Anthers present	May 28 N = 1 June 6 N = 1 June 11 N = 1	June 10 N=1 June 11 N=1 June 16 N = 9 June 17 N = 8 June 25 N = 2
Stigmas first appear	June 6 N = 1	June 10 N=1
Stigmas present Note this includes dates of only the few distalmost stigmas persisting, listed again below.	June 6 N = 1 June 10 N = 1 June 11 N = 5 June 16 N = 3 June 17 N = 4	June 10 N=1 June 11 N=2 June 16 N = 8 June 17 N = 9 June 25 N = 2
Anthers & stigmas both present	June 6 N = 1 June 11 N = 1	June 10 N=1 June 11 N = 1 June 16 N = 8 June 17 N = 8 June 25 N = 2
Culms with no anthers or stigmas	None during this study	June 6 N = 1 June 11 N = 4 June 17 N=1
Anthers shed	June 10 N = 4 June 11 N = 6 and thereafter	June 25 N = 1 June 28 N = 1 July 6 N = 2 July 10 N = 8 All shed June 28 & thereafter
Stigmas brown or shed exc distal few still fresh	June 10 N = 1 June 11 N = 3 June 16 N = 3 June 17 N = 4	June 17 N = 1 June 25 N = 1
Flowering finished	June 16 N = 3 June 17 N = 2 June 25 N = 3 and thereafter	June 28 and thereafter
Perigynia green	June 10 until turning yellow ~July 7 N = 22	June 25–July 16 N = 23
Perigynia yellow/green- yellow	July 7 N = 4 July 10 N = 1	July 16 N = 1
Perigynia brown	July 16 N = 1 July 31 brown & shedding N=1	July 31 N = 1

Table 2. Number of individuals photographed on each date

Date	<i>Carex waponahkikensis</i>	<i>Carex scoparia</i>
May 28	1	0
June 6	1	2
June 10	1	2
June 11	4	5
June 16	6	7
June 17	6	9
June 25	3	3
June 28	2	1
July 6	0	2
July 7	4	8
July 10	1	9
July 16	1	1
July 31	2	1

Figure 7. *Carex waponahkikensis* on June 11, and the rock marker identifying this individual clump.



Carex scoparia is widespread in North America, but *C. waponahkikensis* is limited to a narrow range on the eastern Maine coast and nearby coastal New Brunswick, Canada (Lovit 2022). Analysis of genetic data (Escudero et al. 2019) has shown that *C. waponahkikensis* is derived from *C. scoparia*, and the two species may have diverged from each other as recently as during or after the last glacial maximum in North America, which ended about 17,000 or fewer years ago. Extant *C. waponahkikensis* populations grow in areas covered by ice until the last glacial retreat from the area 14,000 years ago. Molecular study suggests the two species have complete, or nearly complete, reproductive isolation (Escudero et al. 2019). The difference flowering phenology documented here also provides evidence of complete or nearly complete reproductive isolation.

ACKNOWLEDGEMENTS

I am grateful to Marcial Escudero, University of Seville, Spain, for reading this paper and offering suggestions.

LITERATURE CITED

- Escudero, M., M. Lovit, B.H. Brown, and A.L. Hipp. 2019. Rapid plant speciation associated with the last glacial period: Reproductive isolation and genetic drift in sedges. *J. Linn. Soc., Bot.* 190: 303–314.
- Fernald, M.L. and K.M. Wiegand. 1910. A summer's botanizing in eastern Maine and western New Brunswick. Part 2. Technical notes on some of the plants collected. *Rhodora* 12: 101–146.
- Lovit, M. 2022. Botanical history and geographical distribution of *Carex waponahkikensis* (Cyperaceae). *Rhodora* 124: 71–90.
- Lovit, M. and A. Haines. 2012. A new name and status for *Carex scoparia* var. *tessellata* (Cyperaceae). *Bot. Notes* 14: 1–5.