An Introduction to Viticulture, Winemaking and Wine

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From Vineyard to Wine Glass

By

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This book is dedicated to all those souls, who at various times have been fellow travelers with me through the world of wine. Except for my father, who in 1962 introduced me to wine in the form of a bottle of 1955 Nuits-St.-Georges Premier Cru, and my mother and sister, they are far too many to mention individually. Sadly, some have gone, but those who remain will realize if they chance to read this dedication.

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PREFACE

The principal aim of this book is to provide newcomers to the world of wine with sufficient scientific and technical background and guidance to allow progress in their own particular fields, such as growing sound grapes, making good wine, investing and trading wine and the serving, tasting, assessment or judging of wine. In effect, I have attempted to cover all important aspects relating to grapes and wine, albeit necessarily in simplified and abbreviated form. Knowledge of science at high school, college or similar level is a definite advantage regarding most sections of Chapters 2, 3 and 5, although much of the book can be read comfortably by those with little scientific background. The book is intended for the use of novice vine growers, winemakers and trade personnel, students of horticulture, viticulture and/or oenology (such as those attending junior college or university courses or those studying for Wine and Spirit Education Trust–WSET–certificate or diploma, or similar qualifications) and students attending sommelier courses. It is hoped too, that it will be of interest to enthusiastic amateurs and those more experienced in the world of wine. Much of the book, especially Chapters 2, 3 and parts of 5, has been written from a practical viewpoint, so that aspiring vineyard owners, winemakers, sommeliers and traders may find sufficient guidance to enable them to start in the right direction along the path toward the realization of their dreams.

The Bibliography and Further Reading section that terminates every chapter contains a list of general reading matter, most of it technical, but some items are of a more descriptive nature and hence are suitable for all readers. For readers with sound scientific experience or enthusiastic curiosity, details of important and very specific scientific papers, both original research articles and reviews, are included. All the bibliographical items can be accessed, in some form or other, by use of the internet and indeed, a fair number can be found only by that means. Note that a few articles may be accessed freely through the internet only as abstracts or summaries, the full article needing a subscription or arrangement with the publisher.

I am very grateful to the many people who supplied photographic images for inclusion in a large number of the figures; there are too many to mention here, but their identities can be found in the figure captions. I thank also my wife and family for their patience and understanding during the long hours of preparation of this book.

Alan Buglass,

June 2022

CHAPTER 1

INTRODUCTION AND BRIEF HISTORY

1.1 Wine and Vines

Wine is one of the world's premium beverages and its many styles are enjoyed by people from all walks of life in a wide variety of contexts. A common definition of wine is "the fermented juice of freshly harvested grapes"; it is derived from the fruit of grapevine plants, which belong to the genus *Vitis* (Fig. 1-1). Wine is a name more loosely used to describe the fermented juice of other fruit like apricots or elderberries, or even vegetables such as beetroot, or cereals like rice, but in this book it refers solely to fermented grape juice as mentioned above. In practice, the best wine is usually produced by certain cultivated varieties (cultivars) of the species whose full name is *V. vinifera* Linné spp. vinifera, but which herein simply will be referred to as *V. vinifera.* Collectively, these are by far of greatest importance in the world of wine. In common with the other *Vitis* species, *V. vinifera* is a climbing, ground-covering plant that thrives in wind-sheltered, sunny, moist but well-drained situations (Chapter 2.3). Its wild progenitor, *V. vinifera* silvestris, can still be found in such locations, usually on hillsides, in forest clearings and by riversides in countries surrounding the Mediterranean Sea–from the Iberian peninsular in the west through southern Turkey to the trans-Caucasian countries around the Black and Caspian Seas in the east.

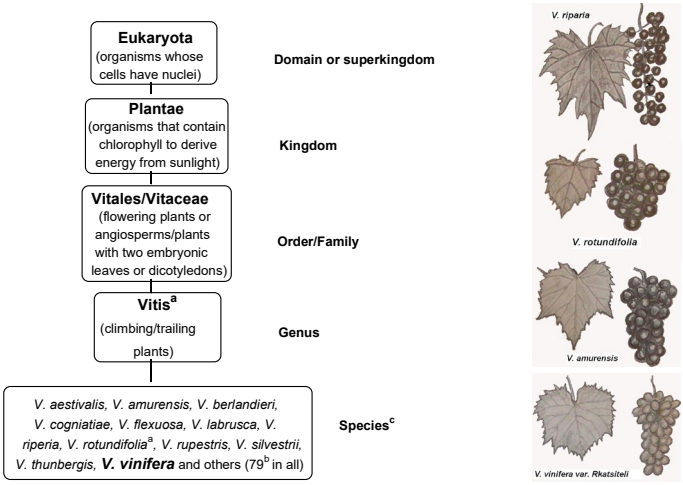

Figure 1-1 Family tree of *Vitis vinifera*. [a]Sometimes divided into two subgenera: Euvitis (the major one) and Muscadin (minor), which includes *V. rotundifolia*. [b]Actual number of species depends on whether some are classed as subspecies of others. [c]Species are further divided into varieties; *V. vinifera*, in particular, has thousands of varieties.

