Botanical Notes

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IDENTIFICATION AND ECOLOGY OF RARE *CHENOPODIUM* IN MAINE

Chenopodium is a poorly understood genus in Maine comprised of 19 species. These plants, referred to as pigweeds and goosefoots, are primarily annual species of open, xeric habitats. They are well known for taxonomic difficulty created by phenotypic plasticity and lack of macroscopic morphological differences. Species of *Chenopodium* are often undeterminable without mature fruits, particularly among closely related species. In addition, limited collecting and poor distributional data create a situation in which species may be misidentified or overlooked. Many of Maine's historically occurring species are not well represented in the University of Maine herbarium. Therefore, it is generally difficult for plant biologists to acquire search images of these species. This in turn decreases the likelihood of rediscovery. Text and images are presented in this note concerning *Chenopodium* morphology in an attempt to clarify identification keys covering our region and stimulate field surveys that target these species.

Maine *Chenopodium* are herbaceous, mostly annual species of open, dry, frequently disturbed habitats. A large percentage of the state's species are native to Eurasia or western North America and are weedy in the northeast. A few species do, however, normally occur in non-anthropogenic habitats, such as forests and salt marshes. This genus can be recognized by its flowers that have a monochlamydeous, sepaloid perianth, five or fewer stamens, and 2(–5) stigmas. The fruits are small, dry, indehiscent, single-seeded, and usually more or less enclosed in the persistent perianth. The leaves are alternate, simple, with entire to lobed margins, and often farinose. Most species possess a taproot provided with a weak system of fibrous roots.

The following species of *Chenopodium* are native and rare in Maine:

1. *C. berlandieri* Moq. var. *bushianum* (Aellen) Cronq.
2. *C. berlandieri* Moq. var. *macrocalycium* (Aellen) Cronq.
3. *C. foggii* Wahl
4. *C. humile* Hook.
5. *C. rubrum* L.
6. *C. standleyanum* Aellen
7. *C. strictum* Roth var. *glaucophyllum* (Aellen) Wahl

All except *C. foggii* and *C. strictum* var. *glaucophyllum* are currently listed as plants of state conservation concern by the Maine Natural Areas Program (1999).

A description of the morphology is provided for each of these species using Clemants (1992), Bassett and Crompton (1982), and Wahl (1954) as primary sources. When known, distributional and ecological data is also provided. Prior to species discussion is a brief review of morphology of important reproductive characters.

The calyx is comprised of 3–5 sepals in *Chenopodium*. The number is diagnostic among Maine species and is correlated with fruit orientation, another important character. Most species in Maine have five sepals per flower (Figure 1), while others normally have only 3 (Figure 2). The sepals may possess a prominent keel on the abaxial (*i.e.*, outside) surface. These species will then have a calyx that appears pentagonal or star-shaped in fruit (Figure 1). Given that the fruits are more or less orbicular in outline, species of *Chenopodium* with keeled sepals will therefore have a calyx that does not conform to the shape of the fruit. Other species have sepals that lack prominent keels. These species will have a calyx that appears relatively circular in outline and conforms to the shape of the fruit (Figure 3). Another sepal character is the degree to which the calyx conceals the fruit. In some species, the fruit is completely enclosed by the persistent sepals (Figure 1), and in other species the fruit is readily visible (Figure 3).

Figure 1. *Chenopodium album*. Note the five sepals that are keeled on the abaxial surface, provided with abundant farina, and enclose the fruit.

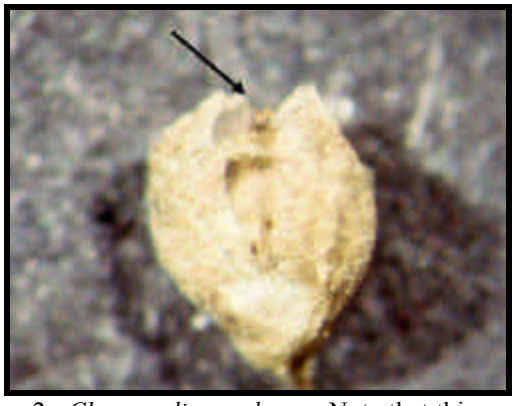

Figure 2. *Chenopodium rubrum*. Note that this species has only three sepals per flower (only two of which are visible). The arrow points to the styles, demonstrating this species has vertically oriented achenes.

