

Grape Diseases And pests on the Territory of Today's Czech Republic During The Reign of Austro-Hungarian Empire

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Abstract: The middle of the 19th century was a disaster for the whole vine-growing Europe. New grape diseases and pests gradually spread with plants imported from the Atlantic Ocean. Over fifty years the vineyard area decreased by 40% of the original acreage. The biggest threat was phylloxera, against which there was finally found the best environmental solution. The minor problems, such as powdery and downy mildews of vine, were solved by annual application of chemical products for over 150 years now. In this article, we discuss how the disaster was spread over the territory of today's Czech Republic and how it was addressed.

Keywords: carbon disulfide (CS₂), cupric sulfate (CuSO₄), downy mildew (*Plasmopara viticola*), kerosene, phylloxera (*Viteus vitifolii*), powdery mildew (*Erysiphe necator*), sulfur (S), vineyard area.

I. Introduction

From 1790 to 1907 the area of planted vines in Moravia decreased by 60% [1], which means from 30,000 hectares to 12,000 hectares. "The causes of vineyard extinction were mainly diseases that occurred recently, which were unknown to the vineyard owners, this led to the vineyard destruction; it was mostly due to peronospora or downy mildew." (*Plasmopara viticola*) In the beginning of the last century, the situation got rapidly worse and thus the provincial council deputies of wine regions sent out suggestions for improvement of the Czech viticulture in Moravia. In 1908, the applications were submitted in order to gain support of Czech Department of Agriculture to purchase copper sulfate, sprayers, microscopes for common activities, lectures and premium vineyard material [2].

Powdery mildew (*Erysiphe necator*) first appeared in Europe in England in 1845, and in the south of Austria-Hungary in 1850, and a little later on our territory. It certainly took some time, before the significant economic damages influenced vine plantings. So there had to be other causes, thus economical - the rise of industry and the loss of agricultural economic priority. Soon after the powdery mildew there followed phylloxera (*Viteus vitifolii*), it was discovered in England in 1863, in Klosterneuburg in 1872 as well as in Šatov near Znojmo, or in Moravia, for the first time in 1890. In 1876 white rot (*Metasphaeria diplodiella*) appeared in Italy (also introduced from America), along with Brenner (*Pseudopeziza tracheiphila*) first discovered in 1885 in France. In 1878 in France was discovered a serious disease – downy mildew (*Plasmopara viticola*). At once there was too much.

II. Materials And Methods

As a source of information, we chose monthly reviews of "Provincial wine association for Moravian Margraviate", Wine reviews from the years 1907 – 1914, and additional data were obtained from various contemporary publications of Austria-Hungary and Germany issued before 1914.

III. Discussion

1. Phylloxera

Phylloxera surpassed all pathogens; it clearly liked Europe. "The spread of downy and powdery mildews in the vineyards caused vine growers considerable damages, which were increased to the highest level when a new, yet far more severe pest – phylloxera, appeared. Phylloxera began its destructive work first in Klosterneuburg (Lower Austria) in 1872; thence it spread abroad in all vine-growing regions of Austria except Bohemia." [3].

The description of phylloxera invasion in Austria-Hungary is available here: „In *Austria*, the phylloxera was first detected in some regions: in 1872 in Klosterneuburg, Lower Austria; in 1880 in Styria and Istria; in 1884 Carniola; in 1888 in Trieste, Gorizia and Gradisca; in 1890 in Moravia; in 1901 in German region in Šatov near Znojmo; in 1894 in Czech territory in Velké Pavlovice; in 1894 in Dalmatia, and in 1901 in Tyrol. In Hungary phylloxera was already detected in 1875 and in Transylvania, Croatia and Slavonia in 1880. And this year phylloxera was detected in Herzegovina. Only in Greece and Montenegro, as well as in Austria in Bohemia, in Vorarlberg, Galician Carinthia, Bukovina and Bosnia the vineyards were considered to be free from

phylloxera until 1913. Nowadays we also have to add Czech Kingdom to the countries infested with phylloxera. Vineyards in Czech Kingdom are protected by the long distances from the vine-growing regions of the other countries, and they are protected by broadband of non-vine-growing regions and mountains, as well as by law regulations on the import of vine plants. And all these favorable circumstances did not prevent the introduction of phylloxera in Bohemian vineyards. On the 25 June 1913 an official commission found the presence of phylloxera in the vineyards of Institute of Pomology in Troy. Phylloxera has probably been present in Troy vineyards for several years. The question is: how it got to Troy. The closest phylloxera infested vineyards are in the north of Saxony near Dresden and Meissen, and in the south of Moravia." [4]

In 1907, phylloxera was again detected on Czech territory in two wine regions: in the political district of Znojmo (contaminated area) in Přímětice, and in the political district of Hodonín (contaminated area) in Velké Bílovice. So at the end of 1907, 16 Czech municipalities were infected in Moravia, with the vineyard area of 844.38 hectares. The area completely destroyed by phylloxera was about 160 hectares. "All the vineyards in Hustopeče district around Velké Pavlovice are infected; about 60% of vineyards propagated from this district were destroyed. Only 2 vine growers on Czech territory, namely in Německé Knínice, requested non-percentage loans. Direct control of aphids by means of carbon disulfide happened again this year in the Czech territory but on a smaller scale, which explains the fact that winemakers are more inclined to plant common vines, and to leave domestic vineyards to their fate. Nowadays vine growers produce grafted plants to themselves using national and regional stratification greenhouses at the price of 4-5 hellersapiece, which is very cheap, and under these circumstances it seems to them that maintenance of home vineyards by means of carbon disulphide is too expensive. As a result the plantings of vines grafted onto American rootstocks have significantly increased in the regions infested with phylloxera." [5]

