MORPHOLOGICAL, PHENOLOGICAL AND MOLECULAR DIVERSITY OF WOODLAND GRAPE (*VITIS SYLVESTRIS* GMEL.) GENOTYPES FROM THE SZIGETKÖZ, HUNGARY

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From 2012 to 2015 32 woodland grape genotypes were collected from the Szigetköz and the Fertő-Hanság National Park, Hungary, and ex-situ preserved in the gene bank of the NARIC Research Institute for Viticulture and Enology in Badacsony, Hungary. Phenological development stages based on the BBCH scale and ampelographic data according to 30 OIV descriptors were recorded. Isozyme and SSR analyses were carried out in the preserved genotypes, 18 *Vitis vinifera* varieties and 20 rootstocks were also analysed for comparison. Summarizing the results it can be established, that the ex-situ preserved genotypes are true-to-type woodland grapes, belonging to *Vitis sylvestris* GMEL. var. typica. Further quest, ex-situ and in-situ preservation and analyses of the *Vitis sylvestris* GMEL. germplasm in Hungary are needed.
Keywords: woodland grape, phenology, morphology, ampelography, SSR, isozyme

Morphologische, phänologische und molekulare Diversität von Genotypen der Waldrebe (*Vitis sylvestris* GMEL.) der Szigetköz, Ungarn. In den Jahren 2012 bis 2015 wurden 32 Waldreben-Genotypen auf der Szigetköz und im Fertő-Hanság Nationalpark, Ungarn, gesammelt und ex-situ in der Genbank des NARIC Forschungsinstitut für Weinbau und Önologie in Badacsony, Ungarn, konserviert. Es wurden phänologische Entwicklungsstadien auf der Grundlage der BBCH-Skala und ampelographische Daten von 30 OIV-Deskriptoren erfasst. In den Genotypen wurden Isozym- und SSR-Analysen durchgeführt, 18 *Vitis vinifera* und 20 Unterlagsrebsorten wurden zum Vergleich ebenfalls analysiert. Zusammenfassend lässt sich feststellen, dass es sich bei den ex-situ konservierten Genotypen um typgetreue Waldreben handelt, die zu *Vitis sylvestris* GMEL. var. typica gehören. Weitere Untersuchungen, ex-situ- und in-situ-Konservierung und Analysen der genetischen Ressourcen von *Vitis sylvestris* GMEL. var. typica in Ungarn sind erforderlich.
Schlagwörter: Waldrebe, Phänologie, Morphologie, Ampelographie, SSR, Isozyme

Many theories exist about the evolution of the European grapevine (*Vitis vinifera L.*). According to De Candolle (1894) the grapes originate from the Trans-Caucasus. Based on the geographical principle in evolution by Darwin (1883), the regions of the primary origin of cultivated plants were created by Vavilov (1932) based on the diversity of the wild relatives of the given species. In this system, the European grapevine (*Vitis vinifera L.*) was classified (together with pistachio and almond) to the Central Asiatic Center.

In after-glacial Eurasia, the woodland grape (*Vitis sylvestris* Gmel.) spread throughout Europe and existed even in the southern part of Scandinavia. In its natural territory humans liked its fruit, they collected and consumed them. The first *Vitis vinifera* type seeds (long seeds with well-developed "beak") were found among the excavation findings originating from the 2nd millennium BC. Towards the west and south, the *Vitis vinifera*-like seed findings appeared gradually from later and later ages. This proves that some time in the past the *Vitis sylvestris* coming from the Trans-Caucasus was taken into cultivation by the people of ancient Asia. Later the seeds considered to be already *Vitis vinifera* were received by the people of antique West-Asia and the people living in the islands of the Aegean Sea, who spread them on the northern and southern banks of the Mediterranean Sea (Kozma, 1991).

According to Terpó (1986), *Vitis vinifera L.* is not uniform, but the progeny of several original grape species. The main fundaments among the *Vitis sylvestris* Gmel. could be the hermaphrodite flowered *V. hissarica* and the *V. nuristanica*. In 1988 he developed a new intraspecific taxonomic system of *Vitis sylvestris* Gmel. The basis of his taxonomy was to sort the woodland grapes into "subspecies" based on the hairs of the leaves and into "varietas" based on the shape of the leaves. He deduced the eco-geographical groups ("convarietas") of *Vitis vinifera* directly or indirectly from these varieties.

