CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Bursaphelenchus mucronatus Mamiya and Enda, 1979 pine wood nematode

Pest Rating: A

Kingdom: Animalia, Phylum: Nematoda,

Class: Chromadorea, Order: Rhabditida,

Family: Aphelenchoididae

Comment Period: 08/30/2024 through 10/14/2024

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Bursaphelenchus mucronatus* is described herein and a permanent rating is proposed.

History & Status:

Background:

The genus *Bursaphelenchus* Fuchs, 1937, includes more than 100 species found worldwide. Most are ectophoretic (carried on the outside of an organism) and found associated with dead or dying trees. They are mainly associated with *Pinus* species, although some are found with broad-leaved trees (e.g. *Quercus* spp., *Populus* spp., and *Alnus* spp.) or palms (e.g. *Cocos* spp.) (CABI, 2024). *Bursaphelenchus* species are mainly mycophagous (feeding on fungi) and are transmitted by different insect-vector species, either by maturation feeding or oviposition of the insect adults (Singh et al., 2013). Some species are plant pathogens. The insect vectors are mainly beetles, distributed in a wide range of families, including Cerambycidae, Curculionidae (including the subfamily Scolytinae), and Buprestidae (Ryss et al., 2005).

The pine wood nematodes, *Bursaphelenchus xylophilus* and *B. mucronatus*, are members of the pinewood nematode species complex. These two nematodes share many similarities in morphology, vector relationships, life cycles, and host trees, and interbreeding between the two species has been reported (Tomalak and Filipiak, 2021). *Bursaphelenchus xylophilus* is likely native to North America, is

known to be in California, and has a C-rating https://blogs.cdfa.ca.gov/Section3162/?p=8871. *Bursaphelenchus mucronatus* is likely native to Eurasia where it is widely distributed, and is now found in many European countries and Japan. There are records of *B. mucronatus* in Quebec, Canada, but it has not been found in the United States. *Bursaphelenchus mucronatus* is vectored by cerambycid longhorn beetles, also known as "sawyers", in the genus *Monochamus*.

Bursaphelenchus is a migratory endoparasite with a complex lifecycle. There are two distinct dietary phases – feeding on plants (phytophagous) and feeding on fungi (mycophagous). The nematodes enter the host pine tree when the vector beetle (*Monochamus* spp.), undergoes maturation feeding. The nematodes feed on plant cells around the cortical and xylem tissues, spreading by migrating through the tissues. This activity can lead to wilting symptoms. As the trees decline, they often undergo a secondary attack from decay fungi. The nematodes feed on the fungi that invade the tree and multiply into very large numbers.

It also has two developmental forms - propagative forms found when living inside the trees, and dispersal forms found when they move into the insect pupal chambers. In both phases, nematodes develop from an egg to an adult via three propagative juvenile phases (J1 is inside the egg) - J2, J3, and J4. When conditions inside the tree become unfavorable, the nematodes enter the dispersal phase in which the propagative J2 molts to an alternative dispersal stage -D3. In the presence of the vector beetle, D3 molts to an alternative fourth-stage dispersal juvenile -D4 (Futai, 2013).

Monochamus spp. beetles occupy the same area of the tree as the nematodes. *Monochamus galloprovincalis* is the most important vector species in Europe and Asia (Sousa et al., 2001). The D3s aggregate around the pupal chambers of the beetles and molt to the D4 only if beetles are present (Maehara et al., 1996). The D4 larvae are picked up by the adult beetles as they emerge, and they settle beneath the elytra and inside the trachea of the beetles. The nematodes can then be transmitted to new trees during oviposition or adult feeding (Li et al., 2007; Shibata and Okuda, 1989).

This nematode is not known to kill pine trees in Europe and Asia, in contrast to *B. xylophilus*. It appears to be a weak pathogen to some pine species but can be damaging to pine seedlings (Zhou et al., 2016). Inter- and intra-specific variations among isolates of the two species are observed, and the nematode strain/pine host-specific interactions are not thoroughly understood. The susceptibility of California pines under natural conditions is unknown. Variations of susceptibilities may exist between strains, varieties, sub-species, and species, and since it is not known to be in the U.S., continued regulation is reasonable (Comments of K. Dong, CDFA Nematologist (https://nematode.unl.edu/pest2.htm).