A. V. Horňanský[6] writes 1908 how phylloxera was described by the deputies of Austrian imperial chamber in their reports: „The deputy Jukl (German from Lower Austria): the existing vineyards infected by phylloxera are maintained with carbon disulfide, and the state also helps vine growers. The destroyed vineyards are restored with grafted vines; nowadays 13 nurseries are producing grafted plants (in 1902 - 7 nurseries) with an area of 87 1/2 ha (on 440 parcels), of which a quarter are provincial. From Korneuburg (the headquarters) the vines are sent, the quarantine works are done with the aid of local improvement institution. Knowledge about vine spreads by means of lectures, grafting and wine courses. In 1906 there was an order of 25 millions of American vine cuttings, in 1907 - 48 millions cuttings. Peasants received 2.1 millions cuttings in 1902, 17 millions in 1907, 18 millions in 1908, but not for free. 1000 cuttings cost 6 K, 1000 rooted American plants cost 20 K, and 1000 grafted plants cost 100 K, and only the truly needed vine growers got the plants, others paid double prices; in 1908 the price for vine growers was reduced to half. The planting of grafted vines in Lower Austria continues: 4400 ha (over 22.000 parcels) in 1904, 5700 ha (29.000 parcels) in 1907, 7400 ha (37.000 parcels) in 1908, so that nearly a third of the vineyards in Lower Austria are planted with grafted vines.

The deputy Biankini (a Croatian from Dalmatia): Out of 50.047 ha of vineyards (Dalmatia) 36.000 ha are infested with phylloxera; today barely 4.000 ha are replanted with grafted plants. The government support of Dalmatian winemakers is very weak. Government appointed vine inspectors, and traveling teachers, courses and further winemaking excursions were also organized, excellent vineyards and nurseries were established, American vines were supplied for free or very cheap, nurseries were supported, wine products (wire, gum, cork) were supplied, but those actions did not decrease the spread of phylloxera. Money would have helped more to the Dalmatian wineries than corks and gums. The fight against phylloxera in Dalmatia region should have already been supported by the Government 15 years ago. The result of phylloxera spread was the migration of the population mainly to America, as it can be observed in military reports. The decline of the vine-growing industry was probably due to a shortage of capable workers, which ran away to earn money abroad, and those who stayed home were asking for big wages.

The Deputy List (German from Lower Austria): Carbon disulfide for phylloxera control must be bought from Hungary (from Pressburg), the government should take care of cheaper production in Austria. The need for copper sulfate (500 wagons in total in Austria) must be satisfied by domestic cheap production. Among the grape pests are mainly the grubs on young plants along with hares and wild rabbits, partridges and others. Law hunting for vine-growing regions has to be changed. Winemakers' debt rises every year. The government has a duty to step in, to increase support, especially in terms of Lower Austria. The government is requested by all appropriate means to decrease the price on copper sulfate. The government is requested to move the deadlines of repayment of non-percentage phylloxera loans from January 1, 1909 to January 1, 1910. The government is requested to increase and grant the credits on emergency renovation of infested vineyards if it was not enough in 1908, in particular to devastated peasants, according to the law of 28 March 1892 r. a. no. 61 about loan procurement. Moravia has 6.000 ha of phylloxera infested vineyards, and Lower Austria has 35.000 ha. As a result of phylloxera spread the population moves to America. From the stenographic record: Winemaking in the Austrian House of Commons in Vienna"

Phylloxera was also an important issue for the government, "Tenth report on the activities of the Department of Agriculture of the Czech Council for Moravian Margraviate in its first decade, 1898 - 1907" [7]:,1902: Business fights with the Ministry of plowing parties using wine subsidies. There was requested an independent wine expert for the Czech wine region. There was requested the tax discounts for new vineyards. 25 copies of the book K. Fořt - "Phylloxera of vine" (costs 20 K) was purchased and distributed between nurseries and schools in vine-growing districts. Subsidies for viticulture were granted by Czech Department of State and Regional Support in order to protect the vines against various pests, except phylloxera. The subsidies to combat phylloxera were divided for the whole period by regional committee, although Czech Department constantly seeks in vain for this subsidy. State and regional subsidies are distributed according to a key in 56 (Czech): 44 (German) in 1900-1905, since 1906 according to the key 60: 40 between the Czech and German sections. State and region donate 8000 K for the viticulture, of which Czech Department received 4480 K in 1900-1905 from each subsidy, and 4800 K annually from 1906. For those 10 years Czech Department has divided in total 52.650 kg of copper sulfate, 8780 kg of sulfur, 1284 downy mildew sprayers, 171 sulfur dispensers, 30 lamps to catch butterflies and 6601 K in cash for the purchase of copper sulfate, frost stations etc. "

Austro-Hungarian government did not take care of pest control and winemakers' education in their native languages [8]: "I. Moravian Provincial Committee agreed with the proposal to permit subsidy in the amount of 200 K to the vine-growing association of Moravian Margraviate from winemaking subsidy in 1908, issuing regulations, in the Czech language easy-to-understand, relating to phylloxera.

