



Botanical Notes

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THE *JUNCUS BUFONIUS* COMPLEX IN MAINE

Juncus bufonius L. is a common and wide-ranging rush with a nearly cosmopolitan distribution (Brooks and Clements 2000). In Maine, it is often found in moist, disturbed soils along roadsides, shores, and field edges. It is easily recognized apart from other members of its genus by its annual habit and relatively large inflorescence that occupies 50% or more of the plant's height (Figure 1).



Figure 1. Habit of *Juncus bufonius*.

Two taxa in the *Juncus bufonius* complex have traditionally been recognized in Maine—*J. bufonius* var. *bufonius* and *J. bufonius* var. *halophilus* Buch. & Fern. (the latter plant referred to as *J. ambiguus* at the specific level). These two plants were separated on the basis of morphology and habitat (Clements 1990, Fernald 1950). Recent publications (Gleason and Cronquist 1991, Brooks and Clements 2000) have not recognized *J. bufonius* var. *halophilus* due to difficulties in identifying this plant on a world-wide scale. As a result this taxon is poorly known in Maine and is lacking needed conservation effort.

The *Juncus bufonius* group is complicated by additional taxa in western Europe. Up to seven species have been recognized there (Cope and Stace 1978). This region has provided an ideal setting for study of this complex. Cope and Stace (1978, 1983, 1985) have performed careful research of this aggregates' taxonomy, morphology, cytology, and reproductive biology. Their work has revealed distinctive diploid species that are partly obscured by a highly variable, polyploid species. This note summarizes research of Cope and Stace and presents ecological and distributional information of *J. ambiguus* in Maine.

Cope and Stace (1978) recognize five species in the *Juncus bufonius* complex in western Europe: *J. ambiguus* Guss., *J. foliosus* Desf., *J. hybridus* Brot., *J. sorrentinii* Parl., and *J. bufonius* L. The former four species are diploid taxa with distinctive and relatively

uniform morphologies. These four species also possess somewhat differing ecologies and distributions. For example, in Europe *J. foliosus* is restricted to fresh water habitats of the western and south-western portions of the continent whereas *J. hybridus* is found in both fresh water and saline habitats of the southern region of the continent. In addition, most of these diploid species possess different chromosome numbers: *J. ambiguus* $2n=34$; *J. foliosus* $2n=26$; *J. hybridus* $2n=34$; and *J. sorrentinii* $2n=28$. Together, this information supports the existence of four, discrete taxa. The taxonomic problems of this complex, however, largely reside in the fifth species recognized by Cope and Stace (1978)—*J. bufonius sensu stricto*.

Observing a narrowly defined *Juncus bufonius* (i.e., one in which the diploid taxa are not included) reveals an extremely variable plant that occasionally approaches the morphology of other recognized species in this complex. Cope and Stace (1985) have shown *J. bufonius* to be a polyploid species (tetraploid and hexaploid with $2n=54-110$). Based on several lines of evidence, including hybridization experiments and study of patterns of variation in sympatric populations, it appears that *J. bufonius* has been derived through hybridization of the diploid species of this complex. This process appears to have both occurred with multiple parental combinations and to be continuing in present day. For these reasons, *J. bufonius* is a complex and polymorphic assemblage of different morphologies that, without careful study, causes substantial confusion in this group and obscures the distinctiveness of the diploid species. It is because of *J. bufonius sensu stricto* that many plant biologists believe that *J. ambiguus*, and other diploid species, should not be recognized. Rather, they favor a single, variable taxon. This approach fails to take into consideration the weight of evidence and overlooks the evolutionary history of this group.

The diploid species of the *Juncus bufonius* complex should be recognized for several reasons. They possess unique and consistent morphologies. Though *Juncus bufonius s. s.* occasionally possesses characteristics of the diploid species, it never demonstrates the full combination of morphological characters of any diploid. For example, *J. foliosus* is identified by its relatively wide leaves (wider than 1.5 mm), tepals with a dark line on either side of the midrib, anthers 1.2–5.0 times as long as the filaments, and conspicuous seed coat ornamentation. *Juncus bufonius s. s.*, though rarely, will sometimes possess long anthers (up to 5.0 times as long as the filaments) or tepals with dark lines. However, it will not possess the other three distinctive characters of *J. foliosus*. Therefore, though requiring careful study, these species can be reliably separated without resorting to chromosomal or molecular data.

