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

PLATYPUS KORYOENSIS (COLEOPTERA: PLATYPODINAE)

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. Most information used originates from the Korean Republic, where *Platypus koryoensis* and its symbiont *Raffaelea quercus-mongolicae* have been found associated with mortality of oaks since 2004. No data were found for other countries where *P. koryoensis* is recorded (Taiwan and Far-East Russia).

PEST OVERVIEW

Taxonomy
Platypus koryoensis (Murayama, 1930). Synonym: *Crossotarsus koryoensis* (Murayama, 1930).

Associated fungi
Raffaelea quercus-mongolicae (Hong *et al.*, 2006; Kim *et al.*, 2009a), which is distinct from *R. quercivora* (associated with *P. quercivorus* and oak wilt in Japan) (Lee *et al.*, 2008). Other fungal associations have been studied in the Republic of Korea, and identified: 14 genera (from 11 orders) of filamentous fungi belonging to Ascomycota and Basidiomycota (Suh *et al.*, 2011), 104 species of decay fungi (Lee *et al.*, 2008), 8 yeast species (Suh *et al.*, 2013; Yun *et al.*, 2015).

The pathogenicity of associated fungi is not known, although it is suspected for *R. quercus-mongolicae*. *P. koryoensis* and *R. quercus-mongolicae* are considered to contribute to mortality of oak in the Republic of Korea, but the mechanism of tree death has not been explained, and other fungal associations of *P. koryoensis* have been studied (Suh *et al.*, 2011). *R. quercus-mongolicae* has shown ability to colonize sapwood, contribute to sapwood discoloration and disrupt sap flows around the inoculation sites of *Quercus mongolica*, but pathogenicity tests were inconclusive (Torii *et al.*, 2014). Molecular biological investigations on the pathogenicity of *R. quercus-mongolicae* have not been conducted, largely due to the need for genomic information. The draft genome sequence of a strain, which could be used for this purpose, was recently analysed (Jeon *et al.*, 2017). The role of the fungi identified has not been determined to date. Yun *et al.* (2015) noted that the yeasts identified had different abilities to produce enzymes involved in degradation of wood components.

Morphology and biology
Adults measure ca. 4 mm (Park and Lyu, 2007, which includes morphological characters and identification key for Platypodinae of Korea). Males and females tunnel into the wood (Moon *et al.* 2008). According to Lee *et al.* (2011, citing others), galleries are constructed mainly in the sapwood and occasionally in the heartwood.

P. koryoensis is univoltine in Central part of the Republic of Korea, and it overwinters in all life stages in galleries. Flights of emerging adults from brood trees begin in late April and peak in late June and early July (Nam *et al.*, 2013, citing others). Adult flight began when the air temperature was around 16 °C, and they were most active at 20-27°C. Nam *et al.* (2013) modelled the flight of *P. koryoensis* and showed that the median date of flight had changed progressively over the past 40 years, advancing by 9 days during this period as the annual mean temperature increased. The lower developmental threshold temperature for *P. koryoensis* was considered to be 5.8°C.

P. koryoensis is able to attack and kill vigorous trees (Lee *et al.*, 2011). *P. koryoensis* and *R. quercus-mongolicae* have been found both on living and dead stems of hosts (Kim *et al.*, 2009a). During the last years' mass-mortality of *Q. mongolica* trees in the Republic of Korea, intermediate to heavy infestation by *P. koryoensis* was always observed on dead *Q. mongolica* trees (Torii *et al.*, 2014 citing others). On *Q. mongolica*, *P. koryoensis* first infested the lower trunk (Lee *et al.*, 2011). In a study on the spatio-temporal distribution of *P. koryoensis*, it was aggregated near dead or partially dead trees in all sites. Results indicated that *P. koryoensis* prefers larger trees for initial attack and in the following years aggregated individuals disperse to new hosts (Nam *et al*., 2011).

Many trees can survive for one or more years after initial *P. koryoensis* infestation (only minor wilting was observed on many of these trees), and it is likely that in succeeding years, many trees will be attacked again by *P. koryoensis,* which will often result in total tree mortality (Lee *et al.*, 2011). It was noted that the level of damage by the disease increases as the number of beetle entrance holes increases, and management of beetle density is critical to reduce damage (Nam *et al.*, 2011; Nam *et al.*, 2013, citing others).