II. In order to accelerate and simplify the procedure of authorization of non-percentage phylloxera loans, the substantive proposals were made to target political instructions and revenue agencies.

III. On request, to produce sufficient amounts of American rootstocks in the state and regional vineyards to cover the needs of winemakers, according to the options taken into consideration, the government states that the production of rootstocks to the establishment of new vineyards is the matter of producers themselves, and that officials can only rarely take care of above mentioned material."

The further phylloxera related discussions of government (Austria-Hungary and Moravia) in 1907 showed that the representative of the Ministry of plowing promised to increase the state contribution to phylloxera control from 16.000 K to 40.000 K per year, as well as the representatives of the country (Moravia) promised to increase regional contribution to 42.000 K. The contribution was mainly intended for the establishment of national and regional vine nurseries. Beyond this amount, additional 8.000 K were granted to control other grape pests and to purchase carbon disulfide against phylloxera. Governorship issued annually a decree regarding the submission of applications for the receipt of American vines held by state and country for the period of 1908/9.

"The Ministry of plowing ordered a Hungarian nursery owner Sigmund Teleki from Villany in the requested time period of 1908/9 to deliver 20.000 pieces of 120 cm long purchased Riparia x Berlandieri hybrids to the nursery in Znojmo. Over the half of this vine material had to be given to the nurseries in Czech territory."

The supply of carbon disulfide: "The supply of carbon disulfide to the winemakers for subsidizing price was covered by regional committee by the half in 1908. The Ministry of plowing requested the R. Schlumberger Company in Vienna (Vöslaw) to cover the needs of Moravian winemakers in 1908 and supply 442 q of carbon disulfide. The planned expenses in 1907 were in the amount of 1.246 K, of which the state and the country each paid half of the amount (623 K)."

Addressed was the incidence of fanleaf degeneration – grapevine yellow mosaic viruses (*Grapevine fanleaf virus*, *GFLV*) in the state and regional nurseries in Mikulov and Hustopeče that were closed for this reason.1908: "Also this year, vineyards were controlled by local committees. The appearance of phylloxera was officially established this year in the villages of Křepice (Hustopeče), Pulkary (Mikulov) and Sakvice or Čejkovice (Znojmo). Municipalities: Vlkoš (Kyjov) Milovická and Pouzdřany (Mikulov) are suspected to be infected. Nowadays 81 municipalities are phylloxera infested on the overall territory, which account for 41 in Znojmo political district, 15 - in Hustopeče and Mikulov political districts, 4 - in Hodonin political district, 1 - in Moravský Krumlov political district, beyond that phylloxera was detected in the municipal districts of Znojmo and Brno."

In order for viticulture to survive those times, the subsidies were needed not only for research purposes but also to the devastated winemakers. In 1908 Czech Department received subsidies from state in the amount of 8000 K for the year 1907 to Moravian viticulture 60% = 4480 K and regional for 1908 in the amount of 8000 again 60% = 4480 K, altogether 8960 K on Czech viticulture (German department 40% = 3520 K of state and 3520 K of regional subsidies, a total of 7040 K to the German viticulture). For the state subsidies there were purchased 214 downy mildew sprayers per 30 K, which were distributed to the regional vine growers associations in wine regions: 24 sprayers: Vel. Pavlovice, Hodonín, Kyjov; 20 sprayers: Uh. Hradiště, Strážnice; Ždánice 19, Klobouky 18, Břeclav 16, Znojmo 10, Krumlov 8, Židlochovice 7; 5 to each of the municipalities: Uh. Brod, Ivančice, Horticultural Department in Bohonice, Slavkov; Napajedla 4. Vine growers associations

paid 10 K for each sprayer. The sprayers were from Nechvíle Company in Vienna, they were proving to be remarkably durable and worked well, the only wish is for vine growers to take care and respect them, and also Czech Department deserves compliments for the delivery of such good sprayers. Vine growers satisfaction with these sprayers was ubiquitous.

Regional subsidies 4480 K were used by Czech Department to purchase 92 q of copper sulfate at the price of 70 K, which was distributed to the vine growers associations at the price of 23.33 K. Following municipalities received 12 q each: Vel. Pavlovice, Hodonín, Uh. Hradiště; Kyjov 11, Břeclav 10, Klobouky 9, Ždánice 7, Strážnice 5, Znojmo 3, Krumlov 2, Židlochovice, Horticultural Department in Bohonice, Slavkov, Uh. Brod, Ivančice, Napajedla 1 q each.

Sprayers and copper sulfate were distributed by Central Association of Czech vine growers; transport expenses of copper sulfate were compensated by vine growers associations, which in Ústi n./L. in Bohemia region was high. The quality of copper sulfate was very good. Subsidies for phylloxera control have the Moravian Regional Committee, and subsidies for other pests control have a Board of Agriculture.

From "The eleventh Activity Report of the Department of Agriculture of the Czech Council for Moravian Margraviate in 1908"[9]. The amount of phylloxera-related devastation in the vineyards is demonstrated in Table 1.