The ancient cultivars of *Vitis vinifera L.* were classified in three convarieties: pontica, orientalis and occidentalis by Negrul (1969). In his work he pointed out, that the crosses between cultivars of different convarieties lead to valuable types: those between pontica and orientalis give some promising wine types; and those of orientalis × occidentalis give early-ripening types; those of occidentalis × pontica segregate and give some high-quality wine types.

Accordingly, these geographical cultivar groups (convarieties) of *Vitis vinifera L.* were not likely to have simultaneously developed, but they evolved from the different woodland grape types side by side, or crossing one another, respectively (Kozma, 1991).

The *Vitis sylvestris* Gmel. in Hungary is a protected species (Farkas et al., 1999). The quest and preservation of its populations are significant in terms of nature conservation and reserve of biodiversity as well. As pointed out before, it is supposed, that this species itself or its crossing with other species could be the progenitor of the European grapevine (*Vitis vinifera ssp*. sativa). The ex-situ conservation of the quested individuals has a great importance from a practical point of view as well, as they can serve as a resistance source in future breeding programs.

The aim of the current study was to assess the morphological, phenological and molecular diversity of woodland grape (*Vitis sylvestris* Gmel.) genotypes preserved in the gene bank of the NARIC Research Institute for Viticulture and Enology in Badacsony, Hungary.

MATERIALS AND METHODS

PLANT MATERIAL

The phenology and ampelography of 32 *Vitis sylvestris* Gmel. genotypes and *Vitis vinifera L.* 'Pinot noir' were recorded (at least 5 plants of each). All the stocks situated in the same location were grafted on Teleki 5C rootstocks (The origins of the accessions are described below.)

For isozyme analyses 18 *Vitis vinifera L.* cultivars and for SSR analyses additional 20 rootstock accessions were added for comparison.

PHENOLOGY AND AMPELOGRAPHY

Phenology of the different 32 woodland grape genotypes and 'Pinot noir' was recorded based on the BBCH scale (Lorenz et al., 1995) from 2014 to 2016.

Morphology of the same accessions was characterized by 30 OIV descriptors (001, 004, 007, 008, 016, 051, 053, 067, 068, 069, 070, 074, 075, 076, 078, 079, 081-2, 082, 084, 085, 087, 088, 089, 151, 354-Alercia et al., 2015).

ORIGIN OF THE WOODLAND GRAPE ACCESSIONS

The woodland grape stocks were labelled with plastic stripes in-situ in the Szigetköz in 2013. All the stocks were marked on a map, were located and the GPS coordinates were saved. Photos were taken in spring and autumn of 2013 and 2014 from all the individuals. In June 2013, young shoots from the individuals were collected and grafted to rootstocks in Badacsony.
Seeds were collected from 5 (genetically identical) female flowered stocks in the Szigetköz in autumn 2013. The seedlings were pricked out in early spring 2014 and young shoots of 23 seedlings were successfully grafted.
All of the 32 accessions are maintained as grafts in the gene bank of the NARIC Research Institute for Viticulture and Enology in Badacsony.

ISOZYME ANALYSES

Dormant canes of woodland grapes from the gene bank were collected in three repetitions in January 2016; subsequently they were stored in plastic bags at 4 °C until processing at the longest for two days. Active enzymes were extracted from the dormant canes as described by Arulsekar et al. (1986). Vertical polyacrylamide gel electrophoreses were carried out in three repetitions of all the three samples/accessions and gels were stained for acid phosphatase (AcP), catechol oxidase (CO), peroxidase (PER) and glutamate-oxaloacetate transaminase (GOT) as described by Royo et al. (1997). Results were evaluated visually. Isozyme bands were digitally scored (1-present, 0-absent).

SSR ANALYSES

DNA extraction and SSR analyses procedures for 11 loci (VVS2, VrZag79, VrZag62, VMC6F1, VVMD27, VVMD5, VMC6E1, VMC6G1, VVMD7, VMCNG4b9, VVMD28) are described in Jahnke et al. (2016).

DATA ANALYSES

Statistical analyses for phenology and ampelography were carried out and figures were created in R (R Core Team, 2013).
Dendrogram creation of isozyme and SSR data was carried out by MolMarker (Jahnke and Smidla, 2019) using Jaccard similarity (Jaccard, 1908) and UPGMA method (Sokal, 1958).

