

EPPO Datasheet: *Monochamus marmorator*

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IDENTITY

Preferred name: *Monochamus marmorator*

Authority: Kirby

Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta:
Coleoptera: Cerambycidae

Common names: balsam-fir sawyer

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EPPO Categorization: A1 list

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EPPO Code: MONCMR

Notes on taxonomy and nomenclature

Monochamus marmorator was first described by Kirby from a specimen from 54°N in Canada in 1837. A number of other names were used for the same species in the 19th and 20th centuries, but the original name is the preferred name.

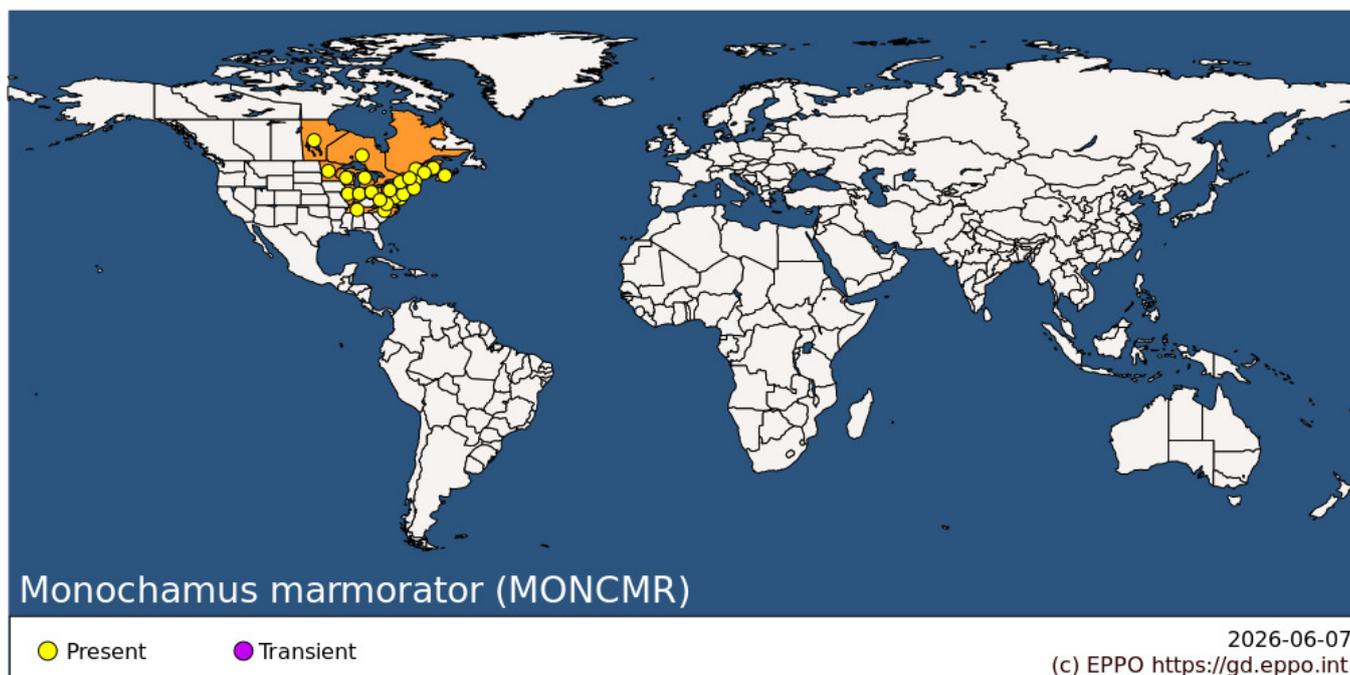
HOSTS

M. marmorator has a limited host range with only two recorded hosts, *Abies balsamea* and *Picea rubens*. Neither species is widely grown in Europe. Miller *et al.* (2013) set up multiple baited and unbaited traps in mature pine stands at 16 locations across North America. *M. marmorator* was the only one of the eight North American *Monochamus* species that was not caught, and it is the only one that does not have pine as a known host.

Host list: *Abies balsamea*, *Abies*, *Picea rubens*, *Picea*

GEOGRAPHICAL DISTRIBUTION

M. marmorator breeds in *Abies balsamea* (balsam fir) in Eastern Canada and the North-Eastern States of the USA, west to the Great Lakes region and south to North Carolina (Baker, 1972). *M. marmorator* is found throughout Eastern North America (Miller *et al.*, 2013). There are no records of *M. marmorator* becoming established outside of its native range.