However, it is now rather rare and since 1997 has been included on the International Union for Conservation of Nature (IUCN) "Red List" of threatened species, having suffered from diseases imported from North America (Chapter 1.4) and loss of habitat due to agricultural changes and urban development. Similarly in other parts of the world, other species of *Vitis* can be found growing wild, for example *V. berlandieri* in Arkansas, New Mexico and Texas, or *V. amurensis* in southern Siberia, China, Japan and Korea. Fig. 1-2 outlines the approximate distribution of various *Vitis* species worldwide, including wild and cultivated varieties. It can be seen that the majority are found in temperate zones; those with mean annual

Figure 1-2 World map showing approximate mean annual temperature zones and distribution of various *Vitis* species. Hybrid means an interspecific cross, such as between a *V. vinifera* variety and a *V. riparia* variety. Species in parentheses are minor ones. Most great wines are made from *V. vinifera* grapes in regions with mean annual temperatures (at sea level) between 10 ºC and 20 ºC, usually in areas closer to 10 ºC.

temperatures between 10 and 20 ºC (see Chapter 2.1.1).

V. vinifera silvestris, like other wild *Vitis* species is mostly dioecious–having male flowers on some plants ("staminate" plants) and female flowers on others ("pistillate" plants). Thus in the wild, staminate plants are barren, while pistillate plants will produce fruit only if their flowers are pollinated by nearby staminate plants. However, during the course of time, natural mutation produced self-pollinating bisexual plants here and there within local wild populations. These latter plants, with "perfect" or hermaphroditic flowers (Fig. 1-3) were generally more fruitful than the

pistillate dioecious plants (the majority) and so were preferentially selected by the earliest farmers for cultivation and propagation because of their consistently greater yield of fruit. Today, the big majority of cultivated vine varieties are self-pollinating, although in the southern USA, the female (pistillate) forms of many dioecious Muscadine varieties are cultivated amongst self-pollinating varieties, and dioecy is still prevalent in wild vine populations of all species.

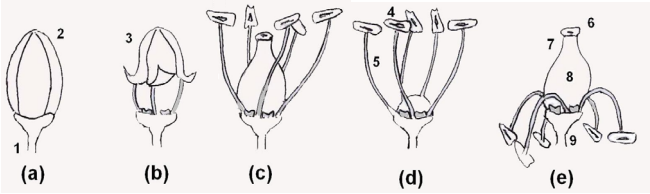

Figure 1-3 Typical vine flowers. (a)-(c) Bisexual flower, containing both male (4 and 5) and female parts (6-9), allowing self-pollination: (a) Unopened (b) Opening; calypta separating (c) Opened. (d) Male (stamenate) flower. (e) Female (pistillate) flower. Key: 1 Pedical; 2 Corolla; 3 Calypta (cap); 4 Anther; 5 Filament; 6 Stigma; 7 Style; 8 Ovary; 9 Nectary. Pistil is the whole female flower part (6, 7 and 8).

Grapevines, like other plants, can reproduce (propagate) asexually or sexually. The former is characterized by the growing of new green shoots and roots from part of an established vine (hardwood or green) in the right conditions (if inserted into soil or some nutrient-rich medium); it gives clones, new plants that are genetically identical and so have the same physiological character as the old vine. Sexual reproduction occurs *via* pollination of the female part of the flower (pistil) by pollen grains from

male part (stamens), either on the same flower or involving different flowers, as explained above. The fruit that develops from the pollination grows, ripens and eventually disintegrates or is eaten by birds or other animals, whereupon the seeds are dropped to the ground (locally or distant from the mother plant) and, under the right conditions, some of them germinate to produce a new plant. This time, however, the new vine is genetically different to either parent, and hence is noticeably different in physiology; it is in fact a new variety. Hence sexual reproduction of grapevines is used by mankind to make completely new varieties with certain advantageous traits (although it will be seen in Chapter 2.1.3 that this is no simple task), whereas asexual reproduction is used to propagate favoured clones of particular varieties (see Chapters 2.2.2 and 2.2.3).

