Study of grapevine cultivars used for the production of Malvasia wine using ampelographic and molecular methods

K. Biniari and M.N. Stavrakakis

Laboratory of Viticulture
Agricultural University of Athens


Peloponnese
Cyclades
Rhodes
Crete

- Malvasia, the famous Greek wine, that has been internationally known since the 14th century was probably made by the use of several grape cultivars. Main cultivars were (or among these cultivars) Monevasia, Athiri, Thrapsathiri, Aidani, Trifera, Glykerithra, Ladikino, Tactas etc which are characterized by their peculiar light aroma.
- It is not exactly known when the import of the Greek grape cultivars in the countries of Western Europe started. Although in Greece there was and still is only one variety with the name Monevasia, in Western Europe a great number of cultivars with the general name Malvasia (or Malvazia, Malvatica, Malvoisie) are mentioned (ROVASENDA 1887; POULIAT 1888; MOLON 1906; VIALA et VERMOREL 1904). In this group there are cultivars, the name of which indicates a Greek origin such as Malvasia Candia (or M. di Candia, M. bianca di Candia), Malvasia nera di candia (or M.nera, Malvosie noire musquee), Malvasia greca, malvasia di Zante, Malvasia aspri and the cultivars Malvasia bianca di Piemonte, M. lipari, M. lunga, M. del Cianti, M. aromatica, M. rojia, M. bianca di trani, M. candida etc. It is highly possible that most of the above cultivars originated from local cultivars which were renamed in Malvasia irrespective of whether they had the aromatic character or not.

Code	Cultivars	Berry color
1	**Athiri**	(W)
2	**Thrapsathri**	(W)
3	**Thrapsa**	(B)
4	**Aidani**	(W)
5	**Glykadi**	(W)
6	**Agrioglykadi**	(W)
7	**Glykerithra**	(W)
8	**Tryfera**	(W)
9	**Plyto**	(W)
10	**Liatiko**	(B)
11	**Dafni**	(W)
12	**Vidiano**	(W)
13	**Vilana**	(W)
14	**Ladikino**	(B)
15	**Monemvasia**	(W)
16	**Malvasia di candia**	(W)
17	**Malvasia chianti**	(W)
18	**Malvasia lunga**	(W)
19	**Malvasia aromatica**	(W)
20	**Malvasia istria**	(W)
21	**Malvasia lazio**	(W)
22	**Malvasia nera**	(B)

