

Cucumis melo is among the Few Species Independently Domesticated Three Times and on Two Continents

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Introduction

Melon is among the commercially most important fruit crops and has therefore received a lot of attention from breeders, especially in the U.S. and China. As a result, there are numerous commercially important varieties, all belonging to one species, *Cucumis melo*. Until recently, it was unclear whether melon, which occurs wild in Africa, Asia, and Australia, was initially domesticated in Africa or Asia or even on both continents. The high diversity of landraces in India and East Asia supports the idea of an Asian domestication center, but the occurrence of wild populations in northeast Africa suggest that the species may also have been domesticated there (Kirkbride, 1993).

The question of where and how often *C. melo* was domesticated has now unequivocally been answered in two studies (Endl et al., 2018; Zhao et al., 2019). The first of these used molecular-phylogenetic data from a sample of 90% of all currently accepted 65 species of *Cucumis* (www.cucurbit.de) and dense geographic sampling of *C. melo* itself. Importantly, the sampling included field-collected plants from wild and feral populations in Africa, Iran, India, Australia, North America, and Indian Ocean islands. The results of this uniquely complete sampling revealed that melon was domesticated once in Africa and once in Asia. This is clear from an early split in the phylogenetic tree, with the African wild populations in one clade (marked in red in Fig. 1) and all other melon accessions in a second clade (marked in blue and green in Fig. 1). The African landraces are commonly referred to as "African *agrestis*" melons and formally described as *C. melo* ssp. *meloides*. All remaining melon cultivars from Europe, India and East Asia group with *C. melo* ssp. *melo* forma *agrestis* plants from India and Asia Minor, the "Asian *agrestis*" melons. In other words, the Asian form *agrestis* is the ancestor of most of our modern market melon cultivars, whereas the African subspecies *meloides* is the ancestor of an economically less important, but genetically diverse and probably still underexploited group of African cultivars, including "Tibish",

"Fadasi" and presumably also "Seinat". The Australian wild populations represent another genetically distinct clade, but have never been domesticated (Endl et al., 2018).

The other study analyzed genomic variation in 1,175 resequenced accessions of *C. melo* that represent the global diversity of the species (Zhao et al. including H. Schaefer, 2019). The results support the two domestication events in Africa and Asia but suggest a third independent domestication event in China. The inferred phylogeny (their Fig. 1) shows again an early split between African *C. melo* ssp. *meloides* (their "WAF & CAF" clades) and Asian *C. melo* ssp. *melo*. However, the single-nucleotide polymorphism (SNP) data clearly show that the Asian clade further splits into two clades, each comprising wild and domesticated forms (their "melo" and "agrestis" clades), one involving Indian accessions, the other Chinese accessions.

The DNA-based inference of three independent domestication events fits beautifully with archaeobotanical inferences based on fossil melon seeds. The oldest seeds assigned to *C. melo* come from China and date to 4,600 BC (Fuller, 2012), while the oldest African melon seeds are from a site dated to 3,700–3,500 BC in Lower Egypt (see overview in Sabato *et al.*, 2019). Seed remains of *C. melo* from India remain doubtfully identified, but melon cultivars appear to have been present in the Indus, and the Yangtze valleys by the third millennium BC (Fuller, 2006, 2012). Archaeobotanists and economic botanists have therefore suggested one domestication of *C. melo* in the Near East (Egypt?), one in Eastern China (Walters, 1989; Fuller, 2012), and one in India (Fuller, 2006).

It is worth noting that one of the fathers of modern plant breeding, Charles Naudin (1815 – 1899), already in 1859 suggested that the wild populations of melon in India and in Africa were domesticated independently. There is now an urgent need for inventory and storage of traditional African landraces in germplasm collections before they are entirely replaced by modern cultivars of Asian origin.

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Figure 1. Summary phylogeny of *Cucumis* modified from Endl et al. (2018).

