Wild grapevine *(Vitis vinifera* var. *silvestris)* in Italy: Distribution, characteristics and germplasm preservation - 1989 report

R. ANZANI [1]), O. FAILLA [1]), A. SCIENZA [1,2]) and F. CAMPOSTRINI [2])

[1]) Istituto di Coltivazioni Arboree, Università degli Studi di Milano, Via Celoria 2, I-20133 Milano, Italy

[2]) Istituto Agrario Provinciale, Via E. Mach 1, I-38010 San Michele all'Adige, Trento, Italy

S u m m a r y : Research on the distribution and characteristics of wild grapevines *(Vitis vinifera* var. *silvestris)* in Italy was started whose main goals are:

- the preservation of the germplasm by setting up plant collections;
- the furthering of biological knowledge about this plant;
- the study of relations between wild and cultivated grapevines by means of chemotaxonomic techniques;
- the assessment of the possibility of using wild plants for genetic improvement of grapevines.

The gathering of data began in 1984.

221 sites in 15 out of the 20 Italian regions have been indicated as possible locations in which wild grapevines grow. So far, 49 of these sites have been inspected. The greatest number of individuals were found in central Italy. This population is dioecious (male/female = 1.8) with few (2.0 %) hermaphrodite examples.

The leaves of the Italian wild grapevines generally have 3 lobes (57 %), but 5 to 7-lobe (36 %) and non-lobed (8.9 %) plants exist. Lower variability exists with regard to leaf shape. The study of seed morphology has classified the plants into three groupe, one of which is very numerous.

Two germplasm collections have been established with approximately 400 vines.

K e y w o r d s : Vitis vinifera var. silvestris, Italy, geographical distribution, gene resources, gene bank, ampelography, biometry, analysis, sexuality, morphology, leaf, seed.

Introduction

6 years ago (SCIENZA 1983) research on the distribution and characteristics of wild grapevines *(Vitis vinifera* var. *silvestris)* in Italy was started whose main aims are:

- the preservation of the germplasm by setting up plant collections;
- the furthering of biological knowledge about this plant;
- the study of relations between wild and cultivated grapevines by means of chemotaxonomic techniques;
- the assessment of the possibility of using wild plants for genetic improvement of grapevines.

Initial results have already been published (SCIENZA *et al.* 1986 and in print). The distinguishing feature of wild European grapevines as compared to cultivated ones is their sexuality. Wild vines are mostly dioecious: the male/female ratio of Italian population is 2 : 1, with few hermaphrodite examples (2.6 %).

From the data obtained it seems likely that wild vines grow all over the country up to an altitude of 800-1000 m a.s.l.

These plants are liana-like and can achieve a remarkable development up to 15-20 m in height. They adapt to the most geologically diverse soils and can grow in different botanical associations, provided there are trees available to serve as supports. Clusters are of small dimensions, scattered or dense. Berries are small, usually spherical, with about 2 seeds each, black is the predominant colour (9 % are white). The degree of variability in sugar content, acidity, tartaric and malic acid contents is rather large, even the anthocyanin and polyphenol contents show high variability.

Chemotaxonomic studies to compare wild and cultivated vines are being carried out using pollen (TEDESCO *et al.* 1990) and embryonic (SCIENZA *et al.* 1990) protein; and anthocyanin profiles (MATTIVI *et al.* 1990).

Germplasm collections are being set up by multiplying scions from wild plants.

In this paper we report the developments achieved by this project with particular emphasis on leaf and seed morphology.

Leaf and seed morphology have been recognized as important in *Vitis* taxonomy. Leaf size and petiolar sinus angle width are important phylogenetical characteristics, indeed wild grapevines have smaller leaves with a wider sinus petiolar angle than cultivated ones (LEVADOUX 1956). According to STUMMER (LEVADOUX 1956), two kinds of seeds exist: 'sativa' and 'silvestris', the first type is larger and longer, with a higher length/width ratio than the second one.

Materials and method

The gathering of data began in 1984. Based upon spot inspections and information obtained from the Corpo Forestale dello Stato (Italian Forestry Service), some geographical sites where wild grapevines are present were singled out in different regions of the country.

