EPPO Datasheet: *Xiphinema rivesi*

Last updated: 2023-10-10

Datasheets on *Xiphinema americanum sensu lato, Xiphinema americanum sensu stricto, Xiphinema brevicolense* and *Xiphinema californicum* are also available in Global Database.

IDENTITY

Preferred name: *Xiphinema rivesi*
Authority: Dalmasso
Taxonomic position: Animalia: Nematoda: Enoplea: Dorylaimida: Longidoridae
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EPPO Categorization: A2 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: XIPHRI

Notes on taxonomy and nomenclature

Xiphinema rivesi Dalmasso is a member of *Xiphinema americanum sensu lato (s.l.)* group which comprises 64 nominal species (EPPO, 2017; Mobasseri *et al.*, 2019; Lazarova *et al*., 2019 & Vazifeh *et al*., 2019). Most members of the group are difficult to distinguish both morphologically and biochemically. Furthermore, no reliable molecular tests to distinguish between members of *X. americanum s.l.,* or for the identification of those species that have been confirmed as virus vectors, can be recommended yet.Therefore, although it is difficult, identification remains reliant on morphological identification.

HOSTS

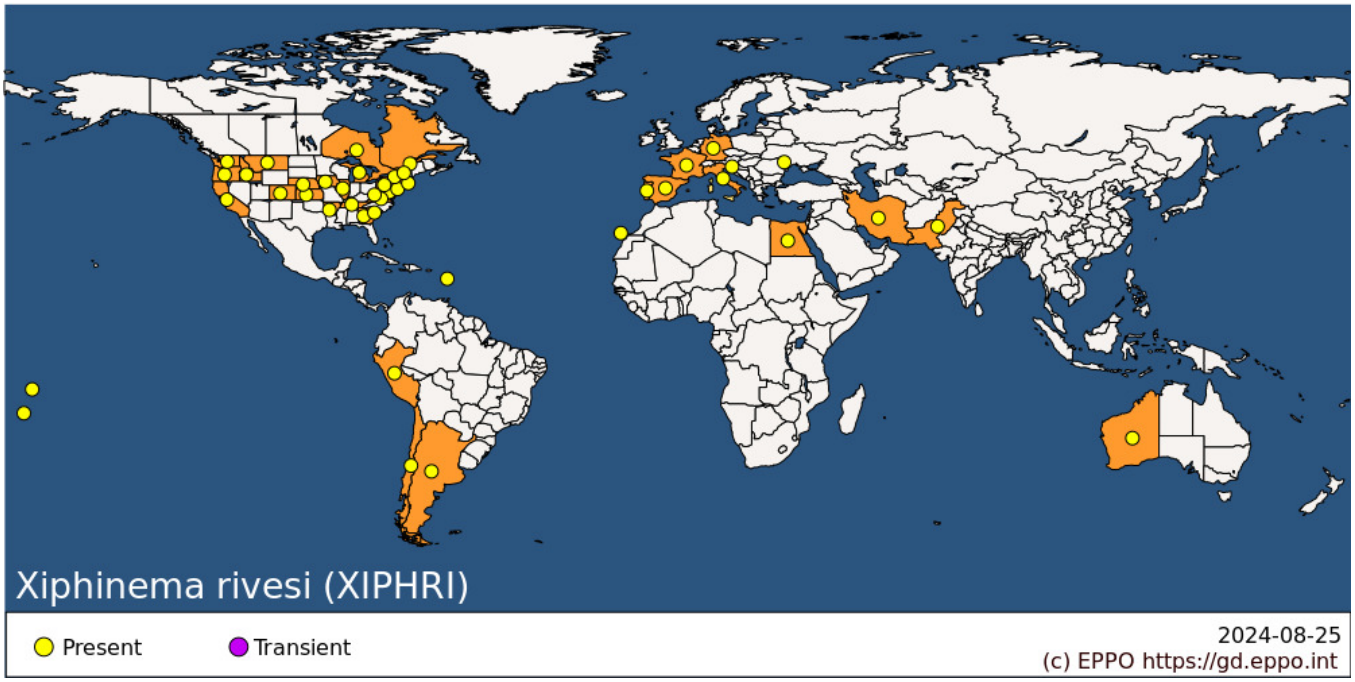
X. rivesi appears to be non-specific with regard to host plants, having been recorded from agricultural, horticultural and non-agricultural soils. The host plants of particular quarantine significance are those to and from which *X. rivesi* transmits viruses. *X. rivesi* transmits *Cherry rasp leaf virus* (CRLV) (*Cheravirus*),*Tobacco ringspot virus* (TRSV) (*Nepovirus*) and *Tomato ringspot virus* (ToRSV) (*Nepovirus*) (Brown *et al.*, 1994). *X. rivesi* is presumed to be a vector of *Peach rosette mosaic virus* (PRMV) (Stobbs & Van Schagen, 1996). The host plant range of these nepoviruses is wide, including woody and ornamental plants, and several weed species. Important host plants of these viruses include *Malus* sp., *Prunus* sp. (plum, cherry, and peach), *Vitis* sp. (Taylor & Brown, 1997).

