Can stomatal traits be used to predict ploidy level in two species of hawthorn?

Stomata size in relation to ploidy level in North American hawthorns (*Crataegus*, Rosaceae)

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Significance statement

Stomatal traits, like size and density, have been the focus of plant research for over a century and, though general trends have been found, variability within particular taxonomic groups and ecological conditions remain poorly understood. On the other hand, few studies have been made to examine how polyploidy promotes ecological differentiation. The study of McGoey and colleagues is interesting because it explores the effect of genetic and environmental factors affecting stomatal traits. As a researcher currently working in understanding variation in stomatal traits in palms, I found this article helpful for my own research.

Crataegus L., a genus of nearly 230 species of plants to which the Mexican tejocote belongs to, is highly complex partly because of the occurrence of polyploidy—a condition where a cell or an organism has more than two homologous sets of chromosomes. Polyploidy, however, might be one of the most powerful mechanisms for plants to colonize new territories. Polyploid plants have advantages over their diploid congeners like a greater ability to tolerate poor soils and drought conditions, thus allowing them to expand their geographic distribution.

However, there is little understanding on the relationship between polyploidy and ecological differentiation. One of the problems for studying polyploids is that identification remains methodologically challenging because it usually depends on the availability of tissue from where chromosomes can be counted, or nuclei can be extracted and passed through a flow cytometer.

Therefore, the team of researchers of the University of Toronto led by Brechann McGoey, looked for morphological differences in *Crataegus* leaves that would correlate with ploidy levels. The researchers measured stomatal size and density to test whether these traits could be used to predict ploidy level. They were also interested to see if there was any association between morphological variation and geographic distribution.

They examined two species within the *Crataegus* series Douglasianae found in the Pacific Northwest of the US and Canada: *Crataegus suksdorfii* (Sarg.) Kruschke, occurring in conifer forests, and *C. douglasii* Lindl., growing in xeric areas. *C. suksdorfii* diploids, triploids, tetraploids, and pentaploids are known, while most individuals of *C. douglasii* are tetraploid.

The study is based on the analysis of stomatal size and density of 15 specimens of *C. suksdorfii* (8 diploids and 7 tetraploids) and 17 tetraploid *C. douglasii* trees. According to the study, depending on the place of the leaf from where measurements are taken, stomata size will vary. Therefore, to ensure comparability between individuals, researchers took measurements from the mid-right section of the abaxial surface of the leaf.

The results of their research show that stomata size varies within ploidy levels indicating this trait cannot be used to assess the level of ploidy in these species of hawthorn. General trends show that tetraploid *C. douglasii* individuals have the largest stomata, and *C. suksdorfii* diploids have slightly larger stomata than autotriploids of the same species. The team also found that stomatal density cannot be predicted by ploidy level.

Stomatal traits in both species of *Crataegus* are also affected by environmental factors such as precipitation and temperature. Ploidy level was associated with elevation and negatively associated with precipitation and temperature. Tetraploid *C. douglasii* are found in more xeric conditions than diploid and triploid *C. suksdorfii* adding evidence to the idea that polyploids tolerate more extreme conditions than their diploid relatives. Interestingly, they did not find any relationship between stomatal density and environmental factors.

Researchers conclude that stomatal traits are the result of genetic and environmental factors and that stomata size corresponds more to taxonomical groups in *Crataegus* than to ploidy level. This, of course, remains an interesting field of study in *Crataegus*.

Figure 1: *Crataegus gaylussacia* A.Heller, growing inland at the Point Reyes National Seashore, California. Researchers believe this is an autotriploid, and distinct from diploid and allopolyploid *C. suksdorfii*. **Photo by: Timothy A. Dickinson. (c) 2010 Royal Ontario Museum**.