TAXONOMY, ECOLOGY, AND BIOGEOGRAPHY OF CAREX SECTION OVALES IN INDIANA

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ABSTRACT

The most recent treatment of Carex section Ovales for Indiana dates to Deam’s 1940 “Flora of Indiana.” This updated treatment, based upon a thorough review of herbarium material and recent field studies, increases the number of taxa in the state from 17 to 20. Additions include C. misouriensis P. Rothr. & Reznicek, C. projecta Mackenzie, and C. tenera Dewey var. echinodes (Fernald) Wiegand. Nineteen species occur in northern-most Indiana. Southern Indiana is characterized by fewer and widespread species from Carex section Ovales; only C. alboluteccens Schweinitz has a predominately southern distribution in the state. Salient taxonomic and ecological notes are provided for each species as well as a key to 27 taxa occurring in Indiana and nearby Illinois, Michigan, and Ohio.

Key words: Carex, section Ovales, biogeography, distribution, Indiana flora, Midwest flora

INTRODUCTION

Charles C. Deam served as a pioneer in the development of modern state floras. His “Flora of Indiana” (Deam 1940) set a standard for thoroughness and the breadth and depth of collections used as a floristic database. In the decades since the publication of the “Flora,” there has been further progress in our understanding of Indiana’s flora. These efforts have included floras of significant natural features such as Yellow Birch Ravine Nature Preserve (Yatskievych & Yatskievych 1987) and Mounds State Park (Rothrock et al. 1993). There also has been the publication of numerous county records for rare and unusual plants, the product of a vigorous Natural Heritage program within the Indiana Department of Natural Resources. And, of course, the “Flora of the Chicago Region,” which includes northwest Indiana, has gone through 4 editions (Swink & Wilhelm 1994).

In spite of these important floristic activities in the state, there has been a lack of a sustained, coordinated effort to maintain and update a statewide flora (Crovello & Keller 1981). In fact, several important herbarium collections in Indiana have suffered due to lack of active use. Recently, efforts of the Indiana Academy of Science’s Biological Survey and Natural Areas Committee (Jacquart 1999) have begun to reinvigorate the study of Indiana’s biota. The Indiana Biological Survey (www.indianabiologicalsurvey.org), as an initial step, has initiated development of a unified database of collections across the state. As envisioned, this searchable database would result in the creation of a virtual museum collection.
and an ability simultaneously to query multiple herbaria that house Indiana material. In light of these developments, it is timely to review some of the taxonomically complex plant groups in Indiana.

Carex L., with approximately 100 species in Indiana (Deam 1940), is the largest genus in the state’s flora. Carex section Ovales, with at least 17 species, is the largest and most complex section within the genus. Although the treatment in the “Flora” was very ably done by Frederick Hermann, then at the University of Michigan, section Ovales has become both better understood (e.g., Rothrock 1991, Rothrock et al. 1997, Rothrock & Reznicek 2001) and better collected in the intervening years. We undertook a critical review of Carex section Ovales with two purposes: (1) to provide a dataset for testing and implementing the database model of the Indiana Biological Survey and (2) to furnish an updated treatment, in traditional format, of the taxonomy, biogeography, and ecological characteristics of those species occurring in Indiana.

MATERIALS AND METHODS

Collections of Carex section Ovales from Indiana were verified and entered into a relational database from the following herbaria: BUT, IND, MICH, MOR, ND, and PUL. MOR contains recent collections by G. Wilhelm, F. Swink, and co-workers; MICH as well as BUT contain personal collections by A.A. Reznicek and P.E. Rothrock. These significantly enhance and update the records for members of this section in Indiana.

In order to explore the biogeography of section Ovales, the counties of Indiana were grouped into seven bioregions (Fig. 1) based upon Homoya (1985). Due to its very small size, Homoya’s Black Swamp Natural Region had to be merged with the Central Till Plain Natural Region for the purposes of this analysis. Similarly, the small Southern Bottomlands Region had to be combined with the Southwestern Lowlands Natural Region and Shawnee Hills with Highland Rim. The maps of species distribution resolve only to the county level. As a result, counties that straddle 2 regions were assigned to a single region based upon which natural region occupied the greatest portion of the county. In this analysis, the smallest natural region, the Northwestern Morainal region, included 3 counties. The largest region, the Central Till Plain, consisted of 34 counties.

