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**HISTORY AND EVOLUTION OF VINE ARCHITECTURE
DIVERSITY OF TRAINING SYSTEMS IN 19TH CENTURY IN FRANCE**

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1 - HISTORY AND EVOLUTION OF VINE ARCHITECTURE

Vine architecture is the result of the training system (geometry of plantation, pruning, trellising) and of the vigour of the grape variety (including the root-stock if we include subterranean architecture). The vine is a creeper. This study will start with what is known of vine architecture during Gallo-Roman times. This study presents, partly, the diversity of vine architecture in 19th Century France (in particular the work of Guyot, Foex etc.).

2 - DIVERSITY OF VINE LANDSCAPES IN ITALY

The vine architecture of northern Italy, at least as far south as Tuscany is, undoubtedly the most diverse in the world; if we include the rest of Italy and Sicily, we are likely to find all possible types of vine architecture.

Frégoni (1991) distinguished two major juxtaposed influences in Italy which rarely became intermingled over the course of time.

- The Greek and Middle-eastern influence in Sicily and the South of Italy, which are typical of dry Mediterranean climates, where goblet is the model architectural form
- The Etruscan influence in the damper, more wooded Northern regions, where the vines were trained in trees and later held up by various types of supports.

Columelle or Pliny the Elder described 6 major types of vine architecture (figure 1) (Carbonneau *et al.*, 2001):

- 1) Low, mushroom-shaped in very dry zones;
- 2) Goblet in typical Mediterranean areas;
- 3) Short trunk attached to a wooden picket in damper areas;
- 4) Long trunk with at least partially trailing shoots of intensely vigorous vines, again with trellising;
- 5) Vines close to houses or verandas, trellised in pergola forming a canopy
- 6) Cultivated vines growing amongst trees, which could reach enormous sizes.

Models 1 and 2 are typical results of Greek and Middle-Eastern influences.
Models 4 and 6 are the result of Etruscan influences.

Model 3 is similar to model 2, but adapted according to the plant's vigour; it would have been used either in its original form (goblet attached to a wooden picket) or modified according to Etruscan influences.

Model 5 is found in both areas, but most likely applied in different manners; optimisation of the cultivatable land and proximity of dwellings in the case of Greek and Middle-eastern influences, whereas in the Etruscan context, cultivation would have involved vigour control and high production levels.

Returning to this Greek-Etruscan 'dichotomy', it is possible to consider viticulture in conjunction with the culture of fruit-bearing trees. Greek and Middle-Eastern viticulture is closely associated with the cultivation of olive trees which are traditionally trained in a highly aerated goblet configuration, whereas Etruscan viticulture is closely linked to the cultivation of temperate climate fruit trees where the architecture is often very elaborate and even voluminous.

As a result of the effects of natural conditions or of human intervention, we may define two principal types of architecture :

- an architecture of moderate size and contained volume, resulting itself from moderate vigour, often accompanied by optimum sun exposure, notably by a central opening of the plant with the fruits largely protected. This configuration is well represented by traditional goblet forms.
- an architecture of large dimensions, the principal objective being to distribute the vigour by various means, often at the cost of an imposing structure due to the wide spatial spread of the vegetation

3 - EVOLUTION OF VITICULTURE IN GAUL IN THE MEDITERRANEAN CONTEXT

The viticulture and the cultivars of *Vitis vinifera sativa*, derived from *Vitis vinifera silvestris*, probably originated in the Middle-east in Tanscaucasia during the Neolithic era between 8000 and 9000 BC.

Spreading out from here, with probably significant implantation in Greece and neighbouring islands, agriculture and undoubtedly viticulture, spread along the Mediterranean periphery arriving in Gaul some 5000 BC. The association between southern Gaul and the Middle-east are therefore dates back very many years, as testified by the presence of the Phoenicians.

The old aboriginal populations of Gaul then endured the arrival of the Celts from about 900 BC, a land which they totally occupied by around 200 BC. The Phocéens founded the town of Masilia (Marseille) around the year 600 BC, bringing with them vines and olive trees. It would therefore be logical to assume that this new wave of contact between Greece and the Middle-east on the one hand, and the Celts (integrated in southern Gaul) on the other hand, increased the amount of expertise exchanged in relation to the vine and vine products.

The only evidence of the viticulture of the Gauls was limited to a few vines in Marseilles or in the area of the Berre marsh established by the Phocéens (4th century before BC), which were most likely trellised vines for table grapes (Tcherna, 1999).

