Phytophthora ramorum

A Practical Guide for the Nursery Stock and Garden Centre Industry

defra
Department for Environment
Food and Rural Affairs

This publication has been written by ADAS with funding from Defra Plant Health Division. ADAS gratefully acknowledges the help and assistance provided by the Defra *P. ramorum* Industry Liaison Group and other consultative bodies in the preparation of this booklet.

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Published by the Department for Environment, Food and Rural Affairs.
Printed in the UK, August 2005, on recycled material containing
80% post-consumer waste and 20% totally chlorine free virgin pulp.

PB 11041

What to do if *P. ramorum* is suspected

If you know or suspect that species of *Camellia, Rhododendron, Viburnum* or any other known host plant are affected by the disease, notify Plant Health & Seeds Inspectorate (PHSI) immediately. The disease is notifiable and this is a legal requirement. PHSI will specify what to do under Statutory Notice. In the meantime:

- Do not handle or move the plants elsewhere.
- Inspect all other susceptible plants for symptoms and keep under observation. Include nursery perimeters with trees or likely hosts such as 'wild' *Rhododendron* and *Viburnum*.
- Do not apply anti-*Phytophthora* chemical treatments (e.g. fungicide products based on etridiazole, fosetyl-aluminium or propamocarb hydrochloride) to plants where *P. ramorum* infection is suspected. Such fungicides are likely to suppress *P. ramorum* and seriously compromise the management of the disease.
- Restrict or, where practical, avoid the use of overhead watering with plants known or suspected to have *P. ramorum* infection.
- Obtain and provide PHSI with all necessary documentation and records including supplier details, cultural history and plant passport information.

What to do if *P. ramorum* is confirmed

If *P. ramorum* is confirmed, PHSI will issue a Statutory Notice detailing the action required (see PHSI Eradication Policy at section 9.2). Ensure all the required actions including the stipulated removal and destruction of plant material, containers and associated soil or growing media are implemented as soon as possible and by the deadline laid out in the Statutory Notice. PHSI may also specify the following actions:

- For container grown plants, disinfect the bed or bench surface on which the plants were standing.
- Do not use anti-*Phytophthora* chemical treatments on any plants held under Statutory Notice.
- Cease or minimise the use of overhead irrigation during the holding period stipulated by the Notice.

With field grown nursery stock, take appropriate measures to prevent re-infection of the site. These measures may include:

- Not planting susceptible plants within a 4m radius around an infected plant for three years or,
- Removal and deep burial of soil (0.5m depth from 4m radius around infected plant) or,
- Based on results with other *Phytophthora* species, steam or chemical treatment may be attempted as an alternative to removal.

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Loose Posters

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Minimising Risk and Disease Prevention (A4)
Disease Symptoms in Ornamental Plants and Trees (A3)

1. Introduction

Phytophthora ramorum is a fungus-like pathogen capable of causing serious damage to a wide range of ornamental plants, within which more hosts are being recognised, in nursery situations, woodlands and amenity plantings. In Western USA, the disease is causing the death of large numbers of several native oak species and is commonly known as Sudden Oak Death. In Europe, *P. ramorum* has been confirmed mainly on container grown varieties of *Camellia, Rhododendron and Viburnum*. It has also been found in established *Rhododendron* plantings, principally in public and historic gardens and, more rarely, in unmanaged woodland sites.

Of particular concern, is the wide host range of *P. ramorum* in UK nursery situations. Most notably, this includes *Camellia, Pieris, Rhododendron* and *Viburnum*. Disease symptoms vary with the host plant and include leaf blight, leaf and shoot lesions and shoot dieback. In laboratory tests, European isolates appear to be more aggressive as regards bark infections than those of the USA.

EU legislation has been introduced to prevent the further introduction and spread of the disease. UK legislation has been amended along the same lines and *P. ramorum* is a notifiable disease, subject to statutory control measures. This Guide is aimed at commercial nurseries, garden centres and other hardy plant retailers. It provides important information about *P. ramorum* in the UK including its symptoms, sources of spread, current host range and practical control measures.

