



Wine

PRODUCTION AND QUALITY



SECOND EDITION
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WILEY Blackwell

Preface

This book comprises a single volume on the topics of wine production, tasting and quality. In 2005, *Wine Production: Vine to Bottle* was published by Blackwell. This book became required reading for many basic oenology and more general wine courses held at institutions in several countries around the world. A Spanish-language edition, *Producción de Vino*, was published by Editorial Acirbia. The year 2009 saw the publication by Wiley of *Wine Quality: Tasting and Selection*; this work won the Gourmand Award for Best Wine Education Book in the World for that year, and subsequently the Gourmand Award for the Best Wine Education Book in the years 1995–2014. *Wine Production and Quality* is a combined second edition of these books. In the years since the publication of the previous works, there has been much change in the wine industry, and the perceptions of critics and expectations of consumers have also shifted. Accordingly, the text has been revised and expanded, and there is much new material. The book is divided into two parts: [Part 1](#) – Wine Production and [Part 2](#) – Wine Quality.

There are, of course, many detailed books on the topics of grape growing and winemaking, and the multifarious individual aspects thereof. These books, although very valuable to oenology students, grape growers and winemakers, are often highly scientific or technical. There are also several ‘coffee table’ books that paint a picture that may be appreciated by consumers and those with merely a passing interest. In [Part 1](#) of this book, ‘Wine Production’, we aim to provide a concise, structured yet readable understanding of wine production, together with a basic source of reference. Although the content includes

necessary scientific information, it is designed to be easily understood by those with little scientific knowledge.

In [Part 2](#) of the book, 'Wine Quality', we aim to provide an understanding of the concepts and techniques of tasting, assessing and evaluating wines for their styles and qualities, and of the challenges in assessing and recognising quality in wines. We also discuss the faults that can destroy wines at any quality level and the misconceptions as to what constitutes quality. As with [Part 1](#), the text is written primarily for the reader with limited scientific knowledge, but at times it is necessary to take a more scientific approach, especially when examining the compounds that give rise to aromas, flavours and, particularly, taints. The text is also unashamedly interspersed with the occasional anecdote, for it is not just our personal perceptions but also our experiences that shape our interaction with what can be the most exciting of beverages. The tasting structure and tasting terms used are generally those of the *Systematic Approach to Tasting of the Diploma Level* of the Wine & Spirit Education Trust. Accordingly, we hope the book may prove valuable to those studying for, or considering studying for, this internationally recognised qualification.

The book does not examine grape varieties in detail, or other than by way of example, the profiles and qualities of the vast array of wines produced in the wine regions of the world. There is already a wealth of literature on these topics. We briefly look at Champagne, Sherry and Port as the leading examples of wines made by their particular methods. However, there are many references to Bordeaux and its wines. Our reasons are straightforward: Bordeaux is the largest 'fine' wine region in the world. Its reputation has been largely built upon the unsurpassed excellence of the Grands Crus Classés wines, although the majority of the production is of 'everyday Bordeaux'. The region

remains a benchmark, flagship and model to winemakers and wine lovers around the world.

The information contained in this book is not from any parochial or polarised viewpoint. However, the authors, like all wine lovers, cannot (and do not wish to) claim to be totally objective. During the research and preparation, we have spent much time in wine regions in both the Old and New Worlds. We listened to diverse and detailed viewpoints from many hundreds of practitioners, including growers and vineyard workers in both cool and hot climates, family winery owners, winemakers and technicians working with large-scale producers, consultants and representatives of wine institutes. Accordingly, we believe *Wine Production and Quality* will prove valuable to food and beverage industry professionals, wine-trade students, wine merchants, sommeliers, restaurateurs and wine lovers, as well as those entering (or thinking of entering) the highly competitive world of wine production.

We wish to thank everybody who has given their time, knowledge and opinions. We also wish especially to thank Antony Moss MW and Trevor Elliott for reviewing the text and making valuable suggestions. We also wish in particular to thank the Wine & Spirit Education Trust for allowing us to use, adapt and extract from the *WSET*[®] Systematic Approach to Tasting - Diploma.

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Acknowledgements

[Figures 1.2, 1.4, 1.5, 4.2](#): Christopher Willsmore

[Figure 4.10](#): Zuccardi Argentina

[Figure 7.1](#): Château Lassegue

[Figure 15.1](#): Champagne Taittinger/Hatch Mansfield

[Figure 15.2](#): Brett Jones

[Figure 16.2](#): Riedel

[Figure 25.5](#): AMOS INDUSTRIE

[Figure 25.10](#): Zuccardi Argentina

All other figures: Keith Grainger

Acknowledgement is given to Wine & Spirit Education Trust for allowing the use of the *WSET® Systematic Approach to Tasting - Diploma*.

PART 1

Introduction to Part 1 - Wine Production

No other beverage is discussed, adored or criticised in the same way as wine. To a few, it is something to be selected with the greatest of care, laid down until optimum maturity, carefully prepared for serving, ritually tasted in the company of like-minded people using a structured technique and then analysed in the manner of both the forensic scientist and literary critic. To many, it is simply the bottle bought in the supermarket according to the offer of the moment, drunk and perhaps enjoyed on the same day as purchased. To those favoured with living in wine-producing regions, it is often the beverage purchased from the local producers' cooperative from a dispenser resembling a petrol pump, taken home in a 5- or 10-litre container and drunk with each and every meal.

