Department for Environment Food & Rural Affairs

Pest specific plant health response plan:

Outbreaks of xylophagous cerambycid beetles

Figure 1. Adult *Saperda candida*. © Gilles Gonthier under licence (https://creativecommons.org/licenses/by/2.0/).

Figure 2. Adult *Oemona hirta*. © Epitree under licence (https://creativecommons.org/licenses/by-nc/2.0/).

Figure 3. *Neocerambyx raddei* adult © Wang Xioa-Yi (via EPPO Global Database)

Figure 4. Damage caused by *Neocerambyx raddei* © Wang Xioa-Yi (via EPPO Global Database)

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This publication is available at

https://planthealthportal.defra.gov.uk/pests-and-diseases/contingency-planning/

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Executive summary

Background	
This contingency plan lays out the Plant Health Service response to findings of live non-native cerambycid beetles in England. The general principles below and in the plan are suitable for the management of interceptions and outbreaks of non-native cerambycid beetles. However, the biology should be taken into account for any findings, as this will vary depending on the species found and may affect the pest management. Specific examples included in the annexes to this plan are *Saperda candida*, *Oemona hirta* and *Neocerambyx raddei*.	
Surveillance	
Demarcated zones (5.31-5.36)	Infested zone = 100 m around known infested plants Buffer zone = ≥ 2 km
Surveillance activities (5.37-5.44)	• Visual surveys will be carried out in the infested and buffer zone • Pheromone trapping surveys where available • Regular surveillance of sentinel trees • Suspicious symptoms found by ground surveys to be followed up by tree climbers
Response measures	
Interceptions (5.1-5.8)	• Consignment should be destroyed or re-exported if live or dead larvae or feeding damage is seen. • Tracing exercises carried out where required • UKPHINs notification to be made.
Outbreaks (5.45-5.53)	• Infested and symptomatic plants within 100 m of infested plants to be felled and removed • If felling is deemed inappropriate an alternative eradication measure may be feasible • Plants and hedgerows to be cut to ground level • Inspection of felled trees • Sentinel trees to be installed for monitoring • Restrictions on replanting host species
Key control measures	
Biological	N/A
Chemical	Insecticides are unlikely to prevent spread
Cultural	Felling and destruction of infested trees, trapping
Declaration of eradication	
Eradication can be declared if no pest is detected during annual surveys for the duration of two complete lifecycles of the pest after the infested material has been destroyed.	

* Numbers refer to relevant points in the plan.

Contents

1. Introduction and scope

1.1. This pest specific response plan has been prepared by the Defra Risk and Horizon Scanning team. It describes how the Plant Health Service for England will respond if an infestation of a non-native cerambycid of concern is discovered. This plan is applicable to all findings of all cerambycids but some biological information has been included for specific species of concern - *Saperda candida* (round-headed apple tree borer), *Oemona hirta* (lemon tree borer) and *Neocerambyx raddei* (oak longhorn beetle).

1.2. The plant health authorities in Northern Ireland, Scotland, Wales and the Crown Dependencies have been consulted on this plan and will use it as the basis for the action they will take in the event of a non-native cerambycid of concern being detected in their territories.

1.3. This document will be used in conjunction with the *Defra Generic Contingency Plan for Plant Health in England* (https://planthealthportal.defra.gov.uk/assets/uploads/Generic-Contingency-Plan-for-Plant-Health-in-England-FINAL-2.pdf), which gives details of the teams and organisations involved in pest response in England, and their responsibilities and governance. It also describes how these teams and organisations work together in the event of an outbreak of a plant health pest.

1.4. The aims of this response plan are to facilitate the containment and eradication of cerambycids and to make stakeholders aware of the planned actions.

1.5. Pest specific information to complement the response plan is provided in Annex I, II and III for *Saperda candida*, *Oemona hirta* and *Neocerambyx raddei*, respectively.

2. Summary of threat

2.1. Larvae of xylophagous cerambycids bore galleries into the sapwood and heartwood of their hosts, weakening, and sometimes leading to the death of, these plants (Eyre and Haack, 2017).

2.2. Feeding damage and the death of plants impacts the economy, with respect to reduced yield, the environment, with respect to the loss of ecosystem services, and society, with respect to declining recreational and amenity sites (e.g. Gao *et al.*, 1993; Jim and Chen, 2009).

2.3. Three cerambycids of concern are *S. candida*, *O. hirta* and *N. raddei*:

- *Saperda candida* is primarily a pest of fruit trees including *Cydonia oblonga* (quince), *Malus domestica* (apple), *Pyrus communis* (pear), *Prunus avium* (cherry), *P. domestica* (plum) and *P. persica* (peach). It is native to North America and is currently present in southern Canada and central and eastern USA although there have also been European outbreaks in Germany. More information can be found in Appendix A.

- *Oemona hirta is* highly polyphagous, with most records of damage coming from woody dicotyledons, particularly species endemic to its native New Zealand. Other than this, there are records of significant damage on *Diospyros kaki* (persimmon), *Vitis vinifera* (grapevine), *Malus* spp. (apple), *Populus* spp. (poplar) and *Ulex europaeus* (gorse) The distribution is limited to New Zealand, but there have been two UK interceptions on *Wisteria* sp. in 1983 and 2010. More information can be found in Appendix B.

- *Neocerambyx raddei* is a serious pest of *Quercus* sp. (oaks), *Castanea* sp. (chestnuts) and *Castanopsis* spp. (chinquapin). It is native to Asia and has been reported in China, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Taiwan, Vietnam, and Far Eastern Russia, with no findings in Europe. More information can be found in Appendix C.

3. Risk assessments

3.1. *Saperda candida* has an unmitigated and mitigated UK Plant Health Risk Register score of 48 and 32 respectively. Overall scores range from 1 (very low risk) to 125 (very high risk). These scores are reviewed as and when neew information becomes available.

https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/viewPestRisks.cfm?cslref=10333

3.2. *Oemona hirta* has an unmitigated and mitigated UK Plant Health Risk Register score of 45 and 30 respectively.

https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/viewPestRisks.cfm?cslref=25156

3.3. *Neocerambyx raddei* has an unmitigated and mitigated UK Plant Health Risk Register score of 45 and 45 respectively.

https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/viewPestRisks.cfm?cslref=20985

4. Actions to prevent outbreaks

4.1. *Saperda candida* and *O. hirta* are GB Quarantine Pests (Schedule 1 of The Plant Health (Phytosanitary Conditions) (Amendment) (EU Exit) Regulations 2020) and are therefore prohibited from being introduced into, or spread within GB. Further pest and host specific requirements are listed in Schedule 7.

4.2. As of June 2021 *N. raddei* is also listed as a GB Quarantine Pest. This amendment was made in SI 2021/641, which also lists the pest specific requirements for hosts of the pest.

4.3. *Saperda candida* and *O. hirta* are EU Union Quarantine Pests and are therefore prohibited from being introduced into, or spread within, the Union Territory.

4.4. *Saperda candida, O. hirta* and *N. raddei* are A1 listed pests for the EPPO region and are therefore recommended for regulation by EPPO member countries.

4.5. General measures listed in ISPM 15 are in place to prevent the entry of wood boring pests.

4.6. The Plant Health Service (including the Animal and Plant Health Agency (APHA), Defra, Fera Science Ltd. and Forestry England) should be aware of the measures described in this plan and be trained in responding to an outbreak of cerambycid beetles. It is important that capabilities in detection, diagnosis and risk management are available.

5. Response

Official action to be taken following the suspicion or confirmation of a cerambycid on imported plants

5.1. If a cerambycid is suspected by the Plant Health and Seeds Inspectorate (PHSI) or Forestry Commission (FC) to be present in a consignment moving in trade, the PHSI or FC must hold the consignment until a diagnosis is made. Samples should be sent to Fera Science Ltd., Plant Clinic, York Biotech Campus, Sand Hutton, York, YO41 1LZ (01904 462000) or Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, GU10 4LH (0300 067 5600), in a sealed bag or container, within at least two other layers of containment, which are not liable to be crushed during transit. Damaged eggs, larvae or pupae should be submitted in tubes of 70% ethanol to prevent further degradation.

5.2. In instances where either live beetles or signs of live beetles is strongly suspected or confirmed, the inspector shall determine the level of plant health risk in the circumstances taking into account the weather conditions, the time of year and the likelihood of the pest escaping and order the appropriate remedial action. This may involve, if possible, the reloading of material back into the freight container and closing the doors or requiring the consignment be covered to prevent insect escape.

5.3. When an infestation of a cerambycid is confirmed, the PHSI or FC should advise the client of the action that needs to be taken by way of an official plant health notice. If deemed to be a risk following formal identification the consignment should be destroyed by either wood chipping, incineration or deep burial.

5.4. Where there is a high risk of escape before destruction, fumigation and/or foliar insecticides may be used under guidance from the Defra Risk and Horizon Scanning team.

5.5. If intercepted inland, ideally any host plants should be surveyed on the site or in the immediate vicinity initially, before extending out to within a radius of at least 1 km around the finding for a time period equal to the maximum recorded time for development + one additional year. In the first year, these surveys will be regular and intensive.

5.6. A UKPHINS (UK Plant Health Interception Notification System) notification should be made upon confirmation of an interception of live cerambycid beetles. UKPHINS is the IT system for recording findings and non-compliance in order to maintain records and notify other National Plant Protection Organisations (NPPO) of plant health issues.

5.7. If all or part of the consignment has not been held and has been distributed to other premises prior to diagnosis, trace forward and trace back inspections should take place upon suspicion or confirmation of a cerambycid. Details of recent past and future consignments from the same grower/supplier should also be obtained.

