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AMPELOGRAPHIC CHARACTERIZATION OF GRAPEVINE VARIETIES USING LEAF SHAPE (*)

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SUMMARY

The seven coordinates of the main and secondary veins and the three coordinates of the lateral sinus of 20 OTU's ascribed to 16 grapevine varieties were obtained by Rodrigues' method (1952) of characterizing the shape of the leaves. An attempt for the separation of the different grapevine varieties is made using several numerical taxonomic techniques.

The results show a good separation of the different grapevine varieties and the possibility of utilization of these techniques to study the relations of the grapevine varieties among themselves.

This problem is of great interest to the portuguese viticulture where a large number of ancient grapevines have several names in the different regions of the country where these are grown.

INTRODUCTION

The grapevine leaf has always received a particular attention as a basic organ for the grapevine varieties characterization and identification.

According to the work of Ravaz (1902), Galet (1951) and Rodrigues (1952), the study of the leaf became known as ampelometry, a complementary science of ampelography.

All these studies have been of great tradition in Portugal and some authors have presented in the past significant methodological contributions (Costa, 1900; Carvalho, 1912; Navarro,

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1932; Vasconcellos, 1938; Sousa, 1938; Rodrigues, 1939, 1952). For comparing the shape of the leaves of some grapevine varieties (*Vitis vinifera* L.) characterized by Rodrigues' phyllometric method, described in 1952, the techniques of numerical taxonomy were used. In this way we are able to compare overall shapes minimizing the effect of character subjectivity.

With the groups obtained it is possible to advance several hypothesis concerning the synonymy of the different grapevine varieties and help to solve these problems which are of great relevance to the Portuguese viticulture.

MATERIAL AND METHODS

The material employed for this study was taken from specimens of *Vitis vinifera* L. This consists of 20 samples (= OTUs) representing 16 cultivars collected in several localities of Central and South Portugal (Table I).

According to the Rodrigues' phyllometric method (Rodrigues, 1952) the x, y coordinates of 10 landmark points of the leaf margin were measured on fresh leaves from the 5th, 7th and 9th nodes. Altogether, 60 characters were recorded for each set of the three nodes (2 coordinates $\times$ 10 points $\times$ 3 nodes). Characters of 10 samples were averaged to represent an OTU, including the left and the right sides of each leaf.

The 60 characters $\times$ 20 OTUs data matrix was subjected to standard numerical taxonomic procedures (Sneath and Sokal, 1973; Cabral *et al.*, 1977; Curvelo-Garcia *et al.*, 1987). The characters were standardized to obtain a mean of zero and a standard deviation of unity. Taxonomic distances among the OTUs were then computed for all pairs of OTUs. The resulting matrix was clustered using the Unweighted-Pair-Group-Method using arithmetic Averages (UPGMA); the result is presented in the form of a phenogram. The cophenetic coeficient for the phenogram was also computed. This coefficient provides an estimation of the efficiency (or distortion) of the method of clustering used. The data was also subjected to a principal components analysis (PCA) of the matrix of correlations among the characters with the projections of the OTUs and the original characters onto the two principal axes. The shortest connection network (= minimum spanning tree) was computed (Rohlf,

TABLE I

List of cultivars, localities and OTU numbers assigned to them

OTUs number	Name of the cultivar	Localities
1	Abundante	Redondo-Alentejo
2	Abundante	Reguengos-Alentejo
3	Alfa	Oeiras-Ribatejo e Oeste
4	Água Santa	Oeiras-Ribatejo e Oeste
5	Benfica	Oeiras-Ribatejo e Oeste
6	Carignan	Reguengos-Alentejo
7	Competição	Oeiras-Ribatejo e Oeste
8	Crato Preto	Tavira-Algarve
9	Lusitano VII	Oeiras-Ribatejo e Oeste
10	Periquita	Reguengos-Alentejo
11	Periquita	Tavira-Algarve
12	Pinot	Borba-Alentejo
13	Pinot	Reguengos-Alentejo
14	Tinta de Alcobaça	Oeiras-Ribatejo e Oeste
15	Tinta da Gestosa	Oeiras-Ribatejo e Oeste
16	Tinta de Pegões	Oeiras-Ribatejo e Oeste
17	Trincadeira	Reguengos-Alentejo
18	Trincadeira	Escaroupim-Ribatejo e Oeste
19	Valbom	Oeiras-Ribatejo e Oeste
20	Zaire	Oeiras-Ribatejo e Oeste

