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From field to table: perspectives and potential for fruit domestication

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Abstract

Domestication, the evolution of species in response to human selection, is the foundation upon which agriculture is built. Most contemporary crops are the products of evolutionary processes that began thousands of years ago, and that continue today as scientists harness emerging technologies to develop new crop varieties for a rapidly changing world. Current understanding of evolution under domestication is based primarily on annual grains and legumes, species that are propagated from seed each year. However, as concerns mount about a growing population, a changing climate, and sustainable agriculture, attention is refocusing on the development of perennial crops. The domestication process in perennial plant species departs from that observed in annuals due primarily to differences in breeding systems (natural populations of most perennial plants are largely outcrossing) and mode of reproduction (many perennial crops are clonally propagated). These differences have implications for two important aspects of perennial fruit crop domestication: 1) the extent and structure of population genetic variation in crop wild progenitors and 2) the genetic basis of agriculturally important traits. In order to understand how perennial crop domestication might proceed in the future, we look to two of the oldest and most economically important perennial crops, apple (*Malus x domestica*) and grape (*Vitis vinifera*) and their wild relatives to better understand the hallmarks of perennial plant domestication. Using these two examples, we explore the geographic and taxonomic mosaic of perennial crop domestication, the impact of genetic bottlenecks on variation in cultivated populations, crop-wild gene flow, and the genetic basis of phenotypic variation. We emphasize the role of variation housed in wild-relatives for breeding fruits as well as rootstocks. These two iconic crops provide an important roadmap for exploring how best to conserve naturally occurring variation in perennial plant species and how to utilize it in plant breeding.

Key words: domestication, perennial, apple, grape