Creation, preservation, and study of ampelographic collection in the branch of the SPB "Pushkin and Pavlovsky Laboratories of the N.I. Vavilov All-Russian Institute of Plant Genetic Resources (VIR) (St. Petersburg)"

E.N. Kislin*, and *P.V.* Sherov-Ignatiev

Federal Research Center N.I.Vavilov All-Russian Institute of Plant Genetic Resources (VIR), 190000 Bolshaya Morskaya Str., bld. 42, 44, St. Petersburg, Russia

Abstract. The article presents data on the creation, preservation, and study of a collection of grape varieties, as well as their wild relatives, including Amur Grape (*Vitis amurensis* Rupr.), in open ground conditions of the North-West of Russia (St. Petersburg) (59°42.852' s. w., 30°23.784' v. d.). More than 50 samples were planted, of which 42 samples were included in the Institute's database (VIR), both in the permanent (17) and temporary catalog (25). The collection contains representatives of the genera *Ampelopsis, Parthenocissus* and *Vitis* (*Vitis amurensis* Rupr., *V. riparia* Michx., *V. vulpina* L., *V. labrusca* L., *V. palmata* Vahl., *V. coignetiae* Pull.), obtained from the harshest places of their native habitat, as well as from the botanical gardens of Russia. Early, cold-resistant varieties and wild-growing forms of the genus *Vitis*, characterized by stable ripening of the vine and the accumulation of sugars, as well as a low content of organic acids, were attracted. The main grape diseases - mildew and oidium were not identified.

1 Introduction

Currently, the ampelographic collection of the VIR named after N.I. Vavilov is concentrated on the lands of three branches of the Institute: in the Krasnodar Territory (Krymsk), in Dagestan (Derbent), and in the Primorsky Territory (Vladivostok). In recent years, the grape culture in the open ground has gone beyond its traditional cultivation in the southern regions of Russia far to the north. Today, grapes are grown on amateur and farm plots in such regions as Novgorod, Pskov, Leningrad, Vologda, and even the Karelian Republic. This is due to the breeding in recent decades of the most recent cold-resistant and frost-resistant varieties, as well as the demand for grapes and their processed products among the population with a fairly rapid adaptation of the grape plant to new conditions, as well as the fact that in the north-western regions of Russia there are no major pests and diseases of the vine, common in the industrial viticulture zone. Therefore, it is long overdue

* Corresponding author: kislin@yandex.ru

need to create an ampelographic collection in this region. The largest collection of Amur Grape until the 1980s of the last century was collected thanks to Soviet researchers and climbers during many expeditions to the Far East of the USSR, as well as North China and Korea and was located at the All-Russian Research Institute of Viticulture and Winemaking named after Ya.I. Potapenko (Novocherkassk, Rostov region). This collection consisted of more than a thousand different samples of Amur Grape. Nevertheless, after the anti-alcohol reform, as well as the introduction of phylloxera to the Rostov region in the 1980s, this collection died. [1].

Collections of Amur Grape and its hybrids in Soviet times were also created in the Orenburg substation of horticulture and viticulture, as well as at the Far Eastern Experimental Station of the VIR n.a. N.I. Vavilov (Vladivostok). In addition, species forms of the genera *Vitis*, *Ampelopsis*, *Parthenocissus* are grown in botanical gardens of the Russian Federation, including St. Petersburg Botanical Garden, the Main Botanical Garden in Moscow, and the Timiryazev Moscow Agricultural Academy.

Currently, the largest collection of Amur Grape is maintained in Northern China, in the province of Jilin, which has about four hundred samples. Breeding work is also carried out here to breed hybrid varieties, mainly for technical purposes, for the production of dry and "ice" wine, with the involvement of Amur Grape. Such varieties include, for example, Beibing Hong, Beimei, Gongniang Yihao, Zuoyou Hong, Xuo lanhong, Gong Zhubai.

