The separation of *Eleocharis obtusa* and *Eleocharis ovata* (Cyperaceae) in eastern Canada

B.M.H. Larson and P.M. Catling

Abstract: *Eleocharis obtusa* and *Eleocharis ovata* are recognized as distinct species or combined in recent taxonomic literature. To assess their morphological relationship and to evaluate all morphological characters potentially useful for their separation, 11 floral and achene characters were measured on 130 eastern Canadian herbarium specimens. Tubercle width was bimodally distributed and completely separated groups established on the basis of stamen number: plants referable to *E. ovata* had tubercles less than 0.5 mm wide and two stamens, whereas plants referable to *E. obtusa* had tubercles greater than 0.5 mm wide and three stamens. Since determination of stamen number requires dissection under a microscope and tubercle width requires accurate measurement, the most readily utilized character was found to be the ratio of tubercle width to achene width, which can be measured or estimated. The tubercle was less than 2/3 the width of the achene in *E. ovata* and more than 2/3 in *E. obtusa*. Differences in these characters were associated with significant but less dramatic differences in other characters, suggesting that the two taxa should be treated as distinct species.

Key words: *Eleocharis obtusa*, *Eleocharis ovata*, Cyperaceae, taxonomy, classification, Canada.

Introduction

*Eleocharis engelmanii* Steud., *Eleocharis ovata* (Roth) R. & S., and *Eleocharis obtusa* (Willd.) Schultes of *Eleocharis* series *Ovatae* (Svenson 1929, 1953, 1957) are distinctive in being cespitose annuals with smooth, brown, lenticular achenes and differentiated tubercles. They are prevalent in some wetland communities and are sometimes important for the stabilization of shorelines. The southern *E. engelmanii* is very rare and localized in eastern Canada. It is distinctive because its tubercle is less than 1/3 as tall as wide, and although it is as wide as the achene, it is depressed so that it is less than 1/4 of the achene’s height (Fernald 1950; Voss 1972; Hines 1975). This species may also be distinguished by its short bristles that do not exceed the achene and by its relatively long, ellipsoid spikelets. In contrast, the separation of *E. ovata* and *E. obtusa*, taxa that extend further north throughout much of the southern portion of eastern Canada, has long been problematic. They were recognized as distinct species by Svenson (1929, 1953, 1957), Fernald (1950), Voss (1972), Hines (1975), Scoggan (1978), Hinds (1986), and in Kartesz’s (1994) North American list. Drapalik and Mohlenbrock (1960) recognized the two taxa as varieties of *E. obtusa*. Despite this widespread recognition, the persistent difficulty with their identification is evident in some of the recent literature, in which *E. obtusa* is placed in synonymy under *E. ovata* (e.g., Hitchcock and Cronquist 1973; Gleason and Cronquist 1991; Boivin 1992; Douglas et al. 1994).

The only extensive study of *E. ovata* and *E. obtusa*, and the characters used to separate them, was that of Hines (1975). He produced a key that separated a group including *E. ovata*, with two stamens, from a group including *E. obtusa,*
with three stamens. The evidence for this dichotomy was a
discriminant analysis, based on characters other than stamen
number, and a principal components analysis (Hines 1975,
Figs. 13 and 14, respectively). A table of maximum and
minimum values, with standard deviations, for the eight
characters and two ratios that he measured was also pro-
vided. While these data substantially improved our under-
standing of these two taxa, there were some limitations with
Hines' (1975) work. First, the collection locality for the
approximately 30 specimens of each
taxon
that he measured
is unknown. He stated only that the plants were collected
"from a diversity of geographical areas within their ranges." He borrowed specimens only from United States herbaria,
and it is clear from his distribution maps that he used rela-
tively little Canadian material. In addition, the principal
components analysis utilized the difficult character of stamen
number, which was a nearly complete discriminator between
these two taxa, and thus gave no indication of the value of
more readily employed characters. Furthermore, his study
gave no reliable means of assessing the amount of difference
between the taxa, which would contribute to a decision on
appropriate taxonomic rank. Lastly, although he presented
useful quantitative data for differences in some traditional
characters, his key separated E. ovata and E. obtusa on
stamen number alone.

