Monochamus alternatus (Hope)

Coleoptera: Cerambycidae

Japanese Pine Sawyer

Host(s)	CAPS-Approved Survey Method
Major/Primary hosts *Pinus* spp. (Pine), *Pinus densiflora* (Japanese red pine), *Pinus luchuensis* (Luchu pine), *Pinus massoniana* (Masson pine), *Pinus thunbergii* (Japanese black pine), **Other hosts** *Abies* spp. (Fir), *Abies fabri* (Faber's fir), *Abies firma* (Momi fir), *Acer* spp. (Maple), *Cedrus* spp. (Cedar), *Cedrus deodora* (Deodar cedar)*, *Cryptomeria* spp. (Japanese cedar)*, *Cunninghamia sinensis*, *Fagus* spp. (Beech), *Ginkgo* spp. (Ginkgo), *Ginkgo biloba* (Ginkgo), *Juniperus* spp. (Juniper)*, *Larix* spp. (Larch), *Larix leptolepis* (Japanese Larch), *Larix gmelinii* (Dahurian larch), *Larix kaempferi* (Japanese larch), *Liquidambar* spp. (Sweetgum), *Malus* spp. (Apple), *Metasequoia* spp. (Dawn redwood)*, *Picea* spp. (spruce), *Picea abies* (Common spruce), *Picea asperata* (Dragon spruce), *Picea smithiana* (West Himalayan spruce), *Pinus banksiana* (Jack pine), *Pinus bungeana* (Lace bark pine), *Pinus echinata* (Shortleaf pine), *Pinus elliottii* (Slash pine), *Pinus engelmannii* (Apache pine), *Pinus greggii* (Gregg's pine), *Pinus kesiya* (Khasya pine), *Pinus koraiensis* (Fruit pine),	Monochamol, ethanol, and ultra-high release alpha-pinene in a multi-funnel trap.

Pinus leiophylla (Smooth-leaved pine), *Pinus nigra* (Black pine), *Pinus oocarpa* (Ocote pine), *Pinus palustris* (Longleaf pine), *Pinus parviflora* (Japanese white pine), *Pinus pinaster* (Maritime pine), *Pinus ponderosa* (Ponderosa pine), *Pinus radiata* (Radiata pine), *Pinus strobus* (Eastern white pine), *Pinus taeda* (Loblolly pine), *Pinus taiwanensis* (Taiwan pine), *Pinus yunnanensis* (Yunnan pine), (EPPO, 2007; Davis et al., 2008) *Hosts are questionable (Davis et al., 2008)	

Reason for Inclusion in Manual

Monochamus alternatus was a target species in the original EWB/BB National Survey Manual.

Pest Description

Eggs:

"Eggs are about 4 mm [approx. $^{3}/_{16}$ in] long, milk white in color and sickle shaped" (Ciesla, 2001).

Larvae:

"Larvae are white, opaque legless grubs, averaging 43 mm [approx. 1 $^{11}/_{16}$ in] in length when mature with an amber colored head capsule and black mouthparts" (Ciesla, 2001).

Pupae:

"Pupae are white, opaque and cylindrical, 20-26 mm [approx. $^{13}/_{16}$ to 1 in] long" (Ciesla, 2001).

Adults:

"Adults are 15 to 28 mm [approx. $^{9}/_{16}$ to 1 $^{1}/_{8}$ in] in length and range from 4.5-9.5 mm [approx. $^{3}/_{16}$ to $^{3}/_{8}$ in] wide. Females are larger than males but males have longer antennae. Males have antennae 2x the body length and females have antennae 1.3x the body length. The base part of the first, second and third antennal segments have grayish hairs. There are two orange stripes on the protergum, interlaced with three narrower black stripes. The elytra have five longitudinal bands of black and gray rectangular spots" (Ciesla, 2001).

For a more detailed description, as well as information on the pest's biology and ecology, see the Pine Commodity-based Survey Reference.

M. alternatus pupa (Jijing Song and Juan Shi, Beijing Forestry University,

M. alternatus adult (Pest and Diseases Image Library, Bugwood.org)

M. alternatus adult (Pest and Diseases Image Library, Bugwood.org)

Biology and Ecology

In Japan, adult emergence can begin in mid-April to late June, depending on weather conditions. Emergence lasts about 2 months. Adults disperse and locate suitable host material for maturation feeding. Adults can often move 800 m (0.5 mi) when dispersing with a max distance of about 33 km (20.5 mi) (reviewed in Kobiashi et al., 1984).