1982) and projected onto the plot of the OTUs onto the first two principal axes to indicate where possible distortion may be present.

All computations were carried out using the MINT computer program (Rohlf, 1971).

RESULTS AND DISCUSSION

The phenogram obtained from the distance matrix (Fig. 1) shows the following main groups: OTU 1, OTUs 5-14, OTUs 3-9 and OTUs 2-17, the latter being sudivided in three clusters, OTUs 2-11, OTUs 13-18 and 8-17. These six clusters are quite homogeneous as overall shape of three leaves is concerned.

The relative position of the 20 OTUs in the ordination diagram using principal components analysis (Fig. 2) supports the conclusions drawn from the phenogram. The same holds for the results of the shortest connection network (Fig. 2).

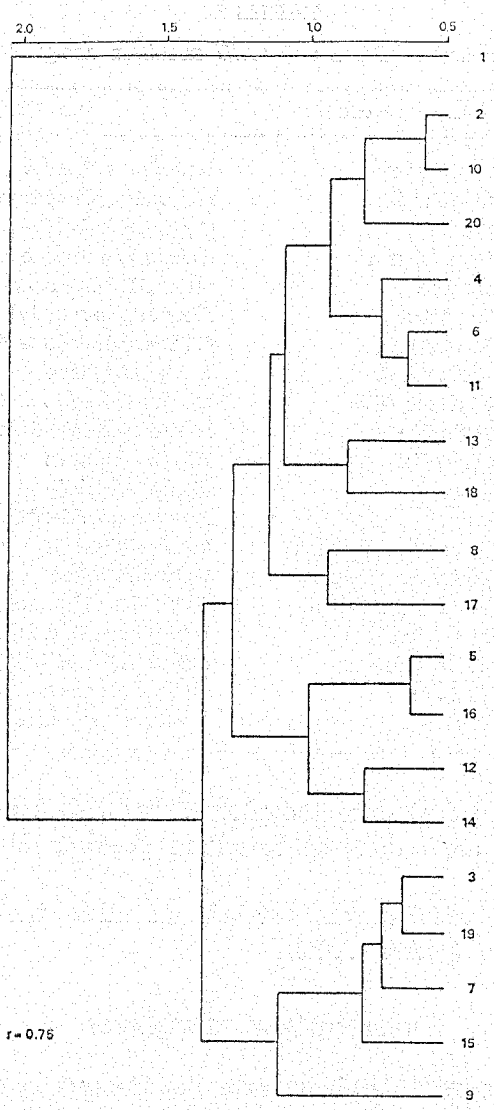

Fig. 1 — Distance phenogram of 20 OTU's based on the UPGMA method for the coordinates of 10 landmark points of the leaves of three nodes (= 60 characters).

Fenograma de distância dos 20 OTUs baseado no método UPGMA, das coordenadas dos 10 pontos das folhas dos três nós (= 60 caracteres).

