

Support trees and shrubs for the Eurasian wild grapevine in Southern Caucasus

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ABSTRACT

A prospecting of habitats and mechanical support host species for the climber Eurasian wild grapevine, *Vitis vinifera* L. subsp. *sylvestris* (Gmelin) Hegi, was carried out on 13 natural populations situated along river bank forests, floodplains and colluvial positions in Georgia (Marneuli, Mtskheta and Gori districts, Gardabani Protected area and Lagodekhi Reserve), Armenia (Akhtala and Tavoush regions) and Azerbaijan (Quba region) during survey of 2013. The research demonstrated that Eurasian wild grapevine (*Vitis vinifera* subsp. *sylvestris*) is found in Southern Caucasus in a wide variety of habitats always linked to water availability. *Punica granatum* trees are the commonest mechanical support for wild grapevine in the South Caucasus and *Hedera helix* often shares the same support trees. However we documented wild grapevines climbing on other 24 different species of trees and large shrubs and, further, 32 associated species. We determined, four different clusters of localities using Structure software and the Weighted Neighbor Joining tree. These clusters are characterized by specific mechanical support and accompanying species. Other vines competing for host with Eurasian wild grapevine belong to the genera *Clematis*, *Hedera*, *Humulus*, *Smilax* and *Vitis* ssp.

Introduction

Wild grapevine (*Vitis vinifera* subsp. *sylvestris* (C.C.Gmel.) Hegi) is a tendril-bearer, woody climber inhabiting forests and scrub along river banks and ravine beds, from Western Europe to Central Asia. It is also available in the South Caucasus area [1] where it is particularly scattered along low caudal watercourses. Zecca et al. [2] have found one Armenian wild grapevine specimen to be the oldest lineage of *V. vinifera* subsp. *sylvestris* among those included in their study, being the Caucasian lineage the result of a division between *Vitis vinifera* and the Asian

lineages in the late Miocene. This is coherent with the results of Pipia et al. [3] studying plastidial DNA and confirms the relevance of the Caucasus wild grapevine populations in the evolution of wild (and cultivated) grapevine, as the cradle of the viticulture [4].

The study of wild grapevine in the Caucasus developed by our team led to the discovery of sanitary problems in roots and aerial parts [5,6].

As a vine, *V. vinifera* subsp. *sylvestris*, although woody, it cannot remain free-standing to any appreciable height. In order to climb, vines need to locate and somehow grasp, lean or hook onto suitable supports [7]. At present studies on lianas or vines and the host species providing

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Table 1
Studied wild grapevine populations in Georgia, Azerbaijan and Armenia in 2013.

Site name	District	River	Interval of latitude N	Interval of longitude E	Alt.	P*
Georgia						
Nakhiduri	Marneuli	Ktsia	41°29'26" - 41°29'13"	44°40' 51" - 44°41'22"	445	C
Tsitsamuri	Mtskheta	Aragvi	41°52'28" - 41°52'38"	44°43'51" - 44°43' 57"	469	C
Tedotsminda	Gori	Liakhvi	42°2'4" - 42°2'20"	44°3'19" - 44°3'42"	639	C
Gardabani	Gardabani	Mtkvari	41°22'10" - 41°22'19"	45°4'6,3" - 45°4'37"	274	F
Skra	Gori	Mtkvari	41°59'11" - 41°59'13"	44°2'47" - 44°2'47"	609	C
Lagodekhi	Lagodekhi	Matmiskhevi	41°48'2" - 41°48'45"	46°19'12 - 46°20'24"	501	A
Azerbaijan						
Guruchai-1	Quba	Guruchai	41°24'1"	48°26'37"	680	F
Guruchai-2	Quba	Guruchai	41°26'3" - 41°26'3"	48°33' 41" - 48°33'50"	404	F
Rostov road Qusarchai 1 & 2	Quba	Qusarchai	41°28'6" - 41°28'9"	48°33'57" - 48°33'59"	385	F
Dellekkend**	Quba	Guruchai	41°24'37"	48°35'13"	413	F
Agbil**	Quba	Qusarchai	41°25'32" - 41°25'35"	48°33'54" - 48°34'4"	415	F
Armenia						
Akhtala	Akhtala	Debed	41°6'18,3" - 41°7'15,8"	44°42'23 - 44°45'16,3"	644	C
Getahovit	Tavoush	Getik	40°54'6" - 40°54' 8,7"3"	45°7'5 - 45°7' 9,6"	719	C

Codes: Alt. Altitude (masl). P* (Position): A: riverbank forest; C: colluvial position (slope of a hill); F: flood plain. ** Not included in the final analysis.