RESULTS AND DISCUSSION

PHENOLOGY

Based on our results it can be established, that there are differences in the time of flowering and fruit set between the different woodland grape (*Vitis sylvestris* Gmel.) genotypes. An average *Vitis sylvestris* stock flowers and ripens later compared to 'Pinot noir' (*Vitis vinifera L.*), but the difference depends on the weather as well. Differences were found only in the dynamics of flowering between female and male woodland grape (*Vitis sylvestris* Gmel.) individuals, but the difference was significant only in 2014 (Fig. 1).

AMPELOGRAPHY

Differences were found between *Vitis sylvestris* Gmel. functional female flowered, functional male flowered accessions and *Vitis vinifera L.* cv. 'Pinot noir'.
Based on the OIV descriptors the following conclusions can be drawn:

- All the woodland grapes were either functional female or functional male flowered, none of them were hermaphrodite (OIV 151: 2 or 4).
- The petiole sinus of the mature leaves is characteristically widely opened for the woodland grape accessions (OIV 079: 1-2).
- The prostrate hairs between main veins on the lower side of the blade of the mature leaves are absent from female flowered woodland grapes and sparse for male flowered ones. (OIV 084: 1 or 3).

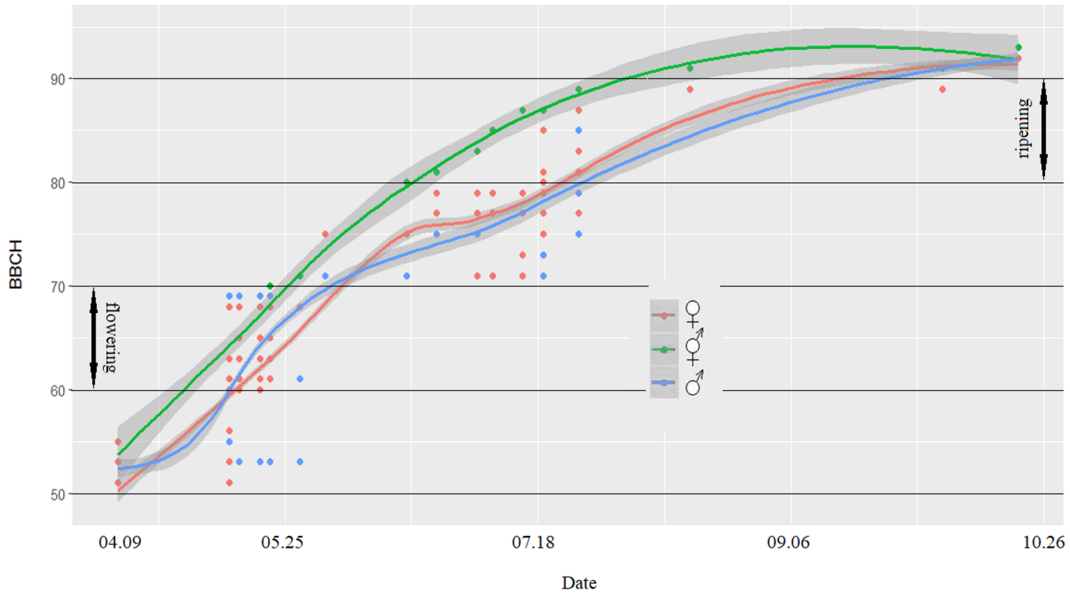

Fig. 1: Average phenology of male (blue), female (red) flowered woodland grape (*Vitis sylvestris* Gmel.) genotypes and hermaphrodite flowered *Vitis vinifera* L. cv. 'Pinot noir' (green) based on the BBCH scale (Badacsony, 2014; standard deviation shown in dark grey)

- The density of erect hairs on the main veins on the lower side of the blade is low for female flowered and medium for male flowered woodland grape individuals (OIV087: 3 or 5).
- The bunches of the female flowered woodland grapes are very short (OIV 202:1) and very loose (OIV 204:1), the berries are very short (OIV 220: 1), globose shaped (OIV 223: 2) with blue-black colored skin (OIV 225: 6).
- Based on the results it can be established, that all the woodland grape accessions belong to *Vitis sylvestris* Gmel. var. typica.

