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## Identification of grape cultivars from Liguria (north-western Italy)

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### Summary

In order to identify grape varieties from Liguria (north-western Italy), 51 accessions (major, minor and neglected cultivars) were compared to those present in the grape collections of the neighbouring regions. Synonyms were confirmed by SSR markers (9 loci). Only 36 unique genetic profiles were found within grapes from Liguria, demonstrating the occurrence of synonyms with cultivars either from the same region or from other grape growing areas. Six evident misnames were found as well as homonyms. Four unexpected synonyms provided an opportunity to trace the likely origin and/or the movement of ancient cultivars, including ‘Vernaccia di San Gimignano’.

**Key words:** *Vitis vinifera* L., true to type, synonyms, DNA typing, molecular markers, microsatellites.

### Introduction

The region of Liguria, in north-western Italy, lies between the southern Alps and the Apennines, with the Mediterranean to the south (Figure). Because of its navigators, Liguria has been famous since ancient times; over the years, its wines have also gained an excellent reputation. These wines include ones produced around Vernazza and Corniglia (eastern Liguria), villages that form part of the so-called *Cinque Terre* (The Five Lands). They have supplied the city of Genoa since the XIII century and were also shipped to France and Belgium along the river Rhone (BACCI 1596). Around 1400-1500 the popular Moscatello produced near Taggia (western Liguria) was traded in most western Mediterranean ports, in Britain and in Flanders (CARASSALE 2002). The monumental work by count Giorgio Gallesio, *Pomona Italiana* (1817-1839) which includes descriptions and plates of about 150 fruit cultivars, including 26 grapes, was produced in Liguria.

After a period of decline, the regional wine economy is undergoing a revival. Most of the wines are based on local grape varieties, such as ‘Vermentino’, widely planted all over the region, ‘Bosco’ and ‘Albarola’, mainly grown on the eastern coast (*Riviera di Levante*), and ‘Ormeasco’ and ‘Rossese di Dolceacqua’, restricted to the western part (*Riviera di Ponente*). Some innovative producers are also growing several minor varieties of local interest, such as ‘Lumassina’, ‘Bianchetta genovese’, ‘Rollo’ and ‘Scimiscia’. A project to study, evaluate and improve the grape cultivars grown in Liguria was begun in 1990. It first ex-

amined clonal selection, virus sanitation and propagation of the major varieties. From 2001 on, minor grapes were also evaluated while local neglected cultivars (often endangered) were rescued. In order to identify the material collected, *i.e.* to establish the right name of each accession, its synonyms and homonyms, investigations were carried out in the region and neighbouring areas. Exchange of cultivars between adjacent areas is in fact quite common. It was already known to ancient ampelographers that the local grape ‘Ormeasco’, grown in the hills north of the town of Imperia, is the same as ‘Dolcetto’ (GALLESIO 1817/1839), a wine grape widespread in Piedmont, ‘Vermentino’, the major grape in Liguria, is identical to ‘Pigato’ (typically grown in a limited area of the Savona province), and the same as ‘Favorita’ from Piedmont (SCHNEIDER and MANNINI 1990).

Comparisons were therefore made of grape varieties from Liguria with varieties from other regions, such as

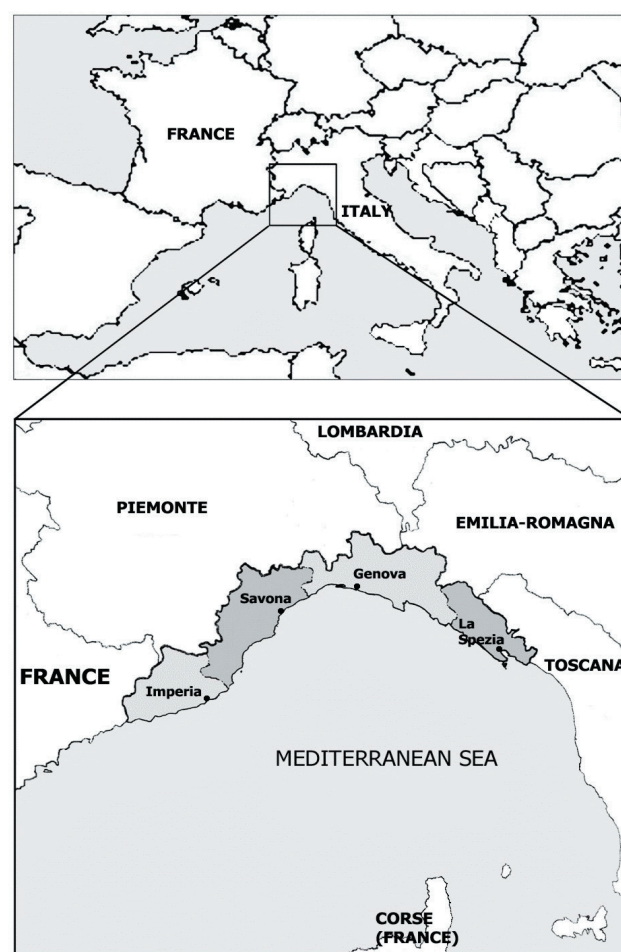


Figure: The region of Liguria and its provinces.