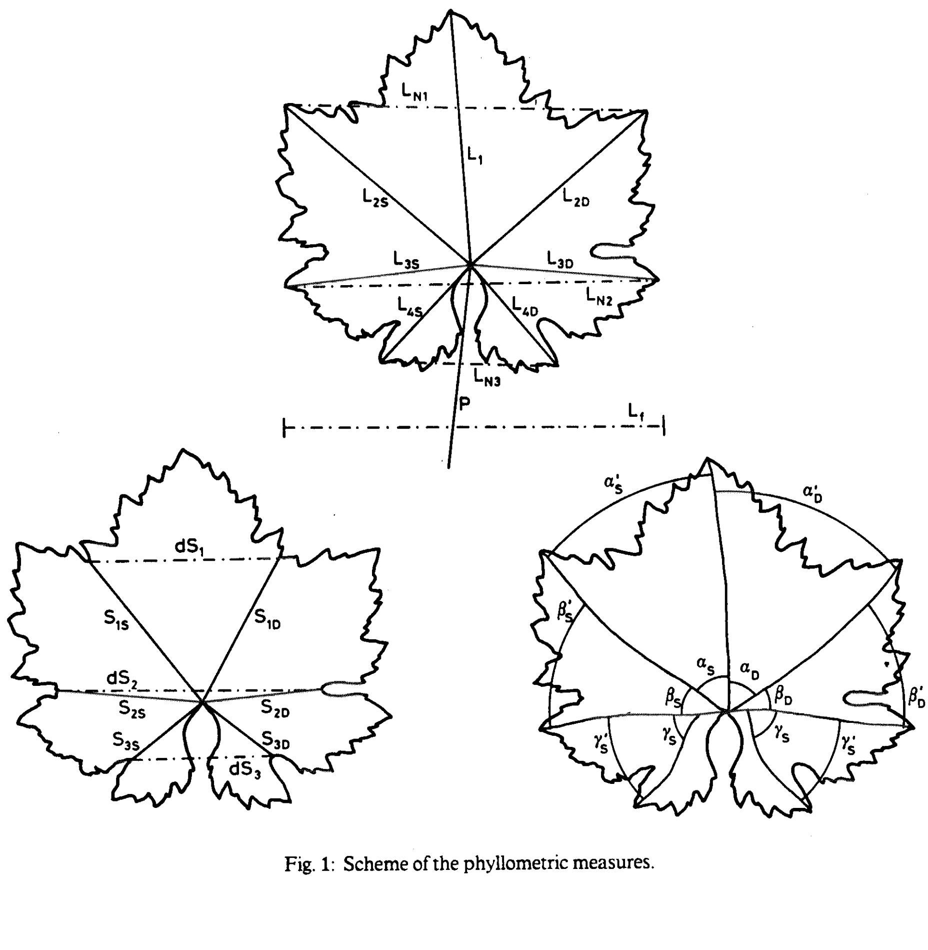

Fig. 1: Scheme of the phyllometric measures.

Whenever possible, the sex type of each individual vine was determined, and a sample made up of 10 leaves located opposite to the flower clusters was taken from each plant and measured. With male plants, a pollen sample was taken. With each female or hermaphrodite plant, samples of ripe grape clusters were collected, so that data from clusters, berries and seeds could be gathered. During winter, ligneous scions were gathered from each plant in order to multiply them in germplasm collections.

On the lower side of each leaf the following measurements were taken (Fig. 1):

L_1 = main vein length;
$L_{2D}, L_{2S}, L_{3D}, L_{3S}, L_{4D}, L_{4S}$ = superior (2), median (3) and inferior (4) lateral vein length; D = right, S = left;
L_{N1}, L_{N2}, L_{N3} = apex lateral vein distances; (1) higher, (2) median and (3) lower;
p = petiolar length;
L_f = maximum leaf width;
$S_{1D}, S_{1S}, S_{2D}, S_{2S}, S_{3D}, S_{3S}$ = superior (1), median (2) and inferior (3) sinus length; D = right, S = left;
$\alpha_D, \alpha_S, \beta_D, \beta_S, \gamma_D, \gamma_S$ = angles between vein at their insertion point or at their extremity ('); D = right, S = left.