It seems that amongst the types vine architectures present in Italy, only those with traits of Greek and Middle-eastern influences were developed to any real extent in Gaul. These vines

are cultivated close to the ground primarily in free-standing or trellised goblet, most likely with different types of trellising.

The question therefore presents itself as to why, given our current understanding of the situation, were the vines trained principally according to the Greek models ?

Why is it that, given the conditions of intense vigour in southern Gaul, as well as in Atlantic and Northern areas of Gaul and France, vine growers concentrated on these particular models - with only slight modifications - without it seems, taking into account other Etruscan-type models, which from a technical point of view, allow easier vigour control and are better adapted to cope with frost and grey rot ?

Why was it that the ancient Gauls, who were masters of wood cultivation, and who invented oak barrels, didn't put their skills to use in the construction of vine training systems?

The explanation for this paradox is complex (Carbonneau *et al*, 2001), but certain hypotheses may be proposed:

The influence of the Romans on viticulture and oenology is less controlled and more diversified, and in fact, Roman colonists were often demobilised legionnaires (2nd and 3rd centuries AD) who brought with them, for example, the practice of using money for trade and a certain degree of know-how. In addition these people were principally non-Latin in origin – Greeks, Spaniards, Illyrians, even Germanians.

In this context, it is quite possible that the vine-growers of Gaul, from the moment of their emancipation, were more affected by Greek and Middle-eastern influences than by Etruscan-predominating Latin influences

3.1 - The Roman Influence

French viticulture was constructed under the influences of different cultures. It is difficult today to estimate the effects of the individual influences. However, we could say that :

- These influences operated in a global fashion, concerning, often at the same time, wine, the vine and viticultural techniques
- The viticulture of Gaul was certainly influenced by the Romans, but probably in a complex manner which means that its Mediterranean character is greater than it would have been had it simply come under Latin influence. It shows a preference for Greek models of vine architecture which became integrated into the viticultural and oenological practices of Gaul itself, thus cultural exchanges existed that pre-dated the Roman colonisation.

3.2 - The role played by local culture

Besides the general trends that formed the origin of the viticulture of Gaul, and which played a role in its development, we cannot ignore the influence of local vine-growers on their own viticultural practices, whether that be in the selection of material to plant or in the development of training systems.

A study of the diversity of vine architectures before the post-*phylloxera* purification, (Deloire, *et al.*, 2001) shows that innovation occurred less in the area of vine architecture (primarily goblet, either free-standing or on wooden pickets dating from the Gallo-Roman era), and more in the detail, where an individual turn of the hand could give rise to a bizarre mixture of styles. Subsequently, experimentation was regularly carried out on vines and in viticultural and oenological techniques.

The cultural and technical hiatus due to the barbarian invasions in the 5th and 6th centuries may also have played a role.

However, certain general principles that had been acquired earlier, such as the Greek type of architecture were never modified, so it seems to me, which is surprising given the nature of certain *terroirs*.

The overall result of this viticultural evolution between the Gallo-Roman period and the arrival of *phylloxera* would appear to be mixed :

On the one hand, there was progress as regards the vine itself and in training and pruning systems. On the other hand, the principal Latin-derived vine architectures seem to have been forgotten.

It may even be said that the situation regressed, when if we compare the Gallo-Roman vineyards which were planted in well-ordered rows, with vines of the Northern and Atlantic vineyards which were grown from runners planted randomly on an annual basis. This was followed by the late return in the 17th and 18th centuries of widespread use of animals (horses and cattle) to cultivate vineyards, as was described by Columelle and Pliny.

4 - DIVERSITY OF TRAINING SYSTEMS IN 19TH CENTURY FRANCE

The areas implanted by viticulture, and the manner in which man cultivated vines in those areas between the Gallo-Roman era and modern times, had an influence on the quality of the wine produced and a long-lasting effect on the French viticultural landscape. There was a multiplication of training systems in the 19th century, and notably in pruning methods, there was, at the same time, a reduction in the basic forms of training systems which at the time were limited to *espalier* and goblet. The accidental introduction of new bio-aggressors in the 19th century were to have important consequences for the viticultural landscape. The *Phylloxera* attack would lead to the renewing of almost the entire French *vinestock*. The development of new diseases caused by the fungi powdery Mildew and Downy mildew (*Oidium*) required treatment of the vine which in turn led to mechanisation in order to facilitate the application of those treatments. This is the reason why training systems and plantation densities were to evolve.