There is a wonderful diversity in the styles and quality of wines produced throughout the world, promoting discussion and disagreement among wine lovers. The wines of individual producers, regions and countries rise and fall in popularity according to consumer, press and TV media perceptions of style, quality, fashion and value. Consumers do not remain loyal when they perceive that their needs and wants are better met elsewhere. If we consider the United Kingdom wine market, back in the 1980s, red wines from Bulgaria were very popular, and white German wines held the No. 1 position in the league table for white wine sales by volume. Australian wines were almost unheard of. By 2005, the wines of Australia held the top position in the UK wine market, by both volume and value of sales. In

2015, Australia still led the field in UK, although, in a market that suffered some decline over the previous 10 years, the volume of sales had slipped by 17%.

Few would dispute that the standard of wines made today is higher than at any time in the 8000 years or so of vinous history. The level of knowledge of producers, and thus the ability to control the processes in wine production, could only have been dreamt of even 40 years ago. Yet when, a few years ago, *Decanter* magazine compiled a list of the greatest wines of all time, the top position was awarded to Château Mouton-Rothschild 1945, and six of the 'top 10' wines were produced more than 40 years ago. Also, in the past few years, globalisation and consolidation of producers have perhaps had the detrimental effect of producing technically good wines whose styles have become standardised. In other words, the wonderful diversity we referred to is under threat.

In this part of the book, we detail how wine is produced, from vine to bottle. Many of the concepts are simple to grasp, others more complex. However, we need to stress at this stage that there is no single, unquestioned approach to wine production. Many procedures in common usage remain subject to challenge. Indeed, if you talk to 50 winemakers, you are likely to hear 100 different viewpoints, and many producers are constantly experimenting and changing techniques.

In considering wine production, there are two distinct stages: the growing of grapes (viticulture) and turning grapes into wine (vinification). Throughout the wine-producing world, there are many in the industry who carry out just one of these stages. There are growers who make no wine but sell their grapes to a wine-producing firm, or who are members of a cooperative that will make the wine. There are also wine producers who have no vineyards, or

insufficient vineyards to supply their grape needs and consequently buy grapes from growers small or large. The decisions made and operations undertaken in both the vineyard and winery will affect the style and quality of the finished wine. These decisions will be based on numerous factors: geographical, geological, historical, legal, financial and commercial. The resources and availability and cost of local labour will have a major impact upon the decisions made and the structure of the wine-production operation. Both the grower and the winemaker are aiming for maximum control: yield, quality, style and cost. Of course, the aim is to make a profit.

Grapes contain all that is basically necessary to make wine: the pulp is rich in sugar, and yeasts are present in the bloom on the skins. These yeasts also migrate onto winery surfaces and may initiate a spontaneous fermentation of the sugar rich *must*. Must may be defined as grape juice and solids prior to fermentation. However, many winemakers choose to inhibit these natural yeasts and use cultured yeasts for fermentations. It should be noted that, unlike in the production of beer (and many spirits), water is not generally used as an ingredient in winemaking. The grapes should be freshly gathered, and ideally the winemaking should take place in the district of origin. However, this is not always adhered to, particularly with regard to inexpensive wines. It is not uncommon for grapes or grape must to travel from one region to another, or sometimes even to another country, prior to fermentation.

Wine is, of course, alcoholic. The alcohol in wine is ethanol, otherwise known as ethyl alcohol. Although it is a natural product, ethanol is toxic and can damage the body if taken in excess. The alcohol is obtained from the fermentation of must by the action of enzymes of yeast that convert the grape sugars into ethanol and carbon dioxide. Although the fermentation lies at the heart of winemaking, every other

operation will impact upon the finished wine. The entire production process may take as little as a few weeks for inexpensive wines, or two years or more for some of the highest-quality wines. In the case of some fortified wines, the production process may take over a decade.

Throughout this book we will usually refer to the area measurement of land in hectares, which is the most used term in member states of the European Union, although the United Kingdom prefers to measure in acres. A hectare is 2.47 acres, some 10,000 square metres of land. Units of liquid measure are expressed in litres (l) and hectolitres (hl) - there are 100 litres in a hectolitre. Units of weight will be stated in grams (g), kilograms (kg) and metric tonnes, i.e. 1000 kg.

The methods and techniques explained in this part of the book include some that have been recently introduced by forward-thinking producers. There is a constant strive for improvement at all levels in the industry. As South African winemaker Beyers Truter says: 'If you ask me: "Have you made the best wine, or the best wine that you can?" and I answer "Yes", then you must take me away and bury me.'

CHAPTER 1

Viticulture - the basics

The aim of the grape grower is, following a successful annual vineyard cycle, to harvest ripe and healthy grapes, of the quality and to the specification required for subsequent vinification. The grower and winemaker are both aware that any deficiencies in the quality of the fruit will affect not only the quality of the wine but also profitability. In this chapter, we will examine the grape vine and its fruit in some detail. We also look at the reasons why vines are grafted onto rootstocks, including the devastating effect of the *Phylloxera* louse, and why crossings have been developed.

1.1 The grape vine

The cultivation of the grape vine is known to have begun some 8000 years ago in the Near East. Archaeological evidence of cultivated grape pips has been found in the Republic of Georgia and dated 6000–7000 BC. A potsherd (fragment of pottery) found in Iran and dated around 5000 BC has been analysed and found to contain salt from tartaric acid, which could only have come from grape juice, and resin used as a wine preservative. Wine presses from 2000 to 3000 BC have been found in south-eastern Turkey. In the ensuing millennia, viticulture spread throughout Europe and parts of Asia, and, in the last 230–460 years, also to New World countries.

