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OPINION

A list of eclectic viruses, virus-like diseases and viroids of grapevines that should not be considered for regulatory oversight: a global plea from virologists

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Abstract
Grapevine (*Vitis* spp.) propagation material is profusely exchanged across geographic and regulatory boundaries. Trading germplasm increases the diversity of cultivars and rootstocks with enhanced viticultural attributes but also risks the dissemination of pests and detrimental pathogens such as viruses in new grape production areas. Therefore, regulations are established to facilitate the safe trade of *Vitis* propagation material with desirable traits. Regrettably regulations are sometimes inadequate. Consequently, the accessibility of desired germplasm for growers might be unduly delayed, providing opportunities to circumvent regulations by illegally introducing germplasm of interest, amidst risking epidemics of viruses of concern, including quarantined agents, and jeopardizing the health of vineyards. To address some of the regulatory limitations, scientists from around the world recently defined phantom agents in fruit crops, including grapevines, and provided a compelling case for their exclusion from regulatory oversight. Simultaneously, a group of virologists realized the need to complement the list of phantom agents in grapevines by considering additional viruses, virus-like diseases and viroids that should not be subject to regulatory oversight. Here, we present a list of nine viruses, 14 virus-like diseases, nine viroids, and 129 presumed viruses of the grapevine, that are not phantom agents but should be excluded from regulation or should not be regulated. Our list is anticipated to assist policy makers adopt regulations that expedite the safe exchange of *Vitis* germplasm across regulatory boundaries while reducing incentives for illicit introductions.

Keywords Virus · Viroid · Virus-like disease · *Vitis* · Economic impact · Regulation · Safe exchange

Introduction

It is customarily for grapevine (*Vitis* spp.) propagation material to be traded among viticulture professionals. Exchanging *Vitis* germplasm not only increases the diversity of cultivars, rootstocks, and advanced breeding selections with enhanced viticultural and enological potential but also risks the dissemination of detrimental pathogens and pests in new grape production areas, potentially jeopardizing the health of vineyards and their sustainability (Golino et al. 2017; Martelli 2017).

Regulations are developed and implemented to facilitate the production of clean planting stocks for growers, and the safe exchange of *Vitis* germplasm of interest to nurseries, propagators, breeders, growers, vintners, and wineries across boundaries (Golino et al. 2017). Viruses and virus-like diseases that are subject to regulatory oversight, as regulated quarantine and non-quarantine agents (officially regulated) or non-quarantine agents (voluntarily regulated), typically cause substantial economic impact by negatively impairing vine vigor, yield, and/or fruit quality. For example, grapevine fanleaf virus (GFLV) and grapevine leafroll-associated virus 3 (GLRaV3) are commonly regulated (Maliogka et al.

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2015; Golino et al. 2017). Based on their well-documented impact and economic concern (Andret-Link et al. 2004; Maree et al. 2013; Naidu et al. 2015; Burger et al. 2017; Digiaro et al. 2017), these two viruses are officially or voluntarily regulated in areas of occurrence to reduce their dissemination via the propagation and planting material, and/or in areas where they have not been described yet to avoid their introduction.

Ideally, regulations target viruses and virus-like diseases that are of economic concern. Unfortunately, regulations can sometimes be deceiving (Maliogka et al. 2015; Golino et al. 2017; Tzanetakis et al. 2024). This is because they (i) require freedom from diseases or viruses that are challenging or impossible to diagnose or (ii) control viruses that have limited or no known detrimental impact on vine vigor, yield, or fruit quality. To address some of the regulatory limitations, many scientists, mostly plant virologists, from more than 120 different institutions around the world recently published an extensive list of phantom agents in fruit crops, including grapevines, and provided a compelling case for their exclusion from regulatory oversight (Tzanetakis et al. 2024). Phantom agents are defined as presumed viral agents associated with symptomatic plants or diseases of unknown etiology, yet neither infected plant material nor reference isolates are available, and no sequence information is available in publicly accessible databases. Therefore, no causal virus or pathogen can be identified, and no diagnostic assays can be developed. Consequently, these agents are impossible to detect (Tzanetakis et al. 2024).