4.1 - TRAINING SYSTEMS AND PRUNING METHODS OF THE VINE

The training systems of the vine may be defined as a combination of the plantation geometry, pruning methods used to construct and renew the vine, and operations to modify the growth of the vegetation; the training system thus defines the form that an individual vinestock adopts. There exists today 40 basic forms or global architectures of vine vegetation (Carbonneau et Cargnello, 1999), and for any given basic form there are a number of possible training systems (10 on average) depending on the pruning and trellising methods adopted.

There are many pruning methods which vary from one viticultural region to another. Pruning leaves woody shoots of varying length on the vine. Short shoots (to or three buds) are called, depending on the region, spurs, “cots, cornes, porteurs”, etc. Long shoots (more than three buds) are called canes, “astes, courgées, archets, verges, baguettes”, etc. Single guyot pruning shows a vine bearing a spur (2 buds) and a cane (6 buds and more)

4.2 - TRAINING SYSTEM AND PLANTATION DENSITY

G. Foex in 1888 distinguished two major types of vineyards in terms of the lay-out of the plantation: randomly-planted vineyards where annual runners are planted without any particular lay-out and vineyards where the vines were planted in a specific arrangement. This is an essential point in the evolution of viticulture and viticultural landscapes.

4.3 - RANDOMLY-PLANTED VINEYARDS

Randomly planted vineyards are characterised by a very high plantation density on account of the cultural practice of planting runners in all directions. Plantation densities varied greatly and could be as high as 60 000 or more plants (runners) per hectare (figure 2, h).

This type of high-density plantation disappeared with the introduction of animals in soil cultivation, since it was necessary to provide access the vines with horses or cattle. Later on this tendency to abandon random planting was continued with the arrival of mechanisation. The invasion of Phylloxera at the beginning of the 20th century and the renewal of the French wine regions also contributed to the elimination of random vine planting.

Today, the choice of training system and plantation density depends on the grape variety, terroir, the style of wine, economic considerations and the physiology of the plant.

Important considerations are nowadays taken into account in the choice of training system, notably the balance between sunlight and the exposed foliar surface, the grape load on the vine and its vigour the quality of the root system in terms of volume and depth (notably its ability to regulate water supply to the arial parts of the vine under conditions of water stress); trellising systems which optimise the microclimate of the grape bunches and leaves, mechanisation of the vineyard; and finally the construction of the woody parts of the vinestock in accordance with its vigour.

4.4 - VINEYARDS IN ORDERED ARRANGEMENT

Vineyards in ordered arrangement were divided into those vines planted with or without intercalated plants. In the case of the former, the intercalated plants may have been market-garden type plants, cereals or olive trees. However, from the beginning of the 20th century,

due to re-plantation following the Phylloxera attack, vineyards consisting only of vinestock, without intercalated species, became the most widespread form of plantation.

For this type of plantation during the 19th century and even earlier, plantation densities were highest in Northern vineyards, and it was even observed that the density decreased as one progressed from the North towards the South. (Du Breuil, 1863).

4.5 - THE DOMINANT TRAINING SYSTEM

Two important basic forms of vine training systems will be described: goblet and espalier.

4.5.1 - Goblet format

In the 19th century and even before, vines in goblet were very widespread. This basic form existed even during Gallo-Romans time. A vine constructed in goblet consists of a trunk of variable height from which the arms extend outwards and upwards forming a kind of vase, open to a greater or lesser extent. The number of arms may vary from three to seven depending on the grape variety and the region. The vegetation may be free-standing or attached to wooden pickets. The goblet system was used in several viticultural regions as we will show during the conference: the Languedoc, Roussillon, Provence, the Lot, Bordeaux, Haute Garonne, Beaujolais, Paris, and the Faculty of Agronomy of Montpellier where specific experimental forms were tested.

Whether or not vines in goblet were trellised or free-standing would depend on the viticultural region, the natural bearing (trailing or erect) of the foliage and above all, the commercial value of the wine (figure 2, g). Trellising systems were usually on wooden pickets or maybe on slate in some regions.