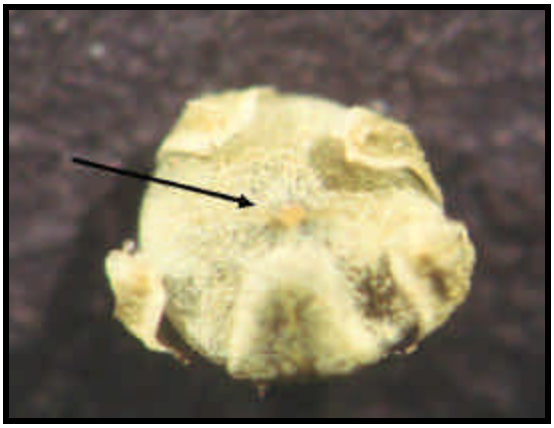

Figure 3. *Chenopodium simplex*. Note the five sepals of this species that lack both prominent keels and farina and do not completely enclose the fruit. The arrow shows the position of the styles demonstrating this species has horizontally oriented achenes.

The sepals of *Chenopodium*, along with other portions of the plant, may be provided with farina, which are inflated hairs that are normally white or yellow-white in color. Surfaces that have farina (a condition called farinose) will have a mealy texture and often be light in color (Figure 1). Species lacking farina on the calyx will not appear to have rough-textured sepals and usually possess a deeper green color.

The fruits of most *Chenopodium* are held inside the persistent sepals at maturity. They may be oriented vertically with the edge of the fruit resting on the bottom of the calyx (Figure 2) or they may be oriented horizontally so that the flat surface rests on the bottom of the calyx (Figure 3). Determining the character state of fruit orientation is simplified by examining the persistent styles on the fruit. In vertically oriented fruits, the styles appear to be positioned at the top edge of the fruit. In horizontally oriented fruits, the styles appear to be positioned in the center of the broad surface. In Maine, all species with vertically oriented fruits also possess three (or rarely four) sepals per flower. Those species with horizontally oriented fruits possess five sepals per flower.

Fruits of Maine *Chenopodium* may be one of two types. Most species have achenes in which the outer layer, called the pericarp, is tightly adherent to the fruit and difficult to remove without scraping away the surface (Figure 4). Other species possess utricles, specialized achenes that have a loosely adherent pericarp that is easily removed from the mature fruit (Figure 5). Species of *Chenopodium* that have utricles will generally exhibit this character without any manual manipulation of the pericarp. Examination of intact fruiting material will show the pericarp separated and flaking away from the body of the fruit.

Figure 4. *Chenopodium album.* Note the tightly adherent and obscurely ornamented pericarp.

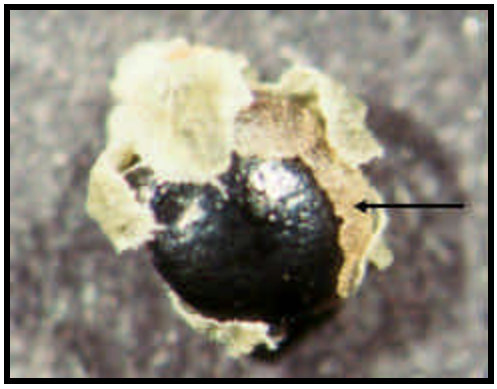

Figure 5. *Chenopodium standleyanum.* The arrow points to a section of the pericarp that is loose and separated from the body of the fruit. Most of the pericarp has already flaked away exposing the lustrous black seed.

The surface of the pericarp is also used for distinguishing of species in *Chenopodium.* In most species, the pericarp is smooth or obscurely ornamented (Figures 1 and 3). In some species, however, the surface of the fruit may be reticulate-patterned with numerous oblong or isodiametric areole. This condition is easily assessed with 10× magnification and can be seen on immature fruits with practice.

Figure 6. *Chenopodium berlandieri* var. *bushianum.* Note the prominently reticulate-patterned pericarp.

The final character reviewed here is the length of the style base (Figure 7). Many species of *Chenopodium* possess stigmas that are distinct all the way to the base (*i.e.*, they do not have a style base). Some species, however, may possess a short section of united styles at the surface of the fruit below the stigmas branches. The length of the style base is frequently only 0.1–0.2 mm long, but is nonetheless recognizable with low magnification. This feature is one of very few characters that can be reliably assessed on immature fruits.

