A SINGLE PAIR OF PARENTS PROPOSED FOR A GROUP OF GRAPEVINE VARIETIES IN NORTHEASTERN FRANCE

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Abstract

With the objective to identify previously unknown parental relationships among grapevine cultivars, 352 cultivars of *Vitis vinifera* L. were analyzed at 17 microsatellite loci. 29 were found to be duplicate genotypes of other cultivars. From the 323 unique genotypes, 89 possible pairs of parents were identified for 52 cultivars (i.e., each putative progeny cultivar shared at least one allele with each putative parent at each of the loci anlayzed). Sixty cultivars were then analyzed with an additional 15 microsatellite markers and from among these 24 possible pairs of parents were identified for 24 cultivars. Fourteen of the 24 (including Chardonnay, Gamay noir, Aligote, and Melon) are possible progeny of Pinot and Gouais blanc. Two cultivars (Aubin and Petit Meslier) are possible progeny of Gouais blanc and Savagnin (syn. Traminer) and three cultivars (Colombard, Meslier St-François and Balzac blanc) are possible progeny of Gouais blanc and Chenin. The possible parents of Syrah were also identified as Dureza and Mondeuse blanche.

1. Introduction

The thousands of *Vitis vinifera* cultivars in existence today are thought to have originated by several mechanisms: domestication of wild vines, spontaneous crosses between wild vines and cultivated varieties and crosses between cultivated varieties. Crosses between cultivated varieties would likely have been spontaneous until the last two centuries, when controlled crosses have been made. Modern methods of genetic analysis permit the detection of possible parental relationships. Recently such a relationship was discovered for the cultivar Cabernet Sauvignon, when microsatellite analysis determined that its likely parents are the cultivars Cabernet Franc and Sauvignon blanc (Bowers and Meredith, 1997). The parents of the cultivars Monbadon and Durif were also identified as Folle blanche x Ugni blanc (Bowers and Meredith, unpublished results) and Peloursin x Syrah (Meredith *et al*., submitted for publication), respectively. These findings, resulting from analysis of a relatively small group of cultivars, prompted a search for additional such relationships. The work reported here focused on a selected group of cultivars associated with the northeastern and southwestern parts of France.

2. Materials and methods

2.1. Plant material

DNA from 51 cultivars was previously extracted from vines growing at the University of California at Davis (Bowers and Meredith, 1997). DNA was extracted from vines of 301 additional cultivars in the INRA variety collection at Domaine de Vassal, near Montpellier, France. These additional cultivars were chosen on the basis of morphological similarity, geographic proximity and published speculation about possible genetic relationships.

2.2. DNA extraction and microsatellite analysis

DNA was extracted from young leaves as previously reported (Bowers *et al*., 1993). Microsatellite loci were PCR amplified as described (Bowers *et al*., 1996), separated on 6% polyacrylamide sequencing gels and visualized by silver staining with a commercial kit (Promega). Thirty-two microsatellite loci were analyzed in total (Table 1). All cultivars were analyzed at 17 loci and a subset of 60 were analyzed at an additional 15 loci.

2.3. Identification of parental relationships

Possible parental relationships were identified by comparing the microsatellite genotypes within all possible sets of three cultivars, with each of the three cultivars being considered as a possible progeny of the other two. For each putative progeny, one allele at each locus must be present in each of the two putative parents.

3. Results

After the initial analysis of all 352 cultivars at 17 loci, 29 were found to be duplicate genotypes (either color clones of the same cultivar or synonyms). From the 323 remaining unique microsatellite genotypes, 89 possible pairs of parents were identified for 52 cultivars. Sixty cultivars were chosen for further study. After analysis of these 60 cultivars with an additional 15 microsatellite markers, 24 possible pairs of parents were identified for 24 cultivars. Fourteen cultivars have the same pair of possible parents: Pinot and Gouais blanc (Table 2). An additional seven cultivars also have Gouais blanc as one possible parent and of these seven, the second parent is Savagnin in two cases and Chenin in three cases (Table 3).

4. Discussion

At this writing, the proposed parental relationships presented here have not yet been subjected to likelihood analysis (work in progress). This analysis, which takes into account the frequencies of the microsatellite alleles inherited by progeny cultivars, will provide an estimate of the probability that these are indeed the parents. Nevertheless, the relatively large number of microsatellite loci (32) employed in this study lends considerable credibility to these relationships. The concept of geographic grouping of grape cultivars has been explored by several authors (e.g., Negrul, 1938; Levadoux, 1956; Bisson, 1995), with the general assumption that these geographic associations also represent genetic groups. Our study presents the first objective genetic data to support this hypothesis. The 14 cultivars that we propose to be the progeny of Pinot and Gouais blanc are all geographically associated with the northeastern part of France, and in fact include all the major cultivars grown in the Champagne, Bourgogne and Beaujolais regions today. Many of them have been described as belonging to the Noirien group, one of the most well-defined geographic groups of cultivars (Levadoux, 1956; Bisson, 1995). That Pinot and Gouais blanc should give rise to so many other cultivars attests to both their age and their importance. Pinot is generally regarded as an ancient variety (Viala and Vermorel, 1901). Gouais blanc has been known at least since the 13th century. In the Middle Ages, Pinot and Gouais were the dominant varieties in the northeastern part of France (Viala and Vermorel, 1903). Once very widespread, today Gouais has all but disappeared, while Pinot is one of the world's most important grapes. Pinot noir is the dominant red wine variety of Bourgogne and a prominent component of the sparkling wines of Champagne. Other forms of Pinot (Pinot gris, Pinot blanc, Meunier) are also important today. (Pinot teinturier, the proposed parent of Romorantin in a cross with Gouais, has a microsatellite genotype almost identical to Pinot) It is not possible to know how many crosses between Gouais blanc and Pinot gave rise to the 14 progenies detected in this study, nor when they occurred. But considering the age and wide distribution of the parents, it is likely that the progeny cultivars are the result of separate crosses that occured in different places and at different times. Some of the progeny (e.g. Gamay noir) have themselves been known for centuries. The direction of the crosses is not now known

but could be determined. Analysis of chloroplast DNA polymorphisms would distinguish the maternal and paternal parents. While it is possible that some of these crosses were deliberate, it is more likely that they were spontaneous because no records of deliberate hybridization involving either of the parental cultivars exist and, furthermore, grapevine breeding is not known to have occurred prior to the 19th century. Savagnin and Chenin, also proposed as parents of multiple cultivars in crosses with Gouais blanc, are also very old cultivars. Savagnin (syn. Traminer) has been suggested to be very closely related to wild *V. vinifera* (Levadoux, 1956). It is to be expected that the oldest cultivars will be the most common parents of other cultivars. Analysis of parentage can provide additional evidence for the age of some cultivars.

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Table 1. Microsatellite markers used in this study.

Phase I: 352 cultivars (17 loci)		Phase II: 60 cultivars (15 loci)	
Marker	Reference	Marker	Reference
VVMD5	Bowers *et al*., 1996	VVMD24	unpublished
VVMD6	Bowers *et al*., 1996	VVMD25	unpublished
VVMD7	Bowers *et al*., 1996	VVMD26	unpublished
VVMD14	unpublished	VVMD27	unpublished
VVMD17	unpublished	VVMD28	unpublished
VVMD21	unpublished	VVMD31	unpublished
VVMD36	unpublished	VMC5A1	unpublished
VVS29	M.R. Thomas, pers. comm.	VMC5H2	unpublished
VrZAG79	K. Sefc, H. Steinkellner, pers. comm	VMC5H5	unpublished
VrZAG62	K. Sefc, H. Steinkellner, pers. comm	VMC5G6	unpublished
VrZAG83	K. Sefc, H. Steinkellner, pers. comm	VMC5G1.1	unpublished
VrZAG93	K. Sefc, H. Steinkellner, pers. comm	VMC5G1.1	unpublished

Table 2. Probable progeny of Pinot x Gouais blanc crosses

Aligoté	Chardonnay	Melon	Gamay noir	Bachet noir
Aubin vert	Franc noir de la Haute Saône	Peurion	Beaunoir	Sacy
Auxerrois	Gamay blanc Gloriod	Roublot	Knipperlé	

Table 3. Additional cultivars of which Gouais blanc is a probable parent

Progeny cultivar	Second parent
Balzac blanc	Chenin
Meslier Saint François	Chenin
Colombard	Chenin
Aubin	Savagnin
Petit Meslier	Savagnin
Romorantin	Pinot fin teinturier
Genouillet	Tressot

Table 4. Other parental relationships detected

Progeny	Syrah	Tressot	César
Parent 1	Dureza	Duras	Pinot
Parent 2	Mondeuse blanche	Petit Verdot	Argant

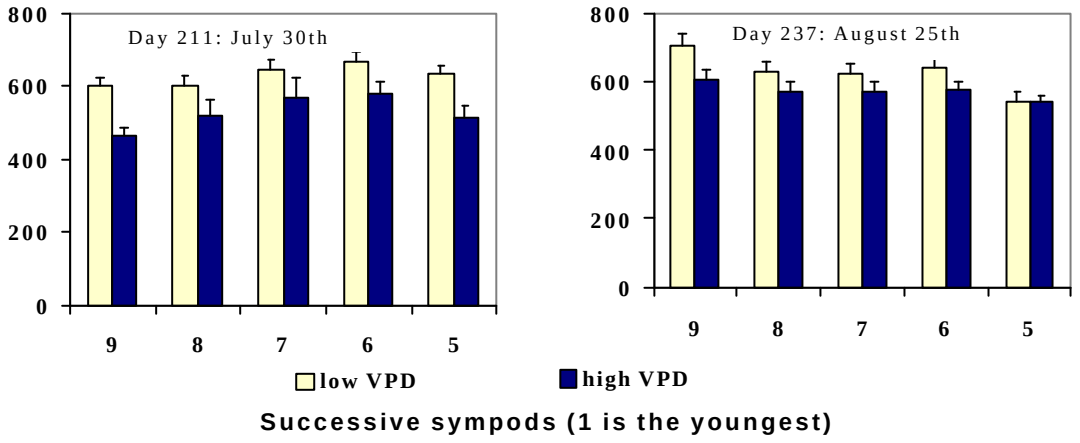

Fig. 1. Effect of lowering VPD on leaf area on successive sympods depending on sampling date (data are mean +se).