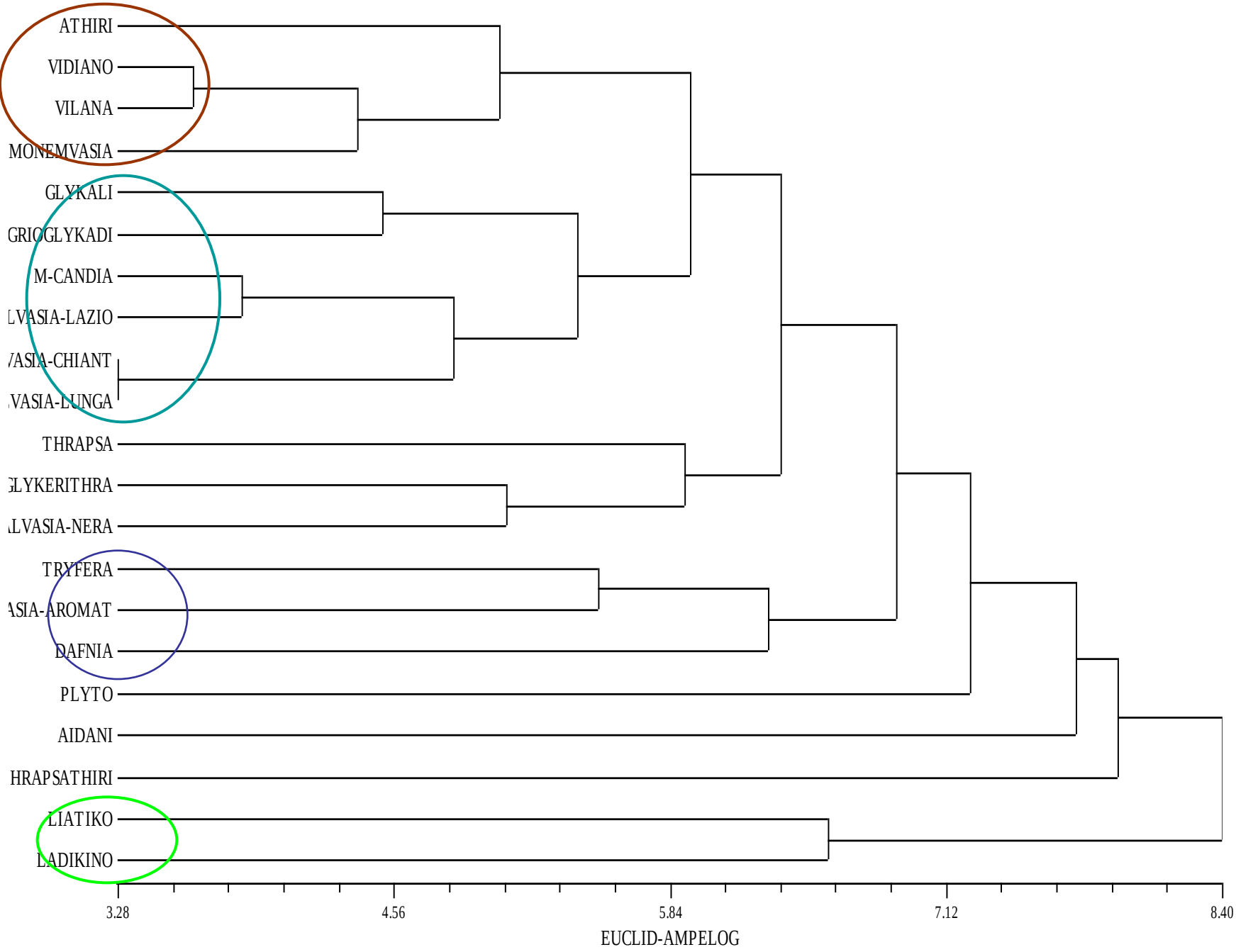
		ATHIRI	THRAPSATHIRI	AIDANI	PLYTO	LIATIKO	VIDIANO	VILANA	LADIKINO	MONEMVASIA	THRAPSA	GLYKERITHRA	TRYFERA	DAFNIA	GLYKALI	AGRIOGLYKADI	MALVASIA-NERA	M-CANDIA	MALVASIA-CHIANTI	MALVASIA-LUNGA	MALVASIA-AROMATIKA	MALVASIA-LAZIO
001	Young Shoot: aperture of tip	7	5	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	1	3	1	3	4	3	3	5	5	3	1	1	1	2	3	1	3	2	1	3	1
004	Young Shoot: density of prostrate hairs on tip	6	7	2	5	7	7	6	5	7	5	7	1	2	3	5	3	3	6	6	3	2
011	Shoot: color of ventral side of internodes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
015-2	Shoot: intensity of anthocyanin coloration on bud scales	3	1	3	3	1	1	3	4	4	1	1	1	1	3	5	1	1	1	1	3	1
016	Shoot: number of consecutive tendrils	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
051	Young leaf: color of the upper side of blade (4 th leaf)	2	2	2	2	2	2	2	7	2	1	2	1	1	1	2	1	2	1	1	2	1
065	Mature leaf: size of blade	7	5	6	6	7	6	6	6	6	5	7	6	7	4	4	5	6	5	5	4	4
067	Mature leaf: shape of blade	4	4	4	4	1	4	4	1	4	4	4	4	4	3,5	4	3	3,5	4	4	4	4
068	Mature leaf: number of lobes	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
072	Mature leaf: goffering of blade	9	9	9	1	9	9	9	1	9	9	1	1	1	1	9	1	1	9	1	9	1
073	Mature leaf: undulation of blade between main and lateral veins	2	1	1	2	3	2	2	3	3	1	1	1	1	1	2	1	1	1	1	1	1
075	Mature leaf: blistering of upper side of blade	5	5	1	3	4	1	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
076	Mature leaf: shape of teeth	2	3	2,5	3	2	3	3	2	3	3	2	2	2	3	3	2	2	3	3	2	3
079	Mature leaf: degree of opening / overlapping of petiole sinus	6,5	5	5	7	5	5	6	3	4	7	4	3	3	5	7	3	5	5	5	5	3
080	Mature leaf: shape of base of petiole sinus	1	1	1	2	2	1	1	2	1	2	1	2	1	2	2	2	2	2	2	2	2
081-1	Mature leaf: teeth in the petiole sinus	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	5	6	2	4	5	5	6	1	5	8	7	1	4	6	6	5	2	7	7	1	1
085	Mature leaf: density of erect hairs between the main veins on lower side of blade	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	3	1
086	Mature leaf: density of prostrate hairs on main veins on lower side of blade	2	5	1	4	5	6	5	1	3	5	5	1	3	5	5	3	2	5	5	2	1
087	Mature leaf: density of erect hairs on main veins on lower side of blade	1	3	6	1	1	1	1	5	1	1	5	5	5	1	1	3	1	1	1	5	1
151	Flower: sexual organs	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
202	Bunch: length (peduncle excluded)	7	8	7	7	5	6	7	5	6	5	4	7	7	5	4	4	6	6	7	5	5
204	Bunch: density	6	6	5	7	6	6	6	6	5	7	7	5	5	4	5	7	5	5	5	6	5
206	Bunch: length of peduncle of primary bunch	3	3	5	2	3	3	5	1	6	2	7	5	7	5	5	4	6	6	6	5	5
220	Berry: length	4	4	5	6	5	5	5	5	5	4	5	5	6	5	5	5	5	5	5	6	4
223	Berry: shape	3	3	2,5	5	3	5,5	3	3	4	5	3	3	3,5	3	3	3	3	3	3	3	3
225	Berry: color of skin	1	1	1	1	5	1	1	7	1	6	1	1	1	1	1	6	1	1	1	1	1
230		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
236	Berry: particularity of flavor	4	4	4	1	4	4	4	4	4	4	4	4	1	1	1	4	4	4	4	2	4
241	Berry: formation of seeds	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
244	Berry: transversal ridges on dorsal side of seeds	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Materials and Methods