RESULTS AND DISCUSSION

Overall Biogeographical Observations

Hermann’s treatment (in Deam 1940) of the genus Carex for Indiana reported 17 species in section Ovales. Three additional taxa are included in our treatment: C. missouriensis P. Rothr. & Reznicek, C. projecta Mackenzie, and C. tenera Dewey var. echinodes (Fernald) Wiegand. Of these 20 taxa, two have only single reports for Indiana—Carex cumulata (L.H. Bailey) Mackenzie and C. missouriensis (Fig. 2; Table 2). As detailed below, an extant population of C. cumulata was documented. However, it is very likely that C. missouriensis has been extirpated from the state. Six species of Carex section Ovales are very widespread (Table 2), having at least one record in each Natural Region of Indiana (Fig. 1). Seven additional species—C. argyrantha, C. crawfordii Fernald, C. merritt-fernaldii Mackenzie, C. opaca (Hermann) P. Rothr. & Reznicek, C. praticola Rydberg (an adventive), C. reniformis, and C. tincta—are not known
The distribution maps (Fig. 2; Table 1) indicate that species diversity in section *Ovales* is biased toward northern and especially northwestern Indiana. The largest number of species (18 out of 20) occurs in the Northwest Morainal (NWM) Natural Region (Table 1). The Northern Lakes (NL) and Grand Prairie (GP) also have high diversity (15 and 14 respectively). Four taxa are fully limited to these northern Natural Regions, while another 6 exhibit a predominately northern distribution in Indiana (Table 2). In contrast, only one species, *C. albolutescens*, has a predominately southern distribution in the state (Fig. 2; Table 2).

We primarily explain this biogeographical pattern on the basis of the diversity of soils and community types in the recently deglaciated areas of northern Indiana. Here one finds a broad range of substrates including coarse grained to peaty, acidic soils as well as fine grained, mineral-rich soils (Ulrich 1966). As a result,
the northern Natural Regions support both the widespread species (largely those adapted to heavy, mineral-rich soils) as well as a suite of species that favors more acidic soils. Secondarily, the high diversity of *Ovales* species in northern Indiana is a result of broadly distributed species that reach a southern range limit in the Great Lakes region. These include the transcontinental species *C. bebbii* and *C. tenera* var. *tendera* as well as the northern hardwoods species *C. projecta*.

The Central Till Plain (CTP) Natural Region supports 14 taxa (Table 1). This
diversity reflects both the large geographical area encompassed by the CTP and the infrequent presence of some northern elements such as *C. scoparia*. In addition, the CTP supports the preponderance of sites for one taxon, *C. tenera* var. *echinodes*.

The Highland Rim (HR) Natural Region has the lowest diversity for section *Ovales* (Table 1). This portion of Indiana is characterized by rugged, well-drained terrain and a scarcity of natural bodies of water and wetlands.
TABLE 1. Number of taxa of _Carex_ section _Ovales_ by biogeographical region.

<table>
<thead>
<tr>
<th>Bioregion</th>
<th>Number of Taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest Morainal (NWM)</td>
<td>18</td>
</tr>
<tr>
<td>Northern Lakes (NL)</td>
<td>15</td>
</tr>
<tr>
<td>Grand Prairie (GP)</td>
<td>14</td>
</tr>
<tr>
<td>Central Till Plain (CTP)</td>
<td>14</td>
</tr>
<tr>
<td>Southwestern Lowland (SWL)</td>
<td>11</td>
</tr>
<tr>
<td>Blue Grass (BG)</td>
<td>10</td>
</tr>
<tr>
<td>Highland Rim (HR)</td>
<td>9</td>
</tr>
</tbody>
</table>

TABLE 2. Distributional Patterns of _Carex_ section _Ovales_ in Indiana

Widespread: _Carex cristatella, C. festucacea, C. molesta, C. muskingumensis, C. normalis, C. tribuloides_

Limited to northernmost bioregions—NWM, NL, and GP: _Carex alata, C. bebbii, C. longii, C. projecta_

Predominately northern in distribution in Indiana: _Carex bicknellii, C. brevior, C. scoparia, C. straminea, C. suberecta, C. tenera var. tenera_

Predominately southern in distribution in Indiana: _Carex albolutebens_

Predominately found in the Central Till Plain: _Carex tenera var. echinodes_

Rare: _Carex cumulata, C. missouriensis_

KEY TO SPECIES OF _CAREX SECTION OVALES_
FROM INDIANA AND ADJACENT REGIONS.

(The key includes seven species, identified with an *, that have not been found in Indiana but occur within a four county distance in Illinois, Michigan, or Ohio).

1. Pistillate scales about as long as or longer than mature perigynia, usually concealing the beaks (though not necessarily the bodies), obtuse to acuminate, but not awned
   2. Perigynium beaks flat, winged, and ciliate-serrulate to apex; perigynia finely granular-papillose, 3–4.5 mm long ..............*C. argyrantha
   2. Perigynium beaks cylindric, unwinged, and more or less entire for 0.4 mm or more from apex; perigynia smooth, usually 4.5–6.5 mm long
      .....................................................*C. praticola

1. Pistillate scales (awns, if any, excluded) shorter than the perigynia at least in the middle portions of the spikes, the apical portion narrower than the beaks and not completely covering them, awned in some species
3. Pistillate scales in the middle or lower portions of the spikes acuminate with a subulate tip or awned.
   4. Perigynia 2.6–4 times as long as wide; the bodies lance-ovate to lanceolate, 0.9–2 mm wide ...............to couplet 15
   4. Perigynia less than 2.5 times longer than wide; the bodies narrowly ovate, ovate, broadly elliptic, circular, or obovate, 1.8–3.9 mm wide.
   5. Larger perigynia (5.8–) 6–7.1 mm long, with beaks 2–2.8 mm long; pistillate scales with the acuminate-awned apex white-hya-
line, fragile and often curled, the midrib not extending into the very tip. ............................... \textit{C. missouriensis}

5. Larger perigynia (2.3–) 2.5–5.5 mm long, with beaks 0.85–2.3 mm long; pistillate scales with the apex firm, greenish to reddish-brown, straight, the midrib extending to the very tip.