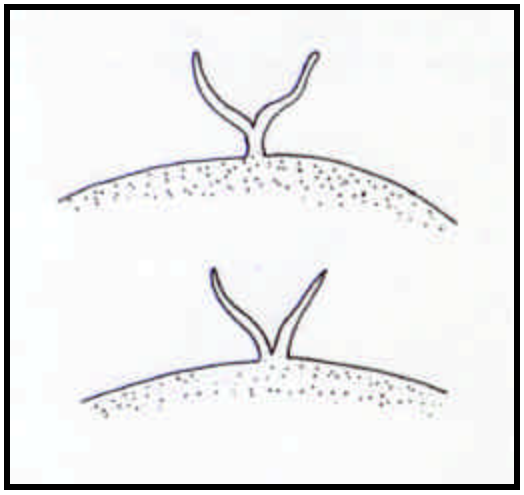

Figure 7. Comparison of different style bases in *Chenopodium.* The upper illustration shows a short style base below the stigmas. The lower illustration shows stigmas that are separate to the base.

SPECIES OF CONCERN

 Chenopodium berlandieri var. *bushianum*

This species, known as Bush's pigweed, is a robust species frequently 70–150 cm tall. It possesses large, farinose leaf blades up to 15.0 cm long. The sepals are keeled, farinose, and conceal the mature, horizontally oriented achene. Both varieties of *Chenopodium berlandieri* are immediately and without difficulty recognized in fruit by examination of the conspicuously reticulate-patterned pericarp. In addition, both varieties (*C. berlandieri* var. *bushianum* and *C. berlandieri* var. *macrocalycium*) sometimes possess a short style base 0.1–0.2 mm long, assisting the identification of immature material from the common *C. album. Chenopodium berlandieri* var. *bushianum* has taller stems, longer and more prominently toothed leaves (Figure 8), spreading to drooping inflorescence branches (Figure 9), and larger fruits (1.5–2.0 mm long) than *C. berlandieri* var. *macrocalycium.*

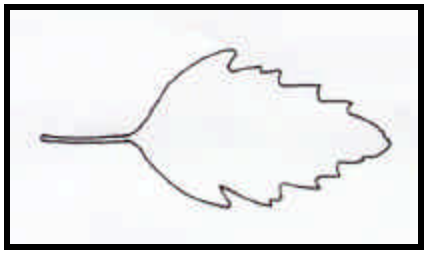

Figure 8. Outline of lower leaf blade of *Chenopodium berlandieri* var. *bushianum.*

Figure 9. Inflorescence of *Chenopodium berlandieri* var. *bushianum.*

Chenopodium berlandieri var. *bushianum* is a native weed of northeastern North America. It normally grows along and adjacent to agricultural fields, roadbeds, and other openings. In New England, it is also been reported to occur in saline habitats near the coast (Seymour 1982). It is known from the following locations in Maine:

(1) Matinicus Island, Knox County (1970);
(2) Southport, Lincoln County (1946);
(3) Mexico, Oxford County (1975);
(4) Saint John Township, Aroostook County (1998);
(5) Wells, York County (1950).

In addition, this species has been observed in Woolwich, Sagadahoc County in 1999 (A. Haines, unpublished).

 Chenopodium berlandieri var. *macrocalycium*

This species, known as seabeach pigweed, is very similar to *Chenopodium berlandieri* var. *bushianum*, particularly in terms of the reticulate-patterned pericarp. It also shares the farinose leaves and sepals and achenes enclosed by the calyx. *Chenopodium berlandieri* var. *macrocalycium* is, however, a smaller plant that is restricted to saline environments. The stems are rarely taller than 50 cm. Its farinose leaf blades are usually shorter than 6.0 cm and typically have less prominent teeth (Figure 10). Furthermore, *C. berlandieri* var. *macrocalycium* possesses inflorescence branches that are normally ascending (Figure 11) and has fruits that average smaller than *C. berlandieri* var. *bushianum*, measuring 1.3–1.7 mm long.

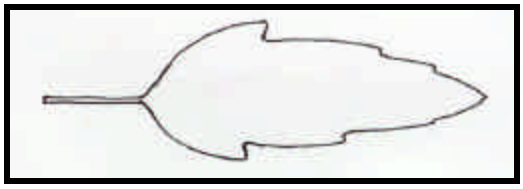

Figure 10. Outline of lower leaf blade of *Chenopodium berlandieri* var. *macrocalycium.*

Figure 11. Inflorescence of *Chenopodium berlandieri* var. *macrocalycium.*

Chenopodium berlandieri var. *macrocalycium* is a native plant of sea beaches and salt marshes. It grows on varied substrate, including sand and organic soils. It is known from the following locations in Maine:

(1) Searsport, Waldo County (1992).