Our preliminary observations of this group suggested that
E. obtusa and E. ovata were distinct taxa, as suggested by
Hines (1975) and contrary to some recent taxonomic treat-
ments. The objectives of the work reported here were (i) to
assess the morphological relationship of E. obtusa and
E. ovata in eastern Canada, a region understudied by Hines
(1975), and (ii) to evaluate all potentially useful taxonomic
characters in terms of both discrimination and utility.

**Methods**

To obtain a representative sample of eastern Canadian variation
within these species, 130 specimens in DAO and CAN (acronyms
from Holmgren et al. 1990) were selected to represent a broad geo-
graphic area (Fig. 1). The sample included a wide variation in plant
size and habit and included plants referable to E. ovata var. ovata
and E. ovata var. heuseri Uechtritz, E. obtusa var. obtusa, and
E. obtusa var. jejuna Fernald. Both var. heuseri and var. jejuna,
plants with short culms of varying lengths, are a late-season growth
response to decreasing daylengths (Hines 1975). The majority of
the specimens selected were from DAO (specimen accession num-
bers listed in Appendix), but a few specimens from CAN were
selected to complete geographic coverage. On each specimen, a
spikelet with fully developed achenes at its base was chosen for
measurement or evaluation of 11 characters, including those listed
in Table 1, as well as stamen and stigma number and scale colour
and shape (as the area between the tip and a line 1 mm proximal
to it). Prior to measuring, the spikelets were soaked in soapy water
to facilitate dissection and reduce breakage.

For measurement of fruit and scale characters, an achene and its
associated scale were selected from near the base of the spikelet.
The scales were placed on a slide and drawn using camera lucida,
so that the area of their tip and their length could be measured using
*sigma-scan* version 3.9 (Jandel Scientific, Corte Madera, Calif.).
The length of the longest bristle was measured as the distance from
its tip to the base of the achene, without correcting for curvature.
Measurements were taken on the adaxial surface of the fruit.
Achene height was measured as the distance from the base of
the achene, below the point of bristle insertion, to the base of the
tubercle. Tubercle height was measured as the distance between
the apex of the achene and the tip of the tubercle. The width of the
tubercle and the achene were measured at their widest points. After
all of the specimens had been measured, spikelet colour (as a reflec-
tion of scale colour) was scored as either reddish brown or purple,
using standards for each colour, during a single examination session.
The first flowers encountered with elongated filaments and dehiscing the apex of the same length was recorded for the longest, mature, dehisced anther. The number of stamens and stigma lobes was recorded from the spikelets of E. ovata (2 stamens) and E. obtusa (3 stamens). Variation in these numbers was also recorded. Anther number, correlations, histograms, and bivariate plots were obtained using STATGRAPHICS PLUS version 7.0 (Statistical Graphics Corporation, Manugistics Inc., Rockville, Md.). To correct for multiple simultaneous comparisons, a Bonferroni correction (Rice 1989) was used for the derivation of ANOVA probabilities. All characters, including ratios, could be fitted to a normal distribution without significant ($p < 0.05$) departure, so the statistical results should be sound.

### Results and discussion

Groups established on the basis of stamen number were completely separable by tubercle width (Figs. 2 and 3). This supports the use of one or both of these characters by Fernald (1950), Svenson (1953, 1957), and Hines (1975), and the treatment of the two taxa as species by the same authors. As suggested by Hines (1975), plants with two stamens, subsequently referred here to E. ovata, had a tubercle width less than 0.5 mm, whereas plants with three stamens, hereafter E. obtusa, had a tubercle greater than 0.5 mm wide. There was a strong correlation between stigma number and stamen number (0.88; $p < 0.0001$), with E. ovata tending to have two stigmatic lobes. However, the correspondence was not complete: only 77% of the variation in stigma number was attributable to stamen number in the recorded flowers. Moreover, 28 of 95 (29.4%) E. obtusa plants had flowers with either two or three stigmatic lobes.