The following six virus-like diseases of the grapevine meet the criteria of a phantom agent: little leaf, infectious chlorosis and leaf reddening of 'Pinot noir', flat trunk, summer mottle, enation, and bushy stunt (Tzanetakis et al. 2024). Little leaf disease was described in *V. vinifera* 'Merlot noir' in India, perhaps in association with a phytoplasma (Singh et al. 1975), but is no longer reported in this country or elsewhere. Infectious chlorosis and leaf reddening disease was described in France upon grafting of *V. vinifera* 'Pinot noir' with other *V. vinifera* cultivars but its etiology is uncertain (Bovey et al. 1980; Martelli and Boudon-Padieu 2006). For flat trunk disease, graft transmission is reported (Hewitt 1975) but the etiological agent is not known (Bovey et al. 1980; Martelli and Boudon-Padieu 2006). Summer mottle was reported only in the red table grape 'Siderites' in Australia. Graft-transmissibility and elimination of the disease by apical meristem culture were reported (Krake and Woodham 1978). Diseased 'Siderites' vines were eradicated, and summer mottle is no longer known to occur in Australia. Enation disease is transmissible by grafting but its etiology remains undetermined (Martelli 1993; Martelli and Boudon-Padieu 2006; Chiumenti et al. 2012, 2013). Enation occurs sporadically nowadays, and its presence is always associated with mixed virus infections. Bushy stunt disease is described as a transitory form of graft incompatibility on certain clones of the rootstock 140 Ruggeri (*Vitis berlandieri* x *V. rupestris*) in Italy (Savino et al. 1991). The disease is eliminated by therapeutic treatment, but its etiology is not known (Martelli 1993; Martelli and Boudon-Padieu 2006). The list of six phantom agents of the grapevine is expected to be considered for revising current regulations by, for instance, excluding little leaf, a currently regulated disease in North America, so that the safe exchange of germplasm across regulatory boundaries can be expedited. Following the publication on phantom agents (Tzanetakis et al. 2024), a group of grapevine virologists, mostly current and past members of the Steering Committee of the International Council for the Study of Virus and Virus-like Diseases of the Grapevine, and allied experts, realized the need to complement the list of phantom agents by considering additional viruses and virus-like diseases of the grapevine that should not be regulated. This is because many viruses and virus-like diseases not only do not meet the criteria set for phantom agents but also fail to meet the basic criteria for inclusion in regulation. Here, we argue that, in addition to phantom agents, several viruses, virus-like diseases, viroids and presumed grapevine viruses should be excluded from regulation or should not be regulated.

Viruses with limited to no viticultural impact that should not be regulated

One hundred and two viruses have been described in grapevines (*Vitis* spp.) worldwide (Fuchs 2024). Several of these 102 viruses cause latent infections in grapevines and are omnipresent in vineyards, often occurring in mixed infections, amidst some might elicit disease symptoms on a susceptible grapevine indicator (Table 1). For example, grapevine rupestris stem pitting-associated virus (GRSPaV) is closely associated with, and likely the causal agent, of two minor diseases, i.e., rupestris stem pitting (Meng and Rowhani 2017) and vein necrosis (Bouyahia et al. 2004), on the indicators *V. rupestris* and 110R, respectively. However. GRSPaV infections are latent in other *Vitis* spp. (Table 1). Grapevine asteroid mosaic-associated virus (GAMaV) is associated with asteroid mosaic but causes mostly latent infections in wine grape cultivars and rootstocks (Kyriakopoulou 1991), as well as in free-living vines (Table 1). Similar observations apply to grapevine rupestris vein feathering virus (GRVFV) and grapevine fleck virus (GFkV) for which disease symptoms are observed only on indicator species, while grapevine Syrah virus 1 (GSyV1) does not cause any disease symptoms in wine grapes or free-living vines (Table 1). Moreover, grapevine Red Globe virus (GRGV) does not seem to induce any disease symptoms (Table 1).

Table 1 Viruses of the grapevine that should not be regulated because they cause latent infections in most *Vitis* spp., amidst some of them might elicit disease symptoms on a susceptible grapevine indicator, and evidence of their detrimental impacts is lacking

