



Department
for Environment
Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for: *Phenacoccus fraxinus*

April 2017

Summary and conclusions of the rapid PRA

Phenacoccus fraxinus is a mealybug pest of *Fraxinus* (ash) trees in China. During the creation of a list of pests on *Fraxinus* by Defra in 2016, information was obtained on this mealybug which indicated that it was having high impacts on urban trees in parts of northern China. As a result, *P. fraxinus* was added to the UK Plant Health Risk Register in February 2017 and this PRA was requested.

Risk of entry

Four pathways were assessed: (i) *Fraxinus* plants for planting; (ii) other plants for planting; (iii) bark or wood with bark; and (iv) cut branches. Entry on all four pathways was assessed as very unlikely. (i) *Fraxinus* plants cannot be moved into the UK under the current national emergency measures; (ii) *P. fraxinus* is largely or entirely a pest of *Fraxinus* and not of other plants; (iii) viable insects are unlikely to be associated with bark; and (iv) mealybugs are not very mobile and would have difficulty transferring to a growing host from cut branches. Confidence was medium on the pathway of other plants for planting, and high for the other three pathways.

Risk of establishment

Establishment outdoors was assessed as likely with medium confidence. It is assumed that *F. excelsior* (European ash) would be a suitable host species. *Phenacoccus fraxinus*

is found in continental parts of China, with hotter summers but much colder winters than the UK. Therefore, overwintering in the UK was not considered limiting, but cooler summers may mean the UK is not suitable for *P. fraxinus*, at least in some upland or northern parts. Establishment under protection is considered unlikely with high confidence, as *Fraxinus* trees are seldom grown in such environments.

Economic, environmental and social impact

In China, the pest has damaged *Fraxinus* street trees in at least two cities (Lanzhou and Xining), with high levels of infestation and/or damage reported. Impacts in the current range are assessed as medium, but with low confidence as it is unclear exactly what impacts have been seen, and what thresholds were used to classify a tree as “damaged”.

As the pest has only one generation per year in China, if it is capable of establishing in the UK, similar impacts to those in China are expected here, assuming the European *F. excelsior* is a suitable host. Potential social and economic impacts are assessed as small. Potential environmental impacts are assessed as medium, as UK *Fraxinus* is vulnerable due to the existing impacts of *Hymenoscyphus fraxineus* (Chalara ash dieback) and impacts from *P. fraxinus* could have a cumulative effect. All these judgements are made with low confidence, due to the many uncertainties over impacts in China, potential for UK establishment and the conditions required for the build-up of high populations which cause impacts.

Endangered area

Potentially, any part of the UK where *Fraxinus* grows may be endangered. However, this is uncertain and it could be that only warmer southern parts of the UK and urban heat islands would be at risk of damaging populations developing.

Risk management options

Continued exclusion is considered to be the best option for the UK. Incursions or outbreaks of *P. fraxinus* could be found in the wider environment, potentially on large trees, and so eradication or containment would be challenging. Chemical control methods against other mealybugs may be effective against *P. fraxinus*, but there are a limited number of insecticides approved for use on trees.

Key uncertainties and topics that would benefit from further investigation

The literature on *P. fraxinus* is limited in quantity and quality. Almost all of it is in Chinese, and thus not particularly accessible in the scope of this rapid PRA. Additionally, the literature which has been sourced appears to be rather variable in quality. Some of the key topics of uncertainty include:

- The full host range, including whether non-*Fraxinus* species are ever hosts, and which species of *Fraxinus* are suitable and/or preferred
- The limits to the full distribution of this species in China
- The suitability of the UK climate for establishment
- The actual levels of damage caused to *Fraxinus* trees, including how often and widespread serious impacts caused by *P. fraxinus* occur in China
- Several species assigned to the genus *Phenacoccus* have proven to be highly invasive and it is unclear what biological characteristics have enabled these to be more invasive than mealybug species in other genera
- Currently, the UK has emergency measures in place which prohibit the movement of *Fraxinus* both into and within the UK. If these emergency measures were to be altered or removed in future, elements of this PRA will require re-assessment

Images of the pest

No good-quality, reliably identified, images of *P. fraxinus* (or its damage) could be found.

Images found at <http://www.mxbaila.com/news/zhuanjiazhidao/95.html> (accessed 31 May 2017) are reported to be *P. fraxinus*, and are morphologically consistent with a *Phenacoccus* sp. as they typically produce conspicuous elongate, white, cottony ovisacs such as those depicted in one of the photographs.

Is there a need for a detailed PRA or for a more detailed analysis of particular sections of the PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

No	<input checked="" type="checkbox"/>				
Yes	<input type="checkbox"/>	PRA area: UK or EU		PRA scheme: UK or EPPO	

While there are many uncertainties over the assessment of this pest, these arise largely from the lack of accessible, quantified information available. The limited literature which does exist is largely in Chinese, and of variable quality. Conducting a full literature search, or even identifying which of the papers already sourced should be priorities for professional translation, would be challenging.

Some information, e.g. on the climatic requirements or full host range of *P. fraxinus*, appear to be lacking and these uncertainties cannot be resolved until primary research has been conducted. Other information, e.g. on the levels of damage in China, may be resolved by contact with Chinese entomologists and increased access to the existing literature – for example, professional translation of full versions of the key papers.