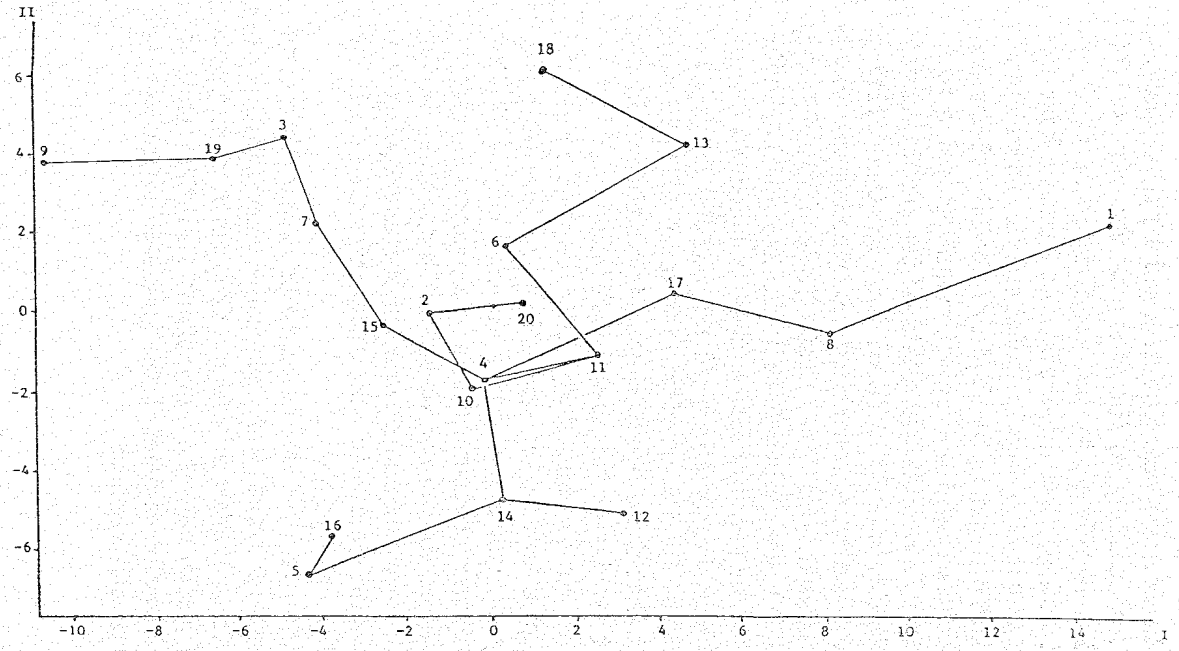

Fig. 2 — Projections of the 20 OTU's onto the plane defined by the first (48,3 %) and the second (18,9 %) principal components on a matrix of correlations among the 60 characters. The shortest conection network is projected onto the two principal components to indicate where possible distortions may be present.

Projecções de 20 OTUs no plano definido pelas primeira (48,3 %) e segunda (18,9 %) componentes principais da matriz de correlação entre os 60 caracteres. A árvore de conexão simples está projectada nas duas componentes principais para indicar as possíveis distorções.

When the character vertors are related to the projection of the OTUs onto the principal axes, trends in the variation of the leaf shape become evident. The first principal component separates the leaves acording to the shape of the base of the petiole sinus, which is related to the coordinates of C, C_1, c and c_1 (Fig. 3, 4 and 5). The separation of leaves along the second principal component is due to variations in characters S_1 and S_2 (Fig. 3, 4 and 6), that is the depth of the lateral sinuses.

Traditional studies caried out by other authors using morphological characters from different parts of the plant, pointed out the high similarity among some of the varieties included in our study. These authors considered as synonymous Pinot (OTU 13) and Carignan (OTU 6), Crato Preto (OTU 8) and Trincadeira (OTU 17) and Trincadeira (OTU 18) and Periquita (OTUs 10 and 11). Our results confirm these conclusions except for OTU 18, which is clearly separated from OTUs 10 and 11. A possible explanation for the atypical position of OTU 18 may be due to the fact that these leaves belong to plants previously submitted to heat treatment for virus eradication.

The results of the present study indicate that numerical taxonomic techniques can be of great help in assessing the overall similarity of grapevine leaves, even using a limited number of quantitative characters from its marginal configuration. These types of studies are of special importance to the Portuguese viticulture where a large number of ancient grapevine varieties have several names in the different regions of the country where these are grown.