X. rivesi has been shown to be associated with several fruit crops such as apple (*Malus domestica*), peach (*Prunus persica*), almond (*Prunus dulcis*), raspberry (*Rubus idaeus*) (Wojtowicz *et al.*, 1982; Hafez *et al.*, 1992), persimmon (*Diospyros kaki)* and cherry (*Prunus avium*) (Urek *et al.*, 2005). It has also been shown to be associated with other plants such as oak (*Quercus* sp.), hackberry (*Celtis* sp., alfalfa (*Medicago* sp.), maize (*Zea* sp.), poplar (*Populus* sp.) and potato (*Solanum tuberosum*) (Wojtowicz *et al.*, 1982; Hafez *et al.*, 1992). *X. rivesi* has been reported several times to be associated with grapevine (*Vitis vinifera*) (Dalmasso, 1969; Arias & Navacerrada, 1973; Lamberti & Bleve-Zacheo, 1979; Ebsary *et al.*, 1984; Lamberti *et al.*, 1994, Urek *et al.*, 2005). It has also been detected several times on *Citrus* sp. (Maqbool, 1986; Fadaei *et al.*, 2003; Handoo *et al.*, 2015; Ibrahim & Handoo, 2016).

Host list: *Acer negundo, Allium sativum, Celtis sp., Citrus x aurantium var. sinensis, Diospyros kaki, Juglans sp., Juniperus sp., Liquidambar styraciflua, Malus domestica, Mangifera indica, Medicago sativa, Populus sp., Prunus avium, Prunus persica, Quercus sp., Rubus idaeus, Rubus sp., Solanum tuberosum, Sorghum bicolor, Vitis vinifera*

GEOGRAPHICAL DISTRIBUTION

X. rivesi has been reported from all continents. It is considered as the most widespread *X. americanum* group species in North America (Robbins & Brown, 1991). *X. rivesi* was reported and described from France already in 1969 (Dalmasso, 1969). In the EPPO region, *X. rivesi* is present in France, Germany, Italy, Moldova, Portugal, Spain and Slovenia (Lamberti *et al.*, 1994; 2000; Bello *et al.*, 2005; Širca *et al.*, 2007; Urek *et al.*, 2003, 2005). It is also present in Argentina, Chile, Peru. It was detected in Pakistan (Maqbool, 1986) and Iran (Fadaei *et al.*, 2003), and for the first time in Africa in Egypt (Handoo *et al.*, 2015; Ibrahim & Handoo, 2016).