4.5.2 - Vines in Espalier or Vertical trellis

Du Breuil proposed in 1863 that training systems should be used for vines producing wines of high added-value (already !). Examples are the vineyards of Lunel, Frontignan, Saint-Georges d'Orques (Languedoc), L'Hermitage, Condrieu, Saint-Péray. Furthermore, he suggested that vines should be cultivated not in trellised goblet but in espalier. This system was already in use in the rich vineyards of Bordeaux and the form it confers on the vegetation is totally different from that obtained with goblet. In this case the vegetation is trained in a vertical fashion. It consists of a trunk of variable height from with one or two lateral arms, called the "bearing wood" on which the vine grower leaves spurs and/or long canes which carry the fruit. The bearing wood was held up by horizontal wood supports which were later replaced by iron wires. The growing shoots may be attached at a 2nd (higher) wire - and this is what trellising consists of. The espalier training system is currently the most widely used in France and indeed throughout the world. Examples dating from the 19th century are give in Figure 2, a,b.

Generally speaking it is interesting to observe that since the event of Phylloxera and for other reasons (reduction in the consumption of wine, international competition, urbanisation etc.) the French vineyard surface area has gone from 2.3 (two point three) million hectares in 1862 (Lachiver, 1988; Dion, 1977), to 900,000 (nine hundred thousand) hectares in 1999.

5 - THE DIVERSITY OF PRUNING SYSTEMS IN 19th CENTURY FRANCE

The vine is a creeper. Without physical support, it adopts the form of a bush, which is what we see in arid conditions. In other situations the vine is a plant which, even if it doesn't grow vigorously, requires that the vegetation be physically supported during its development; this is what a trellising system consists of. Trees were the most ancient type of trellising system onto which wild vines would attach themselves and which could be used to collect the grapes (*Vitis vinifera silvestris*). This system originates from the Etruscans and is little seen in France (Carbonneau *et al.*, 2001). This natural system of vines trained on trees was sometimes used to cultivate vines for winemaking (*Vitis vinifera sativa*). The abandoning of such a system is understandable for economic reasons and also in the interest of the quality of the harvest: if the grape bunches were covered by excessive tree foliage, it would have been difficult to carry out phytosanitary treatments and also there would have been considerable competition between the root systems of the tree and the vine (Figure 2, l).

The vine would have been pruned in different ways, varying according to the imagination of the vine grower and experimentalists. The training systems presented below are taken principally from 19th century reference texts (Chancrin, 1908 ; Chaverondier, 1876; Du Breuil, 1863; Foex, 1888; Guyot, 1864). The training systems are presented according to their adoptive viticultural region. These are only a few selected examples and not an exhaustive list. The systems have also been selected in order to pay homage to certain 19th century authors in the field of viticulture.

Two examples of espalier system of the Jura (Figure 2, c) and the Haute-Marne (Figure 2, d) are presented.

Figure (2, f) shows the formation of a particular training system practised in Chablis. The rows were planted in a transversal orientation with respect to the slope of the hills, with 1.33 metres between the rows and 0.75 metres along the row. The cutting containing the same year's shoot was called the "chapon" or the "crossette". The third year following plantation, the shoot was pruned down to 3 buds. The fourth year, in addition to a 3-bud cane, a two-bud spur was left at pruning. With each pruning further spurs were left which gave, after 10 years' of plantation, 4 permanent cordons. Figure (2, f) shows the vine in vegetation before the harvest. This example clearly shows that in parallel with the basic goblet and espalier forms, there existed, due to the diversity of pruning methods, a diversity of original training systems, which in effect constituted different basic forms.

Before adopting the espalier form, regions such as Bordeaux and Burgundy used the training systems shown during the talk. In Bordeaux this consisted of a trunk and a single long cane per vinestock. In Burgundy, the vines were planted randomly. In both cases, the number of vine plants per hectare could be very high.

Another particular system, known as vines planted in the form of a half-barrel was found in Moselle (Figure 2, i). A related training system existed in the region of Pouilly-sur-Loire. This form approached the Moselle half-barrel. There were 4 to 6 permanent cordons growing from the same vine. Each permanent cordon that was trellised bore a spur with two buds and a spur with three or four buds. These systems are related to the basic goblet form.

Chaverondier (1876) described diverse forms of cane-pruned vinestock. In this case, the vinestock is vertical, with a trunk of variable height, where the cane remaining after pruning was deliberately curved to a greater or lesser extent forming an arc or even an entire circle.

The principle of this type of training system could be found in different viticultural regions. Depending on the individual region the fruit-bearing shoot was called “vineuse, haste, courgée, arquet, pleyon, pissevin, couronne, archelet, queue, viette, taille, arçon, chièvre, verge, vinée”, or indeed other names.