ISOZYME ANALYSES

Results of the isozyme analyses of the 32 *V. sylvestris* accessions and 18 *V. vinifera* cultivars are presented in Table 1. Based on these results an UPGMA dendrogram was constructed (Fig. 2). The European grapevine cultivars and the woodland grapes separate well in the dendrogram, supporting the different genetic background. Only the ancient cultivar 'Pinot gris' (Szürkebarát) of *Vitis vinifera* L. convar. occidentalis falls to the "*sylvestris*" cluster, supporting the morphological data, that the woodland grapes analysed in this study belong to the typica varietas. Woodland grape genotypes B.2., B.12. and B.13. fall into the *Vitis vinifera* group, even though they are clearly *Vitis sylvestris* based on OIV descriptors. This fact shows the limitations of the isozyme method (Buth et al., 1999).

AcP isoenzyme patterns consist of 2 zones. The presence of a maximum of 4 bands in the faster migrating region represents a distinct locus. This region consists of 3 or 4 bands in the case of *Vitis vinifera* ssp. sativa cultivars, and 3 bands for most of the woodland grapes, but is totally absent in some *Vitis sylvestris* accessions. This phenomenon was indicated earlier (Jahnke et al., 2017) and is confirmed in this study.

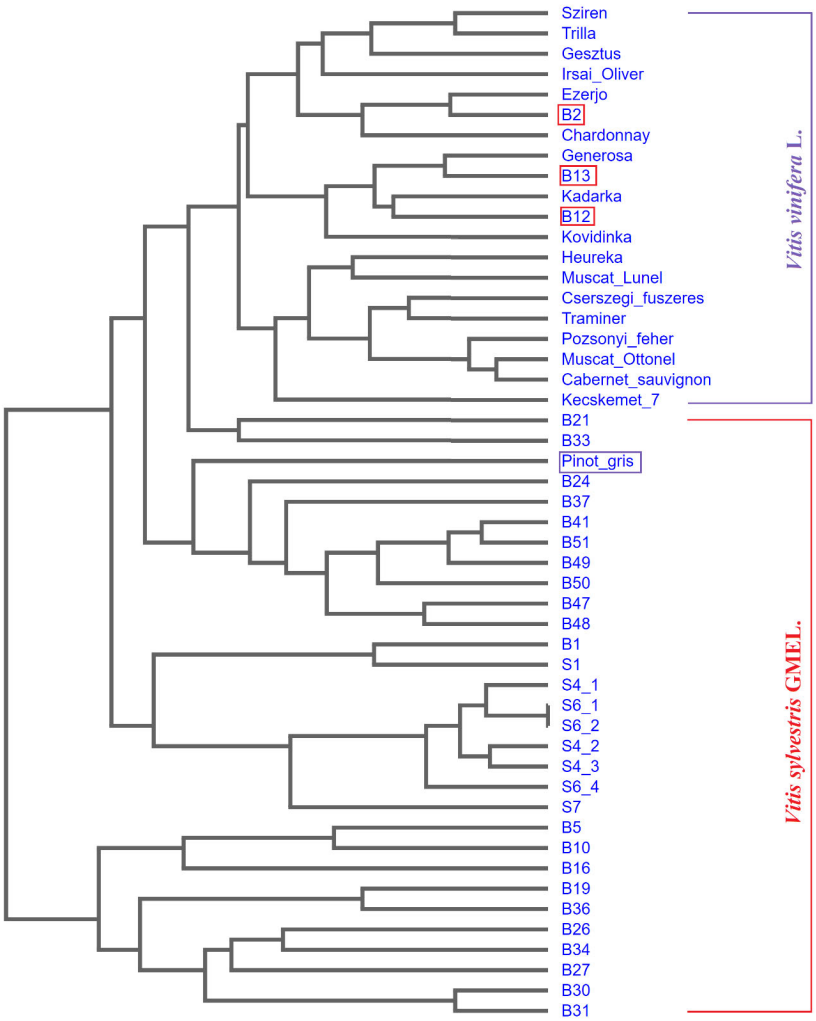

Fig. 2: UPGMA dendrogram of the accessions based on isozyme results

SSR ANALYSES

Based on the SSR results in 11 loci a dendrogram was constructed (Fig. 3.).
The main groups (*V. sylvestris*, *V. vinifera* and rootstocks) form distinct groups.
The *Vitis sylvestris* genotypes form distinct groups and show similarity with *Vitis vinifera* genotypes, which shows their true-to-typeness.

