Prepared by CABI and EPPO for the EU under Contract 90/399003

Data Sheets on Quarantine Pests

Xiphinema americanum sensu lato

IDENTITY

- ***Xiphinema americanum sensu lato***
  Name: *Xiphinema americanum* Cobb *sensu lato*
  Synonyms: *Tylencholaimus americanus* (Cobb) Micoletzky
  Taxonomic position: Nematoda: Longidoridae
  Common names: American dagger nematode (English)
  Notes on taxonomy and nomenclature: For some time the designation of *X. americanum* has been disputed. Tarjan (1969) considered that *X. americanum* was a single species with large intraspecific variation, whereas Lima (1968) argued for a species complex containing seven species. Lamberti & Bleve-Zacheo (1979) divided the species into 15 new species and believed that at least 25 species could be recognized as belonging to the species complex. Current opinion puts the number of species at more than 40, one of which is *X. americanum sensu stricto*. However, the differences between several described species are small, while there is little information on intraspecific variability. For these reasons, and because the illustrations of many of the species are poor, few taxonomists would claim to be able to separate the species with certainty. An international group of taxonomists, under the auspices of EPPO, is currently making a morphological study of the species complex to try to clarify the relationships within it. Other research is directed towards the use of genetic techniques to distinguish species (Vrain *et al.*, 1992). In the meantime, it is difficult to interpret most of the published data on the distribution, host/parasite relationships and virus-vector abilities of the component species.
  This data sheet considers *X. americanum sensu lato*, the species complex as a whole. However, because the quarantine significance of the nematodes derives primarily from the ability to transmit North American nepoviruses, the data sheet concentrates on the few species which have been shown to be vectors. Several other species, not shown to be vectors, have been reported to be present in the EPPO region. They are also mentioned in this data sheet, because they were previously referred to simply as *X. americanum* and it is necessary to indicate clearly that they are distinct from the vector species and have no quarantine significance for the EPPO region. They are *X. brevicolle* Lordello & Da Costa, *X. pachtaicum* (Tulaganov) Kiryanova (=*X. mediterraneum* Martelli & Lamberti), *X. incertum* Lamberti, Choleva & Agostinelli, and *X. simile* Lamberti, Choleva & Agostinelli.
  Bayer computer code: XIPHAM
  EPPO A2 list: No. 150
  EU Annex designation: I/A1 - for non-European populations of *Xiphinema americanum sensu lato* and in particular for *Xiphinema californicum*
- ***Xiphinema americanum sensu stricto***
  Name: *Xiphinema americanum* Cobb *sensu stricto*
  Taxonomic position: Nematoda: Longidoridae
  Notes on taxonomy and nomenclature: The international group of taxonomists working under the auspices of EPPO is reasonably satisfied that the three species which follow are distinct species. However, it is not yet ready to state this for *X. americanum sensu stricto*, which may still correspond to a complex of several species.

Bayer computer code: XIPHAA
EPPO A1 list: No. 150
EU Annex designation: I/A1 - as a non-European population of *Xiphinema americanum sensu lato*

- ***Xiphinema bricolense***
  Name: *Xiphinema bricolense* Ebsary, Vrain & Graham
  Taxonomic position: Nematoda: Longidoridae
  Bayer computer code: XIPHBC
  EPPO A1 list: No. 260
  EU Annex designation: I/A1 - as a non-European population of *Xiphinema americanum sensu lato*
- ***Xiphinema californicum***
  Name: *Xiphinema californicum* Lamberti & Bleve-Zacheo
  Taxonomic position: Nematoda: Longidoridae
  Notes on taxonomy and nomenclature: Griesbach & Maggenti (1990) examined several populations of *X. americanum sensu stricto* and *X. californicum* and concluded that they overlapped in morphometric characters, so that the latter was a junior synonym of the former. However, the international group of taxonomists working under the auspices of EPPO was satisfied that *X. californicum* is a good species.
  Bayer computer code: XIPHCA
  EPPO A1 list: No. 261
  EU Annex designation: I/A1
- ***Xiphinema rivesi***
  Name: *Xiphinema rivesi* Dalmasso
  Taxonomic position: Nematoda: Longidoridae
  Bayer computer code: XIPHRI
  EPPO A2 list: No. 262
  EU Annex designation: I/A1 - as a non-European population of *Xiphinema americanum sensu lato*

HOSTS

X. americanum appears to be virtually non-specific with regard to host plant, having been recorded from agricultural, horticultural and forest soils. The host plants of particular quarantine significance are those to and from which *X. americanum* transmits viruses.

