FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

INTERNATIONAL BOARD FOR
PLANT GENETIC RESOURCES

FAO/IBPGR TECHNICAL GUIDELINES
FOR THE

SAFE MOVEMENT OF GRAPEVINE GERMPLASM

Edited by
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In collaboration with

THE INTERNATIONAL COUNCIL
FOR THE STUDY OF
VIRUSES AND VIRUS DISEASES OF THE GRAPEVINE

INTRODUCTION

Collecting, conservation and utilization of plant genetic resources and their global distribution are essential components of international crop improvement programmes.

Inevitably, the movement of germplasm involves a risk of accidentally introducing plant quarantine pests* along with the host plant material; in particular, pathogens that are often symptomless, such as viruses, pose a special risk. In order to minimize this risk, effective testing (indexing) procedures are required to ensure that distributed material is free of pests that are of quarantine concern.

The ever-increasing volume of germplasm exchanged internationally, coupled with recent rapid advances in biotechnology, has created a pressing need for crop-specific overviews of the existing knowledge in all disciplines relating to the phytosanitary safety of germplasm transfer. This has prompted FAO and IBPGR to launch a collaborative programme for the safe and expeditious movement of germplasm, reflecting the complementarity of their mandates with regard to the safe movement of germplasm. FAO has a long-standing mandate to assist its member governments to strengthen their Plant Quarantine Services, while IBPGR's mandate - *inter alia* - is to further the collecting, conservation and use of the genetic diversity of useful plants for the benefit of people throughout the world.

The aim of the joint FAO/IBPGR programme is to generate a series of crop-specific technical guidelines that provide relevant information on disease indexing and other procedures that will help to ensure phytosanitary safety when germplasm is moved internationally.

The technical guidelines are produced by meetings of panels of experts on the crop concerned, who have been selected in consultation with the relevant specialized institutions and research centres. The experts contribute to the elaboration of the guidelines in their private capacity and do not represent the organizations to which they belong. FAO, IBPGR and the contributing experts cannot be held responsible for any failures resulting from the application of the present guidelines. By their nature, they reflect the consensus of the crop specialists who attended the meeting, based on the best scientific knowledge available at the time of the meeting. The experts that have contributed to this document are listed after this introduction.

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* The word 'pest' is used in this document as it is defined in the revised edition of the International Plant Protection Convention. It encompasses all harmful biotic agents ranging from viroids to weeds.

The technical guidelines are written in a short, direct, sometimes 'telegraphic' style, in order to keep the volume of the document to a minimum and to facilitate updating. The guidelines are divided into two parts: The first part makes recommendations on how best to move grapevine germplasm and is divided into general recommendations, technical recommendations and therapy and indexing strategy. Institutions recovering and maintaining healthy grapevine germplasm, and selected references on therapy procedures are listed at the end of this first part. The second part gives descriptions of the most important pests that could be of quarantine concern.

The information given on a particular pest or disease does not pretend to be exhaustive but concentrates on those aspects that are most relevant to quarantine. At the end of each description a few key references are given, referring mainly to geographical distribution, transmission and methods of indexing.

The present guidelines were developed at a meeting held in Athens, Greece, from 11 to 13 September 1990. The meeting was hosted by the Hellenic Phytopathological Society, and organized in collaboration with the International Council for the Study of Viruses and Virus Diseases of the Grapevine (ICVG).

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GENERAL RECOMMENDATIONS

- Under no circumstances should germplasm be moved as rooted plant material.
- Germplasm should preferably be moved as *in vitro* cultures.
- When available, accessions or cultivars should be obtained from a pathogen-tested collection. Otherwise, material should be obtained from the lowest risk area possible.
- All material should undergo the therapy and indexing procedures described on the following pages.

TECHNICAL RECOMMENDATIONS

Grapevine germplasm can be moved as seed, dormant or green cuttings, *in vitro* cultures or pollen.

A. Collecting and movement of seed

- Sound fruit should be collected from healthy-looking plants.
- Seed should be extracted and washed thoroughly with soapy water, to free seed from pulp.
- Seed should be surface sterilized with a 0.5% sodium hypochlorite solution with 0.1% wetting agent for 10 min and then rinsed thoroughly with water.
- Seed should be surface-dried under shaded conditions and dusted with a fungicide such as thiram.
- For vernalization purposes, the seed should be stored at 4°C for at least 6 weeks.
- Seeds should be germinated in sterilized soil mix in an insect-free containment facility and the seedlings should be kept under observation for at least 3 months.

- If material originates from areas where peach rosette mosaic virus (PRMV), tomato ringspot virus (TomRSV) or blueberry leaf mottle virus (BBLMV) occur, it should be indexed for these viruses when the seedlings have reached a sufficient size.

B. Collecting and movement of cuttings

- Collecting tools (clippers, knives, etc.) should be sterilized by dipping in a 0.5-l.0% sodium hypochlorite solution.

- Cuttings should be collected from healthy-looking plants, as free of pests as possible, and which have been evaluated for freedom of symptoms on fruit, foliage, canes and trunk. Bark patches and the exposed wood surface should be observed. On grafted vines, the graft union should be examined.

- Cuttings should be collected from one year old canes only, preferably as dormant cuttings.

- If green cuttings are taken, leaves, tendrils and bunches should be removed.

- Cuttings should be labeled, packed in a plastic bag and maintained below 22°C, preferably in an ice chest.

- In preparation for dispatch, collected cuttings should be thoroughly washed with a mild detergent and water, using a soft brush, rinsed well with tap water, and towel dried.

- The ends of the cuttings may be dipped in melted, low temperature paraffin.

- Upon receipt, hot water treatment (50°C for 45 minutes or 45°C for 3 hours) should be applied if the material is fully dormant.

- The cuttings should be dipped for 5 min in a 0.5% sodium hypochlorite solution with 0.1% wetting agent, rinsed thoroughly and towel dried.

- The cuttings should then be dipped in a solution of appropriate insecticide and fungicide.

- Material should then be submitted to the indexing procedures described below.

C. Movement of *in vitro* cultures

- The recommendations given under B above should be applied to obtain the cuttings that will provide the explants for meristem-tip culture.
- Explants consisting of the meristem and 1 or 2 leaf primordia should be cultured (Barlass *et al.*, 1982)
- For the movement of *in vitro* cultures, neither antibiotics nor charcoal should be added to the medium.
- Clear plastic culture vessels should be used and the agar concentration should be increased to avoid damage to the plantlets while in transit.
- Special care should be taken to protect the material from extreme temperatures.
- Upon receipt, the material should undergo the indexing procedures described below.

D. Movement of pollen

Available information indicates that there is no risk of transmitting pests by the movement of grapevine pollen.

THERAPY AND INDEXING STRATEGY

The therapy and indexing procedures required to safely introduce grapevine germplasm vary with the type of material to be introduced. The strategy to be followed for the introduction of green and dormant cuttings is presented schematically in Figure 1.

Good insect-proof greenhouse facilities with efficient light and temperature controls are required. Details about greenhouse facilities as well as recommendations and procedures for operating these facilities and the indexing laboratory are given in the "Handbook for Detection and Diagnosis of Graft-transmissible Diseases of Grapevine" (Martelli, 1991).

Indexing of graft-transmitted diseases of grapevine is largely based on biological indexing, either by graft transmission to specific indicator plants, or by mechanical transmission to herbaceous plants. Laboratory tests that complement these biological assays include ELISA, immunosorbent electron microscopy (ISEM), sequential polyacrylamide gel electrophoresis (sPAGE), culturing *(Xyllela fastidiosa, Agrobacterium tumefaciens* and *Xylophilus ampelinus),* dsRNA analysis, and nucleic acid hybridization. The indexing is carried out in two steps:

Short term indexing:

- Observation of symptoms on seedlings or growing plants
- Mechanical inoculation to herbaceous hosts
- ELISA
- Culturing (for bacterial pathogens)
- sPAGE (for viroids)
- dsRNA analysis
- Nucleic acid hybridization

Long term indexing

Grafting to the following indicators:

- *Vitis riparia* Gloire de Montpellier
- *Vitis rupestris* St. George
- Kober 5BB
- Cabernet franc, Pinot noir . . .
  (see footnote to table 1 on p.12)
- Baco 22A
- LN33
- 110R

The pathogens detected by the above mentioned indicators are given in Table 1.

1. Seed

- Material derived from seeds originating from areas where PRMV, TomRSV or BBLMV occur should be indexed for those viruses before being released.
- If material is found to be infected, it should be destroyed or subjected to thermotherapy and/or meristem-tip culture, and retested for freedom from those viruses.

2. Dormant Cuttings

- It is recommended that ten 3-bud cuttings from a single vine be introduced for each accession, to provide material for both propagation and direct indexing.
- As soon as possible after receipt, hot water therapy, either at 50°C for 45 minutes or at 45°C for 3 hours, should be applied. This treatment should only be applied to cuttings that are fully dormant.
- If dormant canes show signs of bud break, the procedure for green cuttings should be followed.

- Following hot water treatment, all the cuttings should be dipped in a sodium hypochlorite solution (0.5% active chlorine) for 5 minutes, rinsed thoroughly in water and then dipped in a solution of an appropriate fungicide and insecticide.
- Three cuttings should be placed in sand, with bottom heat, in a quarantine secure greenhouse.
- Once rooting is assured, the cuttings should be planted in sterilized potting mix, used for short-term indexing, and retained until the indexing is completed.
- Careful observations of these plants for normal growth should be made over a period of one year.
- The remaining dormant canes can be used for woody (long term) indexing.
- Most commonly, indicator vines are bud-, chip- or top graft inoculated. Chip budding is recommended for the detection of rupestris stem pitting.
- Vines which test positive for graft-transmitted diseases should be destroyed or should be subjected to therapy.
- Therapy consists of meristem-tip culture (meristem and one or two leaf primordia) and/or heat therapy at 37°C or more for extended periods.
- Indexing after therapy is absolutely indispensable since even the most reliable therapy methods are not totally effective.

