Medicago arborea Traits Segregating in the Second Generation Families from M. sativa X M. arborea Crosses

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The term segregating in the title indicates that it should be possible to backcross selected traits into alfalfa. Although some of the traits discussed in the following are considered undesirable for alfalfa improvement currently, they could find some use in the future. Importantly, there are several potentially useful traits, e.g., longevity, large seeds, lodging resistance, frost tolerance, and a mysterious heterotic block that we are trying to stabilize and use.

Crosses between M. sativa and M. arborea reported in Vol. 5 of this web site were repeated in 2005 using a different M. sativa seed parent, clone M8. Clone M8 has a complicated pedigree, and behaves as a genetic male sterile with a trace of pollen and a low frequency of selfing. Crosses of M8 X M. arborea produced four sac progeny exhibiting hybrid characteristics, and these were crossed with the sac progeny from MBms to produce some of the second generation families herein reported. The recent sac derivatives involving M8, like the ones from MBms reported in Volume 5 probably are not balanced hybrids, but they are different from each other, and most of the M. arborea genome could be represented in the material.

In the following, the frequency of occurrence of certain traits will be in parentheses e.g. (100:1). The frequencies are for general information, and are not genetic ratios. Observations are based on short seeded rows and hill plots, where some plants probably are lost, and the phenotypes of some plants may not be observed due to competition. Large numbers of spaced transplants likely would reveal additional variation, but we do not have the resources for this.

Contractile growth of seedlings. The first report in Vol. 6 has a table listing the contractile growth of M. sativa and falcata as a point of reference. In brief, M. sativa has it, and M. arborea does not. The sac families are all segregating, and most are a bell-shaped curve with intermediates between M. sativa and M. arborea predominating around the mean. Interestingly, one sac family does not have a normal distribution and leans toward the lack of contractile growth of M. arborea.

Slower vegetative growth and regrowth after cutting typical of M. arborea. Slower growth would seem to be undesirable in alfalfa, except for a productive two cut type. In any case, growth rate is segregating in two ways: continuous in some families, and occasionally discrete large differences in other families. There could be more than one genetic mechanism for growth, and many interactions. It appears to be a trait that can be selected against, barring unforeseen linkages. Seed development and maturity takes longer in M. arborea

and some sac segregates, and this could well be linked to slower M. arborea growth. Also, M. arborea grows in “spurts”, and we have not learned how to predict the spurts nor study them in the sac segregates.

Erratic flowering and fewer flowers per raceme in M. arborea. These traits are undesirable in alfalfa, and started to segregate at a low frequency (ca 100:1) in some sac families. The erratic flowering could be associated with the vegetative growth spurts. A segregate that is typical of M. arborea in flowering pattern and flowers per raceme, had relatively large desirable seeds. This may indicate an unfavorable linkage, and will require further study.

Plant Color. M. sativa has dark green plant color, and M. arborea is lighter green (grey green). M. arborea plant color started to segregate at a low frequency (ca 100:1) in the second generation of derivatives of M8 X M. arborea. If the color is associated with a waxy cuticle and drought resistance, the it could be desirable. Otherwise, it is undesirable.

Leaf size and shape, and stomata size and number per unit area. Leaves are so plastic over stages of growth, and environmental and seasonal considerations that we have not tried to study differences so far. Evaluation of materials in dryer parts of the world could expose some interesting leaf and stomatal phenotypes. The root likely will be involved in drought resistance, also.

M. arborea pod shape. Pod shape is a “strong” M. arborea trait. One of the original sac plants (sac-10) had M. arborea pod shape from the beginning (see photograph in Vol. 5). It has segregated in most families, and about 25% of the plants have pods that tend to look more like M. arborea than M. sativa. At present, we consider it a neutral trait.

M. arborea seed size. Seed size is segregating, and a few segregates (100:1) have been selected that have seeds intermediate between M. sativa and M. arborea. Many factors such as endosperm function could influence seed size, and seed size remains under study.

Flower color. Flower color is segregating and many photographs are presented in Vol. 5. Some segregations are as expected for tetrasomic segregation (35:1), but there is segregation distortion or other factors causing unusual ratios in most families.

M. arborea root morphology. While transplanting sac selections to the greenhouse in the fall, we noticed multiple tap roots on some plants. Then, we started looking at roots of M. arborea. It turns out that some M. arborea plants have multiple tap roots that initiate 3-4 centimeters below the cotyledonary node. The tap appears to divide into 3-5 roots at this point, and each one then grows like a tap root with little side branching. Now, we are studying this condition in both M. arborea and the sac derivatives. More information in 2008.