12 phyllometric indexes were calculated:

standardized superior vein: SSN = $(L_{2S} + L_{2D}) / (2 \times L_1)$;
standardized median vein: SMN = $(L_{3S} + L_{3D}) / (2 \times L_1)$;
standardized inferior vein: AIN = $(L_{4S} + L_{4D}) / (2 \times L_1)$;
α angle = $(\alpha_D + \alpha_S) / 2$;
β angle = $(\beta_D + \beta_S) / 2$;
γ angle = $(\gamma_D + \gamma_S) / 2$;
superior lobature coefficient: SCL = $(S_{1S} + S_{1D}) / (L_{2S} + L_{2D})$;
median lobature coefficient: MLC = $(S_{2S} + S_{2D}) / (L_{3S} + L_{3D})$;
inferior lobature coefficient: ILC = $(S_{3S} + S_{3D}) / (L_{4S} + L_{4D})$;
superior lobe extension coefficient (Grenan 1984): SEC = $L_{N1} / (L_{2S} + L_{2D})$;
inferior lobe extension coefficient: IEC = $L_{N3} / (L_{4S} + L_{4D})$;
R coefficient (Galet 1956): L_1 / L_f.

These 12 coefficients and the main vein length are sufficient to describe shape and lobature characteristics of grapevine leaves (Galet 1956; Grenan 1984).

The length and maximum width of 100 seeds per vine, when possible, were measured.

Two methods of numerical taxonomy were used: discriminant and cluster analyses. Discriminant analysis was carried out using Wilks' method, step-wise procedure, minimizing the Wilks' lambda. Cluster analysis was realized with weighted pair group method centroid, using square Euclidean distances.

Results

Distribution

221 sites have been indicated as possible locations of wild grapevines, 189 of which by the Italian Forestry Service. 49 sites were inspected to ascertain the genetic nature of the vines (excluding the American species) and to collect all data and samples. On average, 3-4 vines occupy each site. Wild grapevines may occur in 15 out of 20 Italian regions, their presence has been

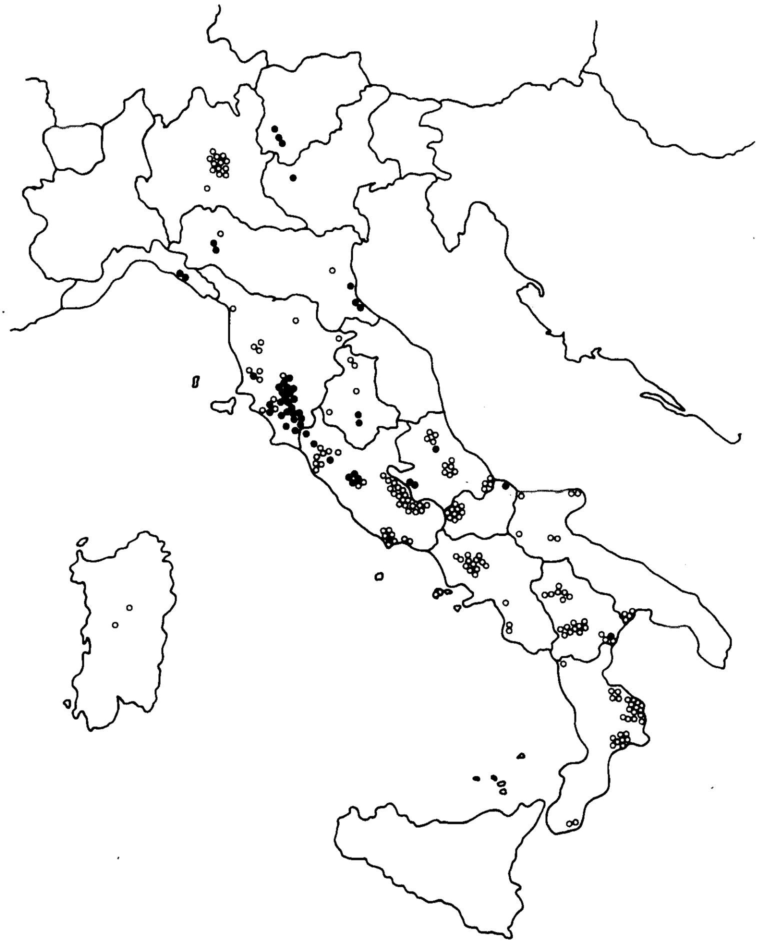

Fig. 2: Location of *Vitis vinifera* var. *silvestris* sites in some Italian regions. Indicated (o) and visited (•) sites.

ascertained in 10 until now. The greatest number of individuals have been found in central Italy (Fig. 2, Table 1).

Sex

About 65 % of the plants were studied during their flowering season. Of these the male/female ratio was approximately 1.8 while hermaphrodite plants accounted for only 2.0 % (Tables 2 and 3).