Amongst the various espalier forms, there is one that was peculiar to the Haute-Marne. This system resembles the guyot form according to Chaverondier (1876). The extension in this case was unusual in that it was curved above the trunk and attached to the trunk by its extremity (Figure 2, d). The spur was pruned to two buds. The extension contained 8 to 10 buds, and the end of the trunk was attached to a small wooden picket

Another particular system was that used in the Haut-Rhin as described by Chaverondier (1876). Three grouped vinestocks each bore a cane arranged in a semi-circle and attached at the base of the vine. The year-old shoots growing from the buds nearest the vine trunk were trained on a central wooden picket and could grow up to three metres in height (Figure 2, h).

The vines of the Côtes du Rhône were sometimes trained on wooden pickets in groups of three such that the apex of the three pickets were joined giving trellises in the form of a cone.

In Sancerre vines were cultivated randomly, with about 40 000 vinestocks per hectare. The vine was pruned to two spurs with 1 or 2 buds. The longest spur (called the major, with three or four buds) was tied down with straw to the wooden picket.

In certain cantons of Allier, Saint-Pourçain and Chantelle, ingenious vine growers developed a particular training system which was well adapted to the white grape varieties of the region (Guyot, 1864). It involved a vertically trellised shoot, a horizontally trellised shoot and a runner all originating in the same vinestock. The vine was thus nourished by two root systems, the permanent root system of the base vine and the annual root system of the runner. (Figure 2, j). I have the feeling that this type of training system warranted further physiological study!

Today espalier and goblet are the dominant training systems throughout most of the vine-growing world.

It is true that vine training systems and pruning methods were very diverse in the 19th century and certainly even earlier than that. The basic forms were relatively limited due to the constraints of historical events, and latterly due to legislation and frequently economic considerations.

Is not now time, in the light of recent experience, to draw upon the biodiversity of vine architectures in a studied manner ?

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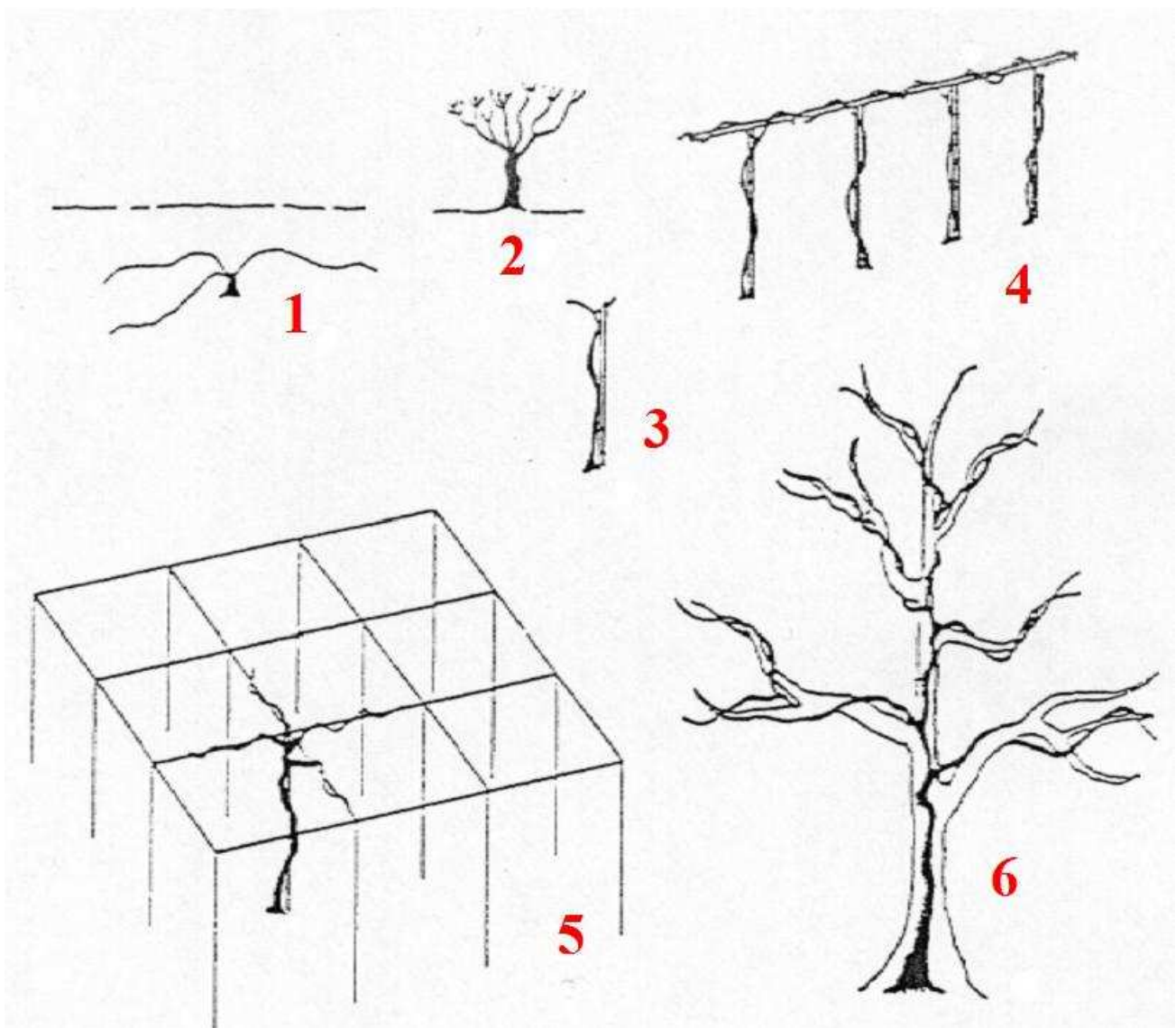
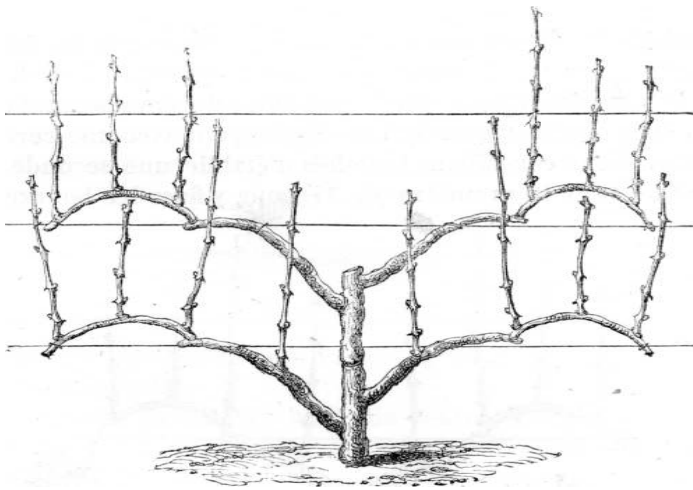


