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CLARIFYING THE TAXONOMY OF *SALICORNIA SENSU LATO* OF THE NORTHEASTERN UNITED STATES

Salicornia europea L. (Amaranthaceae) is a well known succulent, annual halophyte. It belongs to a group of species called glassworts. These diminutive plants possess reduced, opposite, scale-like leaves and inconspicuous flowers borne in groups of three that are sunken into depressions on a fleshy axis. *Salicornia europea* is commonly reported for the northeastern United States. This species is restricted, however, to the old world, and is replaced by three morphologically similar taxa in eastern United States and Canada. These North American species are poorly known and are frequently omitted from recent floras covering our region. Their taxonomic confusion is the result of confused application of scientific names, past reliance on environmentally-induced variation, and loss of characters in drying for herbarium specimens. This note summarizes and clarifies recent morphological, chromosomal, and eletrophoretic work that has revealed endemic North American species of *Salicornia*.

Two genera of glassworts occur in northeastern United States. *Sarcocornia* is characterized by perennial habit, woody rhizomes, and all flowers of a node inserted at the same level (Figure 1).

Figure 1. Flower arrangement of *Sarcocornia* with all three flowers of a node inserted at the same level.

Salicornia is characterized by annual habit, lack of rhizomes, and central flower of a node elevated above the two lateral flowers (Figure 2).

Figure 2. Flower arrangement of *Salicornia* with central flower of node elevated above the two lateral flowers.

In the northeast, *Sarcocornia* is represented by a single species, *Sarcocornia perennis* (P. Mill.) A.J. Scott (Figure 3). It occurs on both coasts of the United States, extending as far north as New Hampshire in the east. *Sarcocornia perennis* is readily identifiable by habit and inflorescence characteristics. This species is usually referred to as *Salicornia virginica*. This is, however, an invalid name for the species as the type specimen of *Salicornia virginica* is an annual species.

Figure 3. *Sarcocornia perennis* from Massachusetts.

Salicornia is represented by three species of glassworts in northeastern United States. One of these species, *S. bigelovii* Torr., is readily identifiable due to macroscopic differences in spike thickness and leaf apex shape (see identification key that follows). The remaining two species, however, *S. depressa* Standl. and *S. maritima* Wolff & Jefferies, are very similar and characters used to identify them are usually distorted or lost in drying for herbarium specimens. Much confusion surrounds the latter two species.

The North American members of the *Salicornia europea* complex have been studied carefully by Wolff and Jefferies (1987). Their work has revealed two taxa in the northeastern United States that differ in ploidy level, electrophoretic profile, morphology, and breeding system. Kartesz (1994) essentially adopted their treatment. Unfortunately, confusing taxonomy obscures its application. Consequently, many recent publications from the northeast are using glasswort names incorrectly.

Salicornia depressa is the most common glasswort in New England (Figure 4). It commonly occurs above mean high tide in saline marshes and Atlantic coast shores. This species is an annual tetraploid that produces fruit through open pollination (*i.e.*, it exserts its stamens prior to dehiscence of anthers). The first validly published name for this species is *S. virginica* L. This name, however, is usually applied to the perennial species (incorrectly so, see above) and is recommended for rejection. The name *S. europea* also should not be used for this taxon as it belongs to a European plant with larger anthers. Critical characters for identification include tubular shape of fertile segments, tapered apex of terminal spike, and exertion of stamens (Figures 2, 4, and 5) (see also identification key).

Figure 4. Habit of *Salicornia depressa* from Maine with tapering terminal spike apex.

Figure 5. *Salicornia depressa* in flower with pollen-bearing stamens exserted beyond floral bracts.