2. Background

P. ramorum was first found in Germany and the Netherlands in 1993, but was not described as a distinct new species until 2001. In California, the disease has quickly reached epidemic proportions and caused the death of a significant number of (some) native oaks and other species. Most notably, the range of native plants affected includes species of *Vaccinium, Arbutus, Rhododendron* and *Umbellularia*. The disease has also caused needle and shoot dieback of Douglas fir (*Pseudotsuga menziesii*), coastal redwood (*Sequoia sempervirens*) and grand fir (*Abies grandis*).

European tree species are also at risk. Although their susceptibility has not been fully determined, those under threat in the UK include the American northern red oak (*Quercus rubra*), Douglas fir (*Pseudotsuga menziesii*), European beech (*Fagus sylvatica*), holm oak (*Q. ilex*), horse chestnut (*Aesculus hippocastanum*), Lawson cypress (*Chamaecyparis lawsoniana*), Sitka spruce (*Picea sitchensis*), sweet chestnut (*Castanea sativa*), sycamore (*Acer pseudoplatanus*) and Turkey oak (*Q. cerris*).

In the UK, nursery inspections began in 2001 and the disease was first confirmed in April 2002 on *Viburnum tinus*. Towards the end of 2003, *P. ramorum* infection was confirmed on a number of tree species in southern England. Also, a second and new species of *Phytophthora* was discovered causing disease on *Rhododendron* and beech (*Fagus sylvatica*) in Cornwall. This pathogen ***Phytophthora kernoviae*** (previously referred to as *Phytophthora* taxon *C* (PtC) and *Phytophthora kernovii*) has since been found on thirty beech trees and two English oaks (*Q. robur*) in Cornwall. All tree finds have so far been in woodland areas heavily populated by infected *Rhododendron*.

By spring 2005, *P. ramorum* had been found at 484 sites in England and Wales as well as a number of sites in Scotland, Northern Ireland and the Channel Isles. These findings include some on established plants growing outside in soil situations. Of these total outbreaks, around half have been successfully eradicated.

3. Reasons for concern

Although European oaks such as the (deciduous) English oak (*Q. robur*) appear to be less at risk from *P. ramorum* some individual trees appear to be more susceptible than others. There are about 200 million oak trees in Britain as well as other native tree species, some of which appear susceptible (see Table 1 at section 5) to attack either by *P. ramorum* or the more recently discovered *P. kernoviae*.

Although UK native oaks are relatively resistant to *P. ramorum*, the wider threat to other hosts has serious economic, socio-economic and environmental implications. A further consideration is that although *P. kernoviae* is currently only recorded in England and Wales though considered to be of exotic origin, early observations suggest it causes more serious disease on *Rhododendron*. However, it appears to have a more limited host range than *P. ramorum*. Disease symptoms are similar to those caused by *P. ramorum*, but as well as being more severe, the blackening on *Rhododendron* tends to be darker and more intense. *Rhododendron* is the primary host for *P. kernoviae* and source of infection, and may succumb in weeks rather than months where infection within the plant is well advanced.

Clearly, a major concern is that large and important components of UK woodlands and amenity plantings, along with heathland flora, are under threat from *P. ramorum*. Of particular concern for nurserymen and garden centres, is the wide and economically significant host range of the pathogen. Also, it's ability to spread quickly in commercial situations is a major consideration given the frequent movement of plants between different nursery sites, landscape plantings, garden centres and, ultimately, home gardens. The possibility of infected plants being imported is also a concern: countries such as the Netherlands, Germany and France remain important sources of supply for the UK market. Such imports often comprise significant volumes of Azalea, *Camellia, Pieris, Rhododendron* and *Viburnum*; each of which are principal hosts of *P. ramorum*. Vigilance, awareness and prompt action are required to deal with suspected outbreaks among all EU nurseries and garden centres. The recent emergence of *P. kernoviae* is a further concern.

4. Biology

4.1 Disease spread

There are several sources and mechanisms of disease spread:

- Movement of infected plants between nursery sites, garden centres and landscape developments.
- Splash dispersal of spores by rain and overhead irrigation systems.
- Wind driven rain carrying and dispersing spores.
- Movement of contaminated soil, growing media or debris around the nursery or garden centre and landscape developments.
- Movement of contaminated soil, growing media or debris on footwear, vehicles or via animals (contaminated footwear is a major risk).