5.8. If available, a pest alert to raise awareness of the cerambycid and its symptoms should be distributed to packers/processors and importers where the cerambycid has been found, and to those in the local area and those associated with the infested premises. Published pest alerts are available on the Plant Health Portal - https://planthealthportal.defra.gov.uk/pests-and-diseases/pest-and-disease-alerts/notifiable-pests/.

Official action to be taken following the suspicion of a cerambycid outbreak

5.9. Suspect outbreaks will be assessed on a case by case basis. An Outbreak Triage Group (OTG), chaired by the Chief Plant Health Officer (CPHO) or their deputy and including specialists from APHA, Defra and other organisations, should be set up to assess the risk and decide on a suitable response. Where appropriate, the OTG will also decide who will be the control authority, and the control authority will then nominate an Incident Controller. An Incident Management Team (IMT) meeting, chaired by the Incident Controller, will subsequently convene to produce an Incident Action Plan (IAP) to outline the operational plan. See the Defra *Generic Contingency Plan for PlantHealth in England* for full details.

5.10. The OTG will set an alert status, which will take into account of the specific nature of the outbreak. These alert levels, in order of increasing severity, are white, black, amber and red (more details of these levels can be found in table 2 of the *Defra Generic Contingency Plan for Plant Health in England*). Under most scenarios, an infestation of a cerambycid suspected in a tree is likely to be given an amber alert status. An amber alert status refers to a serious plant pest/disease with potential for relatively slow, but extensive geographical spread leading to host death and/or major economic, food security or environmental impacts.

Restrictions on movement of material

Wood packaging material

5.11. If a cerambycid is suspected to have emerged from wood packaging material (WPM) at an inland site, all the WPM from the same consignment should be placed under official control pending further investigation.

Nursery, orchard or garden centre

5.12. If a cerambycid is suspected at a nursery, orchard or garden centre, all suitable woody plants and other suspect material should be placed on hold pending further investigation.

Wider environment

5.13. If a cerambycid is suspected in a tree or is found free living in the wider environment, all suitable woody plants and wood material within a radius of 100 m should not be moved out of the 100 m zone pending further investigation.

Preliminary trace forward / trace backward

5.14. If an infested consignment or tree is considered as being the source of the suspect outbreak, investigations regarding the origins of infested consignments will be undertaken to locate other related and therefore potentially infested consignments or plants moving to and from the site. Information should also be obtained on the destination to which suspect consignments have been sent. For findings in the wider environment, where no trace forward or backward can be done, the most likely source should be identified and investigated.

Confirming a new outbreak

How to survey to determine whether there is an outbreak

5.15. Information to be gathered by the PHSI on the suspicion of an infestation of a cerambycid, in accordance with ISPM 6; guidelines and surveillance (https://www.ippc.int/en/publications/615/):

5.16. The origin of the plants.

5.17. Any information on the original source of the pest.

5.18. Details of other premises or destinations where the plants have been sent, where the beetle may be present.

5.19. The layout of the premises and surrounding area (in relation to potential buffer zones), including a map of the fields/cropping/buildings, at risk growers, and details of neighbouring plants, especially any commercial or non-commercial hosts in orchards, parks or gardens.

5.20. Contact details of the appropriate department in the local authority if appropriate.

5.21. Details of the plant variety, growth stage, dimensions (diameter or girth at breast height, approximate height), age/maturity and general condition.

5.22. Description of the surrounding habitat, including all hosts (species and approximate size).

5.23. Area and level of infestation, including life stages and a description of symptoms (photos would be helpful). Symptoms may include larval tunnelling within the wood.

5.24. The location of any known populations, including grid references.

5.25. The date and time the sample was taken, how it was identified and by whom.

5.26. Current treatments/controls in place e.g. chemical treatments.

5.27. Details of the movement of wood and wood packaging, people, equipment, machinery etc. to and from the infested area.

5.28. Cultural and working practices.

5.29. The name, address, email and telephone number of the person who found the pest and/or its symptoms.

5.30. This information should be included on the plant pest investigation template (see Appendix III of the *Defra Generic Contingency Plan for Plant and Bee Health in England*).

5.31. Further to information gathering, surveys of other host plants and host wood should be carried out to confirm the extent of the infestation e.g. in surrounding gardens, parks etc. This initial survey will be used to determine if it is an isolated finding or an established outbreak. For example, where an adult beetle is found but no host plant is located following the survey, the outbreak will be treated as an isolated finding, as there is no evidence to suggest the pest has become established.

5.32. Finance for the surveys will depend on the individual circumstances of the outbreak, and will be subject to discussion, usually between Defra policy, the PHSI and FC.

Sampling

5.33. Any eggs, larvae, pupae or adults found during the course of inspection, survey or tree removal operations, should be submitted by the PHSI or FC to Fera Science Ltd. or Forest Research as in point 5.1.

5.34. If a tree is suspected of containing a cerambycid, destructive sampling is likely to be required for confirmation, including the removal of the bark to reveal young larvae and tunnelling, and cutting through the trunk to reveal deeper galleries within the sapwood and heartwood. This may require the use of contractors.

5.35. Traps may be available for monitoring adult beetles during their flight period.

Diagnostic procedures

5.36. Diagnostic procedures will depend on the species found, but would likely involve morphological identification supported with molecular analysis where possible.

Criteria for determining an outbreak

5.37. An outbreak will be declared if there is evidence showing that a cerambycid has established a population within host trees other than those that the pest has been moved to the UK with. For example:

5.38. An adult beetle and an associated fresh exit hole is found on a mature tree anywhere in England. In this situation, an outbreak of a cerambycid will be declared.

5.39. An adult beetle found on WPM at an importer and a fresh exit hole is found in the wood packaging. In this case, an outbreak will not be declared.

5.40. Where an outbreak is not declared, points 5.3-5.8 should be carried out.

Official Action to be taken following the confirmation of an outbreak

5.41. The identification of the cerambycid following formal diagnosis will inform what action should be taken, with respect to demarcation, surveillance, and management.

5.42. The scale of the outbreak will determine the size and nature of the IMT and action.

Communication

5.43. The IMT will assess the risks and communicate details to the IPPC, EU and EPPO, in accordance with ISPM 17: pest reporting (https://www.ippc.int/en/publications/606/), as well as within Government to Ministers, senior officials and other government departments, devolved authorities, and agencies (e.g., the Environment Agency) on a regular basis as appropriate; and to stakeholders.

5.44. Information on the outbreak will be communicated to residents and businesses outside the infested zone using various media formats e.g. leaflets, official posters, articles in local newspapers, appropriate websites, local radio etc. Consideration should also be given to the use of social media such as a 'Facebook' or 'Twitter' pages where members of the public can post questions relating to the outbreak.

5.45. When an outbreak is considered likely to have a limited public impact, as appropriate APHA or FC's media and communication teams will coordinate external communications. Example scenarios could include an outbreak in a nursery surrounded by a low urban density or in an urban area where there are few host plants resulting in limited felling activity. If the outbreak occurs in an area that is likely to cause significant media and public interest, for example an inner city nature reserve/public park with a high density of trees that require felling, then external communications will be coordinated through the Defra Press Office. In all cases, the Defra Press office must be kept informed of the current status of the outbreak and any action taken.

5.46. Depending on the scale and circumstances of the outbreak, a public meeting may be required to inform the local residents and relevant stakeholders of the surveillance and eradication programme.

5.47. A communication plan could involve the following:

5.48. Frequently Asked Questions: a Q&A will be developed for staff as a reference source for questions considered likely to be asked by the media and members of the public. A version of the document for public dissemination will be made available electronically via the appropriate website.

5.49. Lines to take: outlining the main messages that should be put across to the public.

5.50. Stakeholder/message matrix: the Stakeholder/message matrix sets out the list of stakeholders likely to be affected by any outbreak, the order in which they should be contacted, the timescale and method for contacting them, and who they should be contacted by.

Demarcated zones

5.51. Once an outbreak has been confirmed, a demarcated area should be established around known infested trees. This will include two zones:

5.52. The **infested zone**, where the presence of the cerambycid has been confirmed, and which includes all plants showing symptoms caused by the cerambycid and, where appropriate, all plants belonging to the same lot at the time of planting. As a minimum, the radius of this zone will extend to 100 m around all known infested plants.

5.53. The **buffer zone**, which will initially include the area within 2 km of the infested zone, but may extend further depending on the situation. This can be reduced to an area within 1 km of the infested zone following surveys, if considered appropriate by the IMT.

5.54. Initial maps of outbreak sites should be produced by officials.

5.55. All host plants within the infested and buffer zone should be surveyed for signs of the beetle.

5.56. If it is considered possible that the beetle has been spread to other destinations, such as those with a history of receiving potentially infested trees or wood from within the demarcated area e.g. firewood merchants or local authority green waste disposal sites, then these areas should be surveyed. These zones should be treated as if they are part of the buffer zone.

5.57. The demarcated area should be adjusted in response to further findings. If the cerambycid is found within an area outside the infested zone, this should subsequently be designated as infested.

5.58. The PHSI or FC will contact garden centres, nurseries and other traders of host plants, as well as owners/managers/tenants of woodland areas, conservation areas and amenity land such as parks, within the demarcated areas to inform them of the requirements that will apply to them (see Pest Management Procedures). Controls on the movement of specified plants or wood will be implemented either by statutory plant health notices, or by a statutory instrument, or a combination of the two, depending on the nature and scale of the incident. The location of any demarcated areas will be published on '.gov.uk' in order to inform all other stakeholders (including residents, businesses and landowners) within the demarcated areas of the requirements that will apply to them.