Salicornia maritima is an extremely rare glasswort in New England. Though relatively common from Newfoundland to New Brunswick, it reaches its southern limit in Maine. It is recorded for eastern Maine by Standley (1916) under the name *S. prostrata*. *Salicornia maritima* is an annual diploid that produces fruit through self-pollination (*i.e.*, it does not exsert its stamens, or, if so, after anther dehiscence and pollen shedding within the floral bracts). This name commonly appears in northeastern floras as the common glasswort of Atlantic coast shores. This plant, however, is very rare in New England (state historic in Maine), and its name should be replaced by *S. depressa* in most northeast regional treatments. Critical characters for identification include distally widened fertile segments, blunt and rounded apex of terminal spike, and absence of stamen exsertion (Figure 6) (see also identification key).

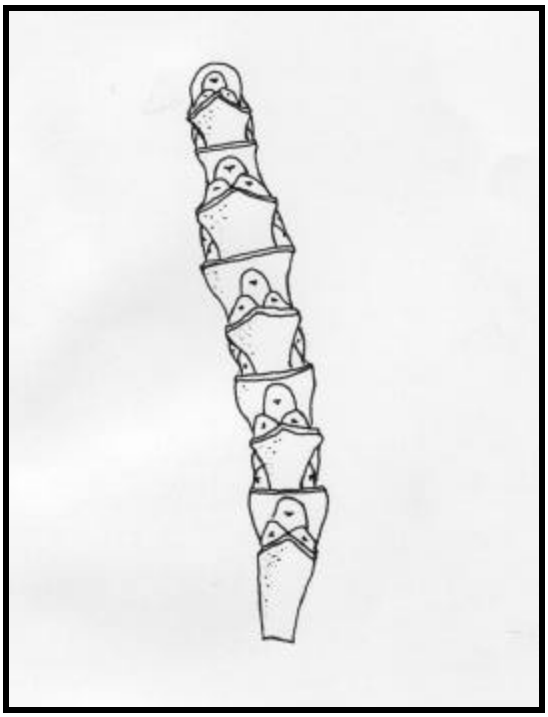

Figure 6. Terminal spike of *Salicornia maritima* showing apically widened fertile segments and rounded spike apex (width of spike approximately 3.5 mm).

Identification Key

[Caution: dimensions in the key are for fresh material]

1a. Plants perennial with woody rhizomes; all three flowers of a given node inserted at the same level ..... ***Sarcocornia perennis***

1b. Plants annual without rhizomes; central flower of each node elevated above the two lateral flowers

- **2a**. Leaf and scale apex acute to acuminate, with a prominent mucro; inflorescence 4.5–6.0 mm thick, definitely wider than the stem; flowers all concealed by bracts ..... ***Salicornia bigelovii***
- **2b**. Leaf and scale apex rounded to acute, without a mucro; inflorescence 1.5–4.0 mm thick, usually of similar thickness as the stem; central flower of a node exceeding the bract and visible
  - **3a**. Inflorescence cylindric to long-tapering, the terminal spike with (5–)7–23(–25) fertile segments; scarious margin of leaves 0.3–4.0 mm wide; flowers with exserted stamens during anthesis; fertile segments cylindric ..... ***Salicornia depressa***
  - **3b**. Inflorescence swollen and rounded near the apex, the terminal spike with (3–)5–10(–14) fertile segments; scarious margin of leaves 0.2–0.3 mm wide; flowers without exserted stamens during anthesis; fertile segments widened in the apical portion ..... ***Salicornia maritima***

Table 1 presents a comparison of glasswort treatments from two recent floras covering the northeastern United States.

Taxon	Gleas. & Cronq.	Magee & Ahles
Salicornia bigelovii	*Salicornia bigelovii*	*Salicornia bigelovii*
Salicornia depressa	*Salicornia europea*	*Salicornia maritima*
Salicornia maritima	*Salicornia prostrata*[1]	*Salicornia prostrata*[2]
Sarcocornia perrenis	*Salicornia virginica*	*Salicornia virginica*

1 = considered as a snynonym of *Salicornia europea* by Gleason and Cronquist (1991).
2 = considered as a synonym of *Salicornia maritima* by Magee and Ahles (1999).