Tubercle width was a better discriminator than the ratio of tubercle width to achene width (Table 1). However, tubercle width requires accurate measurement, whereas the estimation of tubercle width with respect to achene width is relatively easily evaluated and has been used in many keys. Our studies indicate that E. ovata has tubercles mostly less than 2/3 the width of the achene, whereas E. obtusa has tubercles greater than 2/3 the width of the achene, corresponding to keys produced by Fernald (1950) and Svenson (1953, 1957). A complete separation of the two species also resulted from a scatterplot of achene width versus tubercle height to width (Fig. 4). Other continuous characters and ratios analyzed were much less valuable in distinguishing the two taxa (Table 1).

A significant relationship between stamen number and scale colour was found ($\chi^2$, $p < 0.0001$). All plants referable to E. ovata had purple scales. On the other hand, 31.6% of the plants referable to E. obtusa were evaluated as having
Table 1. Means, minima, maxima, standard deviations (SD), F-ratios from one-way ANOVAs, and corresponding probabilities corrected for multiple comparisons (Rice 1989), for 35 plants with two stamens, referable to *E. ovata*, and 95 plants with three stamens, referable to *E. obtusa*, all from eastern Canada.

<table>
<thead>
<tr>
<th>Character (mm)</th>
<th><em>Eleocharis ovata</em></th>
<th></th>
<th><em>Eleocharis obtusa</em></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Mean (mm)</td>
<td>Min. (mm)</td>
<td>Max. (mm)</td>
<td>SD (mm)</td>
<td>Min. (mm)</td>
<td>Max. (mm)</td>
<td>SD (mm)</td>
<td><em>F</em>&lt;sub&gt;[1,120]&lt;/sub&gt;</td>
<td><em>p</em></td>
</tr>
<tr>
<td>Scale length</td>
<td>1.92</td>
<td>1.40</td>
<td>2.30</td>
<td>0.24</td>
<td>2.07</td>
<td>1.50</td>
<td>2.60</td>
<td>0.22</td>
</tr>
<tr>
<td>Bristle length</td>
<td>1.52</td>
<td>1.26</td>
<td>1.78</td>
<td>0.11</td>
<td>1.73</td>
<td>1.26</td>
<td>2.19</td>
<td>0.17</td>
</tr>
<tr>
<td>Achene height</td>
<td>0.86</td>
<td>0.71</td>
<td>1.02</td>
<td>0.07</td>
<td>0.94</td>
<td>0.71</td>
<td>1.10</td>
<td>0.07</td>
</tr>
<tr>
<td>Achene width</td>
<td>0.70</td>
<td>0.55</td>
<td>0.79</td>
<td>0.04</td>
<td>0.82</td>
<td>0.74</td>
<td>0.90</td>
<td>0.04</td>
</tr>
<tr>
<td>Tubercle height</td>
<td>0.33</td>
<td>0.24</td>
<td>0.40</td>
<td>0.04</td>
<td>0.33</td>
<td>0.24</td>
<td>0.43</td>
<td>0.04</td>
</tr>
<tr>
<td>Tubercle width</td>
<td>0.38</td>
<td>0.31</td>
<td>0.48</td>
<td>0.05</td>
<td>0.68</td>
<td>0.52</td>
<td>0.83</td>
<td>0.06</td>
</tr>
<tr>
<td>Anther length</td>
<td>0.38</td>
<td>0.29</td>
<td>0.50</td>
<td>0.06</td>
<td>0.48</td>
<td>0.26</td>
<td>0.71</td>
<td>0.07</td>
</tr>
<tr>
<td>Ratios</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Tubercle height to achene height</td>
<td>0.39</td>
<td>0.30</td>
<td>0.46</td>
<td>0.04</td>
<td>0.36</td>
<td>0.24</td>
<td>0.50</td>
<td>0.05</td>
</tr>
<tr>
<td>Tubercle width to achene width</td>
<td>0.55</td>
<td>0.42</td>
<td>0.71</td>
<td>0.07</td>
<td>0.84</td>
<td>0.67</td>
<td>1.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Bristle length to achene + tubercle height</td>
<td>1.28</td>
<td>1.07</td>
<td>1.43</td>
<td>0.09</td>
<td>1.36</td>
<td>1.08</td>
<td>1.77</td>
<td>0.12</td>
</tr>
<tr>
<td>Tubercle height to tubercle width</td>
<td>0.88</td>
<td>0.60</td>
<td>1.23</td>
<td>0.15</td>
<td>0.49</td>
<td>0.33</td>
<td>0.65</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Fig. 4. Plot of achene width versus tubercle height to width for 130 plants from eastern Canada, including 35 plants with two stamens, referable to *E. ovata*, and 95 plants with three stamens, referable to *E. obtusa*.