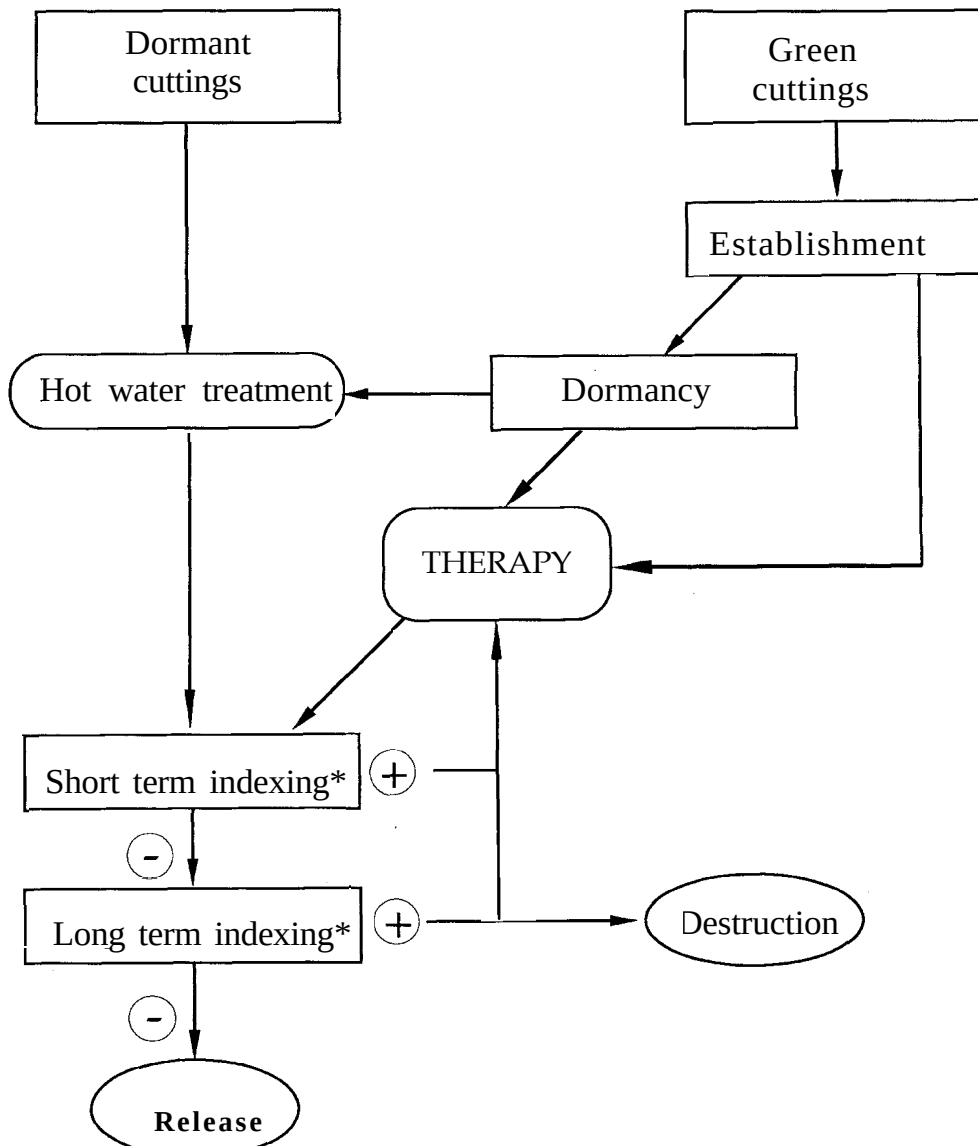
3. Green cuttings

- Green cuttings may harbour latent infections of prokaryotic diseases for which no satisfactory indexing test is available. Therefore, it is recommended that green cuttings be subjected immediately to therapy. Alternatively, the cuttings can be given a treatment for insect pests and be grown in a quarantine greenhouse until sufficient dormant wood is available for hot water treatment and indexing.
- No green cutting material should be used for direct indexing until hot water therapy has been undertaken.
- After meristem-tip culture or hot water treatment, material should be indexed.

4. *In vitro* cultures

- *In vitro* cultures should be checked for microbial contaminationand contaminated tubes should be discarded.
- Plantlets should be established in sterile potting mix and then indexed.
- If material is found to be infected, it should be destroyed or subjected to thermotherapy and/or meristem-tip culture, and retested for freedom from diseases.

Figure 1. Therapy and indexing strategy for cuttings



* See page 9. + = positive - = negative

Table 1. Main indicators for graft-transmitted pathogens of grapevine

Indicator	Pathogens identified
• *Vitis rupestris* St George	Fanleaf Fleck Asteroid mosaic Rupestris stem pitting
• *Vitis vinifera* cv. Cabernet franc, Pinot noir and other red berried cultivars*	Leafroll
• Kober 5BB *(Vitis berlandieri x V. riparia)*	Kober stem grooving
• LN 33 (Couderc 1613 x V. *berlandieri)*	Corky bark Enations LN 33 stem grooving
• Baco 22A	Flavescence dorée Stunting component of leafroll
• *Vitis riparia* Gloire de Montpellier	Vein mosaic
• 110R *(V. rupestris x V. berlandieri)*	Vein necrosis

* The choice of the best indicator for leafroll depends on local climatic conditions and should result from experiments made locally.

Selected references

Barlass, M., Skene, K.G.M., Woodham, R.C. & Krake, L.R. 1982. Regeneration of virus-free grapevines using *in vitro* apical culture. *Ann. appl. Biol.* **101:291-295.**

Bovey, R., Gärtel, W., Hewitt, W.B., Martelli, G.P. & Vuittenez, A. 1980. *Virus and Virus-like Diseases of Grapevines.* Colour Atlas of Symptoms. Payot, Lausanne.

Bovey, R. & Martelli, G.P. 1986. The viroses and virus-like diseases of the grapevine. A bibliographic report, 1979-1984. *Vitis* **25**:227-275.

Caudwell, A., Hewitt, W.B. & Bovey, R. 1972. Les viroses de la vigne, bibliographie 1965-1970. *Vitis* **11**:303-324.

Caudwell, A., Larrue, J., Valat, C. & Grenan, S. 1990. Les traitements à l'eau chaude des bois de vigne atteints de la Flavescence dorée. *Progr. Agric. Vitic.* **107**:281-286.

Duran-Vila, N., Juarez, J. & Arregui, J.M. 1988. Production of viroid-free grapevines by shoot-tip culture. *Am. J. Enol. Vitic.* **39**:217-220.

Frazier, N.W. (ed.). 1970. *Virus Diseases of Small Fruits and Grapevines.* Univ. Calif. Div. Agric. Sci., Berkeley.

Goheen, A.C. & Luhn, C.F. 1973. Heat inactivation of viruses in grapevines. *Riv. Patol. Veg.,* ser. IV **9**:287-289.

Hewitt, W.B. & Bovey, R. 1979. The viroses and virus-like diseases of the grapevine. A bibliographic report, 1971-1978. *Vitis* **l8**:316-376.

Martelli, G.P. 1991. *Handbook for Detection and Diagnosis of Graft-transmissible Diseases of Grapevine.* FAO, Rome. In press.

Martelli, G.P. & Hewitt, W.B. (eds). 1985. Proceedings of the 8th meeting of the International Council for the Study of Viruses and Virus Diseases of the Grapevine (ICVG), Bari, Italy, Sept. 1984. *Phytopathol. Medit.* **24**(1-2):211pp.

McGinnis, A.J. (ed.). 1981. Proceedings of the 7th meeting of the International Council for the Study of Viruses and Virus Diseases of the Grapevine (ICVG), Niagara Falls, Canada, Sept. 1980.

Pearson, R.G. & Goheen, A. C. (eds.). 1988. *Compendium of Grape Diseases.* American Phytopathological Society, St. Paul.

Rumbos, I., Bovey, R., Hewitt, W.B., Gonsalves, D. & Martelli, G.P. (eds.). 1991. Proceedings of the 10th meeting of the International Council for the Study of Viruses and Virus Diseases of the Grapevine (ICVG), Volos, Greece, Sept. 1990. In press.

Tanne, E., (ed.). 1989. Proceedings of the 9th meeting of the International Council for the Study of Viruses and Virus Diseases of the Grapevine (ICVG), Kiryat Anavim, Israel, Sept 1987.

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DESCRIPTIONS OF PESTS

Viral Diseases

1. Ajinashika disease

Cause
An isometric, phloem-limited, non mechanically transmitted RNA virus, c. 25 nm in diameter, is associated with the disease (Namba *et al.*, 1986; 1991).

Symptoms
No appreciable symptoms on the foliage. Sugar content of the berries is reduced, making the crop unmarketable.

Host range
Apparently restricted to *Vitis vinifera* cv. Koshu.

Geographical distribution
Japan.

Transmission
Transmitted by grafting.

Therapy
No information.

Indexing
Grafting to cv. Koshu. The virus associated with the disease can be detected by serology (ELISA, ISEM).

References
Namba, S., Iwanami, T., Yamashita, S., Doi, Y. & Hatamoto, M. 1986. Three phloem-limited viruses of grapevine: direct fluorescence detection. *Food & Fertilizer Technology Center Taiwan Tech. Bull.* 92:1-17.

Namba, S., Yamashita, S., Tsuchizaki, D., Boscia, D. & Gonsalves D., 1991. Purification and properties of a small spherical virus associated with grapevine ajinashika disease. In: Proc. 10th Meeting IGVG. 1990, Volos. (In press.)