Figure 1 : Training systems used by the romans
(PLINE, *Storia Naturale*, 17, 164-166).

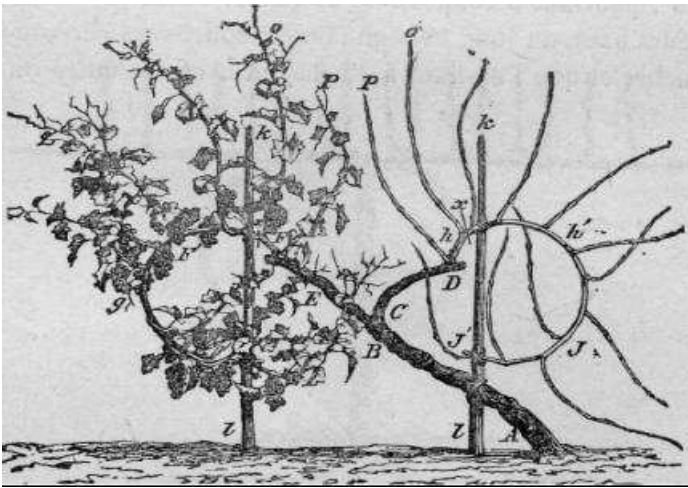
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|---|------|---|
| 1 | type | « coverage » or « rampant »-type with shoots growing horizontally close to the ground |
| 2 | type | « goblet » or alberello type without trellising |
| 3 | type | « distaff » goblet or vertical cordon-type on wooden pickets |
| 4 | type | « curtain » or horizontal cordon-type held in place by both vertical and horizontal wooden pickets and cross-bars (<i>Vitis iugata, canteriata</i>) |
| 5 | type | rectangular « trellis » or pergola type (<i>Vitis compluviata</i>) |
| 6 | type | « canopy » ou albero, type where the vine is supported by a tree (<i>arbustum</i>). |