The purpose of the research:

1. Mobilization, preservation, and study of the collection of cold-resistant grape varieties of early and ultra-early ripening periods with the involvement of the ones most resistant to adverse factors.
2. Identification of economically valuable traits in grape varieties, as well as their wild relatives of various origins in the conditions of St. Petersburg.
3. Determination of the resistance of grape varieties and forms to abiotic stressors, in particular, according to the degree of shoot ripening (the process of preparing tissues for winter conditions).
4. Creation of a collection of various ecotypes of *Vitis amurensis* Rupr., as well as other species obtained from their natural habitat.

2 Objects and Methods of Research

Various ecotypes of species forms of the genera *Ampelopsis, Parthenocissus*, and *Vitis* (*Vitis amurensis* Rupr., *V. riparia* Michx., *V. vulpina* L., *V. labrusca* L., *V. palmata* Vahl., *V. coignetiae* Pull., and others), obtained from the places of their natural growth, as well as from the botanical gardens of the St. Petersburg, Vladivostok, China, as well as grape varieties of various origins introduced from institutions of the former USSR, were involved in the collection of the SPB "Pushkin and Pavlovsky Laboratories" of the St. Petersburg. The total number of cultivars planted in open ground conditions is 83, of which 42 samples are included in the Institute database (VIR), both in the permanent (17) and temporary catalog (25). The collection began to form in 2017. In the autumn period, measurements of the shoot ripening degree on openly wintering bushes were carried out with a feeding area of 2.0 × 1.5 m. Culture is open-earth, own-root, non-watering. The formation on the sections is fan-shaped, trunkless. Ampelographic description of grape varieties and species forms (*Vitis*) was carried out according to the method [2] and [3]. Determination of the total amount of sugars and acids was carried out according to the method [4]. Statistical data processing was carried out according to the methodology [5].

Mobilization of grape varieties and forms. Species forms and varieties were first of all transferred and propagated from the St. Petersburg botanical gardens, and there are three of them in the city, where they have been grown for many decades. In particular, *Vitis*

amurensis Rupr. plants grown from seeds collected in the places of their native habitat (Primorsky and Khabarovsk Territories), since 1855, have been preserved in an amount of more than 25 specimens. From a private collection (Leningrad Region), Amur Grape ecotypes were obtained, obtained in the 1970s and 80s from the Khabarovsk Territory, as well as from the Orenburg subpoint of horticulture and viticulture. Representatives of *V. Coignetiae* have five forms derived from the Botanical Garden named after Peter the Great, brought there from the Kuril Islands in the 1950s and 70s. Samples of North American species (*V. riparia* – 3, *V. palmata* and V. *vulpina*) were obtained from their nativel habitat and have 5 forms. The attraction of varieties of various origins was carried out from Russia, Latvia, Belarus, China, the USA, and Canada. In Russia, samples were obtained from institutions in St. Petersburg, Moscow, Orenburg, Michurinsk, Primorsky Krai, Novocherkassk, Yalta.

The climate of the city of Pushkin, a suburb of St. Petersburg, (59°42.852' s. w., 30°23.784' v. d.) is temperate and humid, transitional from marine to continental. Summers are short, moderately warm, winters are long, unstable, with frequent thaws. Spring and autumn are protracted. The amount of precipitation per year is 630 mm. The sum of active temperatures above 10°C during this period reaches 1800-2000°C, and the frost-free period at an altitude of 2 m is 156 days, on the soil surface is on average 119 days. Average dates of occurrence of average daily temperatures above and below 10°C falls on May 18 and September 19, respectively. The average number of days with temperatures above 10° C ranges from 100-110 to 125-130 days in the west and south. The absolute minimum is -36.0°, the maximum is +35.3° at the average temperature of the warmest month of July +17.7°.

Table 1. The species composition of the gene pool of grapes of the branch of the SPB "Pushkin and Pavlovsky Laboratories of the All-Union Research Institute of Plant Breeding" (St. Petersburg).