Members of the *J. bufonius* complex possess different chromosome numbers (with one exception) and, with respect to *J. bufonius*, show differences in ploidy level. These species also show somewhat differing ecologies and distributions. Additionally, given that some details of the evolutionary history of this complex is known, it makes sense to separate the diploid progenitor species from the hybrid derived taxon (*J. bufonius*).

Juncus ambiguus (synonyms: *J. bufonius* L. var. *halophilus* Fern. and *J. ranarianus* Song & Perr.) is a diminutive coastal halophyte. It rarely exceeds ten centimeters in height and usually possesses a somewhat congested inflorescence. It has a truncate capsule that equals or exceeds the length of the inner tepals. The inner tepals are obtuse to rounded at the apex and are sometimes mucronate tipped (Figure 2). The seeds are nearly smooth (at 30 \times), are 1.11–1.47 times as long as wide, and are ovoid in shape (Figure 3).



Figure 2. Perianth and capsule of *Juncus ambiguus* showing relatively short inner tepals and truncate capsule.



Figure 3. Seeds of *Juncus bufonius* (top) and *J. ambiguus* (bottom) demonstrating differences in seed shape.

Juncus bufonius is a small herb of open inland, or sometimes coastal, habitats. It ranges in height from very stunted to 35 cm tall. It usually possesses an open inflorescence with widely spaced flowers. Its capsules are acute, obtuse, or sometimes truncate at the apex and are almost always shorter than the tepals. The inner tepals are normally acute to acuminate at the apex (Figure 4). The seeds are ornamented with minute areoles that provide the illusion of longitudinal striations (at 30 \times), are 1.34–1.78 times as long as wide, and are obliquely obovoid (*i.e.*, somewhat asymmetrical) (Figure 3). Care needs to be taken when observing the seeds as sometimes the outer integuments can be lost, which would lead the observer to think the seed coat was smooth.



Figure 4. Perianth and capsule of *Juncus bufonius* showing relatively long and acuminate-tipped tepals and obtusely-pointed capsule.

Examining specimens at the University of Maine Herbarium (MAINE) and the Hodgedon Herbarium (NH) reveals that most specimens labeled as *Juncus ambiguus* (usually under the name *J. bufonius* var. *halophilus*) are in fact *J. bufonius*. Many of these specimens were relatively tall individuals with open-branched inflorescences and pointed inner tepals. The confusion may lie in that previous collectors believed *J. bufonius* to be strictly an inland species and, therefore, any species collected from coastal habitats was *J. ambiguus*. As previously noted, both species can occur in saline situations. However, *J. ambiguus* never occurs in fresh water situations. If it were found inland, *J. ambiguus* would be associated with sites possessing salt accumulation (*e.g.*, heavily salted roadways, Department of Transportation sand/salt storage areas).

The following are historic locations of *Juncus ambiguus* based on herbarium review of specimens located at MAINE and NH.

(1) Washington County, Rogue Bluff, salt marsh, 27 July 1914, Clarence Knowlton.

(2) Washington County, Cutler, muddy shore, 7 July 1902, Emile Williams.

In addition to above locations, the New England Botanical Club Herbarium (NEBC) has collections of *Juncus ambiguus* from Knox, Washington, and York Counties.

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Text and photographs contributed by Arthur Haines.

***ELYMUS MACREGORII*, A RECENTLY DESCRIBED WILD-RYE OF EASTERN UNITED STATES.**

The genus *Elymus* is a large, difficult group of tetraploid grasses mostly native to north temperate areas (Barkwork and Campbell, in press). They are perennial species with spike inflorescences in which the nodes alternates on each side of the rachis. Each spikelet bears 3–7 florets. The fruit, a caryopsis, is pubescent at the summit and tightly embraced by the lemma and palea.