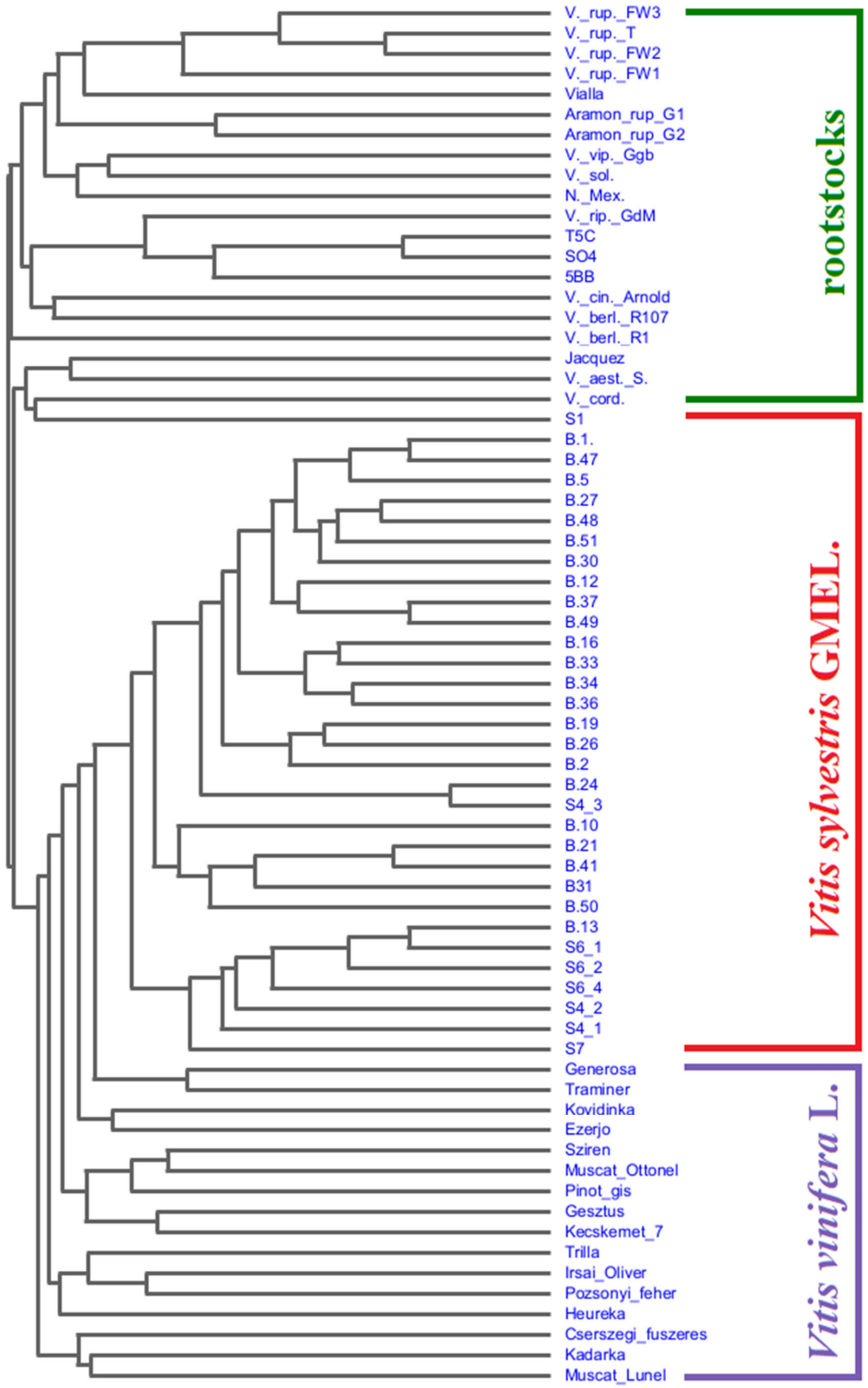

Fig. 3. UPGMA dendrogram of the accessions based on SSR results

Table 1: Isozyme analysis results for AcP, CO, GOT and PER for *V. sylvestris* accessions and *V. vinifera* cultivars