In addition, this species has been observed in Phippsburg and Georgetown, Sagadahoc County in 1999 (G. Hall, unpublished).

 Chenopodium foggii

This species, known as Fogg's pigweed, is a rare and poorly understood species native to eastern North America. It is closely related to *Chenopodium pratericola* Ryd. and *C. desiccatum* A. Nels. These two species are native to western North America and have been introduced in the east. All three of these species have farinose herbage and sepals, fruits with readily separable, minutely echinate, pericarps (*i.e.*, the fruit is a utricle), and small leaf blades (1.0–4.0 cm long) that lack prominent serrations throughout the margin. *Chenopodium foggii* can be distinguished from the two western North American species by examining the leaves. *Chenopodium foggii* has narrow-ovate leaf blades 5.0–18.0 mm wide (the larger commonly wider than 10 mm) that usually possess some form of dentition or lobing, at least near the base (Figure 12). *Chenopodium pratericola* and *C. desiccatum*, on the other hand, have principal leaves with linear to narrow-ovate blades that are usually (6.5–)7.0–9.0 mm wide

and 2.0–3.0 mm wide, respectively. Only western *C. pratericola* may have leaf blades with any form of dentition, but then the teeth are usually restricted to a pair of small basal lobes. *Chenopodium foggii* is further characterized by stems 20–100 cm tall and horizontally oriented fruits 1.0–1.3 mm long that are nearly or completely concealed by the calyx. The habit of *C. foggii* is presented in Figure 13.

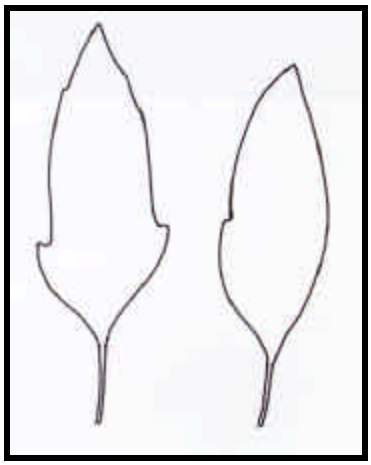

Figure 12. Variation in the lower leaf blade outline of *Chenopodium foggii*.

Figure 13. Habit of *Chenopodium foggii*.

The taxonomy of *Chenopodium foggii* is complicated by differing treatments in regional sources. This species is sometimes included in *C. pratericola* (Gleason and Cronquist 1991), which makes determination of its origin and morphology difficult. Furthermore, some treatments incorrectly state that this species has a tightly adherent pericarp (Magee and Ahles 1999), probably based on Bassett and Crompton (1982). Confusion of this important character would complicate identification. Wahl (1954) described the pericarp as "freely separable from the seed" in the type description.

Chenopodium foggii is a species of woodlands, forest openings, and occasionally disturbed areas such as roadsides and timber harvest sites. It is frequently collected from hillsides, slopes, and outcrop summits in other states. It is historically known from the following locations in Maine:

(1) South Berwick, York County (1898);
(2) Auburn, Androscoggin County (1896).

 Chenopodium humile

This species, known as marshland goosefoot, is a low-growing species. The plants are commonly shorter than 25.0 cm. The stems are widely branched at the base and bear leaves with glabrous blades usually 0.7–3.0 cm long that are entire or nearly so. *Chenopodium humile* is closely allied with *C. rubrum* as evidenced by its flowers with three, weakly keeled, glabrous sepals and vertically oriented fruits. The mature utricles are 0.8–1.0 mm long, with occasional fruits up to 1.2 mm long produced from terminal inflorescences. The fruits are primarily borne in axillary glommerules rather than an elongate terminal inflorescence (Figure 14).

Figure 14. Inflorescence of *Chenopodium humile*.

Wahl (1954) notes that this species sometimes intergrades with *Chenopodium rubrum.* Collections have been made from New York that are 42 cm tall and strictly upright, similar to the next species, but otherwise resemble *C. humile*. Care needs to be taken in separating these two closely related species.

This species is very rare in New England and is known only from a single collection in Maine (Fernald 1911) and on Nantucket Island, MA. *Chenopodium humile* is found in salt marshes and other saline environments. It is known from the following locations in Maine:

(1) Brunswick, Cumberland County (1906).

