Monochamus saltuarius (Gebler)

Coleoptera: Cerambycidae

Sakhalin pine sawyer

Host(s)	CAPS-Approved Survey Method
Major/Primary hosts *Larix kaempferi* (Japanese larch), *Picea abies* (Norway spruce), *Picea asperata* (Dragon spruce), *Pinus densiflora* (Japanese umbrella pine), *Pinus parviflora* (Japanese white pine), *Pinus thunbergii* (Japanese black pine) **Other hosts** *Abies* spp. (Fir), *Abies alba* (Silver fir), *Abies holophylla* (Manchurian fir), *Abies nephrolepis* (Khingan fir), *Abies sibirica* (Siberian fir), *Cryptomeria japonica* (Japanese cedar), *Larix* spp. (Larch), *Larix gmelinii* (Dahurian larch), *Larix leptolepis* (Japanese larch), *Larix sibirica* (Russian larch), *Picea* spp. (Spruce), *Picea jezoensis* (Yeddo spruce), *Picea koraiensis* (Korean spruce), *Picea obovata* (Siberian spruce), *Pinus* spp. (Pine), *Pinus banksiana* (Jack pine), *Pinus nigra* (Corsician pine), *Pinus sibirica* (Siberian pine), *Pinus sylvestris* (Scots pine), *Tsuga sieboldii* (Japanese hemlock) (USDA Forest Service, 1991; Togashi et al., 1994; Jikumaru and Togashi, 1995; Nakayama et al., 1998; Anonymous, 2001; CABI, 2010; Ciesla, 2001; Cesari et al., 2005)	Visual

Reason for Inclusion in Manual

Monochamus saltuarius was added to the manual in 2010. *Monochamus saltuarius* is a target pest on the FY2011 AHP Prioritized Pest List.

Pest Description

Eggs:

Eggs are white and are 3 to 3.5 mm (approx. $^1/_8$ in) long and 0.8 to 1.2 mm (>$^1/_{16}$ in) wide; they are either almost parallel sided or tapered slightly towards one end (Cherepanov, 1990). The ends of the eggs are rounded (Cherepanov, 1990).

Larvae:

Larvae are legless, cylindrical and elongate with an oval head (CABI, 2010). Late instar larvae range from 20 to 28 mm (approx. $^3/_4$ to 1 $^1/_8$ in) long with a head width of 3.5 to 4.0 mm (approx. $^1/_8$ in) (Cherepanov, 1990). The head is flat and partially covered by the prothorax (Cherepanov, 1990).

"Epistoma in anterior half reddish-rust, barely convex; in posterior half, bright, flat, at anterior margin laterally with three long bristles on each side of the longitudinal suture with a pair of staggered bristles (inner bristle slightly in front of lateral), near antennal socket with three bristles in transverse row, on disk with two bristles in transverse row" (Cherepanov, 1990).

"Labrum somewhat rusty, highly tapering towards the base, at anterior margin broadly rounded, in anterior half with long rusty bristles, in posterior half glabrous, medially with pair of long wide-set bristles. Mandibles black, elongate, gently sloping apically" (Cherepanov, 1990).

Diapausing larvae turn from milky white to yellowish-white, whitish-yellow or yellow (Togashi et al., 1994).

The larval stages of *M. saltuarius* and *M. alternatus* can be distinguished through expert examination (CABI, 2010).

Pupae:

The pupae are milky-white and 14 to 20 mm (approx. $^9/_{16}$ to $^{13}/_{16}$ in) long; the width of the abdomen is 4.5-4.8 mm (approx. $^3/_{16}$ in) (Cherepanov, 1990). "[The pupae are] characterized by a large number of spinules in the frontal region and long, large sclerotized spinule at the apex of the urogomphus. Head medially with deep longitudinal trough, lateral to it in front of antennae with numerous long setiform spinules forming broad, longitudinal field, at anterior margin near base of clypeus with six spinules forming transverse row interrupted medially, occiput glabrous, lustrous. Labrum elongate apically broadly rounded, in anterior half along margins with long acicular spinules. Upper ocular lobe with two bristles. Antennae in second half bent ventrad, here spiralled, forming two incomplete (female) or two complete loops (male)" (Cherepanov, 1990).

