The Woody Artemisias: Leaf Morphology and Physiology Part 2 of a Series

By Jim Borland

This is part two in a multi-part series of articles on the Artemisia *genus and its species. Common names include sagebrush, wormwood, and mugworts. This article describes some of the variations found in* Artemisia *leaves. Part three will be published in the Spring 2021 issue of* Aquilegia.

The usual botanical floral markers are used to taxonomically assign members to a species, but since the flowers of artemisias are so small, other botanical features and ecological associations are also used. Differences among this group of lookalikes include:

- Number of flowers to a head;
- Size and shape of leaves, which differ from one portion of the shrub to another and can be ephemeral or persistent;
- Fertility or sterility of individual flowers;
- Palatability to wildlife;
- Adaptability to soil depth;
- Structure;
- Drainage and chemistry;
- Elevation differences;
- Crude protein;
- Monoterpenoid content; and
- Tendency to natural layering.

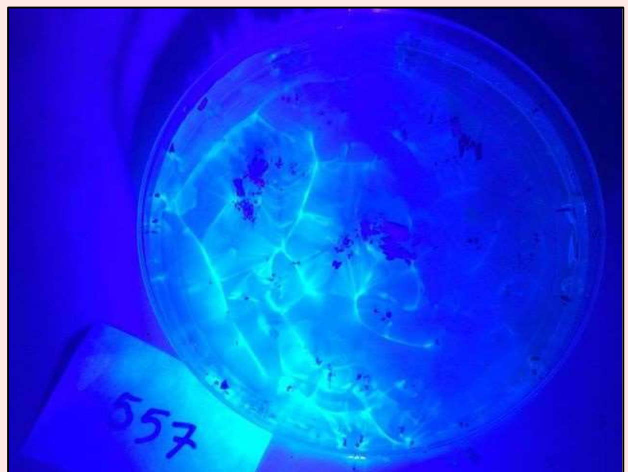
Identifications have proven difficult enough that a simple chemical test has been devised to aid in the identification of a few species. This test involves soaking a few grams of leaves or seeds in a small quantity of methanol or ethanol in a clear bottle for one hour. The solution is then irradiated with a simple ultraviolet lamp and the resulting fluorescence is either a characteristic creamy-blue or brownish-red color. See the sidebar for an example.

The evergreen members of the *Artemisia* genus have the ability to manufacture food at temperatures only slightly above freezing, thus allowing them to get a head start on the growing season. This ability undoubtedly enables many of the more xeric species to utilize the usually more abundant spring moisture before summer and its associated dry conditions and high temperatures force limitations on growth.

Evergreen artemisias with the ability to endure drought conditions are termed “drought enduring” and include: *A. tridentata, A. arbuscula* ssp. *arbuscula*, *A. nova*, *A. pygmaea* and *A. rothrockii*. “Drought evading” types include the deciduous species, such as: *A. cana*, *A. tripartita* and *A. rigida*. Generally, there is a continuum in reduction in leaf size from the large leaves of the more mesic species to the smaller leaves of the xeric species.

Other morphological features associated with artemisias—and other plants growing in dry environments—include leaf vein densities, which are generally greater than those found for the sun leaves of other deciduous dicots. Leaf hairs associated with this group of artemisias can be described as elevated “T”s that form an elevated layer over each leaf, forming a dead air space that is associated with a ►

Species with fluorescence in shades of creamy blue:
Artemisia arbuscula ssp. *arbuscula*
A. arbuscula ssp. *thermopola*
A. cana ssp. *bolanderi*
A. cana ssp. *viscidula*
A. arbuscula ssp. *longiloba*
A. spiciformis
A. tridentata var. *vaseyana*
A. tripartita var. *tripartita*



Live *Artemisia tridentata* ssp. *vaseyana* with its leaves fluorescing blue under UV light. © Maddie Maher

Species with fluorescence in shades of brownish-red:
Artemisia nova
A. rigida
A. tridentata var. *tridentata*
A. tridentata var. *wyomingensis*

◄ reduction in heat load and increasing light reflectance. This canopy undoubtedly reduces transpiration through the corresponding increases in relative humidity and reductions in leaf temperatures.

There is another leaf feature directly associated with decreasing moisture in the native environment: the width of individual water conducting vessels. Vessels of artemisias found in moist environments are wider than those of species from drier habitats. This undoubtedly corresponds to the greater vessel wall pressure, which must be endured by those species subjected to increasing drought with the progress of the growing season and the associated increases in internal cell osmotic pressure.

Since physiological research for different species is still in its infancy, researchers are usually very careful about making broad statements for each species or for the entire sagebrush group regarding any finding. Although this tact is important to science, individual findings are already providing what may prove to be important clues to handling these species in the landscape.

Not surprisingly, one of the most studied species is *A. tridentata* (big sagebrush) and its varieties, undoubtedly the most numerous and important shrub in western North America, where it is found growing over approximately 420,000 square miles.

Although reported adaptations to its environment may not prove similar for other species, the variety *wyomingensis* has been found to initiate root growth activity approximately one month before leaf growth, when soils are yet quite cold in the spring. This special adaptation may allow it to take special advantage of early and plentiful soil moisture before moistness becomes severely limited with the ensuing dry summer.

Root growth, water uptake, transpiration, and photosynthesis all have been found to occur with greater activity in the variety *tridentata* early in the season when soil water is more available and when atmospheric moisture stress is less. The additional ability of this variety to extract soil water at -60 to -70 bars—much above the ability of plants from perennially more moist climates—enables it to survive in dry climates.

***Artemisia tridentata* var. *vaseyana*. © Maddie Maher**

The evergreen nature of var. *tridentata* enables it to get a jump start on the growing season, not only by virtue of having leaves ready for photosynthesis on those warm spring days when deciduous species have not yet produced leaves, but also through the ability to conduct photosynthesis at temperatures hovering around the freezing mark. Another uncommon but enabling feature is the ability of the leaves to shift the optimum temperature at which photosynthesis takes place, from those leaf temperatures common in the spring to those experienced later in the season. This adaptive ability is greater than that yet found for *A. nova* or *A. arbuscula*. A study conducted in the White Mountains of California found the optimum temperature for photosynthetic efficiency for *A. tridentata* var. *tridentata* was 68°F, that for *A. nova* was 77°F and that *for A. arbuscula* was 60°F.

As might be expected for a species found growing over such a broad and diverse area, the control of photosynthesis and its adaptability to low temperatures has been found to be under genetic control for var. *tridentata*. These features probably explain better its adaptability to dry environments rather than any particular morphological leaf feature.

Unlike some other dryland adapted species, photosynthesis in var. *tridentata* is sensitive to leaf temperatures greater than 86°F and to water stress, to which there exists a very sensitive control of the leaf stomates. Since both of these conditions may be found early in the growing season, its ability to flourish in dryland or draughty areas is not simply explained through one simple adaptive ability or process. Its adaptive fit to maximum growth relatively early in the growing season is additionally enhanced through the production of special early season ephemeral leaves, which are shed when moisture stresses become severe.

Jim has been fooling around with native plants for more than 40 years in private, commercial, and public venues. His home garden contains 1000s of native plants, most grown from seed at home and now not supplementally watered for 20 years. Jim has written hundreds of articles, given talks too numerous to count, and continues to grow and plant the two or three native plants not yet in his garden.