Table 1: The overview of phylloxera invasion in Austria up to 1909

Country	Overall vineyard area according to operators of land taxes	Infected and suspicious vineyards	Percentage of Infected and suspicious vineyards	Number of localities
	ha			
Lower Austria	39713	36961.35	93.07	545
Moravia	12119	7.39095	60.99	88
Styria	34.055	25634.29	75.27	364
Carniola	11.631	11.27100	96.90	88
Istria	47.060	43.90530	93.29	43
Trieste	1.244	1.24400	100.00	2
Gorizia and Gradisca	6.977	6.48613	92.96	81
Dalmatia	81852	44530.82	54.40	305
Tyrol	21.000	4.70758	12.42	11
Total	255651	182131.42	71.24	1527

From the numbers above it is possible to conclude that the introduction of phylloxera in Austria until recently caused the destruction of about 70% of the total vineyard area. The amazing speed with which phylloxera kills viticulture, force us to invent the most effective means to preserve the vineyards. Among pesticides, which were of great hope, only carbon disulfide was found to be effective. The injection of carbon disulfide into the soil for the purpose of direct phylloxera control showed nice results, so that the Ministry of plowing decided to compensate 30% of the purchase price of that pesticide to the farmers – vine growers.

Interesting are the records of carbon disulfide consumption in Lower Austria and Moravia in the last three years - as can be seen from the Table 2.

Table 2: Carbon disulfide usage

Year	Lower Austria(kg)	Moravia (kg)
1907	325955	17800
1908	497501	43.780
1909	529328	18.700

According to those numbers carbon disulfide was rarely used in Moravia, and almost exclusively in German wine regions. Direct phylloxera control seems to be difficult to Czech vine growers, and therefore the consumption of carbon disulfide in the Czech vine-growing regions is about 100-300 kg per year. This fact is easy to explain: only a small part of agricultural lands (among those are the lands suitable for viticulture) are dedicated to vine growing; if the vineyards of some communities are threatened by phylloxera, taking into account such a ratio of crop versus vine production, it is easy to understand that the farmers-vine growers could establish (on a suitable ground originally devoted to agricultural uses) a new vineyard on American rootstocks (which are phylloxera resistant), before phylloxera severely damages the old vineyard.

Due to the above described limitations it was recently recommended to perform direct phylloxera control by means of carbon disulfide only in the case of real necessity in the Czech vine-growing regions, and pay high attention to the plantation of American vines. In order to overcome the difficulties, especially in the first period of vine plantation in accordance with the new way of phylloxera control, new state and municipal

nurseries were established in different places, both in Mutěnice, and in Vel. Pavlovice, Kyjov, Čejkovice, Klobouky u Brna and lately also in Strážnice. Each state and municipal nursery consists of three parts, namely:

1. Control vineyard,
2. Mother vineyard and
3. The nursery itself along with the stratification house.

Well connected, rooted plants are supplied to farmers when supply is sufficient for the subsidy cost, i.e. 10 hellers per vine, while the price of cultivated plants is now about 17 hellers apiece. In order to obtain detailed information about the suitability of a certain cultivar for the various vine-growing villages, or even parcels, a certain amount of plants is granted to reliable winemakers for free, which helps to have a greater number of "test fields"; the opinion that free plants serve perhaps only to lower vineyard expenses to farmers is completely false. If the infested regions acquire greater importance, our farmers should not rely on state and municipal nurseries in terms of the establishment of new vineyards and grafted plants support, but they must try to make the required amount of plants at home and with their own material.

In order to support themselves easily with the needed amount of American cuttings for grafting they have to establish a small mother vineyard; for this purpose vine growers are supplied with so-called American rooted vines at a subsidy price of 1 heller apiece (market price is 4 hellers). From one hundred mother vines one can have 1500 cuttings on average. Every winemaker can learn how to breed cuttings and how to grow them, one just need to have a good will and attend vine practical courses organized annually by Wine Commissariat in Hodonin in all major wine regions. Special grafting knives, purchased with subsidies and destined for this particular purpose, are distributed for free among participants of the courses. This allows the farmers to train themselves thoroughly in breeding of American vines.

Another advantage, which can be claimed by vinegrowers from infested villages, is based on tax depreciation of phylloxera infested vineyards and tax exemption of the vineyards planted with American vines. The owners of phylloxera damaged vineyards were granted tax deduction by the law of 3 October 1891 (I. C. No. 150). In order to gain the benefits, it is necessary to request at the Regional Counsel Office either orally or in writing that the damage caused by phylloxera to be detected and the taxes deduced accordingly. It is recommended to make such a request in writing form (no stamp needed) through the Municipal Board; the name of the vineyard owner and parcel number should be indicated in the application form.

But far more important than the tax deduction for phylloxera infested vine regions is the right to a full tax exemption from the newly established vineyards. According to the Law of 26 June 1894 (I. C. No. 138), the vineyards, which were established with American vines in contaminated regions, were exempted from paying taxes for 10 years. Applications for tax exemption must be submitted to the competent tax authority or cadastre records department either by the owner himself, his authorized representative or the mayor of the village; the application can be submitted in oral or written form. In order to tax exemption to be granted, it should meet the following requirements:

1. The parcel should either be located in the infected area or it should be less than 25 kilometers apart from the plot, which is phylloxera infected; in the latter case the application can be submitted only to replace the old vineyard with bred vine plants.
2. The whole area of smaller parcels must be planted with American vines; if the area of the parcel is more substantial, at least 2.500 square meters (695 square fathoms) should be planted.