Leaf morphology

Table 4 indicates the main statistical characteristics of the 13 phyllometric indices studied.

Wild grapevine leaves are small (L_1 35-110 mm), with low length/width ratio (R 0.60-1.00), wide sinus petiolar angle ($\alpha + \beta = 65\text{-}120°$ and IEC 0.7-1.5). Leaves range from non-lobed (SLC 1) to highly lobed (SLC 0.4).

Table 1: Distribution of wild grapevine sites as located in some Italian regions

DISTRICTS	SITES		
	INDICATED	VISITED	VINES
TRENTINO	3	3	13
LOMBARDY	13	0	-
VENETIA	1	1	1
EMILIA	7	3	11
LIGURIA	2	2	3
TOSCANY	37	24	92
UMBRIA	6	2	3
LATIUM	45	8	23
ABRUZZO	16	2	7
MOLISE	11	1	2
APULIA	10	0	-
CAMPANIA	18	0	-
BASILICATE	21	1	6
CALABRIA	29	0	-
SARDINIA	2	0	-
TOTAL	221	49	161

Table 2: Ratio distribution of wild vines in relation to their sex

TOTAL		MALES		FEMALES		HERMAPHRODITES	
INDIVIDUALS	%	INDIVIDUALS	%	INDIVIDUALS	%	INDIVIDUALS	%
101	100	64	63.4	35	34.6	2	2.0

Table 3: Sex characteristics of the wild vines sampled in Italy

TOTAL		PROBABLY POST-CULTURAL*		MALES		FEMALES		HERMAPHRODITES		UNCLASSIFIED		FEMALES OR HERMAPHRODITES	
INDIVIDUALS	%	INDIV.	%	INDIV.	%	INDIV.	%	INDIV.	%	INDIV.	%	INDIV.	%
161	100	8	5.0	64	39.8	35	21.7	2	1.2	32	19.9	20	12.4

* ACCORDING LEVADOUX (1956)

Table 4: Main characteristics of the wild grapevine leaves

	AVERAGE	S.D.	MIN.	MAX
MAIN VEIN LENGTH mm	73.3	19.2	28	169
STAND. SUPERIOR VEIN	0.86	0.08	0.59	1.12
STAND. MEDIAN VEIN	0.61	0.09	0.34	0.94
STAND. INFERIOR VEIN	0.35	0.07	0.17	0.67
SUPERIOR LOBATURE COEFF.	0.71	0.15	0.25	0.97
MEDIAN LOBATURE COEFF.	0.84	0.10	0.38	1.10
INFERIOR LOBATURE COEFF.	0.88	0.06	0.60	1.18
α ANGLE	45.5	6.90	26.5	70.0
β ANGLE	48.0	7.43	27.5	75.5
γ ANGLE	47.0	7.36	21.5	70.5
SUPERIOR LOBE EXTENSION COEFF.	0.63	0.08	0.41	0.96
INFERIOR LOBE EXTENSION COEFF.	1.07	0.21	0.17	1.71
R COEFF.	0.80	0.10	0.53	1.12

Cluster analysis carried out on the lobature coefficients (SLC, MLC and ILC) of the average leaf of each plant classified the wild grapevines in four groups (Fig. 3, Table 5): A1 (38 individuals) 5 to 7-lobe leaves, A2 (7 individuals) 5 to 7 marked-lobe leaves, B1 (11 individuals) light-lobe leaves and B2 (59 individuals) 3-lobe leaves.

Cluster analysis carried out on shape coefficients (SSN, SMN, SIN, α, β, γ, SEC, IEC, and R) of the average leaf of each plant classified the wild grapevines in four groups (Fig. 4, Table 6): C1 (1 individual) very close sinus petiolar angle, C2 (15 individuals) close sinus petiolar angle, D1 (3 individuals) very wide sinus petiolar angle and D2 (97 individuals) wide sinus petiolar angle.

The validity of the results of the cluster analyses has been verified with discriminant analysis. These analyses were carried out using all the collected leaves, after having classified the vines according to cluster analysis groups, and using the same phyllometric indexes as used in the respective cluster analyses.