The grape vine belongs to a family of climbing flowering plants called Vitaceae (formerly Ampelidaceae). The family comprises 15 genera, including the genus *Vitis*, the grape-bearing vine. This genus comprises some 65 species,

including *Vitis vinifera*. It is worth noting that the members of any species have the ability to exchange genes and to interbreed. *V. vinifera* is the European and central Asian species of grapevine, and it is from this species that almost all of the world's wine is made.

1.2 Grape varieties

V. vinifera has, as we now believe, some 10,000 different varieties, e.g. *V. vinifera* Chardonnay, *V. vinifera* Cabernet Sauvignon. Each variety looks different and tastes different. Some varieties ripen early, others late; some are suitable for growing in warm climates, others prefer cooler conditions; some like certain types of soil, others don't; some yield well, others are extremely shy bearing. Some can produce first-class wine, others distinctly mediocre. An illustration of some of the grape varieties planted in Argentina is shown in [Figure 1.1](#).

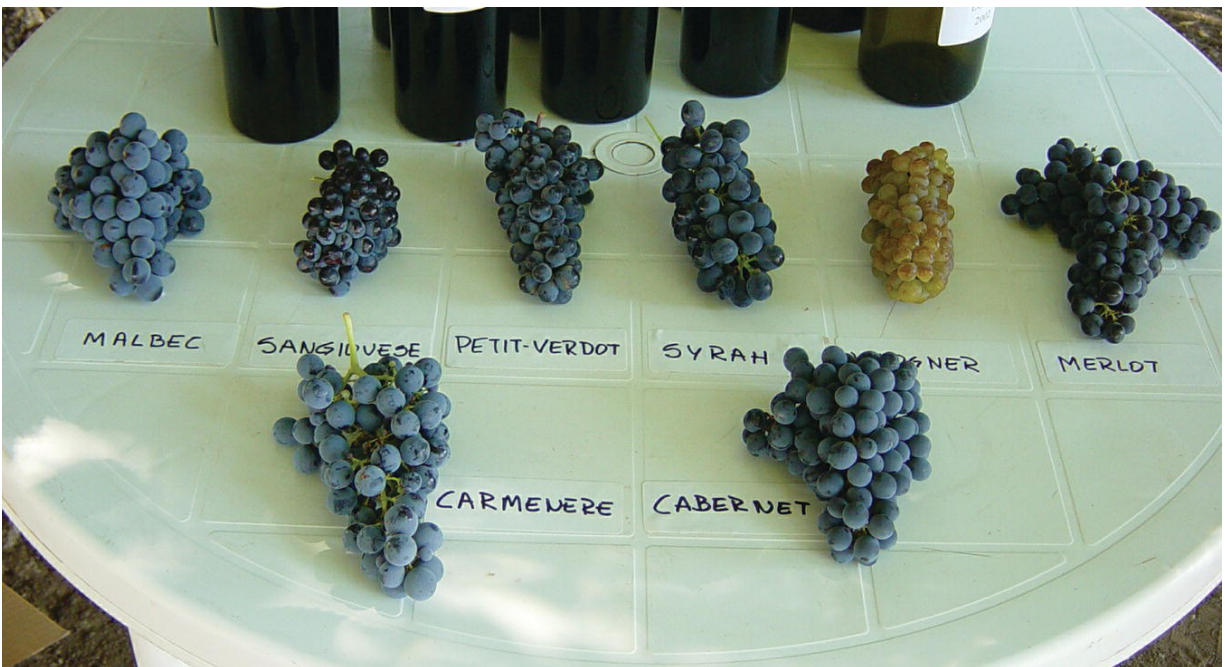


Figure 1.1 Some grape varieties planted in Argentina.

Whilst these are all factors of relevance to a grower, the actual choice of variety or varieties planted in any vineyard may well, as in the European Union (EU), be determined by wine laws. For example, red Beaune must be made from the variety Pinot Noir. It is worth remembering that most of the varieties that we know have been cultivated and refined by generations of growers, although some such as Riesling are probably the descendants of wild vines.

The grape variety, or blend of grape varieties, from which a wine is made is a key factor in determining the design, style, aromas and flavours of the wine. Wines made from a single variety are sometimes referred to as varietals. The name of the variety may be stated on the label, this concept having been introduced in Alsace in the early 1920s and promoted heavily by the Californian producers in the 1970s, and has now become commonplace. However, many wines made from a single variety do not state the fact on the front label, e.g. a bottle of Chablis will rarely inform you that the wine is made from Chardonnay. Many top-quality wines are made from a blend of two or more varieties, with each variety helping to make a harmonious and complex blend. This may perhaps be compared with cooking, where every ingredient adds to taste and balance. Examples of well-known wines made from a blend of varieties include most red Bordeaux, which are usually made from two to five different varieties (Cabernet Sauvignon, Cabernet Franc, Merlot, Malbec, Petit Verdot), and red Châteauneuf-du-Pape where up to 13 can be used.

Of the 10,000 or so different grape varieties, only 500 or so are commonly used for winemaking. The names of just a few of these, e.g. Sauvignon Blanc, are very well known. Some varieties are truly international, such as Chardonnay, which is planted in many parts of the world. Others are found in just one country, or even one region within a country such as the Mencia variety in north-west Spain.

Many varieties have different names in different countries and even pseudonyms in different regions of the same country. So, for example, southern Portugal's Fernão Pires changes its name to Maria Gomes further north in Bairrada, and Croatia's Trbljan has perhaps 13 synonyms within the country.