It is determined by law that the tax exemption applications should be submitted by the end of December of the year, in which the planting of the parcel was completed.

In order to console the vinegrowers and increase the rate of establishment of new vineyards to substitute phylloxera devastated vineyards, the government decided to allow special support (where necessary) in the form of non-percentage loans in accordance with the law of 28 March 1892 (I. C. No. 61); if the vine grower will find himself in great distress due to phylloxera damage, he is entitled by the law to apply for non-percentage loan that would allow him to establish a new vineyard with American rootstocks.

Non-percentage loan to establish a new vineyard with American rootstocks is granted only under the condition that the applicant is the owner of the vineyard, which was destroyed or at least severely damaged by phylloxera. By the law of 23 August 1895 (I. C. No. 138) it was subsequently established that non-percentage loans can be granted not only to the parcel on which the old vineyard was damaged by phylloxera, but also to another parcel, for instance to the field where the owner of the damaged vines intends to grow American vines.

The winemakers from Lower Austria, and also from German regions of Moravia, annually submit hundreds of applications to obtain non-percentage loans, in accordance with this the total amount of granted loans in the region is amazing. Czech vine-growing regions submitted about 30 applications since the introduction of phylloxera, despite the fact that the situation of our farmers is far worse than anywhere else; the possible cause could be the low self-esteem of our farmers, who in their distress, seek to obtain secret loans, or just do not have enough knowledge necessary to apply for non-percentage loans [3].

Since the introduction of phylloxera in Czech wine regions in Moravia 10 years have passed but due to the destructive work of this pest one third of Czech vineyards were damaged. By the end of 1911 25 Czech wine villages were infected in the following judicial districts:

- a. Znojemský: Kuchařovice 1903, Žerotice 1906, Přímětice 1907, Horní Dunajovice 1910, Tvoříhráz 1910, Domčice 1910.
- b. Hustopečský: Velké Pavlovice 1901, Rakvice 1904, Hor. Bojanovice 1904, Štarvičky 1905, Kobylí 1909, Bořetice 1909, Vrbice 1909, Uherčice 1909, Němčičky 1911.
- c. Židlochovský: Nykolčice 1905, Nosislav 1906, Křepice 1908, V. Němčice 1909.
- d. Kloboucký u Brna: Krumvíř 1909.
- e. Hodoňský: Čejkovice 1902, Mutěnice 1903.
- f. Břeclavský: Žižkov 1903, Bílovice 1907.
- g. Mor. Krumlovský: Německé Knínice 1906.

Compared to the previous years in 1910 the infested area increased by 115.49 ha, and phylloxera was discovered in Němčičky (close to V. Pavlovice), Hustopeče; it is now a total of 1165.56 ha infested. Since carbon disulfide was rarely applied to direct phylloxera control in Czech vine-growing regions, about 400 ha of vineyards were completely destroyed in a short period of time. About 200 ha of damaged area were replaced with new vineyards on American rootstocks [10].

Phylloxera liquidation was time consuming and hard, but eventually winemakers had to learn to live with it. Already in 1869 soil injection of carbon disulfide (CS₂) was used against it, and its amount used in European vineyards gradually grew [11]. 200 tons of saturated sodium sulfide were applied in 1878 only in France, in ten years the amount of this soil pesticide increased to 10.000 tons [12]. In Moravia, where phylloxera was introduced later, vinegrowers learned from the French experience and relied more on rootstock. Annual contamination of vineyard soil with carbon disulfide probably did not exceed a value of 50 tones in Moravia. But in France, where the kerosene was also tested, as in 1894, the situation is described by [13]: "After grubbing and burning the vineyard, kerosene was added in the amount of 2 l/plant into each hole remained from the root system, that was "insured" by application of carbon disulfide (200 g/plant), opening was then covered with soil and sprinkled again with kerosene at a dose of 2 l/m²". Another method practiced in France since 1870 was drowning of phylloxera. According to Piaż[12] in 1889 30.000 hectares of vineyards were inundated on the plains. It was necessary to create a layer of water (20-30 cm high) on the soil surface, so about 30 million liters of water were required per hectare of a vineyard. Besides chemical and physical methods the problem was solved biologically in two ways: by crossing the resistant American vines with European vines and by grafting. The first generation of hybrids produced only low quality wines, these hybrids were later banned in most European countries. But they created the basis for the next generation of grape breeding, if the quality of European wines could be maintained.

Finally the cheapest biological way was established: grafting of cultivated vines onto resistant rootstock. The procedure was already practiced over millennia by Romans in order to adapt noble vines to different locations. Significant support was probably gained from the law I. C. in 1894, which proclaimed tax exemption for vineyards planted on American rootstock for ten years. Moreover every winemaker who planted a vineyard with grafted plant could obtain non-percentage loan and plants were still subsidized. But it cost a lot, although largely due to the ignorance of winemakers. Even in 1908, A. V. Horňanský [7] wrote: "Many winemakers still do not believe in the existence of phylloxera, they rather believe in cellar phylloxera – that is in frequent uninvited guests."

2. Other diseases and pests

The most important are powdery and downy mildews.

Powdery mildew first appeared in Europe in England in 1845, and in 1848 it was already detected close to Paris, and in 1852 the whole France was infected [14]. Justus von Liebig had then assumed that powdery mildew appeared as a result of inadequate nutrition [15]. In 1850 it was already in Spain, Italy and the south of Austria-Hungary.