Virus	Acronym	Disease on a *Vitis* indicator	Disease on other *Vitis*	Geographic distribution	Vector	Impact	Taxonomy (genus / family)	References	GenBank accession number
Grapevine rupestris stem pitting-associated virus	GRSPaV	stem pitting on *V. rupestris*, and vein necrosis on 110R (*V. berlandieri* x *V. rupestris*)	none	worldwide	none	negligible	*Foveavirus* / *Betaflexiviridae*	Garau et al. 1987; Credi and Babini 1997; Reynolds et al. 1997; Komar et al. 2007; Komar et al. 2010; Meng and Rowhani 2017	AF057136
Cherry leafroll virus	CLRV			extremely restricted	none	unknown	*Nepovirus* / *Secoviridae*	Herrera and Madariaga 2001; Ipach et al. 2003	FR851461, FR851462
Grapevine leafroll-associated virus 7	GLRaV7	none	none	widespread	none	unknown	*Velarivirus* / *Closteroviridae*	Al Rwahnih et al. 2012b, 2017; Reynard et al. 2015	HE588185
Grapevine Syrah virus 1	GSyV1	none	none	worldwide	none	unknown	*Marafivirus* / *Tymoviridae*	Al Rwahnih et al. 2009; Sabanadzovic et al. 2009; Sabanadzovic et al. 2017	FJ436028
Grapevine asteroid mosaic-associated virus	GAMaV	asteroid mosaic on *V. rupestris*	none	worldwide	none	unknown	*Marafivirus* / *Tymoviridae*	Kariakopoulou 1991, Sabanadzovic et al. 2017; Thompson et al. 2021	AJ249357
Grapevine rupestris vein feathering virus	GRVFV	vein feathering on *V. rupestris*	none	worldwide	none	unknown	*Marafivirus* / *Tymoviridae*	Sabanadzovic et al. 2017; Saldarelli et al. 2017	AY706994
Grapevine fleck virus	GFkV	fleck on *V. rupestris*	none	worldwide	none	unknown	*Maculavirus* / *Tymoviridae*	Credi and Babini 1997; Spring et al. 2012; Sabanadzovic et al. 2000; Sabanadzovic et al. 2017	AJ309022
Grapevine Red Globe virus	GRGV	none	none	worldwide	none	unknown	*Marafivirus* / *Tymoviridae*	Crettazo and Velasco 2017; Sabanadzovic et al. 2017	AJ249360
Grapevine-associated marafivirus	GaMV	unknown	unknown	China	unknown	unknown	*Marafivirus* / *Tymoviridae*	Fan et al. 2021	MZ422607

One of these viruses, i.e., GRSPaV, is so widespread that it is considered a major contributor to the inherent virome of the grapevine in association with some viroids (Saldarelli et al. 2017). Comparative performance analyses of diseased and GRSPaV-free vines indicated little or no negative impact on vine size, yield components, time of budburst, and fruit juice chemistry (Table 1). Similarly, the impact of GFkV on vine vigor and fruit yield and quality is negligible in most cases (Table 1). Although grapevine-associated marafivirus (GaMV) was recently described (Fan et al. 2021), it is anticipated to have negligible effect on vine health by analogy with other marafiviruses. Furthermore, grapevine leafroll-associated virus 7 (GLRaV7) is not associated with any disease in grapevines and cherry leafroll virus (CLRV) has not been described in grapevines in more than 20 years (Table 1). No biological vector, i.e., mealybugs, scales, aphids, nematodes, *Cicadellidae* or *Membracidae*, is described or suspected for any of the aforementioned nine viruses (Table 1). Based on

the ubiquitous nature of most of them, except GaMV which was identified from a mixed-infected interspecific hybrid in China (Fan et al. 2021), their lack of known or suspected vector, and the latent infections that most of them are associated with, except on indicator *Vitis* species (Table 1), GRSPaV, GFkV, GRGV, GSyV1, GAMaV, GRVFV, GaMV, CLRV, and GLRaV7 should not be regulated. We acknowledge that the effects of GRGV, GSyV1, GAMaV, GRVFV, GaMV, CLRV, and GLRaV7 on the viticultural performance of infected grapevines are yet to be studied, but no detrimental impact on vine vigor, and fruit yield is suspected.