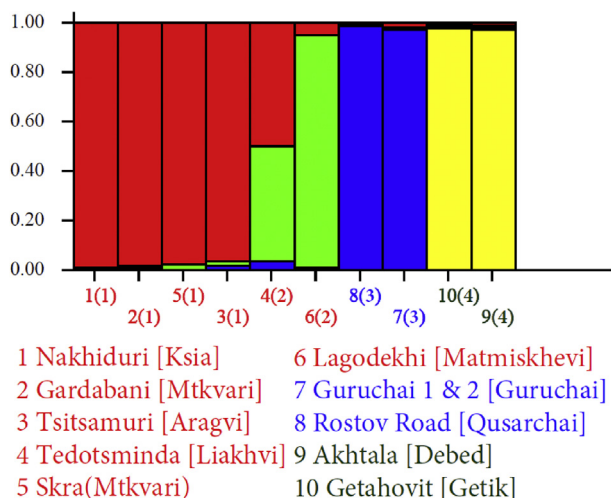


Fig. 1. Structure of the sampled populations in Southern Caucasus.
Note: Color codes: Bars: Red, group 1; Green, group 2; Blue, group 3; Yellow, Group 4; labels and countries: Red, Georgia; Blue, Azerbaijan; Green, Armenia.

their mechanical support are scarce although vines may exhibit host specificity based on the tree species identity, size or shape [8,9].

The objective of the present work is to analyze the species that provide mechanical support to the wild grapevine in Southern Caucasus, and the geographic structure of the ensemble.

Material and methods

The study of species associated to wild grapevine and characterizing the habitats was simultaneous to the sanitary prospection of natural populations of wild grape organized in Georgia, Armenia and Azerbaijan in October 2013 [6]. These zones are included within the Holarctic kingdom, Eurosiberian region, and assigned to the Caucasian or Irano-Turanian, biogeographical provinces. The location based on GPS coordinates and the habitats of the different populations studied is shown in Table 1.

Sampling plots were irregular according, in each site, to the structure of wild grapevine populations. Trees were recorded as a host when the branches of the vine grew clearly supported on their branches and a part of the foliage of the vine appeared intermixed or above the one of the host.

Photographs and voucher specimens were collected for confirming in field preliminary identification of species. Identification process was

conducted in the different institutes and universities of the authors and revised at the Plant Biology and Ecology Department of the Universidad de Seville (Spain) using as basic resources different floras of Armenia, Azerbaijan and Georgia [10–13].

Nomenclature of species and abbreviations of authors were standardized according to The Plant List [14].

Data were first organized in a 59 taxa x 10 localities matrix, where presence was coded as 1 for associated species and 10 for species further acting as mechanical support for Eurasian wild grapevine individuals. The transposed matrix was generated later. This matrix was processed using DARwin 6.0 [15]. Two dissimilarity matrices were calculated [16] for localities (Units: 10 and Variables: 59, Dissimilarity index: Counts - Chi², 500 bootstraps, this is an even dissimilarity which is a Euclidean distance) and species (Units: 59 and Variables: 10, Dissimilarity index: Counts - Chi², no bootstraps, this is an even dissimilarity which is a Euclidean distance). Weighted neighbor-joining tree was calculated for localities. A hierarchical tree for species was constructed using the Ward's minimum variance algorithm [16]. These trees were further processed with FigTree v1.4.3 [17]. We used Structure [18] which works using stochastic Bayesian methods of Markov Chains - Monte Carlo, and Harvester [19] in order to determine the optimal number of groups of localities. This last software set focus on molecular studies thus we adapted for Structure our data (species presence) in terms of haplotype alleles.

Results and discussion

Pomegranate (*Punica granatum*) is the commonest mechanical support species for Eurasian wild grapevine in the sites studied, and *Hedera helix* often shares the same support trees. However we documented wild grapevines climbing on other 24 different species of trees and large shrubs and, further, 32 associated species. We determined, four different clusters of localities using Structure (Fig. 1) and the Weighted Neighbor Joining tree (Fig. 2). These clusters are characterized by specific mechanical support and accompanying species (Fig. 3).

Wild grapevine-associated and mechanical support species follow primarily a major biogeographical pattern. Groups 1, 2 and 4 roughly fall within the Euro-Siberian Region and group 3 within the borders of the Irano-Turanian Region.