6. Perigynium bodies clearly obovate, often with conspicuous “shoulders,” abruptly contracted into the beak; broadest leaves 2.5–6 mm wide ............................... \textit{C. alata}

6. Perigynium bodies elliptical, circular, or weakly obovate, gradually tapered to gently contracted into the beak; broadest leaves 1.5–3 (–3.7) mm wide.

7. Perigynium bodies cuneately tapering to the base, the base therefore subacute and the body ± diamond shaped; inflorescences ± compact, stiffly erect, with 3–5 spikes ................................. \textit{C. suberecta}

7. Perigynium bodies convexly tapered to the base, the base therefore rounded and the body elliptical, circular or weakly obovate; inflorescences ± compact to elongate and nodding, with 3–9 spikes.

9. Pistillate and staminate scales with white-hyaline to pale yellowish margins; perigynia greenish to straw colored or pale brown, (2.3–) 2.5–4 (–4.2) mm long, with 0–4 often indistinct nerves on the inner face ............................... \textit{C. festucacea}

9. Pistillate and staminate scales with reddish-brown margins; perigynia reddish-brown, (3.8–) 4–5.5 mm long, usually with 5 or more conspicuous nerves on the inner face ............................... \textit{C. straminea}

3. Pistillate scales obtuse or merely acute

10. Perigynia 2 mm wide or less

11. Leaf sheaths loose and expanded near the summit, uniformly pale or greenish, sharp-edged or bearing narrow wings continuous with the midrib and/or edges of the leaf blade; widest blades 3–7 mm wide; perigynia often thin and scale-like, the wings often conspicuously narrowed (even indented) near the middle of the body to form a cuneate base; vegetative shoots with leaves spreading and spaced along distal 1/2 of the shoot

12. Perigynia stiffly spreading or recurved, the spikes more or less globose; pistillate scales 1.6–2.3 mm long, usually hidden between perigynia; summit of leaf sheaths and/or ligules often rust-tinged............................... \textit{C. cristatella}

12. Perigynia loosely spreading, ascending, or appressed, the spikes subglobose to ovoid-oblong; pistillate scales 2–3 mm long, evident in the spikes; summit of leaf sheaths and ligules not colored
13. Inflorescences stiffly erect, oblong, spikes overlapping; perigynia usually more than 40, beaks appressed-ascending; lower leaf sheaths firm at summit ... *C. tribuloides

13. Inflorescences arching or nodding, the lower spikes usually separated; perigynia 15–40, loosely spreading or ascending; lower leaf sheaths friable at summit

............................................ C. projecta

11. Leaf sheaths usually tight, the edges ± rounded, unwinged; widest blades 1–4 (–4.2) mm wide (or blades wider in *C. normalis* in which the sheaths generally have green veins contrasting with white intervenal areas); perigynia usually plumply planoconvex, the wings typically tapered evenly to the round or sometimes cuneate base; vegetative shoots with leaves ascending and clustered at apex

14. Perigynia 2.5–4 times as long as wide, the bodies lanceolate-ovate to lanceolate, the distance from beak tip to top of achene mostly 2.2–5 mm (about 3/5 the length of the perigynia)

15. Perigynia 0.9–1.3 mm wide; achenes 0.6–0.8 mm wide; inflorescences dense, the lowest internodes 2–3(–5) mm long. ............................................. *C. crawfordii

15. Perigynia 1.2–2 mm wide; achenes 0.7–1.1 mm wide; inflorescences dense to open or arched, the lowest internodes 2–17 mm long

16. Inflorescences erect to arching, dense or open but the spikes usually approximate; pistillate scales acuminate; perigynia usually ascending ....... *C. scoparia

16. Inflorescences arching or nodding, spikes well separated; pistillate scales obtuse or acute; perigynia spreading ............. *C. tenera* var. *echinodes*
20. Sheaths smooth; pistillate scales greenish to yellowish-brown

21. Perigynia nerveless on adaxial face, 1.2–1.8 mm wide, rust-colored; achenes 0.6–0.9 mm wide ..................... C. bebbii

21. Perigynia nerved on adaxial face or if nerveless then 1.8–3 mm wide, not rust colored; achenes 0.9–1.3 mm wide

22. Leaf blades 2.5–6.5 mm wide, the mouth of sheaths prolonged up to 2 mm above base of leaf blades; perigynium bodies narrowly ovate (ca. 2–2.5 times as long as wide) and usually greenish or greenish-brown tinged ................. C. normalis

22. Leaf blades 1.5–4 mm wide, the mouth of sheaths concave or at most shortly prolonged above base of leaf blades; perigynium bodies broadly elliptic (mostly 1.5–2 times as long as wide), quickly turning pale- or yellowish-brown ...................... C. molesta

19. Inflorescences usually open at least proximally, lowest internodes greater than 6 mm long

23. Perigynium bodies broadly elliptic to circular (0.9–1.3 times as long as wide), abruptly narrowed to beak; leaves 1–3.5 mm wide; lower pistillate scales (and adjacent staminate scales) acute ..................... C. festucacea