2. American nepovirus diseases

Cause
Four distinct nepoviruses, separately or in combination, may be involved to varying degrees in the etiology of these diseases: blueberry leaf mottle virus (BBLMV), peach rosette mosaic virus (PRMV), tomato ringspot virus (TomRSV) and tobacco ringspot virus (TRSV). All these viruses have isometric particles, 30 nm in diameter, and bipartite RNA genomes (Gilmer *et al.*, 1970; Gilmer & Uyemoto, 1972; Gooding & Hewitt, 1962; Ramsdell & Myers, 1974).

Symptoms
Symptoms induced by TomRSV vary with *Vitis* species or hybrids and environmental conditions. In cold climates, European grapes decline rapidly, exhibiting stunted growth, mottled leaves, distortion of leaves and canes, little fruit set with straggly and shelled clusters. In warmer climates, yield but not vigour is affected. Bunches are small and straggly and leaves may show chrome yellow flecking along the veins (California's yellow vein). A similar decline is induced by TRSV in *V. vinifera.* PRMV in *V. labrusca* causes a severe disease with similar symptoms, which is known to be seed transmitted.

Host range
These four viruses have a more or less wide range of wild and cultivated hosts, and are transmitted by sap inoculation to a range of experimental hosts.

Geographical distribution
Northeastern USA (Michigan, New York, Maryland and Pennsylvania) and Canada (Ontario). TomRSV also occurs in grapes in a restricted area of central California.

Transmission
All four viruses are transmitted by grafting and by mechanical inoculation. *Xiphinema americanum sensu stricto* and *X. rivesi* transmit TomRSV type strain (decline), whereas *X. californicum* transmits TomRSV yellow vein strain. TRSV is transmitted by *X. americanum sensu lato,* and PRMV by *X. americanum sensu stricto, Longidorus diadecturus* and *L. elongatus.* No vector of BBLMV is known. In grape, PRMV (Ramsdell & Myers, 1974), TomRSV and BBLMV are seed transmitted at a low percentage.

Therapy
Thermotherapy and meristem-tip culture.

Indexing

Grafting to Grenache or Carignan (yellow vein), Baco noir (TomRSV-induced decline), and Chardonnay (TRSV). Diagnostic herbaceous hosts are:

- BBLMV: *Nicotiana clevelandii* (local necrotic rings and systemic necrotic spots).
- PRMV: *Chenopodium quinoa* (faint chlorotic lesions, systemic mottling and top necrosis);
- TomRSV and TRSV: *Phaseolus vulgaris* (systemic necrosis of topmost leaves) and *Cucumis sativus* (chlorotic lesions and systemic mottling);

Serology (ELISA, ISEM) (Gonsalves, 1980; Ramsdell, *et al.*, 1979).

References

Gilmer, R.M. & Uyemoto, J.K., 1972. Tomato ringspot virus in “Baco noir" grapevines in New York. *Plant Dis. Reptr* **56**:133-135.

Gilmer, R.M., Uyemoto, J.K. & Kelts, L.J. 1970. A new grapevine disease induced by tobacco ringspot virus. *Phytopathology* **60**:619- 627.

Gonsalves, D. 1980. Detection of tomato ringspot virus in grapevines: irregular distribution of virus. pp. 95-106. In: Proc. 7th Meeting ICVG. 1980, Niagara Falls.

Gooding, G.V., Jr & Hewitt, W.B. 1962. Grape yellow vein: symptomatology, identification, and the association of a mechanically transmissible virus with the disease. *Am. J. Enol. Vitic.* **13**:196-203.

Ramsdell, D.C. & Myers, R.L. 1974. Peach rosette mosaic virus, symptomatology and nematodes associated with grapevine “degeneration” in Michigan. *Phytopathology* **64**:1174-1178.

Ramsdell, D.C., Andrews, R.W., Gillett, J.M. & Morris, C.E. 1979. A comparison between enzyme-linked immunosorbent assay (ELISA) and *Chenopodium quinoa* for detection of peach rosette mosaic virus in “Concord” grapevines. *Plant Dis. Reptr* **63**:74-78.

Uyemoto, J.K., Taschenberg, E.F. & Hummer, D.K. 1977. Isolation and identification of a strain of grapevine Bulgarian latent virus in Concord grapevine in New York State. *Plant Dis. Reptr* **61**:949-953.

3. European nepovirus diseases

Cause

Seven distinct nepoviruses, separately or in combination, may be involved to varying degrees in the etiology of these diseases: artichoke Italian latent virus (AILV), arabis mosaic virus (ArMV), grapevine Bulgarian latent virus (GBLV), grapevine chrome mosaic virus (GCMV), raspberry ringspot virus (RRV), strawberry latent ringspot virus (SLRV) and tomato black ring virus (TBRV). All these viruses have isometric

particles, 30 nm in diameter, and bipartite RNA genomes (Bercks & Stellmach, 1966; Martelli *et al.*, 1966; 1977).

Symptoms
Similar to those induced by GFLV: leaf and cane deformation, chlorotic mottling, reduced vigour, heavy crop losses (Rüdel, 1985) and bright yellow discolorations (chromogenic strains).

Host range
AILV, ArMV, RRV, SLRV and TBRV have a more or less wide range of wild and cultivated hosts. Mechanically transmitted to a variable range of experimental hosts.

Geographical distribution
Central Europe, part of Eastern Europe and Balkans. ArMV is common in certain areas of France (Charentes, Alsace) and Germany (Palatinate) and rare in Bulgaria, Hungary, northern Italy, Switzerland and Yugoslavia. GBLV and GCMV are reported from Bulgaria, Czechoslovakia, Hungary, USSR and Yugoslavia. GBLV also occurs in Portugal, where it was found for the first time and described as CM-112 virus (Ferreira & Sequeira, 1972). RRV, SLRV and TBRV are mainly restricted to Germany (Palatinate and Moselle).

Transmission
Transmitted by grafting and mechanical inoculation. *Xiphinema diversicaudatum* transmits ArMV and *Longidorus attenuatus* transmits TBRV to grapevines (Martelli, 1978). Vectors of other viruses are unknown.

Therapy
Thermotherapy and meristem-tip culture.

Indexing
Grafting to Siegfriedrebe (ArMV, RRV, TBRV), or to Pinot noir or Jubileum 75 (GCMV). Diagnostic herbaceous hosts are:

- AILV - *Cucumis sativus* (chlorotic and/or necrotic local lesions followed by severe systemic mosaic)
- ArMV - *Nicotiana glutinosa* (chlorotic ringspots).
- GBLV - *C. quinoa* (necrotic lesions, systemic mottling and necrosis);
- GCMV - *Datura stramonium* (transient systemic yellowish and zonate spots);
- RRV - *Nicotiana clevelandii* (necrotic local spots and rings, systemic vein necrosis);
- SLRV - *Cucumis sativus* (chlorotic lesions, systemic interveinal chlorosis and necrosis);
- TBRV - *Chenopodium quinoa* (necrotic local lesions, systemic mosaic and top necrosis);

Serology (ELISA, ISEM) (Rüdel *et al.,* 1983; Russo *et al.,* 1980). Molecular hybridization (ArMV) (Steinkellner *et al.,* 1989).

References

Bercks, R. & Stellmach, G. 1966. Nachweis verschiedener Viren in reisigkranken Reben. *Phytopathol.* Z. **56**:288-296.

Ferreira, A.A. & Sequeira, A.O. De 1972. Preliminary studies on an undescribed grapevine virus. *Ann. Phytopathol.* No hors série:l13-120.

Martelli, G.P. 1978. Nematode-borne viruses of grapevine, their epidemiology and control. *Nematol. Medit.* **6**:1-27

Martelli, G.P., Lehoczky, J. & Quacquarelli, A. 1966. Host range and properties of a virus associated with Hungarian grapevines showing macroscopic symptoms of fanleaf and yellow mosaic. pp. 389-401. In: Proc. Int. Conf. Virus Vector Perenn. Hosts and *Vitis.* 1965, Davis. Div. Agric. Sci. Univ. Calif., Davis.

Martelli, G.P., Gallitelli, D., Abracheva, P., Savino, V. & Quacquarelli, A. 1977. Some properties of grapevine Bulgarian latent virus. *Ann. appl. Biol.* **85**:51-58.

Rüdel, M. 1985. Grapevine damage induced by particular virus-vector combinations. *Phytopathol. Medit.* **24**:183-185.

Rüdel, M., Alebrand, M. & Altmayer, B. 1983. Untersuchungen über den Einsatz des ELISA-Tests zum Nachweis verschiedener Rebviren. *Wein-Wiss.* **38**:l77-185.

Russo, M., Martelli, G.P. & Savino, V. 1980. Immunosorbent electron microscopy for detecting sap-transmissible viruses of grapevine. pp. 251-257. In: Proc. 7th Meeting ICVG. 1980, Niagara Falls.

Steinkellner, H., Himmler, G., Laimer, M., Mattanovich, D., Bisztray, G. & Katinger, H. 1989. Konstruktion von cDNA von Arabis Mosaik Virus und deren Anwendung für Diagnose. *Mitt. Klosterneuburg* **39**:242-246.

4. Fanleaf (Infectious degeneration)

Cause

Grapevine fanleaf nepovirus (GFLV) (Hewitt, 1954). Isometric particles of 30 nm in diameter, with a bipartite genome made up of two functional single-stranded RNA species (Quacquarelli *et al.,* 1976). Some strains of GFLV have an additional satellite RNA (Fuchs *et al.,* 1991).

Symptoms

Distorting virus strains: reduced vigour, malformation of leaves and canes, short internodes, chlorotic mottling, fewer and smaller bunches with shot berries and poor setting. Chromogenic virus strains: bright yellow discolorations of the foliage varying from scattered spots to total yellowing. Masking of symptoms in summer. (Vuittenez, 1970.)

Host range

Natural host range restricted to *Vitis*. Moderately wide range of herbaceous hosts infected by sap inoculation (Hewitt *et al.*, 1962).

Geographical distribution

Worldwide.

