This text is an integral part of the *EPPO Study on bark and ambrosia beetles associated with imported non-coniferous wood* and should be read in conjunction with the study

Pest information sheet
Bark beetle

PHLOEOTRIBUS LIMINARIS (COLEOPTERA: SCOLYTINAE)

peach bark beetle

EPPO Lists: Not listed. The assessment of potential risks in this information sheet is not based on a full PRA for the EPPO region, but on an assessment of the limited information for that species used to prepare the information sheet.

PEST OVERVIEW

Taxonomy

Phloeotribus liminaris (Harris 1852). Synonyms: *Phloeophthorus liminaris, Phthorophloeus liminaris, Tomicus liminaris, Phthorophloeus mississippiensis* (Atkinson, 2018).

Associated fungi

No mention of fungal associations was found.

Morphology and biology

Phloeotribus liminaris adults measure ca. 2-2.5 mm (Pennacchio *et al.,* 2004). *P. liminaris* has two generations per year in North America, or sometimes three in the southernmost latitudes (Wood, 1982). In Italy, *P. liminaris* was observed to have two generations per year and it overwinters as adults (Pennacchio *et al.*, 2011). In the reproductive phase, *P. liminaris* usually attacks damaged or weakened host trees, as well as material deriving from felling (Pennacchio *et al.,* 2004, citing others). Population build-ups due to breeding in slash or wind-thrown trees can lead to massive attacks on healthy trees during breeding. However, normally beetles tunnelling in healthy trees usually are either pitched out or killed by the gum reaction (Kirkendall *et al.*, 2015 citing others). *P. liminaris* overwinters in both adult and larval stages (Hanavan *et al.* 2012, citing others). Adults overwinter either in short, individual galleries dug in the internal bark of host trees in good or deteriorated vegetative conditions, or in breeding galleries in dead trees (Wood, 1982; Pennacchio *et al.*, 2004). This phase is responsible for damage to wood (see below).

Spring broods are produced by both overwintering parent adults and developed adult progeny from overwintering larvae (Hanavan *et al.*, 2012, citing others). The female initiates the reproductive attacks by boring a short entrance tunnel through the inner bark to the outer wood layer in weakened or damaged trees (Pennacchio *et al.*, 2004). The male then enters, mating takes place and the female constructs a subcortical egg tunnel, 2-7 cm long, and deposits 80-100 eggs in niches. The larvae feed on the inner bark and outer wood, resulting in short, deeply engraved tunnels (Guthmiller and Hall, 2001; Barnd and Ginzl, 2009). The next generation adults emerge and disperse in search of live host trees, where they carve overwintering niches between the bark and cambium (Pennacchio *et al.*, 2004, citing others). Entrance holes of winter refuges are in bark cracks (Pennacchio *et al.*, 2004).

Males are attracted to *Prunus serotina* trunks infested with female beetles, suggesting that females release a sex pheromone (VanDerLaan-Hannon and Ginzel, 2011; Ethington *et al.*, 2016). Furthermore, according to experiments, adults are attracted to benzaldehyde, suggesting that they locate suitable hosts by orienting to cherry volatiles (Ethington *et al.*, 2016).

A study by Hanavan *et al.* (2012) with *P. serotina* indicates that brood galleries are mainly located in the lower half of the tree trunk (noted as consistent with other authors' findings), whereas they are less frequent in both live and dead branches, and then only in branches exceeding 2.5 cm in diameter.

Spread biology
Both males and females are able to fly, but no specific information was found on the dispersal capacity. Movement among stands is not currently understood (Hanavan *et al.*, 2012).