Piedmont, Emilia-Romagna, Tuscany, southern France and Corsica. Suspected synonymy arising from direct observation of plant morphology were checked by nuclear DNA typing through Simple Sequence Repeat (microsatellite) markers.

Microsatellite analysis proved to be an objective, reproducible and powerful tool for grape cultivar genotyping. Microsatellites are generally used for verifying synonyms and homonyms (MARTÍN *et al.* 2003, BOCCACCI *et al.* 2004, SANTIAGO *et al.* 2005, ALMADANIM *et al.* 2007, LACOMBE *et al.* 2007). Moreover, their co-dominant Mendelian inheritance allows the reconstruction of crosses (BOWERS and MEREDITH 1997, BOWERS *et al.* 1999 a, DETTWEILER *et al.* 2000; CRESPIAN 2003, VOULLAMOZ and GRANDO 2006, DI VECCHI-STARAZ *et al.* 2007, SCHNEIDER *et al.* 2008, LAUCOU *et al.* 2008) and the description of population genetic structure (SEFC *et al.* 2000, ARADHYA *et al.* 2003).

This paper presents and discusses synonyms and homonyms established for grapes, comparing 51 cultivars from Liguria with major and minor varieties from neighbouring regions. The aim of the work was: a) to accurately identify grape cultivars, b) to establish for each cultivar the reference name (when officially registered) and synonyms, c) to ascertain synonyms (and therefore duplications) in grapevine collections, and d) to investigate the origin of some ancient grapes and their movement along historical routes.

### Material and Methods

Tab. 1 lists the 51 grape cultivars from Liguria included in this study. Four further cultivars from Piedmont, homonyms of several grapes from Liguria, were also investigated (Tab. 2). All the material, maintained in an *ex-situ* collection located in Albenga (province of Savona), was visually examined for the main ampelographic and morphological characters. Surveys in the following grape collections were carried out by the same team, looking for possible synonymy to be checked by DNA typing. Four collections in the nearby regions were visited, the first three in Italy, the last in France: a) that held by CRA, Istituto Sperimentale Viticoltura Sez. Arezzo, at Paolo Loriani's farm Podere Scurtarola, near Massa Carrara (Tuscany); b) that held by the Catholic University of Piacenza, Istituto di Fruttivicultura, at Stefano Casaroli's farm La Quercia Verde, near Piacenza (Emilia-Romagna); c) that held by CNR, Istituto di Virologia Vegetale, at Grinzane Cavour near Alba (Piedmont); d) that held by INRA at the Domaine de Vassal (Languedoc-Roussillon, <http://www.montpellier.inra.fr/vassal>). The first three collections are specifically oriented to preserve local cultivars. In the last, cultivars from south-eastern France, Corsica and Italy were investigated.

Major morphological characters (38 ampelographic descriptors selected from Genres 081 list: <http://www.genres.de/eccdb/vitis> (Tab. 3) were recorded (data not shown) with the aim of comparing either material in the field or already published descriptions, when present, especially of varieties included in the Italian, French and Span-

ish National Catalogues (<http://www.politicheagricole.it>; <http://www.onivins.fr/EspaceProPlants/VarietesIndex.asp>; CHOMÉ *et al.* 2003).

For microsatellite analysis, DNA was extracted from young leaves (0.2 g) following the procedure described by THOMAS *et al.* (1993), but with some modifications. Samples were analysed at 9 SSR *loci*: VVS2 and VVS5 (THOMAS and SCOTT 1993), VVMD5, VVMD7, VVMD27, VVMD36 (BOWERS *et al.* 1996; 1999 b), VrZAG62, VrZAG67 and VrZAG79 (SEFC *et al.* 1999). Six of these *loci* were proposed by THIS *et al.* (2004) as common markers for international use.

Samples were then analysed on an ABI 3130 capillary sequencer (Applied Biosystems, Foster City, Calif., USA). Data were processed by the GeneMapper Software 4.0 (Applied Biosystems) and alleles defined by their size (in bp), compared with standard (GeneScan-500 LIZ, Applied Biosystems).

