History of rootstocks in South Africa (Part 2)

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Keywords: Riparia, rupestris, Berlandieri, Champinii, origin, habitat, rootstocks.

This is the second article in the series on the history of rootstocks in the South African wine, table and raisin grape industries. It focuses on the origin, natural habitat, distribution and characteristics of the native American *Vitis* species that were used by breeders in the development of the commercial rootstocks used in South Africa and other parts of the world today. The parentage and qualities that each passed onto the “children” will also be discussed.

**Origin of the American *Vitis* species (characteristics and geographical distribution) used for the development of our commercial rootstocks**

The commercially used rootstocks Richter 99, Richter 110, Paulsen 1103, SO 4, Ruggeri 140 and 101-14 are all crosses of *Vitis rupestris*, *Vitis riparia* and *Vitis Berlandieri*. These were the native American *Vitis* species that were used in crosses for use as rootstocks to replace the devastated European wine grape vineyards in the last quarter of the 19th century. Ramsey on the other hand is not a commercial hybrid, but a natural hybrid of *Vitis Champinii*, also native to the USA. US 8-7 is a cross between Richter 99 and Jacquez, and 143 B a cross between *Vitis vinifera* cv. Aramon and *Vitis riparia*.

Information about the natural habitat and environmental adaptation of the native American *Vitis* species can be valuable in order to understand the characteristics of the commercially developed rootstocks selected or bred from them. The key principles are that:

- The characteristics of grape species reflect their native environment,
- The commercially produced rootstocks or “children” will reflect characteristics of the grape species or “parents” from which it originated, thus
- Parent knowledge will guide us to understand the characteristics of the off-spring, or our knowledge of *Vitis rupestris*, *Vitis Berlandieri*, *Vitis riparia* and *Vitis Champinii* can guide us to understand the qualities of our commercial rootstocks Richter 99, Richter 110, 101-14, Ramsey, SO 4, Paulsen 1103, and Ruggeri 140.

Every rootstock contains qualities/characteristics of its parent or combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents. Looking back more than 130 years, one has to hand it to the European viticulturists who selected the above combination of parents.

*Vitis riparia* is the most widely distributed of any American species of grape. It is found in the Canadian states of Manitoba, Quebec and Ontario, all through the north and north-eastern parts of the USA, as far south as Oklahoma, Arkansas and Tennessee, and as far west as Washington and Oregon, basically from the Atlantic coast to the Rocky Mountains. The map of distribution in Figure 1 clearly shows the habitat being to the north of the drier, warmer states. The natural growing habitat is along the banks of streams, in ravines, on the islands of rivers, and in wet places. *Vitis riparia* is also known as the River Bank Grape due to its presence close to rivers/streams on deep, moist soils well supplied with water. It has a climbing growth habit and can easily “invade” trees in search of sunlight. It often grows on the side of the road, up telephone poles and on fences and is frequently seen draped on trees and shrubs at the edge of a forest. The name “riparia” means “riverbank” and while *Vitis riparia* does grow along streams and rivers, it will grow nearly anywhere, as long as there is enough water. Another characteristic of *Vitis riparia* is its very good resistance to extreme cold conditions in winter; looking at its distribution into north-eastern USA and Canada, this should be no surprise. Some species can tolerate up to minus 30°C. This means that it has a short vegetative cycle, because in order to survive the extremely cold winters of the north-eastern USA it needs to mature its wood early, before the cold sets in. This is why all commercial rootstocks with *Vitis riparia* parentage ripen their fruit early (101-14, SO 4).

Eastern North America tends to be a region of abundant summer rain. A grape species, like *Vitis riparia*, that is adapted to this environment does not need a deep root system that searches through the soil for water. *Vitis riparia* is native to regions where phylloxera is present and its roots are resistant to the insect. The *Vitis riparia* species was very popular as rootstock due to the fact that it could be used directly as rootstock. Professor Alexis Millardet of the University of Bordeaux already identified it as a potential breeding parent in 1874 and sent representatives to the Missouri and Mississippi River Valleys in 1875 - 1876 to collect *Vitis riparia* material. It was initially thought that any *Riparia* species would make a suitable rootstock, but it soon became clear that this was not the case. Proper selection of the most suitable species had to be done first. Riparia Gloire de Montpellier is the most well known of these intraspecies selections and is still used as rootstock today in certain parts of the world. It preferred similar soil types to that which Jacques was grown in South Africa and therefore did not become an important rootstock.

*Vitis vinifera* cultivars grafted onto *Vitis riparia* in France showed early maturation, attained high yields and good sugar content. The vines did not have very good drought tolerance and had limited resistance to free lime (high pH) in the soil. It also did not perform well on sandy soils, probably due to its low drought tolerance and shallow root system. It has a very short vegetative cycle and sheds its leaves very early.