Discussion of the characteristics of individual grape varieties is a detailed topic and is beyond the scope of this book. For further information, the reader is referred to the Bibliography.

1.3 The structure of the grape berry

Although the juice of the grape is seen as the essential ingredient in the wine-making process, other grape constituents also have roles of varying importance, and we will briefly examine these, including their impact upon the wine produced.

[Figure 1.2](#) shows a section through a typical ripe grape berry.

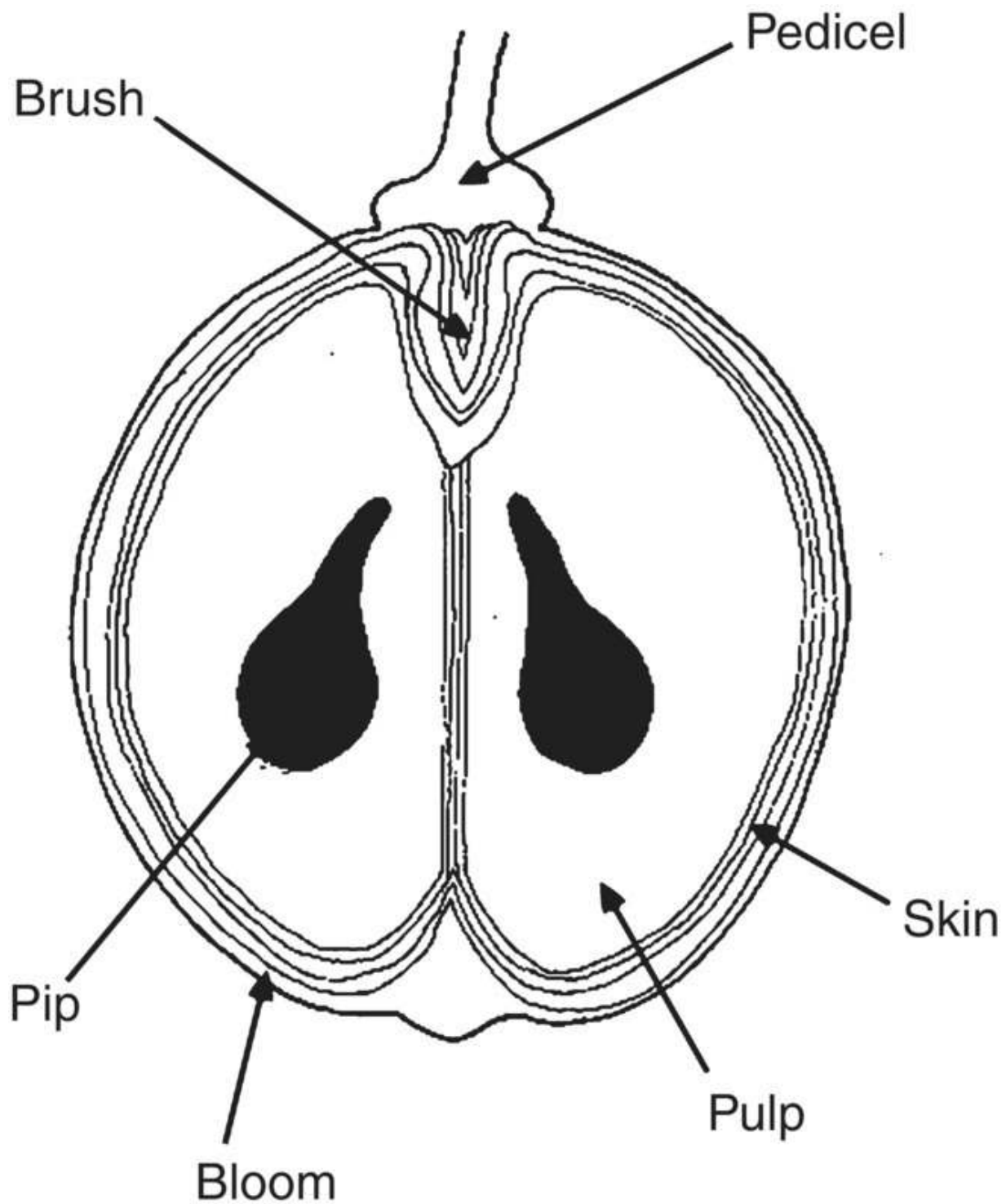


Figure 1.2 Structure of the grape berry.

Source: Courtesy of Christopher Willmore.

1.3.1 Stalks

A cluster of grape berries includes a considerable amount of stems (stalks). The individual stalk of each berry is the pedicel, which is attached to the rachis, or main axis stem of the cluster. The cluster is attached to the vine by the peduncle, and it is this stem that is usually cut by the grape picker, if the fruit is being harvested by hand. Stalks contain tannins that may give a bitter taste and an astringent feel to wine. Whether or not the stems are included in early stages of the winemaking process is a matter of choice, depending on the style required. The winemaker may choose to destem the grapes completely before they are crushed. Alternatively, the stalks, or just a small proportion of them, may be left on to increase the tannin in red wine to give extra structure. Also, if the stalks are not removed, they perform a useful task in the pressing operation by acting as drainage channels, helping to prevent juice pockets.