Synonyms were investigated by comparing the genetic profile of each cultivar with the genetic profiles of: a) the synonyms found in the collections, presumed on the basis of vine morphology, b) about 500 cultivars included in an SSR genetic database developed by CNR, Istituto di Virologia Vegetale (unpublished data), and c) presumed synonyms available in the literature.

Profiles were compared with IDENTITY 1.0 software (WAGNER and SEFC, 1999). The probability of identity PI (PAETKAU *et al.* 1995) was calculated as  $\sum p_i^4 + \sum \sum (2p_i p_j)^2$ ,  $p_i$  and  $p_j$  being the frequencies of allele  $i$  and  $j$  respectively.

### Results and Discussion

**S y n o n y m s :** Of the 51 cultivars from Liguria, 36 unique genetic profiles were detected; four further genotypes corresponded to the four cultivars from Piedmont, homonyms of several Ligurian grapes. Thus 40 genetic profiles are shown in Tab. 4, with the names of the cultivars and their synonyms. With this population, the probability of obtaining identical genotypes at all nine *loci* from different cultivars was estimated as  $10^{-12}$ , while a value close to  $10^{-8}$  was found in cultivars from Croatia (MALETIĆ *et al.* 1999). It is therefore highly unlikely to detect false synonyms with these nine SSR *loci*. Furthermore, ampelographic information on vine morphology (not shown) strongly supported the genotyping results.

Several synonyms refer to cultivars from the same Liguria region: 'Pane e torta' turned out to be a local name for 'Bosco', a rather important grape of eastern Liguria; 'Frate pelato' was the same as both 'Genovèse' from France and 'Scimiscià', a variety from the province of Genoa recently included in the Italian Catalogue; 'Colombana' was the same as 'Verdecana'. 'Albarola (Kilhgren)' showed a genetic profile corresponding to that of 'Albarola', although differing in bunch compactness (clonal variation).

Most of the detected synonyms, however, involved grapes from neighbouring areas, both from Italy and France (shown as references in the second column of Tab. 4). Many cultivars found in Liguria are present and

Table 1

Grape cultivars from Liguria included in this study; their provenance, grape colour, use, cultural importance in the region, and data recorded for identification

Cultivars from Liguria	Provenance (province*)	Berry colour **	Use	Cultural importance ***	Morphology/ Fingerprint
Albarola	Lavagna, Né (GE)	B	Wine	L	+/+
Albarola	La Spezia province	B	Wine	R	+/+
Albarola (Kilhgren)	Sarzana (SP)	B	Wine	N	+/+
Antico rubino	Calice al Cornoviglio (SP)	N	Wine	N	+/+
Barbarossa	Finale Ligure (SV)	R	Wine, Table	L	+/+
Barbarossa 1	Riomaggiore (SP)	N	Wine	N	+/+
Barbarossa 2	Riomaggiore (SP)	N	Wine, Table	L	+/+
Barbarossa verduna	Nasino (SV)	Rs	Wine, Table	E	+/+
Bianchetta genovese	Genoa province	B	Wine	L	+/+
Bordó	Arcola (SP)	B	Wine, Table	N	+/+
Bosco	La Spezia province	B	Wine	R	+/+
Bracciola bianca	Arcola Loc. Masignano (SP)	B	Wine	N	+/-
Bracciola nera	Arcola (SP)	N	Wine	N	+/+
Bruciapagliaio	Monterosso (SP)	B	Wine	E	+/+
Colombana	Arcola, Levante (SP), Né (GE)	B	Table	L	+/+
Croetto	Ranzo (IM)	N	Wine	E	+/+
Frate pelato	Monterosso (SP)	B	Wine	E	+/+
Gallizzone	Castelnuovo Magra (SP)	V	Wine, Table	N	+/+
Granaccia	Savona province	N	Wine	L	+/+
Granaccio	Ortovero, Arnasco (SV)	N	Wine	N	+/+
Greco bianco	Santo Stefano Magra (SP)	B	Wine	N	+/+
Luigese	Arcola (SP)	B	Table	N	+/+
Madera	Quiliano (SV)	B	Wine, Table	E	+/+
Malvasia nera	Levanto (SP)	N	Table	E	+/+
Massarda	Soldano (IM)	B	Table	N	+/-
Massaretta	Ortonovo (SP)	N	Wine	L	+/+
Menuetta	Quiliano (SV)	B	Wine, Table	E	+/+
Merla	Sarzana (SP)	N	Wine	L	+/+
Moron	Bolano (SP)	N	Wine, Table	N	+/-
Moscaticello di Taggia	Ceriana (IM)	B	Wine	N	+/+
Pane e torta	Finale Ligure (SV)	B	Wine, Table	E	+/+
Piccabón	Monterosso (SP)	B	Wine	N	+/+
Pollera	Santo Stefano Magra (SP)	V	Wine	N	+/+
Pollera	Arcola (SP)	V	Wine	L	+/+
Porporino	Finale Ligure (SV)	N	Wine	N	+/-
Rollo	Né (GE)	B	Wine	L	+/+
Rossese	Campochiesa, Cisano sul Neva (SV)	R	Wine	L	+/+
Rossese	Dolceacqua (IM)	V	Wine	R	+/+
Rossese bianco	Arcola (SP)	B	Wine	L	+/+
Rossese bianco	S.Biagio della Cima, Soldano (IM)	B	Wine	L	+/+
Rossese bianco	Riomaggiore (SP)	B	Wine	E	+/+
Scimiscià	Genoa province	B	Wine	L	+/+
Scozzetto 1	Bolano (SP)	N	Wine	N	+/+
Scozzetto 2	Bolano (SP)	V	Wine	N	+/+
Sinsón	Ortovero (SV)	N	Wine, Table	E	+/+
Tintorino	Levanto (SP)	N	Wine	E	+/+
Uva spina	Ceriana (IM)	N	Wine	E	+/+
Verdea	Quiliano (SV)	B	Wine, Table	N	+/+
Verdecana	Né (GE)	B	Wine, Table	N	+/+
Vermentino	Savona province	B	Wine, Table	R	+/+
Vermentino nero	Castelnuovo Magra (SP)	N	Wine	L	+/+