Table 1. Treatment of *Salicornia* and *Sarcocornia* in Gleason and Cronquist (1991) and Magee and Ahles (1999).

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TAXONOMY AND DISTRIBUTION OF *ACORUS* IN MAINE

Acorus is a small genus of perennial herbs with aromatic oils in the leaves. Known as sweet-flags, they are moderate-sized emergent plants of marshes and still, shallow water (Figure 1). Due to the presence of a spadix (a fleshy spike of flowers) and a structure interpreted as a spathe (bract subtending the spadix), this genus has traditionally been included in the Araceae. The subtending structure of *Acorus*, however, has been determined not to be a spathe but rather the distal portion of a sympodial leaf (Ray 1987). What was formally interpreted as a flowering stem is the proximal portion of the sympodial leaf. Together with DNA sequences (Duvall *et al*. 1993), this information supports placing *Acorus* in its own family, the Acoraceae.

Figure 1. *Acorus calamus* with spadix (inflorescence) and sympodial leaf (structure functioning as flowering stem and bract).

Recent work by Thompson (1995) and others has documented the presence of two species of *Acorus* in Maine. These species have traditionally been treated as *Acorus calamus* L. or, more recently, as *A. americanus* (Raf.) Raf. Detailed studies of morphology, cytology, essential oil chemistry, isozymes, and ethnobotany

(Thompson 2000) support recognition of both species. *Acorus calamus* is triploid species native to the old world. Though it produces flowers, it does not produce mature fruit and is considered sterile. *Acorus americanus* is a diploid species native to North America. It is fertile and produces mature fruit. Most herbaria have not yet separated their collections into the appropriate taxa (*i.e.*, they recognize all their material as either *A. calamus* or *A. americanus*) and therefore the distribution of these species is poorly known. Botanical survey work in Maine needs to recognize the existence of two species of sweet-flag. Table 1 presents morphological characters that separate these plants.

Character	*A. calamus*	*A. americanus*
Leaf veins	1 prominent	2–6 prominent
Sympodial leaf	usually shorter than or equal to vegetative leaves	usually equal to or taller than vegetative leaves
Vegetative leaf	0.5–2.0 cm wide	0.3–1.2 cm wide
Leaf margin	often crisped or undulate	usually entire
Spadix	usually 4.9–8.9 cm long at anthesis	usually 3.3–7.4 cm long at anthesis
Flowers	3.0–4.0 mm long	2.0–3.0 mm long
Fruits	not produced	obpyrimidal berries

Table 1. Comparison of discriminating morphological features for Maine *Acorus.*

The number of prominent leaf veins provides a diagnostic character for separating species of *Acorus.* Unfortunately, experience is needed to assess this character correctly. Thompson (2000) describes *A. calamus* as having a single prominent midvein and *A. americanus* as having a prominent midvien and 1–5 additional raised veins. Both *A. calamus* and *A. americanus*, however, have a prominent midvein and one or more notable secondary veins. The degree of prominence of these secondary veins relative to the midvein is the diagnostic feature. In *A. calamus* the secondary veins are no more than 0.5 times the width of the midvein (*i.e.*, the midvein is much wider than all other veins of the leaf) (Figure 2). In *A. americanus* one or more of the secondary veins are about 0.75 to 1.0 times as wide as the midvein (*i.e.*, at least one secondary vein is nearly or fully as wide as the midvein) (Figure 3).

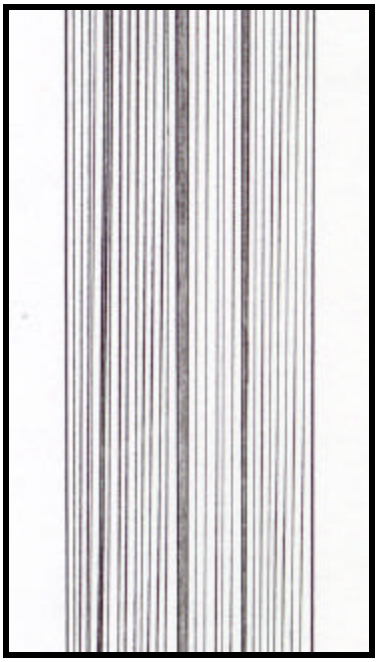

Figure 2. Surface of *Acorus calamus* leaf showing prominent midvein, somewhat raised secondary veins, and the many, fine tertiary veins.