Nature of the damage
P. liminaris tunnels into the bark. In the wintering phase, the pest may dig refuges in the internal bark of trees in good vegetative conditions, leading in subsequent years to damage to the cambium, causing irregular growth of woody tissues and the formation of gum spots in the wood (Pennacchio *et al.*, 2004). Galleries extend into the living tissue beneath the bark (cambial layer and outer cortex), which often causes gummosis and localized growth abnormalities. Although gumming can result from wounds caused by other insects, fungal infection and abiotic factors, it appears that attacks by *P. liminaris* are a major cause of gum spots in *P. serotina* saw-timber (Barnd and Ginzl, 2009).
There is conflicting information about mortality in the literature. Hanavan *et al.* (2012, citing others) note that the beetles are not tree killers but result in a lower grading of *P. serotina* wood due to gummosis. Forest Health Fact Sheet (2011) mentions that trees are rarely killed, but usually weakened which may predispose the tree to other pests. Other sources refer to mortality (of *P. serotina*). Michigan State University (2014) states that the tunnelling can kill the tree, Allen (1999) that large infestations on *P. serotina* lead to girdling of the tree, and death within one or two growing seasons. Guthmiller and Hall (2001) mentions serious mortality in forest-grown *P. serotina* in New York State.

Detection and identification
- *Symptoms.* When the beetle density is very high, external signs on the tree of the presence of the beetle can be observed: abundant accumulation of frass at the tree base and between bark cracks, emission of gum from entrance holes (Pennacchio *et al.*, 2004). It is noted that other bark beetles such as *Dryocoetes betulae* and *Scolytus rugulosus* also cause gummosis in *P. serotina*, although to a far lesser extent (Barnd and Ginzel, 2009).
- *Trapping.* Chemical attractants noted by Atkinson (2018) are: alpha pinene + ethanol, or only ethanol; and light trapping methods such as: mercury vapor + ultraviolet, or ultraviolet on its own.
- *Identification.* A morphological description is provided in Pennacchio *et al.* (2004). Some sequences of *P. liminaris* are available in GenBank (https://www.ncbi.nlm.nih.gov).

Distribution (see Table 1)
P. liminaris is native to North America. It is present in Canada and the Eastern half of the USA, from North to South and is widespread in the native range of *P. serotina* (Pennacchio *et al.*, 2004, citing others; Barnd and Ginzel, 2009).

In the EPPO region, *P. liminaris* was found in 2004 in mixed woods in the Ticino River Park (Lombardia region, northern Italy), where many trees of *P. serotina,* 10-20 cm in diameter and aged 25-45 years, were heavily colonized by wintering and adult refuges, suggesting that the introduction was not recent (Pennacchio *et al.*, 2004). It was later found in Pombia (Piemonte) in the Parco Naturale della Valle del Ticino (Pennacchio *et al.*, 2011).

P. liminaris is listed for France in the catalogue of Alonso-Zarazaga *et al.* (2017). However, it has been trapped only once (Noblecourt and Lessieur, 2016), has never been seen since, and is not established (L-M Nageleisen and T. Noblecourt, pers. comm. 2018-05).

Host plants (see Table 2)
Hosts of *P. liminaris* are *Prunus* spp. (Rosaceae). *P. serotina* is the preferred host, but *P. persica* is also mentioned. Hosts include other wild and cultivated *Prunus*, such as *P. americana*, *P. angustifolia*, *P. mexicana*, P. *pensylvanica* (See Table 2).

In Italy, only *P. serotina* was found infested, and *P. avium*, *P. padus* and *P. laurocerasus* in the same areas were not reproductive hosts. Only signs of maturation feeding and failed attempts to bore galleries were observed in *P. padus*. In addition, trials consisting in offering fresh trunks of *P. armeniaca*, *P. persica*, *P. domestica* and *P. laurocerasus* close to attacked *P. serotina* in areas of high infestation during the flight period did not result in successful colonization (Pennacchio *et al.*, 2011).

Kirkendall *et al.* (2015) mentions 'mulberry' in relation to damage and mortality observed on some trees (including *Prunus*) in the USA in the 1900s (citing Wilson *et al.*, 1909; Beal and Massey, 1945), while Atkinson (2018) lists *Maclura pomifera* (Moraceae) as a host (based on an unpublished record). The original published records were not available, and the host status of Moraceae is not clear. No other non-Rosaceae host were found.

Known impacts and control in current distribution

In the USA, *P. liminaris* was studied in the early 1900s as it started damaging and even killing peach, black cherry, wild cherry trees and mulberry in the Northeastern USA. Before that, it was not considered an economic problem, though originally described as associated with "peach yellows" (Kirkendall *et al.*, 2015 citing others). The main damage is due to gum spotting (gummosis), which reduces the commercial value of the wood. *P. serotina* wood is used in the production of cabinets, musical instruments and other valuable articles (Pennacchio *et al.*, 2004, citing others). Gum spotting can reduce the veneer value of *P. serotina* by 50–90% (Kirkendall *et al.*, 2015, citing others).