We are gratefull to Prof. F. James Rohlf, State Universty of New York at Stony Brook, for numerous constructive comments, to the staff of Centro de Cálculo Científico of Instituto Gulbenkian de Ciência for the computing facilities, and to Dr. H. Machado Jorge, President of the Instituto Português da Qualidade, for financial support.

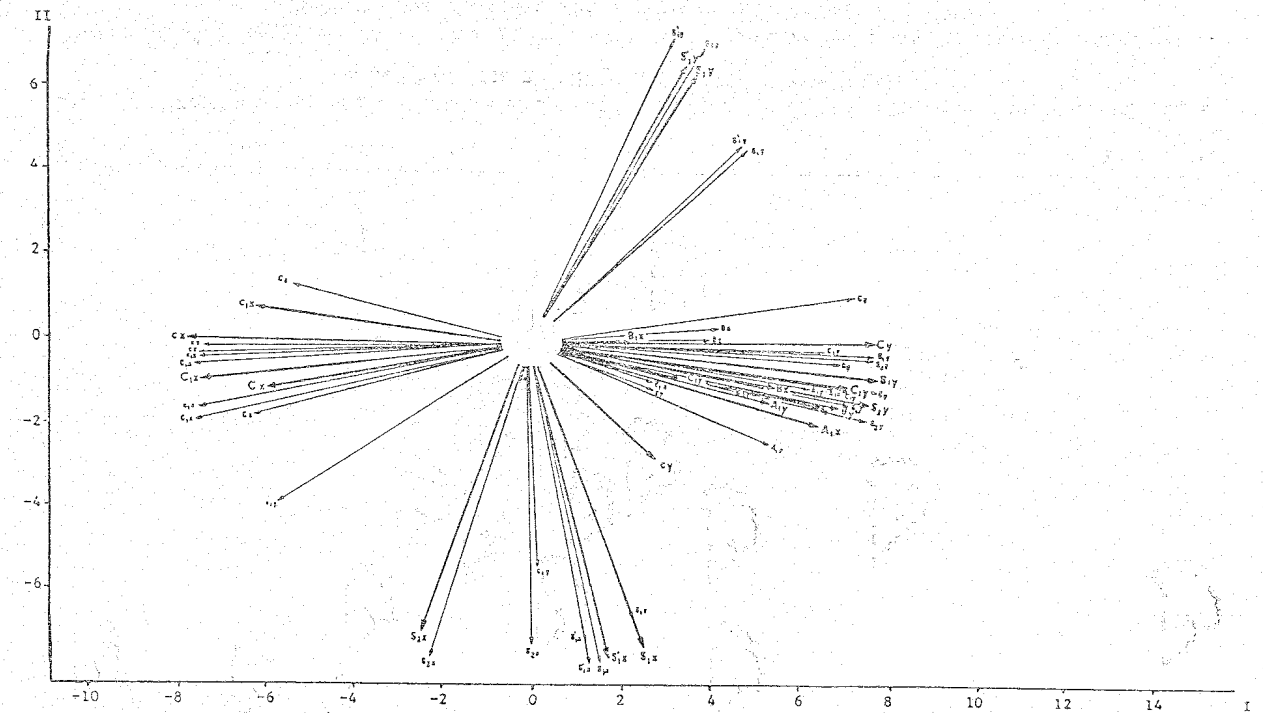

Fig. 3 — Projections of the 60 eigen vectors onto the plane defined by the first two principal components.

Projecções dos 60 vectores próprios no plano definido pelas duas primeiras componentes principais.