Spread biology
Both males and females fly and disperse (Lee *et al*., 2011). No details were found on the flight capacity of *P. koryoensis*, but it has spread within Korea.

Nature of the damage
Infested trees show wilting of the foliage throughout the entire crown after mass attack of *P. koryoensis* resulting in tree death within a few years (Lee *et al.*, 2011; Yun *et al.*, 2015).

Detection and identification

- *Symptoms*. Partial wilting and sap exudates near *P. koryoensis* entrance holes were observed (Lee *et al.*, 2011). Sticky traps and multi-funnel traps were found effective for monitoring (Kim *et al.*, 2010).
- *Trapping.* The male-produced aggregation pheromone blend in *P. koryoensis* has been determined (Kim *et al.*, 2009b). The pheromone component citral was effective to attract *P. koryoensis* and could be used to develop control methods (Kim *et al.*, 2017). Ethanol in trap logs was effective in trapping *P. koryoensis* (Son *et al.*, 2015).
- *Identification.* Hong *et al.* (2006) analyzed the morphological differences with the closely related species *P. quercivorus*, and Park and Lyu (2007) indicate morphological characters and an identification key for the Platypodinae of Korea. The draft genome sequence of *R. quercus-mongolicae* (strain KACC44405) has been determined and is in GenBank (Jeon *et al.*, 2017).

Distribution (see Table 1)
P. koryoensis is present in the Republic of Korea, Far-East Russia and Taiwan; a record in North-East China is uncertain (see Table 1). *P. koryoensis* was first recorded from Korea in 1930 (Kim *et al.*, 2009a, citing Hong *et al.* 2006), and has been found associated with mortality of oaks in the Republic of Korea since 2004. Kim *et al.* (2009a, citing others) mentions that the epidemic continued in the Republic of Korea and was spreading southwards.
R. quercus-mongolicae has been reported only from the Republic of Korea.

Host plants (see Table 2)
In the Republic of Korea, *P. koryoensis* and *R. quercus-mongolicae* are mostly associated with *Quercus mongolica*, and rarely with *Q. aliena* and *Q. serrata*, but these are less present in the original outbreak area in Central part of the Republic of Korea (Kim *et al.*, 2009a). *Carpinus laxiflora* and *Acer* are mentioned as hosts in Beaver and Shih (2003) based on a 1985 article, but no recent direct record was found. The host record for *C. laxiflora* is occasionally repeated in the Korean literature, but not that for *Acer*. The significance of these non-Fagaceae hosts is not known.

Known impacts and control in current distribution
P. koryoensis was first recorded in Korea in 1930, but oak mortality started occurring in 2004 (Gyeonggi Province). The Korean Forest Institute estimated that over 16000 trees had been killed in 2006-2009 in Gyeonggi Province (Nam *et al.*, 2013, citing others). Both forest and landscape oaks have been affected (Kim *et al.*, 2009c).

Kim *et al.* (2009a) make the hypothesis that the emergence of oak death may be linked to global warming, which has allowed *P. koryoensis* to extend its distribution in the Republic of Korea. Similarly, Nam *et al.* (2013) hypothesised that there is a link between the earlier flight period over the past 40 years (see *Morphology and biology*) and recent outbreaks.

Control: Control measures have been applied against *P. koryoensis* in the Republic of Korea, such as removing killed trees, using sticky sheets to cover the lower trunks of oak trees and trap large numbers of the beetles (Nam *et al.*, 2013, citing others), spraying pesticides (Kim *et al.*, 2017, citing others), fumigating infected trees using metham sodium (Kim *et al.*, 2017), using a water-based mass-trapping device (Park *et al.*, 2016).

POTENTIAL RISKS FOR THE EPPO REGION
Pathways
Entry
Life stages of *P. koryoensis* are associated with the xylem of its hosts. All wood commodities may be pathways. Processes applied to produce wood commodities would destroy some individuals. 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. The wood would also degrade and may not be able to sustain development of the pest. Current imports of *Quercus* or non-coniferous wood appear to be minor from the Republic of Korea, based on data in the EPPO PRA on *Massicus raddei* (EPPO, 2018). There is an uncertainty on the host status of *Carpinus laxiflora* and *Acer*. Bark on its own is an unlikely pathway.
It is not clear if small-sized plants are attacked, i.e. whether plants for planting or cut branches may also be a pathway. This could be the case at least for bonsais. 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. It is not known if there is a trade of host plants for planting or cut branches. *Acer* spp. are widely used to produce bonsais, but the host status is not clear.