North America: Canada (Manitoba, New Brunswick, Nova Scotia, Ontario, Québec), United States of America (Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, Vermont, Virginia, West Virginia, Wisconsin)

BIOLOGY

M. marmorator larvae tunnel extensively through the wood of moribund balsam fir (*Abies balsamea*) trunks, frequently passing through patches of wood decayed by white rot fungi. The larvae of *M. marmorator* need enzymes that are produced by fungi in order to digest the cellulose of host trees. Kukor and Martin (1986) found that cellulases from *M. marmorator* larvae that were fed on a fungus free diet lacked cellulolytic activity and were unable to digest cellulose, but cellulolytic activity could be restored by feeding the larvae wood permeated by fungi.

The following text is generic to *Monochamus* spp. from the Eastern United States. The larvae are commonly known as ‘sawyers’ because of the loud noise they make while feeding. Freshly cut, felled or dying trees or trees that recently died, are preferred. Recently felled trees are particularly attractive to *M. marmorator* (Baker, 1972). Young larvae feed on the inner bark, cambium and outer sapwood, forming shallow excavations called surface galleries and filling them with coarse fibrous borings and frass. As they grow older, they bore deep into the heartwood, and then turn around and bore back towards the surface, thereby forming a characteristic U-shaped tunnel. A pupal cell is formed at the outer end of the tunnel, from which the adult emerges by chewing a hole through the remaining wood and bark. Full-grown larvae are often more than 50mm long (Baker, 1972). After emergence, *Monochamus* spp. adults need to feed on the living bark of young twigs for sexual maturation. This phase is obligatory before oviposition. There is a wide between- and within-species variation in adult longevity, from ca. 1 month to ca. 5 months (EFSA, 2018). Generally, the life cycle is 2 years although in some years it is only one. Because of the overlapping generations, the adults are found each year and may be more abundant in some years depending on the availability of host material and habitat conditions.

Miller (1986) studied the impact of excluding *Monochamus* spp. from freshly cut bolts (sections of a log) of *Pinus taeda* on other insects. The presence of *Monochamus* spp. significantly reduced the number of emerging *Ips calligraphus* (Coleoptera: Curculionidae), *Platysoma cylindricum* (Coleoptera: Histeridae) and *Medetera bistriata* (Diptera: Dolichopodidae). Although *M. marmorator* is not known to be a pest of *Pinus* this demonstrates that reducing *Monochamus* sp. populations could lead to increased populations of other damaging species, and this may also be applicable on the hosts of *M. marmorator*.

M. marmorator is thought to be a vector of pinewood nematode, *Bursaphelenchus xylophilus* (Zhang *et al.*, 2007). Dauer larvae of pine wood nematode, *Bursaphelenchus xylophilus* have been found in association with of *M. marmorator*

on *Abies balsamea* in Minnesota (Wingfield & Blanchette, 1983). Blatt *et al.* (2019) collected *Monochamus* spp. from Christmas tree (*Abies balsamea*) plantations in Nova Scotia. *B. xylophilus* was recovered from the three *Monochamus* spp. that were caught: *M. marmorator*, *M. notatus* and *M. scutellatus*.

DETECTION AND IDENTIFICATION

Symptoms

The following signs and symptoms may be seen in wood infested with *Monochamus* spp. (Wilson, 1975):

1. Slits chewed by adult female for egg laying in the bark, although only a minority of these may have eggs in them
2. Scoring in the xylem and phloem caused by larval feeding
3. Frass – the waste expelled by feeding larvae from trees
4. Oval shaped holes made by larvae as they bore deeper into sap wood
5. Circular exit holes created by adults

Morphology

The description of juvenile stages below is generic to *Monochamus* species.

Eggs

Monochamus spp. eggs are white, elongate, cylindrical and slightly flattened, with rounded ends (Akbulut *et al.*, 2017). They are about 3 mm long and 1 mm in diameter.