Group 1 is present in colluvial and flood plain forestall areas of central Georgia (Fig. 4a) within *Carpinus* - *Quercus* forests, at altitudes from 250 to 610 m above sea level. *Carpinus betulus*, *Cornus mas*, *Cornus sanguinea*, *Crataegus caucasica* and *C. monogyna*, *Diospyros lotus*, *Pyrus caucasica*, *Paliurus spina-christi*, *Populus alba* and *Corylus avellana* provide mechanical support to *Vitis vinifera* subsp. *sylvestris*. Other species of trees, like *Acer monspessulanum*, *Acer platanoides*, *Fagus orientalis* and

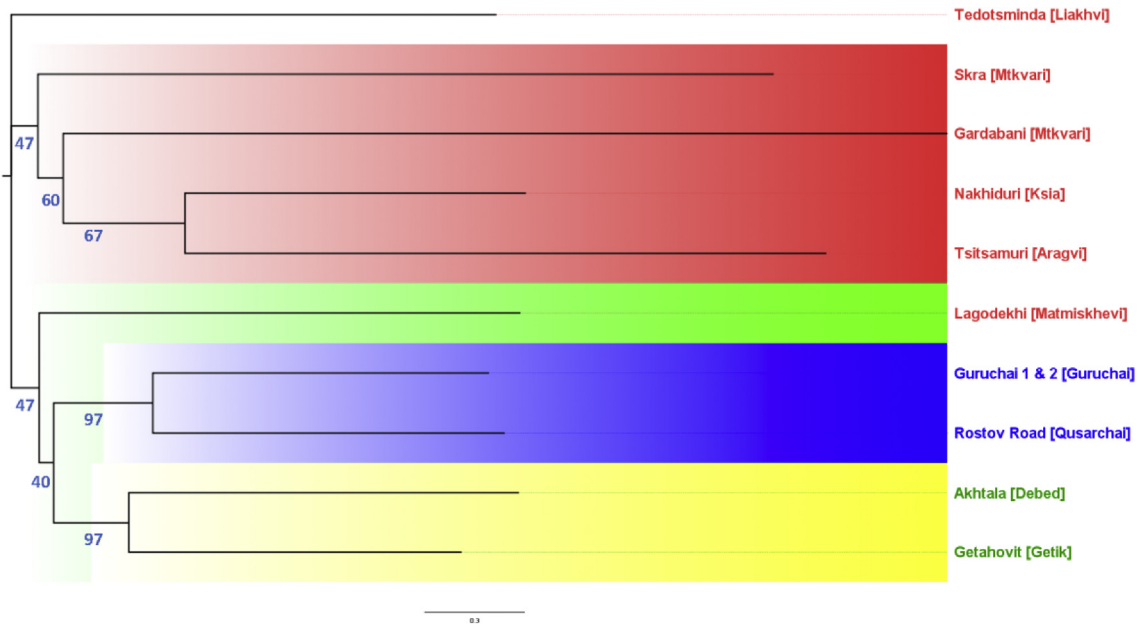


Fig. 2. Weighted Neighbor Joining tree for populations in Southern Caucasus.

Note: numbers below branches represent support in percentage of 500 bootstraps. Color codes: Shadows: Red, group 1; Green, group 2; Blue, group 3; Yellow, Group 4; tip labels: Red, Georgia; Blue, Azerbaijan; Green, Armenia.