Fig. 1. Fanleaf - chronic symptoms in *V. rupestris.* (Dr G.P. Martelli, Universitá degli Studi, Bari)

Fig. 2. Fanleaf - shock symptoms (chlorotic rings and lines) in *V. rupestris.* (Dr G.P. Martelli, Universitá degli Studi, Bari)

Transmission

Transmitted by grafting and sap inoculation. Vector is the dagger nematode *Xiphinema index* (Hewitt *et al.,* l962).

Therapy

Thermotherapy and meristem-tip culture (Goheen & Luhn, 1973; Barlass *et al.,* 1982)

Indexing

Grafting to *Vitis rupestris* St. George. Diagnostic herbaceous hosts are *Chenopodium amaranticolor* and *Gomphrena globosa* (Hewitt *et al.,* 1962). Serology (ELISA), immunosorbent electron microscopy (ISEM) (Bovey *et al* ., 1980), molecular hybridization (Fuchs *et al.,* 1991).

References

Barlass, M.,Skene, K.G.M., Woodham, R.C. & Krake, L.R. 1982. Regeneration of virus-free grapevines using *in vitro* apical, culture. *Ann. appl. Biol.* **101**:291-295.

Bovey, R., Brugger, J.J. & Gugerli, P. 1980. Detection of grapevine fanleaf virus in grapevine tissue extracts by enzyme-linked immunosorbent assay (ELISA) and immune electron microscopy (IEM). pp. 259-275. In: Proc. 7th Meeting ICVG. 1980, Niagara Falls.

Fuchs, M., Pinck, M., Etienne, L., Pinck, L. & Walter, B. 1991. Characterization and detection of grapevine fanleaf virus using cDNA probes. *Phytopathology* **81**:559-565.

Goheen, A.C. & Luhn, C.F. 1973. Heat inactivation of viruses in grapevines. *Riv. Patol. Veg,* ser. IV **9**:287-289.

Hewitt, W.B. 1954. Some virus and virus-like diseases of grapevines. *Calif. Dept. Agric. Bull.* 43:47-64.

Hewitt, W.B., Goheen, A.C., Raski, D.J. & Gooding, G.V., Jr 1962. Studies on virus diseases of the grapevine in California. *Vitis* **3**:57-83.

Quacquarelli, A., Gallitelli, D., Savino, V. & Martelli, G.P. 1976. Properties of grapevine fanleaf virus. *J. gen. Virol.* **32**:349-360.

Vuittenez, A. 1970. Fanleaf of grapevine. pp. 217-228. In: *Virus Diseases of Small Fruits and Grapevine.* Ed. N.W. Frazier. Univ. Calif. Div. Agric. Sci., Berkeley.

5. Fleck (Marbrure)

Cause

Grapevine fleck virus (GFkV), an isometric, phloem-limited, non mechanically transmitted RNA virus, c. 30 nm in diameter (Boscia *et al.,* 1991; Boulila *et al.,* 1990).

Symptoms
Localized clearing of the veinlets of *Vitis rupestris* and, with severe strains, deformation of the leaves. European grapevine varieties and other American *Vitis* species and their hybrids are symptomless carriers (Hewitt *et al.,* 1972). First reported in Europe as "Marbrure" by Vuittenez *et al.* in 1966.

Host range
Restricted to *Vitis*.

Geographical distribution
Worldwide.

Transmission
Transmitted by grafting. No vector known. Natural spread reported from South Africa (Engelbrecht & Kasdorf, 1990).

Therapy
Thermotherapy and meristem-tip culture.

Indexing
Grafting to *V. rupestris.* Detection of GFkV can be done by serology (ELISA, ISEM) (Boscia *et al.,* 1991).

Fig. 3. Fleck - clearing of the veinlets of *Vitis nipestris.* (Dr G.P. Martelli, Universitá degli Studi, Bari)

References

Boscia, D., Martelli, G.P., Savino, V. & Castellano, M.A. 1991. Identification of the agent of grapevine fleck disease. *Vitis* (in press).

Boulila, M., Boscia, D., Di Terlizzi, B., Castellano, M.A., Minafra, A., Savino, V. & Martelli, G.P. 1990. Some properties of a phloem-limited non mechanically-transmissible grapevine virus. *J. Phytopathol.* **129**:151-158.

Engelbrecht, D.J. & Kasdorf, G.G.F. 1990. Field spread of corky bark, fleck, leafroll and Shiraz decline diseases and associated viruses in South African grapevines. *Phytophylactica* **22**:347-354.

Hewitt, W.B., Goheen, AC., Cory, L. & Luhn. C. 1972. Grapevine fleck disease, latent in many varieties, is transmitted by graft inoculation. *Ann. Phytopathol.* No hors série:43-47.

Vuittenez, A., Legin, R. & Kuszala, J. 1966. Observations sur une mosaïque de la vigne, probablement indépendante du virus du court-noué. *Ann. Epiphyt.* **17** No hors serie:67-73.

6. Grapevine stunt

Cause

An isometric, phloem-limited, non mechanically transmitted RNA virus, c. 25 nm in diameter, is associated with the disease (Namba *et al.*, 1986).

Symptoms

Delayed vegetation in spring, short in ternodes, small, curled leaves, sometimes with scorched margins. Fruit setting impaired, few, shelled bunches. Summer recovery occurs so that newly produced vegetation is apparently normal.

Host range

Apparently restricted to *Vitis vinifera* cv. Campbell Early.

Geographical distribution

Japan

Transmission

Transmitted by grafting and the leafhopper *Arboridia apicalis.*

Therapy

Thermotherapy.

Indexing

Grafting to cv. Campbell Early.

References

Namba, S., Iwanami, T., Yamashita, S., Doi, Y. & Hatamoto, M. 1986. Three phloem-limited viruses of grapevine: direct fluorescence detection. *Food & Fertilizer Technology Center Taiwan Tech. Bull.* **92**:1-17.

7. Leafroll

Cause

Several phloem-limited closteroviruses with particle length ranging from 1800 to 2200 nm, called "grapevine leafroll-associated viruses" (GLRaVs), are thought to be causal agents. Other viruses could be involved.

Symptoms

Downward rolling and discoloration of the leaves, which turn reddish-purple or yellowish in red- and white-fruited cultivars, respectively. Bunches may be small and with discolored and tasteless berries. Symptoms are outstanding in late summer-autumn. American *Vitis* spp. and their hybrids used as rootstocks can be symptomless carriers (Goheen et al., 1958; Goheen, 1970).

Host range

Restricted to *Vitis*.

Geographical distribution

Worldwide.

Fig. 4. Leafroll - severe symptoms on Merlot. (Dr R. Bovey, ICVG, Prangins)

Transmission

Transmitted by grafting. GLRaV III is also transmitted by *Pseudoccus lungispinus* and *Planococcus ficus* (Rosciglione & Gugerli, 1989; Tanne *et al.,* 1989).

Therapy

Thermotherapy and/or meristem-tip culture.

Indexing

Grafting to any of several red-fruited cultivars of European grapes (Mission, Gamay, Cabernet franc, Cabernet sauvignon, Pinot noir, Barbera). Serology (ELISAand ISEM) (Gugerli *et al.,* 1984; Teliz *et al.,* 1987; Zimmermann *et al.,* 1990), Western blotting and dsRNA patterns (Hu *et al.,* 1990; Rezaian et al., 1991).

References

Goheen, A.C. 1970. Grape leafroll. pp. 209-212. In: *Virus Diseases of Small Fruits and Grapevine.* Ed. N.W. Frazier. Univ. Calif. Div. Agric. Sci., Berkeley.

Goheen, A.C., Harmon, F.N. & Weinberger, J.H. 1958. Leafroll (white Emperor disease) of grapes in California. *Phytopathology* **48**:51-54.

Gugerli, P., Brugger, J.J. & Bovey, R. 1984. L'enroulement de la vigne: mise en évidence de particules virales et développement d'une méthode immuno-enzymatique pour le diagnostic rapide. *Rev. Suisse Vitic. Arboric. Hortic.* **16**:299-304.

Hu, J.S., Gonsalves, D. & Teliz, D. 1990. Characterization of closterovirus-like particles associated with grapevine leafroll disease. J. Phytopathol. **128**:1-14.

Fig. 5. Leafroll - symptoms on Sémillon blanc.
(Dr R. Bovey, ICVG, Prangins)

Rezaian, M.A., Krake, L.R., Canying, Q. & Hazzalin, C.A. 1991. Detection of virus-associated dsRNA from leafroll infected grapevines. *J. Virol. Methods* **31**:325-334.

Rosciglione, B. & Gugerli, P. 1989. Transmission of grapevine leafroll disease and an associated closterovirus to healthy grapevine by the mealybug *Planococcus ficus* Signoret. pp. 67-69. In: Proc 9th Meeting ICVG. 1987, Kiryat Anavim.

Tanne, E., Ben-Dov, Y. & Raccah, B. 1989. Transmission of closterovirus-like particles by mealybugs (Pseudococcidae) in Israel. pp. 71-73. In: Proc 9th Meeting ICVG. 1987, Kiryat Anavim.

Teliz, D., Tanne, E., Gonsalves, D. & Zee, F. 1987. Field serological detection of viral antigens associated with grapevine leafroll disease. *Plant Dis.* **71**:704-709.

Zimmermann, D., Bass, P., Legin, R. & Walter, B. 1990. Characterization and serological detection of four closterovirus-like particles associated with leafroll disease on grapevine. *J. Phytopathol.* **130**:205-218.

8. Line pattern

Cause
Grapevine line pattern virus, a possible member of the Ilarvirus group, with quasi spherical to bacilliform particles, 24 to more than 100 nm in length and a multipartite RNA genome (Lehoczky *et al.*, 1989).

Symptoms
Bright yellow discolorations of the leaves in the form of scattered spots of blotches, marginal rings or maple-leaf line pattern. Reduced vigour and yield.

Host range
Restricted to *Vitis vinifera.*

Geographical distribution
Hungary.

Transmission
Transmitted by grafting and by mechanical inoculation. Vector unknown.

