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
Ambrosia beetle

MONARTHRUM MALI (COLEOPTERA: SCOLYTINAE)
apple wood stainer

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
Monarthrum mali (Fitch 1855). Synonyms: *Pterocyclon mali, Tomicus mali, Pterocyclon longulum, Monarthrum praeustum; Pterocyclon praeustum; Pterocyclon omissum.* Bright & Torres (2006) synonymized *M. praeustum* Eggers (known from the Caribbean) with *M. mali* Fitch (eastern North America). However, some authors believe these may be distinct (e.g. Atkinson, 2018). In this datasheet, *M. mali* and *M. praeustum* are considered as synonyms, but when information is known to relate to *M. praeustum*, this is specified.

Associated fungi
No specific information was found, but the genus *Monarthrum* is xylomycetophagous (fungus-farming ambrosia beetles), and female *M. mali* have mycangia for carrying the associated fungus (cited in Smith and Hulcr, 2015).

Morphology and biology
Adults of *M. mali* measure ca. 2 mm and are reddish-brown to nearly black (Brooks, 1916, Kirkendall *et al.*, 2008 citing others). Relatively little is known about its biology and life cycle. *M. mali* breeds in dying, injured or recently cut logs and stumps, of practically all species of hardwoods (Baker, 1972; Kirkendall *et al.*, 2008; Smith and Hulcr, 2015, citing others). Brooks (1916) refers to attacks on young apple trees 50 years before his publication (apparently live orchard trees). Males are strongly attracted to ethanol, and are the sex that colonizes new breeding material. It is very likely that males produce a long-distance pheromone attractive to both sexes (Kirkendall *et al.*, 2008, citing others). Males initiate galleries boring into the xylem (Smith and Hulcr, 2015). Female galleries extend into the wood (Felt, 1905; Smith and Hulcr, 2015 citing others). *M. mali* has a preference for trees above 24 cm DBH (Smith and Hulcr, 2015, citing others). *M. mali* was trapped in Tennessee between mid- January and mid-October (Oliver & Mannion 2001). This may reflect multiple generations per year in suitably warm climates, but no published information was found.

Spread biology
The flight capacity of *M. mali* was studied under controlled conditions in a flight mill (Seo *et al.*, 2017). Over 50% of the *M. mali* tested flew >100 m during a 24-h period, with 18% flying 500-1000 m and 5% flying >1000 m. The longest single flight distance was ca. 37 m, and the average total flight distance ca. 214 m. This shows a relatively limited dispersal capability without wind or anthropogenic assistance (Seo *et al.*, 2017).

Nature of the damage
M. mali tunnels into the xylem and its associated fungus/fungi lead to a dark staining of the wood.

Detection and identification
- *Symptoms:* Felt (1905) mentions the following symptoms: withering leaves, bark becoming loosened from the wood, emergence holes, and galleries in the wood.
- *Trapping. M. mali* is attracted to ethanol (Klingeman *et al.*, 2017).
- *Identification.* Diagnosis characters for *M. mali* are given in Smith and Hulcr (2015). In Italy, it may be confused with *Gnathotrichus materiarius* (larger, also introduced) and differentiating characters are given in Kirkendall *et al.*, 2008 (citing others).

Distribution (see Table 1)
Monarthrum mali is abundant throughout eastern North America (Kirkendall, 2008), and has been introduced into a few Western US states (see Appendix 1). All records for the Caribbean relate to *M. praeustum*, which is considered as a synonym by some authors, but not all (see *Taxonomy* above).

In the EPPO region, one specimen was collected in 2007 in Belluno province (Veneto region, Italy), and given the conditions (trapping in a nature reserve), it was considered as established in that area and resulting from a recent introduction, which may represent «at least a temporarily successful colonization»; at that time, it had not been found in other trapping locations in Italy (Kirkendall *et al.*, 2008; Kirkendall and Faccoli, 2010). No further record for Italy was found.

