Grapevine Relevance and Grapevine in near East Origins

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The origins of the main cultivar groups of *Vitis vinifera*, their relationships with wild grapevine populations, and the use of other *Vitaceae* are relevant issues for the improvement and conservation of *Vitis* diversity. Morphometric studies, domestication indices, multivariate analyses, and Bayesian hypothesis testing have been used.

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1. Grapevine Relevance and Diversity

The grapevine, olive, date palm, fig, and pomegranate constitute the core of domesticated fruit species in Western Asia and the Mediterranean [1]. The fruits of the grapevine, *Vitis vinifera* L. (*Vitaceae*), can be consumed directly as table grapes, dried as raisins, or pressed into a must that can be fermented into wine, which contains 12–17% alcohol. The consumption of alcoholic beverages, and not only grape wine, was an important element of the nutrition, ritual and economy of early societies in Mesopotamia, Egypt, Syria, and the Levant [2][3][4].

Domesticated grapevine belongs to the Genus *Vitis* (*Vitaceae*), which comprises two sub-genera and over 60 species. Grapevine (*Vitis vinifera* L.) is widely cultivated, especially in Mediterranean-type climates. More than 40.000 grapevine cultivar names exist worldwide, corresponding to a little more than 15.000 grapevine genotypes [5][6][7]. Grapevine is a glycophyte, so with low salt tolerance (ClNa up to 40 mM, EC close to 4 dS/m), concentrations of 80 mM (EC close to 8 dS/m) produce significant damage [8].

Wild (*Vitis sylvestris* C.C.Gmelin) and cultivated (*V. vinifera*) grapevines mainly differ in their reproductive biology. Wild grapevines are dioecious, with males producing great quantities of pollen; on the other hand, most cultivated grapevines are self-pollinated hermaphrodites, producing small pollen amounts [9]. Negrul [10][11] argued in 1946 that hermaphrodite-cultivated grapes result from the selection of hermaphrodite branches accidentally appearing in male *V. sylvestris*. According to Sosnovszky [12][13], the ancestors of *Vitis* had bisexual flowers, and unisexual development is the result of reduction through evolution. Some cultivars, such as *Ohanes* and *Bicane*, are functionally female and may require assisted pollination.

Four main theories on the origin of cultivated grapevine have been published [14] with their variants. They are summarized as follows:

1. Monophyletic and Monospecific: Local populations of cultivated grapevine descend from local wild populations. Both are conspecific.
2. Theory was proposed between 1882 and 1946 by De Candolle [15], Hegi [16], Planchon [17], Baranov et al. [18], and Negrul [10] and has been clearly supported by Levadoux [19], who also refers to some Pliocene *Vitis* fossils from Europe, known as *V. parasylvestris* Kirch., *V. tokayensis* St., or *V. ausoniae* Gaud. et Str, as conspecific.
3. Monophyletic and Bispecific: Cultivated grapevine descend from an extinct ancestor that is also presumably an ancestor of wild grapevine, being both two distinct separate species. Occasional hybridization may have produced some cultivars or cultivar groups [20]. Sosnovszky [12][13] stated that the Eurasian cultivated grapevine did not directly derive from *V. sylvestris*, which is morphologically well distinct from *V. vinifera* and extremely polymorphic, with its own history, geographical area, and natural habitat. This author [12][13] suggests that *V. sylvestris* and *V. vinifera* developed independently from a bisexual extinct ancestor who gave place to diverse types of cultivated grapevines; it is quite possible that the cultivated grapevine consists of an anthropogenic hybrid swarm involving crossing with *V. sylvestris* of several extinct *Vitis*.
4. Polyphyletic and Multispecific: Regional populations of cultivated grapevine descend from different wild ancestors extinct or not. Cultivated grapevine is divided into species with their corresponding wild relatives. The primary species hybridized, producing new cultivar groups. In 1925, Andrasovzsky [21] recognized five fundamental species, organized geographically, and the offspring of bispecific crosses between them, as well as pedigrees involving three species.
5. Hybrid Hypothesis: Cultivated grapevine descend through hybridization from wild European and Asiatic grapevines. Terpó [22] attributes the origin of cultivated grapevines to the domestication and crossing among populations of at least two species: *Vitis sylvestris* Gmel. (dioecious) and *Vitis nuristanica* Vassilcz. (hermaphrodite).

