FOREST PEST SPECIES PROFILE

October 2007

Bursaphelenchus xylophilus (Steiner & Buhrer) Nickle

Other scientific names: *Aphelenchoides xylophilus* Steiner & Buhrer; *Bursaphelenchus lignicolus* Mamiya & Kiyohara
Order and Family: Tylenchida: Aphelenchoididae
Common names: pine wood nematode; pine wilt nematode; pine wilt disease

Bursaphelenchus xylophilus, the pine wilt nematode, is the causal agent of pine wilt disease. Native to North America where it is not considered a serious pest, the nematode is a major threat to Asian and European pine forests and has resulted in extensive tree mortality in countries where it has been introduced.

DISTRIBUTION

Native: North America (Canada, Mexico, US)

Introduced:
Asia and the Pacific: Japan (early 1990s, first record in 1905), Republic of Korea (1988), China (1982), Hong Kong (1999)

Europe: Portugal (1999)

IDENTIFICATION

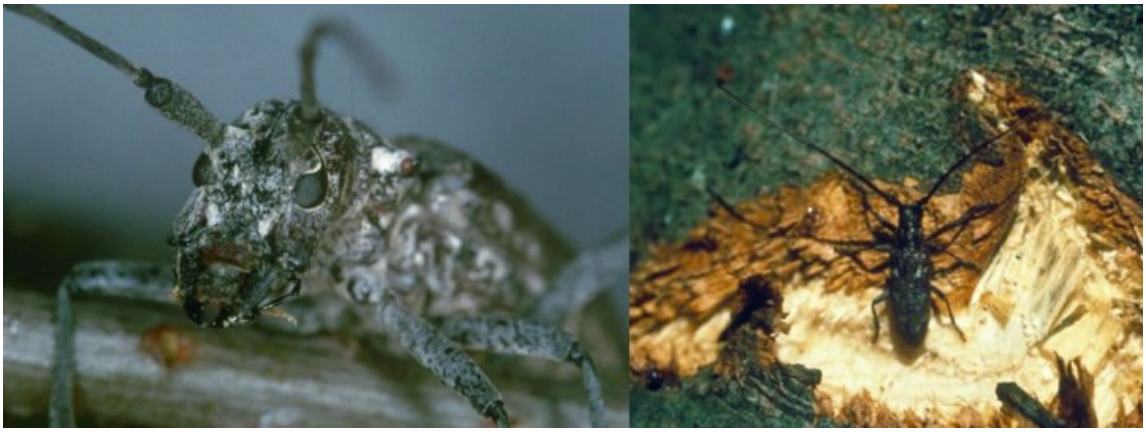
B. xylophilus shows the general characters of *Bursaphelenchus* spp. with lips high and offset, a weakly developed stylet with reduced basal knobs, well developed median bulb with a dorsal oesophageal gland opening inside (EPPO/CABI, 1997; Shi, 2005). The female's post-uterine sac is long and in males, the tail is curved ventrally, conoid and has a pointed terminus. A small bursa is situated terminally and spicules are well developed, with a prominent rostrum. Characteristics distinct to the species *B. xylophilus* include: spicules in males are flattened into a disc-like structure (the cucullus) at their distal extremity; the anterior vulval lip in the female is a distinct overlapping flap; and the posterior end of the body is rounded in nearly all females (EPPO/CABI, 1997; Shi, 2005).

HOSTS

Pinus spp. are the main hosts and the dead wood of all pines can provide substrate for nematode development. Examples of species susceptible to attack as living trees include *P. bungeana*, *P. densiflora*, *P. echinata*, *P. luchuensis* *P. massoniana*, *P. nigra*, *P. palustris* *P. pinaster*, *P. strobus*, *P. sylvestris* and *P. thunbergii* (EPPO/CABI, 1997; Diekmann *et al.*, 2002). *Larix*, *Abies*, *Picea* and *Pseudotsuga* species can also act as hosts though reports of damage are rare (EPPO/CABI, 1997).