Larvae

Monochamus spp. young larvae are soft-bodied, elongate, and dirty white in colour, with a light yellow thorax and an amber brown head. The final instar larvae have 10 abdominal segments, and the length of mature larvae is between 25 and 50 mm (Akbulut *et al.*, 2017). *Monochamus* spp. larvae can be identified using DNA barcoding, but it has not been validated for all species (EFSA, 2018).

Pupae

Monochamus spp. pupae resemble the adults with reduced wings, legs, antennae and mouthparts clearly visible. They are about 1.5-3 cm long.

Adults

M. marmorator adults are noted to be dark brown and marbled with irregular bands of white and yellow (Baker, 1972).

Linsley and Chemsak (1984) give a description of adult *M. marmorator*:

‘Male: Form moderate sized, tapering posteriorly, integument brownish to fuscous, legs head and pronotum usually dark; pubescence recumbent fulvous and whitish. Head with front shallowly convex, finely shallowly punctate, densely clothed with fulvous recumbent pubescence; genae short, slightly convergent; antennae extending about four segments beyond elytra, basal segments minutely, densely punctate, not aspirate, segments clothed with minute depressed pubescence, segments three to six with apical sensory areas. Pronotum about as long as broad, lateral tubercles prominent, bunt at apices; apical and basal transverse impressions shallow, vaguely rugulose; disk with a median, linear, glabrous callus; punctures sparse, irregular, each bearing an erect dark seta; pubescence irregular, fulvous and recumbent; prosternum rugulose, densely pubescent; meso- and metasternum vaguely punctate, densely, somewhat irregularly pubescent, suberect hairs numerous. Elytra about 2.5 times as long as broad; base behind scutellum rugose, humeri with few small asperites; punctures behind fine, sparse, becoming obsolete toward apex; pubescence consisting of variegated patches of fulvous and whitish recumbent pubescence, nonpubescent areas strongly shining; apices elongate, narrow, sutures vaguely angulate. Scutellum rounded at apex, densely pubescent.

Legs densely pubescent. Abdomen minutely punctate, densely, irregularly, pubescent, last sternite rounded at apex. Length 20-24 mm.

Female: form more robust. Antennae about as long as body, white annulate. Pronotum often broader than long. Abdomen with last sternite truncate at apex, sides tufted. Length 18-29 mm.'

Detection and inspection methods

There is no specific information for *M. marmorator*, but *Monochamus* spp. are attracted to weakened, dying or dead host trees. Therefore, such trees, which often have partly or completely discoloured needles, should be the focus of surveillance for *Monochamus* spp. Close inspection may allow the detection of oviposition slits in the bark of dead or dying trees, oval-shaped larval entrance holes in the sapwood under the dead bark, or round adult exit holes in the sapwood. Larvae can also be extracted from the bark or sapwood, and adults can be found walking or resting on cut or dead wood during the summer (EFSA, 2018). The most efficient detection method is trapping (see below). Blatt *et al.* (2019) caught *M. marmorator*, *M. notatus* and *M. scutellatus* in traps in plantations of healthy Christmas trees (*Abies balsamea*) showing that there are exceptions to the general association between *Monochamus* spp. and weakened or dead trees.

Traps

In a field and laboratory study, Fierke *et al.* (2012) provided evidence that monochamol is a component of the pheromone produced by male *M. scutellatus*. Field data also suggested that it is likely to be a pheromone for *M. marmorator* and support for the hypothesis that it is a pheromone for the genus *Monochamus*.

In a large study at 16 sites across North America, Miller *et al.* (2013) demonstrated that multiple-funnel traps baited with a blend of ipsenol, ipsdienol, ethanol and α -pinene were attractive to the *M. titillator* / *M. carolinensis* complex, *M. scutellatus*, *M. clamator*, *M. obtusus* and *M. maculosus* (synonym = *M. mutator*). This mixture of four compounds, was more effective than unbaited traps or traps with a mixture of ipsenol and ipsdienol or traps with a mixture of ethanol and α -pinene. Ethanol is produced by stressed conifer trees and α -pinene is a constituent of the oleoresin of most pine species. Ipsenol and ipsdienol occur naturally in pine forests (Miller *et al.* 2013).