Given the information assembled within the time scale required, is statutory action considered appropriate / justified?

Yes Statutory action

 No Statutory action

Phenacoccus fraxinus is a mealybug pest of *Fraxinus*, which is causing impacts on trees in limited parts of China, notably street trees in two northern cities. As *P. fraxinus* is not present in the UK, or elsewhere in Europe, statutory action against this pest is appropriate.

Stage 1: Initiation

1. What is the name of the pest?

Phenacoccus fraxinus Tang (Hemiptera: Pseudococcidae).

No synonyms are known, and there are no English common names. The common name in simplified Chinese is 白蜡绵粉蚧. The only detailed morphological descriptions which are published are in Chinese (Tang, 1977, 1992) which makes comparison of this species with European *Phenacoccus* species difficult.

2. What initiated this rapid PRA?

The Defra Plant Health Risk and Horizon Scanning team created a list of pests on *Fraxinus* (ash) which were not present in the UK during 2016. A number of pests were identified as causing impacts in their native ranges. This subset of pests causing impacts is currently undergoing initial screening through the process of adding them to the UK Plant Health Risk Register¹. *Phenacoccus fraxinus* is one of the pests which has already been added to the Risk Register, and during these discussions in February 2017, a rapid PRA was requested.

3. What is the PRA area?

The PRA area is the United Kingdom of Great Britain and Northern Ireland.

Stage 2: Risk Assessment

4. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC²) and in the lists of EPPO³?

This mealybug is not listed in the EC Plant Health Directive and is not recommended for regulation as a quarantine pest by EPPO, nor is it on the EPPO Alert List.

¹ <https://secure.fera.defra.gov.uk/phiw/riskRegister/>

² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF>

³ <https://www.eppo.int/QUARANTINE/quarantine.htm>

5. What is the pest's current geographical distribution?

Phenacoccus fraxinus has only been recorded from China, and the available information suggests it has only been recorded in provinces in the northern region, just south of Inner Mongolia and eastwards. However, *Fraxinus* is found at high densities in the northern parts of China, becoming scarcer further south. Therefore, there is the possibility that *P. fraxinus* is present in more southern areas in China, but due to the lower density of *Fraxinus*, the mealybug is less likely to be seen and recorded as it, too, will be scarcer.

Table 1: Distribution of *Phenacoccus fraxinus*

North America:	Absent
Central America:	Absent
South America:	Absent
Europe:	Absent
Africa:	Absent
Asia:	China: records from the northern and central provinces: Gansu (Liu <i>et al.</i> , 2011) Hebei (Chu <i>et al.</i> , 2013 – as <i>P. kaxinus</i>) Henan (Chu <i>et al.</i> , 2013 – as <i>P. kaxinus</i>) Qinghai (Qian, 2001) Shanxi (Xie, 1998; Gao <i>et al.</i> , 2015; Zhang <i>et al.</i> , 2012) Tianjin (Chu <i>et al.</i> , 2013 – as <i>P. kaxinus</i>) Tibet (Xizang) (Wang, 1981; cited in Scalenet, 2017)
Oceania:	Absent

Websites such as <http://zhibao.yuanlin.com/bchDetail.aspx?ID=2640> also list Beijing, but it is unclear what sources are used for this information and confirmation of the presence of *P. fraxinus* in this province from other sources has not been possible.

6. Is the pest established or transient, or suspected to be established/transient in the UK/PRA Area?

Phenacoccus fraxinus has never been recorded in the UK.

There are no records of interceptions elsewhere in Europe recorded on EUROPHYT (data accessed 7 April 2017).

7. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK/PRA area?

Fraxinus species. All published literature which could be accessed used phrases such as “hosts mainly *Fraxinus*”. Where a host species has been recorded, this is *Fraxinus chinensis* (e.g. Gao *et al.*, 2015; Zhang *et al.*, 2012).

Various Chinese websites⁴ additionally list, or have listed, a much greater range of hosts from different genera and families, but none of these websites include sources for the information they contain and further information on non-*Fraxinus* hosts could not be located. However, Liu *et al.* (2011) do not list *Fraxinus* as a host: rather, they list the hosts of *P. fraxinus* as *Salix* and *Ailanthus* (willow and tree of heaven), though this is based on automatic translation of the common names in Chinese and thus may be inaccurate.

European ash (*F. excelsior*) is a very common and widely distributed species in the UK (BSBI, 2017), which is of economic and environmental significance to the UK. However, it is unclear if *F. excelsior* would be a suitable host for *P. fraxinus*.

8. What pathways provide opportunities for the pest to enter and transfer to a suitable host and what is the likelihood of entering the UK/PRA area?

Fraxinus plants for planting

There is only one generation of *P. fraxinus* per year and nymphs overwinter from around October to March, choosing sheltered places such as bud scales or cracks in the bark (Qian, 2001; Zhang *et al.*, 2002; Zhang *et al.*, 2003). From third countries such as China, Annex IV of the EU Plant Health Directive 2000/29/EC states that deciduous trees and shrubs must be moved while dormant and free from leaves. Therefore, it is likely that the life stage associated with imports of *Fraxinus* trees from China would be the overwintering nymphs, which are cryptic. The movement of *Fraxinus* into Qinghai province in the 1980s has been linked with the introduction of *P. fraxinus* into this part of China (Qian, 2010). While *P. fraxinus* is very likely to be associated with *Fraxinus* plants, currently, no *Fraxinus* trees from any origin may be imported into (or moved within) the UK. Under the UK Plant Health Order (2015), *Fraxinus* must come from an area declared to be pest-free for *Hymenoscyphus fraxineus* (Chalara ash dieback). As no such pest-free area has ever been declared in any part of the world, no *Fraxinus* trees can be imported into the UK.