1.3.2 Skins

Skins contain colouring matters, aroma compounds, flavour constituents and tannins. There are several layers of skin; the outside waxy layer with its whitish hue is called bloom. This contains yeasts and bacteria. Below this, we find further layers containing complex substances called polyphenols (a class of flavonoids), which can be divided into two groups:

1. *Anthocyanins (black grapes)* and *flavones (white grapes)* give grapes their colour, and as phenolic biflavanoid compounds, they form antioxidants which help preserve the wine and perhaps provide health-giving properties. The predominant anthocyanin in *V. vinifera* grapes is malvidin 3,5-diglucoside ($C_{29}H_{35}O_{17}$).
2. *Tannins* are bitter compounds that are also found in stalks and pips. They can, if unripe or incorrectly

handled, give an excessively dry, green or bitter mouth feel on the palate. Tannin levels are higher in red wines where more use is made of the skins in the winemaking process and with much greater extraction from the skins than in white and rosé wines. Tannin gives full-bodied red wines 'grip' and firmness in the mouth. Some varieties such as Cabernet Sauvignon, Syrah and Nebbiolo contain high levels of tannins; others such as Gamay have much lower levels.

1.3.3 Yeasts

Yeasts are single-celled micro-organisms belonging to the Fungi kingdom. Their usual method of reproduction is by budding. There are over 1500 species, of which just a few are of interest to the winemaker. The enzymes in yeasts are, of course, essential for the wine-fermentation process. Yeasts, together with bacteria, attach themselves to the bloom on the skins of grapes. There are two basic groups of yeast present on the skins:

- Wild yeasts: these are mostly of the genera *Kloeckera* and *Hanseniaspora*. Wild yeasts only operate aerobically. Once in contact with grape sugars, they can convert these sugars to alcohol, but only up to approximately 4% alcohol by volume (abv), at which point they die.
- Wine yeasts, of the genus *Saccharomyces* (sugar fungus). These can operate both aerobically and anaerobically. During a fermentation, they may continue to work until either there is no more sugar left in the juice or an alcoholic strength of approximately 15% has been reached, at which point they die naturally.

1.3.4 Pulp

The pulp or flesh contains juice. If you peel the skin of either a green or black skinned grape, the colour of the flesh is not dissimilar. The actual juice of the grape is almost colourless, with the very rare exception of a very few varieties that have tinted flesh, e.g. Gamay Teinturier and Dunkelfelder. The pulp contains water, sugars, fruit acids, proteins and minerals:

- Water: approximately 70–80% of the grape pulp is water.
- Sugars: when unripe, all fruits contain a high concentration of acids and low levels of sugar. As the fruit ripens and reaches maturity, the balance changes, with sugar levels rising and acidity falling. Photosynthesis is the means by which a greater part of this change occurs. Grape sugars are mainly represented by fructose and glucose, with each comprising between 8 and 12% of the weight of a ripe berry. Sucrose, although present in the leaves and phloem tubes of the vine, has no significant presence in the berry because having been transported into the grape, it is hydrolysed into its constituents. As harvest nears, the producer can measure the rise in sugar levels by using a refractometer, as illustrated in [Figure 1.3](#).
- Acids: tartaric acid and malic acid account for between 69 and 92% of the acidity of the grape berry, the latter being of a higher proportion in unripe grapes. During the ripening process, the amount of malic acid decreases, and tartaric becomes the principal acid. In fact, the amount of tartaric acid remains constant, but it is diluted as the grape berry swells. Tartaric acid is not found in significant quantities in any other cultivated fruits of European origin, although it is a component in bananas, mangos and tamarinds. Acids have an important role in giving wine a refreshing, mouth-watering taste and also give stability and longevity to

the finished product. There are tiny amounts of other organic acids present in grapes, including acetic, citric and succinic acids. Amino acids are also present in tiny amounts, mainly arginine and proline.

- Minerals: potassium is the main mineral present in the grape pulp, with a concentration of up to 2500 mg/l. Of the other minerals present, none has a concentration of more than 200 mg/l, but the most significant are calcium, magnesium and sodium.



Figure 1.3 Refractometer.

1.3.5 Pips

Pips or seeds vary in size and shape according to grape variety. Unlike with stalks, there is no means of separating them at reception at the winery and, if crushed, will impart astringency to the wine owing to their bitter oils and hard tannins. As we shall see later, modern presses are designed to minimise this happening. We will discuss grape-berry development in [Chapter 4](#).

1.4 Crossings, hybrids, clonal and massal selection

1.4.1 Crossings

It is possible to cross two varieties of *V. vinifera* (by fertilising one variety with the pollen of another variety) and thus produce a *crossing*, itself a new variety. For example, the variety Marselan is a crossing of Cabernet Sauvignon and Grenache, and was bred in 1961 by the French National Institute for Agricultural Research (INRA). The aim of breeding the crossing was to create a disease-resistant variety with the heat tolerance of Grenache together with the elegance and finesse of Cabernet Sauvignon. It should be noted, however, that a crossing will not necessarily inherit the characteristics of its parent varieties.

1.4.2 Hybrids

It is important not to confuse the term *crossing* with *hybrid*. A hybrid is a 'crossing' of two vine species. Hybrids, in the first half of the twentieth century, were planted extensively in France, but during the 1960s and 1970s, some 325,000 hectares (ha) were grubbed up. The use of hybrids is prohibited in the EU for the production of wines of the Protected Designation of Origin (PDO) category, in theory the highest quality level.

1.4.3 Clones and massal selection

From any variety, breeders can select individual clones. Clonal selection is basically breeding asexually from a single parent, aiming to obtain certain characteristics such as yield, flavour, good plant shape, early ripening, disease resistance, etc. Each vine will be identical in DNA and 'personality'. Planting of vineyards with single clones of a

variety became commonplace in the 1970s to 1990s. However, in spite of the tremendous development with clonal selection during the past 40 years, many growers believe that old vines give the highest-quality juice. Massal selection involves taking cuttings from outstanding and perhaps old vines in a vineyard and propagating the budwood. This process is now regaining popularity. Research on genetic modification of vines is taking place, but at present no wine is produced from genetically modified plants.