\* Provinces of Liguria: GE = Genoa, IM = Imperia, SP = La Spezia, SV = Savona.

\*\* Berry colour according to OIV descriptor code 225: B = white, R = red, Rs = pink, V = violet, N = black.

\*\*\* R = regional; L = local; N = neglected; E = endangered.

Table 2

Grape cultivars from Piedmont also included in this study because homonyms of several grapes from Liguria; their provenance, grape colour, use, cultural importance in the region, and data recorded for identification

Cultivars from neighbouring areas	Provenance (province*)	Berry colour **	Use	Cultural importance ***	Morphology/ Fingerprint
Barbarossa	Castelnuovo Bormida (AL)	Rs	Table	N	+/+
Barbarossa	Bricherasio (TO)	Rs	Wine, Table	N	+/+
Rossese bianco	Roddino (CN)	B	Wine	L	+/+
Rossese bianco	Monforte (CN)	B	Wine	E	+/+

\* Provinces of Piedmont: AL = Alessandria, TO = Torino, CN = Cuneo.

\*\* Berry colour according to OIV descriptor code 225: B = white, Rs = pink.

\*\*\* L = local; N = neglected; E = endangered.

Table 3

List of the morphological descriptors recorded in this study

Codes	Descriptors
OIV001	Young shoot: opening of the shoot tip
OIV003	Young shoot: intensity of anthocyanin coloration on prostrate hairs of the shoot tip
OIV004	Young shoot: density of prostrate hairs on the shoot tip
OIV006	Shoot: attitude (before tying)
OIV007	Shoot: color of the dorsal side of internodes
OIV008	Shoot: color of the ventral side of internodes
OIV016	Shoot: number of consecutive tendrils
OIV051	Young leaf: color of upper side of blade (4th leaf)
OIV053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)
OIV065	Mature leaf: size of blade
OIV067	Mature leaf: shape of blade
OIV068	Mature leaf: number of lobes
OIV070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade
OIV072	Mature leaf: goffering of blade
OIV074	Mature leaf: profile of blade in cross section
OIV075	Mature leaf: blistering of upper side of blade
OIV076	Mature leaf: shape of teeth
OIV078	Mature leaf: length of teeth compared to their width
OIV079	Mature leaf: degree of opening / overlapping of petiole sinus
OIV080	Mature leaf: shape of base of petiole sinus
OIV081-1	Mature leaf: teeth in the petiole sinus
OIV081-2	Mature leaf: petiole sinus base limited by vein
OIV083-2	Mature leaf: teeth in the upper lateral sinuses
OIV084	Mature leaf: density of prostrate hairs between main veins on lower side of blade
OIV087	Mature leaf: density of erect hairs on main veins on lower side of blade
OIV094	Mature leaf: depth of upper lateral sinuses
OIV151	Flower: sexual organs
OIV202	Bunch: length (peduncle excluded)
OIV204	Bunch: density
OIV206	Bunch: length of peduncle of primary bunch
OIV208	Bunch: shape
OIV209	Bunch: number of wings of the primary bunch
OIV223	Berry: shape
OIV225	Berry: color of skin
OIV231	Berry: intensity of flesh anthocyanin coloration
OIV235	Berry: firmness of flesh
OIV236	Berry: particular flavor
OIV241	Berry: formation of seeds

even widespread in Tuscany under the names of 'Canaio-  
lo', 'Bonamico', 'Livornese bianca', 'Barsagli-  
na', 'Malvasia bianca lunga' (or 'Malvasia del Chianti'), 'Vernaccia di