The *Elymus virginicus* L. complex is recognized by 2–3 spikelets per node that disarticulate below the glumes, well-developed and subequal glumes, terete and indurate glume bases, and erect spikes (Figures 1 and 2). Members of this complex are self-pollinating species with relatively small anthers (1.5–4.0 mm long). Recent taxonomic work by Ralph Brooks and Julian Campbell (Campbell, unpublished) has revealed the existence of undescribed species. These species have likely gone undetected due to their close similarity to the common *E. virginicus*. This note presents identifying characteristics for the new species found in Maine and describes its distribution and phenology.



Figure 1. *Elymus virginicus* var. *virginicus*. Note the characteristic upper leaf that usually partly sheathes the inflorescence in this variety.

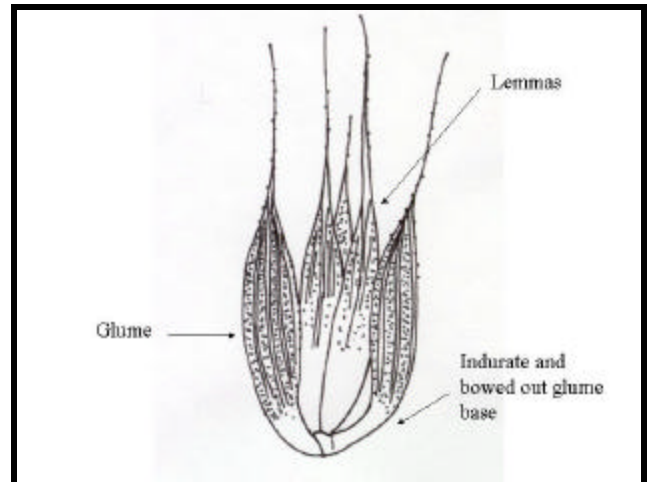


Figure 2. Detail of an *Elymus virginicus* spikelet. Note the absence of veins in the basal 1.0–4.0 mm of the glumes.

Several varieties of *Elymus virginicus* have traditionally been recognized. These taxa were recognized on the basis spike color and exertion from the upper leaf sheath, glume width and shape, awn length, internode length, and culm height, among other characters. Careful review of the morphology of this diverse complex has led researchers to remove *E. virginicus* var. *glabriflorus* (Vasey) Bush (also referred to as *E. virginicus* var. *australis* (Scribner & Ball) Hitchc.) from *E. virginicus* and elevate it to specific status as *E. glabriflorus* (Vasey ex. Dewey) Scribner & Ball. This species was recognized by its relatively wider spikes, longer awns, and more spreading spikelets.

Brooks (1974) was first to note that *Elymus glabriflorus* appeared to consist of two entities. However, the type specimen chosen by Brooks was determined to be difficult to interpret and the varietal epithet he selected (*minor*) was already in use. Later study by Campbell (unpublished) has shown that in fact two species should be recognized from material previously all referred to as *E. glabriflorus*.

Elymus glabriflorus is now realized to be a forest and grassland species of southeastern United States. It occurs in a variety of soil moisture regimes (wet-mesic to dry-mesic) and typically flowers from mid-June to late July. Morphologically, *E. glabriflorus* is identified by numerous flowers per spike (15–30 nodes per spike) separated by short internodes (3.0–5.0 mm long) and leaves with brown auricles 0.0–2.0 mm long.

Elymus macgregorii R. Brooks & J.J.N. Campbell, a recently recognized species, is known from the eastern United States, including New England (Figure 3). It is more restricted in its habitat and is found on rich, mesic, circumneutral soils of hardwood slopes and

floodplains. It typically flowers from late May to mid-June throughout most of its range. Morphologically, *E. macregorii* is identified by its relatively fewer flowers per spike (9–18 nodes per spike) that are separated by longer internodes (4.0–7.0 mm long) and leaves with black auricles 2.0–3.0 mm long.



Figure 3. *Elymus macregorii*. Note the characteristic long awns and long internodes of the spike.