1.5 Grafting

Although nearly all the world's wine is produced by various varieties of the species *V. vinifera*, the roots on which the *V. vinifera* vines are growing are usually those of another species, or hybrids of other species. Why is this? *V. vinifera* has already been described as the European species of vine, because of its origin. Other species of grapevine exist whose origins are elsewhere, particularly in the Americas, e.g. *Vitis rupestris*. However, although these other species produce grapes, the wine made from them has a most unpleasant taste. Therefore, *V. vinifera* is the species that is used to produce almost all of the world's wine.

At the time that the countries in the New World were colonised, it was obvious that wine could be produced in parts of many of them, but *V. vinifera* needed to be brought from Europe in order to produce palatable wines. However, *V. vinifera* had no resistance to the many pests and diseases that existed in the New World. Disastrously, during the late nineteenth century, these pests and diseases found their way from the USA to Europe on botanical specimens and plant material. The vineyards of Europe suffered initially from mildews, which will be detailed in [Chapter 5](#), and then

from a most lethal pest, *Phylloxera vastatrix*, that eats into the roots of *V. vinifera*, resulting in the vines dying.

1.6 *Phylloxera vastatrix*

Of all the disasters that have struck the vineyards of Europe over the centuries, the coming of *Phylloxera vastatrix* (recently reclassified as *Daktulosphaira vitifoliae*; see [Chapter 5](#)) was by far the most devastating. It was first discovered in 1863 in a greenhouse in Hammersmith, London, and named *Phylloxera* in 1868, the same year as the pest was found in vineyards in the Rhône valley in France. It was noted in Bordeaux in 1869, and by 1877 it had arrived in Geelong in Victoria, Australia. It was found in New Zealand in 1885.

Phylloxera had lived in North America, east of the Rocky Mountains, for thousands of years. Naturally the American species of vines had become resistant, the roots having developed the ability to heal over after attack. As the pest wound its devastating way throughout the vineyards of France, into Spain and elsewhere during the latter years of the nineteenth century, many attempts were made to find a cure. Poisoning the soil and flooding the vineyards were two of the ideas tried, which now seem extreme. Many growers simply gave up, and in many regions the amount of land under vines shrank considerably. In the Chablis district of Burgundy, there were some 40,000 ha of vines prior to the arrival of *Phylloxera*, and owing to the invasion of the pest (together with crop losses owing to spring frosts) this had shrunk to 550 ha by the end of the Second World War.

Phylloxera is an aphid that has many different manifestations during its life cycle, and can breed both asexually and sexually. An illustration of *Phylloxera* in its root-living form is shown in [Figure 1.4](#). When reproducing

asexually, eggs are laid on the vine roots and hatch into crawlers. These develop into either wingless or winged adults. *Phylloxera* only feeds on the roots of *V. vinifera*. The vine's young, feeder roots develop nodosities - hook-shaped galls. The older, thicker, storage roots develop wart-like tuberosities. The cambium and phloem are destroyed, preventing sap from circulating and synthesised food being transmitted downward from the leaves. Root tips can be killed by a process of strangulation by the canker. It must be stressed that *Phylloxera* affects the very life of the vine rather than the quality of the grapes and resulting wine.