No.	Name of genera and species	Number of samples	including species forms
Genus *Ampelopsis* Michx.			
1	*A. japonica* (Thunb.) Makina	1	1
Genus *Partenocissus* Planch.			
2	*P. quinquefolia* (L.) Planch.	1	1
3	*P. inserta* × *P. quinquefolia*	1	1
Genus *Vitis* (Tournef.) Linn.			
1	*V. amurensis* Rupr.	25	1
2	*V. x andersonii* Rehder	1	1
3	*V. Coignetiae* Pull.	5	1
4	*V. labrusca* L.	1	1
5	*V. palmata* Vahl.	2	1
6	*V. riparia* Michx.	3	1
7	*V. tiliaefolia* Kunze	1	1
8.	*V. vulpina* L.	1	1
	Total:	**42**	**10**
	Interspecific varieties of the genus *Vitis*	**38**	**7**
	European-Asian varieties	**3**	1
	Total:	**83**	**18**

3 Results and Discussion

42 samples of grape varieties and forms are maintained in the field, including species (wild relatives) of various origins, of which 17 samples are in the permanent and 25 in the temporary catalog. These, in particular, include such varieties and forms as Amethystovy, Minnesota-78, Kay Gray, Abaimovsky, Korinka russkaya, Cherny bessemyanny zimostoyky, Tayozhny izumrud, Marsha Foch, Juodupe, Meda, Guna, Khasansky sladky, which are assigned permanent catalog numbers. The remaining samples not included in the VIR catalog are undergoing a preliminary assessment for resistance to adverse environmental conditions. In 2017-2022, more than 500 seedlings of grapes aged two to three years of various origins were planted in the school for further collection replenishment and expansion. This planting material includes more than 40 varieties and species forms that have not yet been included in the Institute database due to insufficient duplication.

The most resistant to abiotic environmental factors and long-living (grown in the conditions of St. Petersburg and the region) for more than fifty years and more forms of Amur Grape with such valuable traits as a high degree of shoot ripening even in cold and rainy years (Amursky iz Komsomolska), a reduced content of organic acids in fruits, bisexual type of flower (Amursky iz Omska and Amursky – ACG). Figure 1 shows data on shoot ripening for two years (2021 and 2022), and 2022 differed from the previous year with lower temperatures and more precipitation in August and September, when the shoots are quenched and prepared for winter. Other forms of Amur Grape are also attracted to the collection, such as the Amursky iz Komsomolska, which was obtained at one time from the TAA (Moscow) and the Amursky Shatilova iz Orenburga. They have been grown in the Leningrad region since the 1970s. The Baltic varieties Sukribe and Guna, as well as the Far Eastern variety Khasansky sladky, are characterized by satisfactory ripening of the vine and the accumulation of sugars, as well as a fairly low content of organic acids. The berries ripening beginning in these varieties starts in the middle of August. Figures 2 and 3 present data on the total content of sugars and organic acids during the full ripening of some grape varieties and forms over two years. There were no signs of mildew and oidium damage in all the studied samples.

In the future, it is expected to use molecular genetic research methods because they are an excellent addition to the laborious classical ampelographic (morphological) methods of describing wild species, and also will allow to establish their genetic relationship [6]. Thus, for example, it was found that *V. flexuosa* and *V. amurensis* are genetically similar species, although they have different growth areas. This kind of research helps to avoid confusion in the description and further mobilization of species samples in the collection. Recently, *V. amurensis*, as one of the most cold-resistant species, has been increasingly used as an object for studying reactions to cold stress [7], as well as for studying the biosynthesis and catabolism of a nonspecific plant resistance inducer - the phytohormone of abscisic acid (ABA) when exposed to low temperatures [8]. Much attention is also paid to the study of the biochemical composition of fruits of wild species, especially *V. amurensis*, which are characterized by a high content of polyphenolic compounds, and are increasingly used for medical purposes [9]. Moreover, the polymorphism of this species implies not only the identification of differences between different ecotypes in morpho-biological indicators, but also in the qualitative composition of endogenous compounds, in particular, polyphenols, which will allow in the future to select the most valuable samples for medical use [10].