23. Perigynium bodies ovate, lanceolate, or narrowly elliptic, gradually tapering to beak; leaves 1.3–6.5 mm wide; lower pistillate scales (and adjacent staminate scales) obtuse

24. Sheaths at least sparsely papillose (visible at 30x) dorsally near the base of leaf blade, the lower sheaths not prominently whitish mottled nor cross-septate; perigynium beaks appressed or ascending, exceeding subtending scales by 0–0.8 mm, their shoulders straw-colored to reddish brown at maturity .................... C. tenera var. tenera

24. Sheaths totally smooth, the lower sheaths often whitish-mottled and cross-septate; perigynium beaks spreading, exceeding subtending scales by 0.7–1.6 mm, their shoulders greenish to greenish brown at maturity

25. Widest leaves 2.5–6 mm wide; inflorescences erect to bent, the lowest intern-
odes mostly 6–10 (–11.5) mm long, the rachis stiff; plants forming small, ± erect clumps of less than 40 culms C. normalis

25. Widest leaves 1.5–3.5 mm wide; inflorescences arching or nodding, the lowest internodes (6–) 10–21 mm long, the rachis usually thin and wiry; plants often forming large, spreading clumps of many culms ........... C. tenera var. echinodes

10. Perigynia greater than 2 mm wide

26. Spikes 12–28 mm long with tapering bases and acute tips; perigynia lanceolate, 6–9 mm long; vegetative culms conspicuous at time of fruiting .................. C. muskingumensis

26. Spikes less than 12 mm long, or if longer, with rounded bases and/or tips; perigynia, if lanceolate, less than 6 mm long; vegetative culms absent or present at time of fruiting

27. Perigynium bodies obovate (widest above the middle of the body); leaf sheaths green-nerved ventrally nearly to the summit; achenes 0.7–1.2 mm wide

28. Beaks spreading, slender and abruptly contracted from the body; pistillate scales acute; styles with a strong S-loop at the base .................. C. albolutescens

28. Beaks appressed-ascending, triangular and gradually tapered from the body; pistillate scales obtuse or acute; styles straight or occasionally bent

29. Perigynia nerved on adaxial face; widest leaves 2–4 mm wide, their sheaths concave at summit C. longii

29. Perigynia nerveless on adaxial face; widest leaves 3–6 mm wide, their sheaths truncate at summit or extending up to 3 mm above base of leaf blades

.................. C. cumulata

27. Perigynium bodies lanceolate, ovate, elliptic, circular, or reniform (widest at or below the middle of the body); leaf sheaths various, some with a prominent hyaline band ventrally; achenes 0.9–1.9 mm wide

30. Perigynia finely granular-papillose (visible at 30×), the body reniform, 0.6–0.9 times as long as wide (3.2–4.9 mm wide); lower pistillate scales obtuse-rounded

.................. *C. reniformis

30. Perigynia smooth, the body narrowly ovate, elliptic, or more or less circular, (0.7–) 0.9–2.5 times as long as wide (1.5–4.6 (–4.8) mm wide); lower pistillate scales obtuse to acuminate

31. Larger perigynia 5–7.1 mm long, perigynia thin, bi-convex (the bulge formed by the achene usually equally prominent on both perigynium faces)
32. Leaf sheaths finely papillose (visible at 30×); perigynia thin, translucent, usually with coppery-tinged wings, strongly and evenly 4–8-nerved over achene; pistillate scales usually reddish-brown; anthers (2.4–) 2.8–4.2 mm long; plants in small clumps in usually dry to mesic habitats

................................. C. bicknellii

32. Leaf sheaths smooth; perigynia ± thickened and opaque, with greenish or pale brown wings, finely and irregularly (0–) 1–7-nerved over achene; pistillate scales pale yellowish-brown; anthers 2.2–3.4 mm long; plants in dense, large clumps (up to 200 culms) in wet habitats

................................. *C. opaca

31. Larger perigynia less than 5 mm long, perigynia usually plumply planoconvex at maturity

33. Leaf sheaths green-ribbed ventrally nearly to sheath summit; spike tips acute; perigynia rust-colored at maturity, cuneately tapered to the base; beaks appressed, gradually tapered

................................. Carex suberecta

33. Leaf sheaths with a white-hyaline area ventrally near the summit; spike tips obtuse or rounded; perigynia straw-colored, greenish, or sometimes brown at maturity, rounded to the base; beaks ascending to spreading, abruptly contracted (or gradually tapered in C. normalis)

34. Perigynium bodies narrowly ovate to ovate (ca. 2–2.5 times as long as wide), greenish, the beaks gradually tapered; leaves 2.5–6.5 mm wide; proximal sheaths loose, intervenal areas often pale or whitish, the mouth of sheaths prolonged up to 2 mm above base of leaf blades ................. C. normalis

34. Perigynium bodies broadly ovate to circular (ca. 1–2 times as long as wide), quickly turning pale- or yellow-brown or rust colored, the beaks often abruptly contracted from body; leaves 1–3.5 mm wide; proximal sheaths evenly colored and tight, the mouth of sheaths concave or at most shortly prolonged above base of leaf blades