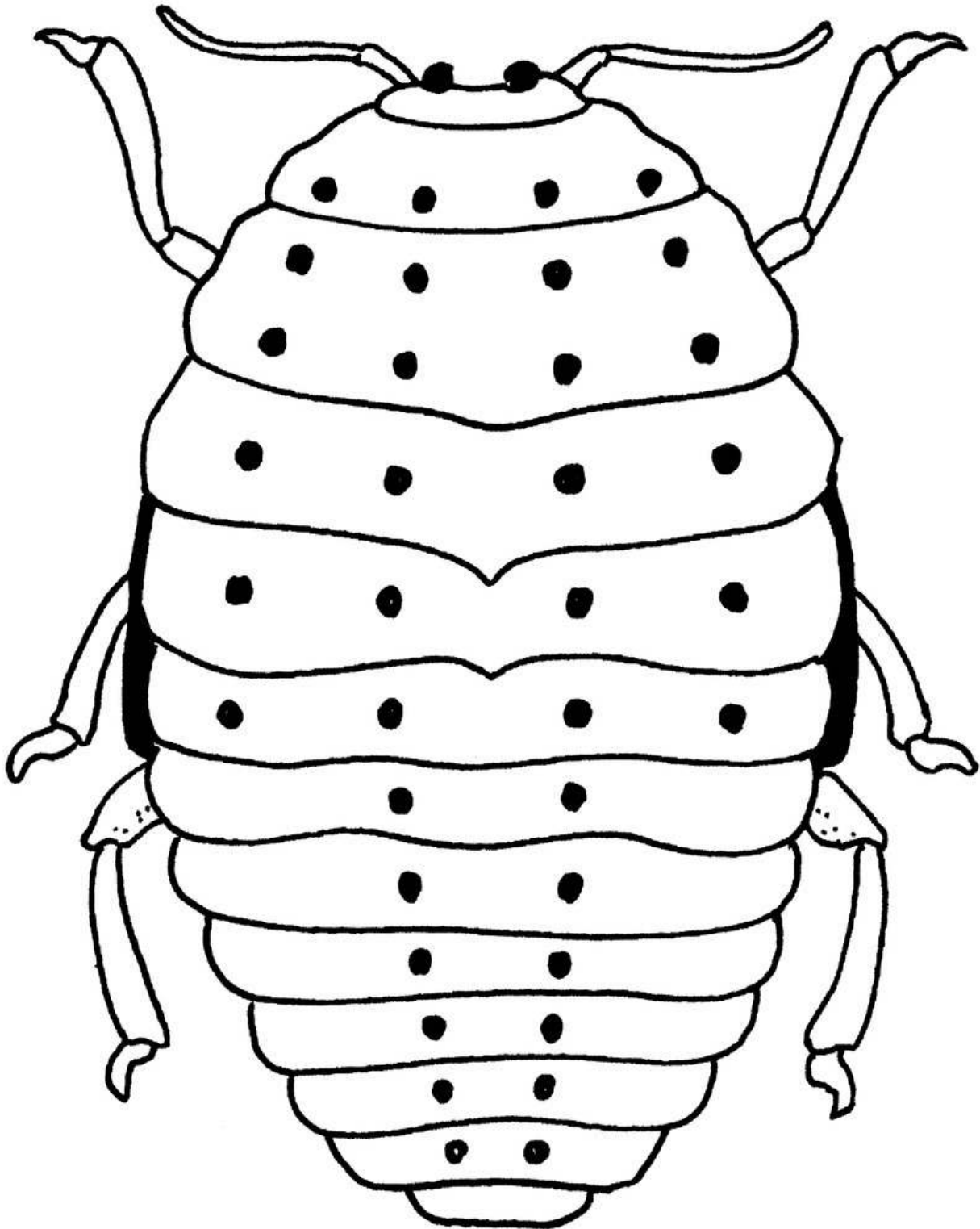


Figure 1.4 *Phylloxera* louse.

Source: Courtesy of Christopher Willsmore.

As we have seen, the grapes of American species of vines make unpleasant-tasting wine. However, if a *V. vinifera* plant is grafted onto an American species rootstock (or a hybrid of two American species), then the root is resistant to attack. The grafted plant yields quality grapes perfectly suitable for winemaking. The primary functions of the roots are to provide anchorage for the vine and to draw up water and nutrients, including trace elements that will help give the wine flavours. So, producers almost the world over began grafting their vines. The economic cost of *Phylloxera* is huge – the cost of purchasing grafted vines from a nursery may be four times that of ungrafted material.

Although the vast majority of the world's vines are now grafted, there are still several areas where ungrafted vines are common, including Chile, areas of Argentina and most of the Mosel in Germany. *Phylloxera* will not live in certain soil types, including sand and slate. The states of Western Australia, South Australia and Tasmania are *Phylloxera*-free. For *Phylloxera* to spread, it is usually transmitted on plant materials, grapes, clothing, tools, picking bins or vehicles – unless transported, the aphid will spread only a hundred metres or so in a season. So, as in Chile and the *Phylloxera*-free parts of Australia (known as *Phylloxera* Exclusion Zones), a rigorous quarantine programme has excluded the louse, for its arrival in the vineyards could spell economic disaster. To prevent any risk of the aphid spreading on equipment, this must be thoroughly disinfected or heat treated. For example, tractors may be put into a chamber and heated to 45°C for 2 h; picking bins may be heated to 70°C for 5 min. New vine planting material must also be heat treated: 50°C for 5 min is effective.

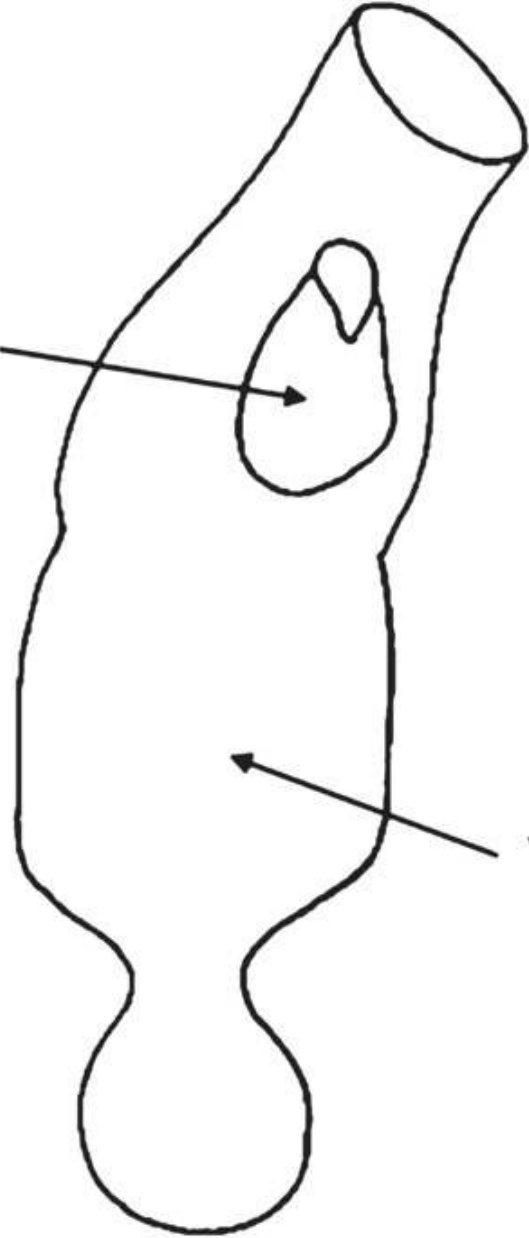
1.7 Rootstocks

There are many different American species of vines, and just a few of these are suitable for rootstocks. Three of the most widely used are *Vitis berlandieri*, *Vitis riparia* and *Vitis rupestris*. The choice of species for rootstock will depend not only on the vine stock, but also on the climate and soil type. Most commercially used rootstocks are hybrids of two American species. [Table 1.1](#) describes several rootstocks in common usage. In some regions, the grafting of vines still takes place in the vineyards, but it is usual for producers to buy new vines from specialist nurseries, where they have been bench-grafted. The grower wishing to establish a new vineyard, or replace existing vines, will order from the nursery a specified clone of a variety of *V. vinifera* pre-grafted onto a suitable species or hybrid of root stock. The most common type of graft used nowadays is the machine-made omega cut, as illustrated in [Figure 1.5](#).