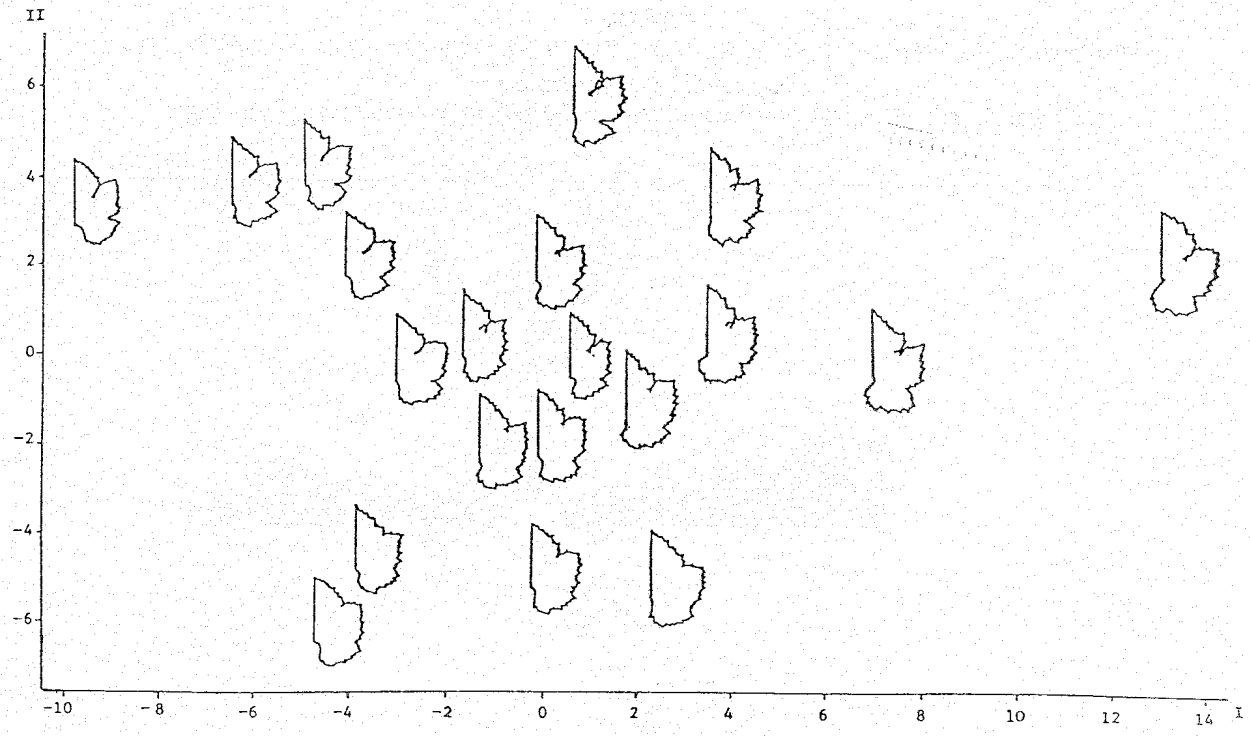

Fig. 4 — Projections of the leaves of the 9th node of the 20 OTU's onto the first two principal components (see also Fig. 2 for OTU's identification).

Projecções das folhas do 9.º nó, dos 20 OTUs no plano definido pelas duas primeiras componentes principais (ver também Fig. 2 para a identificação dos OTUs).