Ryall *et al.* (2015) provided evidence that monochamol is attractive to *M. scutellatus*, *M. notatus* and *M. carolinensis* which supported evidence from previous studies (e.g. Fierke *et al.* (2012); Allison *et al.* (2012)), they also provided the first evidence that monochamol is attractive to *M. maculosus* and *M. marmorator*. The studies also demonstrated a synergism between monochamol and host volatiles. Allison *et al.* (2012) showed that monochamol is attractive to *M. titillator* as well as to traps baited with (2R*,3R*)-2,3-hexanediol plus α -pinene (but not to traps baited with (2R*,3R*)-2,3-hexanediol alone). There is evidence showing that monochamol is attractive to 12 *Monochamus* species and so it has excellent potential for surveys of beetles of the genus (Ryall *et al.* 2015).

Miller *et al.* (2016) tested the efficacy of different combinations of α -pinene, monochamol and ipsenol for catching *Monochamus* spp. in two Canadian provinces and eight states in the USA. The study provided evidence of the beneficial effect of including both monochamol and ipsenol in lures. Monochamol did not increase catches of other Cerambycidae, bark beetles, other weevils or bark beetle predators. Boone *et al.* (2019) tested the efficacy of teflon-coated cross-vane traps with four lures monochamol: 2 mg/day; ipsenol: 2.5 mg/day, 2-methyl-3-buten-1-ol: 10 mg/day; and α -pinene: 500 mg/day. Large numbers of *M. carolinensis*, *M. maculosus*, *M. notatus*, *M. scutellatus*, *M. clamator*, and *M. titillator* were trapped in North America, while large numbers of *M. alternatus* were trapped in China. This result demonstrated that such traps could be used for the detection of non-native *Monochamus* spp. in Europe.

PATHWAYS FOR MOVEMENT

There is no specific information on the pathways for *M. marmorator* and so the following information is generic to the genus. *Monochamus* spp. can naturally disperse by flight. A number of dispersal studies have been carried out with *Monochamus* spp. For example, *Monochamus alternatus* adults were shown to be able to disperse 3.3 km from infested logs to diseased trees (Kobayashi *et al.*, 1984). In a mark-recapture experiment in Spain, *Monochamus galloprovincialis* (Olivier) flew a maximum of 22.1 km with around 2% of beetles flying further than 3 km (Mas *et al.*

, 2013).

Pinewood nematode, which is vectored by *Monochamus* spp. has been found to be able to spread at a mean rate of 5.3 km per year in Portugal (de la Fuente *et al.*, 2018), 6 km / year in Japan (Togashi & Shigesada, 2006) and an estimated 7.5 km / year in China (Robinet *et al.*, 2009). However, long distance human assisted spread of pine wood nematode can occur over much larger distances with a mean annual dispersal of 111-339 km estimated in China (Robinet *et al.*, 2009).

Monochamus spp. can be spread in coniferous wood and coniferous wood packaging material, dunnage, particle wood and waste conifer wood, hitchhiking and in finished wood products (EFSA, 2018, Ostojá-Starzewski, 2014). Between 1998 and 2018 there were 124 interception records of *Monochamus* sp. on wood packaging material in the EU (EFSA, 2018). Between 1984 and 2008, there were 42 interceptions of *Monochamus* spp. on wood packaging material in the USA which were identified to species level: *M. alternatus* (17), *M. carolinensis* (Oliver) (2), *M. clamator* (Leconte) (1), *M. galloprovincialis* (Oliver) (5), *M. sartor* (Fabricius) (5), *M. scutellatus* (Say) (2), *M. sutor* (Linnaeus) (9) and *M. teserula* White (1) (Eyre & Haack, 2017). *Monochamus* spp. females lay their eggs in various parts of their trees, including smaller branches down to 2 cm in diameter. Plants for planting are considered to be an unlikely pathway for the spread of *Monochamus* spp. because they tend to attack weakened or dead trees and weakened trees are unlikely to be traded (EFSA 2018). However, the trapping of *Monochamus* spp. in plantations of healthy Christmas trees (*Abies balsamea*) suggests there would be some risk in importing host trees from North America into the EPPO region (Blatt *et al.*, 2019).

PEST SIGNIFICANCE

Economic impact

There is little information about the specific impacts of *M. marmorator*. Belyea (1952) studied the causes of damage to balsam fir around Lake Nigigon, Ontario, Canada. *M. marmorator* were scarce in this region during the period of the study and so it was not possible to determine the significance of this species as a pest.