"Abdomen moderately elongate, gradually tapering towards tip. Abdominal tergites in posterior half convex in anterior half transversely depressed, medially with longitudinal groove, lateral to it in posterior half with rusty acicular spinules directed backward and forming dense transverse

band divided by median longitudinal groove. Two-three rows of spinules observed in each transverse band. Tergite VII is convex, lustrous, triangular, gently rounded apically, in posterior third with solitary minute, sometimes barely perceptible, setiform spinules. Tergite VIII semi-circular, convex, lustrous, and without spinules. Urogomphus at the tip of abdomen is highly extended, terminating in long large, slightly anteriorly curved, sclerotized spinule. Ridges bordering the tip of the abdomen laterally (ventral view) with two-five minute setigerous spinules on the ventral side. Valvifers of female spherical, basally slightly wide-set, apically with small tubercle, bent towards each other" (Cherepanov, 1990).

Adults:
"Length [of the adult is] 11-20 mm [approx. $^{7}/_{16}$ to $^{13}/_{16}$ in]; body predominantly black; head with sparse yellowish-grey pubescence; pronotum and elytra in both sexes with numerous yellowish or whitish spots; legs and first antennal segments partly with grey spots; antennal segments 3 to 11 in male, uniformly black; in female basal halves of these segments with whitish-grey pubescence, antennae long" (Bense, 1995).

"Elytra parallel-sided (male) or from base slightly enlarged posteriorly (female), apically separately rounded… Abdominal sternite V short, apically emarginate, at posterior angles with long dense hairs forming a cluster on each side (female) or rounded, with uniform brownish bristles (males)..." (Cherepanov, 1990).

Monochamus saltuarius adult (Cyorgy Csoka, Hungary Forest Research Institute, Hungary, Bugwood.org)

Biology and Ecology

This species has a similar life history to other *Monochamus* species (Ciesla, 2001). These beetles are indigenous to temperate regions and usually attack stressed or recently killed hosts (Ciesla, 2001). This species usually has one generation per year, although it may take up to two years in some areas (Ciesla, 2001).

Both mating and oviposition occur at night (Davis et al., 2008). After mating occurs, eggs are laid in slits cut in the bark by females (Ciesla, 2001).

Larvae initially feed in the phloem but later tunnel into the sapwood and heartwood (Ciesla, 2001) and go through four instars (Davis et al., 2008). The larvae overwinter in the final instar (Davis et al., 2008; Togashi et al., 1994).

Pupation occurs in a pupal cell in the wood and emergence occurs when adults chew a round exit hole through the wood and bark from the pupal cell (Edmonds et al., 2000).

Under laboratory conditions, Jikumaru et al. (1994) found that adult females survived from 3 to 80 days with an average of 47.8 days at 25°C (77°F). The mean preoviposition rate was approximately 11 days at 25°C (77°F) while Nakayama et al. (1998) found it to be 16 days at 20°C (68°F). Mean ovipositions was approximately 42 days at 25°C (77°F) (Jikumaru et al., 1994) and approximately 12 days at 20°C (68°F) (Nakayama et al., 1998). Females produced an average of 70 eggs at 25°C (77°F) with the range being 0 to 172 (Jikumaru et al., 1994). There was no significant difference found in the mean longevity between males and females (Nakayama et al., 1998). Adult emergence was found to take approximately 183 to 244 degree days above 10°C (50°F) (Jikumaru and Togashi, 1995; Togashi et al., 1994).

Adults undergo maturation feeding before mating takes place, feeding on the bark of tender young shoots mainly during the day (Davis et al., 2008; Ciesla, 2001). These species maturation feed on healthy hosts although oviposition usually occurs on stressed trees (Hanks, 1999). The spread of nematodes vectored by *Monochamus saltuarius* occurs during maturation feeding (Ciesla, 2001). Adults are strong fliers and may be aided by wind to disperse several kilometers although most do not disperse that far (Davis et al., 2008; Ciesla, 2001).

Countries of Origin

M. saltuarius was first described from a specimen from Western Siberia (CABI, 2010).

Current Distribution

M. saltuarius is currently distributed in Austria, Belarus, Bosnia and Herzegovina, China, Croatia, Czech Republic, Estonia, Germany, Hungary, Italy, Japan, Korea, Latvia, Lithuania, Mongolia, Poland, Romania, Russia, Slovakia, Slovenia, Switzerland, and Ukraine (USDA-APHIS, 2010).