Surveillance

5.59. Ideally, all host plants should be surveyed in the buffer zone. Hosts nearest to the infested zone should be surveyed first, with decreasing priority as the distance increases from the infested zone. The area closest to the infested zone, and high risk premises, such as nurseries and firewood importers, may be surveyed by a systematic survey of all host plants and plant products, and the rest may be surveyed by surveying just high risk hosts. The areas to be surveyed systematically and by surveying only high risk hosts, and how this should be done, will be determined by the IMT.

5.60. A selection of sentinel plants will also be surveyed on a more regular basis, ideally at least three times per year (in spring, summer and winter). These will be single or groups of trees of the most favoured hosts of the cerambycid selected to have a representation across the demarcated area. These trees could be selected on a circular route around the outbreak site (based on public pathways or other convenient routes), thereby providing a balance between being representative and accessible.

5.61. Hosts will initially be surveyed by inspectors from the ground with the aid of binoculars. Qualified tree climbers may also be used, as they can spot symptoms that would not be possible to detect from the ground. A decision on when and where to use tree climbers will be made by the IMT.

5.62. If suspicious symptoms are seen on host plants, as well as non-host plants, that cannot be dismissed as being likely to be due to another cause, destructive sampling is required to confirm infestation by the cerambycid, including the removal of the bark to reveal young larvae and tunnelling, and/or cutting through the trunk or branches to reveal deeper galleries within the sapwood and heartwood (Ostojá-Starzewski, 2016).

5.63. If available, traps may also be used for monitoring of adult beetles during their flight period.

5.64. Surveys will be carried out annually, and will continue until no beetle has been detected for at least two lifecycles of the beetle. These surveys will be carried out by ground surveyors and tree climbers, with a specific survey plan developed based on the outbreak situation.

5.65. The first surveys of the demarcated area will be carried out as soon as possible after the outbreak has been discovered. For deciduous trees, subsequent surveys will be carried out during the winter or early spring when the trees are not in leaf, as this is considered to be the best time of the year to detect exit/ejection holes.

5.66. To aid surveillance, trees to be inspected or which have been inspected can be mapped using GIS software or similar.

Pest Management procedures

5.67. The movement of host plants and plant products (e.g. wood and wood packaging) out of or within the demarcated area should be restricted as appropriate.

5.68. All host plants within a radius of at least 100 m of any plant or plant product found to be infested should be cut down and removed. The distance chosen will depend on the biology of the cerambycid. If there is little information on its biology, it should be considered to be similar to *A. glabripennis*. There is evidence showing that *A. glabripennis* is able to fly greater than 100 m and up to 203 m (Straw *et al.*, 2016), therefore felling of preferred hosts further than 100 m should be considered. This would depend on the outbreak situation (including the extent, age and source of the outbreak) and host distribution in and around the infested zone. If infested plants are found outside the flying period for the beetle, the felling and removal should be carried out prior to the start of the next flying period, but ideally within a short space of time to allow the felled trees to be checked for further signs of infestation which could lead to the need to fell additional trees.

5.69. The removal of host plants will remain the responsibility of the occupier or other person in charge of the premises and should be carried out under notice. Contact information for the Arboricultural Association with their register of qualified tree surgeons and ConFor (Confederation of Forestry Industries) will be provided to enable landowners to identify qualified operatives to carry out removal work. In exceptional circumstances, the removal of trees and shrubs may be carried out by the PHSI or FC.

5.70. In the case of private householders, officials may agree to organise the felling and removal of host trees and shrubs with responsibility for payment of costs remaining with the occupier or other person in charge, or for it to be undertaken by the relevant local authority which will be responsible for determining whether to accept responsibility for the costs of the work or seek recovery. Exceptionally, officials may, in the interests of speed, have to arrange for the work to be carried out and bear the cost, where possible seeking recovery after the event.

5.71. The radius of the areas described may be adjusted to reflect the density of potential and favoured hosts and the number of beetles, larvae, exit holes and other symptoms that have been found.

5.72. In exceptional cases where the IMT concludes that felling is inappropriate, an alternative eradication measure may be applied offering the same level of protection against the spread of the cerambycid.

5.73. Plants and hedgerows should be cut as close as possible to ground level. The cut surface should be examined for signs of cerambycid activity. If signs are found then the stumps should be ground down to a level at which no symptoms are seen or, alternatively, the stumps should be dug up. Any roots above ground may also need to be removed.

5.74. If the removal of stumps could cause unacceptable damage, fine mesh may be used to cover the stumps to prevent the escape of any remaining beetles, and to prevent any re-infestation (van der Gaag *et al.*, 2010; Roselli *et al.*, 2013). The IMT will advise this on a case by case basis.

5.75. Where feasible all felled trunks and branches should be cut into sections of a size that can be easily turned over and examined by inspectors before disposal. The outside of the logs and cut ends must be examined for any signs of cerambycid damage. This could include exit holes and frass. Damage that is considered to potentially be caused by the cerambycid should be checked by cutting thin slivers of wood away from the surface to reveal whether there is any tunneling below, and/or splitting the wood open with a hand axe. An alternative to cutting open suspect logs in the field is to transfer them to a laboratory or other facility set up to carry out this task. If this option is taken then the logs need to be transported within three layers of containment and the laboratory/other facility needs to be licensed to hold such materials.Although time consuming, this may yield valuable information, including the extent and age of an outbreak.

5.76. The possibility of using foliar insecticide treatments and/or biopesticides will be considered by the IMT for trees or shrubs within the infested zone if the outbreak is discovered during the potential adult flight period. They could help to prevent further spread of cerambycids in the year that the outbreak is first discovered. However, they are likely only to be beneficial for heavy infestations of the beetle, where there is a high likelihood of further spread, as treatments have the potential to act as repellents to adult beetles.

5.77. Prior to any pesticides being used, the risk posed by the pesticide to people and the environment will be assessed.

5.78. Any applications should be made following the advice on the product label and be in accordance with HSE guidance. In some cases there may be a requirement to carry out a Local Environment Risk Assessment for Pesticides (LERAP) depending on the product used and the situation of the finding.

5.79. If there is a finding within a SSSI, Natural England should be contacted to assess the threat of the pesticide application to the site.

5.80. After the clearance of plants in the infested area, sentinel plants of an appropriate size may be planted and/or marked out from already established plants within this zone in order to attract and monitor for the cerambycid. The plants will be as close as possible to the locations where the infested plants were found, ideally on publicly owned or managed land, but always with the prior consent of the person in charge of the land. The plants will be inspected for signs of infestation a minimum of twice a year. If signs or symptoms of cerambycids are seen, these plants will be destructively sampled.

Disposal plan

5.81. During the cerambycid flight period, all felled plants and parts of plants from the infested area should be destroyed/processed as soon as possible after it has been inspected, within a maximum of one week. Options for destruction/processing are:

5.82. Wood chipping. This would be the most appropriate method of disinfesting shrubs, trees and branches.

5.83. Burning or incineration.

5.84. Moved under containment to a location known and approved by the PHSI or FC. For example, material with no visible signs of infestation could be moved to a new location in cerambycid proof containers (e.g. steel shipping containers) and dealt with once conditions are too cool to permit adult activity.

5.85. During the winter, unprocessed logs may be indelibly marked then moved out of the infested area under official notice if they are going to a site where they will be processed by one of the following methods before the following flight season:

5.86. Wood chipping. It may be possible to leave the chipped material in situ but away from footpaths etc. (e.g. where large areas are infested) under an Environment Agency exemption which permits a maximum of 250 cubic metres in any one deposit.

5.87. Burning or incineration. Burning either in situ (under an Environment Agency exemption, which allows a total quantity not exceeding 10 tonnes to be burned in any period of 24 hours) or at a commercial incinerator. NB: it will often not be practical to burn whole trees or large sections, other than those with small diameters e.g. branch wood.

5.88. Other methods of disposal, such as deep burial of non-hazardous waste at a local authority approved landfill site, or use as biomass, may be considered on a case by case basis.

5.89. In cases where a local authority has the necessary equipment and facilities to carry out the removal and destruction of host material in amenity areas, arrangements may be explored with the authority concerned for the disposal of material from other sources such as private dwellings and commercial premises.

5.90. Any disposal of waste material must be done in accordance with the relevant legislation. Growers need to obtain permission for exemptions from the Agricultural Waste Regulations from the Environment Agency. No charges are made for these exemptions. Further information on activities that require a permit and those which require the registration of an exemption can be found on the EA website at: https://www.gov.uk/topic/environmental-management/environmental-permits.

5.91. Landowners need to ensure that any clearance complies with Habitat Regulations. If needed, permissions can be sought to undertake emergency activities e.g. felling. Further information may be obtained from Natural England or the FC (the latter being the lead authority for all forestry activity).

Replanting

5.92. No host plants will be planted in the demarcated area during the outbreak, except sentinel/trap plants. Trees suitable for replanting will be dependent on the cerambycid found.

6. Criteria for declaring eradication / change of policy

6.1. The outbreak will be declared eradicated if the pest is not detected for a period covering at least two lifecycles of the cerambycid.

7. Evaluation and review of the contingency plan

7.1. This pest specific contingency plan should be reviewed regularly to take into account of changes in legislation, control procedures, pesticides, sampling and diagnosis methods, and any other relevant amendments.

7.2. Lessons should be identified during and after any outbreaks of cerambycid beetles or other pest, including what went well and what did not. These should be included in any review of the contingency plan leading to continous improvement of the plan and response to outbreaks.

8. Annex A - *Saperda candida* (round-headed apple tree borer)

Background

Distribution

Saperda candida is native to North America and is currently present in southern Canada and central and eastern USA (EPPO Global Database, 2018a) (see figure 1). The beetle was also recorded on the Island of Fehmarn, Germany, in 2008, following finds of circular bore holes (~ 9 mm diameter) and a beetle on stems of *Sorbus intermedia* (Swedish whitebeam) along an avenue in Johannisberg and Mattiasfelde (EPPO Reporting Service, 2008). Eighteen of the 250 trees lining the avenue were subsequently felled and incinerated, and monitoring carried out within 2 km of the infested trees. Further symptoms were discovered on two *Malus* trees on a private property and on *Crataegus* on a public green. The beetle is currently classed as under eradication in Germany.