*Vitis riparia* was by far the single most important American *Vitis* species in terms of its contribution to the development of phylloxera resistant rootstocks. Its excellent phylloxera resistance, ease of propagation and availability for direct use as rootstock resulted in more than 75% of reconstituted vineyards in France being planted with the *Vitis riparia* species by 1902.

*Vitis rupestris* is named after “Rupes”, Latin for rocks, which describe its usual habitat, rocky creek beds. Its roots grow deep for anchorage where they can explore for water as creek beds dry up in
summer. It grows along the ground as a shrub and should rather be called a “grape bush”; as it does not have a climbing growth habit like *Vitis riparia*. It is native to the central United States, from Texas, Oklahoma, Arkansas, and Missouri to Tennessee, Kentucky, Ohio, and West Virginia. The map in Figure 2 shows the distribution of *Vitis rupestris* throughout the USA. It used to grow on the prairies in well-drained areas that collected water during the rainy season. Once cattle moved through the Midwest and south this species was grazed almost to extinction, and is now confined to gravelly river beds and sand bars where it has deep rooting in soils with a good supply of moisture.

The deep rooting habit makes *Vitis rupestris* types good choices for sites where a vine might need to go looking for water—hillsides and other well-drained sites, for example. Like *Vitis riparia*, *Vitis rupestris* is native to a region with phylloxera and when used as a rootstock it provides protection against the pest. In the grafted state with *Vitis vinifera* cultivars it showed preference for deep, well-drained stony, moist soils in warmer climates. It induced moderate vigour and had a long vegetative cycle causing delay in maturation of the fruit. It performed poorly on shallow dry compacted soils and was sensitive to soil fungi associated with wet subsoils. It did not perform particularly well on soils containing free lime.

*Vitis rupestris* could also be used directly as rootstock due to its relative ease of rooting and grafting. Just as in the case of *Vitis riparia*, many species of *Vitis rupestris* occurred; more than 100 were identified and evaluated. Out of these Rupestris du Lot (also known as Rupestris St George), Rupestris Metallica and Rupestris Martin are some of the best known. Rupestris du Lot became a popular species for direct use as rootstock in France and the USA, but not in South Africa. It induced strong vigour but relatively moderate yields (mainly due to poor fruit set, especially on Muscat d’Alexandrie, which was an important cultivar in SA), showed poor resistance to drought, subsoil wetness and *Phytophthora cinnamomi*. Rupestris
Martin (named after the owner of the farm on which it was selected in Montpellier, France) showed strong vigour and good adaptation on heavy dry soils. It was used as parent species for the development of many very successful rootstocks.

*Vitis riparia* and *Vitis rupestris* are very important in the history of rootstock breeding because they provided selections that could immediately be used in vineyards for grafting with *Vitis vinifera* cultivars (Rupestris du Lot and Riparia Gloire de Montpellier). No additional crossings or selection among seedlings were necessary which proved valuable, considering the haste at which vineyards needed to be replaced.

In contrast to the non-European wine producing countries, such as most of the New World, where low soil lime content is typical, the European wine producing countries have many calcareous soils. Initially the lack of adaptation of the rootstocks to these calcareous soils was a serious problem. The crosses of *Vitis riparia* and *Vitis rupestris* were not well adapted to calcareous soils and iron deficiency (lime induced chlorosis) symptoms occurred. To improve the adaptation of the rootstocks to lime rich soils, rootstock breeders had to continue their search for suitable parents that would be a source of adaptation to these soils. Enter *Vitis Berlandieri*.

**Vitis Berlandieri**

*Vitis Berlandieri* was first described by Professor Jules Planchon in 1880, and named it after the Swiss botanist Jean-Louis Berlandier who first collected it in Texas in 1834. It is a species that grows naturally on the dry limestone hills of central Texas and also known to occur on similar soils in New Mexico and northern Mexico. See Figure 3. The soils in central Texas (notably the Edwards Plateau) where *Vitis Berlandieri* is native, consist of a shallow topsoil underlain by limestone. It is on these shallow hillside soils that *Vitis Berlandieri* grows.