An outbreak of thousands of adults was reported in a stand of mature *P. serotina* in 2000 in Wisconsin, where the beetles emerged from logging slash and attacked live standing trees, stressed by water-logged soils. This was the first damage by *P. liminaris* in Wisconsin, whereas it had long been a serious pest of peach orchards in southeastern USA, and had caused serious mortality in forest grown black cherry in New York State (Guthmiller and Hall, 2001).

In Italy, the possible damage by *P. liminaris* to *P. serotina* did not raise particular concerns, since this tree is an invasive species in the forests of that region. Pennacchio *et al.* (2004) reported that studies on the bioecology have been initiated in areas of recent introduction, in view of potential damage to *Prunus* orchards, particularly the extensive cultivations of *P. persica* in the Po Valley. In later observations, no species other than *P. serotina* was found to be attacked in Italy (see *Host plants*) (Pennacchio *et al.*, 2011).

Control: In the USA, the only known control strategy is utilizing traditional silvicultural practices such as destroying infested wood. No natural enemies are known for having a decisive role in the control (Pennacchio *et al.*, 2004, citing others). Frank and Mizell (2009) note that often only newly transplanted trees and shrubs or high value ornamental trees justify the cost of chemical management.

POTENTIAL RISKS FOR THE EPPO REGION

Pathways

Entry

Life stages of *P. liminaris* are associated with the bark. *P. liminaris* entered Italy with an unknown pathway. *P. liminaris* has also been intercepted in the Republic of Korea on imported 'logs and timbers' of *P. serotina* from the USA (Choi *et al.*, 2003). Given its biology and host range, all wood of *Prunus* hosts with bark, especially of *P. serotina*, may be a pathway. No information was found on the trade of *P. serotina* wood from North America into the EPPO region. Cases of non-compliance recorded in the EU include some on wood of *Prunus* sp. and *Prunus avium*, i.e. indicating some trade. Residual wood of *P. serotina* could potentially be a minor part of imported wood chips, wood waste or used in constructing wood packaging material. Processes applied to produce wood commodities would destroy some individuals. The wood would also degrade and may not be able to sustain development of the pest. The likelihood of entry on wood chips, hogwood and processing wood residues would be lower than on round wood, as individuals would have to survive processing and transport, and transfer to a suitable host. Bark may be a pathway, but no information was sought on whether bark of *Prunus* is traded.

Plants for planting and cut branches of a certain diameter may be a pathway, but data is lacking (the only information refers to a minimum diameter of 2.5 cm for infestation of *P. serotina* branches). Plants for planting are normally subject to controls during production, and attacked plants may be detected and discarded. Cut branches are a less likely pathway, as they are used indoors, and the pest is unlikely to be able to transfer to a suitable host. No information was sought on the trade of such commodities.

Summary of pathways (uncertain pathways are marked with '?'):

- *wood (round or sawn, with bark, incl. firewood) of hosts*
- *non-coniferous wood chips, hogwood, processing wood residues (except sawdust and shavings)*
- *wood packaging material if not treated according to ISPM 15*

- *bark of hosts?*
- *plants for planting (except seeds) of hosts?*
- *cut branches of hosts?*

Because of the uncertain host range within Prunus, pathways may cover all Prunus species.

Spread (following introduction, i.e. within EPPO region)
Some natural spread would probably occur as adults fly. Hosts are widely present in the EPPO region (see *Establishment*). No information on the spread in North America is available. From the limited information available on the situation in Italy, local spread among stands of living trees appears to be rather slow (rather old and intensive infestation, yet in a limited area). Human-assisted pathways, especially wood or wood waste, may help in creating multiple foci in the EPPO region thus contributing to spread.