Hosts: Abies sibirica (Siberian fir), *Larix gmelinii* var. *olgensis* (Olga Bay larch), *L. sibirica* (Siberian larch), *Picea* sp. (spruce), *Picea abies* (Norway spruce), *Pinus* sp. (pine), *Pinus densiflora* (Japanese red pine), *Pinus halepensis* (Aleppo pine), *Pinus nigra* (Austrian pine), *Pinus pinaster* (maritime pine), *Pinus sylvestris* (Scots pine), *Pinus thunbergiana* (Japanese black pine) (EPPO, 2024; Nemaplex, 2010).

Symptoms: Nematode infection of trees occurs mainly via wounds made by beetles feeding on twigs. Nematodes are found in the vascular tissue of twigs, stems, and trunks. They migrate, feed, and reproduce within the resin canals and the cambium cells. In the young *Pinus* shoots, *B. mucronatus*

multiplies in the resin canals and attacks the epithelial cells. Approximately three weeks after infection, the tree shows early symptoms of 'drying out', in the form of reduced oleoresin exudation. The vascular system may become blocked by secondary resin originating from radial parenchyma cells damaged because of nematode infection. In addition, cavitation, possibly caused because of increased production of volatile defense compounds, may disrupt water transport. Tissues can be destroyed mechanically as the nematode migrates through the host (Mamiya and Enda, 1979).

Transmission: Compared to many other plant-parasitic nematodes, *Bursaphelenchus* has a complex life cycle including both an intermediate beetle vector (*Monochamus* sp.) and a primary tree host (*Pinus* sp.). Propagative nematode stages (egg to adult) live exclusively within the pine whereas the dispersal life stages are also associated with the beetle. The dispersal juveniles aggregate around the pupal chamber to wait for the beetles to pupate. Once the beetle has reached the late pupal stage or early adulthood, the nematode molts to a final dispersal stage and enters the vector beetle's tracheae system. After the beetles complete their maturation and emerge from the trees, they fly to new trees to feed on and oviposit, also transporting the nematodes (Zhao et al., 2016).

Beetles carrying nematodes and nematodes on their own can be moved with wood packing materials, logs, and wood chips, and lumber (if not kiln-dried) (Li et al., 2009; Dwinell, 2004).

Damage Potential: Bursaphelenchus mucronatus at times has been reported as a weak pathogen, a non-pathogen, a mutualist, or even a suppressor of *B. xylophilus* in some situations (Liao et al., 2014; Ryss et al., 2018; Kanzaki and Futai, 2006), but several studies indicated the contrary conclusions: that pine trees, especially seedlings could be seriously damaged to the point of mortality by *B. mucronatus* (Akbulut et al., 2014; Zhao et al., 2009; Zhou et al., 2016).

Worldwide Distribution: Asia: *China, Japan, Kazakhstan, Korea, Republic, Taiwan, Thailand*. Europe: *Armenia, Austria, Azerbaijan, Belarus, Estonia, Finland, France, Georgia, Germany, Greece, Italy, Latvia, Lithuania, Moldova, Norway, Poland, Russia, Serbia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Ukraine, Romania*. North America: *Canada.*

Official Control*: Bursaphelenchus mucronatus* is on the EPPO's A1 list for Brazil and Iran (EPPO, 2024). It is on the USDA PCIT's harmful organisms list for Brazil and Taiwan (USDA PCIT 2024).

California Distribution: none

California Interceptions: none

The risk that *Bursaphelenchus mucronatus* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Native and non-native pines are widespread in California. This nematode is likely to establish wherever its insect vector can survive.

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: **2**

- Low (1) Not likely to establish in California; or likely to establish in very limited areas.
- **Medium (2) may be able to be established in a larger but limited part of California.**
- High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** The host range includes trees in several families.

Evaluate the host range of the pest.

Score: 2

- Low (1) has a very limited host range.
- **Medium (2) has a moderate host range.**
- High (3) has a wide host range.

3) **Pest Reproductive Potential:** This nematode can reproduce rapidly, especially at high temperatures in summer. One tree can produce millions of nematodes. It relies on its insect vector to find new hosts, and the beetles can fly.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 2

- Low (1) does not have high reproductive or dispersal potential.
- **Medium (2) has either high reproductive or dispersal potential.**
- High (3) has both high reproduction and dispersal potential.

4) **Economic Impact:** The economic impact is uncertain with conflicting reports of this nematode as a pathogen only of stressed or already dying trees, a non-pathogen, a pathogen only of seedlings, or a cause of tree mortality, especially of exotic species. It is vectored by wood-inhabiting beetles.