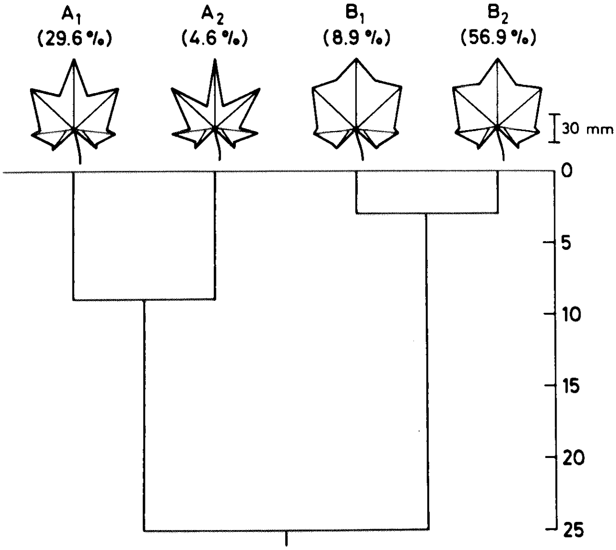

Fig. 3: Dendrogram and average leaf types of the cluster analysis relative to lobature characteristics of the wild vine leaves.

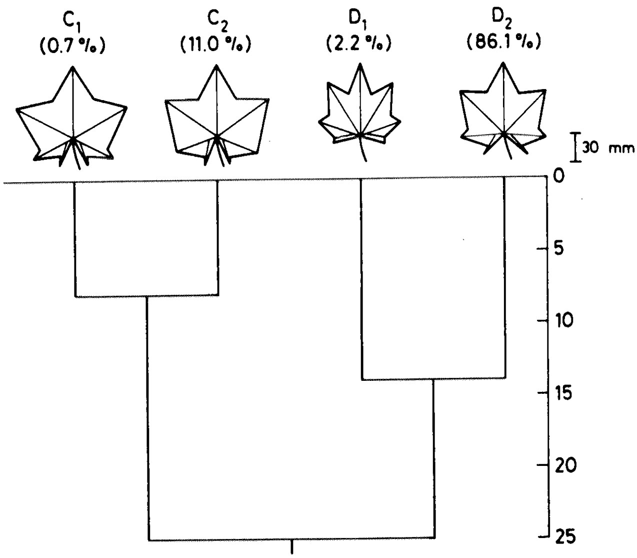

Fig. 4: Dendrogram and average leaf types of the cluster analysis relative to shape characteristics of the wild vine leaves.

Table 5: Average lobature coefficients of the four lobature cluster groups

GROUP	SUPERIOR	MEDIAN	INFERIOR
B2	0.76	0.87	0.89
B1	0.87	0.91	0.91
A2	0.38	0.58	0.82
A1	0.61	0.80	0.86

Table 6: Average angles of the four shape cluster groups

GROUP	ANGLES		
	α	β	γ
D2	44.8	47.1	46.5
D1	32.1	37.2	38.2
C2	52.6	56.6	53.0
C1	60.4	55.7	44.3

The discriminant analysis regarding the lobature groups (Fig. 5, Table 7) indicates that superior and median lobes are of greater importance than inferior ones, 68 % of cases correctly classified show a high variability in leaf lobature both within plants and groups.

The discriminant analysis regarding the shape groups (Fig. 6, Table 8) indicates the greater importance of the angles α, β and γ. The results of grouped cases correctly classified (76 %) show a satisfactory difference between the groups.

Leaf lobature is different in northern, central and southern Italy. In northern Italy, type A1 (5 to 7-lobe leaves) is prevalent; in southern Italy, type B2 (3-lobe leaves) is prevalent, in central Italy both types are present (Table 9).

Leaf morphology is related to plant sex. Leaves in male plants are smaller than in female ones, of analogous and petiolar sinus angle. Hermaphrodite plants show greater leaf size and a less open petiolar sinus angle (Table 10).

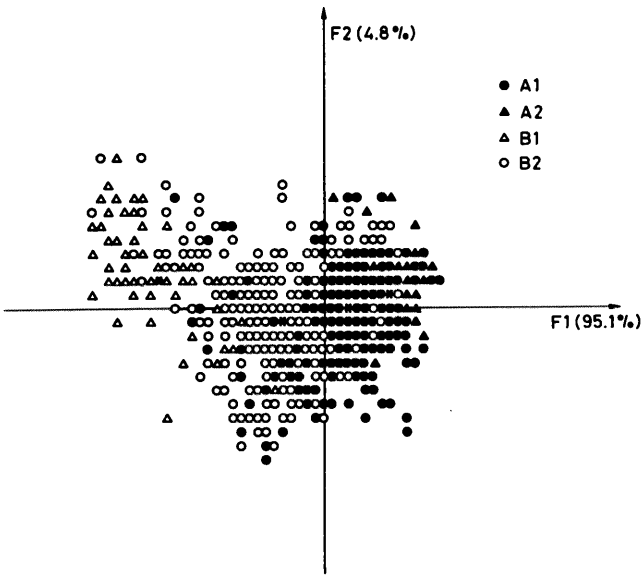

Fig. 5: Diagram of the discriminant analysis relative to lobature characteristics of the wild vine leaves.