San Gimignano', and 'Canaio bianco'. 'Bervedino' (from  
Emilia-Romagna) and 'Verdea' (from Piedmont and other  
regions) are also synonyms of grapes grown in Liguria.

Table 4

Genetic profiles at 9 SSR *loci* (allele sizes in bp) of the synonym and the homonym cultivars analyzed. In the first column are listed the cultivars from Liguria and the homonyms from other regions. In the second column are shown the reference names (reported in the literature and/or in National Catalogues)

Cultivars from Liguria and related homonyms from other regions	Reference names	VVMD5	VVMD7	VVMD27	VVMD36	VVS2	VVS5	VrZAG62	VrZAG67	VrZAG79									
Albarola (Kilgren)	<i>Albarola (I), Bianchetta genovese (I)</i>	231	235	243	263	180	180	251	296	133	155	95	147	188	194	126	139	248	258
Albarola (La Spezia)																			
Bianchetta genovese																			
Albarola (Lavagna, GE)		225	235	247	263	188	188	253	263	133	139	87	87	188	194	139	153	250	250
Antico Rubino, Scozzetto 1		227	227	239	249	188	194	269	296	133	151	95	147	194	200	132	150	244	258
Barbarossa (Finale Ligure, SV)		235	237	239	247	178	184	263	263	133	143	109	113	186	204	132	132	250	254
Barbarossa 1, Merla	<i>Canaiolo (I)</i>	227	239	233	239	184	188	263	265	133	135	99	147	188	204	132	139	250	258
Barbarossa 2, Porporino	<i>Bonamico (I)</i>	225	227	253	263	182	184	253	253	133	135	99	117	200	202	139	163	238	244
Barbarossa verduna	Grisa rousa (I) Grec rouge (F) <i>Cipar (C)</i>	227	235	247	253	184	184	253	263	133	143	113	147	188	194	132	150	238	250
Barbarossa (Castelnuovo B., L)		227	239	239	247	180	184	263	265	133	145	95	95	194	196	126	132	250	258
Barbarossa (Bricherasio, TO)		227	235	239	247	184	188	263	294	133	143	109	109	194	204	126	153	250	258
Botdó	<i>Chasselas rouge (F)</i>	227	235	239	247	184	188	263	294	133	143	109	109	194	204	126	153	250	258
Bracciola nera	<i>Chasselas (F)</i>	233	239	253	253	184	194	263	265	133	145	87	117	194	200	139	139	250	250
Bruciapagliaio, Rollo	<i>Rollo (I)</i> <i>Livornese Bianca (I)</i> <i>Pogadebiti (F)</i>	225	231	239	249	182	194	265	269	133	133	119	147	194	200	139	150	244	250
Colombana, Verdecana, Verdea																			
Croetto	<i>Verdea (I)</i>	233	239	247	247	178	188	263	265	133	133	99	147	194	204	139	139	244	248
		225	245	247	253	178	194	247	247	133	151	95	95	186	188	139	150	248	250
Frate pelato, Scimiscià	<i>Scimiscià (I)</i> <i>Genovèse (F)</i>	225	235	239	253	178	188	253	263	133	133	87	117	188	200	139	153	250	258
Gallizzone		225	231	239	247	180	188	247	269	133	151	109	147	194	204	126	132	244	258
Granaccia	<i>Alicante (I)</i> <i>Grenache (F)</i> <i>Garnacha (S)</i>	225	239	239	243	194	194	265	269	137	145	87	117	188	188	132	150	256	256
Gramaccio																			
Greco bianco	<i>Carrignan (F)</i>	225	227	239	239	180	184	263	263	143	145	107	117	186	188	126	139	250	258
		225	225	247	249	188	194	263	263	139	155	109	147	200	204	139	150	244	250
Luigese	Luglienga (I) Lignan (F)	227	235	247	247	184	184	263	296	145	155	109	147	192	194	126	126	238	250