Evaluate the economic impact of the pest on California using the criteria below.

Economic Impact: A. E

A. The pest could lower crop yield.
B. The pest could lower crop value (including increasing crop production costs).
C. The pest could trigger the loss of markets (including quarantines).
D. The pest could negatively change normal cultural practices.
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: 2

- Low (1) causes 0 or 1 of these impacts.
- **Medium (2) causes 2 of these impacts.**
- High (3) causes 3 or more of these impacts.

5) **Environmental Impact:** If this nematode becomes established, it could damage native pine trees.

Evaluate the environmental impact of the pest on California using the criteria below.

Environmental Impact: A

A. **The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes**.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening, or ornamental plantings.

Environmental Impact Score: 2

- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Bursaphelenchus mucronatus:* medium

Add up the total score and include it here. **10**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post-Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

***Evaluation is "*not established"**.

Score: 0
-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of the introduction score minus the post-entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 10***

Uncertainty:

The severity of damage from this nematode, if it were to be introduced into California forests and landscapes, is unknown. Although the main vector *Monochamus galloprovincalis* is not known to be in California, other *Monochamus* species that are present may be able to vector this nematode.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Bursaphelenchus mucronatus*** **is A.**

References:

Dwinell, L.D., 2004, January. Mitigating the pine wood nematode and its insect vectors in transported coniferous wood. In Proceedings of the Fourth International Congress of Nematology, 8-13 June 2002, Tenerife, Spain (pp. 825-835). Brill.

EPPO Database. https://gd.eppo.int/taxon/BURSMU Accessed 8/8/2024

Futai, K. 2013. Pine wood nematode, *Bursaphelenchus xylophilus*. Annual Review of Phytopathology 51, 61–83. Kanzaki, N. and Futai, K., 2006. Is *Bursaphelenchus mucronatus* a weak pathogen to the Japanese red pine? Nematology, 8(4), pp.485-489.

Li, H., 2008. Identification and pathogenicity of *Bursaphelenchus* species (Nematoda: Parasitaphelenchidae) (Doctoral dissertation, Ghent University).

Li, H., Trinh, P.Q., Waeyenberge, L. and Moens, M., 2009. Characterisation of Bursaphelenchus spp. isolated from packaging wood imported at Nanjing, China. Nematology, 11(3), pp.375-408.

Liao, S.M., Kasuga, S. and Togashi, K., 2014. Suppressive effects of on pine wilt disease development and mortality of B. xylophilus-inoculated pine seedlings. Nematology, 16(2), pp.219-227.

Mamiya, Y. and Enda, N., 1979. *Bursaphelenchus mucronatus* n. sp. (Nematoda: Aphelenchoididae) from pine wood and its biology and pathogenicity to pine trees.

Shibata, E. and Okuda, K., 1989. Transmission of the pine wood nematode, *Bursaphelenchus xylophilus* (Steiner et Buhrer) Nickle (Nematoda: Aphelenchoididae), by the Japanese pine sawyer, *Monochamus alternatus* Hope (Coleoptera: Cerambycidae), to pine twigs under laboratory conditions. Japanese Journal of Nematology, 18, pp.6-14.

Singh, S.K., Hodda, M., Ash, G.J., and Banks, N.C. 2013 Plant-parasitic nematodes as invasive species: characteristics, uncertainty, and biosecurity implications. Ann. Appl. Biol. 163, 323–350.

Sousa, E., Bravo, M.A., Pires, J., Naves, P., Penas, A.C., Bonifacio, L. and Mota, M.M. 2001. *Bursaphelenchus xylophilus* (Nematoda: Aphelenchoididae) associated with *Monochamus galloproincialis* (Coleoptera: Cerambycidae) in Portugal. Nematology, 3, 89–91

Tomalak, M. and Filipiak, A., 2021. Effects of inter‐specific crossbreeding between the invasive pine wood nematode, *Bursaphelenchus xylophilus* and native *B. mucronatus* on morphology and reproduction of the hybrid offspring. Forest Pathology, 51(2), p.e12676.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. Accessed 8/8/2024.

Zhou, L.F., Chen, F.M., Wang, J.C., Pan, H.Y. and Ye, J.R., 2016. Virulence of *Bursaphelenchus mucronatus* to pine seedlings and trees under field conditions. Forest Pathology, 46(6), pp.643-651.

Responsible Party:

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***Comment Period: 08/30/2024 through 10/14/2024**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Pest Rating: A