EPPO Region: France (mainland), Germany, Italy (mainland), Moldova, Portugal (mainland), Slovenia, Spain (mainland, Islas Canárias)
Africa: Egypt
Asia: Iran, Pakistan
North America: Canada (Ontario, Québec), United States of America (Arkansas, California, Colorado, Georgia, Idaho, Illinois, Iowa, Kansas, Maryland, Michigan, Montana, Nebraska, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington, West Virginia)
Central America and Caribbean: Guadeloupe
South America: Argentina, Chile, Peru
Oceania: Australia (Western Australia), Samoa, Tonga

BIOLOGY

X. rivesi is a migratory ectoparasite and spends its entire life cycle in the soil, moving in the moisture film covering soil particles. The individuals appear to be attracted to young growing roots where they feed by puncturing with their stylet several successive layers of cells and extracting cytoplasm. Females produce eggs parthenogenetically (males being rare or absent). The number of developmental stages for this species is unclear, data indicates the possibility of either 3 or 4 juvenile development stages. Alkemada and Loof (1989) reviewed the literature on *X. americanum* group juveniles and reported that some published measurements clearly indicated four juvenile stages while three larval developmental stages were also reported (Halbrendt & Brown, 1992; Robbins *et al.*, 1996). The life cycle requires at least 1 year to complete. Optimum temperatures for reproduction are 20-24°C (Hunt, 1993). There is no specialized long term survival stage, however, all stages have been found to survive and mature (but not multiply) in soil in the absence of a host. The nematode does not survive long periods in frozen soil, and in areas of low winter temperatures overwintering is mainly in the egg stage. Where the soil is not frozen, all stages can survive over winter.

X. rivesi is an efficient vector of several viruses, with adults and juvenile stages able to transmit viruses (McGuire, 1964; Teliz *et al.*, 1966). When the nematode feeds on a virus-infected plant, virus particles are extracted from the

cells within the cytoplasm, and these adhere to the lining of the stylet and pharynx. The virus particles are injected into the next healthy plant on which the nematode feeds. Nematodes may transmit virus acquired up to 2 years previously (Bitterlin & Gonsalves, 1987).

X. rivesi was confirmed as a vector of CRLV,TRSV and ToRSV (Brown *et al.*, 1994) fulfilling the criteria established by Trudgill *et al.* (1983). The ability to transmit virus may vary among different populations of the same nematode species (Griesbach & Maggenti, 1989; Brown *et al.*, 1994). Transmission of PRMV by *X. rivesi* has never been independently confirmed in transmission tests. Stobbs and Van Schagen (1996) reported *X. rivesi* as a vector of PRMV by recovering 4 *X. rivesi* nematodes per litre of soil sampled around the roots of PRMV infected vines.

DETECTION AND IDENTIFICATION

An EPPO diagnostic protocol is available for *Xiphinema americanum sensu lato* PM 7/95 (EPPO, 2017) as well as an IPPC Diagnostic Protocol (IPPC, 2016).

Symptoms

Plants roots attacked by *X. rivesi* in the absence of a virus, generally exhibit no clear characteristic symptoms in the aerial parts. Symptoms are most often similar to those resulting from environmental stresses. With high populations, a general reduction in vigour is observed and this appears in characteristic patches in the crop corresponding to the highest concentration of nematodes (Heve *et al.*, 2015). When nematode feeding results in virus transmission the characteristic symptoms of the particular virus develop in the crop. These usually first appear in the aerial parts of the plant in the growing season after transmission to the roots has occurred. However, some host plants remain symptomless after infection and therefore may escape detection (NVWA, 2010).

Morphology

X. rivesi nematodes are minute, soft-bodied, vermiform and nearly transparent. They have a hard, needle-like stylet (odontostyle and odontophore) at the mouth-end of the body which is capable of being extruded to puncture plant cells. General morphological characteristics of *X. rivesi* are relatively short compared to other non *X. americanum* s.l. species (usually <150 ?m) stylet (odontostyle + odontophore), thick cuticular lining of the pharynx, males usually absent or rare, female genital branches equally developed, uterus short and without Z-organ, presence of symbiotic bacteria in the oocytes and in the intestines of juveniles, short conoid tail with rounded terminus, females without sperm present in uteri or oviduct.