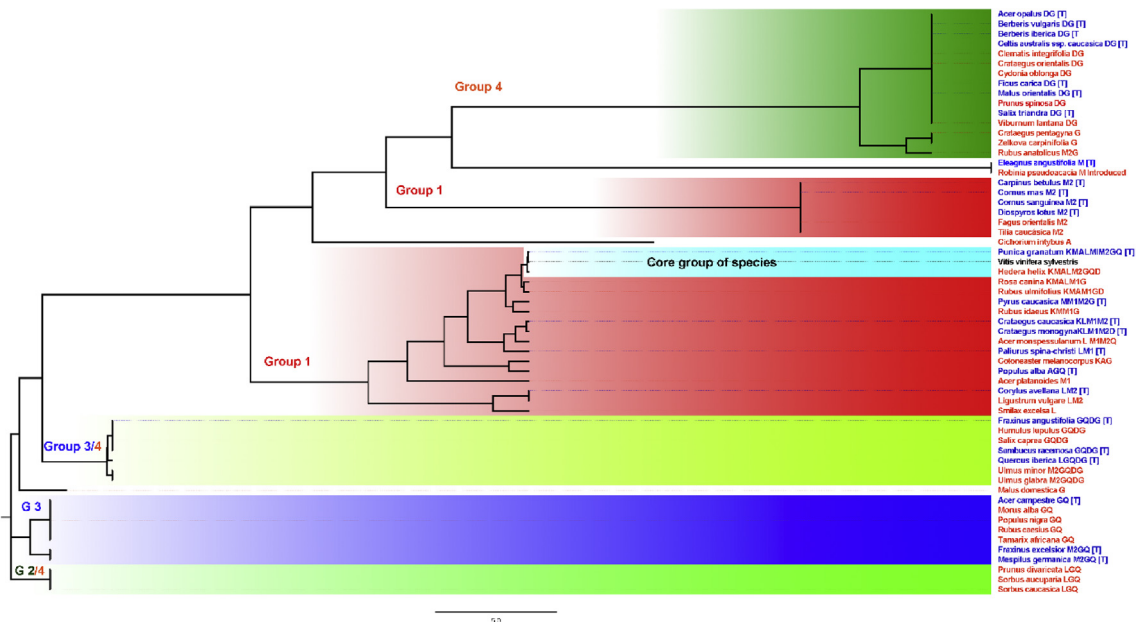


Fig. 3. Minimum variance hierarchical tree for species.

Note: labels above branches represent groups in Figs. 1 and 2. Color codes: labels: Red, species associated; Blue, species providing mechanical support.

Tilia caucasica were present but we did not recorded wild grapevine climbing on these. Accompanying species include shrubs like *Cotoneaster melanocarpus*, *Ligustrum vulgare*, *Rosa canina*, and brambles such as *Rubus ulmifolius*, *Rubus idaeus*.

Group 2 is present in the riverbank forest of Lagodekhi in eastern Georgia (Fig. 4b) at c. 500 m of altitude. Here *Corylus avellana*, *Prunus divaricata*, *Quercus iberica*, *Sorbus aucuparia* and *S. caucasica* are main mechanical supports. Other accompanying species include shrubs like *Ligustrum vulgare* and climbers such as *Smilax excelsa*.

Group 3 is present in wet flood plains of Irano-Turanian territories of eastern Azerbaijan (Fig. 4c). It shows a relatively high anthropic

impact (*Morus alba*, *Populus nigra* plantations). Here *Fraxinus angustifolia*, *F. excelsior*, *Mespilus germanica*, *Prunus divaricata*, *Sambucus racemosa*, *Sorbus aucuparia* and *S. caucasica* are main mechanical supports. Other trees present are *Salix caprea*, *Ulmus glabra* and *U. minor*. Another climbers are *Humulus lupulus* and the invader species *Vitis rupestris* and *V. vulpina*, which are escaped rootstocks.

Group 4 is present in hillslopes of Armenia (Fig. 4d). Here trees and large shrubs grow sparse. Some, like *Acer hyrcanum*, *Berberis vulgaris* and *B. iberica*, *Celtis australis* subsp. *caucasica*, *Ficus carica*, *Malus orientalis*, *Fraxinus angustifolia*, *Quercus iberica*, *Sambucus racemosa* and *Salix triandra* act as main mechanical supports for wild grapevine. Other