Tab 4, continued

Cultivars from Liguria and related homonyms from other regions	Reference names	VVMD5	VVMD7	VVMD27	VVMD36	VVS2	VVS5	VrZAG62	VrZAG67	VrZAG79								
Madera	<i>Listan (F)</i> <i>Palomino fino (S)</i>	227	239	249	253	271	133	145	87	117	188	194	132	152	250	256		
Malvasia nera	<i>Moscato d'Amburgo (I)</i> <i>Muscat de Hambourg (F)</i> <i>Muscat of Hamburg</i>	231	237	247	249	253	294	135	149	109	186	192	126	155	238	254		
Massaretta	<i>Barsagliana (I)</i>	245	245	239	257	247	253	133	155	109	147	194	196	150	159	248	258	
Menuetta	<i>Malvasia bianca lunga (I)</i>	225	239	239	253	253	253	145	145	99	109	196	200	139	139	242	250	
Moscattello di Taggia	<i>Moscato bianco (I)</i> <i>Muscat à petits grains blancs (F)</i>	227	235	233	249	178	194	243	263	133	133	109	186	126	139	250	254	
Pane e torta, Bosco	<i>Bosco (I)</i>	225	235	239	263	180	184	263	269	133	135	109	147	188	196	250	258	
Piccabón	<i>Fernaccia di San Gimignano (I)</i> <i>Canaiolo bianco (I)</i> <i>Bervedino (I)</i>	225	225	239	249	182	188	263	275	135	143	95	188	190	132	238	244	
Pollera (S. Stefano Magra, SP)		225	237	247	249	178	188	257	263	143	155	147	200	204	139	150	244	250
Pollera (Arcola, SP), Scozzetto 2		225	231	239	249	188	194	257	257	133	151	147	194	200	139	139	244	258
Rossese (Campochiesa, IM)		225	235	233	239	180	180	269	269	133	135	117	186	204	150	150	258	258
Rossese (Dolceacqua, IM)	<i>Rossese (I)</i> <i>Tibouren (F)</i>	225	237	247	249	178	178	263	263	133	139	87	186	204	139	139	248	258
Rossese bianco (Arcola, SP)	<i>Ruzzese (I)</i>	227	245	247	249	188	194	263	263	133	155	95	200	204	139	155	238	250
Rossese bianco (S. Biagio, IM)		225	233	239	247	178	184	253	263	133	139	87	186	186	139	139	248	250
Rossese bianco (Riomaggiore, SP)	<i>Grillo (I)</i>	225	227	249	249	178	194	253	294	143	149	117	186	202	126	126	246	250
Rossese bianco (Roddino, CN)	<i>Rossese bianco (I)</i>	225	227	247	253	178	184	263	294	139	155	109	194	204	132	155	248	250
Rossese bianco (Monforte, CN)		225	227	249	253	180	188	263	275	133	133	95	200	200	132	139	244	258
Sinsón, Uva spina	<i>Cinsaut (F)</i>	225	225	243	247	180	180	253	275	133	133	147	188	204	139	139	254	258
Tintorino		231	251	239	251	190	200	237	253	133	133	99	194	194	126	144	244	250
Vermentino	<i>Vermentino (I, F)</i>	233	237	249	249	180	180	263	263	133	151	87	200	204	132	132	248	258
Vermentino nero	<i>Vermentino nero (I)</i>	225	239	239	253	184	188	249	249	135	143	95	188	192	132	165	238	250

\* The name of the cultivar in the country where the name is officially used is in italics: C = Croatia, F = France, I = Italy, S = Spain.

'Luigese' is identical to 'Luglienga' ('Lignan' in France), a very ancient grape thought to be native of Italy. Cultivars from Spain and southern France ('Grenache', 'Carignan', 'Palomino fino'), either from Provence ('Grec rouge', 'Tibouren', 'Cinsaut') or Corsica ('Pagadebiti', 'Genovèse'), together with cultivars spread all over the world ('Chasselas', 'Muscat Hamburg', 'Muscat à petits grains blancs'), were all found in Liguria.

Looking into details, cultivars from Liguria are shown in Tab. 4 with their revealed reference identities. Reference names according to the National (Italian, French and Spanish) Catalogues are shown in italics. As regards Italy, except for 'Albarola', 'Bianchetta genovese' and 'Granaccia', 'Alicante', 'Grenache' (synonyms that our analyses confirmed but are already known and acknowledged by the Italian Catalogue), none of the others had been previously detected or published. The cultivar 'Rollo', grown in Liguria also under the name of 'Bruciapagliaio', for example, is registered in the Italian Catalogue as different from 'Livornese bianca' present along the coast of Tuscany, but our results showed that they are the same.