⁴ For example: <http://zhibao.yuanlin.com/bchDetail.aspx?ID=2640>, <http://baike.so.com/doc/2236817-2366714.html> or <http://www.chinabaik.com/t/9509/2015/1108/3819171.html> [all accessed 7 April 2017 and which largely appear to be copies of one another]; http://www.slyy.org/slyyforestpest/web_com/pestinfo.aspx?name=%B0%D7%C0%AF%C3%E0%B7%DB%F2%BB [accessed 11 October 2016, *P. fraxinus* page no longer available April 2017]

Even if the UK requirements for freedom from *H. fraxineus* were lifted in future, the EU Plant Health Directive 2000/29/EC contains Annex IV requirements which state that *Fraxinus* imports from certain countries, including China, must come from a pest free area for *Agrilus planipennis* (emerald ash borer). This will limit the areas from which *Fraxinus* can be sourced, though *A. planipennis* is not found throughout China (though this may just be due to the lower density of *Fraxinus* in southern parts), so it is possible some Chinese *Fraxinus* could be certified as free from *A. planipennis* and imported. Overall, the pathway of **Fraxinus plants for planting** is assessed as **very unlikely with high confidence**.

Other woody plants for planting

As with *Fraxinus*, nymphs would overwinter in bud scales or cracks in the bark of dormant trees (Zhang *et al.*, 2002), or all life stages may be associated with leaves and other green parts. In Annex III of the EU Plant Health Directive, there are controls on the importation of plants for planting of specified genera, including prohibitions on genera including *Malus*, *Prunus* or *Pyrus*. In Annex IV, there is an additional requirement for deciduous trees and shrubs to be imported dormant, without leaves. However, the status of species other than *Fraxinus* as suitable hosts for *P. fraxinus* is unclear, and at a minimum, these appear to be less preferred hosts. Therefore, it is assumed that very few plants (if any) will be infested with *P. fraxinus*, and the pathway of **other woody plants for planting** is assessed as **very unlikely**. However, this judgement is made only **with medium confidence**, as the frequency at which *P. fraxinus* infests hosts other than *Fraxinus* is a key uncertainty.

Bark or wood with bark

As nymphs overwinter in cracks in the bark among other places (Zhang *et al.*, 2002), they could be associated with bark or wood with bark. However, pre-export treatments (such as drying) are likely to kill the pest if heat is used, while drying without heat will take some time, and hence viable insects are unlikely to be associated with this product. Even if viable insects were present, mealybugs are not particularly mobile, and would have difficulty locating and transferring to a living host after arrival in the UK. There are also requirements in Annex IV of the EU Plant Directive concerning *Fraxinus* wood, wood chips and isolated bark, from China and other countries, where the wood or bark must be certified as having originated in an area free from *A. planipennis*. However, *A. planipennis* is not found throughout China, so some *Fraxinus* wood and bark from the range of *P. fraxinus* may be able to be certified as free from *A. planipennis* and imported. There are also import restrictions on wood and/or bark of some other host genera, but as the association of *P. fraxinus* with non-*Fraxinus* hosts is unclear, it is very difficult to assess the risks of association of the pest with bark of other trees. Drying or other treatments on the wood will still serve to reduce the number of viable insects, regardless of the host. Overall, the pathway of **bark or wood with bark** is considered **very unlikely, with high confidence**.

Cut branches

Fraxinus is not a common plant used in floristry or other decorations using fresh foliage. Even if *Fraxinus* is imported for decorative purposes, cut branches are perishable items, and more likely to be imported to the UK from origins which are geographically closer, e.g. Europe. If Chinese *Fraxinus* branches were to be imported, then mealybugs are unlikely to be able to locate and transfer to a suitable growing host after arrival in the UK because they have limited mobility. The same caveats apply to cut branches of other host genera, though, as before, the association of *P. fraxinus* with other hosts is uncertain. The EU Plant Health Directive considers cut branches to be “plants”, and as such the EU requirements on plants of *Fraxinus* and other woody hosts outlined previously will also apply to the importation of cut branches. In addition, there is a requirement in Annex VB for inspection of cut branches of *Fraxinus* originating in China before entry into the EU. Overall, the pathway of **cut branches** is assessed as **very unlikely, with high confidence**.

Fraxinus
plants for
planting

Very unlikely	<input checked="" type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
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Confidence

High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>
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Other
woody
plants for
planting

Very unlikely	<input checked="" type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
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Confidence

High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>
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Bark or
wood with
bark

Very unlikely	<input checked="" type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
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Confidence

High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>
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Cut
branches

Very unlikely	<input checked="" type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input type="checkbox"/>	Very likely	<input type="checkbox"/>
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Confidence

High Confidence	<input checked="" type="checkbox"/>	Medium Confidence	<input type="checkbox"/>	Low Confidence	<input type="checkbox"/>
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9. If the pest needs a vector, is it present in the UK/PRA area?