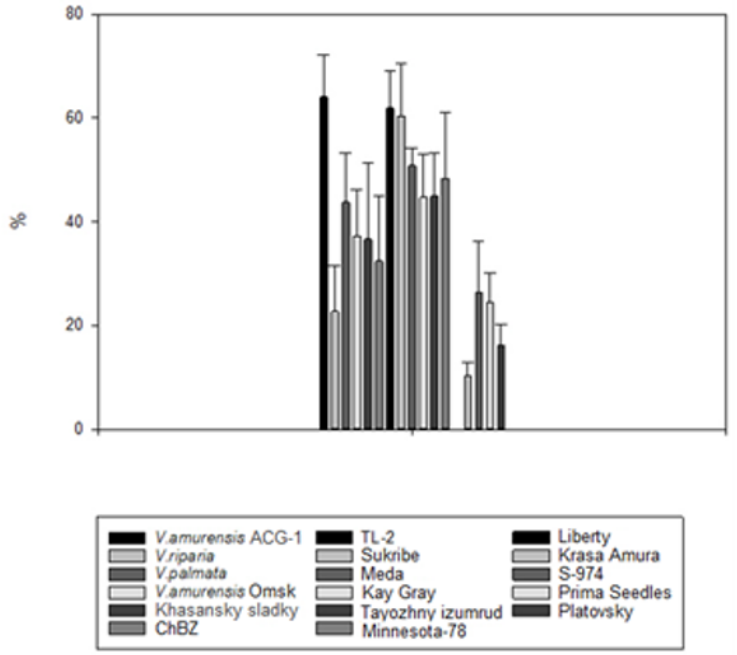

Fig. 1. Ripening of shoots in grape varieties and forms of different origins.

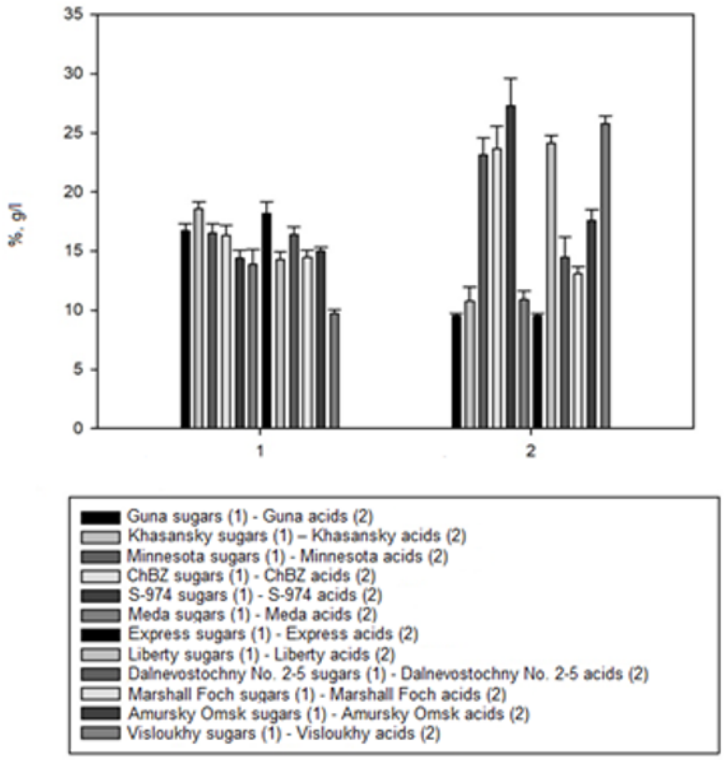

Fig. 2. Content of sugars (1) and organic acids (2) in grapes of various origins.