35. Leaf sheaths finely papillose (visible at 30×), especially near the base of the leaf blade

36. Pistillate scales dark rust or reddish-brown; leaves of fertile shoots 2–4,
35. Leaf sheaths smooth

36. Pistillate scales greenish to yellowish; leaves of fertile shoots 3–6, the leaf sheaths not puckered

37. Perigynia 2–2.4 (–2.6) mm wide; distance from summit of achene to tip of beak 0.8–1.5 mm; larger achenes 1–1.35 mm wide

............... *C. tincta

37. Perigynia 2.5–3.4 mm wide; distance from summit of achene to tip of beak 1.8–3.1 mm; larger achenes 1.3–1.5 mm wide

............... *C. merritt–fernaldii

35. Leaf sheaths smooth

38. Spikes on larger inflorescences 2–4 (rarely more), rounded at the base, the terminal one lacking a conspicuous staminate base; inflorescences mostly 1.3–3 cm long (the lowest internodes generally 1.5–6 mm long); perigynium bodies elliptic to ovate (rarely circular), 1–1.6 times as long as wide............... C. molesta

38. Spikes on larger inflorescences (4–) 5–7 or more, tapered at the base, the terminal one with a conspicuous staminate base; inflorescences typically 2.5–4.5 (–6) cm long (the lowest internodes generally 5–13 mm long); perigynium bodies broadly ovate to circular, (0.7–) 0.9–1.2 times as long as wide

39. Larger perigynia 3.2–4.7 (–5) mm long, 2.5–3.3 (–3.5) mm wide, the adaxial face usually nerveless; larger achenes 1.4–1.8 mm wide............... C. brevior

39. Larger perigynia 2.5–4 (–4.2) mm long, 1.5–2.4 (–2.6) mm wide, the adaxial face mostly 2–4-nerved; larger achenes 0.9–1.3 mm wide

............... C. festucacea
NOTES ON INDIVIDUAL SPECIES

1. *Carex alata* Torrey. *Carex alata* is primarily distributed along the Atlantic coastal region from central Florida to southeastern New Hampshire (Rothrock et al. 1997). Inland it has several secondary centers of distribution: central New York, northwest Pennsylvania westward to Indiana, and southeastern Missouri to central Tennessee. In Indiana it is limited to northern counties were it thrives in mostly organic soils associated with fens, lake margins, wet prairies, red maple (*Acer rubrum*) or swamp white oak (*Quercus bicolor*) woods, tamarack (*Larix laricina*) swamps, and even *Sphagnum* bogs. Putative hybrids between *C. alata* and *C. scoparia* (Rothrock et al. 1997) and between *C. alata* and *C. tribuloides* (Mohlenbrock 1999) have been reported from Ohio and Illinois respectively.

2. *Carex albolutescens* Schweinitz. In some floras of the southeastern United States, this species has been confused with *C. festucacea*. Unlike *C. festucacea*, *Carex albolutescens* has clearly obovate perigynia with sharper adaxial nervation, narrower achenes, and a strong lateral sinuosity at the base of the style (Rothrock 1991).

In Indiana, *C. albolutescens* occurs primarily in the Ohio River Valley. It grows in mucky or sandy, acidic soils of swampy woods with pin oak (*Quercus palustris*), red maple, or sweet gum (*Liquidambar styraciflua*) or sometimes in wet sandy meadows.

3. *Carex bebbii* (L.H. Bailey) Fernald. In the field *C. bebbii* resembles a diminutive *C. cristatella* in that both have somewhat spherical spikes with numerous, small perigynia. Besides characters in the key to species, *C. bebbii* can be distinguished from *C. cristatella* by its narrower leaves (only reaching 4.2 mm compared to 7.5 mm in *C. cristatella*) that, on vegetative shoots, are clustered near the apex.

*Carex bebbii* is very broadly distributed across northern North America (Mastrogiuseppe et al., in rev.). In Indiana, this species is limited to the northern counties where it grows in wet, usually calcareous soils of lake shores and wet prairies and occasionally in wet sandy meadows.

4. *Carex bicknellii* Britton. *Carex bicknellii* has a center of distribution in the dry prairies of the upper Midwest, including Missouri, Iowa, Illinois, eastern Kansas, and southeastern Nebraska (Rothrock & Reznicek 2001). A secondary center of distribution extends from southeastern Pennsylvania to Massachusetts where *C. bicknellii* occupies barrens and other habitats with dry, sandy soils. *Carex bicknellii* is found in open habitats with sandy soils such as railroad right-of-ways, remnant prairies, old cemeteries, stabilized dunes, and open black oak (*Quercus velutina*) woods. These habitats are most often associated with the Northwestern Morainal and Grand Prairie Natural Regions of northwestern Indiana. The single Jefferson County collection (19 June 1935, C.C. Deam 56228A, IND) comes from a flat woods “on the Schuman farm, about 2 mi. NE of Hanover.”
5. Carex brevior (Dewey) Lunell. A review of herbarium materials indicated that Deam’s (1940) “Flora” did not clearly differentiate this species from C. molesta. As described in the key to species, spike number and shape and perigynium shape separate these two taxa. In addition, the achenes of C. brevior are much wider than those of C. molesta (larger achenes 1.4–1.8 mm wide versus larger achenes 0.9–1.3 mm). Carex brevior is most common in portions of Indiana with prairie elements, particularly the northwestern counties. Here C. brevior occurs in sandy soils of fields, dunes, and open woods. The Huntington County collection is a waif of a road verge. Carex brevior occasionally may be found in the eastern and southeastern United States, outside its natural range, as a weed of road verges. More robust specimens of C. brevior sometimes resemble C. merritt-fernaldii and, in fact, the L.M. Umbach (5289, MICH) collection from Port Chester in Porter County was originally identified and annotated as C. merritt-fernaldii. The two species are most easily distinguished by their leaf sheaths. Those of C. brevior are always smooth, while those of C. merritt-fernaldii have fine papillae (visible at 30×).