Therapy
No information.

Indexing
Graft transmission to cv. Jubileum 75. Diagnostic herbaceous hosts are: *Cucumis sativus* (chlorotic lesions and systemic mottle), *Nicotiana glutinosa* (chlorotic lesions, systemic mottling and necrosis).

Reference

Lehoczky, J., Boscia, D., Burgyan, J., Castellano, M.A., Beczner, L. & Farkas, G. 1989. Line pattern, a novel virus disease of grapevine in Hungary. pp. 23-30. In: Proc 9th Meeting ICVG. 1987, Kiryat Anavim.

9. Wood pitting and/or grooving diseases (rugose wood)

Cause

Still undetermined. Grapevine virus A (GVA), a closterovirus with particles 800 nm long (Castrovilli & Gallitelli, 1985; Conti *et al.*, 1980) is apparently more often associated with rugose wood than with leafroll (Gugerli *et al.*, 1991). Another closterovirus with particles 1400 to 2200 nm in length is associated with corky bark (Namba *et al.*, 1991).

Symptoms

Reduced vigour, delayed bud opening in spring, reduced yield, swelling of the trunk above the bud union, sometimes showing thick and rough bark with spongy texture. Woody cylinder of scion, root-stock, or both, marked by pits

Fig. 6. Rugose wood - corky appearance of the bark above the graft union. (Dr G.P. Martelli, Universitá degli Studi, Bari)

and/or grooves corresponding to peg- and ridge-like protrusions on the cambial surface of the bark. No specific symptoms on the foliage, but vines may decline and die. Certain cultivars and rootstocks are symptomless carriers (Beukman & Goheen, 1966; Goheen, 1988; Graniti & Martelli, 1966; Savino *et al.*, 1989).

Host range
Restricted to *Vitis.*

Geographical distribution
Worldwide.

Transmission
Transmitted by grafting. GVA can be transmitted with difficulty by sap inoculation to a very restricted range of herbaceous hosts. It is also transmitted by *Pseudococcus longispinus, P. ficus* and *Planococcus citri* (Rosciglione & Castellano, 1985). Corky bark is transmitted by P. ficus (Tanne *et al.*, 1989). Natural spread has been reported in several countries.

Therapy
Thermotherapy and meristem-tip culture.

Fig. 7. Rupestris stem pitting - basipetal pitting extending downwards from the point of inoculation. (Dr A.C. Goheen, University of California, Davis)

Indexing

Grafting to *V. rupestris,* LN 33 and Kober 5BB for differentiating between the diseases of the complex:

(a) **Rupestris stem pitting:** basipetal small pits below grafted tissues in *V. rupestris.* No symptoms in LN 33 and Kober 5BB.

(b) **Corky bark:** stem grooving in LN 33 accompanied by swellings of basal internodes due to secondary phloem proliferation. Stem grooving in *V. rupestris.* No symptoms in Kober 5BB.

(c) **Kober stem grooving:** stem grooving in Kober 5BB. No symptoms in LN 33 and *V. rupestris.*

(d) **LN 33 stem grooving:** stem grooving in LN 33 without phloem proliferation. No symptoms in Kober 5BB and *V. rupestris.*

Mechanical transmission to *Nicotiana benthamiana* (systemic vein clearing or yellowing) (Conti *et al.,* 1980) or to *N. clevelandii,* serology (ELISA, ISEM) and molecular hybridization (for GVA) (Minafra *et al.,* 1991). ELISA for the corky bark-associated closterovirus (Namba *et al.,* 1991).

References

Beukman, E.F. & Goheen, A.C. 1966. Corky bark, a tumor-inducing virus of grapevines. pp. 164-166. In: Proc. Int. Conf. Virus Vector Perennial Hosts and *Vitis.* 1965, Davis. Div. Agric. Sci. Univ. Calif., Davis.

Castrovilli, S. & Gallitelli, D. 1985. A comparison of two isolates of Grapevine virus *A. Phytopathol. Medit.* **24**:219-220.

Conti, M., Milne, R.G., Luisoni, E. & Boccardo, G. 1980. A closterovirus from a stem-pitting-diseased grapevine. *Phytopathology* 70:394-399.

Goheen, A. C. 1988. Rupestris stem pitting. p. 53. In: *Compendium of Grape Diseases.* Eds R.G. Pearson & A.C. Goheen. American Phytopathological Society, St. Paul.

Graniti, A. & Martelli, G.P. 1966. Further observations on legno riccio (rugose wood), a graft transmissible stem-pitting of grapevine. pp. 168-179. In: Proc. Int. Conf. Virus Vector Perennial Hosts and *Vitis.* 1965, Davis. Div. Agric. Sci. Univ. Calif., Davis.

Gugerli, P., Rosciglione, B., Brugger, J.J., Bonnard, S., Ramel, M.E. & Tremea, F. 1991. Further characterization of grapevine leafroll disease. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

Minafra, A., Russo, M. & Martelli G.P. 1991. A cloned probe for the detection of grapevine virus A. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

Namba, S., Boscia, D., Azzam, O., Maixner, M., Hu, J.S., Golino, D. & Gonsalves D., 1991. Purification and properties of closterovirus-like particles associated with grapevine corky bark disease. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

Rosciglione, B. & Castellano, M.A. 1985. Further evidence that mealybugs can transmit grapevine virus A (GVA) to herbaceous hosts. *Phytopathol. Medit.* **24**:186-188.

Savino, D., Boscia, D. & Martelli, G.P. 1989. Rugose wood complex of grapevine: can grafting to *Vitis* indicators discriminate between diseases? pp. 91-94. In: Proc 9th Meeting ICVG. 1987, Kiryat Anavim.

Tanne, E., Ben-Dov, Y. & Raccah, B. 1989. Transmission of corky-bark disease by the mealybug *Planococcus ficus. Phytoparasitica* **17**:55.

10. Yellow dwarf

An enveloped virus, c. 80 nm in diameter, resembling tomato spotted wilt virus (TSWV) has been observed, in Taiwan, in thin sections in plants affected by a disease called yellow dwarf. Symptoms include stunting and chlorotic to yellow mottling of the leaves, which are malformed and may show necrotic spots. No information on the host range and the mode of transmission is available (Chen *et al.*, 1981).

Reference

Chen, H.L., Tzeng, D.S. & Chen, M.J. 1981. Preliminary studies on the grapevine yellow dwarf, a new virus disease in Taiwan. *Natl. Sci. Counc. Monthly*, ROC **9**:584-591.

11. Yellow mottle

Cause

Alfalfa mosaic virus. Tripartite RNA genome and four classes of bacilliform particles, c. 18 nm wide and 30, 35, 43 and 57 nm long.

Symptoms

Yellow discolorations of the foliage in the form of speckling, blotches, rings and lines. No appreciable reduction of vigour and yield (Bercks *et al.*, 1973).

Host range

Extremely wide range of wild and cultivated hosts.

Geographical distribution

Central and western Europe: Bulgaria, Czechoslovakia, Germany, Hungary and Switzerland.

Transmission
Transmitted by grafting and by mechanical inoculation. Vectors unknown, but suspected to be aphids.

Therapy
No information.

Indexing
Grafting to cv. Chardonnay or Veltliner rouge précoce (Beczner & Lehoczky, 1981). Diagnostic herbaceous hosts are: *Phaseolus vulgaris* (necrotic lesions), *Chenopodium amaranticolor* and *C. quinoa* (chlorotic lesions, systemic mosaic and top necrosis), *Ocimum basilicum* (systemic bright yellow mottling). Serology (ELISA).

References
Beczner, L. & Lehoczky, J. 1981. Grapevine disease in Hungary caused by alfalfa mosaic virus infection. *Acta Phytopathol. Acad. Sci. Hung.* **16**:119-128.

Bercks, R., Lesemann, D. & Querfurth, G. 1973. Über den Nachweis des *alfalfa mosaic virus* in einer Weinrebe. *Phytopathol. Z.* **76**:166-171.

Viroid Diseases

1. Yellow speckle

Cause
Two distinct viroids, grapevine yellow speckle viroid 1 (GYSVd 1) (Koltunow & Rezaian, 1988) and grapevine yellow speckle viroid 2 (GYSVd 2, previously named GV1B) (Koltunow & Rezaian, 1989), cause the yellow speckle disease individually or in combination (Koltunow *et al.*, 1989). The viroids have a circular single-stranded RNA with extensive internal base pairing resulting in rod-like structures. The complete sequence is known. GYSVd 1 has 367 nucleotide residues and GYSVd 2 has 363 residues.

Symptoms
Green to chrome yellow speckles, scattered over the leaves or clustered along the veins producing a vein-banding pattern. Symptom expression is erratic and plants infected with GYSVd 1 may be symptomless, while the presence of GYSVd 2 correlates with symptom expression in the field (Koltunow *et al.*, 1989).

Geographical distribution

Probably worldwide. Similar viroids have been reported elsewhere (Semancik *et al.*, 1987; Szychowski *et al.*, 1991; Minafra *et al.*, 1990) but their nucleotide sequences have not been compared with those of GYSVd 1 and GYSVd 2.

Transmission

By grafting, micro-injection and slash inoculation of purified viroid preparations. Natural spread of yellow speckle disease in the field has been observed (Woodham & Krake, 1982). Transmission by pruning shears and tools is likely.

Indexing

Two-dimensional gel electrophoresis may be used. More definitive identification may be carried out by probe hybridization or by polymerase chain reaction techniques.

Therapy

The grapevine viroids can be eliminated by culturing meristem-tips of shoots grown at 10°C (Duran-Vila *et al.*, 1988). Grapevine seedlings, grown from seed of infected plants, also have not been found to contain viroids.

References

Duran-Vila, N., Juarez, J. & Arregui, J.M. 1988. Production of viroid-free grapevines by shoot-tip culture. *Am. J. Enol. Vitic.* **39**:217-220.