Monochamus spp. are not considered to be plant pests in their own right because they do not tend to attack healthy trees however, they can cause damage to timber and can facilitate the introduction and spread of pine wood nematode in Europe (EFSA, 2018). *Monochamus* spp. rarely, if ever, attack vigorously growing trees (Gibson, 2010). However, the impact from *Monochamus* spp. in the USA is high, largely due to the export restrictions of forestry products associated with pine wood nematode, *Bursaphelenchus xylophilus* (Miller *et al.*, 2013). In the USA, *Monochamus* spp. larvae, are also responsible for extensive damage to fire damaged, dying, recently killed, and felled conifers of various species—but especially pines, spruce, true firs, and Douglas-fir. The larvae damage infested trees and logs through a series of extensive mines that introduce decay-causing fungi (Baker, 1972, Gibson, 2010). Wood chips harvested from wood infested by *Monochamus* species can be too small for use at pulp mills (Wilson, 1962).

Control

Wilson (1962) studied attacks by wood boring insects on stacks of felled balsam fir, *Abies balsamea* in Minnesota. *M. scutellatus* was the most frequently observed cerambycid beetle, accounting for c. 90-95% of all beetles observed. *M. notatus* and *M. marmorator* were also occasionally observed. Piles of wood placed in full shade suffered less damage than wood exposed to the sun. Also, standard piles with less wood exposed to beetle damage suffered less damage than piles stacked in 'pens' with wood stacked in open perpendicular layers. The average volume of wood lost from standard piles of wood over two years in the sun ranged from 0.47% of interior logs to 2.64% for exterior logs and for piles in the shade from 0.37% for interior logs to 0.59 % for exterior logs. Damage to felled wood can be reduced by: i) transporting wood as soon as possible after felling; ii) placing wood in the shade of other trees; iii) covering wood in a layer of 45 cm of slash iv) stacking wood in standard piles to reduce the area exposed to beetle attacks; v) removing bark from felled wood; vi) immersing logs in water; vii) applying insecticides to exposed wood (Wilson, 1962, Wilson, 1975). *Monochamus* damage can be prevented by not exposing wood during the July-September egg laying period and minimized by processing any infested wood as soon as possible (Gibson, 2010).

Phytosanitary risk

Although there are no known records of *M. marmorator* becoming established outside its natural range in North America, the species should be considered as a phytosanitary risk wherever its host genera (i.e. *Picea*, *Abies*) are found, because interceptions of *Monochamus* spp. in wood packaging material in Europe have shown there is a viable pathway.

The introduction of non-native *Monochamus* spp. such as *M. marmorator* into Europe could introduce pine wood nematode to new locations and hosts, and enhance the rate of spread of the pest. Pinewood nematode has caused severe damage to forests in East Asia and in Europe and the impacts are likely to increase (EFSA, 2018). *M. maculosus* is thought to be a vector of pine wood nematode (Akbulut & Stamps, 2012) and has been found in association with of *M. marmorator* on *Abies balsamea* (Wingfield & Blanchette, 1983).

PHYTOSANITARY MEASURES

The EU has emergency measures to prevent the spread of pinewood nematode within the union (EU, 2012). These measures include demarcating areas, destruction of contaminated material, heat treatment of wood and wood products, hygiene protocols for forestry vehicles and transport conditions for plants, wood and bark (EFSA, 2018). Measures to reduce the risk of wood becoming infested during transit include: not transporting wood through infested areas; not transporting wood during the flight season or covering the wood during transit. Debarking of harvested wood can also reduce risks from *Monochamus* spp. (EFSA, 2018).

Recommended phytosanitary measures to reduce the risk of the introduction and spread of non-European *Monochamus* spp. and pinewood nematode are set out in the EPPO commodity standard for Coniferae, PM 8/2 (3). For example, there are recommendations by host species to reduce the risk of introducing pinewood nematode or its *Monochamus* sp. vectors on wood, such as pest free areas, treatment of wood and conditions for the transport of the wood (EPPO, 2018).

The treatment of wood according to ISPM 15 will reduce the risk of the introduction of xylophagous pests such as *Monochamus* spp. and pine wood nematode being introduced to previously uninfested areas in wood packaging material, although treatments are not always applied effectively (Haack *et al.*, 2014).

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Datasheet history

This datasheet was first published online in 2022. It is maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.



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