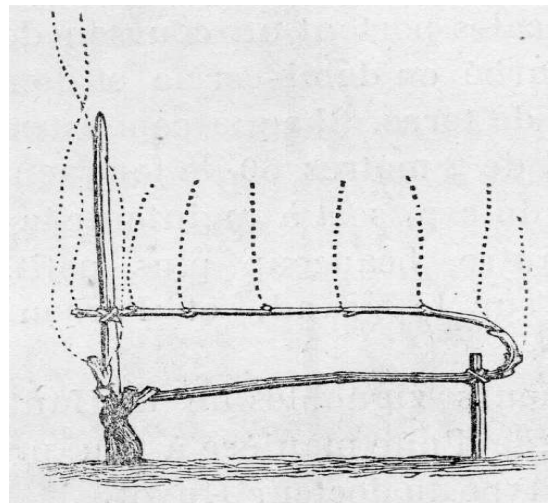
(a) Espalier V.S.P.). pruning type « palmette »



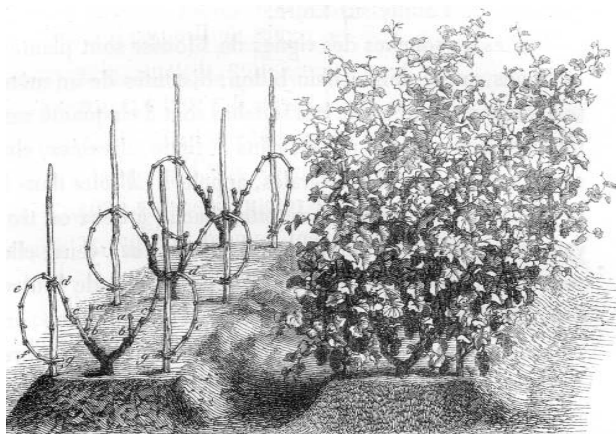
(b) Espalier (V.S.P.). pruning type « Guyot » (Médoc)



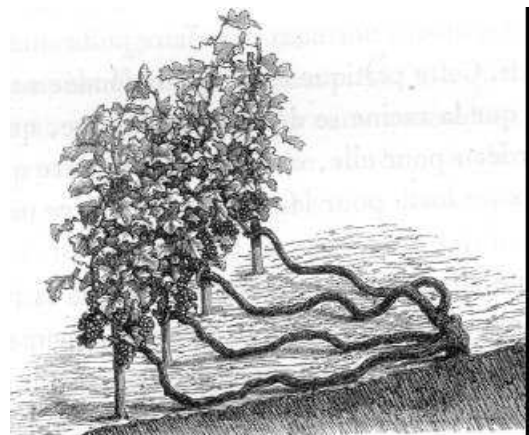
(c) Stake-V.S.P. pruning type « courgée ».



(d) Stake-V.S.P. pruning with a long cane

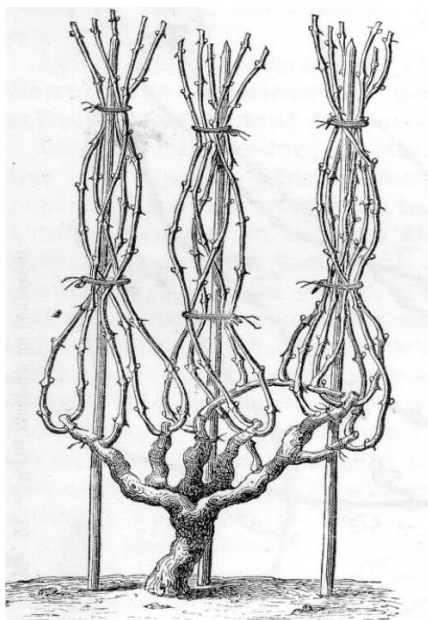


(e) Stake-V.S.P. Pruning double bending.

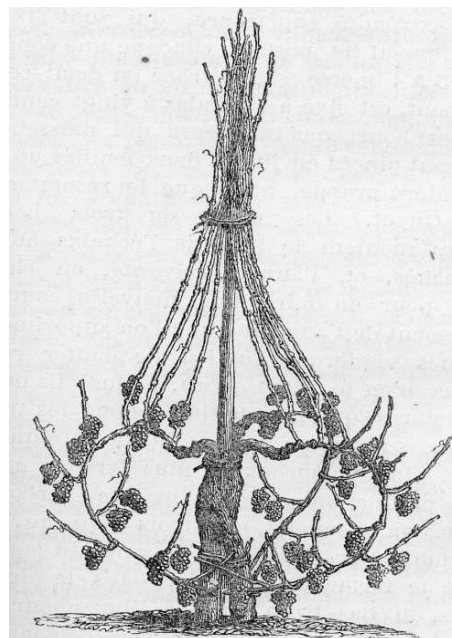


(f) Multi stakes. Pruning with long cordon.

