

Grapevine crown gall: an old, emerging disease

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History

- **1853. First written report of crown gall disease**

Fabre, E. and Dunal, F. (1853): Observations sur les maladies regantes de la vigne. Bull. Soc. Cent. Agric. Dep. Herault. 40, 46.

- **1897. F. Cavara identified bacteria, termed *Bacillus ampelopsorae*, as the causal agent of crown gall of grapevine**

Cavara, F. (1897) Tubercolosi della vite. Intorno alla eziologia de alcune malattie di piante coltivate. Stazioni Sperimentali Agrarie Italiane 30, 483–487.



Fridiano Cavara

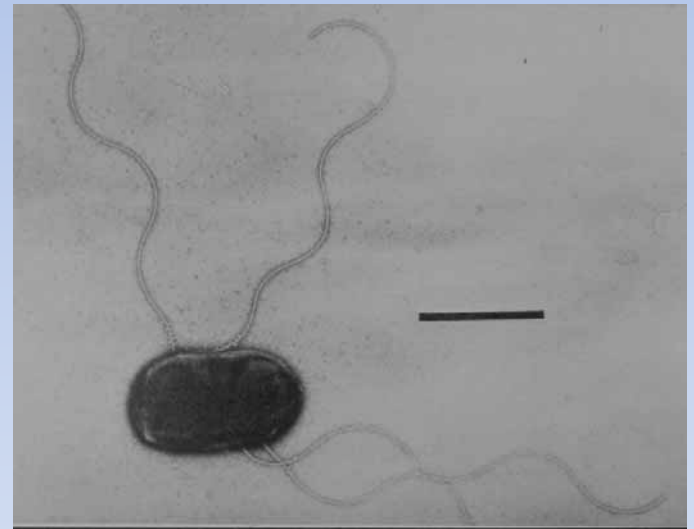
Causal agent of disease

- *Agrobacterium vitis* (Ti) (Ophel and Kerr, 1990)



Host-specific to grapevine

- Gram negative
- Nonsporeforming
- Rod-shaped (0.6–1.0 × 1.5–3.0 μm)
- Occurring singly or in pairs
- Motile by 1–4 peritrichous flagella
- Aerobic



- *A. tumefaciens* (biovar I) (Ti)
- *A. rhizogenes* (biovar II) (Ti)