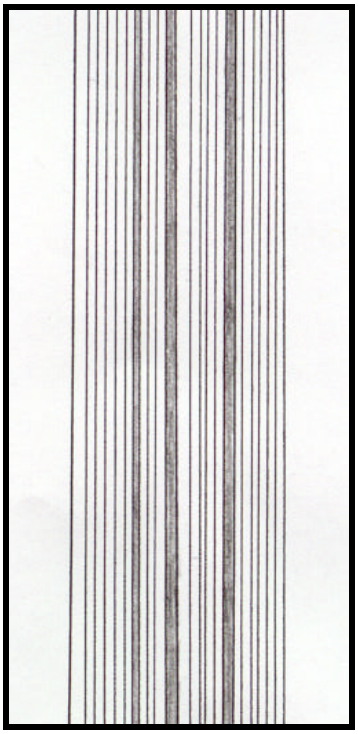

Figure 3. Surface of *Acorus americanus* leaf showing prominent midvein, +/- equally prominent secondary veins, and the many, fine tertiary veins.

Leaf width is also cited by Thompson (2000) as a useful separating character. Indeed, specimens from the University of Maine Herbarium (MAINE) show a difference in leaf width between the species. *Acorus calamus* possesses relatively wider leaves, the widest leaf commonly exceeding 1.0 cm in width (mean=1.2; range 0.7–1.7 cm, n=13). The leaves of *A. americanus* average narrower, the widest usually narrower than 1.0 cm (mean=0.8; range 0.5–1.3 cm; n=21). The above measurements include vegetative and sympodial leaves and were performed on dried specimens.

The definitive character for identification of North American *Acorus* is fruit formation. Only *A. americanus* produces mature fruits. Unfortunately, this trait is seasonal and can only be assessed when fruits of sweet-flags begin to mature. *Acorus calamus* shows an abortive ovary in late summer that appears as if the ovary is shriveling. *Acorus americanus*, on the other hand, will show swelling ovaries in late summer that collectively increase the diameter of the spadix. Based on collections at MAINE, the earliest a specimen showed developing fruits in Maine was 26 July. Therefore, assessing fruit development is possible only in late summer and fall.

Acorus calamus and *A. americanus* inhabit a wide variety of mineral soil wetlands in Maine. Examination of label data revealed that both species are sometimes planted. The distribution of sweet-flags in Maine is presented in Figure 4.

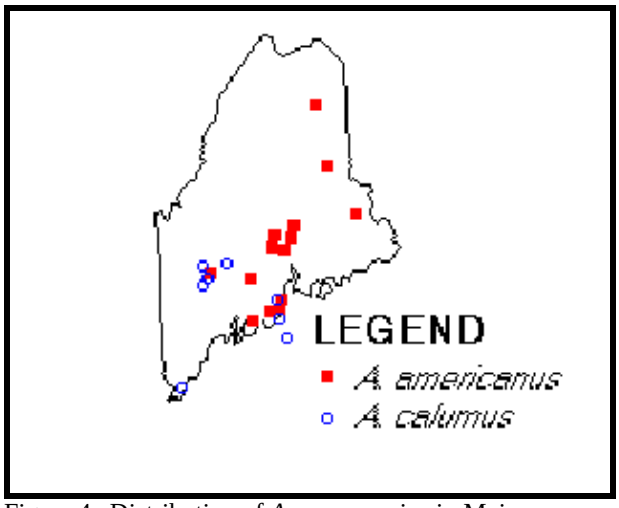

Figure 4. Distribution of *Acorus* species in Maine based on MAINE collections.

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