Detection and inspection methods

X. rivesi can be detected by extraction from soil or growing media (as is the case for most ectoparasitic plant?parasitic nematodes). Nematode extraction techniques, such as the Flegg?modified Cobb technique (Flegg, 1967) or Oostenbrink (Oostenbrink, 1960) or other suitable elutriation methods can be used for extraction of longidorid nematodes. Migratory endoparasites may also be present in soil residues adhering to plant roots, bulbs and tubers. Consequently, *X. rivesi* may be found following processing of plant material using methods such as modified Baermann processes. Detailed descriptions of extraction equipment and procedures can be found in EPPO PM 7/119 (1) Nematode extraction (EPPO, 2013). After extraction, the nematodes are examined by high-power microscopy in order to identify the species.

PATHWAYS FOR MOVEMENT

X. rivesi spends its entire life cycle in the soil, feeding on roots of host plants. It can only live in moist soil where it can move at most 1 m per year, unless assisted by run-off. Bare rooted plants free from soil are not a pathway for movement. The pest is transported solely in soil associated with plants for planting, plant products (such as, soil associated with ware potatoes), bulk soil and any other goods contaminated with soil. Spread over longer distances is possible in moist soil transported with or without plants. Soil and growing media attached to (agricultural) machinery, tools and packaging materials may also constitute a pathway for movement, but such soil may dry out and consequently lead to reduced viability of the pest.

PEST SIGNIFICANCE

Economic impact

X. rivesi is present in several EPPO member countries but no reports are known about direct economic damage of this nematode species to crop plants. However, the importance of *X. rivesi* is linked to its capacity to vector the following American viruses (Taylor & Brown, 1981), which are important mainly on fruit crops: ToRSV, TRSV, CLRV, and it is also presumed to transmit PRMV.

In many areas of North America, *X. rivesi* occurs more frequently than *X. americanum sensu stricto.* and is the most widespread *X. americanum* group species (Robbins & Brown, 1991). In the EPPO region, transmission of nepoviruses by *X. rivesi* in the field has not been reported. Under experimental conditions, the ability to transmit ToRSV and TRSV has been shown in Slovenia (Širca *et al.*, 2007). It is assumed that the *X. rivesi* populations present in other areas in the EPPO region are also able to transmit these nepoviruses but so far this has not been reported. As was the case for the Slovenian *X. rivesi* population, the ability to transmit ToRSV was proven with *X. rivesi* from Chile (Auger *et al.*, 2009).

Both ToRSV and TRSV have wide host ranges. A review of effects of the viruses on economically important crops was performed by NVWA (2010) and is summarized here. Adverse economic effects caused by ToRSV are principally related to fruit crops, particularly grapes and raspberries. In grapes, yield reductions of between 37 and 63% were reported in vineyards in New York, USA. Fifty percent yield reductions were reported in some raspberry cultivars whilst other cultivars were unaffected. ToRSV was also implicated in apple union necrosis and decline in American apple orchards. Severe losses have also been reported on blueberry in New York and peach in Pennsylvania. The virus is known to infect species of *Prunus* (cherries and plum), *Ribes* and *Rubus* (some cultivars) but no reduction in yield has been reported in these crops. Among the horticultural crops ToRSV has been reported to produce symptoms on leaves of pelargonium making plants unmarketable. In Türkiye, symptoms of infection were reported on wild blackberry plants, but not in neighboring peach orchards (Sertkaya, 2010). In Lithuania, ToRSV was detected in 4.6% of one raspberry cultivar (Stankiene *et al.*, 2012), but impacts due to the virus infection are unknown. TRSV causes yield losses in soybean and blueberries in the USA. Serious losses were also reported in grapes in vineyards affected by a mixed infection of TRSV and ToRSV. The virus also affects cucurbits but causes only minor damage to these crops. Elsewhere, 60-80% yield losses due to TRSV were reported in aubergine in India and minor losses were reported in capsicum in Mexico (FERA, 2014).