- Collection of young and fully expanded leaves in the period of rapid increase of shoots
- Storage at - 80 °C

DNA extraction

- According to Thomas et al (1993) with minor modifications


ATHIRI
VIDIANO
VILANA
MONEMVASIA
GLYKALI
GRIOGLYKADI
M-CANDIA
LVASIA-LAZIO
VASIA-CHIANT
VASIA-LUNGA
THRAPSA
GLYKERITHRA
LVASIA-NERA
TRYFERA
ASIA-AROMAT
DAFNIA
PLYTO
AIDANI
HRAPSATHIRI
LIATIKO
LADIKINO
3.28
4.56
5.84
7.12
8.40
EUCLID-AMPELOG

PCR reaction

- H_2O
- Buffer solution
- 200 µM from each deoxynucleotide (dATP, dGTP, dCTP and dTTP)
- 50 ng primer
- 60 ng DNA
- 1 unit polymerase (Qiagen)
- Final volume of reaction 25 µl

Primer's Code	Sequence 5'-3'	Number of bands
1224	CAGGCCCTTC	8
1225	AGGTGACCGT	11
1226	CGCAGGATGG	11
1227	GTGTGCCCCA	10
OPM-01	GTTGGTGGCT	14
OPM-02	ACAACGCCTC	9
OPM-05	GGGAACGTGT	3
OPM-18	CACCATCCGT	20
OPF-03	CCTGATCACC	7
OPF-05	CCGAATTCCC	14