Although comprehensive distribution mapping of the two taxa was beyond the scope of the present study, their distributions differed in the herbarium sample used (Fig. 1). As suggested by the literature (e.g., Fernald 1950; Hines 1975), *E. ovata* occurs further to the north than *E. obtusa*, from Newfoundland to the north shore of Lake Superior, reaching its southern limit in New Jersey and southern Illinois. *Eleocharis obtusa* occurs throughout much of southeastern North America, from northern Florida to eastern Texas, reaching its northern limit on the north shore of Lake Superior and in southern Quebec. Both taxa occur on the central west coast of North America, and *E. ovata* also occurs in Europe. In addition to these distributional differences, the taxa have contrasting habitat preferences. In eastern Canada, *E. ovata* is the more prevalent species in acidic, nutrient-poor sites on the Canadian Shield, where granite and sand-derived substrates are frequent. It is also disjunct in the western Lake Erie region (A.A. Reznicek, personal communication), although specimens from that region are not represented in our sample. In contrast, *E. obtusa* is the more prevalent species south of the Canadian Shield, where it occurs on alkaline or neutral substrates, often in nutrient-rich sites.

**Conclusion**

Tubercle width was found to have a non-overlapping bimodal distribution in the *E. ovata* — *E. obtusa* group in eastern Canada. The cluster with narrower tubercles, referable to *E. ovata*, corresponds to a stamen number of two, whereas the cluster with wider tubercles, referable to *E. obtusa*, corresponds to a stamen number of three. These differences were associated with significant but less dramatic differences in other characters, including distribution and habitat, which suggests that the two taxa should be treated as distinct species.
Given the preceding discussion and the data in Table 1, and noting that the determination of stamen number requires careful dissection using a microscope, a reliable and efficient key couplet for separating these taxa is as follows:

1a. Tubercle width 0.31–0.48 mm (dry); tubercle less than 2/3 (0.42–0.71) the width of the achene; stamens two

1b. Tubercle width 0.52–0.83 mm (dry); tubercle more than 2/3 (0.67–1.03) the width of the achene; stamens three

\[E.\ ovata\]

\[E.\ obtusa\]

Acknowledgements

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References


Appendix

Herbarium accession numbers of plant specimens utilized for this study.
Specimens from DAO: 141540, 141541, 146572, 167535, 169759, 186837, 186839, 208983, 228994, 228996, 229006, 235751, 252302, 252303, 252305, 252308, 252309, 252310, 252312, 252314, 252315, 252316, 252320, 252330, 252332, 252333, 252334, 252335, 252336, 252337, 252338, 252339, 252340, 252341, 252342, 252344, 252345, 252346, 252347, 252348, 252349, 252350, 252351, 252352, 252353, 252354, 252355, 252356, 252357, 252358, 252359, 252360, 252361, 252362, 252363, 252364, 252366, 252367, 252372, 252376, 252377, 252379, 252381, 252383, 252384, 252385, 252387, 252403, 252408, 252409, 252410, 252413, 252415, 252420, 252422, 252423, 252424, 252427, 252427, 252429, 252432, 252434, 252435, 252436, 252437, 252438, 252439, 252440, 252441, 252442, 252444, 252445, 252446, 252447, 252448, 252449, 252450, 252451, 252452, 252453, 252454, 284444, 329796, 337198, 344034, 458639, 462496, 464958, 464959, 464963, 465487, 466804, 542516, 544496, 571380, 573662, 579178, 582242, 582245, 582561, 585006, 585893, 586279, 586457, 587344, 597183, 603969, 615040, 624521, 625681, 625716, 627944, 632698, 637885, 641738, 662708, 664095, 667913, 683576, 683577.
Specimens from CAN: 27515, 27516, 440204.