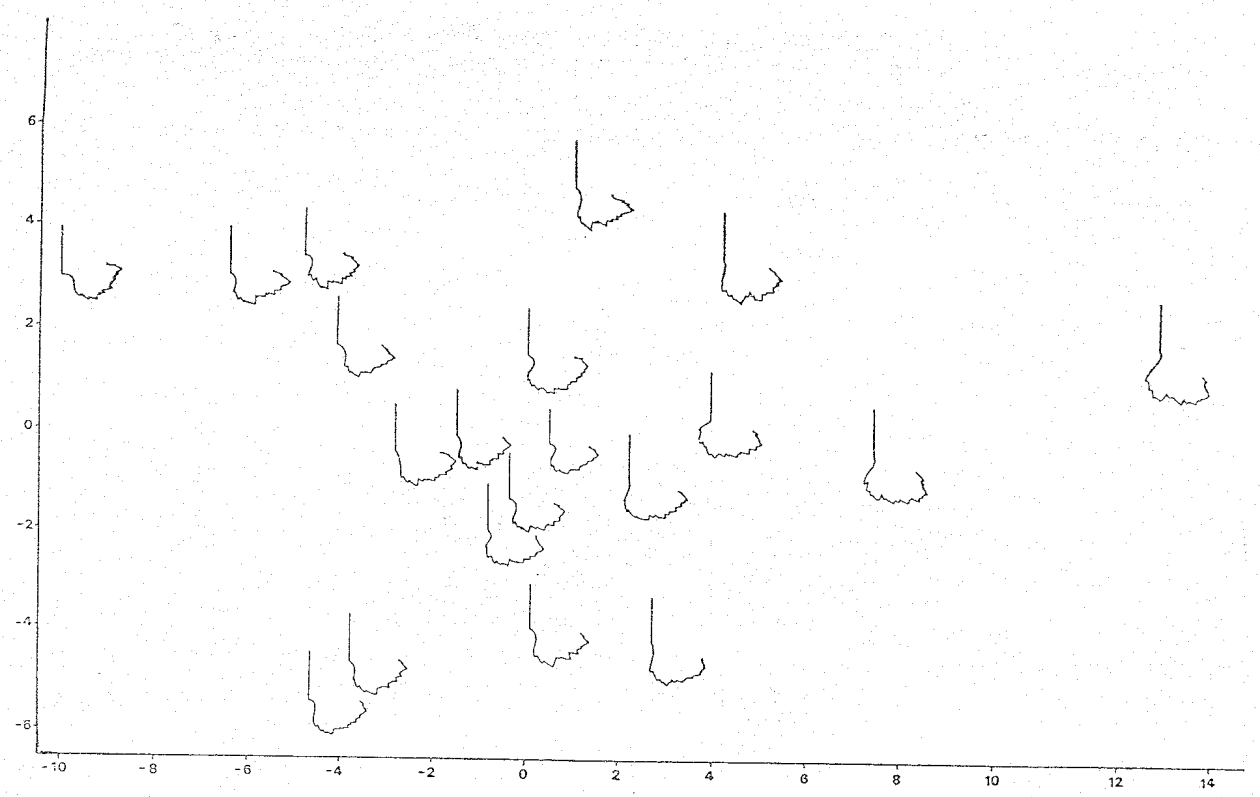

Fig. 5 — Detail of Fig. 4 showing only the projections of the lobe C of the 9th node of the 20 OTU's onto the first two principal components (see also Fig. 2).

Detalhe da Fig. 4 mostrando só as projecções do lóbulo C das folhas do 9.° nó dos 20 OTUs nas duas primeiras componentes principais (ver também Fig. 2).