Adults are attracted to host volatiles including monoterpenes and ethanol (Ikeda and Oda, 1980; Ikeda et al., 1980). Adults initially feed on current and first year growth and will feed on older material as they age. Adults are attracted to both recently diseased trees and fresh logs. Feeding occurs during the day while mating and oviposition occur at night. Mating occurs around 10

days after emergence. Females then lay eggs singly in oviposition scars. Females lay an average of 60 to 109 eggs on the tree bark (reviewed in Kobiashi et al., 1984).

Eggs hatch in 6 to 9 days. Larvae molt multiple times (4 times in the field, up to 9 in the lab) and feed on the sapwood and phloem tissues of the host plant (reviewed in Kobiashi et al., 1984). Overwintering occurs in the larval stage in wood galleries (Ciesla, 2001). Larvae take 625 degree days to complete development above 12.5°C (54.5°F). Mature larvae construct a pupal chamber, plugging the opening with wood borings. The pupal stage lasts 17 to 19 days, while the callow adult stage lasts 6 to 8 days (reviewed in Kobiashi et al., 1984). Adults emerge from rounded exit holes (Ciesla, 2001).

This species usually has one generation per year, although sometimes one generation may take two years to complete (reviewed in Kobiashi et al., 1984).

Countries of Origin

Ciesla (2001) states that this species is indigenous to China (including Taiwan) and also Korea, Laos, and Japan.

Current Distribution

This species is present in: China, Hong Kong, Japan, Korea, Laos, Taiwan and Vietnam (Ciesla, 2001; EPPO, 2007; EPPO, n.d.).

Distribution in United States

M. alternatus is not known to occur in the United States. No positive data has been recorded in NAPIS for this pest (K. Handy, personal communication, 2009). However, infested wood crating was found with live adults in a warehouse in Western New York in 1998 (Anonymous, n.d.).

Pathway

According to AQAS data, most interceptions of *M. alternatus* have occurred in general cargo with a few occurring in permit cargo. Most interceptions were also found on wood products including wood, crating and dunnage (AQAS, accessed October 10, 2009). Eggs, larvae, and pupae) can be transported in "unprocessed logs, wooden crating, pallets and dunnage" (Ciesla, 2001).

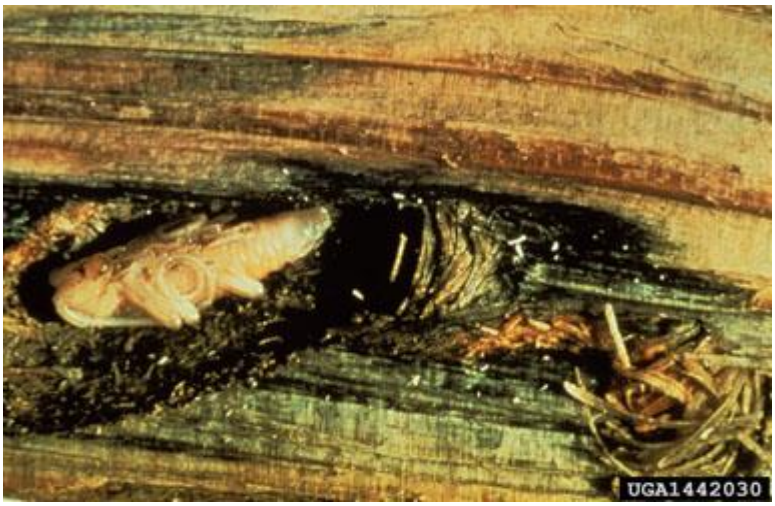
Pathogens Vectored

M. alternatus is a vector of the pine wood nematode, *Bursaphelenchus xylophilus*. *B. xylophilus* is indigenous to North America and is not known to be pathogenic to conifers in its native range (reviewed in CABI/EPPO, 1997; reviewed in Ciesla, 2001; Cram and Hanson, 2004). *M. alternatus* also vectors *B. mucronatus* and *B. kolymensis*. These nematodes are native to Asia

and are not known to occur in North America. The pathogenicity of these and other Eurasian nematode species to North American pines is not currently known (reviewed in Ciesla, 2001).

Damage

External signs of infestation include round emergence holes ~9 mm (approx. $^1/_3$ in) in diameter and oviposition scars on the bark. Inside a tree, larvae construct S-shaped and vertical galleries packed with frass and shredded wood. Larvae also create small slits in the bark through which the frass mixture is expressed. Prior to pupation, final-instar larvae make oval-shaped holes which they may plug with wood borings. Pupal chambers are U-shaped and are found in the xylem. All life stages may be present under the bark and mature adults can be found feeding on the bark of stressed trees and recently cut logs (reviewed in Kishi, 1995; CABI/EPPO, 1997; reviewed in Ciesla, 2001; Cram and Hanson, 2004; reviewed in CAB, 2005).