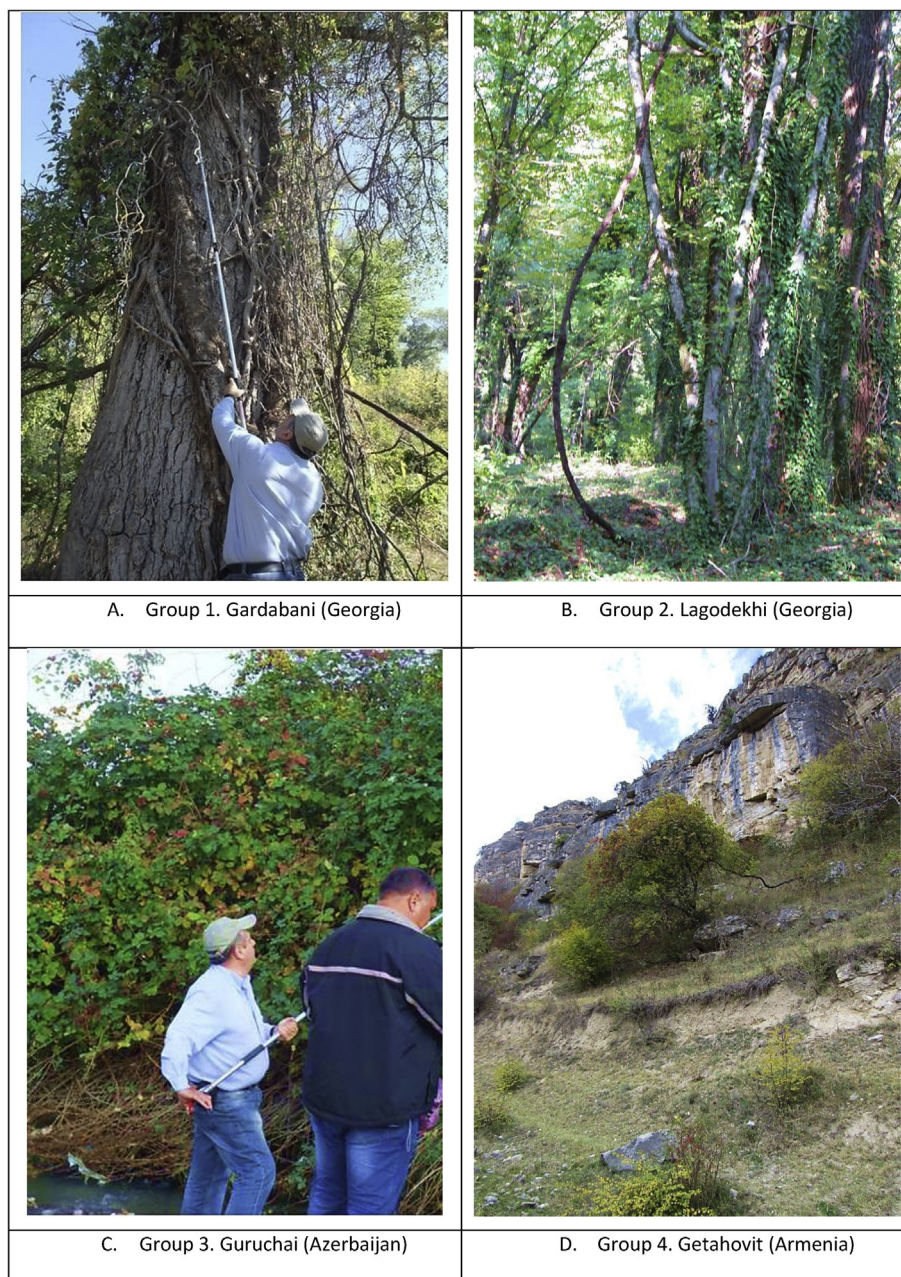


Fig. 4. Representative localities for Eurasian wild grapevine in the Caucasus.

trees and shrubs present are *Crataegus orientalis* and *C. pentagyna*, *Cydonia oblonga*, *Prunus spinosa*, *Salix caprea*, *Ulmus glabra* and *U. minor*, *Viburnum lantana* and *Zelkova carpinifolia*. Climbers and brambles include *Clematis vitalba*, *Humulus lupulus*, and *Rubus anatolicus*. Unlike dense forests, here the shoots of the vine often must progress at ground level several meters to find a tree on which they can grow successfully (Fig. 4D). Here, grapevines growing closely at the foot of the cliff take advantage of the rocks as a mechanical support in place of trees and shrubs (Fig. 5).

The presence in the sampled localities of tree and shrub species that do not support Eurasian wild grapevine lianas may be due to mechanical characteristics of the host, human intervention in the case of plantations (*Malus domestica*, *Morus alba*, *Populus nigra*, *Robinia pseudoacacia*) or simply at random. This is worthy of further investigation.

Conclusions

Eurasian wild grapevine (*Vitis vinifera* subsp. *sylvestris*) is found in Southern Caucasus in a wide variety of habitats always linked to water availability. In forests and scrubs wild grapevines require mechanical support provided by trees and large shrubs but also can climb on cliffs.

Mechanical support is often provided by *Punica granatum* and other numerous tree and large shrub species of the genera *Acer*, *Berberis*, *Crataegus*, *Diospyros*, *Elaeagnus*, *Ficus*, *Fraxinus*, *Malus*, *Mespilus*, *Populus*, *Paliurus*, *Pyrus*, *Quercus*, *Salix* and *Sambucus* that are more specific in habitat requirements.

Other vines competing for host with Eurasian wild grapevine belong to the genera *Clematis*, *Hedera*, *Humulus*, *Smilax* and *Vitis* spp.



Fig. 5. Eurasian wild grapevine climbing the cliff in Getahovit (Armenia).

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.aasci.2018.06.005>.

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