Various methods to control new enemies were tested. Sulfur was proven to be effective against powdery mildew, it is still effective today. English gardener Kyle accidentally used it first [12] in 1846, *Goethe* [14] claims that the first to apply it was Duchatré in 1850. In the late 19th century up to 250 kg of sulfur was annually applied per hectare in the Southern France [12]. In the early years of the 20th century, a total of 100.000 tons of sulfur was applied annually in the dose of 16 kg/ha for treatment in France [16]. In the period of 1898 - 1907 8.78 tons of sulfur and 171 sulfur dispensers were allocated for free to the Czech regions [7] (Bohemia and Moravia). Sulfur allocated of free was occasionally used as a medicine for cattle instead of the vineyard.

"The vinegrowers in the most critical time of powdery mildew damage stood there without help, without guidance, without resources. And when help arrived, and spraying of vineyards with Bordeaux mixture (copper sulfate) was strongly recommended by professional, educated and prudent winemakers, Moravian

winemakers did not trust this substance, fearing that the wine from sprayed grapes will be bad and astringent" [1]. "In the second half of the last century the Austrian viticulture was devastated. In most of the years the harvest was bad in terms of quality and sometimes even quantity – disappointing yields. The prevalence of years with low harvest over the normal years in most of the cases was caused by new grape pests. Thus, in 1850 *oidium* from fungi family, whose deleterious effect on the vine has no need to be mentioned, began to spread over South Tyrol (powdery mildew). Thirty years later, in 1880 and again in the Tyrol region, Austrian viticulture was attacked by a new terrible disease - *reddening* (downy mildew).

Luckily we were able to react quickly and find the means to control these diseases - oidium and reddening. Good and wise advanced winemakers started to use those means immediately (sulfur powder against powdery mildew and copper sulfate solution with lime inclusions against downy mildew) in the vineyards of Lower Austria, Tyrol and Styria; they were content with the outcome. Here in Moravia - especially in the Czech regions – there were not many such winemakers; our winemakers did not believe for a long time that downy mildew was indeed a disease, which could be controlled by suitable means, and even now there are many winemakers who think that once the disease was not observed over one year it had already disappeared and would never return.

The majority of our farmers do not know anything about oidium yet, although on different occasions, such as vine courses and lectures; this disease has been lengthily discussed. For example this year many vineyards were infected with powdery mildew, but no one thought - with few exceptions – that this disease could be controlled by freely distributed sulfur powder and sprayers along with advices given by Czech Department of Agricultural.

This year is considered to be average in terms of wine production and quality; grape harvest on entire Czech territory is about 30.000 hectoliters of wine, which quality is not perfect. The main reason of moderate yield is that the vines were weaker due to adverse infection of downy mildew last year (1910), the other reason is that the weather after the flowering was not favorable; the result of cold and rainy weather is irregular flowering and accordingly uneven berries and clusters. During veraison the vineyards were devastated by wasps that sucked the berries to the skins; the damage was so significant that in many villages with early-ripening varieties the harvest started earlier in order to preserve at least some part of the yield; mice also caused considerable damage of the vineyards. Newly planted vineyards were damaged by grubs in many villages this year. The pressure of downy and powdery mildew infection along with some other diseases and pests was low this year, no significant damages were caused.

Repeated tests of processing machines correspond entirely to the results from previous years. With Hengel's machine for vine breeding (*note: grafting machine*) it was confirmed this year that it is possible to produce large amounts of grafted vines daily; however, the durability of grafted plants is still in question that could only be answered by the vineyards planted with those plants." [10] The fast onset of new diseases and pests was a big problem to our viticulture. Without help from the state it would not have probably survived. Furthermore, it would be necessary to create a reasonable subsidy, which would allow to deliver inexpensive copper sulfate, sulfur and sprayers to the vine-growers; and it should be based not only on the damages of a particular winemaker in recent years, but also on the evidence of new pests on the territory of Czech vine-growing area such as "akarinosa", the control of this pest will be related to considerable expenses [17]. *Note: this is an attack of non-specified mites such as grape erineum mite (Colomerus vitis) that causes leaf curling or grape leaf rust mite (Calepitrimerus vitis) that causes hairiness.*

The development of vines in certain months is also interesting, for example: The report of vineyards condition in Austria in the end of June 1910. The Northern wine regions, mainly Moravia and Lower Austria show worse state of vineyards when compared to May. The cause of deterioration was unfavorable wet weather, resulting in prolonged and irregular course of flowering. Grape berry moth cause severe damages, and unusual humidity promoted the development of downy mildew, while preventing its efficient control. Since this month numerous thunderstorms were observed, and the second generation of grape moth caused even more damages on grapes, the yield forecast in northern regions (excluding Czech) was really bad. Southern vineyards were in better condition, and yet the mass expansion of downy mildew caused severe damages, so that in some places where it was not controlled in time, the yield forecast was not very satisfactory. The control of powdery mildew gave good results. But continual humidity caused further strong infections in the vineyards.