A similar result was found for 'Vernaccia di San Gimignano', a grape behind a wine produced in the village of San Gimignano in Tuscany. Vernaccia di San Gimignano, renowned since the Middle Ages, was the first wine in Italy to be awarded the DOC appellation more than 50 years ago. Our data show that 'Vernaccia di San Gimignano' is identical to 'Canaiolo bianco' planted in Tuscany, as well as to 'Bervedino', grown in Emilia-Romagna (both registered in Italy as different varieties); and this grape is also present in Liguria with the name of 'Piccabón' (or 'Picabón'), precisely in the area of the *Cinque Terre* (The Five Lands: Vernazza, Monterosso, Corniglia, Manarola and Riomaggiore). As already mentioned, wines from the *Cinque Terre* had a solid reputation in the XV century and before. Precisely in Tuscany the fame of "Vernaccia from Corniglia" is emphasized in the novels of GIOVANNI BOCACCIO (1313-1375) and FRANCO SACCHETTI (1332-1400), who wrote that woody material of "Vernaccia" was introduced into Tuscany from the *Cinque Terre* (TELLINI 2007). It was GIORGIO GALLESIO (1817/39) who claimed that name of the wine Vernaccia derives from its original *Cinque Terre* village of Vernazza, and reported the spread of 'Piccabón' right in the same place where Vernaccia was produced (and where we found 'Piccabón' as a neglected cultivar today). GALLESIO strongly believed 'Piccabón' to be the same as 'Vermentino', because he could not account for the lack of the name *Vermentino* in historical documents referring to Liguria. On the other hand, we do not believe it is a coincidence that 'Piccabón' is identical to 'Vernaccia di San Gimignano'. If, according to SACCHETTI, the introduction of planting material from the *Cinque Terre* into Tuscany truly occurred, we could presume 'Vernaccia di San Gimignano' (originally 'Piccabón') was brought from Liguria in the XIV century or even before.

Several synonymies confirm historical trade and migration routes between Spain, southern France, Corsica and Liguria. The Corsican 'Pagadebiti' and 'Genovèse' turned out to be the same as 'Rollo' (or 'Bruciapagliaio') and 'Scimiscià' respectively. The latter was believed to be

a unique and quite peculiar speciality of Genoa province. We also found the same grape in the *Cinque Terre* under the name of 'Frate pelato'. The Corsican name of 'Genovèse' could simply recall the introduction into the island from Liguria.

Regarding the identification of 'Rossese' (from Dolceacqua, in the province of Imperia) with the French 'Tibouren', it is difficult to say whether this cultivar came to Liguria from Provence or *vice versa*. 'Rossese', the leading coloured wine grape in Liguria, is used to produce the appellation wine Rossese di Dolceacqua in the western part of the region, close to the French border. According to GANZIN (1901), 'Tibouren' was introduced into the region of Var (southern France) in late XVIII century. There it covers 417 ha nowadays, and is used for quality rosé wines.

Another grape from Provence, 'Cinsaut', can be found in the *Riviera di Ponente*, where it is named 'Sinsón' (or 'Sinseur'). Another local name is 'Uva spina' (*i.e.* "prickle grape") because of the pronounced and protruding pistil residue remaining on the berry when still green. This grape, in Liguria, is currently at risk of disappearing from vineyards, while 'Cinsaut' plantings cover as much as 24,000 ha in the South of France.

Nearly half the investigated cultivars from Liguria, however, showed unique genotypes; they should be considered original and therefore valuable genetic resources. All of them have appeared in lists and/or ampelographic descriptions referring to Liguria grape growing areas dating back to the XIX century or before. Grapes such as 'Barbarossa' from Finale Ligure, 'Bracciola bianca', 'Bracciola nera', 'Gallizzone', 'Massarda', 'Rossese bianco' from Arcola, 'Vermentino nero', etc. should be regarded as local sources of genetic diversity which need to be maintained and protected.

**H o m o n y m s :** Our studies revealed some groups of homonyms, resulting from different genotypes (Tab. 4). 'Albarola' from Lavagna, of limited importance, is different from the registered 'Albarola', which is instead one of the main regional grapes.