In 1807, Clemente [23][24][25][26] proposed the first systematic approach to grapevine diversity. Kolenati [27] first discussed in 1846 the origins of cultivated grapevines and proposed a classification of grapevines, wild and cultivated, in Georgia. Different authors followed Clemente's point of view; however, it was not possible to acquire a better view of grapevine diversity patterns until the beginning of the 20th century, when Russian agronomists carried out an in-depth study on the wild and cultivated grapevines of Western and Central Asia, especially in the *Ampelographia USSR* [18][28]. In this framework, the Russian agronomist Negrul proposed the recognition of three groups of cultivars, or *Proles*, namely: *Occidentalis*, *Pontica*, and *Orientalis* [10][19].

2. Grapevine in the near East Origins and Domestication

The Near East includes the eastern Mediterranean regions, the territories along the Euphrates and Tigris rivers, and the nearby regions of Central Asia, with the boundary to the north in the southern Caucasus and to the south in the Arabian and Sahara deserts. *Vitis* traces from the area are derived from pollen, wine residues, grapes (especially seeds), and wood remains [1][9][29]. The archaeobotanical remains that provide the most information are the seeds, which have been preserved under different conditions: charred, dried, or waterlogged. The carbonization process, with many variables (exposure time, temperature, humidity, and chemical composition), or

conservation in an aquatic environment, can affect the morphology of grape seeds and hinder their taxonomic identification, i.e., their ascription to wild or domesticated populations [29][30][31][32].

The pollen record from cores in the present range of wild grape within this area shows low but consistent *Vitis* counts, at least from the beginning of the Holocene, e.g., Ghab Valley (Syria), Lake Van (Turkey), and Lake Urmia (Iran) [33].

The oldest wild grape (*Vitis sylvestris*) seeds (8400 B.C.) associated with human activity, about 3 mm long, were excavated in Turkey at Nevali Çori, near the city of Urfa, on the slope of a tributary valley of the Euphrates (Hilvan province, Turkey). Domestication and cultivation of the grapevine seems to have occurred between the seventh and fourth millennium B.C., and between the Black Sea and Iran, including the Caucasus and the Upper Euphrates [9][34]. Slightly to the east of Lake Urmia, Lake Zeribar (Zagros Mountains, Iran), *Vitis* pollen first occurred in the core just before c. 4300 cal BC. This evidence was interpreted as grape cultivation spreading to the south-east, but there is no indication of substantial plantings. At present, the earliest evidence for grape used in wine production comes from the sixth millennium BC (Neolithic) site of Hajji Firuz Tepe (Lake Urmia basin, Iran) in the form of a tartaric acid residue [33]. The first convincing evidence of grapevine (*Vitis vinifera*) seeds, with indications of grape cultivation, was uncovered in Turkey at Kurban Höyük (5700–5200 B.P. non-calibrated radiocarbon date) [35].

Grapevine cultivation seems to have spread westward from western Asia. In Crete and Greece, the beginning of grapevine cultivation may have started around the fifth millennium B.C. [36]; however, archaeobotany in Greece suggests that there was a transitional period when grapevine seeds were neither domesticated nor wild [37]. This could have a connection between the seeds and the wine pressings found at Dikili Tash, suggesting that the use of grapes to produce wine may have begun independently of the domestication process [38]. In Spain, Phoenician influence during the first millennium B.C. seems to have played an important role in the development of viticulture and wine production, although the grapevine was exploited by local populations in the Neolithic before contact with Mediterranean cultures [29][39]. This would support the theory of an independent domestication center in Western Europe [40].

The analysis of archaeological grapevine seed remains from West Asia and nearby areas and their comparison with modern cultivars may provide interesting data to reconstruct the history of grapevine domestication and cultivation [41]. In West Asia, numerous archaeological grape seeds have been recovered, notably from Chalcolithic and Bronze Age levels, and are attributed to cultivated grapevine [42][43].

Among the most remarkable findings of the recent study of Vitaceae seed remains from Tell QaraQuzaq and Tell Khâmis is the discovery of seeds attributable to the genus *Ampelopsis* together with those of *Vitis* and the presence of "sternosperms", narrower anomalous seeds, characteristic of "sultana" grapes, as a step to the total absence of seeds. This leads researchers to propose that the process of apirenia is a phenomenon that began more than four thousand years ago in the Near East.

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