Virus-like diseases that should not be regulated

Grapevine viruses responsible for an economic disease or highly associated with a disease of economic relevance should be regulated, while, arguably, virus-like diseases should not be considered for regulatory oversight. This is because virus-like diseases can only be identified by biological assays, which lack sensitivity and specificity in comparison with laboratory diagnostic assays (Rowhani et al. 2017a; Al Rwahnih et al. 2015). Thirteen virus-like diseases of the grapevine have an uncertain etiology and limited economic impact, except eventually at a local level, and an additional virus-like disease, i.e., Syrah decline, lacks a virus etiology (Table 2). Syrah decline causes swelling at the graft union with stem grooves, bark cracks, and reddening of the leaves. Different *V. vinifera* 'Syrah' clones show variable degrees of sensitivity to the decline with 110R and 99R being the most sensitive rootstocks. Recent studies elegantly described a genetic origin of Syrah decline rather than a viral etiology (Table 2). Among the other virus-like diseases, Ajinashika disease is only reported in the interspecific hybrid 'Koshu' in Japan (Table 2). Although an antiserum was produced against an isometric virus of 25 nm in diameter named grapevine Ajinashika-associated virus, the etiology of Ajinashika disease remains unclear. Shiraz (syn. Syrah) disease is reported from Australia and South Africa (Table 2). This virus-like disease affects vine growth, delays or prevents budburst, and severely affects fruit production. Diseased vines never recuperate and usually die within five years. Grapevine virus A and GLRaV3 or grapevine leafroll-associated virus 4 are associated with Shiraz disease (Table 2). Nonetheless, the etiology of Shiraz disease remains unclear, and the involvement of genetic factors is not excluded. Chasselas latent is described following grafting of asymptomatic *V. vinifera* 'Chasselas' onto the rootstocks Kober 5BB, 5 C, and *V. rupestris* (Table 2). The etiology of this virus-like disease is not known. 3309 C stem necrosis and distortion was described as a decline of *V. vinifera* 'Pinot noir' clone 23 grafted onto rootstock 3309 C (Table 2). Declining vines displayed solid red leaves, poor vigor, and severe stem necrosis and distortion of the rootstock. Efforts to graft-transmit a causal agent and identify a viral agent by high-throughput sequencing (HTS) failed (Al Rwahnih, unpublished results). Therefore, the etiology of 3309 C stem necrosis and distortion is unclear. 110R necrotic union is associated with certain clones of *V. vinifera* 'Pinot noir', 'Pinot gris', and 'Chardonnay' grafted on the rootstock 110R (Table 2). Symptoms consist of solid red ('Pinot noir') or chlorotic ('Pinot gris' and 'Chardonnay') leaves and a necrosis of the graft union. Bench grafting but no chip-bud inoculation of 'Pinot noir' and 'Chardonnay' on 110R reproduced necrotic union symptoms. No novel virus was identified by HTS (Al Rwahnih, unpublished results) and the etiology of 110R necrotic union is not known. Vein necrosis is latent and widespread in *Vitis* spp. The rootstock 110R is an indicator, displaying necrosis of leaf veins (Table 2). The causal agent is not known although evidence is linking vein necrosis to some variants of GRSPaV. Vein mosaic is latent in wine grapes and rootstocks. On the indicator *V. riparia* 'Gloire de Montpellier', symptoms consist of chlorotic blotches and green mosaic along the vein tissue (Table 2). Vein mosaic is widespread in *Vitis* spp. and can be eliminated by therapeutics treatment (Martelli 1993; Martelli and Boudon-Padieu 2006). The etiology of vein mosaic is not known. *Vitis rupestris* stem and vein necrosis is observed when *V. vinifera* 'Abujiaoxi' is grafted onto *V. rupestris*, 110R or *V. riparia* 'Gloire de Montpellier' (Table 2). The disease is reported only from Japan. Isometric virus-like particles of 26 nm in diameter were observed in the phloem parenchyma cells of symptomatic 110R and *V. rupestris* but attempts to mechanically transmit them to herbaceous host failed. The agent of this virus-like disease is not known. Infectious necrosis was reported from the former Czechoslovakia, Italy and Ukraine (Table 2). In Italy, diseased vines of 'Italia' displayed reduced vigor, foliar chlorotic and translucent spots that coalesce and become necrotic, short clusters, and berries with corky spots. The disease is graft transmissible to *Vitis riparia* 'Gloire de Montpellier' (Table 2) but transmission assays to herbaceous hosts were not successful. The etiology of infectious necrosis disease is not known although bacteria have been suspected as causal agents (Granata and Appino 1989; Ulrychova et al. 1975). Young leaf mosaic affects the interspecific hybrids 'Kyoho', 'Campbell Early, 'Takao' and 'Steuben' that display severe mosaic and yellow mottling symptoms with asymmetric leaf blade and curling, as well as fanleaf-like symptoms on shoots. Foliar symptoms are apparent in late spring but fade away during summer months. In addition, young berries of 'Kyoho' and 'Takao' show necrotic spots prior to veraison. The etiology of young leaf mosaic is not known (Table 2). Shoot necrosis is described in *V. vinifera* 'Razaki' in Italy. Disease symptoms are mostly confined to young shoots and consist of brown spots, depressed necrotic