No vector is required. This is a free-living insect.

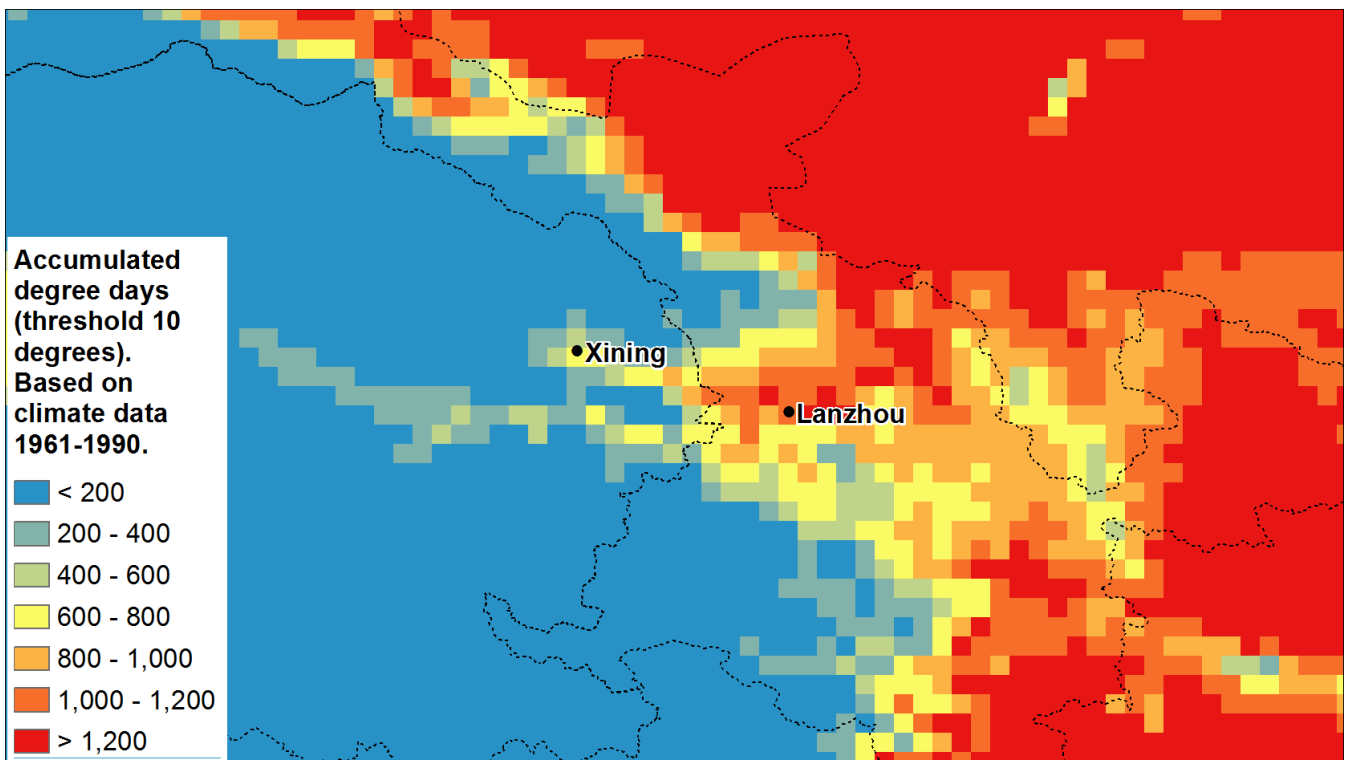
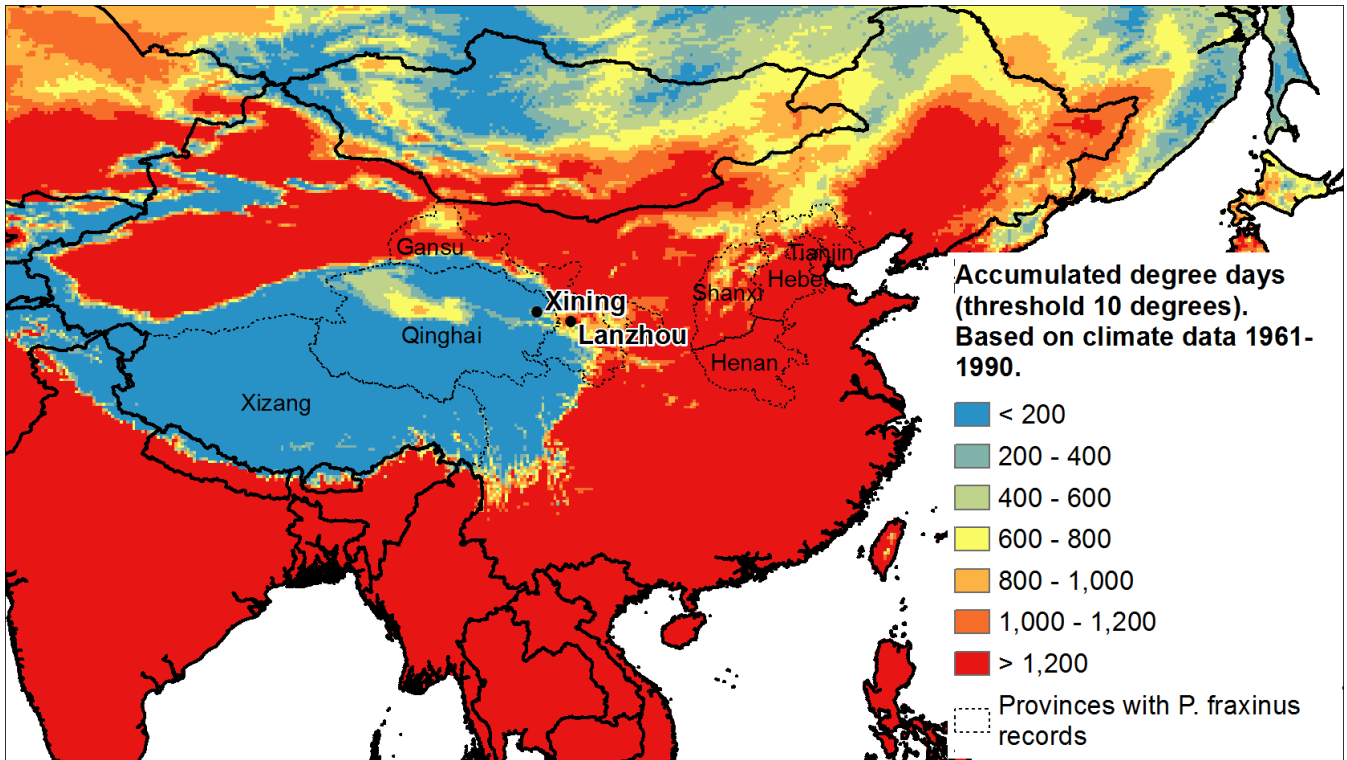
10. How likely is the pest to establish outdoors or under protection in the UK/PRA area?