Amplification conditions

- 5 min — 94 °C

- 1 min — 94 °C
- 1 min — **44** °C
- 2 min — 72 °C

} **35 cycles**

- 10 min — 72 °C

Electrophoresis

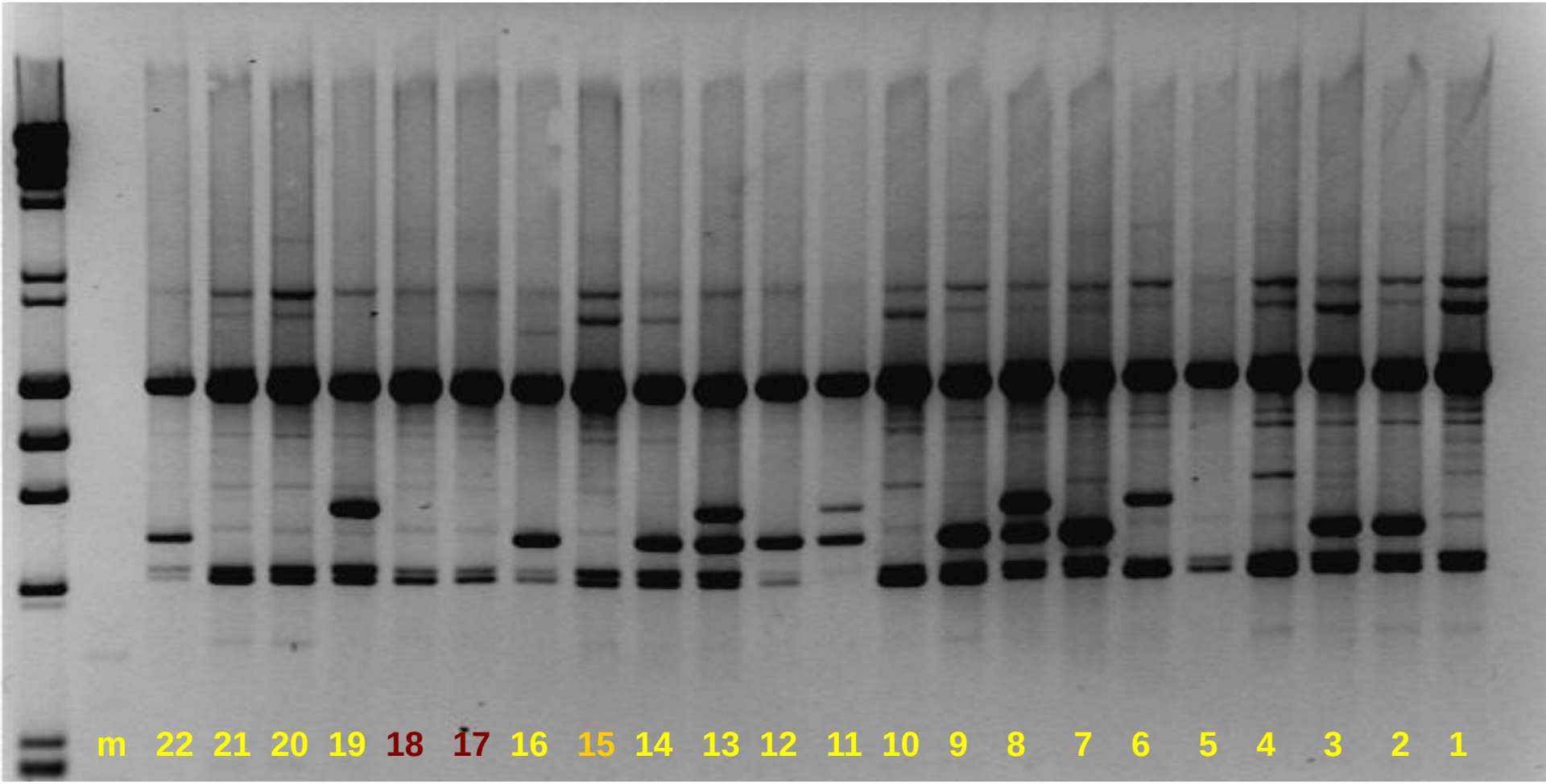
- Gel concentration 2 % agarose in TAE buffer
- 120 V for 4 hours
- Staining with EtBr
- Photograph gels on Gel- Doc 1000 (Biorad)