Table 2 Virus-like diseases of the grapevine that should not be regulated

Virus-like disease	Associated virus	*Vitis* indicator	Geographic distribution	Impact	Taxonomy (genus / family)	References
Syrah decline	none	none	worldwide	severe	n/a	Puckett et al. 2018; Renault-Spilmont et al. 2007; Spilmont and Le Cunff 2023
Ajinashika	grapevine Ajinashika-associated virus (GAaV)	interspecific hybrid 'Koshu'	Japan	severe	unknown	Terai 1991; Namba et al. 1991
Shiraz disease	grapevine virus A, GLRaV3, GLRaV4	*V. vinifera'* Merlot'	Australia, South Africa	severe	*Vitivirus / Betaflexiviridae Ampelovirus /Closteroviridae*	Goszczynski 2007; Goszczynski and Habili 2012; Maree et al. 2012; Wu et al. 2020; Wu et al. 2023
Chasselas latent	none	Kober 5BB (*V. berlandieri x V. riparia*), 5 C (*V. berlandieri x V riparia*), *V. rupestris*	Switzerland	unknown	n/a	Bovey 1972; Martelli 1993; Martelli and Boudon-Padieu 2006
3309 C stem necrosis and distortion	none	3309 C (*V. riparia* x. *V. rupestris*)	USA	none	n/a	Lima et al. 2009; Rowhani et al. 2017b
110R necrotic union	none	110R (*V. berlandieri* x *V. riparia*)	USA	none	n/a	Al Rwahnih et al. 2012a; Rowhani et al. 2017b
Vein necrosis	GRSPaV	110R (*V. berlandieri* x *V. riparia*)	worldwide	none	*Foveavirus* / *Betaflexiviridae*	Legin and Vuittenez 1973; Martelli 1993; Bouyalia et al. 2004, Martelli and Boudon-Padieu 2006; Mannini and Digiaro 2017
Vein mosaic	none	*V. riparia* 'Gloire'	worldwide	none	n/a	Martelli 1993; Mannini and Digiaro 2017
V. rupestris stem and vein necrosis	none	*V. rupestris*, 110R, *V. riparia* 'Gloire'	Japan	none	n/a	Matsumoto and Ohki 1998
Infectious necrosis	none	*V. riparia* 'Gloire'	Italy, Ukraine, former Czechoslovakia	limited	n/a	Vanek 1966, Posdena and Vanek 1975, Milkus et al. 1978; Granata and Appiano 1989
Young leaf mosaic	none	interspecific hybrids 'Kyoho', Takao', 'Steuben', and *V. labrusca* 'Campbell Early'	Japan	none	n/a	Tanaka 1988
Shoot necrosis	none	*V. vinifera* 'Razaki'	Italy	limited	n/a	Martelli and Russo 1965
Stunt	none	interspecific hybrid 'Campbell Early'	Japan	limited	n/a	Namba et al. 1986; Martelli and Namba 1993
Yellow dwarf	none	none	Taiwan	none	n/a	Chen et al. 1981

n/a: not applicable

striations on basal internodes that become necrotic within 2–3 weeks. Vines exhibiting shoot necrosis have a low vigor, few clusters but no foliar symptoms. Symptoms were not reproduced by grafting on *V. rupestris* and 'Mission' and 'Thompson Seedless' (Table 2) but mechanical transmission of a virus to herbaceous hosts failed. The etiology of shoot necrosis is not known. Stunt is reported only from Japan and is apparently restricted to the interspecific hybrid 'Campbell Early' (Table 2). Symptoms consist in delayed vegetation, short internodes, small and curled leaves, and poor fruit set. The disease is transmitted by the leafhopper *Arboridia apicalis*. Sanitation is documented but the etiology of stunt disease is not known. Finally, Yellow dwarf is reported from Taiwan where diseased vines exhibit yellowing and dwarfing, and chlorosis and mottling of the leaves frequently displaying yellow spots in the spring, and malformations in late

autumn. Enveloped spherical particles of about 83 nm in diameter were observed in symptomatic tissue. Attempts to transmit this spherical virus to a range of herbaceous plants failed, and the etiology of yellow dwarf is unclear. In summary, these 14 virus-like diseases lack strong biological justifications for inclusion in regulation due to their uncertain etiology, limited geographic distribution and restriction to certain cultivars or rootstocks for some of them, and negligible, if any, documented or suspected economic impact (Mannini and Digiaro 2017; Martelli et al. 2017). Therefore, these 14 virus-like diseases should not be regulated.