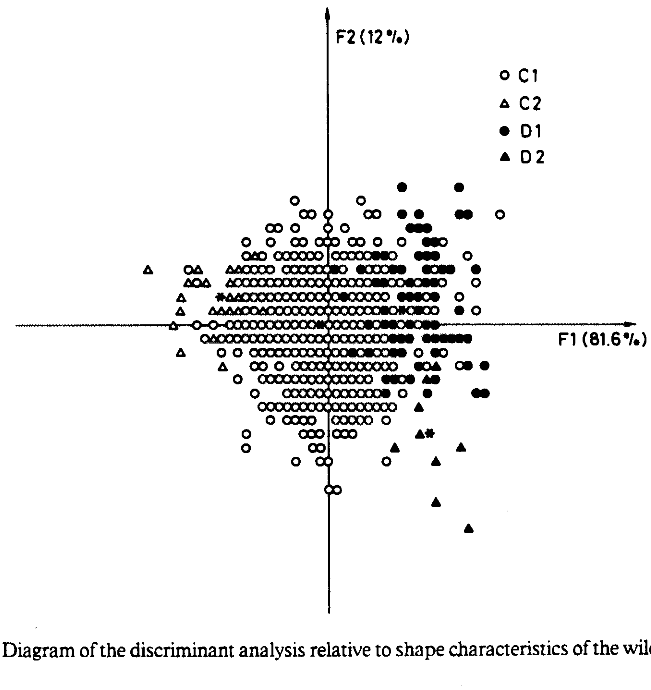

Fig. 6: Diagram of the discriminant analysis relative to shape characteristics of the wild vine leaves.

Table 7: Discriminant analysis about lobature cluster groups

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	% OF VARIANCE	CANONICAL CORRELATION	AFTER FUNCTION	D.F.	WILKS' LAMBDA
				0	9	0.38***
1	1.44	95.1	0.77	1	4	0.93***
2	0.07	4.8	0.26			

STANDARDIZED CANONICAL DISCRIMINANT FUNCTIONS COEFFICIENTS

	FUNC. 1	FUNC. 2
SUPERIOR LOBATURE COEFF.	**0.71**	0.87
MEDIAN LOBATURE COEFF.	**0.42**	-1.13
INFERIOR LOBATURE COEFF.	0.07	0.36

POOLED WITHIN - GROUPS CORRELATION BETWEEN DISCRIMINATING VARIABLES AND CANONICAL DISCRIMINANT FUNCTIONS

	FUNC. 1	FUNC. 2
SUPERIOR LOBATURE COEFF.	**0.92**	0.35
MEDIAN LOBATURE COEFF.	**0.79**	-0.59
INFERIOR LOBATURE COEFF.	0.25	0.07

CLASSIFICATION RESULTS

ACTUAL GROUP	N° OF CASES	PREDICTED GROUP MEMBERSHIP (%) A2	B1	A2	A1
B2	779	**55.8**	29.7	0.9	13.6
B1	122	9.0	**91.0**	0.0	0.0
A2	63	0.0	0.0	**81.0**	19.0
A1	406	20.2	4.7	12.1	**63.1**

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED : 62.3%

Seed morphology

Seed characteristics and variability are shown in Table 11. Cluster and discriminant analyses were used in the same way as in the leaf morphology study.

Cluster analysis carried out on length, width and length/width ratio of the average seed of each of the 30 vines of which the seeds could be measured classified the wild grapevines in three groups (Fig. 7, Table 12): A (25 individuals) average seed type, B (2 individuals) small and round seeds; C (3 individuals) large and long seeds.