6. Carex cristatella Britton. This species is common in unshaded marshes, edges of ponds and lakes, wet ditches, wet woods, river banks, and swampy flood-plains throughout most of Indiana. In southernmost Indiana this species is infrequent and near a southern limit of its range.

Sometimes C. cristatella is confused with C. tribuloides. However, normal vigorous specimens are easily distinguished from C. tribuloides by the globose shape of the spikes. Of the 2 species, C. cristatella is much less tolerant of shaded conditions. Also, unlike C. tribuloides, decumbent culms of C. cristatella do not seem to root at their nodes. Both species have relatively late flowering and fruit maturation periods for members of section Ovales. Mature achenes develop in early July and can be retained on the inflorescence until mid-August. The majority of Ovales species shed mature fruit by the third or fourth week of June.

7. Carex cumulata (L.H. Bailey) Mackenzie. Morphologically C. cumulata is most similar to C. longii but has more conic spikes and strongly concave perigynia without adaxial nervation. In spite of searching for this species in other likely sites in Indiana (such as Jasper-Pulaski Fish and Wildlife Area), we found C. cumulata to be limited to Willow Slough Game Preserve in Newton County. It also occurs in Illinois in adjacent Kankakee (Swink & Wilhelm 1994) and Iroquois (Reznicek 10836; ILLS, MICH) Counties. At Willow Slough, this species grows in sandy, acidic soils of pin oak savannas, especially along fire-breaks where there is periodic disturbance. It declines as the Polytrichium moss stage of succession is reached. As a further ecological note, the achenes of C. cumulata ripen in mid-August, late for a member of section Ovales and, unlike other species in the section, do not readily germinate without a pre-treatment of moist stratification (Rothrock, unpublished data).

8. Carex festucacea Willdenow. In the field, C. festucacea looks like C. brevior with small perigynia and has occasionally been confused with it in herbaria. In
Indiana, *Carex festucacea* has a wider distribution than *C. brevior*, occupying a range of wet or seasonally wet habitats such as low flatwoods (especially with pin oak), wooded ravines, wet fields and prairie, and low roadsides and ditches. Less often, this species may be found in drier habitats such as wooded slopes.

9. *Carex longii* Mackenzie. *Carex longii* is common along the Atlantic and Gulf of Mexico coastal plain. In fact, it has an almost weedy quality in the southern United States where it enters early successional habitat with sandy soils, reaches reproductive maturity quickly, and can spread to some degree through the rooting of decumbent culms. Disjunct populations occur to the west of Lake Erie and east and south of Lake Michigan. In Indiana, *C. longii* is limited to the northwestern counties (especially the Northwestern Morainal and Grand Prairie Natural Regions). Here it inhabits wet or seasonally wet, acidic, sandy soils of open woods dominated by pin oak or red maple, marshes, fields, and prairies. Less often, *C. longii* is found in drier habitats or *Sphagnum* bogs. Some manuals (e.g. Gleason 1952; Radford *et al.* 1964) have reduced *C. longii* to synonymy with *C. albolutescens*. Rothrock (1991) demonstrated that the two are clearly distinctive species. Mature fruits are produced in early July.

10. *Carex missouriensis* P. Rothrock & Reznicek. This recently described species superficially resembles *C. bicknellii*. *Carex missouriensis* favors wet habitat, typically prairie swales, compared to the more mesic to dry habitats of *C. bicknellii*. The single 1944 record for *C. missouriensis* in Indiana is from a “wooded ravine 5 mi NE of Clinton” (R.M. Kriebel 10198, PUL). Efforts to re-locate the population were unsuccessful, although an area along US 41, now occupied by a dwelling and a stream swale invaded by *Phalaris arundinacea*, appears to be the most likely site.

11. *Carex molesta* Bright. Although described in Deam (1940) as infrequent to rare, *Carex molesta* is actually widespread in Indiana. It seems to be particularly frequent in the heavy, calcareous soils of the Central Till Plain region of east central Indiana. *Carex molesta* thrives in early to mid-successional habitats including mesic to wet roadside banks and ditches, low edges of fields as well as edges of marshes, and wooded openings.