Viroids should not be regulated

Eight viroids from the family *Pospiviroidae* have been identified in grapevines (Table 3). Another viroid, grapevine hammerhead viroid (GHVd), is unclassified (Table 3). None of these nine viroids is known to be pathogenic to grapevines, except grapevine yellow speckle viroid 1 (GYSVd1) and grapevine yellow speckle viroid 2 (GYSVd2), which can cause yellow speckle disease with symptoms apparent during hot years but not during milder years (Koltunow et al. 1989; Di Serio et al. 2017; Habili 2017; Martelli 2017). GYSVd1 and hop stunt latent viroid (HSVd) are ubiquitous in grapevines and considered as contributors to the inherent virome of the grapevine with GRSPaV (Saldarelli et al. 2017). GYSVd2 has a worldwide distribution but is reported only sporadically. Japanese grapevine viroid (JGVd) was initially identified in Japan and more recently in South Africa (Table 3). Australian grapevine viroid (AGVd) and citrus exocortis viroid (CEVd) have a worldwide distribution, unlike grapevine latent viroid (GLVd), which is described in China and Italy, as well as grapevine yellow speckle viroid 3 (GYSVd3), which is present in China and Japan (Table 3). GHVd is reported in the USA, France, South Africa, Italy, and Greece (Table 3). GYSVd1 and HSVd are seed transmitted but no biological vector is known for any of these nine viroids (Di Serio et al. 2017; Habili 2017; Martelli 2017). No data are available on the effect of any of these nine viroids, including GYSVd1 and GYSVd2, on vine vigor, yield and fruit quality, and none is suspected. Together, these nine viroids should not be regulated in grapevines.

Agents that are not *bona fide* grapevine viruses and should not be regulated

When naming a novel virus, it is customary to mention the host in which the virus was first described. For example, GFLV refers to a virus that infects grapevines and causes fanleaf symptoms. Many novel grapevine viruses are identified by HTS and are *bona fide* viruses of the grapevine (Fuchs 2024). Regrettably, grapevine is sometimes mentioned in the name of a virus for which *Vitis* spp. are not a host or at best are a doubtful host. These are probably not *bona fide* viruses of the grapevine. Such viruses have been identified when characterizing the microbiome of selected grapevines by HTS. These 128 viruses are likely adventitious and use fungi, bacteria, insects or yeast as a host and are probably present in or on the grapevine tissue that is

Table 3 Viroids of the grapevine that should not be regulated because there is no evidence of detrimental impacts, amidst two of them can elicit foliar yellow speckle disease symptoms during hot years

Viroid	Acronym	Disease	Geographic distribution	Impact	Taxonomy (genus / family)	References	GenBank accession number
Grapevine yellow speckle viroid 1	GYSVd1	yellow speckle	worldwide	unknown	*Apscaviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017	AF059712
Grapevine yellow speckle viroid 2	GYSVd2	yellow speckle	widespread	unknown	*Apscaviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017	J04348
Grapevine yellow speckle viroid 3	GYSVd3	none	China, Japan	unknown	unassigned / *Pospoviroidae*	Jiang et al. 2009; Jiang et al. 2012	DQ371462, PP541765
Japanese grapevine viroid	JGVd	none	Japan, South Africa	unknown	*Apscaviroid* / *Pospoviroidae*	Chiaki and Ito 2020; Morgan et al. 2023	LC500206
Australian grapevine viroid	AGVd	none	worldwide	unknown	*Apscaviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017	X17101
Grapevine latent viroid	GLVd	none	China, Italy	unknown	*Apscaviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017; Rotunno et al. 2018	KR605505
Hop stunt viroid	HSVd	none	worldwide	unknown	*Hostuviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017	X06719
Citrus exocortis viroid	CEVd	none	worldwide	unknown	*Pospiviroid* / *Pospoviroidae*	Di Serio et al. 2017; Habili 2017	J02053
Grapevine hammerhead viroid	GHVd	none	France, South Africa, Italy, Greece, USA	unknown	unclassified	Wu et al. 2012; Gambino et al. 2014; Candresse et al. 2017; Pappi et al. 2020; Morgan et al. 2023	KR736334

analyzed by non-targeted detection methods such as HTS (Table 4). In addition, grapevine angular mosaic virus was recently shown to have been previously misidentified as a *bone fide* virus of the grapevine (Mahillon et al. 2024) (Table 4). Together, these 129 viruses that carry grapevine or *Vitis* in their name but are likely not *bona fide* viruses of the grapevine should not be regulated.