The report on the vineyards condition in Austria in the end of July 1910. According to reports from the Ministry of plowing the results of yield forecast got significantly worse in July. Moravia was supposed to have no harvest at all, the same situation was observed in the most vine-growing regions such as Lower Austria, Styria and Caniola. Better news came from the German part of Tyrol. In Dalmatia and Austrian Littoral the forecasts differ. So in the Marshaly Benkovic in Dalmatia there is a prospect of a very good yield, while in Kotor, Dubrovnik and Sin the yield is predicted to be average to very poor. The main cause of this yield decline in most Austrian wine regions is devastating downy mildew infection in July that was observed not only on

leaves but even on berries in some regions. There, where the first spraying of copper sulfate was performed at the right time and it was not soon washed away by rain, average or small yield could be expected, as it happened in German Tyrol. In many places, especially in Lower Austria even the most diligent winemakers were not able to control effectively downy mildew, which flourished under the influence of warm daily rains. Warm and humid weather was also a further reason for powdery mildew expansion on grapes this year, even in regions like Lower Austria, where as a rule it barely appears and sulfur control is not obligatory each year. In Istria in some places black blight (dead-arm disease *Phomopsis viticola*) was observed. Due to persistent wet weather the vineyards were full of weeds and summer works could not be done on time. According to these official reports from the Ministry of plowing one could find the status of the vineyards in different regions: In Lower Austria it was average to below average; in German Tyrol it was average to above average; in Italian Tyrol it was below average; in Styria it was average to below average; in Carniola it was average to very poor; in Gorizia and Gradisca it was above average to the average; in Trieste and Istria it was average to below average; on the Kvarner islands it was above average to below average; in Dalmatia it was very good to very bad; in Bohemia it was above average to average; and in Moravia it was below average to very bad“ [18].

„According to a report from the Department of Phytopathology “Research Station of Economy and Physiology of Czech Agricultural Council” in Prague, in 1912 the grapes in Bohemia were severely damaged by downy mildew (*Plasmopora viticola* Berk. – peronospora or reddening) that significantly multiplied, as well as by powdery mildew (*Oidium Tuckeri* Berk. – berry destroyer or black ore). Among pests the most harmful were grape berry moth (*Tortrix pilleriana* Sch.) and grape moth (*Conchylis ambiguella* Huh), and in less amount - vine mite (*Eriophyes vitis*). Chlorosis (yellowing) of vines appeared again in Mělnicku. The extended knowledge about phylloxera can be found in following books: K. Fořt About grape aphids (1 K) and About phylloxera (40 h), which can be sent by Vine review administration (in Vel. Pavlovice in Moravia)“ [4].

There were also detected less damaging diseases:

„Brenner. (*Pseudopeziza tracheiphila*) This disease appeared in our vineyards last year, where it caused considerable damages. Also this year, the vineyards are attacked by this disease, though not in the same amount as last year, so the damages would not be as high, although some data would be briefly reported in this paper. This disease is not new, and it was known even to the old winemakers from earlier times, when the damages were observed in our region. People called it “reddening” – this name was referred to all diseases that destroy leaf. Brenner is caused by certain fungus. Means of direct control are not known yet. As the pathogen is present in the infected, dry leaves it is recommended to collect all the dry leaves and burn them. I observed this year and last year that if the vineyards were sprayed with copper sulfate solution in early spring, or at the beginning of the second half of May, they suffered less from Brenner when compared to the vineyards that were sprayed later during the season“ [19].

Chlorosis. It could be rather often observed on vines (as well as on fruit trees, especially on pear, apple and apricots), the phenomenon when vine leaves lose normal green color; they turn either yellow, or sometimes white. It is said that this vine is suffering from yellowing, or chlorosis. Not only the appearance of leaves, but the overall state of the plant, affected with yellowing, shows that this situation is definitely of diseased nature. Vines infected with chlorosis have delayed development in terms of growth and fertility, if the disease is present for several years plant can die. Chlorosis (yellowing) causes the destruction of green pigments in leaves, namely chlorophylls, in different parts of the plant, especially the leaves [20].

About many diseases and pests, including those with two hands from more distant history, we can learn the following texts: „About the wineries in Klobouky. I have found some records in old documents and books and I hope it will be of interest to our winemakers: 1176 was very dry; it did not rain from Easter till the 15th of August. But the yield of the grapes was high.

1282: It was a hard winter that lasted till the 25th of May. Many birds and animals as well as vineyards and fruit trees were damaged. There was no harvest that year.

1338: There flew a great amount of grasshoppers from Hungary, which destroyed all the crops. Our vineyards have suffered a great damage. Vines were completely destroyed, the grapes fell down.

1605: Hungarian hajduks (from the side of Stephen Bocskay) visited our region, the most severe damages they caused in Diváky and Polehradice, after they went to Hustopeče and destroyed everything. They drank all the wine, and that what they did not manage to drink they poured into the ditch. The regions of Brno and Uherske-Hradiste were devastated.

1621: Saxon Rajtárs attacked the house of Baptists in Polehradice and destroyed it; they emptied 20 barrels of wine.

1641: It was a general crop failure and consequently high prices. Severe winter damaged our vineyards so that there was no wine. Great frosts came in May and June, causing a lot of damage to fruit trees, young plants and vegetables.

1645: Swedes visited our region. City of Hustopeče was attacked and wine in cellars was drunk. What they did not drink they nevertheless poured into the ditch.

1663: Turkish army visited our region; a lot of damages were made in Kurdejov. Wine from barrels was destroyed.

1704: Hungarian rebels again attacked Klobouky and destroyed wine stocks.