Statistical analysis

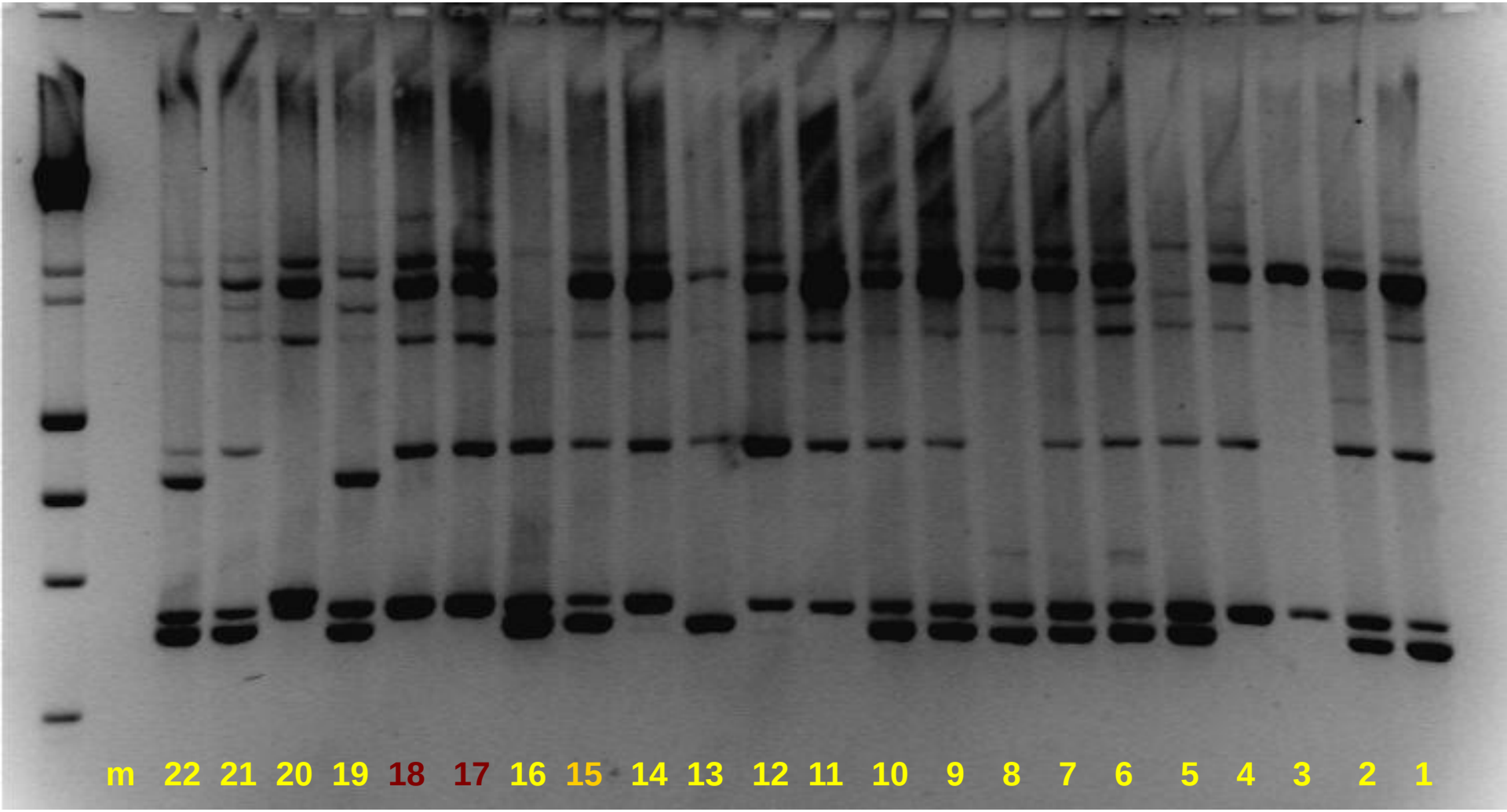
- Calculation of degree of genetic similarity with the type

I= n/ m+n, where **n** is the number of common