Koltunow, A.M. & Rezaian, M.A. 1988. Grapevine yellow speckle viroid - structural features of a new viroid group. *Nucl. Acid Res.* **16**:849-864.

Fig. 8. Yellow speckle - scattered yellow spots in an European grape leaf. (Dr G.P. Martelli, Universitá degli Studi, Bari)

Koltunow, A.M. & Rezaian, M.A. 1989. Grapevine viroid lB, a new member of the apple scar skin viroid group contains the left terminal region of tomato planta macho viroid. *Virology* **170**:575-578.

Koltunow, A.M., Krake, L.R., Johnson, S.D. & Rezaian, M.A. 1989. Two related viroids cause grapevine yellow speckle disease independently. *J. gen. Virol.* **70**:3411-3419.

Minafra, A., Martelli, G.P. & Savino, V. 1990. Viroids of grapevine in Italy. *Vitis* **29**:173-182.

Semancik, J.S., Rivera-Bustamante, R. & Goheen, A.C. 1987. Widespread occurrence of viroid-like RNAs in grapevines. *Am. J. Enol. Vitic.* **38**:35-40.

Szychowski, J.A., Doazan, J.P., Leclair, P., Garnier, M., Credi, R., Minafra, A., Duran-Vila, N., Wolpert, J.A. & Semancik, J.S. 1991. Relationships among grapevine viroids from sources maintained in California and Europe. In: Proc. 10th Meeting ICVG. 1990, Volos. In press.

Woodham, R.C. & Krake, L.R. 1982. Grapevine yellow speckle disease - studies on natural spread observed in the field. *Vitis* **21**:337-345.

2. Other viroids affecting grapevines

- Citrus exocortis viroid (CEVd-g)
- Hop stunt viroid (HSVd-g)
- Australian grapevine viroid (AGVd)

The previously known CEVd and HSVd also occur in grapevines (Garcia-Arenal et *al.*, 1987; Sano *et al.*, 1985). These have a world-wide distribution. AGVd is a viroid of 369 nucleotide residues, mechanically transmitted to cucumber, tomato and to viroid-free grapevines. The above three viroids do not induce visible symptoms on grapevine (Rezaian, 1990).

References

Garcia-Arenal, F., Pallas, V. & Flores, R. 1987. The sequence of a viroid from grapevine closely related to the severe isolate of citrus exocortis viroid. *Nucl. Acid Res.* **15**:4203-4210.

Rezaian, M.A. 1990. Australian grapevine viroid - evidence for extensive recombination between viroids. *Nucl. Acid Res.* **18**:1813-1818.

Sano, T., Ohshima, K., Uyeda, I., Shikata, E., Meshi, T. & Okada, Y. 1985. Nucleotide sequence of grapevine viroid: a grapevine isolate of hop stunt viroid. *Proc. Jpn Acad.* Ser. B. **61**:265-268.

Virus-like Diseases

1. Asteroid mosaic

Cause
Unknown, suspected to be a virus.

Symptoms
Translucent spots with a star-like shape between primary veins. Reduced vigour and yield (Hewitt, 1954; Hewitt & Goheen,1959).

Host range
Restricted to *Vitis*.

Geographical distribution
Reported from California. Symptoms of asteroid mosaic have been reported from Italy, Republic of South Africa and recently from Greece (Kyriakopoulou, 1991; Refatti, 1970).

Transmission
Graft-transmitted. No vector known.

Therapy
No information.

Indexing
Grafting to *V. rupestris.*

References
Hewitt, W.B. 1954. Some virus and virus-like diseases of grapevine. *Calif. Dept Agric. Bull.* **43**:47-64.

Hewitt, W.B. & Goheen, A.C. 1959, Asteroid mosaic of grapevines in California. *Phytopathology* **49**:541.

Kyriakopoulou, P.E. 1991. Symptoms of grapevine asteroid mosaic in Greece. In: Proc. 10th Meeting ICVG. 1990, Volos. In press.

Refatti, E. 1970. Asteroid mosaic of grapevine. pp. 212-214. In: *Virus Diseases of Small Fruits and Grapevine.* Ed. N.W. Frazier. Univ. Calif. Div. Agric. Sci., Berkeley.

2. Bushy stunt

Cause
Unknown, suspected to be a virus.

Symptoms
Stunted and bushy vegetation of European grape scions due to the contemporary proliferation of apical and axillary buds. Yield is reduced. American rootstocks are symptomless carriers (Savino *et al.*, 1991).

Host range
Restricted to *Vitis*.

Geographical distribution
Italy.

Transmission
Transmitted by grafting. Vector unknown.

Therapy
Thermotherapy.

Indexing
Grafting to cv. Italia and Sangiovese.

Reference
Savino, V., Di Terlizzi, B., Rivieccio, S. & Di Silvio, F. 1991. Presence in clonal rootstocks of a graft-transmissible factor that induces stunting and bushy growth in European grapevines. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

3. Enation disease

Cause
Unknown, suspected to be a virus.

Symptoms
Delayed bud breaking, slow and bushy growth of shoots in the initial stages of vegetation. Strongly malformed basal leaves bearing laminar or cup-shaped out-growths (enations) on the underside of the blade. Symptoms do not recur every year on the same vines (Hewitt, 1954).

Host range
Restricted to *Vitis*.

Geographical distribution
Australia, Europe, Israel, New Zealand, Republic of South Africa, eastern Turkey, USA and Venezuela.

Transmission
Transmitted by grafting. Vector unknown.

Therapy
No information.

Indexing
Grafting to LN 33 (Martelli *et al.*, 1966). Successful transmission is erratic and rarely exceeds 30% (Garau *et al.*, 1989).

References
Garau, R., Prota, U. & Cugusi, M. 1989. Studies on reproduction of enation symptoms by grafting in Sardinia. pp. 203-206. In: Proc 9th Meeting ICVG. 1987, Kiryat Anavim.

Hewitt, W.B. 1954. Some virus and virus-like diseases of the grapevine. *Calif. Dept. Agric. Bull.* **43**:47-64.

Martelli, G.P., Graniti, A., Lamberti, F. & Quacquarelli, A. 1966. Trasmissione per innesto della "malattia delle enazioni" della vite. *Phytopathol. Medit.* **5**:122-124.

Fig. 9. Enations on the underside of a grape leaf clustered along the main veins. (Dr G.P. Martelli, Universitá degli Studi, Bari)

4. Infectious graft incompatibility

Cause
Unknown, suspected to be a virus.

Symptoms
Reduced growth, decline or rapid death of *Vitis vinifera* scions grafted onto some rootstock varieties (Durquéty *et al.*, 1973; 1977).

Host range
Restricted to *Vitis*.

Geographical distribution
Reported only from France.

Transmission
Graft-transmitted (Fallot *et al.*, 1979; Legin & Walter, 1986). No vector known.

Therapy
Thermotherapy and meristem-tip culture (Legin & Walter, 1986).

Indexing
Grafting to Kober 5BB.

References
Durquéty, P.M., Fallot, J., Ruchaud, C., Bénassac, J.P. & Dauty, R. 1973. Le clone et ses réactions au greffage. I. Existence, dans un cépage population, de clones présentant divers degrés de compatibilité avec certains porte-greffes. *Progr. Agric. Vitic.* **90**:122-129.

Durquéty, P.M., Ruchaud, C., Gazeau, J.P. & Fallot, J. 1977. Le clone et ses réactions au greffage. II. Nouvelles recherches sur l'incompatibilité clonale d'Abouriou greffé sur 5BB. Autres cas chez la vigne. *Progr. Agric. Vitic.* **94**:420-427.

Fallot, J., Ruchaud, C., Durquéty, P.M. & Gazeau, J.P. 1979. Le clone et ses réactions au greffage. III. La transmission de l'incompatibilité au greffage entre 5BB et *Vitis vinifera*. *Progr. Agric. Vitic.* **96**:211-216.

Legin, R. &Walter, B. 1986. Etude de phénomènes d'incompatibilité au greffage chez la vigne. *Progr. Agric. Vitic.* **103**:279-283.

5. Roditis leaf discoloration

Cause
Unknown. GFLV and carnation mottle virus (CarMV) are both associated with the disease (Avgelis & Rumbos, 1991).

Symptoms
Yellowish and/or reddish discolorations of different areas of the leaf blade (along the veins, intraveinal, sectorial). Leaf deformation, reduced size and number of bunches (Rumbos & Avgelis, 1989).

Host range
CarMV has a range of wild and cultivated hosts.

Geographical distribution
Greece.

Transmission
Transmitted by grafting and mechanical inoculation.

Therapy
No information.

Indexing
Grafting to cv. Mission

References
Avgelis, A.D. & Rumbos, I.C. 1991. Carnation mottle virus isolated from vines affected with "Roditis leaf discoloration". In: Proc. 10th Meeting ICVG. 1990, Volos. In press.

Rumbos, I.C. & Avgelis, A.D. 1989. Roditis leaf discoloration-A new virus disease of grapevine: symptomatology and transmission to indicator plants. *J. Phytopathol.* **125**:274-278

6. Summer mottle (vein mottle)

Cause
Unknown.

Symptoms
Pale green vein banding, similar to that caused by vein mosaic (Krake & Woodham, 1978).

Host range
Restricted to *Vitis*.

Geographical distribution
Reported only from Australia.

Transmission
Graft-transmitted. No vector known.

Therapy
Meristem-tip culture.

Indexing
Grafting to cv. Sideritis, Cabernet franc and Mission. *V. riparia* and LN 33 do not show symptoms (Woodham & Krake, 1983).

References
Krake, L.R. & Woodham, R.C. 1978. Grapevine vein summer mottle: a new graft-transmissible disease. *Vitis* **17**:266-270.

Woodham, R.C. & Krake, L.R. 1983. A comparison of grapevine summer mottle and vein mosaic diseases. *Vitis* **22**:247-252.