In Maine, *Elymus macregorii* is most likely to be confused with *E. virginicus*. Other wild rye species that may occur in rich, hardwood forests, such as *E. canadensis*, *E. wiegandii*, and *E. riparia*, are easily separated from *E. macregorii*. All three of these species have arching or drooping spikes, in contrast to the erect spikes of *E. macregorii*. The former two species also have outward arching awns, especially in the apical portion of the spike, as opposed to the straight awns of *E. macregorii*. The latter species has very narrow glumes (0.2–1.0 mm wide) that are hardly broadened apically, compared to the wider glumes of *E. macregorii* (1.0–1.8 mm wide). The following identification key will serve to separate *E. macregorii* and *E. virginicus*. Figure 4 and 5 present comparison photographs of these two species.

Identification Key

1a. Spikes 1.0–2.0(–2.5) cm wide, with erect to ascending spikelets; glumes, including the awns, 1.0–2.7 cm long [the awns 0.0–10.0(–15.0) mm long]; lemmas, including the awns, 1.0–3.0 cm long [the awns 0.5–20.0 mm long]; spike included to exerted from the upper leaf sheath; leaf blades glabrous ***E. virginicus***

1b. Spikes 2.5–4.0 cm wide, with spreading-ascending spikelets; glumes 2.7–4.0 cm long [the awns 10.0–25.0 mm long]; lemmas mostly 3.5–4.5 cm long [the awns 15.0–40.0 mm long]; spike exerted from upper leaf sheath; leaf blades pubescent or glabrous

..... ***E. macregorii***



Figure 4. Spikes of *Elymus macregorii* (left) and *E. virginicus* (right).



Figure 5. Spikelet of *Elymus macregorii* (top) and *E. virginicus* (bottom) comparing total spikelet length and awn length.

Four separate subspecific taxa of *Elymus virginicus* are recognized to occur in Maine—*E. virginicus* var. *virginicus*; *E. virginicus* var. *intermedius* (Vasey ex A. Gray) Bush; *Elymus virginicus* var. *jejunus* (Ramaley) Bush; and *E. virginicus* var. *halophilus* (E.P. Bicknell) Wiegand. Separating these taxa from *E. macregorii* is generally unproblematic, with the exception of *E. virginicus* var. *jejunus*. Campbell (unpublished) notes that material of *E. macregorii* from Arkansas, Missouri, Oklahoma, and Texas are transitional to *E. virginicus* var. *jejunus*. These transitional plants show somewhat smaller spike dimensions (as to awns and internodes) and less glaucous foliage than typical *E. macregorii*.

Campbell has noted on herbarium sheets of *E. macregorii* at the University of Maine Herbarium (MAINE) that some plants from Maine also appear to be transitional to *E. virginicus* var. *jejunus*. Furthermore, Maine specimens of *Elymus macregorii* do not flower as early as individuals of this species from other parts of its range. Maine plants appear to enter anthesis in early to mid-July, closer to the flowering time of *E. virginicus*. These transitional plants, however, often possess pubescent adaxial leaf surfaces and sometimes have pubescent spikelets. These are character states that are not usually found in *E. virginicus* var. *jejunus* and help to differentiate these transitional plants.

The following historic locations of *Elmus macregorii* are based on specimens housed at the University of Maine Herbarium (MAINE), the United States National Herbarium (US), and the New England Botanical Club Herbarium (NEBC). These specimens consist primarily of material annotated by Julian Campbell.

- (1) Bank of Pleasant River, 25 July 1904, Brownville, J.C. Parlin.
- (2) September 1894, Westbrook, P. Ricker.
- (3) Moist bank, 20 August 1900, Cumberland, G. Chamberlain.
- (4) With *Onoclea sensibilis*, *Fraxinus pennsylvanica*, *Acer rubrum*, *Acer saccharum*, *Acer saccharinum*, *Quercus bicolor*, etc., in wet, rich, flat, wooded river-bottom, south bend of St. George River, west of Vaughn Neck, 6 August, Warren, George Rossbach.
- (5) Mount Cutler, 20 July 1909, Hiram, Merrill.
- (6) Wooded stream bank, 24 July, Passadumkeag, F.H. Steinmetz and Gashureiber.
- (7) Bank of Kennebec River, August 1910, Norridgewock, J. Parlin.
- (8) Floodplain, 1925, Bethel.

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