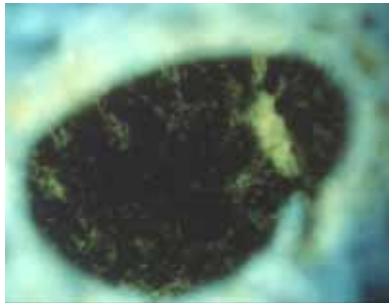
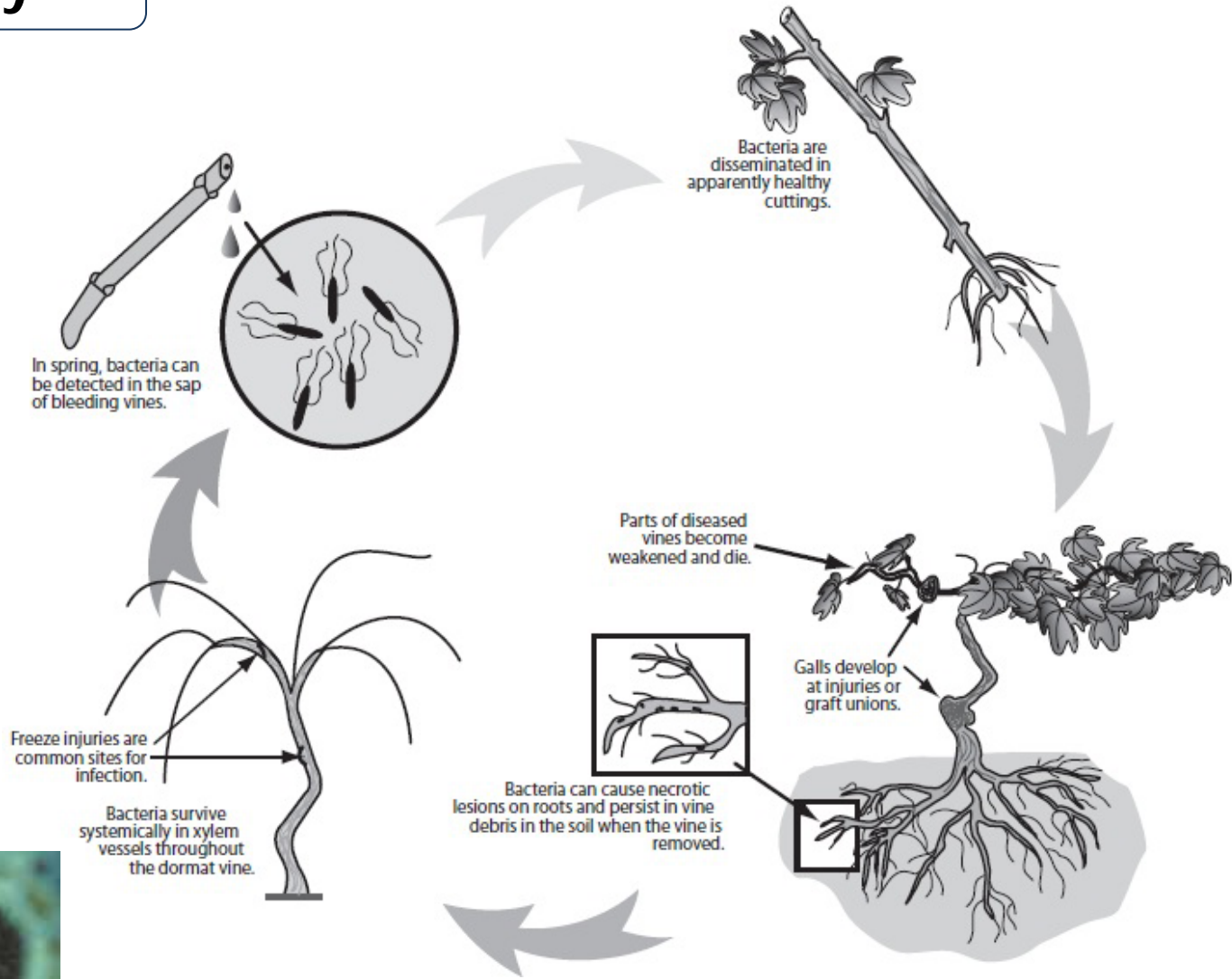
Broad host range pathogens

Economic significance

- Reduces vigor and yield of grapevines
- Severe disease may cause partial or complete death of infected plants
- High losses occur especially in nurseries where different graft combinations with visible symptoms are unmarketable and must be discarded



Disease cycle



Management

Production of *A. vitis*-free grapevines



Shoot tip propagation



Thermotherapy

Microshoot tip

Macroshoot tip

Management

Planting of crown gall and cold-resistant cultivars and rootstocks

Susceptibility of selected grape scion and rootstock cultivars to crown gall

Country	Susceptible	Resistant
Scion cultivars		
South Africa	Muscat d'Alexandrie	Chardonnay, Simillon, Riesling, Carignan, Blanca ovoide
Chile	Pumard, Pais, Pedro Jimenez Totontel, Moscatel negra	Regina
Italy	Merlot, Lambrusco, Albana, Muscat Hambourg, Cardinal, Italia, Perla	
Israel	Muscat d'Alexandrie, Dabouki, other local varieties	
U.S.	Chardonnay, Merlot, Riesling, Cabernet Sauvignon, Grenache, and other vinifera	Several <i>V. labrusca</i> cultivars and some hybrid,
Rootstocks		
South Africa	110-Richter, 99-Richter, Jacques, Ramsey	Paulsen 775, Freedom, Couderc 3309, 101-14 Mgt, Kober 5BB
Spain	161-49	
Italy	Teleki 5C, 17-37, Paulsen 775, Kober 5BB, 420 A	
Hungary	Kober 5BB, Teleki 5C, Teleki 8B, Paulsen 775, 287C	Riparia Gloire, 101-14 Mgt
Israel	Ruggeri 140	1103 Paulsen
U.S.	110-Richter, Teleki 5C	Couderc 3309, Riparia Gloire 101-14 Mgt