bands of x and y cultivars.

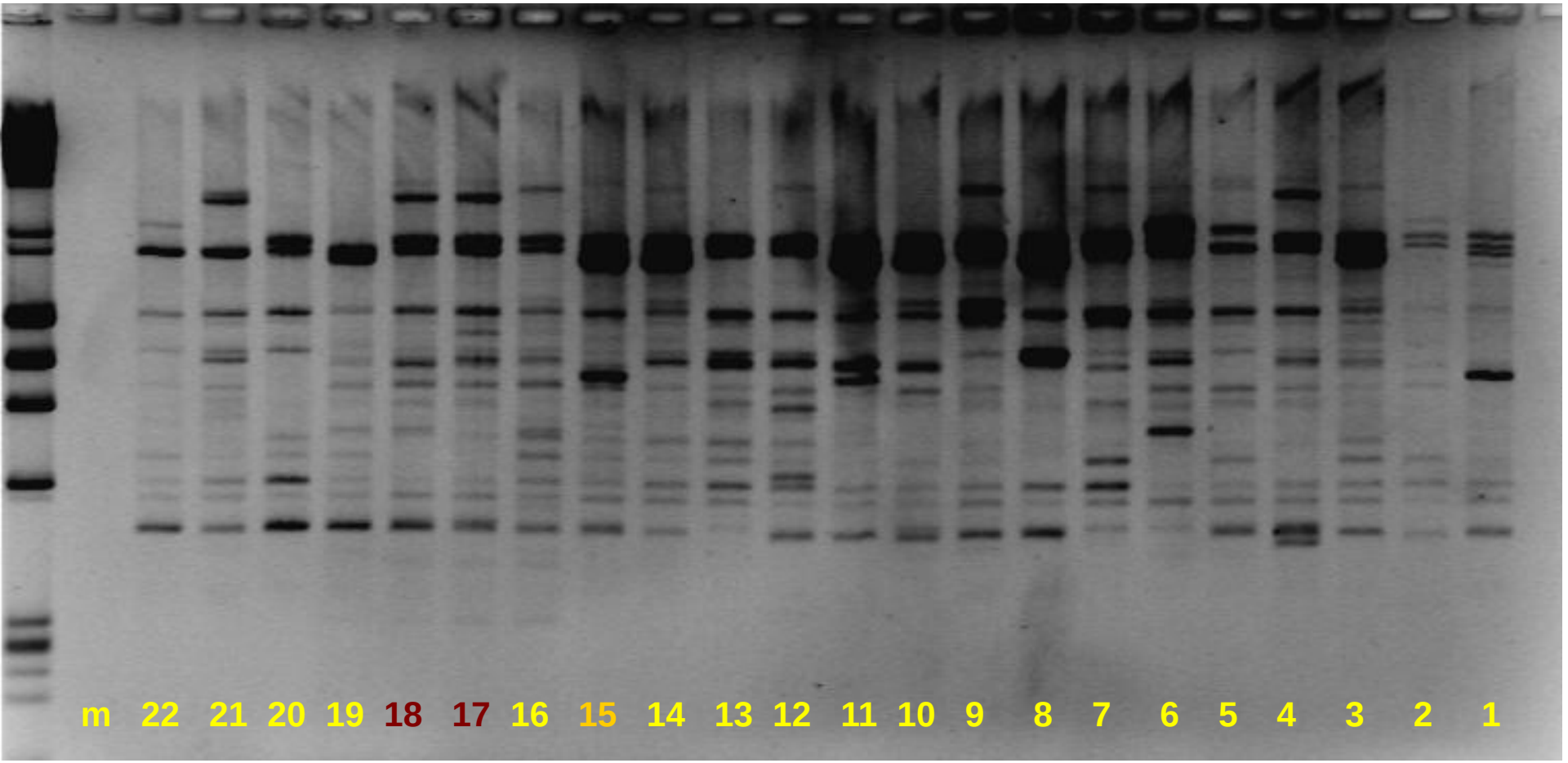
- Dendrogram with the statistical program NT-SYSTEM 1.8 developed by Rohlf, based on method UPGMA