Table 8: Discriminant analysis about shape cluster groups

FUNCTION	EIGENVALUE	% OF VARIANCE	CANONICAL CORRELATIION	AFTER FUNCTION	D.F.	WILK'S LAMBDA
				0	27	0.59***
1	0.55	81.6	0.60	1	16	0.89***
2	0.08	12.0	0.27			

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC. 1	FUNC. 2
STAND. SUPERIOR VEIN	-0.18	-0.08
STAND. MEDIAN VEIN	0.14	1.64
STAND. INFERIOR VEIN	-0.62	0.00
α ANGLE	0.47	0.10
β ANGLE	0.43	0.15
γ ANGLE	0.18	0.44
SUPERIOR LOBE EXTENSION COEFF.	-0.08	-0.37
INFERIOR LOBE EXTENSION COEFF.	-0.49	-0.30
R COEFF.	0.03	1.60

POOLED WITHIN-GROUPS CORRELATION BETWEEN DISCRIMINATING VARIABLES AND CANONICAL DISCRIMINANT FUNCTIONS

	FUNC. 1	FUNC. 2
α ANGLE	**0.75**	-0.26
β ANGLE	**0.69**	0.22
γ ANGLE	**0.44**	**0.40**
SUPERIOR LOBE EXTENSION COEFF.	**0.48**	**-0.66**
INFERIOR LOBE EXTENSION COEFF.	**-0.57**	0.02
STAND. INFERIOR VEIN	-0.10	0.32
R. COEFF.	-0.10	0.05
STAND. MEDIAN VEIN	-0.15	0.12
STAND. SUPERIOR VEIN	-0.14	0.31

CLASSIFICATION RESULTS

ACTUAL GROUP	N° OF CASES	PREDICTED GROUP MEMBERSHIP (%) D2	D1	C2	C1
D2	1179	**74.7**	8.6	14.3	2.4
D1	30	3.3	**96.7**	0.0	0.0
C2	151	15.9	0.0	**78.8**	5.3
C1	10	0.0	0.0	0.0	**100.0**

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED : 75.84%

Discriminant analysis (Fig. 8, Table 13) indicates the great importance of seed length in grouping the vines. 72 % of grouped cases correctly classified show a satisfactory difference between the groups.

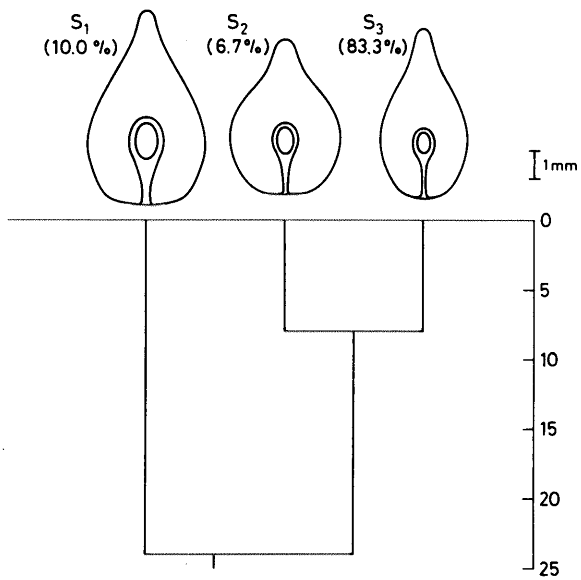

Fig. 7: Dendrogram and average leaf types of the cluster analysis relative to seed morphology of the wild vines.

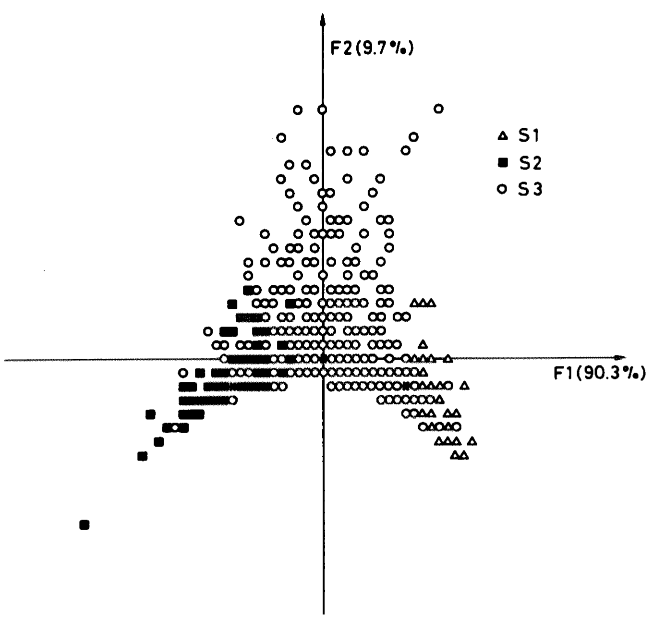

Fig. 8: Diagram of the discriminant analysis relative to seed morphology of the wild vines.