Pupal chamber and pupa in wood (USDA-APHIS- Rocky Mountain Region Archive, USDA-APHIS, Bugwood)

M. alternatus is a major vector of the pine wood nematode *Bursaphelenchus xylophilus*, which transmits the bacterium *Pseudomonas* sp., a causal agent in pine wilt disease in Asia. Pine wilt disease caused by *B. xylophilus* is characterized by decreased resin production, chlorosis, and wilting of needles. Chlorosis and wilting may initially occur on a single branch and then spread to the rest of the tree (reviewed in CABI/EPPO, 1997). Tree decline and death can occur in heavily infected trees in one growing season; crowns of infected trees turn from green to reddish-brown (Mamiya, 1988).

Maturation feeding on *Pinus massoniana* (William M. Ciesla, Forest Health Management International, Bugwood.org)

Exit hole (Jijing Song and Juan Shi, Beijing Forestry University, Bugwood.org)

Survey

1.1 Survey Site Selection

Identify known or prospective hosts of *M. alternatus* and follow the general instructions on **General Site Considerations for Trap Placement** in the manual section **Planning a Survey.**

1.2 Trap and Lure

The CAPS-approved survey method for *M. alternatus* is a choice of two lure combinations in a multi-funnel trap (Fan et al., 2007).
The two lure options are:

Option 1) ethanol and ultra-high release alpha-pinene, or
Option 2) monochamol, ethanol, and ultra-high release alpha-pinene

Alpha-pinene is a host volatile released by pine trees. It is a generic attractant for many pine-attacking wood-borers and bark beetles. Ethanol is released by microorganisms in decaying woody tissue and is used by insects to locate stressed trees (Byers, 1992).

11/21/13: The combination of alpha pinene, ethanol, and the pheromone "monochamol" has been added as an approved method. This combination has been shown to be more effective than just alpha pinene and ethanol. Monochamol is the name given to 2- (undecyloxy) -ethanol, the male-

produced pheromone of *Monochamus galloprovincialis*, a congener of *M. alternatus* (Teale et al., 2011).

For the 2014 season, either combination may be used. In 2015, the approved method will only be the combination of alpha pinene, ethanol, and monochamol.

The release rates of these lure are highly temperature-dependent. However, CAPS has listed a conservative length of effectiveness that will be effective for even the warmest climates in the CAPS community. The ethanol and ultra-high release alpha-pinene lures are both effective for eight weeks; the monochamol lure is effective for four weeks.

IPHIS Survey Supply Ordering System Product Names:

1) Alpha Pinene UHR Lure
2) Ethanol Lure
3) Monochamol Lure
4) Multi-funnel Trap, 12 Funnel, Wet or
5) Multi-funnel Trap, 8 Funnel, Wet

There are two alpha pinene products available in the IPHIS Survey Supply Ordering System: 1) Alpha Pinene Lure and 2) Alpha Pinene UHR Lure. The Alpha Pinene Lure is an un-gelled lure in a bottle dispenser that is used by the PPQ Program for *Tomicus piniperda* (pine shoot beetle). This lure should only be used for the program survey.

The Alpha Pinene UHR Lure is a polysleeve, ultra-high release dispenser used for other EWB/BB targets. This lure should be used with the Ethanol Lure for the following two EWB/BB targets: *Monochamus alternatus* and *Tomicus destruens*.

1.3 Trap Placement

Follow the general instructions on **Trap Placement** and **Trap Setup** for multi-funnel traps in the manual section **Conducting a Survey**.

1.4 Time of year to survey

In Japan, *M. alternatus* requires one or two years to complete its life cycle. In central Japan, adults emerge between May and late July (CABI, 2007; Togashi and Magira, 1981). In sub-tropical China, the insect can complete two to three generations per year (CABI, 2007). In bivoltine populations, overwintering adults emerge between April and May and the first-generation adults emerge between July and August; in trivoltine populations, the three generations emerge from March through November (CABI, 2007).

Identification

CAPS-Approved Method

Morphological.

Mistaken Identities

M. alternatus could be confused with other *Monochamus* species. *Monochamus carolinensis* and *Monochamus titillator* are similar-looking species that are present in the United States and there are many other native *Monochamus* species.

Resources and High Resolution Images

Images
http://www.forestryimages.org/browse/subthumb.cfm?sub=4532&Start=1&display=60&sort=2

Pest's biology and ecology
Pine Commodity-based Survey Reference
http://caps.ceris.purdue.edu/survey_manuals

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Revisions

April 2005:
Removed option of ethanol + AP.
Added note about change to panel traps for 2016.

July 2016:
NAPPFAST map removed.