Management

Biological control

A. rhizogenes, strain K84

A. rhizogenes, strain K1026



Management

Biological control

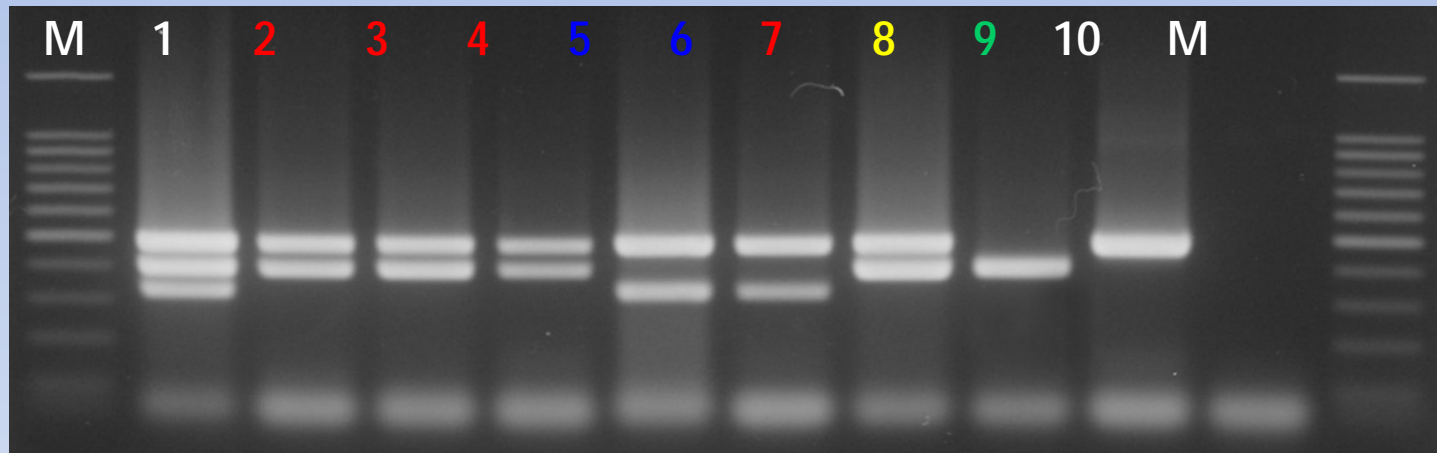
BACTERIAL STRAINS AS BIOLOGICAL CONTROLS OF GRAPEVINE CROWN GALL

Bacterium	Strain	Origin	Reference
<i>Agrobacterium vitis</i> (n.t.)	F2/5	Grapevine, South Africa	Staphorst <i>et al.</i> , 1985
<i>Agrobacterium tumefaciens</i> (n.t.)	HLB2	Hop, China	Xiaoying <i>et al.</i> , 1986
<i>Agrobacterium tumefaciens</i> (n.t.)	J73	Plum, South Africa	Webster <i>et al.</i> , 1986
<i>Agrobacterium vitis</i> (n.t.)	E26	Grapevine, China	Yajie <i>et al.</i> , 1990; Wang <i>et al.</i> , 2003
<i>Agrobacterium</i> spp. (n.t.)		Various, Romania	Kupferberg <i>et al.</i> , 1991
<i>Agrobacterium rhizogenes</i> (n.t. derivatives)		Soil, Russia	Khmel <i>et al.</i> , 1991
<i>Agrobacterium tumefaciens</i> (n.t.)	MI15	Grapevine, China	Xie <i>et al.</i> , 1993
<i>Pseudomonas corrugata</i>		Grapevine, Canada	Bell <i>et al.</i> , 1995
<i>Pseudomonas fluorescens</i>	CR330D	Grapevine rhizosphere, Moldavia	Khmel <i>et al.</i> , 1998
<i>Pseudomonas</i> spp.	1100-6	Apple, U.S.A./Canada	Eastwell <i>et al.</i> , 2006
<i>Agrobacterium vitis</i> (n.t.)	VAR03-1	Grapevine, Japan	Kawaguchi <i>et al.</i> , 2007
<i>Bacillus subtilis</i>	BS-F4	Italy	Biondi <i>et al.</i> , 2009
<i>Pseudomonas fluorescens</i>	IPV-BO G19	Apple, Italy	Biondi <i>et al.</i> , 2009

Management

Indexing of grapevine

PCR



Primers	Target gene	Reference
VCF3/VCR3	<i>virC</i>	Suzaki i sar., 2004.
VirD2S4F716/VirD2S4R1036	<i>virD</i>	Bini et al., 2008
VirFF1/virFR2	<i>virF</i>	Bini et al., 2008
PGF/PGR	<i>pehA</i>	Herlache i sar., 1997; Szegedi i Bottka, 2002.
UF/B1R/B2R/AvR/ArR	23S rRNA	Pulawska et al., 2006

Management

Indexing of grapevine

Pathogenicity assay

- A: Tomato
- B: *Nicotiana glauca*
- C: Sunflower
- D: *Kalanchoe* sp.