Distribution in United States

M. saltuarius is not known to occur in the United States.

Pathway

Solid wood packing material may serve as a pathway for the spread of this insect. Plant parts that may conceal the pest include bark (eggs); stems, shoots, trunks and branches (eggs, larvae, pupae, adults); and wood (larvae, pupae, adults) (CABI, 2010).

Pathogens Vectored

This genus has been recognized as the main vector of *Bursaphelenchus xylophilus*, a phytoparasitic nematode (Kobayashi et al., 1984; Ciesla, 2001). This pathogen is native to North America and does not damage native conifers (Ciesla, 2001). However, it has caused extensive mortality to several indigenous pines abroad, especially in Japan and China where it is spread by *M. alternatus* (Evans et al., 1996).

Monochamus species may also vector the nematodes *B. mucronatus* and *B. kolymensis*. Although it is not known to cause extensive mortality on hosts (*Abies*, *Larix* and *Pinus* spp.) in its native range of Siberia, it has the potential to become pathogenic to North American conifers if introduced with an exotic *Monochamus* spp. (USDA Forest Service, 1991).

Damage

In its native range, *M. saltuarius* is a pest of *Abies* spp., *Larix* spp., *Picea* spp. and *Pinus* spp. that are either dying or recently felled (Davis et al., 2008). This pest can reduce quantities of timber and wood product values (Ciesla, 2001).

Symptoms caused by *M. saltuarius* are similar to other *Monochamus* spp. Adults cause round emergence holes, oviposition scars on the bark and damage on the bark of shoots by maturation feeding (Davis et al., 2008). Galleries are packed with a mixture of frass and shredded wood. This mixture can be expelled through small slits in the bark produced by larvae (Davis et al., 2008). Oval shaped pupal chambers can be found in the xylem where they can be plugged with wood shavings (Davis et al., 2008).

Damage caused by *Monochamus saltuarius* (Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org)

Characteristics of pine wilt disease caused by certain nematodes spread by *M. saltuarius* includes chlorosis, wilting, and decreased resin production (reviewed by CABI/EPPO, 1997). The crowns can also turn reddish-brown in infected trees and death of the tree can occur within one growing season (Mamiya, 1988). It is important to note that there are many biotic and abiotic factors that can cause similar damage as *M. saltuarius* so do not rely on these symptoms exclusively when looking for *M. saltuarius* (Ciesla, 2001, CABI, 2005).

Survey

CAPS-Approved Method

The CAPS-Approved survey method is visual inspection. There are no known attractants for *M. saltuarius*.

Survey hosts for signs of damage: oviposition scars and round to oval adult exit holes; dead shoots, resulting in reddish-brown foliage, from adult feeding (Davis et al., 2008). This type of damage can be caused by other biotic and abiotic factors (Davis et al., 2008). Identification of insect life stage is necessary for reporting positive data. Remove bark and inspect for "larval galleries packed with frass and wood shreds," U-shaped pupal chambers, and insect life stages (Davis et al., 2008).

When looking for damage on trees, pay attention for oviposition sites (narrow slits in bark), frass filled boring tunnels and round or slightly oval adult exit holes (Ciesla, 2001). Also look for dead tips that are reddish-brown from adult maturation feeding (Ciesla, 2001). Pupal chambers are U-shaped and when pressure is applied over galleries, the bark will depress (Ciesla, 2001, CABI, 2005).

It should be noted that symptoms are identical to those caused by native *Monochamus* species (Ciesla, 2001).

Time of year to survey
Depending on climate, adults emerge in the spring or early summer (Davis et al., 2008).

Identification

CAPS-Approved Method
Morphological. Morphological characters should be examined by a well-trained taxonomist with expertise on the Cerambycidae family. The larval stage of *M. saltuarius* can only be distinguished from *M. alternatus* by expert examination (CABI, 2010).

A key to differentiate adults, larvae and pupae of certain *Monochamus* spp. (including *M. saltuarius* and *M. sutor*) can be found in Cherepanov (1990).