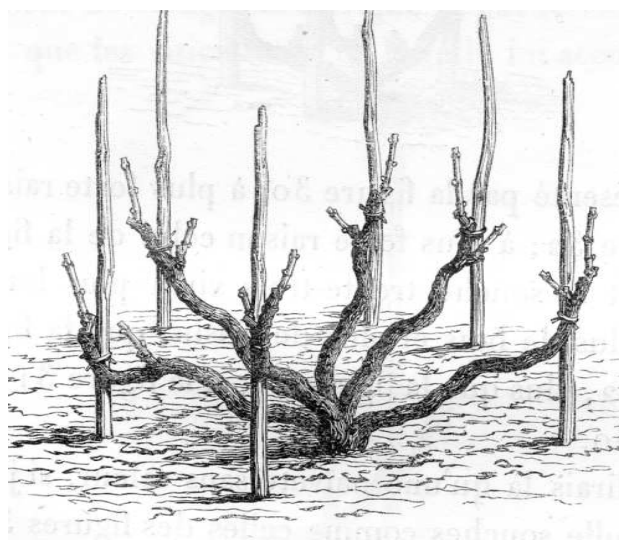
Figure 2 (a, b, c, d, e, f) : training systems in 19th Century France, before the phylloxera period (Chaverondier (1876); Foëx (1888); Guyot (1864)).



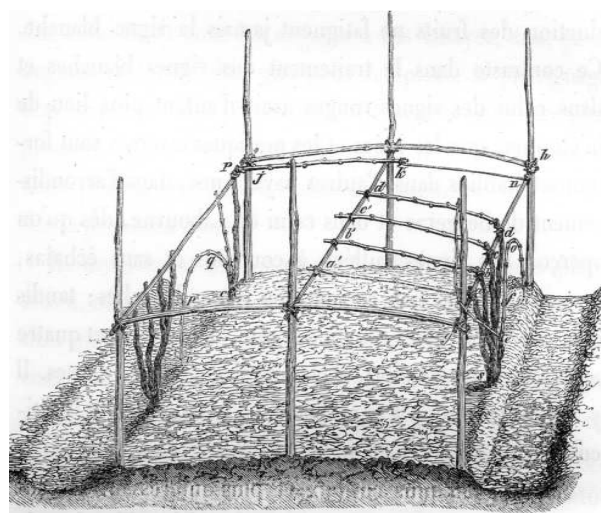
(g) Multi stakes. Pruning as a Goblet



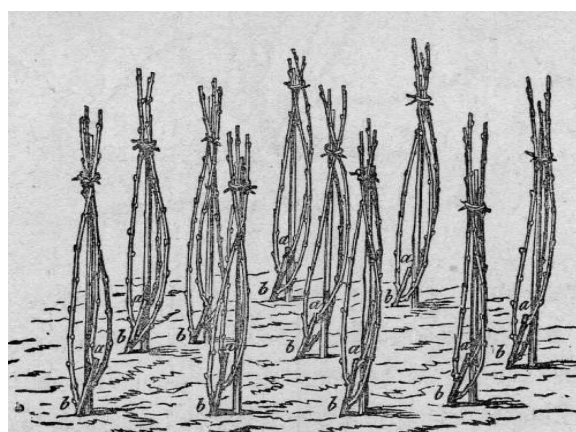
(h) Stake. Pruning type « couragee ».



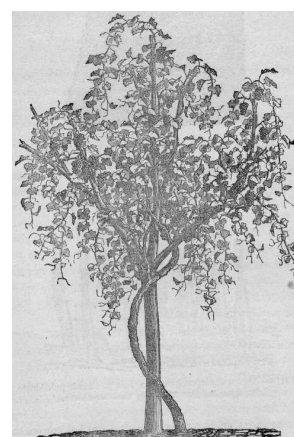
(i) Multi stakes radiating. Pruning with long cordons.



(j) « Harp ». pruning with long canes with layering.



(k) Vine in « foule ». Stakes.



(l) Vine in tress (alberate). Pruning in bending.

Figure 2 (g, h, i, j, k, l) : training systems in 19th Century France, before the phylloxera period (Chaverondier (1876); Foëx (1888); Guyot (1864)).