Table 4 Viruses that should not be regulated because they probably do not use grapevine as a host

Virus	Likely host	Taxonomy (genus / family)	References	GenBank accession number
Grapevine angular mosaic virus	unknown	n/a	Mahillon et al. 2024	n/a
Grapevine-associated RNA viruses 1–18	insect or fungus	unclassified / unclassified	Nerva et al. 2022; Nuzzo et al. 2022	MW648517-MW648528
Grapevine-associated negative single-stranded RNA viruses 1–5	insect or fungus	unclassified /unclassified	Nerva et al. 2022	MW648503-MW648507
Grapevine-associated jiviviruses 1 and 2	oomycete or fungus	unclassified / unclassified	Chiapello et al. 2020a; Candresse et al. 2023	OP428756-OP428764
Grapevine-associated cogu-like virus 1	insect or fungus	*Bocivirus* / *Phenuiviridae*	Bertazzon et al. 2020; Chiapello et al. 2020a	MN520751-MN520753
Grapevine-associated cogu-like viruses 2–4		*Laulavirus* / *Phenuiviridae*	Bertazzon et al. 2020; Chiapello et al. 2020a	MN520754-MN520759 MT353902-MT353904
Grapevine-associated partitiviruses 1–4	fungus	*Delatapartitivirus* / *Gammapartitivirus*	Al Rwahnih et al. 2011; Nuzzo et al. 2022	
Grapevine associated tombus-like viruses 1–4	fungus	unclassified / unclassified	Nerva et al. 2022	MW648532-MW648535
Grapevine-associated totiviruses 1–3	fungus	unclassified / *Totiviridae*	Al Rwahnih et al. 2011	GU108585, GU108594, GU108598
Grapevine-associated mymona-like viruses 1–2	fungus	unclassified / *Mymonaviridae*	Nerva et al. 2022	MW648486-MW648487
Grapevine-associated mitoviruses 1–22	fungus	unclassified / *Mitoviridae*	Nerva et al. 2022	MW648457-MW648478
Grapevine-associated mononega-like viruses 1–7	fungus	*Humbramonavirus* / *Mymonaviridae*	Nerva et al. 2022	MW648479-MW648485
Grapevine-associated narna-like viruses 1–15	yeast	unclassified / *Narnaviridae*	Nerva et al. 2022	MW648488-MW648502
Grapevine-associated levi-like viruses 1–11	bacterium	unclassified / *Fiersviridae*	Nerva et al. 2022	MW648446-MW648456
Grapevine-associated mycobunya-like viruses 1–4	fungus	unclassified / unclassified	Nerva et al. 2022	MW648542-MW648545
Grapevine-associated chrysoviruses 1–4	fungus	unclassified / *Chrysoviridae*	Al Rwahnih et al. 2011	GU108588-GU108591
Grapevine-associated botourmia-like viruses 1–9	oomycete or fungus	unclassified / *Mitoviridae*, *Narnaviridae*, *Botourmiaviridae*	Nerva et al. 2022	MW648428-MW648436
Grapevine-associated noda-like viruses 1–2	insect	unclassified / *Nodaviridae*	Nerva et al. 2022	MW648508 MW648509
Grapevine-associated tymo-like virus	fungus	unclassified / *Tymovirales*	Hily et al. 2018	NC_040837
Grapevine virga-like virus	oomycete or fungus	unclassified / unclassified	Silva et al. 2018; Shvets et al. 2022	MK257732
Grapevine toga-like virus	insect	unclassified / *Togaviridae*	Chiapello et al. 2020b	MT682063
Grapevine-associated sobemo-like virus 1	insect	unclassified / *Solemoviridae*	Nerva et al. 2022	MW648530
Grapevine-associated alphaflexiviridae 1	fungus	unclassified / *Alphaflexiviridae*	Al Rwahnih et al. 2011	HM852918
Grapevine-associated gammaflexiviridae 1	fungus	Unclassified / *Gammaflexiviridae*	Al Rwahnih et al. 2011	HM852917
Grapevine-associated hypovirus 1	fungus	unclassified / *Hypoviridae*	Al Rwahnih et al. 2011	GU108591
Grapevine-associated phenui-like virus 1	fungus	unclassified / *Phenuiviridae*	Nerva et al. 2022	MW648513
Grapevine-associated botybirnavirus 1	fungus	unclassified / unclassified	Nerva et al. 2022	MW648437, MW648438
Grapevine-associated jingchu-like virus 1	fungus	unclassified / *Jingchuvirales*	Nerva et al. 2022	MW648445
Grapevine-associated fusarivirus 1	fungus	unclassified / unclassified	Nerva et al. 2022	MW648444
Grapevine-associated cryspo-like virus 1	yeast	*Cryspovirus* / *Partitiviridae*	Nerva et al. 2022	MW648442