Hosts

Cydonia oblonga (quince), *Malus domestica* (apple), *Pyrus communis* (pear), *Prunus avium* (cherry), *P. domestica* (plum) and *P. persica* (peach) are considered to be important cultivated hosts, while *Amelanchier* (Juneberry), *Aronia* (chokeberry) *Crataegus* (hawthorn), *Malus coronaria* (wild crab-apple) and *Sorbus* (mountain ash) are considered important wild hosts (Hess, 1940; EPPO, 2009). Some other hosts mentioned, such as the flowering plant, *Solidago rugosa*, may only be incidental/visited by adults. An up to date host list can be found on the EPPO Global Database - https://gd.eppo.int/taxon/SAPECN/hosts.

Lifecycle

Following a 5 to 17 day period after eclosion (emergence period) in the host plant, adults emerge over a month period between April and July in their native range. This follows a latitudinal gradient moving from the south to the north in this native range (Wilson, 1924; Hess, 1940). After mating and following a period averaging 13 days (ranging from 4 to 26 days), females move to the base of the trunk to lay their eggs, preferably in warm, humid conditions (Hess, 1940). They first make a slit in the bark with their mandibles, before making a semi-circular opening to one side of the slit between the bark and the cambium into which their eggs are laid (Hess, 1940). Under experimental conditions, females laid an average of 21 to 41 eggs over a period of about 22 days (ranging from 8 to 41 days), and it is expected that females would lay closer to 41 eggs over a longer time period in nature (Becker, 1918; Hess, 1940).

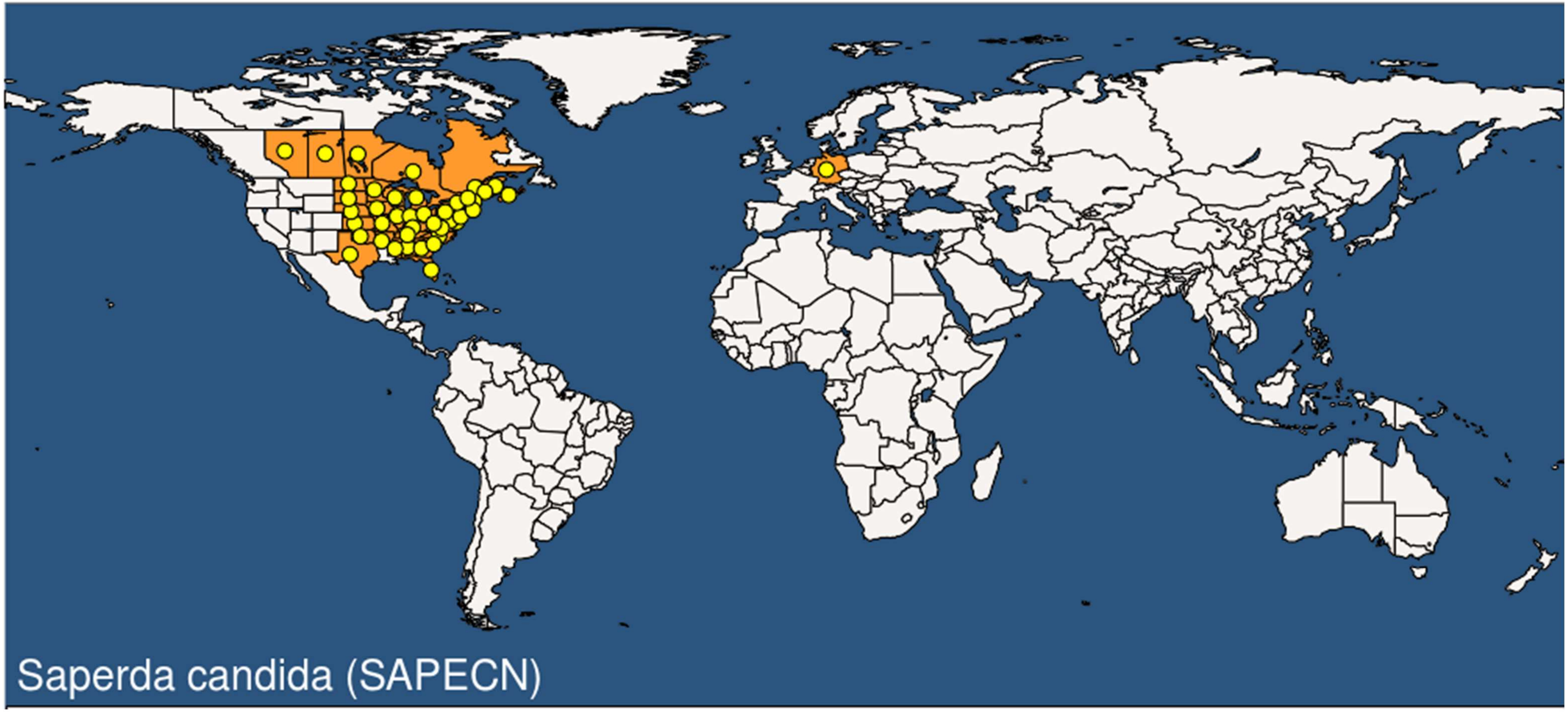

Figure 5. Distribution map for *Saperda candida* as of June 2022. (Source EPPO Global Database). The link below provides up to date distribution data. https://gd.eppo.int/taxon/SAPECN/distribution.

Larvae hatch from the eggs in about 14 and a half days (ranging from 10 to 25 days) and initially bore into the inner bark or cambium layer, before tunnelling into the wood as they develop (Wilson, 1924; Hess, 1940; EPPO, 2010). Larvae continue to form galleries upwards and downwards through the trunk near to where they hatched until late autumn. During this they leave a trail of frass which is pushed through openings in the trunk (Chandler, 1949). During the winter, larvae move to the bottom of their tunnels (at or below ground level) (Hess, 1940). The length of larval development depends on the temperature and can take between one and five years in the native range of the beetle (Hess, 1940). Once mature, the larvae excavate pupal chambers near to the bark (Wilson, 1924; Hess, 1940). Pupation generally lasts about 20 to 25 days (Becker, 1918; Brooks, 1920; Hess, 1940).

Hess (1940) recorded the average lifespan of male and female adults as 11 and 26.2 days, respectively, but this is likely to be an underestimate due to the confined experimental conditions the adults were subject to. Adults feed on foliage, fruit and bark, with hawthorn being preferred over apple, pear and chokeberry (Hess, 1940). Bark was also preferred over fruit and foliage when the beetle was studied on apple trees (Hess, 1940).

Detection and inspection methods

Morphology

Egg: Light cream colour when laid and turns light brown as it ages. The egg is about 3.5 mm long and 1.3 mm wide.

Larva: Legless and cream coloured. A newly hatched larva is about 3-4 mm long, while a mature larva is about 40-45 mm long. The pre-pupal stage is shorter, and is about 18-19 mm long in males, and 24-25 mm long in females.

Pupa: Initially light yellow, before the mandibles, eyes, wings and leg joints darken with age. The pupa is 18-19 mm long in males, and 23-24 mm long in females.

Adult: The dorsal side of the body is light brown, with the exception of two white stripes, which extend from the head to the tip of the elytra. The eyes are black, and the antennae, face, legs, and the under surface of the body are silvery white. Adults range from 12-22 mm long, though most are between 18 and 20 mm long. Males and females differ by their pygidium (hind segment), which is entire in males and formed of two longitudinally separated plates in females.

Fig. 6. Adult *S. candida*. © Ben Sale under licence https://creativecommons.org/licenses/by/2.0/.

Diagnostics

There are no morphological keys that will allow the positive identification of eggs, larvae or pupae of *S. candida*. Adults can be identified to the family Cerambycidae using Booth *et al.* (1990) and confirmed to the genus *Saperda* using Bense (1995). Identification to species requires regional keys and descriptions, which can be obtained using Nearns *et al.* (2017). There are no published reference sequences for *S. candida*, though there are sequences for 17 other species within the genus.

Symptoms

Whole plant

Feeding by young larvae within the trunk cambium can prevent the circulation of sap, weakening the tree, inhibiting fruit production, causing dieback, and eventually leading to the death of the tree (Hess, 1940; Chandler and Flint, 1942; EPPO, 2010). Galleries formed in the wood layer can also weaken the tree to a point that the trunk can be broken off in the wind (Hess, 1940; EPPO, 2010).

Trunk

Larvae bore galleries underneath the bark in the cambium layer and the sapwood of the tree, which can be seen when the bark is removed (Hess, 1940). As the larvae feed, they also produce a copious amount of frass, which can be seen at the base of the tree trunk (Wilson, 1924; Hess, 1940). Additionally, when adults emerge from the pupal chamber and leave the tree, they produce emergence holes of around 4.7 and 6.1 mm in diameter (males and females, respectively) (Hess, 1940). Generally, the emergence holes are concentrated near the base of the trunk, within the first 7 or 8 inches, though very occasionally they are found several feet above the ground (Hess, 1940).

Surveillance

Visual inspection is the primary method for detecting infested trees. Surveys should focus on all woody host plants, particularly *Cydonia oblonga* (quince), *Malus domestica* (apple), *Pyrus communis* (pear), *Amelanchier* (Juneberry), *Aronia* (chokeberry) *Crataegus* (hawthorn), *Malus coronaria* (wild crab-apple) and *Sorbus* (mountain ash). Symptoms to look for include:

- Frass underneath the tree (Wilson, 1924; Hess, 1940).
- Exit holes in the trunk (averaging 4.7-6.1 mm in diameter), with a focus on the first 7-8 inches of trunk from the ground (Hess, 1940).
- Adult beetles, which are easily recognised from their colouration.