Accession ID	Origin	AcP								CO						GOT				PER					
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	1	2	3	4	1	2	3	4	5	6
Sziren	*Vitis vinifera* L.	1	1	1	1	1	1	1	0	0	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1
Trilla		1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1
Gesztus		1	0	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1
Heuréka		1	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1
Generosa		1	1	1	1	1	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	1	1	1	1
Kecskemét 7		1	0	1	0	1	1	1	1	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1
Cserszegi fűszeres		1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1	1
Irsai_oliver		1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1	1	0	1	1	1	1	1
Kovidinka		0	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1	1
Szurkebarat		1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	0	0	0	1	1	1
Ezerjo		1	1	1	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1
Pozsonyi fehér		1	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	0	0	0	1	1	0	1	1
Kadarka		0	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1
Muscat Lunel		1	0	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	0	0	1	1	1	1
Muscat Ottonel		1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1
Piros Tramini		1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	1	1	1	1	1
Cabernet sauvignon		1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0	0	1	1	0	1	1
Chardonnay		1	1	1	0	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1
B1	*Vitis sylvestris* GMEL.	1	0	1	1	1	1	1	0	1	0	0	1	0	0	0	0	1	1	0	1	1	1	1	1
B2		1	0	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1	1
B5		1	1	1	1	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	1	1	0	1	1
B10		1	1	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	0	0	1	0	1	1
B12		0	1	1	1	1	1	1	0	1	0	1	0	0	0	1	1	1	1	0	1	0	0	1	1
B13		0	1	1	1	1	1	1	0	1	0	1	0	0	0	1	1	1	1	0	1	1	1	1	1
B16		0	1	1	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	1	1	1	1	1
B19		0	1	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	1	0	0	1	1
B21		1	0	1	1	1	1	1	0	0	1	1	0	1	0	0	1	1	0	0	1	1	0	1	1
B24		0	1	0	1	1	1	1	0	0	1	0	0	1	0	1	1	0	0	0	1	1	0	1	1
B26		0	1	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	0	1	1
B27		1	1	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	1	1	0	1	1	1
B30		1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	1	1	1
B31		1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	0	1	1
B33		1	0	1	0	1	1	1	0	0	1	1	1	0	0	1	1	1	1	0	0	1	0	1	1
B34		0	1	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1
B36		1	1	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	1	1
B37		1	1	1	0	1	1	1	0	0	1	0	0	1	0	1	1	0	0	0	0	1	0	1	0
B41		1	1	1	0	1	1	1	0	0	1	0	0	1	0	1	1	1	1	0	0	0	0	1	0
B47		1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	1	1
B48		1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1	0	0	0	1	0	0	1	0
B49		1	1	1	0	1	1	1	0	0	1	0	0	1	0	1	1	1	0	0	0	0	0	1	1
B50		1	1	0	1	1	1	1	0	0	1	0	0	1	0	1	1	1	1	0	0	0	0	1	1
B51		1	1	1	0	1	1	1	0	0	1	0	0	1	0	1	1	1	1	0	0	0	0	1	1
S 4/1		1	1	1	0	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1
S 4/2		1	1	1	0	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	1	0	1	1
S 4/3		1	1	1	1	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	1	0	1	1
S 6/1		1	1	1	1	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1
S 6/2		1	1	1	1	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1
S 6/4		1	1	0	0	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1
S7		1	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	0	0	1	0	1	1	1	1
S1		1	1	1	0	1	1	1	0	1	0	0	1	0	0	0	0	1	1	0	1	1	0	1	1

CONCLUSIONS

Summarising the results, it can be concluded, that the ex-situ preserved genotypes are true-to-type woodland grapes, belonging to *Vitis sylvestris* Gmel. var. typica.
The results support – as suggested by Bodor et al. (2010) – the further quest, ex-situ and in-situ preservation and analyses of the *Vitis sylvestris* Gmel. germplasm in Hungary.