Outdoors

Despite the impacts of *H. fraxineus*, *F. excelsior* is still very common in the wider environment throughout the UK, with only a few areas (such as the extreme north of Scotland) where it is less widely distributed (BSBI, 2017). However, it is unclear if *F. excelsior* would be a suitable host for *P. fraxinus*, or if this mealybug is restricted to Asian species of *Fraxinus*. For the remainder of this PRA, it is assumed on a precautionary basis that European species of *Fraxinus*, including *F. excelsior*, will be suitable for *P. fraxinus*.

Phenacoccus fraxinus is considered to be capable of overwintering as nymphs in bark cracks in the UK, as the parts of China where it is known to occur have a continental climate, with much colder winters than experienced in the UK. For example, over a 30-year time period, Xining had a January mean minimum temperature of -14.1°C, with -11.3°C in Lanzhou (both cities where *P. fraxinus* has been recorded causing impacts). Southampton in the UK had a mean minimum temperature in January of +2.9°C (WWIS, 2017).

Summer temperatures are, however, higher in central China than in the UK (WWIS, 2017), though the two cities where *P. fraxinus* has been recorded damaging urban trees are on the north-western edge of the Tibetan Plateau, which is cooler than lowland northern areas. Mapping the Chinese annual accumulated day degrees at a base temperature of 10°C clearly illustrates the Tibetan Plateau (Fig. 1), though when the area around Lanzhou and Xining is examined at a larger scale (Fig. 2), both cities are on the margins of the plateau's influence. Lanzhou had an average annual day degree accumulation of 1061 (base 10°C), which is higher than any part of UK (Fig. 3) (comparing the two countries using the same global source dataset from New *et al.*, 2002). However, Xining has only 629 accumulated day degrees on average. Most of the UK south of a line between the Humber estuary and the Bristol Channel has day degree accumulations equal to, or greater than, this value (Fig. 3). However, as the thermal requirements of *P. fraxinus* are not known, the threshold temperature for development was based on a common value for insects, but may not reflect the specific requirements of *P. fraxinus*. Therefore, the maps in Figs. 1-3 only serve to compare day degree accumulations between China and the UK, using an arbitrary threshold value, and do not indicate areas in either country which may be suitable or unsuitable for *P. fraxinus*.



Figures 1 & 2. Accumulated day degrees (threshold 10°C) for the whole of China (top) and for the area around the cities Lanzhou and Xining (bottom), using data from New *et al.* (2002) (time period 1961-1990, with a spatial resolution of 0.5° latitude and longitude). Both Lanzhou and Xining have had high populations of *Phenacoccus fraxinus* on urban *Fraxinus* trees. As the thermal requirements of *P. fraxinus* are unknown, the threshold temperature for development and the boundaries between the classes on the map were set at arbitrary values and do not indicate areas suitable or unsuitable for development of the pest.