BIOLOGY

The spread of this nematode is via wood-boring beetles in the genus *Monochamus*: *M. alternatus* in China, Korea and Japan, and *M. carolinensis*, *M. scutellatus* and *M. titillator* in North America (Diekmann *et al.*, 2002; Shi, 2005). They become infested with the nematode just before emerging as adults from diseased host trees. Adult beetles can act as vectors for thousands of nematodes. The beetles fly to healthy pines where they feed on the thin bark of twigs and shoots. The nematode enters the trees via the feeding wounds created by the beetles. They feed on fungi and multiply in the host trees. Pine wilt disease is most prevalent in warm climates as the nematode completes its life cycle in 12, 6 and 3 days at 15, 20 and 30°C, respectively (Diekmann *et al.*, 2002).



Species of *Monochamus* serve as vectors for the pine wilt nematode (Photos: Bugwood.org (L-R) - L.D. Dwinell, USDA Forest Service; J. Tomminen, University of Helsinki)

SYMPTOMS AND DAMAGE

Within host trees, the pine wilt nematodes reproduce rapidly and the infested trees show symptoms of decline approximately three weeks later (Kiritani and Morimoto, 2004). Initial symptoms appear in summer through early autumn, and include yellowing and needle wilting. Dead trees characteristically exhibit reddish-brown foliage throughout the crown. No oleoresin flows from wounds made to the trunk, branches or twigs of diseased trees which is a first indication of the presence of nematodes (Diekmann *et al.*, 2002; Kiritani and Morimoto, 2004).

Usually trees die rapidly, but in cooler areas disease development may be slower and affected trees may survive until the following year. High temperatures and low precipitation in summer can accelerate damage because of their impacts on feeding by the adult beetle vectors, the propagation of the nematode and water stress on trees (Kiritani and Morimoto, 2004). In Asia, infected trees have been noted to die within 40 days and the entire pine forest invaded by the nematode declines in 3-5 years (Shi, 2005). Kiritani and Morimoto (2004) noted that most infected trees die within a year of infection in warm temperate climatic zones.

Damage caused by the pine wilt nematode including needle discolouration, reddish crowns and stained wood (Photos: Bugwood.org (L-R) - M. Ostry, USDA Forest Service; W.M. Ciesla, Forest Health Management International; L.D. Dwinell, USDA Forest Service)

DISPERSAL AND INTRODUCTION PATHWAYS

Without their vectors, pine wilt nematodes are incapable of moving from one host tree to another. Adult vector beetles are active fliers and peak flight activity is usually about 5 days after emergence. It has been reported that the beetles are capable of flying several kilometers however in most cases, dispersal is only for a few hundred metres (EPPO/CABI, 1997).

Long-distance spread occurs with movement of vector-infested logs and other wood products (Diekmann *et al.*, 2002).

CONTROL MEASURES

Once introduced into a tree *B. xylophilus* is considered impossible to control. Therefore efforts have concentrated on prevention and a combination of silvicultural practices, such as removing dead or dying trees from the forest to help eliminate the source of further infection, and chemical control aimed at the vector beetles. Preventative measures applied in North America include avoiding the planting of non-native pines in areas where the mean summer temperature is greater than 20°C and reducing the susceptibility of trees by fertilizing and watering to avoid drought stress, promote tree health and reduce the chances of borer attack (Shi, 2005). Research on alternative control measures, such as biological control agents for the nematodes and their vectors, insect attractants, breeding of resistant *Pinus* clones and inducing resistance by inoculation of non-pathogenic strains of *B. xylophilus*, is ongoing (EPPO/CABI, 1997; Kiritani and Morimoto, 2004).

Listed as an A1 quarantine pest by EPPO, regulations have been imposed on US and Canadian shipments of unprocessed coniferous wood products since the early 1990s (EPPO/CABI, 1997). To prevent the introduction of *B. xylophilus* and its vectors EPPO recommends that coniferous plants and products should be prohibited from countries where the nematode occurs. If wood is imported, it must be heat treated to a core temperature of 56°C for 30 minutes and accompanied by a heat treatment or phytosanitary certificate. In the case of wood packing materials and particle wood, acceptable alternative treatments include kiln drying and fumigation respectively. Steam/heat treatment or fumigation with phosphine have been proposed as quarantine treatment for wood chips.

References:

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Kiritani, K. and Morimoto, N. 2004. Invasive insect and nematode pests from North America. *Global Environmental Research*, 8(1): 75-88.

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