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REFERENCES

Alercia, A., Becher, R., Boursiquot, J. M., Carara, R., Chomé, P., Costacurta, A., Giust, M., Hundemer, M., Jung, A., Lacombe, T., Maigre, D., Maul, E., Ortiz, J., Schneider, A. and Walker, A. 2015: 2nd edition of the OIV descriptor list for grape varieties and Vitis species. Organisation Internationale de la Vigne et du Vin. Retrieved from http://www.oiv.int/public/medias/2274/code-2e-edition-finale.pdf

Arulsekar, S. and Parfitt, D. E. 1986: Isozyme analysis procedures for stone fruits, almond, grape, walnut, pistachio, and fig. Horticultural Science: 928–933. Retrieved from https://agris.fao.org/agris-search/search.do?recordID=US8704572

Bodor, P., Höhn, M., Pedryc, A., Deák, T., Dücso, I., Uzun, I., Cseke, K., Böhm, É. I., and Bisztray, G. D. (2010). Conservation value of the native Hungarian wild grape (*Vitis sylvestris* Gmel.) evaluated by microsatellite markers. Vitis - Journal of Grapevine Research, 49(1), 23–27.

Buth, D. G. and Murphy, R. W. 1999: The use of isozyme characters in systematic studies. Biochemical Systematics and Ecology, 27(2): 117–129. doi: 10.1016/S0305-1978(98)00052-0

Darwin, C. 1883: The variation of animals and plants under domestication. In The variation of animals and plants under domestication - New York: D. Appleton & Co. doi: 10.5962/bhl.title.87899

De Candolle, A. 1894: Termesztett növényeink eredete. (Origin of our cultivated plants)-in Hungarian. Budapest: Királyi Magyar Természettudományi Társulat.

Farkas, S., Tóth, I. Z. and Molnár V., A. 1999: Magyarország védett növényei (Protected plants of Hungary) – in Hungarian. Mezőgazda Kiadó. Retrieved from https://www.researchgate.net/publication/331310981_Magyarorszag_vedett_novenyei

Jaccard, P. 1908: Nouvelles recherches sur la distribution florale. Bulletin de La Société Vaudoise Des Sciences Naturelles, 163: 223–270. doi: https://doi.org/10.5169/seals-268384

Jahnke, G., Nagy, Z. A., Koltai, G., Hajdu, E. and Májer, J. 2016: Preservation and characterization of woodland grape (*Vitis vinifera* ssp. Sylvestris GMEL.) genotypes of the Szigetköz, Hungary. In Germplasm: Characteristics, Diversity and Preservation. 27-45. Nova Science Publishers, Inc.

Jahnke, G., Nagy, Z. A., Koltai, G., Hajdu, E. and Májer, J. 2017: Absence of an acid phosphatase isozyme locus as a marker candidate for true to typeness in woodland grape (Vitis vinifera L. Ssp. Sylvestris Gmelin). Oeno One, 51(3): 215–220. doi: 10.20870/oeno-one.2017.51.1.1620

Jahnke, G. and Smidla, J. 2019: MolMarker. doi: 10.13140/RG.2.2.20107.03364

Kozma, P. 1991: A szőlő és termesztése I. Budapest: Akadémiai Kiadó, Budapest.

Lorenz, D. H., Eichhorn, K. W., Bleiholder, H., Klose, R., Meier, U. and Weber, E. 1995: Growth Stages of the Grapevine: Phenological growth stages of the grapevine (Vitis vinifera L. ssp. vinifera)—Codes and descriptions according to the extended BBCH scale. Australian Journal of Grape and Wine Research, 1(2): 100–103. doi: 10.1111/j.1755-0238.1995.tb00085.x

Negrul', A. M. 1969. Questions of the origin and breeding of vines on a genetical basis. NI Vavilov and Agricultural Science: 323–339.

R Core Team. 2013: R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from http://www.r-project.org/

Royo, J. B., Cabello, F., Miranda, S., Gogorcena, Y., Gonzalez, J., Moreno, S., Itoiz, R. and Ortiz, J. M. 1997: The use of isoenzymes in characterization of gra-

pevines (Vitis vinifera, L.). Influence of the environment and time of sampling. Scientia Horticulturae, 69(3–4), 145–155. doi: 10.1016/S0304-4238(97)00007-1

Sokal, R. R. 1958: A statistical method for evaluating systematic relationships. In Univ Kans Sci Bull (Vol. 38, Issue February).

Terpó, A. 1986: A kultúrfajok eredete. (The origin of cultivated specieses) (A. Terpó (ed.); Növényrend, pp. 108–109). Budapest: Mezőgazdasági Kiadó.

Vavilov, N. 1932: The Process of Evolution in Cultivated Plants. Proceedings of the Sixth International Congress of Genetics: 331–342.

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