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

- *wood (round or sawn, with or without bark, incl. firewood) of Quercus*
- *wood (round or sawn, with or without bark, incl. firewood) of Carpinus laxiflora and Acer?*
- *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 Quercus hosts, Carpinus laxiflora and Acer?*
- *cut branches of Quercus hosts, Carpinus laxiflora and Acer?*

Spread (following introduction, i.e. within EPPO region)
P. koryoensis is known to have spread within Korea, but no detailed information was found. If only the known hosts are attacked, which have a limited presence in the EPPO region (see *Establishment*), spread may be limited. Spread will also depend on whether *P. koryoensis* is able to attack *Quercus* species present in the EPPO region, which would favour both natural spread and human-assisted spread (especially with *Quercus* wood).

Establishment
According to the climate types in the classification of Köppen Geiger (see Annex 6 of the study), the climate type Cfa[1] is present in the coastal areas of Central Korea, and in part of the EPPO region, such as the Black Sea, Northern Italy and part of the Balkans. The climate types of Far-East Russia (e.g. Dfb[1]) are present in Scandinavia and some countries bordering Russia to the west.
The known hosts of *P. koryoensis* have a limited presence in the EPPO region (mostly as ornamentals), except for *Acer* (but data is lacking on its host status). *P. koryoensis* is an ambrosia beetle, and although it has a strong host association to *Q. mongolica* in the Republic of Korea, it may be able to attack other species. *Quercus* are widespread in the PRA area, with the dominating native oaks in Europe and the

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

Mediterranean area including *Q. robur, Q. pubescens*, *Q. petraea* and *Q. cerris*, and there are many other species such as *Q. suber, Q. ilex*, *Q. afares* (incl. in North Africa). A list of native *Quercus* is provided in the EPPO PRA on *Massicus raddei* (EPPO, 2018). The significance of other hosts is not known.
Consequently, establishment in the EPPO region is considered possible.

Potential impact (including consideration of host plants)
Potential impacts will depend on whether *P. koryoensis* is able to attack native species in its host genera or others in the EPPO region. If not, its impact will be limited because its known hosts are mostly grown as ornamentals in the EPPO region. However, *P. koryoensis* is an ambrosia beetle and may find new hosts to grow its symbiotic fungus. The impact will also depend on the virulence of *Raffaelea quercus-mongolicae* on new hosts, and on whether it is associated with other pathogenic fungi. Potential economic and environmental impact could be massive if other *Quercus* spp. can be attacked and if they are very susceptible to the associated fungi. *Quercus* spp. are important in the environment (including in sensitive habitats), for wood production and as amenity trees.

Table 1. Distribution of *P. koryoensis*

	Reference	**Comments**
EPPO region		
Russian Far-East: Ussuri, Primorye	Park and Lyu, 2007	
Asia		
Korea Republic	Park and Lyu, 2007	First record in 1930 (Kim *et al.*, 2009a, citing Hong *et al.* 2006), but mortality of oak reported since 2004.
Taiwan	Park and Lyu, 2007	
Uncertain record: China (North-East)	Kim *et al.*, 2017	Citing a 2013 publication from the Korea Forest Research Institute. No other record was found in the literature. EPPO RS (2009) mentioned that investigations carried out in Northern China (Liaoning and Jilin provinces) did not detect *P. koryoensis* (although it was highly suspected that it occurred there).

Table 2. Hosts

Family	**Genus/Species**	**Reference**
Fagaceae	*Quercus mongolica*	Hong *et al.*, 2006
Fagaceae	*Quercus serrata*	Hong *et al.*, 2006
Fagaceae	*Quercus acutissima*	Hong *et al.*, 2006
Fagaceae	*Quercus aliena*	Hong *et al.*, 2006
Aceraceae	*Acer*	Beaver and Shih, 2003 citing others
Carpinaceae	*Carpinus laxiflora*	(no recent records)

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