m 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

OPM-02

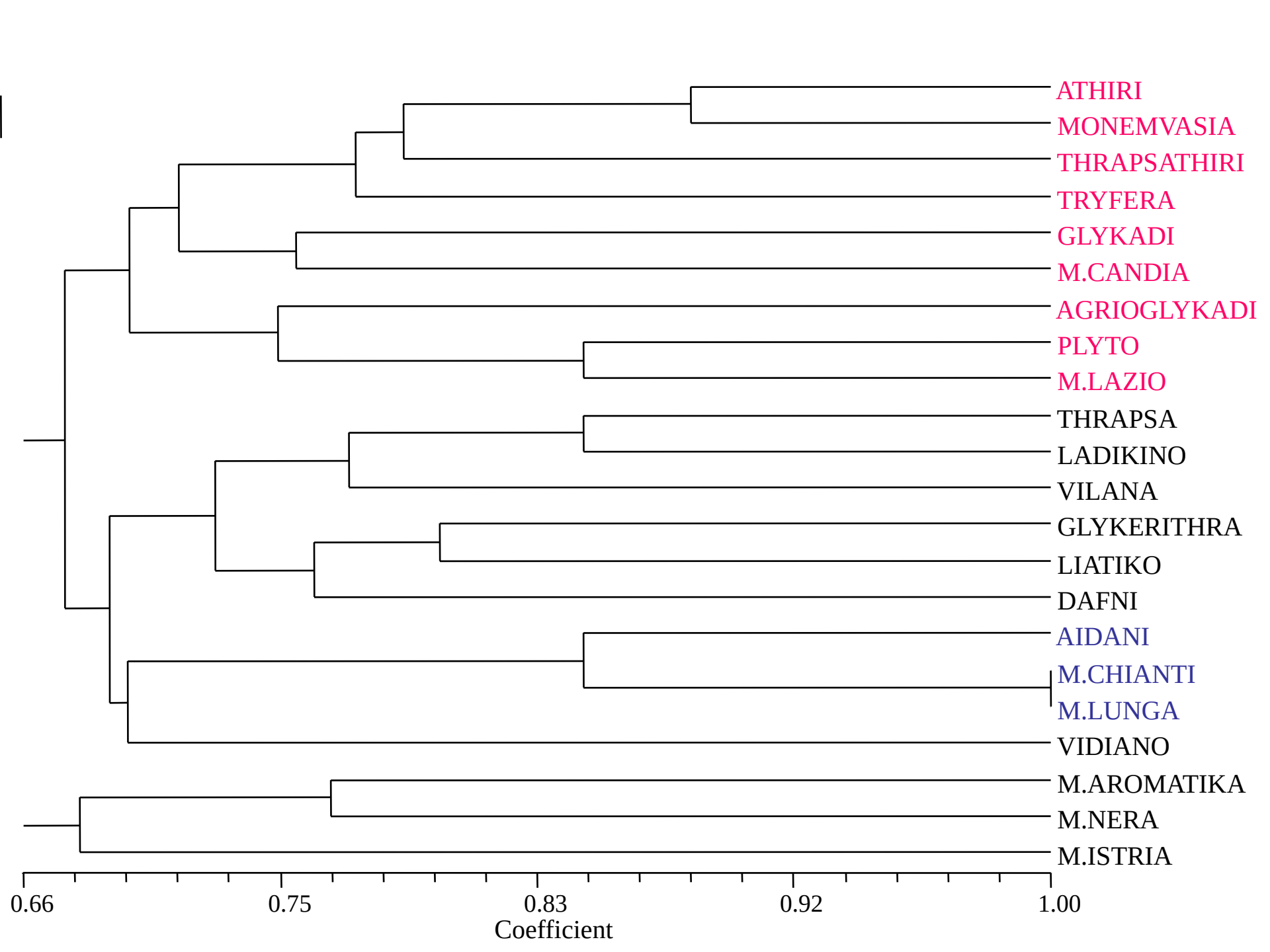


OPM-18



	ATHIRI	THRAPSATHIRI	THRAPSA	AIDANI	GLYKADI	AGRIOGLYKADI	GLYKERITHRA	TRYFERA	PLYTO	LIATIKO	DAFNI	VIDIANO	VILANA	LADIKINO	MONEMVASIA	M.CANDIA	M.CHIANTI	M.LUNGA	M.AROMATICA	M.ISTRIA	M.LAZIO	M.NERA
ATHIRI	1,00																					
THRAPSATHIRI	0,79	1,00																				
THRAPSA	0,66	0,66	1,00																			
AIDANI	0,70	0,67	0,71	1,00																		
GLYKADI	0,70	0,75	0,62	0,70	1,00																	
AGRIOGLYKADI	0,65	0,67	0,59	0,67	0,68	1,00																
GLYKERITHRA	0,65	0,74	0,75	0,72	0,66	0,76	1,00															
TRYFERA	0,79	0,74	0,64	0,65	0,66	0,72	0,72	1,00														
PLYTO	0,72	0,72	0,75	0,74	0,68	0,74	0,76	0,72	1,00													
LIATIKO	0,68	0,75	0,69	0,68	0,60	0,73	0,80	0,71	0,73	1,00												
DAFNI	0,71	0,71	0,69	0,64	0,60	0,66	0,73	0,68	0,68	0,79	1,00											
VIDIANO	0,64	0,75	0,62	0,71	0,69	0,68	0,73	0,61	0,71	0,67	0,72	1,00										
VILANA	0,55	0,65	0,78	0,62	0,54	0,65	0,79	0,62	0,67	0,68	0,68	0,70	1,00									
LADIKINO	0,65	0,69	0,85	0,67	0,63	0,65	0,76	0,67	0,74	0,73	0,75	0,68	0,76	1,00								
MONEMVASIA	0,88	0,79	0,59	0,67	0,75	0,69	0,67	0,79	0,69	0,75	0,68	0,66	0,58	0,67	1,00							
M.CANDIA	0,67	0,79	0,70	0,62	0,75	0,65	0,72	0,67	0,67	0,75	0,68	0,73	0,67	0,69	0,72	1,00						
M.CHIANTI	0,66	0,66	0,72	0,85	0,69	0,63	0,68	0,63	0,68	0,74	0,69	0,69	0,66	0,73	0,66	0,73	1,00					
M.LUNGA	0,66	0,66	0,72	0,85	0,69	0,63	0,68	0,63	0,68	0,74	0,69	0,69	0,66	0,73	0,66	0,73	1,00	1,00				
M.AROMATICA	0,63	0,73	0,62	0,61	0,65	0,59	0,59	0,68	0,61	0,67	0,62	0,60	0,66	0,61	0,68	0,68	0,67	0,67	1,00			
M.ISTRIA	0,67	0,69	0,68	0,65	0,56	0,62	0,65	0,69	0,72	0,66	0,61	0,61	0,65	0,69	0,65	0,60	0,66	0,66	0,68	1,00		
M.LAZIO	0,70	0,73	0,69	0,71	0,72	0,75	0,75	0,73	0,85	0,76	0,65	0,69	0,66	0,68	0,70	0,73	0,72	0,72	0,69	0,75	1,00	
M.NERA	0,63	0,73	0,60	0,61	0,67	0,73	0,73	0,68	0,68	0,74	0,67	0,67	0,70	0,70	0,68	0,70	0,67	0,67	0,76	0,68	0,79	1,00