12. *Carex muskingumensis* Schweinitz. This is the most distinctive member of *Carex* section *Ovales* with lanceolate perigynia reaching 7–10 mm in length. Deam (1940) indicates that this species can form extensive and pure stands in wet woods. *Carex muskingumensis* is particularly abundant in the lower Wabash basin of southwestern Indiana. It also occurs frequently in depressional woods with pin oak, swamp white oak, and silver maple (*Acer saccharinum*) in the Central Till Plain Region and in depressional and floodplain woods in the Northwestern Morainal Natural Region. Swink & Wilhelm (1994) noted that this species prefers soils of high organic leaf and root litter content positioned over mud. Although often growing near *C. tribuloides*, only a single hybrid specimen (with sterile achenes) has been found between these two species (Posey Co., Reznicek *et al.* 10852, BUT, MICH, WIS).
13. Carex normalis Mackenzie. Carex normalis has broad ecological amplitude; it is frequent in mesic to moist or dry open woods and thickets throughout Indiana. Herbarium labels include wooded slopes especially associated with rivers; flat beech (Fagus grandifolia), sugar maple (Acer saccharum), or white oak (Quercus alba) woods; flat post oak (Quercus stellata) woods; wooded bluffs and ravines; woods of creek floodplains; and thickets near ponds, lakes, or ditches. The soils are mineral with low organic content.

14. Carex projecta Mackenzie. This species was not listed by Deam (1940) since most collections have been made since 1970. Carex projecta reaches a southern limit of its range in the extreme northwestern counties of Indiana. Swink & Wilhelm (1994) describe it as a species of morainic slopes and riparian terraces.

Many Indiana collections of C. projecta are difficult to separate from a related species, C. tribuloides, even though, in our experience, the two species are readily distinguished farther north. Further taxonomic study may be warranted. On the one hand, Mastrogiuseppe et al. (in rev.) suggest that C. projecta is in many respects intermediate between C. cristatella and C. tribuloides; and yet, available chromosome counts (Whitkus 1991) indicate that C. projecta (with $n = 32$ versus $n = 35$ for C. tribuloides and C. cristatella) is distinct from both these species. We attribute the problematic nature of Indiana collections of C. projecta to the fact that they come from small, physiologically stressed populations at the periphery of their geographic range.

15. Carex scoparia Willdenow. Although C. scoparia can be a very common species in the northeastern United States and adjacent Canada, it is more restricted in distribution in Indiana. This species can be frequent in the northern quarter of Indiana in unshaded borders of lakes, marshes, low fields, wet prairies, wet railroad right-of-ways, sedge meadows, interdunal flats, and open pin oak woods. The scattered occurrences of C. scoparia in southern Indiana include habitats such as low fields or old pastures, wet woods, and sedge-filled roadside depressions. The soils are frequently sandy and acidic. Because C. scoparia has much intraspecific variation, Fernald (1950) lists 6 forms and varieties. None of these are particularly useful in Indiana.

16. Carex straminea Willdenow. Known as C. richii in Deam (1940), C. straminea is most characteristic of open pin oak, river birch (Betula nigra) swamp woods as well as sedge meadows and lake margins in northwestern Indiana. It typically grows in acidic sandy or peaty soils. A very large population has been located at Willow Slough Game Preserve. Disjunct populations of this rare sedge occur in Harrison and Lawrence County. Putative sterile hybrids (Rothrock et al. 1997) have been reported between C. straminea and C. scoparia (White County) and with C. longii (Newton County).

17. Carex suberecta (Olney) Britton. This species inhabits calcareous soils of unshaded fens, lake margins and seepages, tamarack swamps, and prairie swales, especially in the northern half of Indiana. Putative sterile hybrids between this
species and *C. scoparia* have been reported (Rothrock *et al.* 1997) for Lake County.

18. *Carex tenera* Dewey var. *tenera*. The typical variety of *C. tenera* is rare in Indiana. Swink and Wilhelm (1994) describe it as a species of wet to mesic savannas and prairies. It also has been reported from wooded slopes and dry open woods.

19. *Carex tenera* Dewey var. *echinodes* (Fernald) Wiegand. Preliminary investigation indicates that this taxon should be recognized as a species distinct from typical *C. tenera* and may, in fact, be more closely related to *C. normalis*. In Indiana, *C. tenera* var. *echinodes* often occupies the margins of vernal pools in flat, swampy woods with pin oak, swamp white oak, and red maple. These habitats are frequent in the eastern Central Till Plain Natural Region; however, the populations observed have consistently been of small size, usually fewer than 5 clumps.

20. *Carex tribuloides* Wahlenberg. *Carex tribuloides* is one of the most common *Ovales* species in Indiana. It grows in swampy flat woods as well as banks of streams, seepages, marshes, and wet prairies. The soils range from peaty to rotting logs to mineral-rich. Decumbent culms of *C. tribuloides* can root at their nodes resulting in vegetative spread, a trait not observed for *C. cristatella* and infrequently for *C. projecta*.

Mackenzie (1931) recognizes variety *sangamonensis* Clokey. These plants have more slender leaves (seldom reaching 4.0 mm wide) and shorter perigynia (averaging ca. 3.2 mm). In its extreme, this variety is distinctive and is the common form of the species in the lower Mississippi valley. Some specimens from the southern half of Indiana (e.g. Clay, Fountain, Jennings, Knox, Pike, Rush, and Warrick Counties) can be assigned to variety *sangamonensis*. More work is needed to assess the distinctness and distribution of this entity.