Conclusions

We recommend that nine viruses (GRSPaV, GAMaV, GSyV1, GRVFV, GaMV, GRGV, GFkV, GLRaV7, CLRV) (Table 1), 14 virus-like diseases (Syrah decline, Shiraz disease, Chasselas latent, Ajinashika disease, 3309 C stem necrosis and distortion, 110R necrotic union, vein necrosis, vein mosaic, *Vitis rupestris* stem and vein necrosis, infectious necrosis, young leaf mosaic, shoot necrosis, stunt, and yellow dwarf) (Table 2), nine viroids (GYSVd1, GYSVd2, GYSVd3, JGVd, AGVd, GLVd, HSVd, CEVd, GHVd) (Table 3), GAMV and 129 purported grapevine viruses (Table 4) should be excluded from regulation or should not be considered for regulation at an international, national, or local level. Our rationale is that (i) GLRaV7 is not associated with any disease, (ii) the ubiquitous nature of GRSPaV, GAMaV, GSyV1, GRVFV, GRGV, and GFkV does not suggest any capacity to cause substantial detrimental impact on the viticultural performance of infected vines, (iii) CLRV has not been described in grapevines for more than 20 years, (iv) viroids cause latent infections for the most part with no suspected economic impact, (v) GAMV is not a *bona fide* virus of grapevines, and (vi) the etiology of the 14 virus-like diseases is uncertain or is unrelated to a viral origin. In addition, compelling evidence that 131 presumed grapevine viruses use grapevine as a host is lacking, despite carrying grapevine in their name; therefore, they cannot be considered with confidence as *bona fide* viruses of the grapevine.

Our list of viruses and virus-like diseases of the grapevine that should be excluded from regulation or should not be considered for regulation complements the list of phantom agents of the grapevine that was recently published (Tzanetakis et al. 2024). Moreso, two previously misidentified viruses, i.e., grapevine leafroll-associated virus 8 (Martelli et al. 2012) and grapevine virus C (Monette and James 1990, 1991; Masri et al. 2006), which are not *bona fide* viruses, should be ignored from regulatory oversight. Likewise, grapevine virus Q (Sabanadzovic et al. 2009) should not be regulated because it is synonymous to GSyV1 (Sabanadzovic et al. 2017). Of note, our list does not include any yellows and their phytoplasma agents because we believe that '*Candidatus* Phytoplasma species' should be considered for regulatory oversight, as appropriate and justified by the directionality of the propagation material trade, and local or regional singularities. Similarly, our list does not include any of the recently described *bona fide* viruses of the grapevine that were discovered in the past 10–15 years via HTS because a biological context for these viruses is often limited (Fuchs 2024). Following a more detailed assessment of the potential pathogenicity of these viruses, informed recommendations will then be made on the need or not for their regulation.

It is our expectation that policy makers and regulators will consider our plea. As a result, it is anticipated that revised regulatory schemes will streamline and facilitate the safe exchange of *Vitis* germplasm across regulatory boundaries. Consequently, growers, vineyard managers, nurseries, wineries, and propagators alike will be less tempted to circumvent deceiving regulatory requirements by illegally introducing *Vitis* germplasms of interest. Reducing suitcase introductions of material of interest will undoubtedly contribute to improving the overall health of vineyards and their sustainability.

Declarations

Ethical approval This article does not contain any studies with human participants or animals performed by the authors.

Conflict of interest The authors declare no conflict of interest.

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