Fig. 10. Vein mosaic - chlorotic vein feathering.
(Dr G.P. Martelli, Universitá degli Studi, Bari)

7. Vein mosaic

Cause
Unknown, suspected to be a virus.

Symptoms
Pale green discolorations along the main veins, producing a feathering or banding effect. Several European grape cultivars and American rootstocks can be symptomless carriers (Legin & Vuittenez, 1973).

Host range
Restricted to *Vitis*.

Geographical distribution
Reported from Europe and the Mediterranean countries. Distribution probably wider.

Transmission
Graft-transmitted No vector known.

Therapy
Thermotherapy.

Indexing
Grafting to *Vitis riparia* Gloire de Montpellier.

References
Legin, R. & Vuittenez, A. 1973. Comparaison des symptômes et transmission par greffage d'une mosaïque nervaire de *Vitis vinifera*, de la marbrure de *V. rupestris* et d'une affection nécrotique des nervures de l'hybride *Rup.-Berl.* 110R. *Riv. Patol. Veg* Ser. IV **9** (suppl.):57-63.

8. Vein necrosis

Cause
Unknown, suspected to be a virus.

Symptoms
Symptomless infection in European and most American *Vitis* spp. The hybrid *Vitis rupestris x Vitis berlandieri* 110R shows necrosis of the veinlets on the underside of the leaf blade and, in severe cases, necrosis of the shoot tips (Legin & Vuittenez, 1973).

Fig. 11. Vein necrosis. (Dr A. Caudwell, INRA, Dijon)

Host range
Restricted to *Vitis.*

Geographical distribution
Europe, Mediterranean countries and USA. Distribution is probably wider.

Transmission
Transmission by grafting. Vector unknown

Therapy
Thermotherapy (Savino *et al.*, 1985).

Indexing
Grafting to 110R.

References

Legin, R. & Vuittenez, A. 1973. Comparaison des symptômes et transmission par greffage d'une mosaïque nervaire de *Vitis vinifera,* de la marbrure de *V. rupestris* et d'une affection nécrotique des nervures de l'hybride *Rup.-Berl.* 110R. *Riv. Patol. Veg* Ser. IV **9** (suppl.):57-63.

Savino, V., Boscia, D. & Martelli, G.P. 1985. Incidence of some graft-transmissible virus-like diseases of grapevine in visually selected and heat-treated stocks from southern Italy. *Phytopathol. Medit.* **24** :204-207.

Mollicute diseases

1. Flavescence dorée

Cause
Noncultivable mollicute often referred to as mycoplasma-like organism (MLO) (Caudwell *et al.*, 1971).

Symptoms
Growth reduced in newly infected vines. Lack of lignification of whole shoots or irregular maturation, often black pustules along the internodes. Leaves often rolled downward, becoming golden yellow in white-fruited or reddish in red-fruited varieties. These discolorations are sometimes limited by 1-3 main veins. Creamy spots along the main veins. Drying of the inflorescences or shrivelling of the berries. Symptoms may be localized to part of the plant.

Host range
Apparently restricted to *Vitis*.

Geographical distribution
Southern France (Caudwell, 1964), northern Italy (Fortusini *et al.*, 1989) and possibly USA (New York State) (Maixner & Pearson, 1991).

Fig. 12. Flavescence dorée on Baco 22A. (Dr A. Caudwell, INRA, Dijon)

Fig. 13. Second instar larva (and exuvia) of the vector of Flavescence dorée: *Scaphoideus titanus.* (Dr A. Caudwell, INRA, Dijon)

Transmission

Transmitted by grafting and the leafhopper *Scaphoideus titanus.*

Therapy

Exposure of mature dormant canes to hot water (e.g. 50°C for 45 min)(Caudwell *et al.,* 1991). The vector, which has one generation per year, can be controlled in the field by insecticidal treatments during the egg-hatching period (Caudwell & Larrue, 1986).

Indexing

Grafting to Baco 22A (Baco blanc). Transmission by vectors to herbaceous hosts (Caudwell, 1977). Serology (ELISA, ISEM), especially useful for detection in vectors (Boudon-Padieu *et al.,* 1989), and molecular hybridization (Daire *et al.,* 1991).

References

Boudon-Padieu E., Larrue J. & Caudwell A. 1989. ELISA and dot-blot detection of flavescence dorée - MLO in individual leafhopper vectors during latency and inoculative state. *Curr. Microbiol.* **19**:357-364.

Caudwell, A. 1964. Identification d'une nouvelle maladie à virus de la vigne, la Flavescence dorée. Etude des phénomènes de localisation des symptômes et de rétablissement. *Ann. Epiphyt.* **15**(No. hors serie I):l-193.

Caudwell, A. 1977. Aspects statistiques des épreuves d'infectivité chez les Jaunisses (Yellows) des plantes et chez les viroses transmises selon le mode persistant. Intérêt de la Fève *(Vicia faba)* comme plante-test pour les Jaunisses. *Ann. Phytopathol.* **9**:141-159.

Caudwell, A., Giannotti, J., Kuszala, C. & Larrue, J. 1971. Etude du rôle de particules de type "mycoplasme" dans l'étiologie de la flavescence dorée de la vigne. Examen cytologique des plantes malades et des cicadelles infectieuses. *Ann. Phytopathol.* **3**:107-123.

Caudwell, A. & Larrue, J. 1986. La flavescence dorée dans le Midi de la France et dans le Bas-Rhône. *Progr. Agric. Vitic.* **103**:517-523.

Caudwell, A., Larrue, J., Valat, C. & Grenan, S. 1991. Hot water treatments against flavescence dorée on dormant wood. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

Daire, X., Schneider, B., Seemüller, E., Santoni, S., Berville, A., Boudon-Padieu, E. & Caudwell, A. 1991. DNA cloning and detection of flavescence dorée myco-plasma-like organism. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

Fortusini, A., Saracchi, M. & Belli, G. 1989. Trasmissione sperimentale della flavescenza dorata della vite mediante *Scaphoideus titanus* Ball in Italia. *Vignevini* **16**(9):43 46.

Maixner, M. & Pearson, R.C. 1991. Studies on *Scaphoideus titanus,* a possible vector of grapevine yellows disease, on wild and cultivated grapes in New York. In: Proc. 10th Meeting ICVG. 1990, Volos. (In press.)

2. Other yellows

Cause
Suspected to be noncultivable mollicutes (often referred to as MLOs).

Symptoms
Similar to those of flavescence dorée in *Vitis* (Caudwell, 1961; Caudwell *et al.,* 1971; Credi & Babini, 1984; Gärtel, 1965; Granata, 1985; Magarey, 1986; Rumbos & Biris, 1979).

Host range
In addition to *Vitis,* some yellows may infect weeds and shrubs.

Geographical distribution
Central Europe (Bois Noir, Vergilbungskrankheit), the Mediterranean area and sub-tropical regions.

Transmission
Transmitted by grafting and possibly by dodder *(Cuscuta* spp). Vectors unknown.

Therapy
No information available.

Indexing

Grafting to cvs Chardonnay and/or Baco 22A (Baco blanc).

References

Caudwell, A. 1961. Etude sur la maladie du bois noir de la vigne: ses rapports avec la Flavescence dorée. *Ann Epiphyt.* **12**:241-262.

Caudwell, A., Larrue, J., Kuszala, C. & Bachelier, J.C. 1971. Pluralité des jaunisses de la vigne. *Ann. Phytopathol.* **3**:95-105.

Credi, R. & Babini, A.R. 1984. Casi epidemici di Giallume della vite in Emilia-Romagna. *Vignevini* **11** (3):35-39.

Gärtel, W. 1965. Untersuchungen über das Auftreten und das Verhalten der *flavescence dorée* in den Weinbaugebieten an Mosel und Rhein. *Weinb. u. Keller* **12**:347-376.

Granata, G. 1985. Epidemic yellows in vineyards of cv. Inzolia in Sicily. *Phytopathol. Medit.* **24**:79-81.

Magarey, P.A. 1986. Grape-vine yellows—Aetiology, epidemiology and diagnosis. *S. Afr. J. Enol. Vitic.* **7**:90-100.

Rumbos, I. & Biris, D. 1979. Studies on the etiology of a yellows disease of grapevines in Greece. *Z. PflKrankh. PflSchutz* **86**:266-273.

Fig. 14. Bacterial blight - swollen tissues with longitudinal cracks along the basic internodes of two young shoots. (Dr I. Rumbos, Plant Protection Institute, Volos)

Bacterial diseases

1. Bacterial blight (Maladie d'Oléron, Tsilik marasi)

Cause
Xylophilus ampelinus (Panagopoulos) Willems *et al.* (syn. *Xanthomonas ampelina* Panagopoulos) a xylem-restricted gram-negative bacterium (Panagopoulos, 1969; Willems et al., 1987).

Symptoms
On infected shoots, bud break is delayed or does not occur. Stunted, weak, and/or chlorotic shoots with dark brown streaks on one side, which eventually wilt and die. Swollen branches with soft and cheesy cambial area (hyperplasia) with longitudinal cracks. Cracks may appear on the petioles of leaves and the rachis of the clusters. Brown discoloration of the xylem vessels.

Host range
Restricted to *Vitis*.

Geographical distribution
Europe and Republic of South Africa.

Transmission
Transmitted by propagating material, grafting and pruning tools, and by rain.

Therapy
No information available.

Indexing
Culturing in selective media, and/or immunofluorescence in nutrient agar.

References
Panagopoulos, C.G. 1969. The disease «tsilik marasi» of grapevine: its description and identification of the causal agent *(Xanthomonas ampelina* sp. nov.). *Ann. Benaki Phytopath. Inst.* **9**:59-81.

Willems, A., Gillis, M., Kersters, K., Van den Broek, L. & De Ley, J. 1987. Transfer of *Xanthomonas ampelina* Panagopoulos 1969 to a new genus *Xylophilus* gen. nov., as *Xylophilus ampelinus* (Panagopoulos, 1969) comb. nov. *Int. J. Syst. Bacteriol.* **37**:422-430.