To confirm a tree is infested, destructive sampling is usually required, including the removal of the bark to reveal larvae and tunnelling, and cutting through the trunk to reveal deeper galleries within the sapwood.

Outbreak control methods

Hess (1940) describes a method of hitting infested trees with a large padded wooden mallet 10 times during the pupal/pre-emergence period. This was effective in preventing the emergence of any beetles from 10 young seedling apple trees.

Wood chipping – to dimensions of no more than 15 mm in thickness and width (based on the size of pupae).

9. Annex B - *Oemona hirta* (lemon tree borer)

Background

Distribution

Oemona hirta is native to New Zealand and is present on both main islands (EPPO Global Database, 2018b). It has also been recorded on other islands off the two main islands, including Somes, Mopokuna, Cuvier, Kapiti, Blumine and Pickersgill (Campbell *et al.*, 1984; Moeeds and Meads, 1987; Grehan, 1990). The beetle is fairly widespread in New Zealand, but is uncommon in drier areas (Hosking, 1978).

The beetle was intercepted in the UK on *Wisteria* plants in 1983 and 2010, but no further beetles have been found (EPPO, 2013).

Hosts

Oemona hirta is highly polyphagous, with most records of damage coming from woody dicotyledons (EPPO, 2014). The native New Zealand plant, mahoe (*Melicytus* spp.), is considered to be one of the primary hosts of *O. hirta*, but the beetle has also been recorded on a number of other endemic species to New Zealand, and a number of species that have been introduced to the country (EPPO, 2014; DeNitto *et al.*, 2015). It is likely that a number of hosts remain unrecorded and that *O. hirta* will be able to use other species as hosts outside of its native range.

Damage has been most frequently reported on *Citrus* spp. but other records of significant damage relate to *Diospyros kaki* (persimmon), *Vitis vinifera* (grapevine), *Malus* spp. (apple), *Populus* spp. (poplar) and *Ulex europaeus* (gorse) (EPPO, 2014). Occasional damage has also been reported on *Prunus dulcis* (almond), *P. avium* (cherry), *P. domestica* (plum), *P. persica* (peach), *Vaccinium* sp. (blueberry), *Castanea* sp. (chestnut), *Corylus* sp. (hazelnut), *Pyrus* spp. (pear), *Juglans* (walnut), *Cytisus scoparius* (broom), *Acacia melanoxylon* (blackwood), conifer hosts (*Abies* (fir), *Pinus* (pines), *Chamaecyparis* (cypress), *Cryptomeria*, *Cupressus* and *Sequoia sempervirens* (coast redwood)), *Euonymus japonicus*, *Quercus* sp. (oak), *Paulownia*, *Salix* sp. (willow), *Alnus* (alder), *Acacia*, *Eucalyptus*, *Fraxinus* (ash), *Platanus* (plane), *Podocarpus*, and *Ulmus* (elm) (EPPO, 2014).

A comprehensive list of host plants, containing 200 species from 81 families, can be found in Annex I of the EPPO PRA (EPPO, 2014).

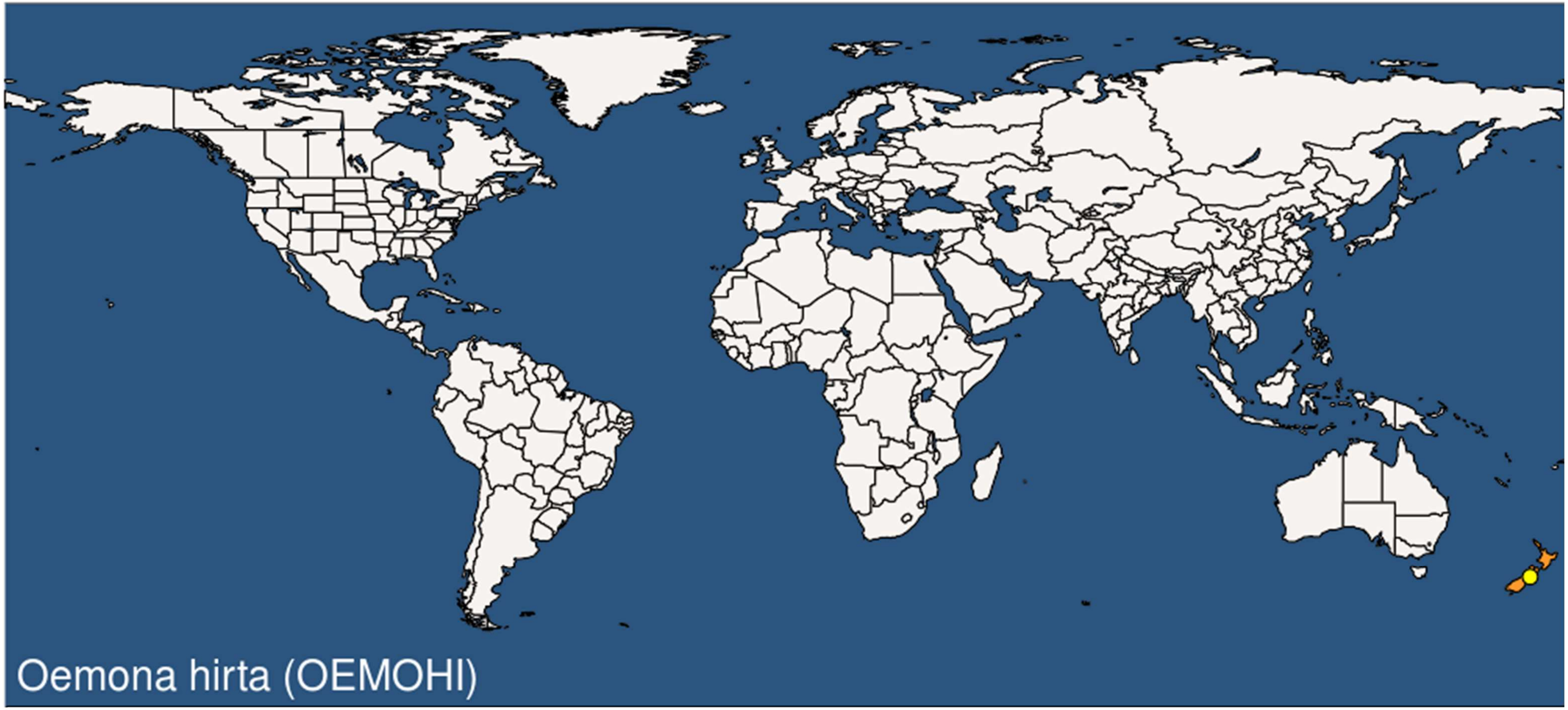

Figure 7. Distribution map for *Oemona hirta* as of June 2022. (Source EPPO Global Database). The link below provides up to date distribution data. https://gd.eppo.int/taxon/OEMOHI/distribution.

Life cycle

Following a short period after eclosion that allows their integument to harden, adults emerge from their host between October and January (EPPO, 2013). After a further 3-4 days, adults begin to mate (Wang *et al.*, 1998; DeNitto *et al.*, 2015). Females then begin to lay eggs singly in the junctions of leaves and stems, bark crevices and fresh pruning wounds (Taylor, 1957; Clearwater, 1981; Lu and Wang, 2005; Gourlay, 2007). Generally, these are laid on twigs and less often on branches and stems or on dead wood (Dumbleton, 1937; Hosking, 1978). Wang *et al.* (1998) reported females laying an average of 51.3 eggs, with an average oviposition period of 17.7 days under experimental conditions. Outdoors, Dye *et al.* (1950) observed an oviposition period of 30 days.

Following an incubation period of 9-13 days, larvae hatch from the eggs and bore directly into the wood of their host, first into the sapwood and then into the heartwood (Dye, 1950; Wang *et al.*, 2002; EPPO, 2013). If they are in a branch, larvae will generally tunnel through the branch towards the stem, and sometimes into the stem itself (EPPO, 2014). There are also some larvae that bore around the branches (Cottier, 1938). Side tunnels leading out of the tree are produced at regular intervals (every 6-8 cm or so), allowing larvae to eject any accumulated frass ("ejection holes", Dumbleton, 1937; Lu and Wang, 2005). Once mature, larvae form a cell in the wood in which to pupate (Clearwater, 1981). Pupation lasts for roughly 2-3 weeks (Cottier, 1938; Wang *et al.*, 2002; Lu and Wang, 2005), though low temperatures may extend this period; Dye (1950) observed a pupation period lasting 63 days outdoors at 11°C and 83% RH.

Adults live for 1-2 months, are generally active at night, and feed on pollen and nectar (Dye, 1950; Clearwater, 1981; Wang *et al.*, 1998; EPPO, 2013). In most parts of New Zealand, the lifecycle of *O. hirta* is two years, but given that the larval period can be completed within 150-300 days at 23°C in the lab, the lifecycle may be as little as one year in warmer climes (Wang *et al.*, 2002; EPPO, 2014). Equally, the lifecycle may be extended beyond two years in colder climes (EPPO, 2014).

Detection and inspection methods

Morphology

Egg: Large (2-2.2 mm) (EPPO, 2013).

Larva: Reaches 25-40 mm in length and about 8 mm wide at maturity, is creamy white, and has dark brown/black mandibles (Hudson, 1934; Dumbleton, 1957; Clearwater, 1981; Ostojá-Starzewski *et al.*, 2010).

Pupa: Around 20-25 mm in size (EPPO, 2014).