Establishment
Areas with suitable climates and host plants are available in the EPPO region, therefore establishment is possible. Based on the classification of Köppen Geiger (see Annex 6 of the study), *P. liminaris* is present in the USA and Canada at least in the climate type Cfa and Dfb[1], which in the EPPO region occur at the Black Sea, Northern Italy and part of the Balkans, as well as the Western part of Russia and neighbouring countries, and the south of Scandinavia. The winter temperatures would not be a limiting factor. In the USA, it is possibly also present in the climate type Cfb[1], but this is not verified based on the limited information available. This would extend the potential suitable area to all oceanic temperate climates of the EPPO region, from the UK and northern Iberic peninsula through to Russia.
Prunus are present in a wide variety of habitats in the EPPO region, including in the wild, planted as forest trees or orchards, and as landscape and ornamental trees. The major host *P. serotina* (EPPO List of Invasive Alien Plants) is widespread in the EPPO region. It was introduced as early as the 17th century and planted as an ornamental, for wood production or soil amelioration; *P. serotina* has become invasive especially in those countries where it had been introduced for forestry use (CABI, 2018, citing others).
The host *P. persica* is grown commercially in the southern part of the region, and is also present in gardens in other areas. Other *Prunus* spp. are widely cultivated commercially for fruit production and in gardens, such as cherries, plums, apricot, almond. Establishment would also depend on whether it is able to attack other *Prunus*. *P. liminaris* has been recorded on several *Prunus* spp. in the USA, and it is not excluded that it may attack others, should it be introduced into the EPPO region. This is especially the case for fruit trees (although it has apparently not been recorded in the USA on some major fruit trees such as apricot or almond). In the Western part of the EPPO region, *Prunus avium*, *P. cerasifera*, *P. mahaleb*, *P. padus* and *P. spinosa* are present in natural environments (San-Miguel-Ayanz *et al.*, 2016).

Potential impact (including consideration of host plants)
P. serotina is widely present in the EPPO region, but is considered invasive in many parts. Therefore if *P. liminaris* affects invasive stands of *P. serotina*, this would be a positive impact. Negative impacts of *P. liminaris* would therefore relate to other *Prunus* spp., especially forest and fruit species. Peach, grown intensively in large parts of Southern Europe is reported as a host; it is not known if current cultivation practices, including good sanitation, would prevent impact. To date, *P. liminaris* has not been found in other *Prunus* spp. in Italy.

Table 1. Distribution

	Reference	**Comments (with references)**
EPPO region		
Italy	Pennacchio *et al.* (2004, 2011)	Lombardia, Piemonte
Absent: France, trapped once only	Noblecourt & Lessieur (2016)	Also mentioned in Alonso-Zarazaga *et al.* (2017), but not established

[1] **Cfa**: warm temperate climate, fully humid, hot summer; **Cfb**: warm temperate climate, fully humid, warm summer; **Dfb**: snow climate, fully humid, warm summer.

	Reference	Comments (with references)
North America		
Canada (Manitoba, Quebec, Ontario, New Brunswick, Saskatchewan)	Atkinson, 2018 citing others	
USA - Connecticut, Delaware, District of Columbia, Florida, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, West Virginia, Wisconsin - Indiana, Minnesota, Oklahoma, Texas - Illinois *Uncertain records:* Alabama, Arkansas, Georgia, Louisiana, Rhode Island, Tennessee, Vermont	-Pennacchio *et al.* (2004, citing others) - Atkinson, 2018, citing others - Helm and Molano-Flores, 2017 - Atkinson, 2018	Considered uncertain here, because referring to unpublished records

Table 2. Hosts

***Prunus* species**	**Family**	**Reference**
P. serotina	Rosaceae	Wood and Bright, 1992
P. americana	Rosaceae	Wood and Bright, 1992
P. angustifolia	Rosaceae	Wood and Bright, 1992
P. persica	Rosaceae	Wood and Bright, 1992
P. mexicana	Rosaceae	Atkinson *et al.*, 2013
P. pensylvanica	Rosaceae	Atkinson 2018 citing others

Uncertain hosts	**Family**	**Reference**
P. cerasus	Rosaceae	Atkinson 2018 (unpublished record)
P. umbellata	Rosaceae	Atkinson 2018 (unpublished record)
Maclura pomifera	Moraceae	Atkinson, 2018 (unpublished record)
'mulberry'		Kirkendall *et al.*, 2015 citing others

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