GEOGRAPHICAL DISTRIBUTION

X. americanum sensu lato is widespread in Canada and the USA and has also been reported from many countries in all parts of the world (Australia, Belize, Brazil, Chile, Guatemala, India, Japan, Korea Democratic People's Republic, Korea Republic, Mexico, New Zealand, Pakistan, Panama, South Africa, Sri Lanka, Uruguay), together with several countries within the EPPO region. However, the separation into new species and the recognition of a species complex makes all older reports unreliable. The following information attempts to present an up-to-date view.

- ***Xiphinema americanum sensu stricto***
  EPPO region: Absent. There is a report of the transmission of tomato ringspot nepovirus by *X. americanum sensu lato* in the former USSR (Koev *et al*., 1970), suggesting indirectly that the known vector *X. americanum sensu stricto* might be present. However, the method used to demonstrate transmission does not exclude the possibility of a 'false positive'

(Trudgill *et al*., 1983) and it is much more likely that the species concerned is *X. pachtaicum* (which is not a vector).
North America: Canada (eastern parts), USA (eastern parts).
EU: Absent.

- ***Xiphinema bricolense***
  EPPO region: Absent.
  North America: Canada (British Columbia).
  EU: Absent.
- ***Xiphinema californicum***
  EPPO region: Absent.
  North America: Mexico, USA (California) (Lamberti & Bleve-Zacheo, 1979).
  South America: Brazil, Chile, Peru.
  EU: Absent.
- ***Xiphinema rivesi***
  EPPO region: France, Germany, Portugal, Spain. It may be an introduction from North America (Lamberti & Ciancio, 1993).
  North America: USA (widespread).
  South America: Possibly present.
  EU: Present.
  Distribution map: The distribution of European populations of *X. rivesi* is illustrated by Alphey & Taylor (1986).
- **Non-vector species**
  EPPO region: All reports of *X. americanum*, other than those of *X. rivesi*, are almost certainly either *X. brevicolle* or *X. pachtaicum*. *X. brevicolle* has been reported from Bulgaria, Hungary, Israel, Italy, Poland, Romania, Russia, Slovak Republic, Spain, Switzerland, Yugoslavia, but Lamberti *et al*. (1991) have proposed that all populations in the EPPO region previously described as *X. brevicolle* should be referred to a new species, *X. taylori*. *X. pachtaicum* is present in Bulgaria, Czech Republic, Cyprus, France, Germany, Greece (including Crete), Hungary, Italy, Malta, Poland, Portugal, Romania, Russia, Spain, Switzerland, Turkey, UK, Yugoslavia. Two other species, *X. incertum* and *X. simile*, occur only in Bulgaria.
  Africa: *X. brevicolle* has been reported from Malawi, Mauritius and South Africa and *X. pachtaicum* from South Africa.
  Asia: *X. pachtaicum* has been reported from Cyprus, Iran and Jordan.
  North America: *X. pachtaicum* has been reported from USA (California). Lamberti & Bleve-Zacheo (1979) described eight other species of the *americanum* group from various localities in the USA, but little information is yet available on their distribution or biology.
  South America: *X. brevicolle* has been reported from Brazil and Peru.
  EU: Present.
  X. americanum has been and continues to be reported from many parts of the world, but these reports should be considered to refer to *X. americanum sensu lato*.

  Lamberti & Bleve-Zacheo (1979) assigned some of these records to new *Xiphinema* spp. and, in addition, other workers have described new species within the species complex. However, the precise taxonomic relationships of these populations remain to be clarified (see Identity).