Host plants (see Table 2)
M. mali commonly occurs on Fagaceae, especially *Quercus* and *Fagus*, but also *Acer*, *Betula*, *Liquidambar*, *Tilia*. There are rare records for *Pinus* and *Tsuga*, suggesting that conifers are not typical hosts (Smith and Hulcr, 2015). *M. mali* probably breeds in most non-coniferous trees in its range according to Kirkendall *et al.* (2008). Consequently, the host range is probably much wider than reported in Table 2.

Known impacts and control in current distribution
Brooks (1916) noted that *M. mali* feeds on forest and orchard trees, casks used for liquids (e.g. wine casks, causing leaking and loss - Smith and Hulcr, 2015, citing others), manufactured mahogany lumber, and that it attacked apple, plum, cherry and orange trees. The same author reports that it is not a common orchard pest, but that 'about 50 years ago' it attracted attention as a pest of apple trees in Massachusetts, where it riddled the trunks of many young trees. *M. mali* has also been shown to be destructive to green lumber and fresh logs of *Liquidambar styraciflua* in the Gulf States of the USA (Baker 1972). The dark staining from the ambrosia fungi and the beetles' tunnels can lower the value of wood for certain uses (Kirkendall *et al.*, 2008). No mention of impact was found from US States where it has been introduced or from Italy.

Control. No control methods are mentioned, except for general methods against bark beetles infestations in Brooks (1916).

POTENTIAL RISKS FOR THE EPPO REGION
Pathways
Entry
Life stages of *M. mali* are associated with the xylem, and *M. mali* may be associated with wood commodities. There is little information available about the biology of *M. mali* and the type of material attacked. It is known to prefer trees >24 cm diameter at breast height (DBH), although attacks on «young» apple trees were reported (the age, which may give an indication of the diameter, is not specified). *M. mali* was collected from firewood following a storm event, mostly on *Acer rubrum* and *Fraxinus americana*, and much fewer individuals on *Betula*, *Quercus* and *Pinus* (Dodds *et al.*, 2017). *M. mali* is reported to probably breed in most deciduous trees in its range, and hosts are possibly not limited to the known hosts in Table 2. 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 is less likely. Bark on its own is an unlikely pathway.
Plants for planting and cut branches are less likely pathways (due to the reference found on preferred diameter). In addition, plants for planting are normally subject to controls during production, and attacked plants may be detected and discarded. Cut branches are used indoors, and the pest is unlikely to be able to transfer to a suitable host.
There may be other factors restricting the association with the different pathways (or establishment), but this outlined analysis did not identify any. Given its abundance in Eastern USA, wide host range, and trade of wood from North America, it is surprising that there have not been more introductions.

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

- *wood (round or sawn, with or without bark, including 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*

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

Because of the large and uncertain host range, pathways may cover all non-coniferous species.
The pathways may also cover known coniferous hosts (though considered non typical hosts in the literature – see Hosts)

Spread (following introduction, i.e. within EPPO region)
Only one specimen was collected in Italy, and it is not known if spread has occurred (although this may take time). *M. mali* appears to be capable of dispersal over a large part of the year (climate allowing); in Tennessee it was collected in ethanol baited traps between mid-January and mid-October (Oliver & Mannion 2001). The beetle may also spread through human-assisted pathways. In Italy, it was found in a nature reserve, from which there is presumably no traded commodities. In the USA, the records in Western States are separated from the native range in Eastern USA, and are most likely due to human-assisted pathways. If *M. mali* was introduced into an area where commodities are produced, it may establish in multiple locations elsewhere through human-assisted pathways.

Establishment
M. mali is considered established in Italy. In the Americas, it appears to be present in a wide range of climates that, based on the climate classification of Köppen-Geiger (see Annex 6 of the study), are also represented in most of the EPPO region. *M. mali* has a very wide host range, which would favour establishment. Many host genera grow in the EPPO region in the wild or in cultivation. Areas with suitable climates and host plants are available in the EPPO region, therefore establishment is possible.

