



Genetic structure and domestication history of the grape

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Background. Grapes, one of the first plants to be domesticated by humans, have been valued since antiquity for fruit, wine, raisin, and juice production. Our goal was to use thousands of molecular markers to assess the genetic diversity in the grape genome, the relationships among grape cultivars, and to explore the history of grape domestication.



Experimental design. We examined over 1,000 samples of the domesticated grape (*Vitis vinifera*) and its wild relative (*V. vinifera* subsp. *sylvestris*) from the USDA grape collections in Geneva, New York, and Davis, California. After extracting DNA from the grape leaves, we developed a genetic fingerprint for each vine using over 5,000 sites in the genome.

Results. Grapes are a tight-knit clan: we found that within our sample, more than half of the vines (58%) also had a clone in the sample, i.e., another plant with an identical fingerprint. We also found that most cultivars appeared to have a close relative in the sample: 75% of the cultivars are related to at least one other cultivar by a first-degree relationship (i.e., parent, offspring, or sibling). Table 1 shows some of the wine grape cultivars with a high number of close relatives.

Table 1

Cultivar	Number of first degree relatives (sibling, offspring, parent)
Gewurztraminer	20
Gouveio	17
Pinot noir	10
White Riesling	9

In general, wine grapes were more closely related to other wine grapes, and table grapes more closely related to other table grapes. Previous studies have reported that grape domestication 6,000-8,000 years ago resulted in larger berries, larger clusters, and “perfect flowers” with both male and female parts on the same vine. When we compared the

domesticated grape to its wild relatives from the Near East (east of Istanbul, Turkey) and Europe, the domesticated grape was more closely related to wild grapes from the Near East, providing strong support for an origin of *vinifera* in the Near East. After domestication, there was likely breeding or crossing between the newly-domesticated *vinifera* and the European *sylvestris*. The domesticated grape retains much of the diversity of their wild *sylvestris* relatives, but it is organized into groups of interrelated cultivars.

Conclusions:

- Grapes were domesticated in the Near East, in support of previous research
- Although most crop domestications involve a reduction in genetic diversity, domesticated grapes have retained much of the diversity found in the wild *sylvestris* grapes
- Many modern grape cultivars are closely related to other cultivars
- Clonal (vegetative) propagation over thousands of years, rather than breeding new cultivars, has led to underexploitation of the potential genetic diversity in grapes

The bottom line. As a species, grapes are genetically diverse, but meeting challenges such as severe pathogen pressure will require new varieties and exploiting available genetic diversity.