  So far, none of the populations from outside North America have been shown to be virus vectors.

BIOLOGY

X. americanum sensu lato lives entirely 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 several successive layers of cells and extracting cytoplasm. Females produce eggs parthenogenetically (males being rare or absent) and, in most populations, four juvenile stages are produced; among the North American populations that transmit viruses, however, three juvenile stages only are commonly found (Brown *et al.*, 1994). The life cycle requires at least 1 year to complete. Optimum temperatures for reproduction are 20-24°C. There is no specialized survival stage and all stages have been found to survive and mature in soil in the absence of a host, but the population will not multiply. 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 the winter.

In North America, *X. americanum sensu lato* is an efficient vector of several nepoviruses, with adults and juvenile stages able to transmit virus (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 oesophagus. The virus particles are injected into the next healthy plant on which the 1966) and nematodes may transmit virus acquired up to 2 years previously (Bitterlin & Gonsalves, 1987).

The individual species involved in nepovirus transmission in North America have now been determined (Brown et al., 1994). *X. americanum sensu stricto* transmits the four main American nepoviruses: tomato ringspot nepovirus (TomRSV), tobacco ringspot nepovirus (TRSV), cherry rasp leaf nepovirus (CRLV) and peach rosette mosaic nepovirus (PRLV); *X. californicum* and *X. rivesi* transmit TomRSV, TRSV and CRLV; *X. bricolense* has only been reported to transmit TomRSV. The ability to transmit virus may vary among different populations of the same nematode species. Griesbach & Maggenti (1989) reported that, of seven populations of *X. americanum sensu lato* (probably *X. californicum*) in California (USA), two populations could transmit strains of both TomRSV and TRSV, one population could transmit only TomRSV, and four other populations failed to transmit any virus.

DETECTION AND IDENTIFICATION

Symptoms

Plants whose roots are being attacked by *X. americanum sensu lato*, in the absence of virus, generally show no clear characteristic symptoms in the aerial parts. 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. Under heavy attack, the roots show swellings close to the root tips.

When nematode feeding results in virus transmission, the characteristic symptoms of the particular virus in the crop concerned develop. These usually first appear in the aerial parts of the plant in the growing season after transmission to the roots has occurred.

Morphology

These nematodes are minute (the largest species of the group being 2.2 mm in length), soft-bodied, vermiform, nearly transparent animals. 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.

The member species of the *X. americanum* group can be readily distinguished from other *Xiphinema* spp. by the following characteristics: small body length, relatively short (usually <150 µm) stylet (odontostyle + odontophore), thick cuticular lining of the

pharynx, males usually absent, 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, males with posteriormost medioventral supplement close to the paired precloacal papillae.

The separation of the individual species within the group is difficult and still subject to controversy among specialists. Lamberti & Bleve-Zacheo (1979) provide details of many of the species, and Ebsary *et al.* (1989) provide a key to the species occurring in North America.

Detection and inspection methods

In order to determine whether nematodes are present, the soil must be subjected to a nematode extraction procedure suitable for migratory soil nematodes of length greater than 1 mm. Methods are described by Hooper (1986). After extraction, the nematodes must be examined by high-power microscopy in order to identify the species.

MEANS OF MOVEMENT AND DISPERSAL

These nematodes can live only in moist soil and in that medium can travel at most 1 m per year, unless assisted by run-off. Dispersal over longer distances would be only in moist soil transported with or without plants.

PEST SIGNIFICANCE

Economic impact

Direct damage to strawberries, fruit trees, forage legumes and forest trees has been shown in the USA, especially by response to nematicide treatment of soils where *X. americanum sensu lato* is known to be present. However, the nematode is most important as a vector of the following American nepoviruses (Taylor & Brown, 1981), which are important mainly on fruit crops.

(a) Tomato ringspot nepovirus (an EPPO A2 quarantine pest; EPPO/CABI, 1996d). Transmitted by *X. americanum sensu stricto*, *X. bricolense* and *X. californicum*, and also by *X. rivesi* (Forer & Stouffer, 1981).