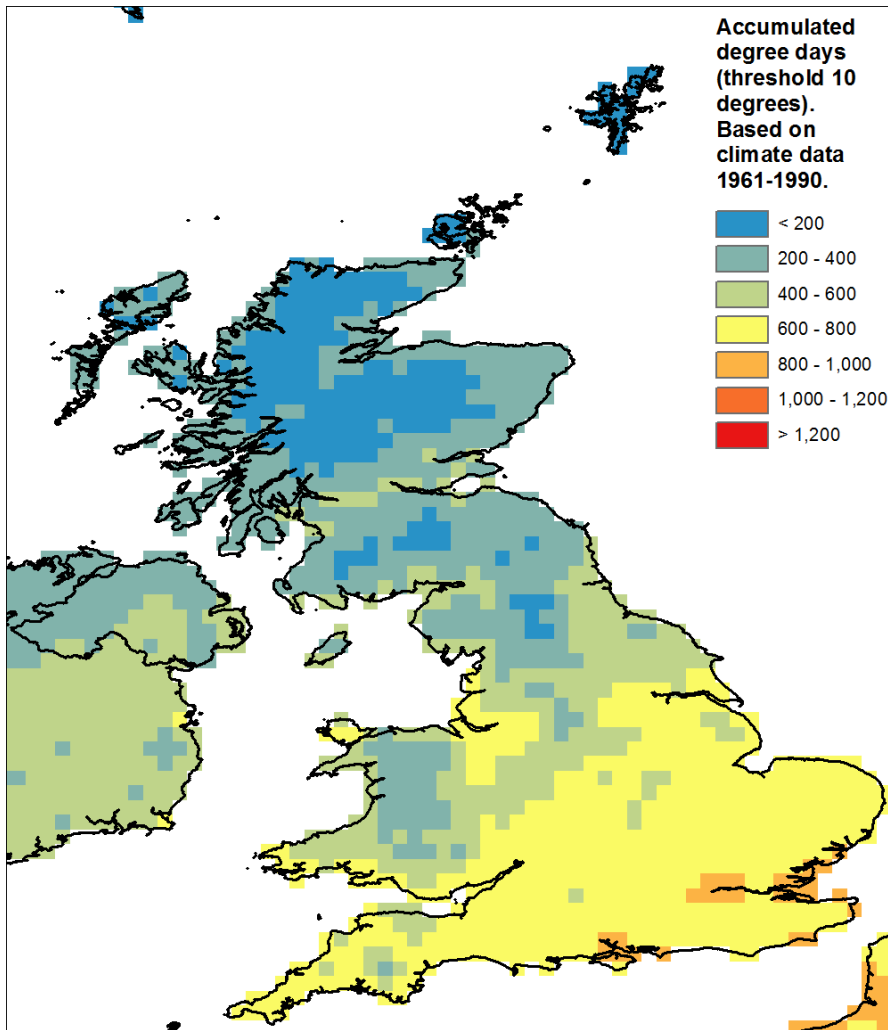


Figure 3. Accumulated degree days (threshold 10°C) for the UK, using data from New *et al.* (2002) (time period 1961-1990, with a spatial resolution of 0.5° latitude and longitude).

Note, this map does not indicate areas where *Phenacoccus fraxinus* may establish. The thermal requirements of this mealybug are unknown. This map only illustrates the number of accumulated day degrees in the UK, using the same thresholds, class boundaries and global source dataset as the maps of China in Figs. 1 and 2.

Overall, **establishment outdoors** in the UK is considered **likely** in the warmer parts of the UK where *P. fraxinus* will have most chance of completing its lifecycle. The risk of outdoor establishment in cooler parts of the UK (northern and upland areas, away from urban heat islands) is likely to be lower. This assessment has only **medium confidence** as it is uncertain whether *F. excelsior* and other European ash species would be suitable hosts. Also, the continental climate in China does differ from the maritime climate in the UK, and it is unclear what climatic requirements *P. fraxinus* actually has for its development.

Under protection

Establishment **under protection** is considered **unlikely**, with **high confidence**. Suitable hosts are not commonly grown in such conditions, or if they are, it will only be for a short time while young before being replanted outdoors.

<i>Outdoors</i>	Very unlikely	<input type="checkbox"/>	Unlikely	<input type="checkbox"/>	Moderately likely	<input type="checkbox"/>	Likely	<input checked="" type="checkbox"/>	Very likely	<input type="checkbox"/>
<i>Confidence</i>	High Confidence	<input type="checkbox"/>	Medium Confidence	<input checked="" type="checkbox"/>	Low Confidence	<input type="checkbox"/>				

Under Protection Very unlikely Unlikely Moderately likely Likely Very likely
 Confidence High Confidence Medium Confidence Low Confidence

11. How quickly could the pest spread in the UK/PRA area?

Natural spread

Mealybugs do not generally have a high capacity for dispersal. Though they have legs, any natural dispersal is likely to be local, and the rate of **natural spread** will be **slow**. Though there are no data on the rate at which *P. fraxinus* can spread, there is no evidence that this species is different to other mealybugs, and so this judgement is made with **high confidence**.

With trade

Movement on traded plants is likely to be much faster than natural spread. Under the current emergency measures in the UK, no *Fraxinus* can be moved, either into or within the country. Therefore, infested *Fraxinus* trees could not be moved within the UK, and would not therefore provide a means for *P. fraxinus* to spread. However, it is possible that individual insects will move onto neighbouring non-*Fraxinus* plants for planting, and these alternative hosts could be moved in trade. Depending on the suitability of other hosts for *P. fraxinus*, mealybugs may be able to develop on the non-*Fraxinus* plant they were moved on, and/or may be able to move onto *Fraxinus* hosts at the new location. There is also the possibility of illegal movement of *Fraxinus* within the UK, but clearly how common this might be is unknown.