Table 1.1 Some rootstocks in common usage

Rootstock name	Hybridisation	Characteristics
Richter 110	<i>berlandieri/rupestris</i>	Fairly vigorous. Suitable for shallow soils. Resistant to 17% active limestone. Moderately drought-tolerant.
Ruggeri 140	<i>berlandieri/rupestris</i>	Vigorous. Grows in exhausted soils. Resistant to 30% active limestone. Very drought-tolerant.
Paulsen 1103	<i>berlandieri/rupestris</i>	Very vigorous. Fair resistance to salinity. Resistant to 17% active limestone. Moderately drought-tolerant.
SO4	<i>berlandieri/riparia</i>	Average vigour. Suitable for poorly drained soils. Resistant to nematodes. Resistant to 20% active limestone.
101-14	<i>riparia/rupestris</i>	Average vigour. Suitable for alluvial soils. Low resistance to active lime.

Bud (dormant)



Vinestock

Rootstock

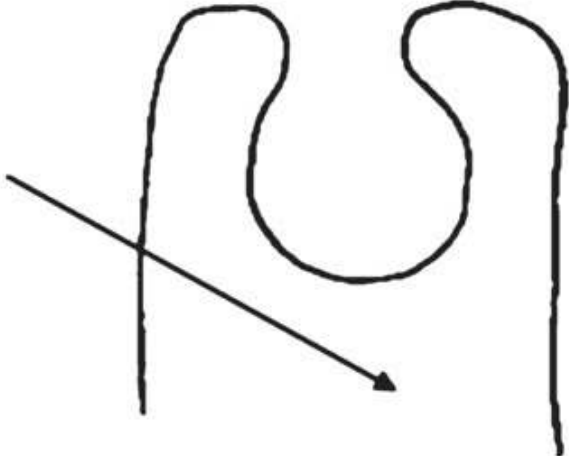


Figure 1.5 Graft - omega cut.

Source: Courtesy of Christopher Willsmore.

Some rootstocks that were once considered to be *Phylloxera*-resistant (e.g. rootstock AXR1) were found not be, in the late twentieth century. Expensive lessons were learned by many a Californian grower. It is also argued that in recent decades, there has evolved a new, even more troublesome biotype of *Phylloxera vastatrix*. Before leaving the topic of rootstocks, we should note that in addition to the primary functions discussed above, roots produce hormones, including cytokinins and gibberellins that stimulate and regulate growth, and control other plant functions.

1.8 The life of the vine

Grapevines can live for over 100 years, but the lifespan will depend upon many factors, including the climate of the country/region in which they are planted, the soil type and the methods of viticulture. In the first few years after planting (3–5 years) as the vine establishes its root system, yields will be naturally low. Even so, such small yields from the young vine can sometimes give intense flavours, and classic varietal character.

As vines grow older, their root systems become more complex with deeper penetration of the ground in search of water and nutrients. It is generally accepted that older vines give particularly good fruit which, of course, can lead to more concentrated and intense wines. After about 20 years, vines start to become less vigorous, thus producing smaller yields. Accordingly, some producers have a replanting cycle to ensure there is no drop in production. They may, for example, decide to replant vineyards when

the vines have reached a certain age - perhaps 30-40 years or so. In areas where there are problems with virus, a vineyard could be grubbed up when the vines are just 20 years old. In the best vineyards, producers will often replace diseased or dying vines on an individual basis, to retain a high average age. Ungrafted vines can have the longest life of all, and there are a few areas in the world where some vines aged 120 years or more still thrive, such as the Grosse Lage (Grand Cru) vineyards of the Dr. Loosen Estate, in the Mosel, Germany.

CHAPTER 2

Climate

Climate and weather have a major influence upon the quality and style of wines produced. This chapter considers the key factors for consideration in terms of suitable climates for viticulture, climatic challenges and the impact upon the styles of wine produced under different climatic conditions. We also look at the topic of climate change.

Most of the world's major wine-producing regions are to be found between 30° and 50° latitude in both northern and southern hemispheres. Within this 'temperate zone', grapes will usually ripen satisfactorily; however, there is a wide range of climatic variation. By way of a simple comparison, we might contrast the cool, damp and sometimes humid climatic conditions of northern Europe with those of the extreme south of Europe and North Africa, where grapes may struggle in the dryness and heat. The overall climate of any vineyard region may be referred to as the macroclimate. However, as we shall see, climate does vary within areas of any region, and even small variations have an important impact upon the quantity, style and quality of grapes produced.

2.1 World climate classifications

The Köppen system of climate classification remains the most widely used method of classifying the world's climates, over 100 years after its inception. Under the system, climates are classified into five bands, each of which has sub-divisions. The five broad bands (with the sub-divisions of the bands of interest to us) are: