

Of Yeast, grapes and wasps: *Saccharomyces cerevisiae* ecology revised

I. Stefanini, L. Dapporto, JL. Legras, A. Calabretta, M. Di Paola, C. De Filippo, R. Viola, P. Capretti, M. Polsinelli, S. Turillazzi, D. Cavalieri¹

¹To whom correspondence should be addressed: Duccio Cavalieri, Centro Ricerche ed Innovazione, Fondazione Edmund Mach Istituto Agrario San Michele all'Adige, via E. Mach, 138010, Trento, Italy, 0039 0461615153, duccio.cavalieri@iasma.it

Supplemental data

Table S1. List of strains isolated from analyzed insect guts.

Table S2. Description of the strains sequenced in the genetic loci selected in this work (*IRC8*, *EXO5*, *URN1*).

Table S3. Primers used for sequencing.

Table S4. List of the strains used for microsatellite analysis in this work.

Fig. S1. Population dynamics of two social insects, *V. germanica*, *V. vulgaris* and *V. crabro*.

Fig. S2. Analysis of seasonal profile of the yeast flora from insect gut.

Fig. S3. Evaluation of the most probable number of K (clusters) able to describe the yeast population analyzed by sequencing of three genome-mimicking genes.

Fig. S4. Effects of groups bootstrapping on cluster discrimination with *dapc*.

Fig. S5. Comparison of the genetic distances calculated with the microsatellite and the genes sequence analyses.

Fig. S6. *Saccharomyces cerevisiae* evolution and heterogeneity.

Table S2. Description of the strains sequenced in the genetic loci selected in this work (*IRC8*, *EXO5*, *URN1*). The source, origin and collection data are reported for each strain.

| Strain | Source | Origin | Collection date | Reference |
|-----------|---|--|-----------------|--------------------------|
| 273614N | Fecal sample | Clinical isolate, Royal Victoria Infirmary, Newcastle UK | | Liti <i>et al</i> , 2009 |
| 322134S | Throat-sputum | Clinical isolate, Royal Victoria Infirmary, Newcastle UK | | Liti <i>et al</i> , 2009 |
| 378604X | Sputum | Clinical isolate, Royal Victoria Infirmary, Newcastle UK | | Liti <i>et al</i> , 2009 |
| AWRI796 | Wine | South Africa | | SGD |
| BC187 | Barrel fermentation | Napa Valley, USA | | Liti <i>et al</i> , 2009 |
| BIBVC1.1 | gut of <i>V. crabro</i> | Isole e Olena, Barberino Val d'Elsa (Florence, Italy) | September 2010 | This work |
| BIBVC4.3 | gut of <i>V. crabro</i> | Isole e Olena, Barberino Val d'Elsa (Florence, Italy) | October 2010 | This work |
| BIBVC5.3 | gut of <i>V. crabro</i> | Isole e Olena, Barberino Val d'Elsa (Florence, Italy) | October 2010 | This work |
| BREAD | bakery | Tavarnelle val di Pesa, Florence, Italy | | This work |
| Buc1 | gut of <i>V. crabro</i> foundress | Mercatale Val di Pesa (Florence, Italy) | July 1999 | This work |
| CIU8 | gut of <i>V. crabro</i> | Tuscany, Italy | August 1998 | This work |
| CPT2 | gut of <i>V. crabro</i> resting on an apple | Mercatale Val di Pesa (Florence, Italy) | August 1998 | This work |
| DBVPG1106 | Grapes | Australia | | Liti <i>et al</i> , 2009 |
| DBVPG1373 | Soil | Netherlands | | Liti <i>et al</i> , 2009 |
| DBVPG1788 | Soil | Turku, Finland | | Liti <i>et al</i> , 2009 |
| DBVPG1853 | White Teff | Ethiopia | | Liti <i>et al</i> , 2009 |
| DBVPG6040 | Fermenting fruit juice | Netherlands | | Liti <i>et al</i> , 2009 |
| DBVPG6044 | Bili wine, from <i>Osbeckia grandiflora</i> | West Africa | | Liti <i>et al</i> , 2009 |
| DBVPG6765 | Wine | Indonesia | | Liti <i>et al</i> , 2009 |
| E32 | gut of <i>V. crabro</i> worker | Mercatale Val di Pesa (Florence, Italy) | October 1998 | This work |
| E4 | <i>V. crabro</i> without gut | Mercatale Val di Pesa (Florence, Italy) | October 1998 | This work |
| EC1118 | Wine | Champagne, France | | SGD |
| F31x | gut of <i>V. polistes</i> | Tignano (Florence, Italy) | October 1998 | This work |
| FL100 | laboratory | laboratory strain collected pre-1968 | | SGD |
| FostersB | Beer | Industrial strain used in the Fosters breweries | | SGD |
| FostersO | Beer | Industrial strain used in the Fosters breweries | | SGD |
| JAY291 | Ethanol production | Brazil | | SGD |
| K11 | Shochu sake strain | Japan | | Liti <i>et al</i> , 2009 |
| Kyotai7 | Beer | Japan | | SGD |

| Strain | Source | Origin | Collection date | Reference |
|---------------|--|--|-----------------|--------------------------|
| L_1374 | Fermentation from must Pais | Cauquenes, Chile | | Liti <i>et al</i> , 2009 |
| L_1528 | Fermentation from must Cabernet | Cauquenes, Chile | | Liti <i>et al</i> , 2009 |
| NCYC110 | Ginger beer from <i>Z. officinale</i> | West Africa | | Liti <i>et al</i> , 2009 |
| NCYC361 | Beer spoilage strain from wort | Ireland | | Liti <i>et al</i> , 2009 |
| NPSM | gut of <i>V.crabro</i> resting on a peach stone | Pelago (Florence, Italy) | July 1998 | This work |
| Reg1b | gut of <i>V.crabro</i> queen | Monsanto, Barberino Val d'Elsa (Florence, Italy) | October 1998 | This work |
| RM11_1A | grape | haploid derivative of Bb32(3), a natural isolate collected by Robert Mortimer from a California vineyard | | Liti <i>et al</i> , 2009 |
| S288c | Rotting fig | Mercedes, California, USA | | Liti <i>et al</i> , 2009 |
| SG60 | Sangiovese natural fermentation | Chianti (Florence, Italy) | | This work |
| Sgu406 | Ripe Sangiovese grape | Chianti (Florence, Italy) | | This work |
| Sgu407 | Ripe Sangiovese grape | Chianti (Florence, Italy) | | This work |
| Sgu428R | Ripe Sangiovese grape | Chianti (Florence, Italy) | | This work |
| Sgu52 | Ripe Sangiovese grape | Chianti (Florence, Italy) | | This work |
| Sgu89 | Ripe Sangiovese grape | Chianti (Florence, Italy) | | This work |
| Sgv114 | gut of <i>V. crabro</i> resting on a Sangiovese grape | Chianti (Florence, Italy) | October 1999 | This work |
| Sigma1278b | Laboratory | Laboratory strain used in pseudohyphal growth studies | | SGD |
| SK1 | Soil | USA | | Liti <i>et al</i> , 2009 |
| Starter | wine | Isole e Olena, Tuscany, Italy | | This work |
| T7 | Oak | Missouri, USA, 2003 | | SGD |
| UC5 | Sake | Japan, pre-1974 | | SGD |
| UWOPS03.461.4 | Nectar, Bertram palm | Telok Senangin, Malaysia | | Liti <i>et al</i> , 2009 |
| UWOPS05.217.3 | Nectar, Bertram palm | Telok Senangin, Malaysia | | Liti <i>et al</i> , 2009 |
| UWOPS05.227.2 | <i>Trigona spp</i> (Stingless bee) collected near Bertam palm flower | Telok Senangin, Malaysia | | Liti <i>et al</i> , 2009 |
| UWOPS83.787.3 | Fruit, <i>Opuntia stricta</i> | Great Inagua Island, Bahamas | | Liti <i>et al</i> , 2009 |
| UWOPS87.2421 | Cladode, <i>Opuntia megacantha</i> | Puhelu Road, Maui, Hawaii | | Liti <i>et al</i> , 2009 |
| VAT11 | Vat for wine fermentation | Isole e Olena, Tuscany, Italy | | This work |
| VAT13 | Vat for wine fermentation | Isole e Olena, Tuscany, Italy | | This work |
| VAT16 | Vat for wine fermentation | Isole e Olena, Tuscany, Italy | | This work |
| Vin13 | Wine | South Africa, produced by the Institute for Wine Biotechnology at the University of Stellenbosch in South Africa | | SGD |
| VL3 | Wine | Bordeaux, France | | SGD |
| VS138 | dried grapes used for Vinsanto fermentation | Chianti (Florence, Italy) | | This work |

| Strain | Source | Origin | Collection date | Reference |
|-----------|---|--|-----------------|--------------------------|
| VS274 | dried grapes used for Vinsanto fermentation | Chianti (Florence, Italy) | | This work |
| VS290 | dried grapes used for Vinsanto fermentation | Chianti (Florence, Italy) | | This work |
| W303 | laboratory | created by Rothstein R. by multiple crossing | | Liti <i>et al</i> , 2009 |
| Y12 | Palm wine strain | Ivory Coast | | Liti <i>et al</i> , 2009 |
| Y55 | Laboratory strain | France | | Liti <i>et al</i> , 2009 |
| Y9 | Ragi (similar to sake wine) | Indonesia | | Liti <i>et al</i> , 2009 |
| YIIc17_E5 | Wine | Sauternes, France | | Liti <i>et al</i> , 2009 |
| YJM269 | Grapes | Austria, Isolated from Blauer Portugieser grapes in 1954 | | SGD |
| YJM789 | derived from a yeast isolated from the lung of an AIDS patient with pneumonia | USA | | Liti <i>et al</i> , 2009 |
| YJM975 | vagina of patient suffering from vaginitis | Ospedali Riuniti di Bergamo, Italy | | Liti <i>et al</i> , 2009 |
| YJM978 | vagina of patient suffering from vaginitis | Ospedali Riuniti di Bergamo, Italy | | Liti <i>et al</i> , 2009 |
| YJM981 | vagina of patient suffering from vaginitis | Ospedali Riuniti di Bergamo, Italy | | Liti <i>et al</i> , 2009 |
| YPS128 | Soil beneath <i>Q. alba</i> | Pennsylvania, USA | | Liti <i>et al</i> , 2009 |
| YPS606 | Bark of <i>Q. rubra</i> | Pennsylvania, USA | | Liti <i>et al</i> , 2009 |
| YS2 | Baker | Australia | | Liti <i>et al</i> , 2009 |
| YS4 | Baker | Netherlands | | Liti <i>et al</i> , 2009 |
| YS9 | Baker | Singapore | | Liti <i>et al</i> , 2009 |
| YVC1E2 | Gut of <i>V. crabro</i> | Isola d'Elba (Tuscany, Italy) | September 2011 | This work |
| YVC2E6 | Gut of <i>V. crabro</i> | Isola d'Elba (Tuscany, Italy) | September 2011 | This work |
| YVC4EST1 | Crop of <i>V. crabro</i> | Isola d'Elba (Tuscany, Italy) | September 2011 | This work |
| YVCE4 | gut of <i>V. crabro</i> queen | Florence, Italy | May 2010 | This work |
| YVPC7.6 | gut of <i>V. polistes</i> | Grassina, Florence, Italy | September 2010 | This work |

Table S3. Primers used for sequencing. A= Amplification, S= Sequencing

| Primer | Sequence | Application | Annealing temperature |
|-------------|-------------------------------|-------------|-----------------------|
| ITS1 | 5'-GTTTCCGTAGGTGAACTTGC -3' | A + S | 60°C |
| ITS4 | 5'-TCCTCCGCTTATTGATATGC -3' | A + S | 60°C |
| EXO5_AmplFW | 5'-GTCCCTTGATGGAACATTTATAC-3' | A + S | 57°C |
| EXO5_AmplRV | 5'-CCAAGAACAAACGTGTCTGTAG-3' | A+S | 58°C |
| EXO5_Seq1FW | 5'-GATGCCCTGCTAGATAACTGG-3' | S | 59°C |
| URN1_AmplFW | 5'-GACACCTGCAGGCAAAAAGTA-3' | A+S | 57°C |
| URN1_AmplRV | 5'-CTATTCCGGATTTATCGGCTC-3' | A+S | 57°C |
| URN1_Seq2FW | 5'-AAAGCCCACTGGGCTAGTCA-3' | S | 59°C |
| IRC8_AmplFW | 5'-TAGGAGCGGAAATAAGGCTGGT-3' | A+S | 60°C |
| IRC8_AmplRV | 5'-CCGCTTGATGATGACTGTATAG-3' | A+S | 58°C |
| IRC8_Seq2FW | 5'-ATCAACCATATCTGACATCTCG-3' | S | 56°C |
| IRC8_Seq4RV | 5'-CTTAGGGTGCTGTGTGAATGT-3' | S | 57°C |

Table S4. List of the strains used for microsatellite analysis in this work. The source and region are reported for each strain.

| strain | Source | region | Provided by | Reference |
|---------------|------------------------|------------------|---|-----------------------------|
| 228 | rum | French Indies | URTPV INRA Antilles Guadeloupe - France | Legras |
| 1014 | grape | Italy | Firenze University | This work |
| 6009 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6050 | wine | California, USA | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6054 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6280 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6320 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6400 | wine | USA | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6491 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 6493 | wine | Italy | Lallemand Inc, Montreal, Quebec, Canada | Legras |
| 273614N | Fecal sample | Newcastle UK | | Liti <i>et al</i> , 2009 |
| 322134S | Throat-sputum | Newcastle UK | | Liti <i>et al</i> , 2009 |
| 378604X | Sputum | Newcastle UK | | Liti <i>et al</i> , 2009 |
| 522Davies | wine | Burgundy, France | UMR SVQV, INRA Colmar - France | Novo |
| 6bPenciu | wine | Romania, | University of Bucharest, Romania | Legras |
| 71B | wine | France | LBE, INRA, Narbonne France | Legras |
| Anchor NT50 | wine | South Africa | Anchor yeast Ltd, South Africa | Legras |
| AWRI350 | wine | Australia | AWRI, Glen Osmond, Australia | Legras |
| AWRI796 | wine | South Africa | AWRI, Glen Osmond, Australia | Legras |
| B94/201 | wine | Alsace, France | UMR SVQV, INRA Colmar - France | Legras |
| BAD52 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| BAE52 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| Bb32 | wine | California, USA | Fred Hutchinson Cancer Research Center, Seattle, Washington USA | Novo |
| BC187 | Barrel fermentation | Napa Valley, USA | | Liti <i>et al</i> , 2009 |
| BIBVC1.1 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| BIBVC4.3 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| BIBVC5.3 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |

| strain | Source | region | Provided by | Reference |
|----------------|--|-------------------|---|------------------|
| BRG | Wine | Burgundy, France | Oenofrance, Bordeaux, France | Legras |
| Buc1 | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| C19 | wine | Alsace, France | Oenofrance, Bordeaux, France | Legras |
| C2C | wine | Languedoc, France | Oenofrance, Bordeaux, France | Legras |
| CAM43 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| Capa1 | Baker strain | France | CIRM, INRA INA PG, Grignon – France | Legras |
| CAX21 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| CBB01 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| CBB04 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| CBS1171 | beer | Netherlands | Centraal bureau voor Schimmelcultures (CBS)- Netherlands | Legras |
| CBS400 | palm wine | Ivory Coast | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| CBS5287 | <i>Vitis amurensis</i> | Russia | Centraalbureau voor Schimmelcultures (CBS)- Netherlands | Legras |
| CBS7765 | <i>Salmo gairduncii</i> (rainbow trout) | Sweden, Göteborg | Centraalbureau voor Schimmelcultures (CBS)- Netherlands | Legras |
| CBS8856 | Sorghum Beer | Ghana | Centraalbureau voor Schimmelcultures (CBS)- Netherlands | Legras |
| CBS8857 | Sorghum Beer | Ghana | Centraalbureau voor Schimmelcultures (CBS)- Netherlands | Legras |
| CECT1882 | veil from wine | Spain | CECT, Madrid, Spain | Liti |
| CER | wine | France | Oenofrance, Bordeaux, France | Legras |
| CHP | wine | Champagne, France | Oenofrance, Bordeaux, France | Legras |
| CLIB 411 | rice wine | Asia | CIRM, INRA INA PG, Grignon – France | Legras |
| CLIB 412 | rice wine | Asia | CIRM, INRA INA PG, Grignon – France | Legras |
| Côte de Blancs | wine | France | Lesaffre , Marcq en Baroeul, France | Legras |
| CY3079 | wine | Burgundy, France | Lalvin | Legras |
| D47-ICV | industrial wine strain | France | UMR SPO, INRA Sup Agro Montpellier, France | Legras |
| DAB110 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB111 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |

| strain | Source | region | Provided by | Reference |
|---------------|---------------|----------------|---|------------------|
| DAB112 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB114 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB115 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, UniversitàUniversità degli Studi di Firenze, Italy | Legras |
| DAB117 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB12 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB121 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB124 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB125 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB127 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB129 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB13 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB130 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB131 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB133 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB137 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB2 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB26 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB4 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB56 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |

| strain | Source | region | Provided by | Reference |
|---------------------|---|-------------------|---|--------------------------|
| DAB59 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB6 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB62 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB63 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB64 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB66 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB67 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB69 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DAB8 | Wine | Tuscany, Italy | Dipartimento di Biotecnologie Agrarie, Università degli Studi di Firenze, Italy | Legras |
| DBVPG1106 | Grapes | Australia | | Liti <i>et al</i> , 2009 |
| DBVPG1373 | Soil | Netherlands | | Liti <i>et al</i> , 2009 |
| DBVPG1788 | Soil | Turku, Finland | | Liti <i>et al</i> , 2009 |
| DBVPG1853 | White Teff | Ethiopia | | Liti <i>et al</i> , 2009 |
| DBVPG6040 | Fermenting fruit juice | Netherlands | | Liti <i>et al</i> , 2009 |
| DBVPG6044 | Bili wine, from <i>Osbeckia grandiflora</i> | West Africa | | Liti <i>et al</i> , 2009 |
| DBVPG6765 | Wine | Indonesia | | Liti <i>et al</i> , 2009 |
| E32 | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| E4 | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| EDV493 | Rum | French Indies | URTPV INRA Antilles Guadeloupe - France | Legras |
| Eg25 | Wine | Alsace, France | UMR SVQV, INRA Colmar - France | Legras |
| F31x | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| fl100 (ATCC 28383) | laboratory | Laboratory strain | UMR SVQV, INRA Colmar - France | Legras |
| fl200 (ATCC 32119), | laboratory | Laboratory strain | UMR SVQV, INRA Colmar - France | Legras |

| strain | Source | region | Provided by | Reference |
|------------------|--|----------------------|--|--------------------------|
| FY10 | Laboratory | Laboratory strain | UMR SVQV, INRA Colmar - France | Legras |
| FZ4m33Bdx | Wine | Bordeaux, France | Institut d'Enologie, Bordeaux, France | Legras |
| GE7 | Wine | Alsace, France | UMR SVQV, INRA Colmar - France | Legras |
| GUF54 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| IR2225 | Wine | Rhône valley, France | Inter Rhône, Avignon, France | Legras |
| IY 03-5-26-5-1-1 | Insect (<i>Chauliodes rastricornis</i>) | Louisiana, USA | Department of Biology, Louisiana State University, USA | Nguyen |
| IY 03-5-30-1-1-1 | Insect (<i>Chauliodes rastricornis</i>) | Louisiana, USA | Department of Biology, Louisiana State University, USA | Nguyen |
| K1 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| K1-MTF2 | Wine | Languedoc, France | UMR SPO, INRA Sup Agro Montpellier, France | Legras |
| K2 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| K3 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| K34 | Wine | Spain | National Research Institute of Brewing (NRIB), Japan | Legras |
| K4 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| K5 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| K9 | Sake | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| KL10 | Wine | Austria | Weinbau Institut Klosterneubourg, Austria | Legras |
| KL19 | Wine | Austria | Weinbau Institut Klosterneubourg, Austria | Legras |
| KL4 | Wine | Austria | Weinbau Institut Klosterneubourg, Austria | Legras |
| KL8 | Wine | Austria | Weinbau Institut Klosterneubourg, Austria | Legras |
| L-1374 | Fermentation from must País | Cauquenes, Chile | | Liti <i>et al</i> , 2009 |
| L1414 | Wine | Beaujolais France | Sicarex Beaujolais; Villefranche sur Saône - France | Legras |
| L1515 | Wine | Beaujolais, France | Sicarex Beaujolais; Villefranche sur Saône - France | Legras |
| L-1528 | Fermentation from must Cabernet | Cauquenes, Chile | | Liti <i>et al</i> , 2009 |
| L2056 | Wine | Rhône valley, France | Inter Rhône, Avignon, France | Legras |
| Lalvin BM45 | Wine | Bordeaux, France | Lallemand Inc, Montreal, Quebec | Legras |
| LR-jura | Wine | Jura, France | Institut Jules Guyot, Université de Bourgogne, Dijon, France | Legras |

| strain | Source | region | Provided by | Reference |
|---------------------|--|------------------|---|-----------------------------|
| M1.2 | grape | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | Townsend |
| M13Fay | grape | Italy | University of Washington, Saint Louis, USA | Fay |
| M15Fay | grape | Italy | University of Washington, Saint Louis, USA | Fay |
| M2.8 | grape | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | Townsend |
| M30Fay | grape | Italy | University of Washington, Saint Louis, USA | Fay |
| M33Fay | grape | Italy | University of Washington, Saint Louis, USA | Fay |
| M4Fay | grape | Italy | University of Washington, Saint Louis, USA | Fay |
| M5.7 | grape | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | Townsend |
| MAH53 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| MJ10 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Ayoub |
| MJ104 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Legras |
| MJ111 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Ayoub |
| MJ112 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Ayoub |
| MJ34 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Legras |
| MJ73 | Wine | Lebanon | CIRM, INRA INA PG, Grignon – France | Legras |
| Sauv | Wine | Fermichamp | UMR SPO, INRA Sup Agro Montpellier, France | Legras |
| MTF1097 | wine | Francw | UMR SPO, INRA Sup Agro Montpellier, France | Legras |
| MTF1309 - EC1118 | wine | Champagne France | Lallemant Inc, Montreal, Quebec | Legras |
| MUCL28071 | Fermented banana | Burundi | MUCL, Louvain, Belgium | Legras |
| MUCL31348 | Wine | Italy | MUCL, Louvain, Belgium | Legras |
| MUCL42920 | Baker | Morocco | MUCL, Louvain, Belgium | Legras |
| NCYC110 | Ginger beer from <i>Z. officinale</i> | West Africa | | Liti <i>et al</i> , 2009 |
| npa21 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa31 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa5a1 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |

| strain | Source | region | Provided by | Reference |
|---------------|---------------|---------------|--|------------------|
| npa5b1 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa5d2 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa61 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa62 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa71 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| npa72 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPAB2-2 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPAB3-14 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPAB3-3 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPCR 2-7 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPCR4-14 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPCR4-15 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPCR5-1 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |
| NPDR4-7 | Palm wine | Nigeria | Nigeria – Dept Biol. Sciences, Michael Okpara University of Agriculture (DBS MOUA) Umudike, Abia State Nigeria | Legras |

| strain | Source | region | Provided by | Reference |
|-----------------------------|---------------------------------------|----------------------------------|--|------------------|
| NPSM | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| NRRL Y-2189 | Drosophila | USA | ARS culture collection | Kurtzman |
| NRRL YB-908 | Sherry tree | Marion, Illinois, USA | ARS culture collection | Wickerham |
| Oenoferm Klosterneubourg | Wine | Austria | Weinbau Institut Klosterneubourg, Austria | Legras |
| Pasteur Red | Wine | France | Lesaffre , Marcq en Baroeul, France | Legras |
| PII33 | Wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| QA23 | Wine | Portugal | Lallemand Inc, Montreal, Quebec | Legras |
| Primeur | Baker | | | Legras |
| R2226 | wine | | | Legras |
| R2323 | Wine | Rhône valley, France | Inter Rhône, Avignon, France | Legras |
| R3574 | Wine | Rhône valley, France | Inter Rhône, Avignon, France | Legras |
| RA17 | Wine | Burgundy, France | Lallemand Inc, Montreal, Quebec | Legras |
| RC212 | Wine | Burgundy, France | Lallemand Inc, Montreal, Quebec | Legras |
| Reg1b | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| RM11-1a | grape | haploid derivative of Bb32(3) | | Liti |
| S288C | Rotting fig | Mercedes, California, USA | | Liti |
| SAC53 | wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| SG10 | Sangiovese natural fermentation | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SG60 | Sangiovese natural fermentation | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU165 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU52 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU406 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU25 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU406 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU407 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU421 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU428R | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SGU89 | Sangiovese grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| Sgv114 | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| SIHA3 | Wine | Germany | Beco, Germany | Legras |

| strain | Source | region | Provided by | Reference |
|-----------------|---------------------------|----------------------------|---|------------------|
| SIHA7 | Wine | Germany | Beco, Germany | Legras |
| SIHA8 | Wine | Germany | Beco, Germany | Legras |
| SK1 | Soil | USA | | Liti |
| SRC120 | Apple cider | Bretagne, France | SRC INRA Le Rheu – France | Legras |
| T73 | Wine | Spain | UMR SPO, INRA Sup Agro Montpellier, France | Querol |
| T7fay | Oak | Babler State Park, MO, USA | University of Washington, Saint Louis, USA | Fay |
| THAI541 | Moss | Thailand | BIOTEC culture collection, Thailand | Sasitorn J |
| THAI543 | Insect fass | Thailand | BIOTEC culture collection, Thailand | Sasitorn J |
| TL229 | Cheese | France | CIRM, INRA INA PG, Grignon – France | Schacherer |
| TL230 | Cheese | France | CIRM, INRA INA PG, Grignon – France | Schacherer |
| UCD13 | Unknown | USA | UC Davis, California United States. | Legras |
| UCD619 | Wine | USA | UC Davis, California United States. | Legras |
| UCD623 | Wine | USA | UC Davis, California United States. | Legras |
| UCD915 | Beer | USA | UC Davis, California United States. | Legras |
| UY4 | Wine | Uruguay | DSM France, Montpellier | Legras |
| UWOPS03.461.4 | Bertram palm | Malaysia | | Liti |
| UWOPS05.217.3 | Bertram palm | Malaysia | | Liti |
| UWOPS05.227.2 | Trigona spp | Malaysia | | Liti |
| UWOPS83.787.3 | <i>Opuntia stricta</i> | Bahamas | | Liti |
| UWOPS87.2421 | <i>Opuntia megacantha</i> | Hawaii | | Liti |
| VAT11 | Vat for wine fermentation | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| VAT13 | Vat for wine fermentation | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| VAT16 | Vat for wine fermentation | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| VS274 | dried grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| VS290 | dried grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| VS291 | dried grape | Florence, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| Vitilevure 58W3 | Wine | Alsace, France | Sofralab, Epernay, France | Legras |
| Vitilevure CSM | Wine | Bordeaux, France | Sofralab, Epernay, France | Legras |
| Vitilevure GY | Wine | France | Sofralab, Epernay, France | Legras |
| Vitilevure MO5 | Wine | France | Sofralab, Epernay, France | Legras |

| strain | Source | region | Provided by | Reference |
|----------------------|-------------------------|--|--|------------------|
| Vitilevure sauvignon | Wine | France | Sofralab, Epernay, France | Legras |
| W3 | Wine | Japan | National Research Institute of Brewing (NRIB), Japan | Legras |
| W303 | laboratory | created by Rothstein R. by multiple crossing | | Legras |
| we14 | Wine | Anchor yeast | Anchor yeast Ltd, South Africa | Legras |
| XRA22 | Wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| XRG25 | Wine | Jura, France | UMR SVQV, INRA Colmar - France | Charpentier |
| Y55 | Y55 | Laboratory strain | France | Liti |
| Y9 | Y9 | Ragi | Indonesia | Liti |
| YIIc17-E5 | YIIc17_E5 | Wine | Sauternes, France | Liti |
| YJM789 | clinical | USA | | Liti |
| YJM975 | clinical | Italy | | Liti |
| YJM978 | clinical | Italy | | Liti |
| YJM981 | clinical | Italy | | Liti |
| YPS1000 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS1009 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS128 | | | | |
| YPS129 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS133 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS134 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS139 | Oak | Pennsylvania, USA | University of Chicago, USA | Sniegowski |
| YPS606 | Bark of <i>Q. rubra</i> | Pennsylvania, USA | | Liti |
| YS2 | Baker | Australia | | Liti |
| YS4 | Baker | Netherlands | | Liti |
| YS9 | Baker | Singapore | | Liti |
| YVC1E2 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| YVC2E6 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| YVC4EST1 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| YVCE4 | Wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| YVPC7.6 | wasp | Tuscany, Italy | Dipartimento di Farmacologia Università di Firenze, Italy | This work |
| ZP563 | <i>Q. pyrenaica</i> | Castelo de Vide, Portugal | CREM, Faculdade de Ciências e Tecnologia Universidade Nova de Lisboa, Portugal | Sampaio |
| ZP567 | <i>Q. pyrenaica</i> | Castelo de Vide, Portugal | CREM, Faculdade de Ciências e Tecnologia Universidade Nova de Lisboa, Portugal | Sampaio |
| Zymaflore F10 | Wine | Bordeaux | Laffort, Bordeaux, France | Legras |

| strain | Source | region | Provided by | Reference |
|---------------|---------------|------------------|--------------------------|------------------|
| Zymaflore VL1 | Wine | Bordeaux, France | Laffort,Bordeaux, France | Legras |
| Zymaflore VL3 | Wine | Bordeaux, France | Laffort,Bordeaux, France | Legras |

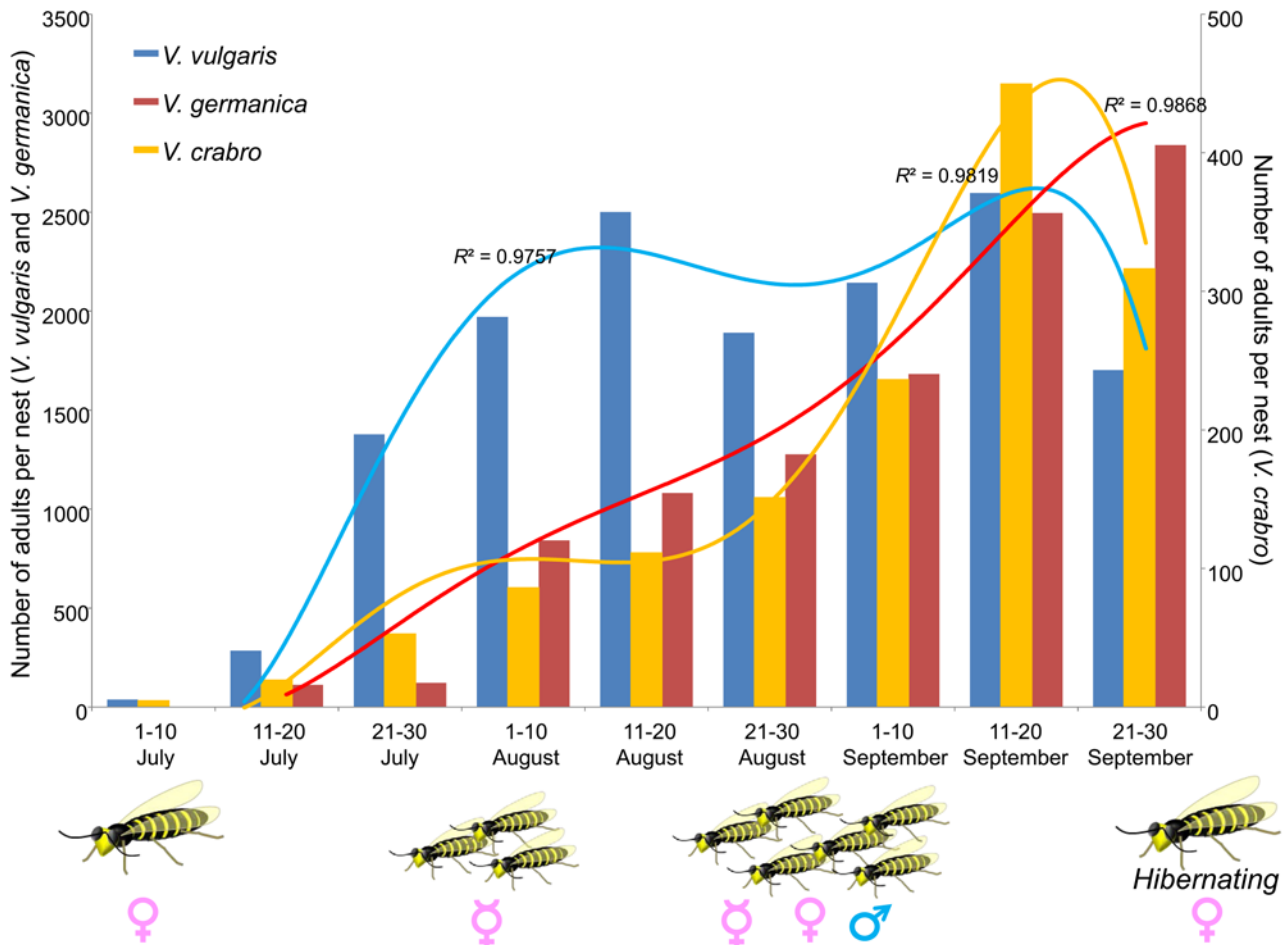


Fig. S1. Population dynamics of two social insects, *V. germanica*, *V. vulgaris* and *V. crabro*. *V. vulgaris* and *V. germanica* data were obtained from Spradbery, 1971 [1], *V. crabro* data were obtained from Matsuura and Yamano, 1984 [2]. After hibernation, queens find new sites to found their nests and start building them. The first eggs laid in the nest will generate the first workers, that will contribute to the successive expansion of the nest and to the care of new larvae. The highest number of insects populating both *V. vulgaris* and *V. germanica* nests is reached in mid-to-late September, a period overlapping grapes harvest.

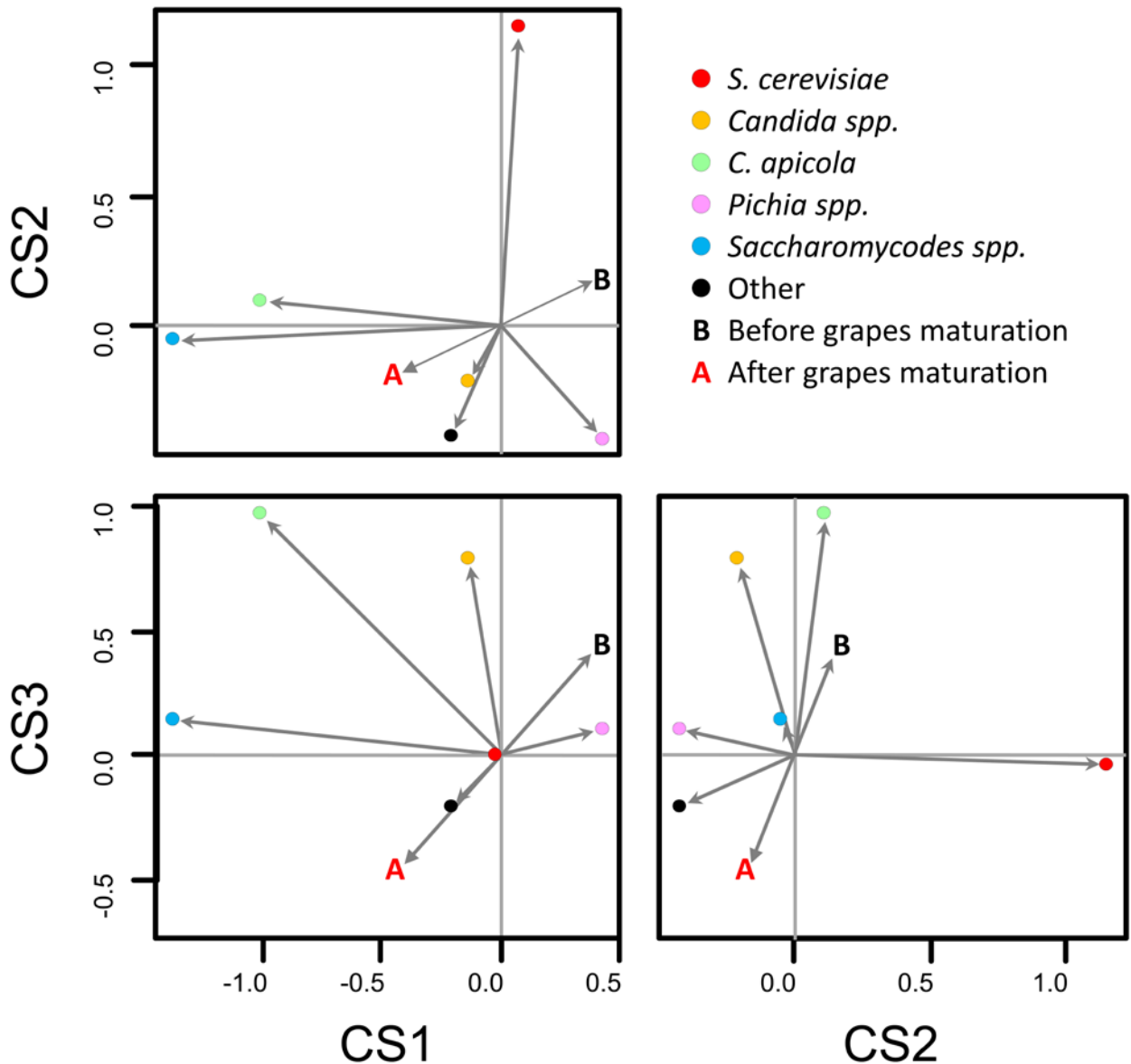


Fig. S2. Analysis of seasonal profile of the yeast flora from insect gut. The yeast species content from social wasp guts was analyzed by correspondence analysis and results are visualized with a duality diagram using the R package *ade4*. Three different components (having eigenvalues >1) were able to explain sample distribution. Every component indicates that the presence of *S. cerevisiae* strains in wasp guts is independent of the collection period of the insect. On the contrary, *C. apicola* strain presence depended on the period of insect capture with respect to the grape maturation mainly being isolated from the gut of insects caught after grape maturation.

Details of the phylogenetic analysis

Distribution of individuals on the phylogenetic tree was evaluated using two different methods. The first, using *Structure*, is based on a Bayesian approach. The second, called dapc (differential Analysis of Principal Components) consists of a PCA applied after selection of the linear combinations of variables (principal components of PCA) which optimize the separation of cases into pre-defined groups. Both approaches have been widely applied to genetic analysis when trying to identify population structures. Since the two analyses, even if based on different approaches, gave almost identical results, they have been complementarily applied to assess different features describing the yeast population in analysis. Such analyses have been applied to assess the most probable number of clusters (each one composed of yeast strains originating from the same ancestor) able to describe the yeast population. Both approaches identified eight different clusters (**Figure S3 A and B**).

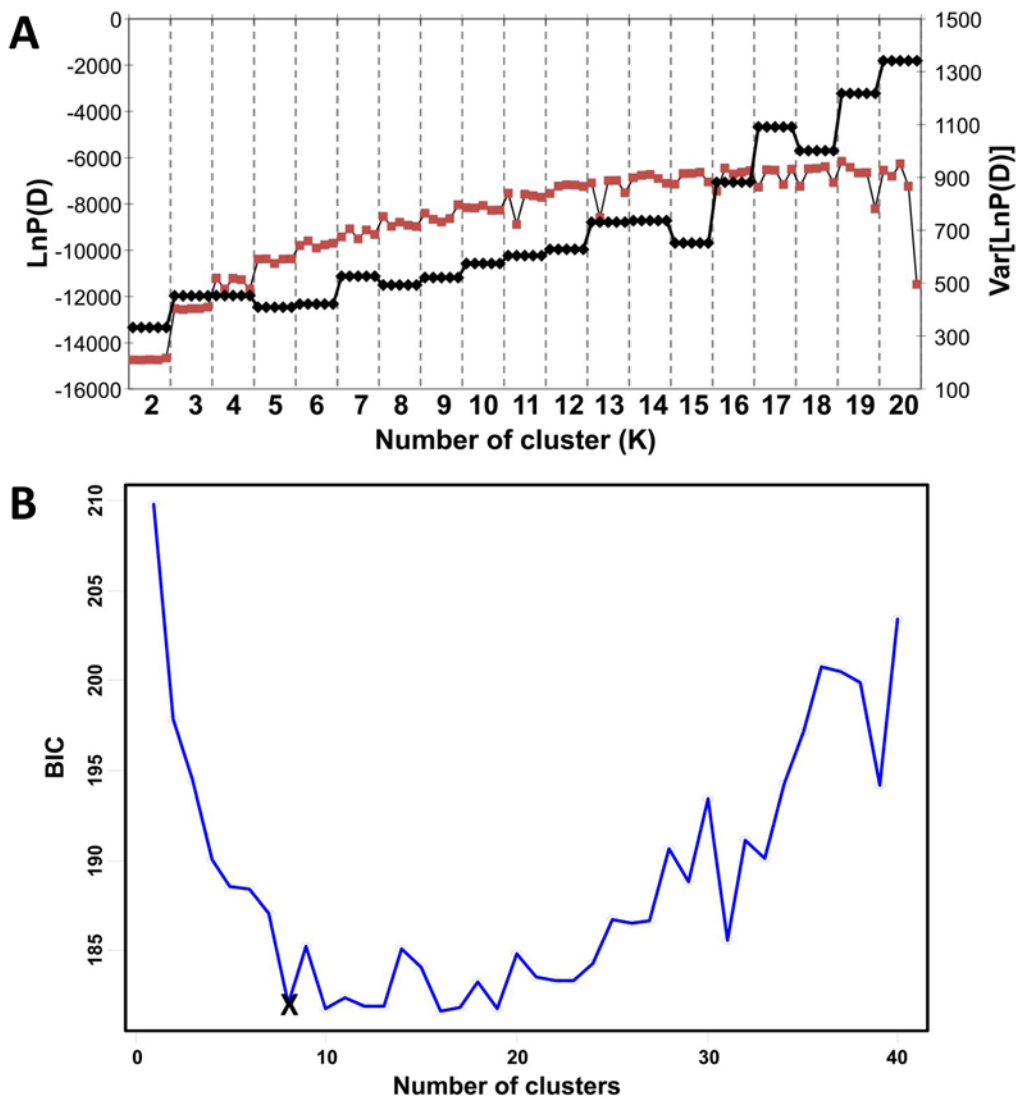


Fig. S3. Evaluation of the most probable number of K (clusters) able to describe the yeast population analyzed by sequencing of three genome-mimicking genes. A- Plot of the likelihood values and variance of the bootstrap samples against K calculated with *Structure*. The most reliable result is obtained with maximization of the likelihood values and the contemporary minimization of their variance ($K=8$ corresponds to the lowest number of clusters associated with a good compromise of the two requests). B- plot of the BIC (Bayesian Information Criterion) calculated with dapc; the optimal clustering solution corresponds to the lowest BIC ($K=8$).

When evaluating the best number on K able to describe the population in analysis with *dapc*, one of the most common effects of over-estimating the components to be retained (the necessary and sufficient components) is that the discriminant functions could model any structure, thus any set of clusters would be incorrectly discriminated. To ward off this eventuality, the analysis was run using 100 randomized groups and the mean probability of a cluster to be composed of the correctly-assigned individuals was evaluated. The results of this bootstrapping of randomly sampled groups (**Fig. S4**) clearly demonstrate that the good cluster discrimination achieved with the analysis was not obtained by chance.

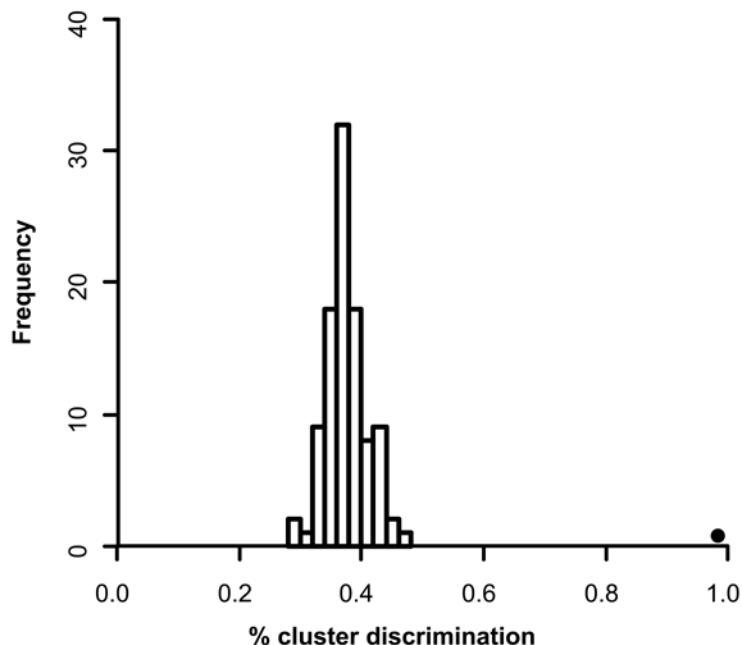


Fig. S4. Effects of groups bootstrapping on cluster discrimination with *dapc*. White bars indicate the times in which the clusters are discriminated with the relative % of cluster discrimination. The black point indicates the % of cluster discrimination obtained with the original sample grouping.

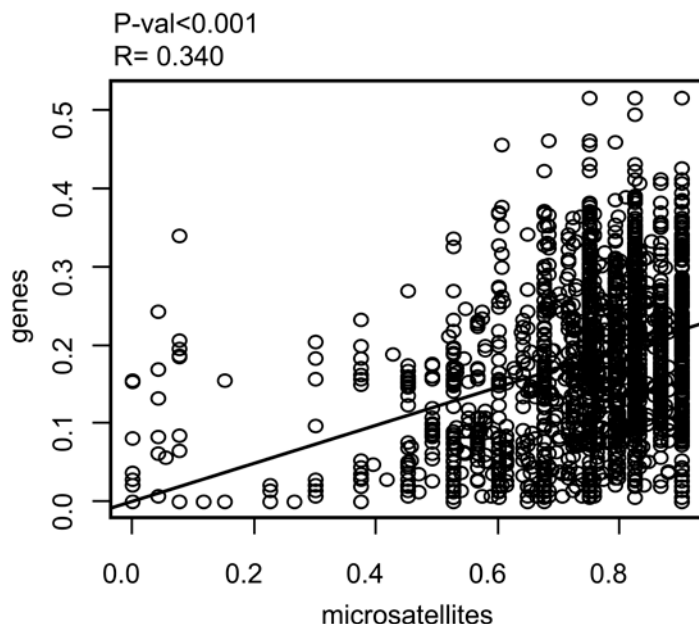


Fig. S5. Comparison of the genetic distances calculated with the microsatellite and the gene sequences analyses. Each white circle indicates a single yeast strain couple.

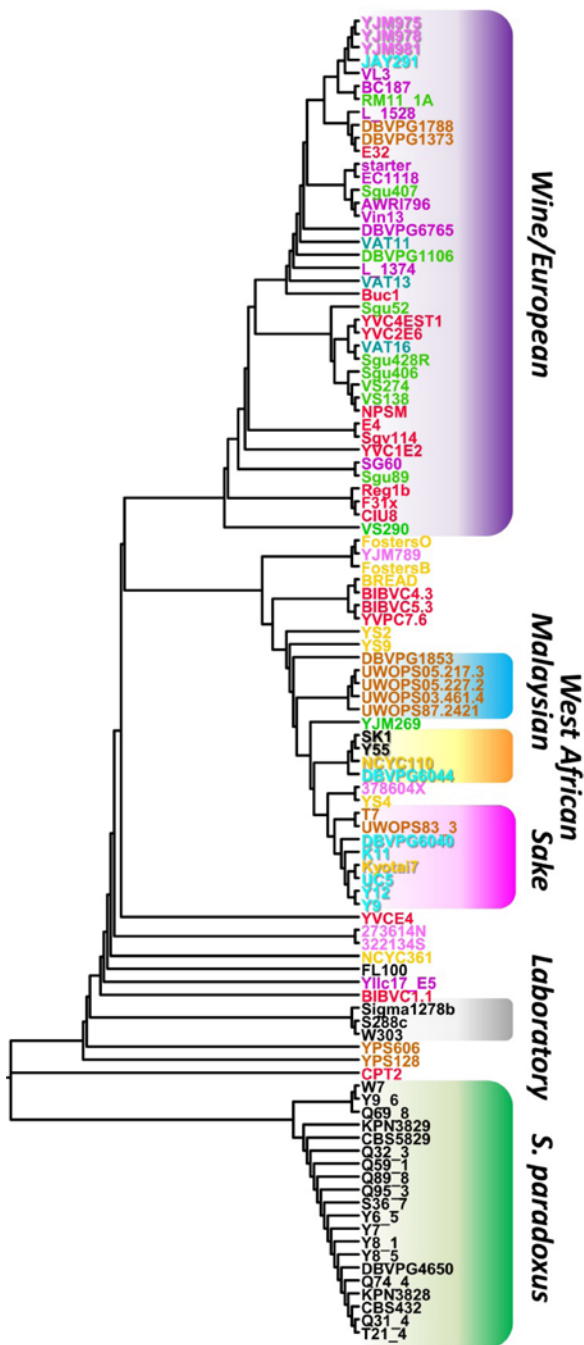


Fig. S6. *Saccharomyces cerevisiae* evolution and heterogeneity. Neighbor-joining cladogram based on the sequences of the three genome-mimicking genes, *EXO5*, *URN1* and *IRC8*. *S. paradoxus* strains were used as the tree root.

REFERENCES:

1. Spradbery JP (1971) Seasonal Changes in the Population Structure of Wasp Colonies (*Hymenoptera: Vespidae*). *J Anim Ecol* 40: 501-523.
2. Matsuura M, Yamane S (1984) *Biology of the vespine wasps*; Springer-Verlag, editor. Berlin, New York.
3. Sebastiani F, Barberio C, Casalone E, Cavalieri D, Polsinelli M (2002) Crosses between *Saccharomyces cerevisiae* and *Saccharomyces bayanus* generate fertile hybrids. *Res Microbiol* 153: 53-58.