There is some uncertainty regarding the rate of spread in trade, as several species assigned to the genus *Phenacoccus*, particularly those native to the Americas, have proved to be highly invasive and have spread rapidly after being introduced to new areas. Examples include Madeira mealybug *P. madeirensis*, Bougainvillea mealybug *P. peruvianus*, Solanum mealybug *P. solani* and cotton mealybug *P. solenopsis* (see individual pest datasheets in the CABI Compendia⁵ for references).

Overall, the potential **spread with trade** is considered to be at a **moderate** pace as there are currently controls on the movement of the main host. However, this judgement has only **medium confidence** as there are several uncertainties and assumptions with this assessment, including the suitability of non-*Fraxinus* hosts for *P. fraxinus* and the fact that several other *Phenacoccus* species have become invasive pests.

⁵ <http://www.cabi.org/publishing-products/compendia/>

<i>Natural spread</i>	Very slowly <input type="checkbox"/>	Slowly <input checked="" type="checkbox"/>	Moderate pace <input type="checkbox"/>	Quickly <input type="checkbox"/>	Very quickly <input type="checkbox"/>
<i>Confidence</i>	High Confidence <input checked="" type="checkbox"/>	Medium Confidence <input type="checkbox"/>	Low Confidence <input type="checkbox"/>		
<i>With trade</i>	Very slowly <input type="checkbox"/>	Slowly <input type="checkbox"/>	Moderate pace <input checked="" type="checkbox"/>	Quickly <input type="checkbox"/>	Very quickly <input type="checkbox"/>
<i>Confidence</i>	High Confidence <input type="checkbox"/>	Medium Confidence <input checked="" type="checkbox"/>	Low Confidence <input type="checkbox"/>		

12. What is the pest's economic, environmental and social impact within its existing distribution?

Li & Zhang (2011) state that more than 80% of the ash trees in Lanzhou city are infested by *P. fraxinus* to some extent. When populations are high, leaves are small, branches may wither, and trees lose vigour. Sooty moulds growing on the excreted honeydew are also a problem (Li & Zhang, 2011). In Xining city, Qian *et al.* (2001) report levels of damage to urban ash trees of over 90% in the worst affected areas, but less than 5% in the least affected areas. Zhang *et al.* (2002) also recorded damage rates in different parts of Xining, ranging from around 3% in the east of the city to over 95% in the west. However, it is unclear what criteria were used by either Qian (2001) or Zhang *et al.* (2002) when assessing a tree as “damaged”. Qian (2010) considers *Fraxinus* street trees in Xining to be endangered by the impacts of *P. fraxinus*, though it is unclear if the trees are being killed by the mealybug, or if it renders ornamental trees unsightly and they are removed for aesthetic reasons.

Only one report of damage to trees in the wider environment was found, and the trees affected didn't appear to be *Fraxinus*. In the Wu Quan mountain park (Lanzhou), insect pests were surveyed and their damage was assessed: *Phenacoccus fraxinus* was ranked as one of the most damaging pests (Liu *et al.*, 2011). However, the hosts listed appear to be *Salix* and *Ailanthus* (not *Fraxinus*), though this is based on automatic translation of the common names in Chinese and thus may be inaccurate.

All reports of damage found seem to be from areas where *P. fraxinus* appears to have been introduced on *Fraxinus* trees for planting 20-30 years previously. The native range of *P. fraxinus* is unclear, but the lack of information on its presence elsewhere in China suggests it is not a significant pest in these areas. It may even be that *P. fraxinus* is actually native to Lanzhou and Xining, but has been able to expand its population (and hence visible levels of damage) after large numbers of *Fraxinus* street trees were planted in the 1980s and 1990s.

Overall, the majority of the impacts in China have been recorded on street trees in China, and thus the main impacts are social. Overall, **impacts on street trees in the affected cities in China** are assessed as **medium**, but this assessment is made with **low confidence** as accessible information on the damage caused is partial and based on the worst case scenarios.

Impacts Very small Small Medium Large Very large
Confidence High Confidence Medium Confidence Low Confidence

13. What is the pest’s potential to cause economic, environmental and social impacts in the UK/PRA area?

As southern parts of the UK have similar annual day degree accumulations (base 10°C) to the area where *P. fraxinus* is causing damage in China (Figs. 1-3), as long as the mealybug is able to get through one generation in a year, and *F. excelsior* is a suitable host, then similar damage might be expected in the UK as is seen in parts of China. However, though annual day degree accumulations may be similar between Xining in China and southern parts of the UK, summers in the UK are slightly cooler (WWIS, 2017) and so the level of fecundity may be lower than in China. As only very high populations of *P. fraxinus* appear to cause damage, and damage has only been reported from urban areas in a small part of China, then conditions may need to be almost perfect for the mealybug before damaging populations can build up, and such conditions may not occur anywhere in the UK.

In China, the greatest impacts appear to be on trees in urban areas, possibly because they are stressed. However, many UK *Fraxinus* trees will be stressed by infection with *H. fraxineus* and thus *P. fraxinus* may cause high impacts in trees grown in the wider environment, as well as to UK street trees. Additionally, *F. chinensis* and other Asian species of *Fraxinus* are likely to have co-evolved with *P. fraxinus*. *Fraxinus excelsior* and other European *Fraxinus* species may be more vulnerable to *P. fraxinus* as they have not co-evolved and developed some resistance. Conversely, European *Fraxinus* species may not be suitable hosts for *P. fraxinus*. As the host range in China is not fully known, this is a major source of uncertainty.

The polyphagous tree mealybug *Phenacoccus aceris* is native to Europe and the UK and has a similar biology to *P. fraxinus*. It is generally kept in check by native parasitoids, but in urban areas, local outbreaks can occur, although these appear to have a negligible impact on the host (C. Malumphy, pers. com., 2017). Trees in urban environments may be stressed and more susceptible to plant pests, and the natural enemies may be less abundant than in more natural situations.

Information from China is limited and what there is, is only partially accessible due to the language barrier, but based on the assumptions that impacts on UK *F. excelsior* could be similar to those seen on *Fraxinus* spp. in northern China, **economic** and **social impacts** are assessed as **small**. However, the potential **environmental impact** is assessed as **medium**. Native *Fraxinus* is already vulnerable due to the impacts of *H. fraxineus*, and *P. fraxinus* may have a cumulative effect and cause high levels of damage to sick trees. The damage to street trees in China may be linked to the mealybug being able to build up to

high populations on stressed trees, and trees infected with *H. fraxineus* will be stressed. Another concern is that trees resistant (or less susceptible) to *H. fraxineus* may be weakened by infestations of *P. fraxinus*. All judgements are made with **low confidence** as there are many uncertainties.

<i>Economic Impacts</i>	Very small <input type="checkbox"/>	Small <input checked="" type="checkbox"/>	Medium <input type="checkbox"/>	Large <input type="checkbox"/>	Very large <input type="checkbox"/>
<i>Confidence</i>	High Confidence <input type="checkbox"/>	Medium Confidence <input type="checkbox"/>	Low Confidence <input checked="" type="checkbox"/>		
<i>Environmental Impacts</i>	Very small <input type="checkbox"/>	Small <input type="checkbox"/>	Medium <input checked="" type="checkbox"/>	Large <input type="checkbox"/>	Very large <input type="checkbox"/>
<i>Confidence</i>	High Confidence <input type="checkbox"/>	Medium Confidence <input type="checkbox"/>	Low Confidence <input checked="" type="checkbox"/>		
<i>Social Impacts</i>	Very small <input type="checkbox"/>	Small <input checked="" type="checkbox"/>	Medium <input type="checkbox"/>	Large <input type="checkbox"/>	Very large <input type="checkbox"/>
<i>Confidence</i>	High Confidence <input type="checkbox"/>	Medium Confidence <input type="checkbox"/>	Low Confidence <input checked="" type="checkbox"/>		

14. What is the pest’s potential as a vector of plant pathogens?

Phenacoccus fraxinus is not known to vector plant pathogens and no evidence was found that it is even suspected of doing so. However, accessible information on this species is very scarce. Some species of mealybugs do vector plant pathogenic viruses (e.g. Tsai *et al.*, 2010), and it is possible that the relevant research on *P. fraxinus* has not been carried out.

15. What is the area endangered by the pest?

All parts of the UK where *Fraxinus* grows may be at risk of establishment of *P. fraxinus*, but it is likely to cause damage only to stressed trees. It is possible that only warmer southern areas and/or urban heat islands would prove suitable for damaging populations to build up over time, but this is uncertain and it may be capable of causing impacts anywhere in the UK.

Stage 3: Pest Risk Management

16. What are the risk management options for the UK/PRA area?

Exclusion

Current prospects for exclusion appear to be good, due to the current UK emergency measures on the movement of *Fraxinus*. Even if growing *Fraxinus* plants were permitted to be imported in future, continued exclusion of *P. fraxinus* would remain the preferred option for the UK.

Eradication or containment

As this pest would be present in the wider environment, eradication or containment would be difficult. It is likely to take some time before an infestation is noticed, and it is likely that initially it would be assumed to be a native mealybug (for example, the polyphagous *P. aceris* (Kaydan *et al.*, 2015)); identification would require slide-mounting of collected specimens and examination by an expert who has access to, and can understand, the species descriptions in Chinese. Therefore, by the time the incursion was identified, it is likely there would have been time for high populations to build up at the affected site. If the pest were present in mature trees, any control measures would be difficult to implement, due to the difficulties of reaching all affected parts of a large tree.

Non-statutory controls

Insecticides are available for use against other mealybug species in the UK, and would probably prove effective against *P. fraxinus*. However, only a few chemicals are approved for use on amenity trees, and fewer still for forests or woodland, which is where this pest is likely to be present. From China, there are a small number of papers available on the use of chemicals against *P. fraxinus* which indicate that populations and spread of the mealybug can be controlled by various treatments, e.g. Chu *et al.* (2013), Qian (2001), Zhang (2002) or Zhu (2004). However, the pesticide regulations in the UK differ markedly from those in China, and any chemicals mentioned in these or similar papers are unlikely to be permitted for use on trees in the UK.

No information on cultural controls could be found from China, but it is possible that pruning badly affected branches (followed by secure disposal of the infested parts) may help to reduce the populations of the pest at a local level.

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