 Chenopodium rubrum

This species, known as red goosefoot, is florally similar to *Chenopodium humile*. *Chenopodium rubrum* possesses vertically oriented utricles enclosed by three, weakly keeled sepals. Like *C. humile*, it essentially lacks farina on its herbage and calyces. *Chenopodium rubrum*, however, is a larger, upright plant with stems 30–60(–80) cm tall and prominently toothed leaf blades up to 15.0 cm long. Oddly, the fruits are smaller, normally 0.6–0.8 mm long, or sometimes up to 1.0 mm long from terminal inflorescences. The sepals of *C. rubrum* are relatively more herbaceous compared to those of *C. humile* and the inflorescences are generally more elongate (Figure 15).

Figure 15. Inflorescence of *Chenopodium rubrum.*

Chenopodium rubrum is halophytic and is found in salt marshes and other saline habitats. In Canada, this species is sometimes found as a weed in anthropogenic habitats (Bassett and Crompton 1982). It is known from the following locations in Maine:

(1) York, York County (1992);
(2) Brunswick, Cumberland County (1912);
(3) Machiasport, Washington County (1947).

 Chenopodium standleyanum

This species, known as Standley's goosefoot, is an erect species up to 60 cm tall (Figure 16). It is essentially a glabrous plant and bears few, if any, farina on the leaves and sepals. The leaves generally have entire margins, although a few teeth may sometimes be present near the base. The fruit is a horizontally oriented utricle (*i.e.*, the pericarp is non-adherent) 0.9–1.3 mm long that is not completely enclosed by the calyx. The sepals are weakly keeled and conform well to the shape of the fruit.

Figure 16. Habit of *Chenopodium standleyanum.*

Chenopodium standleyanum has been incorrectly called *C. berlandieri* var. *boscianum* (Moq.) Wahl by Haines and Vining (1998). However, this latter plant is restricted to the gulf coast states and is not part of northeastern Flora.

Chenopodium standleyanum is a plant of woodlands and forest openings. It prefers disturbed soil, and is therefore often found on banks and at cliff bases where the soil is not stationary (Wahl 1954). This species is sometimes ephemeral at a given site. Plants have been observed in abundance one year, only to disappear the subsequent season. Wahl (1954) has observed this phenomenon when *C. standleyanum* grows on loose rock. Furthermore, this type of substrate often produced robust plants 180 cm tall, as opposed to the more delicate and persistent plants found in forested communities. It is known from the following locations in Maine:

(1) Brunswick, Cumberland County (1912);
(2) South Berwick, York County (1898).

 Chenopodium strictum var. *glaucophyllum*

This species, known as glaucous pigweed, is a weakly farinose species up to 100 cm tall. It has relatively small leaf blades 1.7–3.6(–6.0) cm long that range from finely toothed (the lower) to entire (the middle and upper). Its flowers have five, keeled, somewhat farinose sepals that do not conceal the fruit. The horizontally oriented achene measures 1.9–1.2(–1.5) mm long and is not circular, but is longer on one axis (*i.e.*, oval), and possesses an obscurely patterned pericarp. This species is most likely to be confused with *Chenopodium album*, but the low serrations on the lower leaf blades (Figure 17) and oval achenes not concealed by the calyx serve to identify *C. strictum* var. *glaucophyllum.*

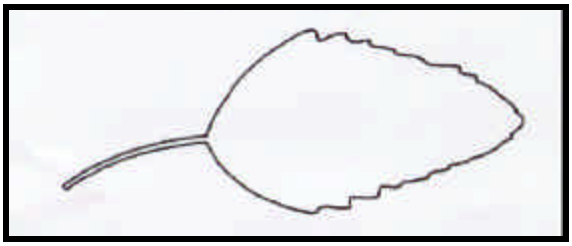

Figure 17. Outline of lower leaf blade of *Chenopodium strictum* var. *glaucophyllum.*

Chenopodium strictum var. *glaucophyllum* is native to northeastern North America. Its origin is sometimes confused as its close relative, *C. strictum* var. *strictum*, is a plant native to Asia. These two taxa are recognized on the basis of leaf blade margin and relative length. The Asian *C. strictum* var. *strictum* has prominently serrate lower leaves with blades 3.0 or more times as long as wide. The North American *C. strictum* var. *glaucophyllum* has finely serrate lower leaves with blades less than 3.0 times as long as wide (Clements 1992). This species normally grows in disturbed areas. These sites are usually related to human activity (*e.g.*, roadsides, edges of lots, railroad yards). *Chenopodium strictum* var. *glaucophyllum* sometimes, however, grows in non-anthropogenic habitats, such as forest openings. It is known from the following locations in Maine:

(1) Topsham, Sagadahoc County (1912);
(2) Canton, Oxford County (1908);
(3) North Berwick, York County (1896).

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