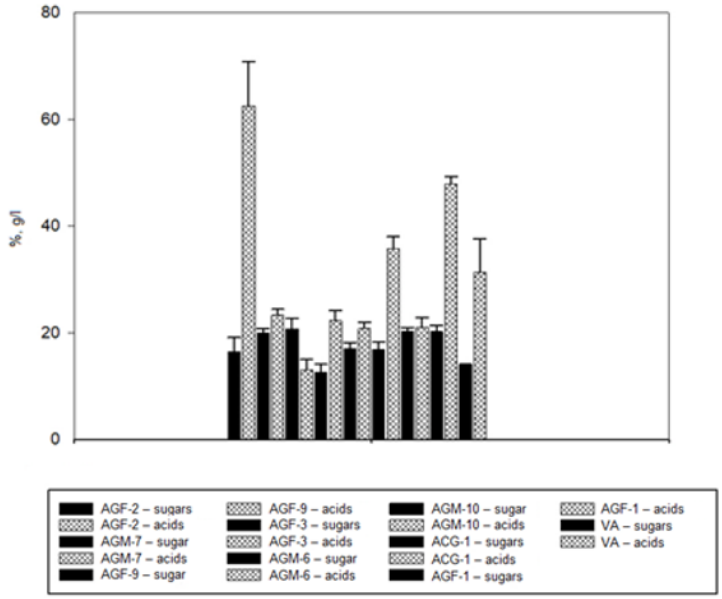

Fig. 3. The total content of sugars and organic acids in grape fruits of specific forms (from left to right). V. riparia – AGF-2, AGF-3, V. amurensis – AGM-6, AGM-7, ACG-1, V. vulpina – AGM-10, V. vulpine x V. amurensis – VA.

4 Conclusions

The varieties of the late ripening period of the Baltic and Far Eastern breeding, which are interspecific hybrids, as well as species forms that are resistant to adverse conditions, primarily to excessive moisture and low values of the sum of active temperatures, have been identified. The most valuable samples for the conditions of the North-West of the Russian Federation (St. Petersburg) are varieties and forms that have a satisfactory degree of shoot ripening and an optimal ratio of sugars and organic acids in berries.

References

1. L.G. Naumova, History and modernity of the ampelographic collection in Nizhny Pridonya. Collection of materials of the international conference "Interactive ampelography and selection of grapes." Krasnodar, September 20-22, 158-164 (2011).
2. M.A. Lazarevsky, *Methods of botanical description and agrobiological study of grape varieties, USSR ampelography.* In 6 volumes (M.: Pishchepromizdat, M., 1946) **1**, 347-400.
3. M.V. Melkonyan, V.A. Volynkin, *Procedure for ampelographic description and agrobiological description and agrobiological assessment of grapes. Grape and Wine Institute* (Magarach, Yalta, 2002) 27.
4. G.S. Morozova, A.M. Negrul, *Workshop on viticulture* (Kolos Publishing House, M. 1966) 287 (250-259).

5. B.A. Dospekhov, *Field experience methodology* (with the basics of statistical processing of research results). - 5th ed., Additional and Rev. (M. Agropromizdat. "Kolos," 1985) 351.
6. H.-J. Kim, S.H. Park, J.-H. Kim, B. Yim, J.-H. Mun, H.B. Kim, Y.Y. Hur, H.-J. Yu. Horticulture, Environment, and Biotechnology **60**, 363-372 (2019) DOI https://doi.org/10.1007/s13580-019-00123-x.
7. L. Zhang, T. Zhao, X. Sun, Y. Wang, C. Du, Zh. Zhu, D. Kiragu Gichuki, Q. Wang, Sh. Li, H. Xin. Plant Molecular Biology, **100,** 95-110 (2019) https://doi.org/10.1007/s11103-019-00846-6.
8. V.S. Khadka, K. Vaughn, J. Xie, P. Swaminathan, Q. Ma, G.R. Cramer, A.Y. Fennell. Vitis riparia (Michx.). Khadka et al. BMC Plant Biology, **19,** 72 (2019) https://doi.org/10.1186/s12870-019-1664-7.
9. L. Zhu, X. Li, X. Hu, X. Wu, Y. Liu, Y. Yang, Y. Zang, H. Tang, Ch. Wang, J. Xu. Molecules, **6(21),** 6696 (2021) doi:10.3390/molecules 26216696.
10. M.P. Razgonova, A.M. Zakharenko, I.V. Derbush, A.S. Sabitov, K.S. Golokhvast. E3S Web of Conferences, **254** 01012 (2021) https://doi.org/10.1051/e3sconf/20 2125401012.