The species within *Berlandieri* are even more numerous than for *Vitis riparia* and *Vitis rupestris*. These are the results of natural variations and adaptations that developed within the species to allow for the different environments in which they grow. Various *Berlandieri* species therefore occur depending on the location. Drought tolerant, small leafed species grow on the hills where they need deep rooting to capture enough moisture, while larger leafed ones grow on river banks where they show similar climbing characteristics as *Vitis riparia*. Here trunks become very thick and the vines spread across the tree canopies. The small leafed drought tolerant species on the hillsides were used as *Berlandieri* parents for breeding. Three species are of importance, namely *Vitis Berlandieri* Rességuier no. 1, *Vitis Berlandieri* Rességuier no. 2 and *Vitis Berlandieri* Las Sorres as they became the *Berlandieri* parent species in crosses with *Vitis rupestris* for rootstocks like Richter 99, Richter 110, Paulsen 1103 and Ruggeri 140.

*Vitis Berlandieri* is also known as the “Fall Grape” owing to the delayed ripening of its fruit. It is a vigorous vine with a very long

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**FIGURE 2.** Geographical distribution of *Vitis rupestris* throughout the south-eastern United States.

Natural shrub-like growth habit of *Vitis rupestris* growing on deep stony and moist soils next to rivers
vegetative cycle (4 weeks longer than *Vitis riparia*). It has excellent tolerance to high lime content in soils. There are differences of opinion as to its resistance to phylloxera because its natural habitat is free of the insect. Some scholars list it as only moderate while others rate it very high as being similar to *Vitis riparia* and *Vitis rupestris* (whichever is the case, *Vitis Berlandieri* hybrids with *Vitis rupestris* and/or *Vitis riparia* species have shown excellent phylloxera resistance). It has never been used directly as rootstock due to its poor rooting ability, but had excellent grafting results with *Vitis vinifera* species. It was imported to France in 1887 for use in rootstock breeding where it was crossed with *Vitis riparia* and *Vitis rupestris* to produce rootstocks with phylloxera resistance and lime tolerance. Breeders now had a lime and drought tolerant breeding partner to use in combination with *Vitis rupestris* and *Vitis riparia* to develop new families of rootstocks that combine adaptation to calcareous soils, drought resistance, ease of propagation (grafting and rooting) and adequate phylloxera resistance. The groups of rootstocks formed by the hybridisation of these three species are some of the most important in viticulture today.

**Vitis Champinii**

*Vitis Champinii* was found throughout central Texas and is considered

![FIGURE 3. Geographical distribution of Vitis Berlandieri throughout the southern United States.](image)

The natural habitat of *Vitis Berlandieri* is the dry calcareous hills of the Edwards Plateau in Texas.
to be a natural hybrid between *Vitis candicans* and *Vitis rupestris*. See Figure 4. It was selected by Thomas Munson around 1900. It grew quite vigorously in almost any soil type. This species has been used directly as a rootstock (Ramsey and Dog Ridge being the most well known) and was found to have moderate phylloxera resistance, but very good nematode resistance. It grafts and roots with difficulty as can be confirmed by most nurserymen. *Vitis Champinii* was also used as breeding parent with *Vitis vinifera, Vitis riparia* and *Vitis rupestris* for the creation of Freedom and Harmony, nematode resistant mostly American used rootstocks.

Table 1 below compares the characteristics of grafting compatibility with *Vitis vinifera* species, ease of rooting, phylloxera resistance and lime and drought tolerance of the breeding/selection parent(s) of *Vitis riparia, Vitis rupestris, Vitis Berlandieri* and *Vitis Champinii*. Table 2 compares the breeding combinations and commercial rootstocks with the same characteristics. It clearly shows the genetic qualities of the combination of parents in the rootstocks. The good grafting compatibility and ease of rooting of *Vitis rupestris* together with the lime and drought tolerance of *Vitis Berlandieri* created some of the most popular rootstocks still in use today (Richter 99, Richter 110, Paulsen 1103 and Ruggeri 140). SO 4’s properties of high lime tolerance, ease of rooting and grafting compatibility was similarly created by the combination of *Vitis Berlandieri* and *Vitis riparia*. Ramsey as a selection of *Vitis Champinii* is still problematic for bench grafting in the nursery.

**TABLE 1. Qualities of American Vitis species.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th><em>V Riparia</em></th>
<th><em>V rupestris</em></th>
<th><em>V Berlandieri</em></th>
<th><em>V Champinii</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grafting compatibility with <em>V vinifera</em></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Ease of rooting</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
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<tr>
<td>Phylloxera resistance</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Moderate</td>
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<tr>
<td>Lime tolerance</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Moderate</td>
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<tr>
<td>Drought tolerance</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**TABLE 2. Qualities of commercial rootstocks created from crossing/selections of American Vitis species.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Parent combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grafting compatibility with <em>V vinifera</em></td>
<td>101-14, R 99, R 110, Ru 140, P 1103, SO 4, Ramsey</td>
</tr>
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