**ADDITIONAL SPECIES KNOWN FROM ADJACENT ILLINOIS, MICHIGAN, AND OHIO**

1. *Carex merritt-fernaldii* was verified from Lucas County, Ohio (Rothrock & Reznicek 2001). *Carex merritt-fernaldii* is most frequent in parts of southern Ontario eastward into Maine, northern New England, and New Brunswick where soils are well-drained, leached, acid sands or gravels.

2. *Carex crawfordii* was collected from Lake County, Illinois in 1991 from a degraded marsh (Mohlenbrock 1999). This northern, transcontinental species is typically found in wet sandy shores, meadows, and ditches in acidic, sandy or organic soils.

3. *Carex opaca* has recently been reported from Saline, St. Clair, and Washington Counties, Illinois (Rothrock & Reznicek 2001). This species is fairly infre-
quent throughout its range but reaches its greatest abundance in areas surrounding the Ozark Mountain system where it inhabits unshaded, poorly drained habitats including highway right-of-ways and “rice prairies.”


5. Carex reniformis is known from Massac County, Illinois, as noted by Mohlenbrock (1999).

6. Carex argyrantha is known from two collections in Berrien County, Michigan, on wooded dunes near Lake Michigan (Henderson 140, MICH; Reznicek 9522, MICH). Efforts to find it in nearby areas of Indiana have so far been unsuccessful.

7. Carex tincta is rare in the western Great Lakes region. Our only nearby collection, dating from June 1923, comes from DuPage County, Illinois (A. Butler s.n., F).

The distinctive Carex sychnocephala, with leafy-bracted heads, is known as close to Indiana as Hillsdale County, Michigan (Fritsch 1993). However, although placed in section Ovales in some works (e.g., Fernald 1950, Gleason 1952), it is here placed in section Cyperoideae.

LITERATURE CITED


Deam, C.C. 1940. Flora of Indiana. Department of Conservation, Indianapolis, IN.


NOTEWORTHY COLLECTION

MICHIGAN

PINUS NIGRA Arnott (Pinaceae)  Austrian or Black Pine

Previous knowledge. Pinus nigra is a native of Europe widely introduced as an ornamental tree. It was reported to “escape locally” in the northeastern United States and adjacent Canada (Gleason & Cronquist 1991), but was given only incidental mention in the Flora of North America (Kral 1993). Pinus nigra was reported as naturalized (successfully reproducing and surviving without human intervention) in Illinois (Pepoon 1927). It was not included in the Michigan Flora (Voss 1973), which included non-native species only if established or naturalized. More recently, P. nigra was reported to become naturalized in western Michigan, where originally planted to stabilize sand dunes (Leege & Murphy 2000). It was also reported as “spreading in the Pacific Northwest” (Petrides & Petrides 1998) without specifics.

Significance. This is the first report of naturalized Pinus nigra from a broad area (six adjacent counties) of Michigan. The actual frequency with which established populations are encountered along Michigan roadways is believed to be much greater than indicated by the few specimens cited here. Originally planted along highways, individuals of the species have fully reached sexual maturity in the past 10–15 years. From those trees the species has been slowly becoming established in suitable, open habitat with a low density of grasses and other vegetation. At each site cited below, there were mature trees with many seedlings and saplings commonly ranging from 15 cm to more than 4 m tall. The high density of young trees can be used as an indicator that the seedlings were not planted.

Diagnostic characters. Pinus nigra is most likely to be confused with the native P. resinosa. The non-native species may be distinguished from the native by its fresh leaves, which bend rather than break when sharply folded; its seed-cone scales, which are cream to light brown or gray, not light red-brown, at the time of seed shed, and some of which bear a minute prickle (easily broken off) that is absent in P. resinosa; and its winter buds, which are pale silvery instead of reddish brown (Kral 1993), though that is a difficult distinction. Also, the bark, especially at a distance, appears dark gray instead of pinkish or reddish brown. Length of leaves on seedlings is shorter than that of adults.

MICHIGAN. GENESEE CO.: Near Fenton, northbound entrance ramp of US highway 23 at Owen Road, T5N R6E Sec. 34, west-facing slope, open prior to growth of pines, about 10 adults with 23 offspring 20–60 cm tall and 35 offspring 0.6–2 m tall, 7 March 1999, B. D. Parfitt 6040 & C. A. Wade (MICH, UMF); West of Grand Blanc, northbound exit ramp from US highway 23 onto Grand Blanc Road, T6N R6E Sec. 23 NE¼ NW¼, west-facing slope, dozens of offspring of all sizes in a thicket near adults, 7 March 1999, B. D. Parfitt 6048 & C. A. Wade (MICH, UMF); Between Davison and Goodrich along the west side of state highway 15 (M-15), T6N R8E Sec. 27 NW¼, open dry 20–30° east-facing slope, three mature trees with about 75 seedlings and saplings of all ages, 1 June 1998, B. D. Parfitt 6020 & J.