(b) Tobacco ringspot nepovirus (recently added to the EPPO A2 list; EPPO/CABI, 1996c), transmitted by *X. americanum sensu stricto*, *X. californicum* and *X. rivesi*.

(c) Cherry rasp leaf nepovirus (an EPPO Al quarantine pest; EPPO/CABI, 1996a), transmitted by *X. americanum sensu stricto*, *X. californicum* and *X. rivesi*.

(d) Peach rosette mosaic nepovirus (recently added to the EPPO A1 list; EPPO/CABI, 1996b), transmitted only by *X. americanum sensu stricto*. This virus is rather less important than the first three.

Soybean severe stunt nepovirus is a relatively minor North American pathogen also reported to be transmitted by *X. americanum*.

In the EPPO region, *X. pachtaicum* and other *Xiphinema* spp. of the *americanum* group are not reported to cause any significant damage (Lamberti & Siddiqi, 1977), nor to transmit virus diseases. Even *X. rivesi*, which has been reported to transmit TomRSV in North America, has not been associated with virus transmission in Europe. The report from the former USSR on the transmission of TomRSV and of a virus causing a leaf crinkle disease in blackcurrant (Koev *et al.*, 1970) can presumably now be discounted as the methods used were subsequently shown to be open to misinterpretation (Trudgill *et al.*, 1983).

Control

Control of viruliferous nematodes in the field presents problems. Treatment of the soil with nematicides can give good control of the nematodes (over 95% control) but the nematodes that remain can still transmit virus to the roots of the crop. At best, soil treatment can slow the spread of virus through the crop. Leaving the soil free of any plant growth for over 2 years will rid the nematode population of virus.

Phytosanitary risk

X. americanum sensu lato is an A2 quarantine pest for EPPO (OEPP/EPPO, 1984), but this classification goes back to a time before the individual species were clearly distinguished. The main phytosanitary risk lies in the known potential of certain of these species to transmit the four American nepoviruses which are also quarantine pests for EPPO (see Economic impact). They could thus act as direct agents for the introduction of these viruses. If the viruses were introduced or spread in the EPPO region, introduction of the vector nematodes would create an additional phytosanitary risk of more rapid spread, and the need for more complex measures for the certification of virus-free material of fruit crops. Populations of these nematodes from outside the EPPO region, especially those from North America, could certainly establish and spread in the EPPO region.

Only *X. americanum sensu stricto*, *X. bricolense*, *X. californicum* and *X. rivesi* are known vectors of the American nepoviruses and thus qualify as quarantine pests for the EPPO region. The first three species could be considered as A1 quarantine pests, while *X. rivesi* would be an A2 pest.

Vector ability has not been reliably reported in any population of *X. americanum sensu lato* outside North America (besides the doubtful Russian record already mentioned, a population from Chile was suspected but not proved to be involved in the spread of TomRSV in plum orchards; Auger, 1989). However, because the species of the *americanum* group present in North America have still not been fully characterized for their identity, geographical distribution and vector ability, and because the ability to transmit virus is defined in relation to nematode population rather than species,, it has been argued that the phytosanitary risk for the EPPO region is presented by "North American populations of *X. americanum sensu lato*". These are besides the only ones which are liable in practice to carry the nepoviruses concerned, since the latter are mostly confined to North America (for exceptions, see EPPO/CABI, 1996a,b,c,d). So populations of *X. americanum sensu lato* from other parts of the world should not be considered to be quarantine pests for the EPPO region.

PHYTOSANITARY MEASURES

EPPO recommends (OEPP/EPPO, 1990) that soil from non-EPPO countries where *X. americanum sensu lato* occurs should be prohibited. Plants with roots may also be prohibited, but if not then precautions should be taken to ensure that the nematodes will not be carried in the roots. The field from which the plants came must have been tested and found free from the nematodes and, if the plants were in a growing medium, that must be either inorganic or have been tested, or treated against nematodes. In addition, the plants can either be bare-rooted (having had growing medium removed 2 weeks previously), or have had the growing medium changed within the previous 2 weeks, or have been kept under special conditions avoiding 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.

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