2. Crown gall

Cause

Agrobacterium tumefaciens (Smith & Townsend) Conn. (mainly biovar 3), a gram-negative bacterium which can be found as latent infection in xylem vessels (Kerr & Panagopoulos, 1977; Panagopoulos & Psallidas, 1978). Biovar 3 has been proposed as a new species: *A. vitis* Ophel & Kerr (Ophel & Kerr, 1990).

Symptoms

Galls on all woody parts of the plant, especially at the graft-union.

Host range

The bacterium responsible for the disease on grapes has a narrow host range, mainly restricted to grapevine.

Geographical distribution

Worldwide.

Fig. 15. Crown gall at the graft union. (Dr I. Rumbos, Plant Protection Institute, Volos)

Fig. 16. Crown gall symptoms extending on the trunk. (Dr I. Rumbos, Plant Protection Institute, Volos)

Transmission

Transmitted by vegetative propagating material, grafting and soil.

Therapy

Hot water treatment of dormant cuttings (Burr *et al.*, 1989).

Indexing

Culturing in selective media. ELISA (Bishop *et al.*, 1989). Inoculation to *Nicotiana glutinosa* and/or *Vitis vinifera* (green shoots).

References

Bishop, A.L., Burr, T.J., Mittak, V.L. & Katz, B.H. 1989. A monoclonal antibody specific to *Agrobacterium tumefaciens* biovar 3 and its utilization for indexing grapevine propagation material. *Phytopathology* **79**:995-998.

Burr, T.J., Ophel, K., Katz, B.H. & Kerr, A. 1989. Effect of hot water treatment on systemic *Agrobacterium tumefaciens* Biovar 3 in dormant grape cuttings. *Plant Dis.* **73**:242-245.

Kerr, A. & Panagopoulos, C.G. 1977. Biotypes of *Agrobacterium radiobacter* var. *tumefaciens* and their biological control. *Phytopathol. Z.* **90**:172-179.

Ophel, K. & Kerr, A. 1990. *Agrobacterium vitis* sp. nov. for strains of *Agrobacterium tumefaciens* biovar 3 from grapevines. *Int. J. Syst. Bacteriol.* **40**:236-241.

Panagopoulos, C.G., Psallidas, P.G. & Alivizatos, A.S. 1978. Studies on biotype 3 of *Agrobacterium radiobacter* var. *tumefaciens.* pp. 221-228. In: Proc. 4th Int. Conf. Plant Path. Bact. 1978, Angers. (Vol. 1.)

3. Pierce's disease

Cause
Xylella fastidiosa, a xylem-restricted gram-negative bacterium (Davis *et al.,* 1978; Wells *et al.,* 1987).

Symptoms
Delayed bud break and interveinal chlorosis in spring. Asymmetrical yellowing or reddening of the leaves, necrosis of interveinal areas and scorching of leaf margins in late summer. Irregular maturation of the wood, fewer and shrivelled bunches. Affected vines often die (Hewitt *et al.,* 1942).

Host range
Very wide among annual and perennial wild and cultivated plants.

Geographical distribution
Western American hemisphere in areas with mild winter temperatures.

Transmission
Transmitted by grafting and by a wide range of xylem feeding insects (Cicadellidae, Cercopidae). Needle inoculation with the cultured bacterium is readily achieved.

Therapy
Hot water treatment of dormant cuttings at 45°C for 3 h or 50°C for 45 min (Goheen *et al.,* 1973).

Fig. 17. Pierce's disease - chlorosis and stunting on Cabernet Sauvignon. (Dr D.A. Golino, USDA, Davis)

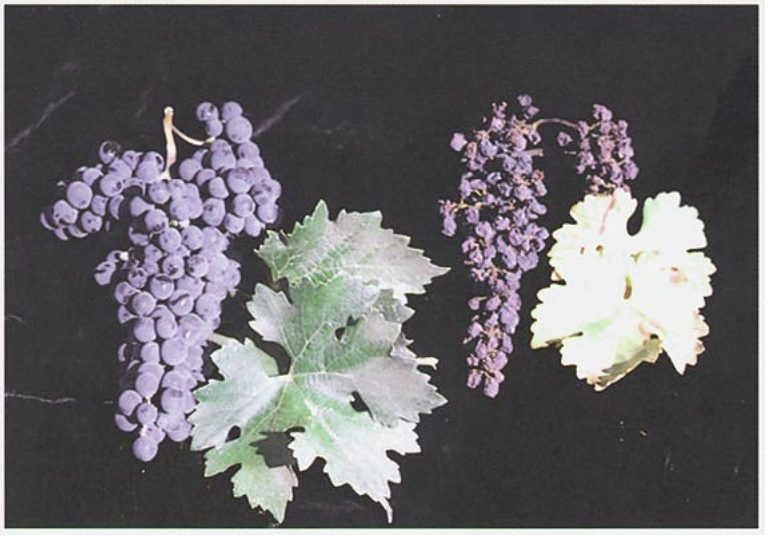

Fig. 18. Pierce's disease - leaf and fruit symptoms on Cabernet Sauvignon (healthy on left). (Dr D.A. Golino, USDA, Davis)

Indexing

Transmission by grafting or vectors to European grapes, serology (ELISA) (Davis *et al.*, 1978). Isolation of the causal agent on selective media (Hopkins, 1988).

References

Davis, M.J, Purcell, A.H. & Thomson, S.V. 1978. Pierce's disease of grapevines: isolation of the causal bacterium. *Science* **199**:75-77.

Goheen, A.C., Nyland, G. & Lowe, S.K. 1973, Association of a rickettsialike organism with Pierce's disease of grapevines and alfalfa dwarf and heat therapy of the disease in grapevines. *Phytopathology* **63**:341-345.

Hewitt, W.B., Frazier, N.W., Jacob, H.E. & Freitag, J.H. 1942. Pierce's disease of grapevines. *Univ. Calif. Agr. Expt Statn. Circ.* **353**:1-32.

Hopkins, D.L. 1988. *Xylella fastidiosa* and other fastidious bacteria of uncertain affiliation. pp. 95-103. In: *Laboratory Guide for Identification of Plant Pathogenic Bacteria* Ed. N.W. Schaad, 2nd ed. American Phytopathological Society, St. Paul.

Wells, J.M, Raju, B.C., Hung, H.Y., Weisburg, W.G., Mandelco-Paul, L. & Brenner, D.J. 1987. *Xylella fastidiosa* gen. nov., sp. nov.: gram-negative, xylem-limited, fastidious plant bacteria related to *Xanthomonas* spp. *Int. J. Syst. Bacteriol.* **37**:136-143.

Fungal disease

Phomopsis cane and leaf spot (Excoriosis)

Cause
The fungus *Phomopsis viticola* Sacc.

Symptoms
Small, black, elliptical, necrotic spots on the lower internodes of the shoots, the petioles of the leaves and the rachis of the clusters. Similar necrotic spots on the leaf blade.

Host range
Restricted to *Vitis*.

Geographical distribution
Worldwide.

Transmission
Transmitted by vegetative propagating material and the rain.

Quarantine measures
- The fungus can be detected by culturing on nutrient media and by microscopic observation.
- If *Phomopsis* is suspected, apply prophylactic fungicide treatment in the greenhouse.
- Surface sterilization of cuttings
- Hot water treatment of cuttings
- Fungicide treatment of cuttings.

References
Bulit, J., Bugaret, Y. & Lafon, R. 1972. L'excoriose de la vigne et ses traitements. *Rev. Zool. Agric. Pathol. Vég.* **l**:44-54.

Hewitt, W.B. & Pearson, R.G. 1988. *Phomopsis* cane and leaf spot. pp. 17-18. In: *Compendium of Grape Diseases.* Eds R.G. Pearson & A.C. Goheen. American Phytopathological Society, St. Paul.

Punithalingam, E. 1979. *Phomopsis viticola.* CMI Description of Pathogenic Fungi and Bacteria. No 635. Commonwealth Agricultural Bureaux, Slough.

Arthropod pests

The risk of introducing arthropod pests of quarantine importance together with grapevine germplasm is minimised when material is handled as recommended in these guidelines. Fumigation with methyl bromide (40g/m^3 for 3 hours) or other fumigants will eliminate arthropod pests-including Coccidae such as *Targionia vitis* Signoret and *Planococcus citri* Risso.

Fig. 19. The sharpshooter, *Cameocephala fulgida*, a vector of Pierce's disease. (Dr J. Clark, University of California, Davis)

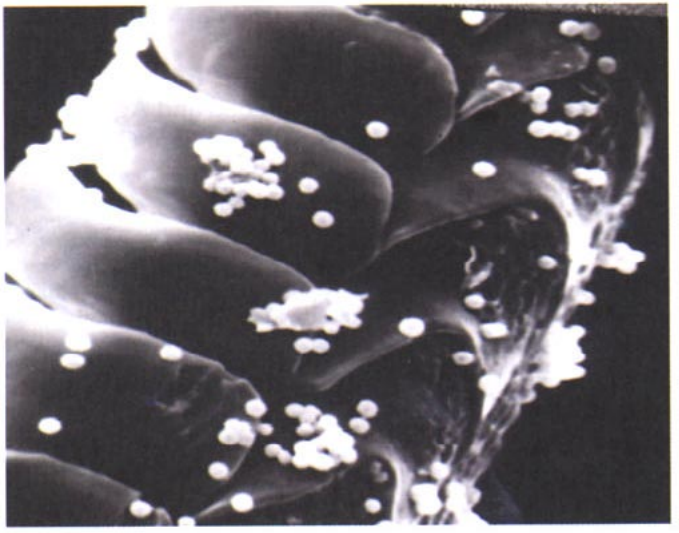

Fig. 20. Stylet of sharpshooter covered with *Xylella fastidiosa*. (Dr J. Clark, University of California, Davis)

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