Adult: Females are 14-31 mm in length and are larger than males, with proportionately smaller antennae (Ostojá-Starzewski *et al.*, 2010). The body colour is red-brown to almost black, and the elytra are covered in fine yellow hairs (Ostojá-Starzewski *et al.*, 2010). A distinctive feature is the transverse, parallel raised ridges on the dorsal surface of the thorax (Ostojá-Starzewski *et al.*, 2010).

Diagnostics

Larvae arriving from New Zealand can be examined with reference to Dumbleton (1957), but this only covers 20 species native to New Zealand, including *O. hirta*, but not other *Oemona* species, so *O. hirta* cannot be excluded from its sister taxa. Duffy (1963) provides a standalone description of *O. hirta* larva, but likewise does not refer to the other *Oemona* species. Therefore, any larvae must either be reared to adult stage or tested using DNA sequencing. The adult may be morphologically diagnosed using Lu and Wang (2005) and Ostojá-Starzewski *et al.* (2010). Three reliable sequences are available for *O. hirta*, but there are no sequences available for other *Oemona* species. However, the barcode region used will usually differentiate between species unless they hybridise or form species complexes.

Symptoms

Larvae bore galleries underneath the bark in the sapwood and heartwood of the tree, predominantly in twigs and branches, but sometimes in the trunk (EPPO, 2014). This feeding can lead to the wilting and death of twigs, and the collapse of branches in the wind. Larvae which bore around branches can also girdle them, leading to their death (Cottier, 1938).

As larvae feed, they produce frass, which may be seen around the ejection holes (EPPO, 2014). These ejection holes, measuring 1-3 mm, may also be able to be seen (EPPO, 2014) and are often produced at regular intervals giving an infested twig a flute-like appearance.

Surveillance

Visual inspection is the primary method for detecting infested trees. Because *O. hirta* has such a wide host range, and there are likely to be many hosts that are unrecorded, all woody plants should be surveyed, with particular focus on *Citrus* spp., *Vitis vinifera* (grapevine), *Malus* spp. (apple), *Populus* spp. (poplar) and *Ulex europaeus* (gorse). Symptoms to look out for include:

- Ejection holes (1-3 mm) and frass
- Dead or wilting twigs and/or branches
- Adult beetles

To confirm a tree is infested, destructive sampling is usually required, including the removal of the bark to reveal larvae and tunnelling, and cutting through the twigs and branches to reveal deeper galleries within the sapwood and heartwood.

Outbreak control measures

The nematode, *Steinernema feltiae*, has shown promising results against *O. hirta* as a biological control agent in studies by Clearwater and Wouts (1980) and Wouts and Clearwater (1980).

Wood chipping – to dimensions of no more than 15 mm in thickness and width (based on the size of pupae).

8. Annex C - *Neocerambyx raddei* (oak longhorn beetle)

Background

Distribution

Neocerambyx raddei is a longhorn beetle species (Family: Cerambycidae, Cerabycinae) native to Asia, and has been reported in China, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Taiwan, Vietnam, and Far Eastern Russia (EPPO Global Database, 2020). Up to date distribution data can be found on the EPPO Global Database - https://gd.eppo.int/taxon/MALLRA/distribution

It is considered to be the most significant pest in oak forests of North Eastern China, infesting approximately 264,00 Ha with an average of 26.5 individual adults per tree, but reaching up to 156 adults per tree in severe infestations (Yang *et al*., 2014).

The beetle is absent from the UK (Duff, 2012) and, with the exception of eastern Russia, has not been intercepted within the EPPO region. The areas of Russia that are affected are the southern parts of Amurskaya oblast, Khabarovskii krai and Primorskii krai. These areas all border north-eastern China, notably Primorskii krai, which borders the Chinese state of Jilin that has been severely affected by the pest (EPPO, 2018b).

Hosts

Neocerambyx raddei is a serious pest of trees in the Fagaceae family, notably *Quercus* sp. (oaks), *Castanea* sp. (chestnuts) and *Castanopsis* spp. (chinquapin), including *Castanopsis cuspidata* and *Castanopsis cuspidata* var. *sieboldii*.

There are also reports of the beetle attacking ornamental and bonsai plants, including *Morus* sp. (Mulberry), *Paulownia* sp., *Fraxinus mandshurica* (Manchurian ash), *Citrus* spp., *Xylosma* sp. (Brushhollies) and *Zelkova* sp. However, these records are considered to be less reliable than those for hosts in the Fagaceae family due to the absence of an original source (EPPO, 2018b).

There have been no reports of *N. raddei* attacking species of *Quercus* or *Castanea* which are present naturally in the UK, however it is unknown whether these could be attacked following the introduction of the pest. A comprehensive host list can be found on the EPPO Global Database - https://gd.eppo.int/taxon/MALLRA/hosts.

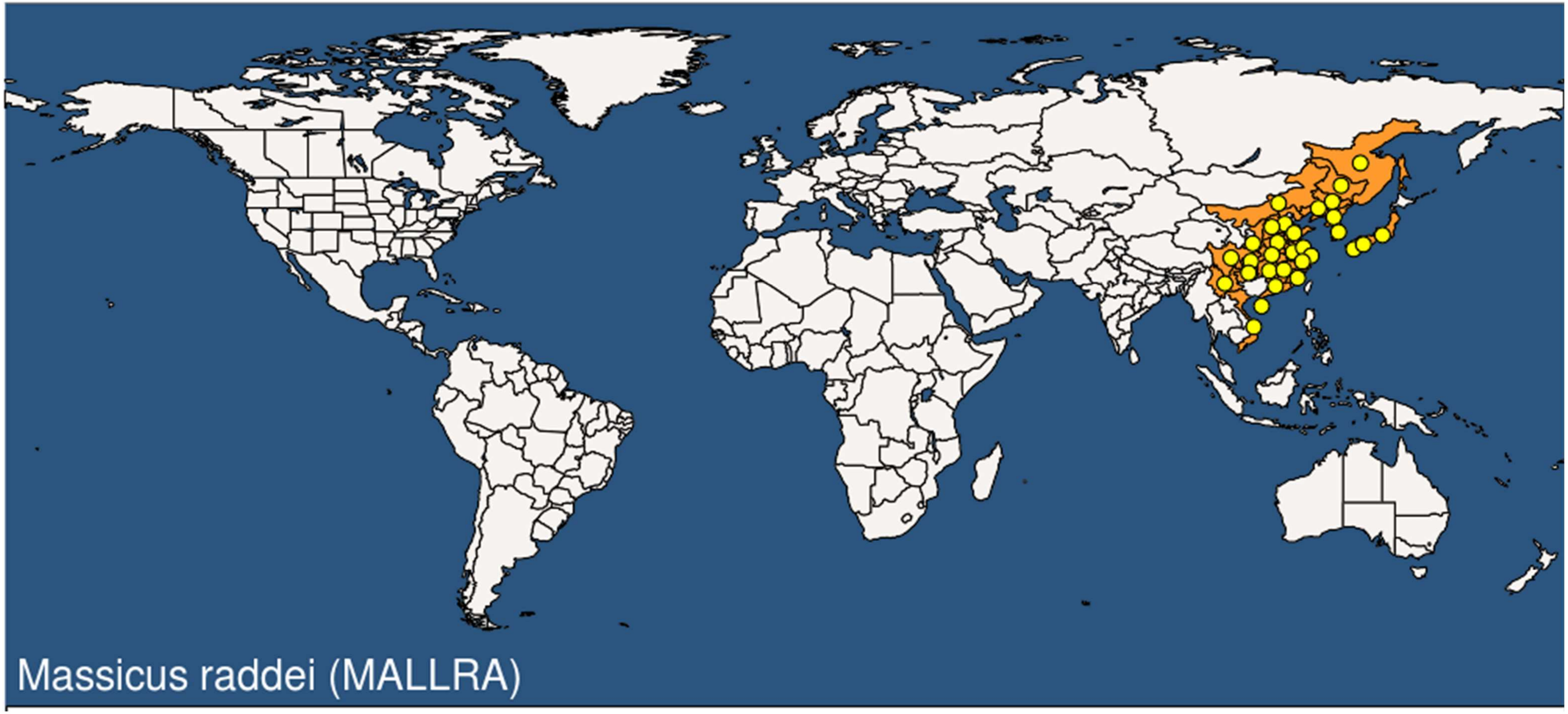

Figure 8. Distribution map for *Neocerambyx raddei* as of August 2022. (Source EPPO Global Database). The link below provides up to date distribution data. https://gd.eppo.int/taxon/MALLRA/distribution.

Lifecycle

Neocerambyx raddei is in the Cerambycinae subfamily of the Cerambycidae family of beetles. It has a long lifecycle that could facilitate introduction via dormant material, with larvae also able to survive in timber and wood packaging material (WPM).

Work by Wang *et al*. (2012) has recorded a total generation time of approximately 3 years, with 6 larval developmental stages. However, this data is based on the beetle's current geographical range, and therefore may vary under the different climatic conditions in the UK.

Emergence appears to be synchronous (Yang *et al*, 2014), with the adult population peaking every 3 years and small numbers of adults emerging in the intervening years. In its native habitat adults emerge between July and August, with temperatures of between 22 and 26°C, and a relative humidity of between 50 and 80%, providing optimal conditions for adult activity (Tang *et al*., 2011).

Trapping studies indicate night time to be the period of peak activity for adults (Jiang *et al*., 2010), with adults flying up to 80m in a single flight and achieving a total flight distance per night of between 300 m and 1 km. Other studies have reported shorter distances (EPPO, 2018b).