It is likely that vines were first propagated in the earliest vineyards by "layering", burying a fruiting shoot of the previous season from an established plant in vacant soil adjacent to the plant (see Fig. 2-3 in Chapter 2.2.2). This method, although no longer widely used, was popular in certain wine regions, like Burgundy, even up to the mid 19th century. Propagation by use of hardwood cuttings is now the major method, but it too was probably known in ancient times and used especially for generating new vineyards in distant places by planting the same varieties. Even in the earliest days, new varieties would be produced randomly from time to time, from germinating seeds of fruit that were the result of natural intraspecific cross-pollination (between the same species). When people were able to travel more easily between continents, taking with them species of *Vitis* that were foreign to the local species, natural interspecific cross-pollination became more common. By the early 19th century, new

varieties were being deliberately raised from seed. In a few favourable cases, the new varieties were cultivated and propagated. Perhaps the best-known of the early examples are Catawba, an interspecific cross (hybrid) of *V. labrusca* and *V. vinifera* (possibly Sémillon) and Concord, a hybrid of Catawba and a *V. vinifera* variety; the former was first raised in North Carolina/Maryland, the latter in Massachusetts.

1.2 Development and Progress

Archeological evidence so far suggests that the earliest known sites of *V. vinifera* cultivation and probable wine production were in Georgia, around 6000 BC. Other early sites are located in northern Iran (~5500 BC) and China (~6000 BC), although in the latter case, the vines would have been one or more of the many indigenous *Vitis* species of China; since documentary evidence indicates that *V. vinifera* was not introduced into China before 1000 BC. The earliest known winery (~4000 BC) as such, complete with primitive press, vats, cups and grape pips, is at Areni, in Armenia, although grape seeds and red juice or wine stains have been found inside earthenware vessels at numerous other sites. By the time of the great Mediterranean civilizations of Egypt, Phoenicia (both ~3000 BC) and later, Greece and Rome, viticulture and winemaking were very well established. Moreover, by these times, after at least 3,000 years of cultivation, many natural mutations would have occurred and favourable mutants would have been selected by farmers and propagated, so that even in these early years it is likely that numerous varieties were used for eating, drying (raisin production) and winemaking.

The ripe fruit of wild *Vitis* species, today, as well as of old, have pigmented (usually dark) skins. Probably a most important mutation was noticed during these early years; an occasional plant (or parts of a plant) with pale fruit would be discovered in a vineyard full of black-fruited vines. We now know this mutation involves the VvmybA1 gene, a transcriptional regulator of anthocyanin biosynthesis that conveys black grape skin pigmentation. Deletion of the functional VvmybA1c allele gives mutants whose fruit have pale or even "white" (in reality, green or golden) skins. So it is likely that pale-fruited varieties like Muscat-à-Petits-Grains were already being cultivated around 3000 BC.

After about 3000 BC, wine culture was spread to other parts of the world by seafaring traders, notably the Phoenicians, to North Africa and southern Europe. This was extended later by the Greeks and especially by the Romans, who took a number of varieties of *V. vinifera* to inland Europe and established many vineyards, even as far north and west as Britain. In doing so, the Mediterranean/western Asian varieties would have plenty of time (several centuries) in their new environments to cross-pollinate with each other or with local *V. vinifera* varieties or even wild vines to produce new cross-bred plants, which if favourable, would be later propagated. Hence it is likely that during this period (~1000 BC to ~300 AD and onwards), the gene pool was considerably enlarged and the number of cultivated varieties significantly expanded.

For a variety of reasons, the taste of these early wines may not have suited most modern palates. Firstly, the use of pine resin was common in some Mediterranean countries. This may have been first used on the internal surfaces of porous earthenware jars as a sealant, but soon became

a popular addition to wine because its strong flavour masked unpleasant flavours due to oxidation, which would have been the norm in those days. “Resinated” wines, like Retsina of Greece and Cyprus, are still produced today. Pine resin gives the wine a distinct non-vinous flavour that is loved by some but hated by others. Secondly, the Romans were fond of sweetening their wines with concentrated (“cooked”) grape juice (“must”), thus producing wines altogether too sweet for most modern tastes. Modern equivalents of this; “color”, “musto cotto” and others are still used to sweeten and darken otherwise pale dry fortified wines, such as Madeira, Málaga, Marsala and Sherry. Thirdly, both the Greeks and Romans were often known to dilute their wines with water (sometimes seawater) before drinking. However, once wooden casks had become widely established (from about 300 AD), most wines would have tasted broadly similar to modern wines, but would have been generally less well rounded, coarser, more oxidized and much more variable in quality. Moreover, most wines (especially white) would be preferentially consumed by the autumn following the vintage, while they were still fresh and fruity, and before oxidation and spoilage really got under way. They would mostly be served straight from the cask and consumed over a short period of time, unless the cask was topped up with new wine. In order to delay oxidation, some winegrowers covered the wine surface in the cask with a layer of olive oil, a practice that survived from the early Roman era.

Originally vines were trained as low bushes or on tree supports, often growing alongside other crops. Later, training of individual vines on wooden stakes or on vertical wooden trellises or pergolas (Fig. 1-4) became popular. Although most modern vine training systems (Chapter