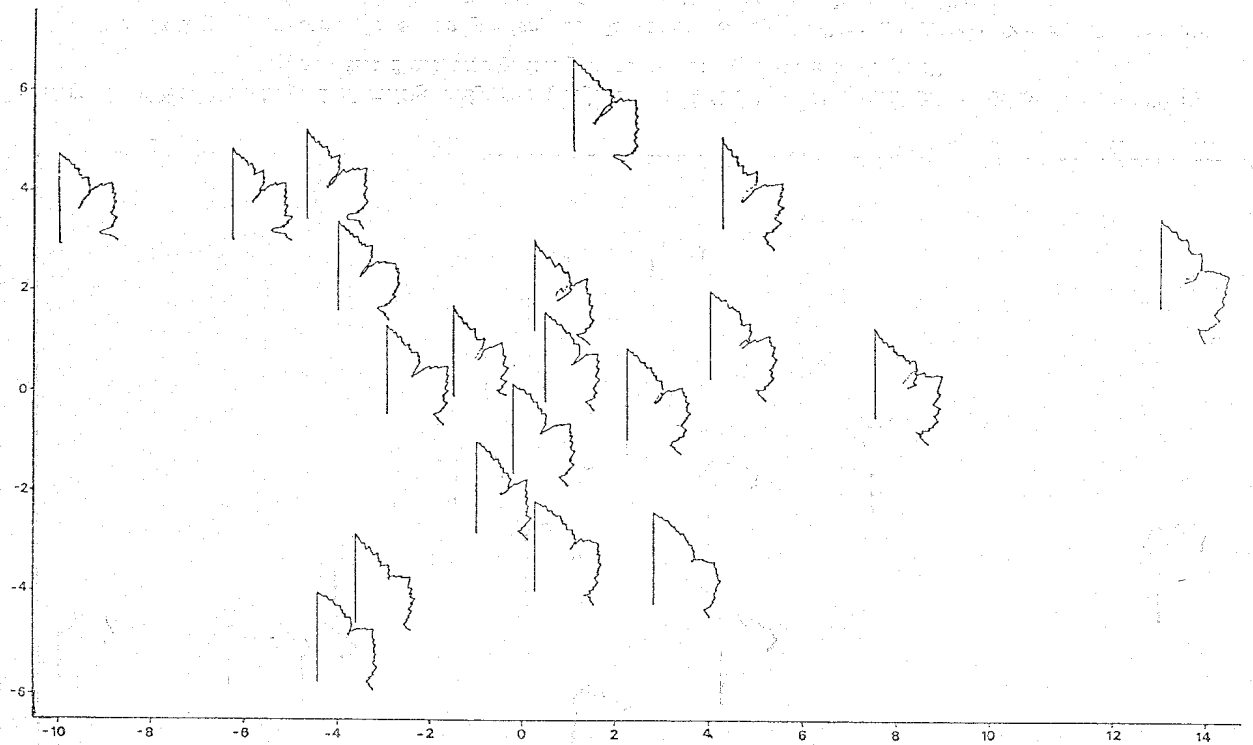

Fig. 6 — Detail of Fig. 4 showing only the lobes A and B of the leaves of the 9th node of the 20 OTU's onto the two first principal components (see also Fig. 2).

Detalhe da Fig. 4 mostrando os lóbulos A e B das folhas do 9.º nó dos 20 OTUs nas duas primeiras componentes principais (ver também Fig. 2).

RESUMO

Caracterização ampelográfica de variedades de videira usando a forma das folhas

É usado o método de Rodrigues (1952) para a caracterização de 16 cultivares (usando 20 amostras-OTUs) com base na filometria. São medidas as coordenadas de 10 folhas de cada um dos três nós (5.º, 7.º e 9.º). Usando métodos de taxonomia numérica é efectuada uma classificação baseada na forma das folhas e estudada a separação obtida no espaço das duas primeiras componentes principais.

Os resultados mostram uma boa separação das diferentes cultivares e a possibilidade de utilização destas técnicas para estudar as relações de sinonímia entre elas.

Este problema é de grande interesse para a viticultura portuguesa onde um grande número de antigas cultivares têm diferentes designações conforme as regiões do país onde são cultivadas.

RÉSUMÉ

Caracterisation ampelographique des varietés de vigne en utilisant la forme des feuilles

La caracterisation de 16 cepáges (20-OTUs) a été élaborée avec le méthode de Rodrigues (1952). Les coordonnées de 10 feuilles ont été mesurées pour les trois noeuds (5.º, 7.º e 9.º). Un essai avec de méthodes de taxonomie numerique a été realisé pour etudier la séparation des cépages.

Les resultats ont montré une bonne séparation des differents cépages et la possibilité d'utiliser cette technique pour etudier les problèmes de sinonimie.

Ce problème est de grand intérêt pour la viticulture portuguaise, où un grand nombre d'ancients cépages ont des noms différents avec les différents régions où elles sont cultivées.

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