Table 9: Distribution of the four lobature cluster groups in relation to grographical location of the wild vines

LOCATION	N° OF VINES	LOBATURE CLUSTER GROUP			
		A1	A2	B1	B2
NORTH	16	**62.4**	18.8	0.0	18.8
CENTER	93	**29.0**	4.3	11.8	**54.9**
SOUTH	6	16.7	0.0	0.0	**83.3**

Table 10: Leaf characteristics in relation to plant sex

	ANGLES			INFERIOR EXTENSION COEFFICIENT	MAIN VEIN LENGTH
	α	β	γ		
MALES	45.1a	47.6a	46.9a	1.11a	70a
FEMALES	45.5a	48.0a	47.0a	1.03b	76b
HERMAPHRODITES	51.8b	55.8b	49.9b	0.79c	95c

Table 11: Main characteristics of wild grapevine seeds

	AVERAGE	S.D.	MIN.	MAX.
LENGTH mm	6.05	0.57	3.70	7.80
WIDTH mm	4.12	0.36	3.00	5.30
LENGTH/WIDTH	1.48	0.16	1.04	2.06

Table 12: Average dimension and shape of the three seed cluster groups

GROUP	N° OF CASES	LENGTH mm	WIDTH mm	LENGTH/WIDTH
S3	158	6.96	4.32	1.61
S2	177	5.06	3.93	1.29
S1	2206	6.06	4.42	1.48

Table 13: Discriminant analysis about seed cluster groups

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	% OF VARIANCE	CANONICAL CORRELATIION	AFTER FUNCTION	D.F.	WILK'S LAMBDA
				1	6	0.59***
1	0.59	90.3	0.61	0	2	0.94***
2	0.06	9.7	0.24			

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC.1	FUNC.2
LENGTH	0.05	-7.13
WIDTH	1.12	7.97
LENGTH/WIDTH	1.26	9.49

POOLED WITHIN - GROUPS CORRELATION BETWEEN DISCRIMINATING VARIABLES AND CANONICAL DISCRIMINANT FUNCTIONS

	FUNC.1	FUNC.2
LENGTH	0.99	-0.13
LENGTH/WIDTH	0.52	0.08
WIDTH	0.26	-0.09

CLASSIFICATION RESULTS

ACTUAL GROUP	N° OF CASES	PREDICTED GROUP MEMBERSHIP (%) S3	S2	S1
S3	158	**88.0**	0.0	12.0
S2	177	0.0	**92.0**	7.9
S1	2206	17.5	12.8	**69.7**

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED : 72.37

Germplasm conservation

Germplasm collections are being established by multiplying scions from wild plants. Thanks to the collaboration of European institutes, in these collections wild grapevines of different European, North-African and Asiatic regions are being gathered in addition to Italian wild grapevines (Table 14).

Table 14: Number of genotypes and vines gathered in the germplasm collection

COLLECTION	GENOTYPES	VINES
SIENA		
ITALIAN	33	106
OTHER	36	160
TRENTO		
ITALIAN	48	90
OTHER	32	85

Conclusion

The research studies are helping to precisely define the distribution and characteristics of wild grapevines in Italy.

From the data obtained and the recent information from the Italian Forestry Service, we can assert that wild vines grow all over the country from 0 to 800 m a.s.l.

This population is dioecious (male/female = 1.8) with few (2.0 %) hermaphrodite examples.

The leaves generally have 3 lobes (57 %) but 5 to 7-lobe (36 %) and non-lobed (8.9 %) plants exist. Lower variability exists with regard to leaf shape: 86.1 % of the vines were classified in the same cluster group.

Due to the increase in sampled vines, the differences between the leaves of male and female plants have become less important with respect to our previous observations (Scienza *et al.* 1988); instead, the differences between the leaves of hermaphrodite and unisexual plants have been confirmed.

The study of seed morphology has classified the plants into three groups, one of which is very numerous (83.3 %).

Investigations on the unvisited sites should confirm these results.

Furthering leaf and seed morphology studies will compare wild and cultivated plants. The germplasm collection will be useful for the comparison.

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