After emerging, females and males survive for approximately 22 and 19 days, respectively, during which time mating occurs. Two to three days after mating, females start to lay their eggs and do so over ~ 14.8 days and these are deposited singly in bark crevices towards the base of the trunk. During oviposition the eggs are coated with a mucus like protective layer. On average each female will lay between 8.5 and 23.7 eggs during the oviposition period. Oviposition preferentially takes place on living trees over 35 years old with rough bark, and mainly on oak trees on sunny slopes and ridges (Sun *et al.*, 2010).

The egg hatch lasts about 11 days (EPPO, 2018a) and the first instar larvae penetrate the bark. The first three instars of the larvae feed on the phloem and cambium layers of wood during the first year, with the 2^{nd} and 3^{rd} instars overwintering within these layers. In the second year, the fourth instars continue to feed in the phloem, before the fifth instars migrate into the xylem where they overwinter. The sixth instars remain in the xylem and pupate, which takes approximately a month prior to emergence in June and July. Throughout their entire development, larvae will tunnel in any direction but create only a single frass ejection hole.

Likely Pathways

The EPPO PRA (2018b) for *N. raddei* identifies plants for planting, firewood and WPM as major pathways for the beetle. The entry of *N. raddei* on plants for planting into the UK is mitigated to some extent by the prohibition of *Castanea* sp. and *Quercus* sp. plants for planting from 3rd countries in accordance with Schedule 6 of The Plant Health (Phytosanitary Conditions) (EU Exit) (Amendment) Regulations 2020 . However, *Castanopsis* spp. are not prohibited, and there is a derogation for bonsai and dwarfed varieties of *Castanea* sp. and *Quercus* sp. The import of these plants for planting, which have a measurement of >9cm at DBH, or >9cm at trunk base in respect of bonsais, therefore remains a risk.

EPPO reports that the distribution of the pest in China is currently limited to sites where logging was prohibited and felling was only allowed for sanitary or scientific purposes until 2017, with Hoffmann *et al*. (2018) reporting that this was extended under the National Forest Protection Programme to phase out all commercial logging operations by 2017. When this is coupled with limited trade to the EU, roundwood (excluding firewood) is considered to be a low risk pathway for the beetle. Firewood is considered to be a higher risk than other roundwood types because of the lower quality of wood.

The import of the pest via WPM is considered to be a risk as, although *Castanea* sp. and *Quercus* sp. are not commonly used timber for WPM, they can be used and longhorn beetles have been regularly intercepted from Europe, other Asian countries, Africa, Australasia and the Americas in WPM despite the introduction of ISPM 15 (Eyre and Haack, 2017). However, the application of ISPM 15 will reduce the likelihood of entry on this pathway to some degree and therefore WPM is considered to be less of a risk than plants for planting and firewood.

Other pathways assessed by the EPPO PRA include wood products. As the width of larval galleries exceed 1cm, they are likely to be apparent, and therefore pieces of infested wood are unlikely to be used for producing wood products such as furniture. Wood chips, hogwood, processing residues and sawn wood are also considered low risk pathways (EPPO, 2018b).

Detection and inspection methods

Morphology

Neocerambyx raddei is in the Cerambycidae family of longhorn beetles, generally recognisable by their highly elongate antennae. Within this family, *N. raddei* sits in the sub-family Cerambycinae distinguishable by a large and undivided stridulatory plate on the mesonotum (Benzel, 2015).

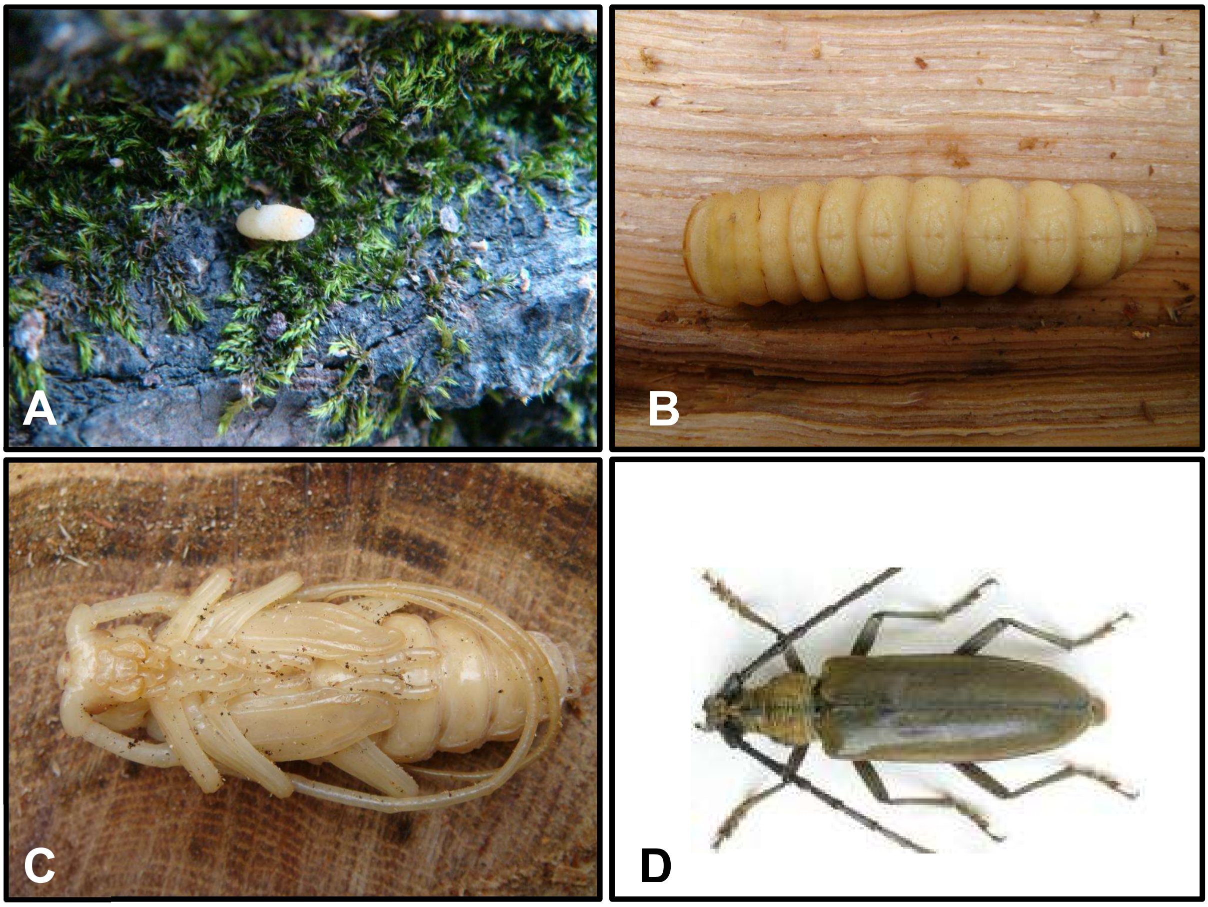

Figure 9. *Neocerambyx raddei* (a) eggs, (b) larva, (c) pupa and (d) female adult (source: EPPO, 2020).

The following morphological descriptions are sourced from the EPPO PRA (EPPO, 2018b):

Eggs: Creamy-white when laid and turning yellow with age. They are elongate ovoid, approximately 4-5 mm x 1.4-2.5 mm. One end is rounded whilst the other tapers to a thick stalk and is coated with a mucus-like protective layer when freshly laid.

Larvae: Creamy white and can reach 65 mm x 11 mm when nearing pupation. However, average lengths range between 5 mm for 1st instars and 50 mm for 6th instars.

Pupae: Yellowish white and measure between 31 and 65 mm long.

Adults: 35-63 mm in length, brownish in colour with yellow setae on newly emerged adults. Male antennae are much longer than the body, whereas female antennae are shorter than the body.

Diagnostics

Neocerambyx raddei is absent from Europe and therefore cannot be identified using European regional keys e.g. Bense (1995). Although lots of biological information is available, there is limited specific descriptive information. Immature stages are described in Kojima (1931), some characteristics are provided in the original description in Bates (1873), and translations of Hua (2009) reportedly give descriptions of adults, but these may not be suitable for species identification. A screening guide has also been produced by Benzel (2015) (EPPO, 2018b), however this is not definitive and is designed for distinguishing between *N. cerambyx* and native US Cerambycidae.

While the complete mitochondrial genome has been sequenced, with reference material deposited in GenBank (Wang *et al*., 2016), it is unclear if this could be used to discriminate between other species within the Cerambycidae by comparative analysis of regions such as the COI region.

Symptoms

Tunnelling of larvae through the cambium, phloem and heartwood reduces tree vigour and in high numbers often leads to wind-breakages (Cao *et al*, 2015). Severe infestations or successive generations of re-infestation may result in tree mortality; there are even some reports of the beetle causing 90% mortality in stands on the upper slopes and ridges of Chinese Oak forests (EPPO, 2018b). Symptoms of infestation are consistent with other cerambycid beetles (see Figure 6), and include dieback of branches, withered crowns, frass ejection holes, emergence holes and the presence of tunnelling frass and/or sawdust at the base of stems (EPPO, 2018b). Whilst the frass ejection holes and subsequent trunk bleeds are symptomatic, they are likely to be too small to be used for pest detection.

Studies in north-eastern China have found that, in infested areas, only trees with trunks greater than 9.02 cm diameter at breast height (DBH) and bark thicker than 0.47 cm were infested. Similarly, bonsai plants larger than 9 cm at the base are considered to be susceptible. The work also showed feeding galleries are normally found in the first 4 m of the trunk, and the majority of pupae are found at a height of 1-4 m but can be found up to 7 m above ground level (Tang *et al*., 2011b).

There is no evidence that the larvae tunnel into wood below ground, leaving the roots unaffected. As two of the high risk hosts *Quercus* spp. and *Castanea* spp. both readily reshoot from the roots, tree mortality may not occur. The production of epicormic growth may therefore be indicative of an infestation.