Electronic nose as an innovative tool for the diagnosis of grapevine crown gall

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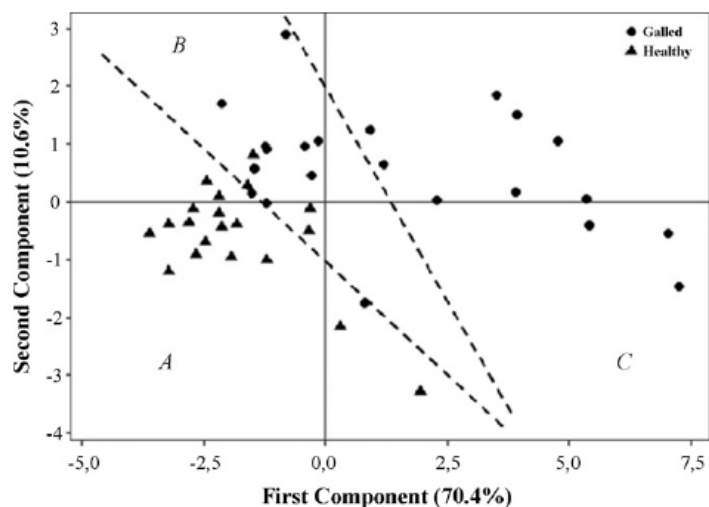


Fig. 4. Score plot of vine samples in the plane defined by the first two principal components. The A zone is characterized by $MDI \leq 0.1$ mm, the B zone by values between 0.1 and 0.3 mm, and the C zone by $MDI \geq 0.3$ mm.

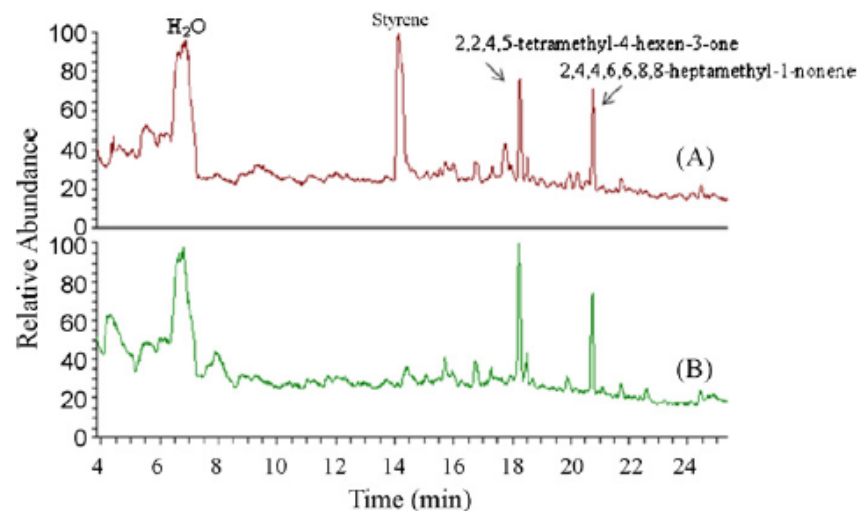


Fig. 2. GC-MS chromatograms of grapevine samples: (A) inoculated with *A. vitis* and (B) not inoculated.

Development and standardization of indexing procedures including protocols of analysis and sampling methods!!!

Quantitative thresholds tolerated for phytosanitary problems in nursery production: <10% and <5% for "standard" and "certified" materials, respectively.

Administrative issues

Agrobacterium vitis

- Not listed as an EU quarantine pest (**EU Directive 2000/29**);
- Commonly regarded as a harmful, widespread pathogen that can reduce the value of propagation material ("**quality organism**");
- **Phytosanitary requirements** for mother and grafted vines on the market (EU Directives **68/193, 11/2002**)
- In international trade: "**regulated non quarantine pest**" (**ISPM 16 - FAO**); the request for phytosanitary inspections on imported consignments and preventive control measures to the exporting Country is based on **equivalent measures** existing in the importing Country.