Looking at the 'Barbarossa' ("red beard") group, those corresponding to 'Canaiolo' and 'Bonamico', bearing both black or dark violet coloured grapes, are evident misnames; in fact 'Barbarossa' is expected to show red grapes. The so-called 'Barbarossa verduna' (*i.e.* with a green hue) corresponds to 'Grisa rousa' in Piedmont (SCHNEIDER *et al.* 2001), 'Cipar' in Croatia (SIMON *et al.* 2007) and 'Grec rouge' in France; it is an ancient cultivar presenting coral-green coloured grapes which was widespread in Europe in the past. Two other 'Barbarossa' grapes were collected in Piedmont (Tab. 2): one of them is also called 'Uva reina', while the other is the red mutation of 'Chasselas blanc', *i.e.* 'Chasselas rouge', as already mentioned by TRUEL (1985). The authentic 'Barbarossa' from Liguria, popular because of the description of GALLESIO (1817-1839), is the one from Finale Ligure. Finally, the pink berried 'Barbaroux' from Provence (registered in the French Catalogue) is different from all the 'Barbarossa' grapes found in Liguria and in Piedmont (data not shown). The cultivar 'Granaccio' is 'Carignan', but the name (an evident error) implies confusion with 'Granaccia' ('Grenache').

Two different ‘Pollera’ grapes were examined: they both have violet grapes and they both come from the eastern side of the region. However their SSR profiles were distinct, and one ‘Pollera’ was identical to ‘Scozzetto’.

There are seven ‘Rossese’ homonyms. Of the two bearing violet/red grapes, from Campochiesa and from Dolceacqua (both grown in western Liguria), only the one from Dolceacqua (already noted here as synonym of ‘Tibouren’) is officially included in the Italian Catalogue. Plantings of the other ‘Rossese’ grapes are mainly limited to the area of Campochiesa, inland of Albenga (Savona province). One of these with white grapes turned out to correspond to ‘Grillo’, a speciality of Sicily, and therefore an example of evident misnaming. The only white ‘Rossese’ (*Rossese bianco*) currently included in the Italian Catalogue is from Roddino (Piedmont); application for official registration of the white grape ‘Ruzzese’, another cultivar grown around Arcola (near Tuscany) is now under examination.

One ‘Rossese’ with white grapes (“Rossese bianco” or “Roxeise”), is documented to have produced excellent wines around the XV century (BACCI 1596). The fame of this wine is the likely reason for the increasing interest in different ‘Rossese’ grapes in many places, in Liguria as well as in the nearby hills of Piedmont.

### Conclusions

Of the 51 grape accessions from Liguria investigated (major, minor and neglected cultivars), 36 proved to be unique genotypes, revealing the occurrence of synonyms with cultivars from the same region as well as from neighbouring areas or from the western Mediterranean basin.

Our results showed how the local grape diversity of an area is strictly related to that of other surrounding regions. This is especially true for Liguria, a land which extends along the Mediterranean coast and is therefore open to great material exchange by sea. Ancient trails which crossed the mountains to the north, connecting inland areas to the sea (such as the salt routes running between Liguria and Piedmont, Liguria and Lombardy), played an important role in exchange and movement of grape material. The finding of several unexpected synonyms has helped to trace the probable origin and/or movement of grapes, contributing to the research on ancient and famous wine cultivars, such as ‘Vernaccia di San Gimignano’, the grape behind one of Italy’s historic wines.

The significant number of unique grape genotypes from Liguria that we have detected represents an important and valuable heritage of biodiversity which should be protected and preserved. Grapevine collections play an essential role in this task. In this specific research, they also allowed the comparison and the analysis of material for identification purposes.

The research also showed the importance of considering cultivars from neighbouring areas (or even more distant ones) in order to allow correct varietal identification. Further development of ampelographic and genetic databases will greatly contribute to the comparison of cultivars

and accessions worldwide, under cultivation or in collections, thus increasing overall the accurate identification of varieties.

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## Corrigendum

In the manuscript:

### Identification of grape cultivars from Liguria (north-western Italy)

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wrong numbers have been listed in Tab. 4:

Table 4

Genetic profiles at 9 SSR *loci* (allele sizes in bp) of the synonym and the homonym cultivars analyzed. In the first column are listed the cultivars from Liguria and the homonyms from other regions. In the second column are shown the reference names (reported in the literature and/or in National Catalogues)

Cultivars from Liguria and related homonyms from other regions	Reference names	VVMD5	VVMD7	VVMD27	VVMD36	VVS2	VVS5	VrZAG62	VrZAG67	VrZAG79								
Antico Rubino, Scozzetto I		227	239	188	194	269	133	151	95	147	194	200	132	150	244	258		
Croetto		225	225	247	253	178	194	247	247	133	151	95	186	188	139	150	248	250
Menuetta	<i>Malvasia bianca lunga (I)</i>	225	239	239	253	178	178	253	253	145	145	99	196	200	132	139	242	250

\* The name of the cultivar in the country where the name is officially used is in italics: C = Croatia, F = France, I = Italy, S = Spain.