There is also evidence of adults feeding on the sap of the tree through wounds they have themselves inflicted (Yang *et al.*, 2011)(EPPO, 2015), so trunk bleeds may be symptomatic, although not conclusive.

Surveillance & Monitoring

Visual inspection is the primary method for detecting infested trees. Surveys should focus on the three confirmed host genera of *Castanea*, *Castanopsis* and *Quercus*. Visual surveys could be carried out year round, as exit holes are likely to be within the first 7m of the trunk and are therefore unlikely to be obscured by leaves. Surveys could be twinned with the trapping described below to coincide with emergence, which based on the life cycle in its native range occurs between July and August. Aerial surveys could be used as an initial quick survey to look for signs of host crown dieback consistent with symptoms of other wood borers, and then be followed up by ground inspections.

Surveys in outbreak situations should include the surveying of the infested zone (100 m around all known infested trees) and the buffer zone (a further 2 km from the infested zone, potentially reduced to 1 km following surveys and agreement from the Incident Management Team). These surveys should be carried out annually until no beetle has been found for at least two lifecycles of the beetle.

Symptoms to look for include:

- Exit holes in the trunk from 1-7m above ground level (Tang *et al*., 2011b)
- Frass underneath the tree, which changes in composition as the larvae develop (Tang *et al*., 2011b) (see figure 6)
    - Year 1 - Faeces only (Dark brown, long and thin in shape)
    - Year 2 - Faeces combined with sawdust (yellow brown and powder like)
    - Year 3 - Faeces, sawdust and water (yellow brown and sticky)
- Frass ejection holes (Tang *et al*, 2011b)
- Adult beetles, feeding on sap from wounds in the tree. Active flying occurs at night and therefore trapping is more suitable for adult surveillance.

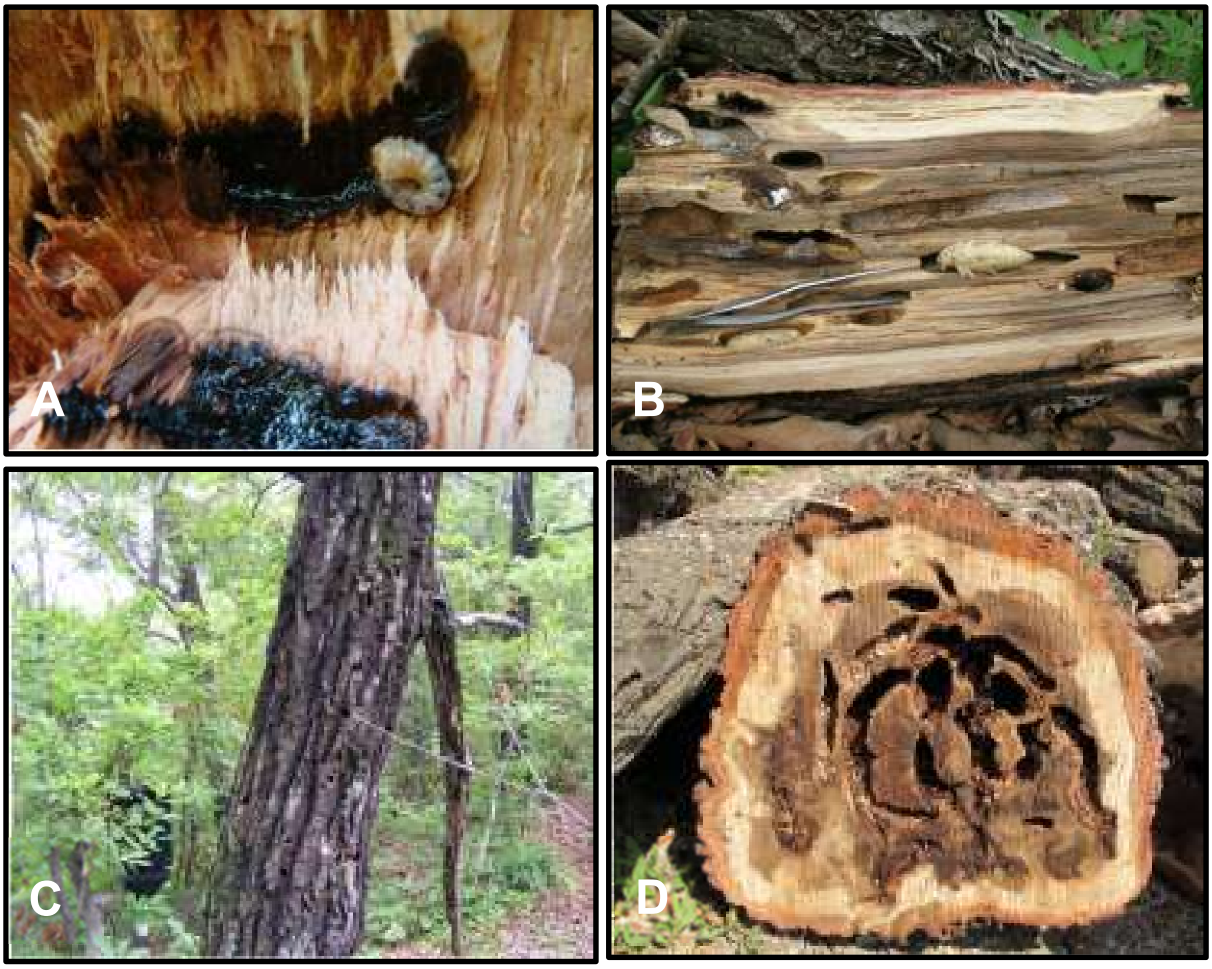

Figure 10. Damage caused by *N. raddei* (a) larval gallery and sticky frass typical of a year 3 larva (b) larval galleries and pupae within xylem (source: EPPO, 2018b) (c) trunk of *Q. liaotungensis* with multiple exit holes (d) cross section of larval galleries (source Cao et al, 2015).

To confirm a tree is infested, destructive sampling is usually required, including the removal of the bark to reveal larvae and tunnelling, and cutting through the trunk to reveal deeper galleries within the sapwood. All life stages can be present on/in trees with a DBH of above 9cm, and therefore this size of tree should be targeted.

Black light traps are non-specific traps using UV light, which are attractive to night flying insects. They can be effective at low population densities, and work by confusing night flying insects which use the moon for navigation (Nielsen *et al.*, 2013). Yang *et al*. (2011) report success using black light traps for *N. raddei* in Chinese forests, with a maximum of 20 kg of adult beetles caught in a single night. These catches included females which were yet to lay eggs, suggesting it may be good for control, as well as for monitoring, in outbreak situations, by removing adults before reproduction occurs. Pest density was reduced by approximately 90% in the Jilin province using this technique (Yang *et al*., 2014). As this is not a selective method of trapping their use will likely trap non-target species and impact on biodiversity within the local environment. The literature suggests they are readily used for catching a variety of lepidopteran and coleopteran species whilst also attractive to species in the Orthoptera, Isoptera and Dictyoptera (Ramamurthy *et al*, 2010).

Pheromones, which would provide a species specific trapping method, have yet to be isolated from *N. raddei* (EPPO, 2018b). Investigations into species specific trapping lures, including the use of pheromones of related beetles, their components and other plant volatiles, have shown that female *N. raddei* are attracted to ethanol and may have potential as a trapping lure. This work also concluded that ethanol baited lure traps were significantly more effective in the canopy when compared to the understorey (Li *et al.*, 2017).

Figure 11. Black light trap (Source Kamminga, 2012) and collected adults from forests in Jilin, China using black light trapping (Yang *et al.*, 2014).

Outbreak control methods

Removal and destruction of infested material

All disposal should be carried out as described in the xylophagous cerambycid contingency plan.

Infested trees, wood packaging material, timber and asymptomatic host trees within the infested zone with a DBH of above 9cm should be cut down, removed and disposed of by chipping or incineration. Wood chipping is deemed appropriate for disposal of smaller trees and branches. Any wood should be chipped to dimensions of 25 mm or less in thickness and width (based on the size of pupae).

Light trapping

Light trapping could be utilised as a mass trapping control measure. The work by Yang *et al.*, (2011) described above suggests black light traps can catch large numbers of adults, including females yet to lay eggs (see figure 7).

Biological controls agents

Some parasitoids have been investigated for their use as biological control agents (BCA) against *N. raddei*. Two of these, *Scleroderma guani* and *Dastarcus helophoroides*, show promise, with the former parasitizing the 1^{st} to 3^{rd} instar larvae and the latter parasitizing more mature larvae and pupae (EPPO, 2018b). Although geographic distribution data is not available for these species, they are widely studied in China for longhorn beetle control, suggesting they are native to Asia.

Chinese studies suggest that, in combination with black light trapping, these BCAs provide an effective Integrated Management System within infested forests. The work also found suitable alternate hosts which could maintain parasitoid population levels whilst no suitable *N. raddei* are available. This work has been carried out using native Chinese beetles as alternate hosts, so further investigation would be required to determine whether this is a viable option in the UK (Yang *et al*., 2014).

In addition, *Sclerodermus pupariae* (Wang *et al*., 2010), *Cerchysiella raddei* (Yang et al., 2014) and the braconid wasps *Rhoptrocentrus quercusi* sp. nov, *Doryctes petiolatus and Zombrus bicolor*, are mentioned as possible BCAs of the beetle (Cao *et al*., 2015).

All of the BCAs mentioned are not known to be present in the UK. Their safety would need to be assessed and a licence granted before any release, which may take several years. Therefore, there are currently no host-specific BCAs available for deployment in the event of an outbreak.

Chemical control

No trunk injection insecticides are currently registered for use in the UK. Other application methods would not be suitable due to the pest surviving within the tree.

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