	ATHIRI	THRAPSATHIRI	THRAPSA	AIDANI	GLYKADI	AGRIOGLYKADI	GLYKERITHRA	TRYFERA	PLYTO	LIATIKO	DAFNI	VIDIANO	VILANA	LADIKINO	MONEMVASIA	M.CANDIA	M.CHIANTI	M.LUNGA	M.AROMATICA	M.ISTRIA	M.LAZIO	M.NERA
ATHIRI	1,00																					
THRAPSATHIRI	0,79	1,00																				
THRAPSA	0,66	0,66	1,00																			
AIDANI	0,70	0,67	0,71	1,00																		
GLYKADI	0,70	0,75	0,62	0,70	1,00																	
AGRIOGLYKADI	0,65	0,67	0,59	0,67	0,68	1,00																
GLYKERITHRA	0,65	0,74	0,75	0,72	0,66	0,76	1,00															
TRYFERA	0,79	0,74	0,64	0,65	0,66	0,72	0,72	1,00														
PLYTO	0,72	0,72	0,75	0,74	0,68	0,74	0,76	0,72	1,00													
LIATIKO	0,68	0,75	0,69	0,68	0,60	0,73	0,80	0,71	0,73	1,00												
DAFNI	0,71	0,71	0,69	0,64	0,60	0,66	0,73	0,68	0,68	0,79	1,00											
VIDIANO	0,64	0,75	0,62	0,71	0,69	0,68	0,73	0,61	0,71	0,67	0,72	1,00										
VILANA	0,55	0,65	0,78	0,62	0,54	0,65	0,79	0,62	0,67	0,68	0,68	0,70	1,00									
LADIKINO	0,65	0,69	0,85	0,67	0,63	0,65	0,76	0,67	0,74	0,73	0,75	0,68	0,76	1,00								
MONEMVASIA	0,88	0,79	0,59	0,67	0,75	0,69	0,67	0,79	0,69	0,75	0,68	0,66	0,58	0,67	1,00							
M.CANDIA	0,67	0,79	0,70	0,62	0,75	0,65	0,72	0,67	0,67	0,75	0,68	0,73	0,67	0,69	0,72	1,00						
M.CHIANTI	0,66	0,66	0,72	0,85	0,69	0,63	0,68	0,63	0,68	0,74	0,69	0,69	0,66	0,73	0,66	0,73	1,00					
M.LUNGA	0,66	0,66	0,72	0,85	0,69	0,63	0,68	0,63	0,68	0,74	0,69	0,69	0,66	0,73	0,66	0,73	1,00	1,00				
M.AROMATICA	0,63	0,73	0,62	0,61	0,65	0,59	0,59	0,68	0,61	0,67	0,62	0,60	0,66	0,61	0,68	0,68	0,67	0,67	1,00			
M.ISTRIA	0,67	0,69	0,68	0,65	0,56	0,62	0,65	0,69	0,72	0,66	0,61	0,61	0,65	0,69	0,65	0,60	0,66	0,66	0,68	1,00		
M.LAZIO	0,70	0,73	0,69	0,71	0,72	0,75	0,75	0,73	0,85	0,76	0,65	0,69	0,66	0,68	0,70	0,73	0,72	0,72	0,69	0,75	1,00	
M.NERA	0,63	0,73	0,60	0,61	0,67	0,73	0,73	0,68	0,68	0,74	0,67	0,67	0,70	0,70	0,68	0,70	0,67	0,67	0,76	0,68	0,79	1,00


ATHIRI
MONEMVASIA
THRAPSATHIRI
TRYFERA
GLYKADI
M.CANDIA
AGRIOGLYKADI
PLYTO
M.LAZIO
THRAPSA
LADIKINO
VILANA
GLYKERITHRA
LIATIKO
DAFNI
AIDANI
M.CHIANTI
M.LUNGA
VIDIANO
M.AROMATIKA
M.NERA
M.ISTRIA
0.66
0.75
0.83
0.92
1.00
Coefficient

- In general, there was genetic variation among the cultivars studied. It is interesting that Greek grape cultivars Thrapsa, Ladikino, Vilana, Glykerithra, Liatiko and Dafni were grouped in a single branch of the tree while Malvasia aromatica, Malvasia nera and Malvasia istria were grouped in a different branch.
- The same holds for the cultivars Aidani, Malvasia del Chianti and Malvasia lunga.
- Another interesting finding was the comparatively lower degree of genetic similarity between the grape cultivar Monemvasia and the group of Malvasia cultivars which varies from 0.65 – 0.72
- Athiri and Malvasia di Candia grouped to a single branch of the tree

Ευχαριστώ