1736: This year it rained a lot and there was no harvest of grape.

1738: The new labor-related patent was created, according to which works were adjusted. Our vineyards have been completely neglected, therefore the yield was low and wine was poor.

1742: The Prussian Department from Brno visited our village. As they were besieged, all stocks of wine were given to them.

6th of September 1775: The new labor-related patent was created, according to which works were adjusted. Our vineyards have been completely neglected, therefore the yield was lower.

1st of November 1781: The work from the patent was partly canceled, and people were able to dedicate more time to the vineyards.

1805: War with France. Frenchmen consumed a lot of wine from our cellars. That year a measure of wheat was 24 zl., of rye 20 zl., of barley 16 zl., and of oats 10 zl.

1809: Frenchmen caused a lot of damages in our region. The year was dry, and there were more grapes.

1844: At night from 17th to 18th June there came a great frost that destroyed our crops. Vines suffered the most. There was no wine. Potatoes and corns were damaged as well.

1848: On the 7th of September Emperor Ferdinand approved the law annulling the vassalage of peasants. Vine yield was average.

1879: The weather conditions in the summer were very unfavorable, in particular in terms of vine. It was cold, and it rained constantly. Nice and warmer weather was observed only at the end of August. The wine was acid.

1883: Strong storms with hail damaged out vineyards.“ [21]

IV. Conclusion

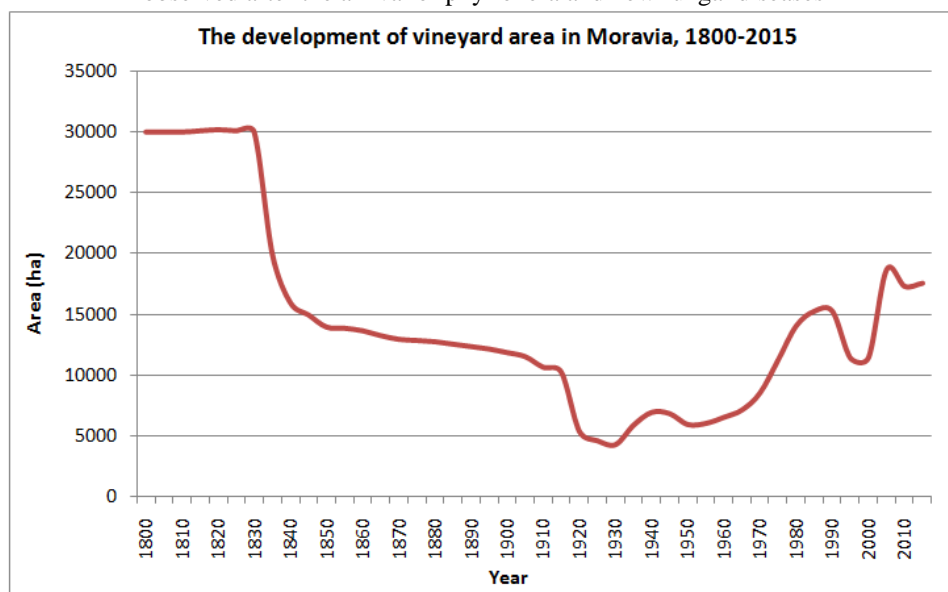
Austria-Hungary state helped a lot by supporting the control of newly arrived diseases by means of subsidies (on sprayers, powder distributors, sulfur, and copper sulfate) and legislation. From 1898 it was obligatory by law to spray the vineyards against downy mildew in time. Those, who did not, were punished with fines or imprisonment.

Kerosene was initially recommended to control pests, at the concentration of 2% against nearly all insects, as well as nicotine, and tobacco liquor. In late forties even in viticulture they started to apply a synthetic substance - DDT. "New American very effective product against pests, called DDT, is very effective against grape moths and mites on the vines. Gesarol, only partially known here, is dusted at a dose of 25 kg per 1 ha, or sprayed at the rate of 1%. Its effectiveness is excellent, and due to low consumption during dusting it is recommended to use only very powerful dispensers"[22].

Biological solutions are the only long-term and sustainable solutions to control phylloxera and other pests and diseases, i.e. plant breeding for resistance and some others. Chemical and physical ways are deadlocked from the long-term perspective. It was never simple to the winemakers, even before the introduction of pests and diseases from America. As a rule, a cure will be found eventually for each disease, as well as a whip for every pest, but nothing is absolute. 100% effect would rapidly lead to destruction of all organisms on the Earth.

The turn of the 19th to 20th centuries was very challenging for Moravian winemakers. Czech speaking winemakers had agricultural farms where vines did not prevail; there were not many information resources in Czech language; and phylloxera and new diseases were first detected in the vineyards at a time when Europe already had a solution. The advantage was that all of this "evil" spread from the southwest of Europe, so it took a while before it came to Moravia. But without financial support from the Austro-Hungarian imperium in the form of subsidized sprayers, dusters, sulfur, copper sulfate and grafted vines, it is possible that Moravian viticulture would not have survived. Of course, as always, the subsidies were not 100% used for the declared purpose, but they were necessary. Decrease in vineyard area (Fig. 1) had a large economic impact on the population of wine regions.

Fig. 1: In the long history of the territory of today's Czech Republic the largest decline in vineyard area was observed after the arrival of phylloxera and new fungal diseases



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