Mistaken Identities
This pest is similar to *Monochamus carolinensis* and *M. titillator* in addition to many other native *Monochamus* species.

Resources and High Resolution Images

Pine Commodity-based Survey Reference:
http://caps.ceris.purdue.edu/survey_manuals

Images:
http://www.forestryimages.org/browse/subimages.cfm?SUB=4060

References

Anonymous, 2001. Illustrations of tree diseases, tree insect pests in Hokkaido: *Monochamus saltuarius*. Hokkaido Research Center, Forestry and Forest Products Research Institute, Incorporated Administrative Agency, Entomology Laboratory. Accessed March 1, 2010, from: http://www.ffpri-hkd.affrc.go.jp/group/konchu/Zukan/HTML/Coleo_Kamikiri-e.htm

Bense, U. 1995. Longhorn Beetles, Illustrated Key to the Cerambycidae and Vesperidae of Europe. Margraf Verlag, Germany. 512 pp.

CABI. 2005. *Monochamus saltuarius*. Crop Protection Compendium.

CABI. 2010. *Monochamus saltuarius*. Crop Protection Compendium. Accessed March 1, 2010 from: http://www.cabi.org/compendia/cpc/

CABI/EPPO, 1997. Quarantine Pests for Europe, 2nd Ed. CAB International, Wallingford, UK.

Cesari, M., O. Marescalchi, V. Francardi and B. Mantovani. 2005. Taxonomy and phylogeny of European *Monochamus* species: first molecular and karyological data. Journal of Zoological Systematics and Evolutionary Research 43(1): 1-7.

Cherepanov, A. I. 1990. Cerambycidae of northern Asia. Vol. 1 & 3, I. E. J. Brill, New York.

Ciesla, W. M. 2001. Exotic Forest Pest Information System for North America: *Monochamus saltuarius*. North American Forest Commission.

Davis, E. E., E. M. Albrecht, and R. C. Venette. 2008. Pine Commodity-based Survey Reference. USDA-APHIS.

Edmonds, R. L., J. K. Agee, R. I. Gara. 2000. Forest Health and Protection. McGraw-Hill. Boston, Massachusetts.

Evans, H. F., D. G. McNamara, H. Braash, J. Chadoeuf and C. Magnusson. 1996. Pest risk analysis (PRA) for the territories of the European Union (as PRA area) on *Bursaphelenchus xylophilus* and its vectors in the genus *Monochamus*. Bulletin OEPP/EPPO Bulletin 26: 199-249.

Hanks, L. M. 1999. Influence of the larval host plant on reproductive strategies of cerambycid beetles. Annual Review of Entomology 44: 483–505.

Jikumaru, S., K. Togashi, A. Taketsune, F. Takahashi. 1994. Oviposition biology of *Monochamus saltuarius* (Coleoptera: Cerambycidae) at a constant temperature. Applied Entomology and Zoology 29(4): 555–561.

Jikumaru, S. and K. Togashi. 1995. Effect of temperature on the post-diapause development of *Monochamus saltuarius* (Gebler) (Coleoptera: Cerambycidae). Applied Entomology and Zoology 31: 145-148.

Kobayashi, F., A. Yamane, T. Ikeda. 1984. The Japanese pine sawyer beetle as the vector of pine wilt disease. Annual Review of Entomology 29:115-135.

Mamiya, M. 1988. History of pine wilt disease in Japan. *Journal of Nematology*. 1988, 20: 219-226.

Nakayama, Y., S. Jikumaru and K. Togashi. 1998. Reproductive traits and diel activity of adult *Monochamus saltuarius* (Coleoptera: Cerambycidae) at two different temperatures. Journal of Forest Research 3: 61-65.

Togashi, K., S. Jikumaru, A. Taketsune and F. Takahashi. 1994. Termination of larval diapauses in *Monochamus saltuarius* (Coleoptera: Cerambycidae). Journal of Japanese Forestry Society 76(1): 30-34.

USDA-APHIS. 2010. New Pest Response Guidelines for Wood-boring and Bark Beetles. USDA-APHIS-PPQ-Emergency and Domestic Programs- Emergency Planning, Riverdale, Maryland.

USDA Forest Service. 1991. Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East. Miscellaneous Publication No. 1495.