Potential impact (including consideration of host plants)
Little damage is recorded in the literature in the current distribution of *M. mali*. However, it is not excluded that *M. mali* may cause local damage in conditions favourable to its biology and where host plants are suitable (i.e. the type of effect reported from the USA on *Malus* or *Liquidambar styraciflua*).

Table 1. Distribution

	Reference	**Comments**
EPPO region		
Italy	Kirkendall *et al.*, 2008	One specimen trapped in 2007, probably established (Kirkendall *et al.*, 2008; Kirkendall and Faccoli, 2010).
North America		
Canada **-** Ontario, Quebec, New Brunswick, Nova Scotia *Uncertain record:* British Columbia	- Majka *et al.*, 2017 - Atkinson, 2018 citing Wood, 1982	- no other record found, nor in Canadian sources, possibly a mislabelled or interception record.
USA **(**Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey,	Atkinson, 2018	*M. mali* has spread within the US, at least to the western states of California, Oregon, Vermont. In Oregon, it was thought to have arrived on untreated, hardwood railroad ties from the Southeast (Oregon Invasive Species Council, 2004). It was introduced to California (Seybold

	Reference	Comments
New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, Wisconsin) - Vermont - California - Oregon	- Atkinson *et al.*, 1991 - Seybold *et al.*, 2016 - Nelson *et al.*, 2006	*et al.*, 2016). In Oregon, it is expected to establish (Nelson *et al.*, 2006)
Uncertain record: Mexico	Atkinson, 2018	Considered uncertain because refers to an unpublished source
Caribbean		
Bahamas	Atkinson, 2018	Relates to *M. praeustum* (see *Taxonomy*)
Cuba	Atkinson, 2018	Relates to *M. praeustum* (see *Taxonomy*)
Dominica	Bright and Torres, 2006	Relates to *M. praeustum* (see *Taxonomy*)
Dominican Rep.	Atkinson, 2018	Relates to *M. praeustum* (see *Taxonomy*)
Guadeloupe	Bright and Torres, 2006	Relates to *M. praeustum* (see *Taxonomy*)
Puerto Rico	Bright and Torres, 2006	Relates to *M. praeustum* (see *Taxonomy*)
Asia		
Uncertain record: 'northern Asia'	Padil (2017)	No reference given; no record was found in the literature.

Table 2. Hosts

Family	Genus/Species	Reference
Altingiaceae	*Liquidambar styraciflua*	Atkinson, 2018
Betulaceae	*Betula*	Dodds *et al.*, 2017
Betulaceae	*Betula lutea*	Atkinson, 2018
Burseraceae	*Dacryodes excelsa*	Atkinson, 2018
Cornaceae	*Cornus florida*	Atkinson, 2018
Cornaceae	*Nyssa* sp.	Atkinson, 2018
Fabaceae	*Inga laurina*	Atkinson, 2018
Fagaceae	*Fagus grandifolia*	Atkinson, 2018
Fagaceae	*Quercus alba*	Atkinson, 2018
Fagaceae	*Quercus laevis*	Atkinson, 2018
Fagaceae	*Quercus nigra*	Atkinson, 2018

Family	**Genus/Species**	**Reference**
Fagaceae	*Quercus prinus*	Atkinson, 2018
Fagaceae	*Quercus rubra*	Dodds *et al.*, 2017
Fagaceae	*Quercus stellata*	Atkinson, 2018
Juglandaceae	*Juglans cinerea*	Atkinson, 2018
Juglandaceae	*Juglans nigra*	Reed *et al.*, 2015
Lauraceae	*Persea palustris*	Seo *et al.*, 2017
Malvaceae	*Tilia* sp.	Atkinson, 2018
Oleaceae	*Fraxinus americana*	Dodds *et al.*, 2017
Rosaceae	*Malus*	As apple, Brooks *et al.*, 1916
Rosaceae	*Prunus*	As plum & cherry, Brooks *et al.*, 1916
Rutaceae	*Citrus*	As orange, Brooks *et al.*, 1916
Sapindaceae	*Acer rubrum*	Dodds *et al.*, 2017
Sapotaceae	*Manilkara bidentatus*	Atkinson, 2018

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