After introduction into the production area, the virus associated with its vector will spread slowly since the nematodes natural spread is a maximum of 1 m per year. The virus and its vector may spread over longer distance mainly with trade of plants with soil attached but the total infested area will however increase slowly. Thus, in the short term, e.g. the first 10 years after introduction the impact is assessed to be low and impacts may occur only on very local scale. In the long term (decades), the virus-vector combination is expected to spread further mainly by human assistance. In Europe the impact of ToRSV and/or TRSV in combination with the vector may become higher than in the USA because of the limited availability of soil fumigants in Europe. The potential impact of the viruses in combination with the vector in Europe was assessed as follows (NVWA, 2010):

- - ToRSV: high impact for several fruit crops.
  - TRSV: high impact for blueberry and probably also for grapes.
  - CLRV: low impact.

- PRMV: low impact.

Control

Control of viruliferous nematodes in the field is problematic. Disinfection of soil can be carried out by physical (heat, steam) or chemical (nematicides) treatments – the efficacy of these measures is limited (it is considered that the efficacy never reaches 100%) and the nematodes that remain in the soil can still transmit viruses to the roots of the host plants (EFSA, 2018). Soil disinfection by physical treatments does not eliminate nematodes under field conditions due to the vertical distribution (depth) of the nematode which depends on availability of roots of host plants and moisture regime (EFSA, 2018). The use of nematicides is restricted in EPPO countries (e.g. EU countries) and at present, no methods are available to control nematode populations in an established orchard (NVWA, 2010).

Keeping the soil free from plant for over 2 years will significantly reduce the nematode population.

Phytosanitary risk

The main phytosanitary risk is linked to the capacity of *X. rivesi* to transmit three American viruses TRSV, ToRSV, CRLV (and possibly PRMV) which are quarantine pests. *X. rivesi* may thus introduce or spread these viruses. If the viruses were introduced or spread further in the EPPO region, introduction of the vector nematodes would increase the risk of spread, and more complex measures for the certification of virus-free material of fruit crops would be needed. Populations of *X. rivesi* from outside the EPPO region, especially those from North America, could establish and spread in the EPPO region.

There are numerous reports of TRSV and ToRSV detection in Europe, however most relate to interceptions, are under eradication and are not know to be widely distributed. CRLV is not known to be present in Europe while PRMV has been detected in low incidence in west Anatolia, Türkiye during almond nursery trees survey in 1992 and 1993 (Azerý & Çýçek, 1997).

PHYTOSANITARY MEASURES

It can be recommended that import of soil from non-EPPO countries where *X. rivesi* occurs should be prohibited. Plants with roots may also be prohibited from import or precautions should be taken to ensure that the nematodes will not be carried in the roots. The field from which the plants originate should have been tested and found to be free from the nematodes and, if the plants were in a growing medium, this medium should be either inorganic or have been tested, or treated against nematodes. If this is not the case, soil or growing medium attached to the plants can be removed and after removal, the plants can be repotted in pest-free soil or growing medium before export. Plants should then be kept under special conditions to avoid the risk of reinfestation.

Soil or growing medium can be treated to kill nematodes by heating to 60°C and maintaining at that temperature for 1 h.

The use of certified or tested plants for planting, grown under conditions that ensure pest freedom reduces the risk of introducing and spreading of viruses not present or having a limited distribution in the region, and of their vector nematodes. Only planting material originating from areas where the nematode has not been reported, and where surveillance is carried out to confirm the absence of the pest (Pest Free Area, Pest Free Production Site) can be declared as pest free material.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1984 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997 (as part of *Xiphinema americanum*), as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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