- Water courses and irrigation reservoirs with contaminated water.
- Contaminated pruning / nursery tools.
- Container / display beds (e.g. gravel / sand) where contamination is near the surface.

The movement of infected plants within the nursery trade is the principal means of long distance spread. Localised spread of the pathogen is by (asexual) spores (sporangia), produced on the surface of infected leaves and shoots. Leaf hosts such as *Rhododendron* and possibly ash, holm oak, sweet chestnut and *Vaccinium* are therefore important sources of inoculum for initiating and maintaining epidemics of tree mortality. *Rhododendron ponticum* is the principal environmental leaf host contributing inoculum to trees (causing lethal bark infections) though some tree species with susceptible leaves may also have a role. These include holm oak (*Q. ilex*), ash (*Fraxinus spp.*) and sweet chestnut (*Castanea sativa*). *Vaccinium* and *Calluna* may also be sources of inoculum where they occur in association with trees.

Spores are likely to be spread by rain splash, wind-driven rain, water run-off, irrigation water, contaminated soil / growing media and animals (mammals are known to spread the disease including humans). Sporangia germinate under moist conditions to release water-motile zoospores capable of spreading the disease still further. Both these spore types can be relatively long lived under humid conditions and have been found in streams, ponds and reservoirs. Care must be taken to ensure sources of crop irrigation water are not contaminated especially where there is a risk of recontamination from soil and plant debris.

Thick-walled, long-lived spores (chlamydospores) allow the long-term survival of the pathogen and are primarily produced within infected plant tissue. Growing media, debris and soil on vehicles, machinery, footwear or animals can also harbour and spread the pathogen.

Plants may not show symptoms until sometime after infection, especially if pathogen activity is suppressed by the use of fungicides with activity against *Phytophthora* species. Symptoms may develop after plants have been sold or moved to a different location and so in this way, the disease can quickly spread between nurseries and garden centres.

4.2 Infection

Like other *Phytophthora* species*, P. ramorum* is a primary pathogen and can infect directly into healthy plant tissue as well as through wounds. In nursery situations, container plants blowing over onto contaminated ground / beds can also become infected. Spores germinating on the surfaces of leaves and stems infect through wounds or natural openings such as leaf stomata and lenticels. Infections often occur in association with areas on the leaf where water accumulates, such as the tips or edges. Pruning cuts are ideal entry points for infection. Plant cells are killed as the infection spreads through plant tissue and disease symptoms follow. Root tissue is rarely attacked. Following infection under optimal conditions, symptoms may appear after only several days. Symptom development may be affected by a number of factors such as temperature. In the winter months, disease progression may be slower, leading to delayed symptom development. On *Rhododendron* leaves there is no evidence of any latent infection.

4.3 Favourable conditions

P. ramorum is a cool temperature pathogen; optimum growth temperature is 20°C whilst minimum and maximum temperatures are 2°C and 30°C respectively. It can survive extended periods of freezing temperatures, even if it doesn't grow. Like other *Phytophthora* species, it requires moisture to complete its life cycle; wet environments favour spore production, dispersal, germination and infection. Therefore, humid conditions which allow moisture to remain on plant leaves and stems, favour disease infection and spread. This may partly explain why so far in the UK, the disease in established plantings is more prevalent in the south-west.

4.4 Populations and mating types

There are two known populations of the pathogen: a North American population and a European population. They differ genetically and to some degree in morphology and adaptive behaviour. European isolates appear to be more aggressive with respect to tree bark infection. However, they share the same potential host range. There are also two mating types of *P. ramorum*, the A1 mating type is most commonly found in the European population, though a single A2 isolate has been found in continental Europe. In the United States, the North American population usually comprises isolates of the A2 mating type although in 2003, European A1 isolates were also found on commercial nurseries in North America. Potentially, mating between the A1 and A2 strains could give rise to even more aggressive or adaptive strains of the pathogen.

5. Hosts

Of particular concern, is the increasingly recognised wide host range of *P. ramorum* in the UK. In addition to the UK recorded hosts listed in Table 1, other confirmed hosts found outside the UK but which are commonly grown here include *Acer, Arctostaphylos, Calluna, Lonicera, Photinia, Pittosporum, Pyracantha, Pseudotsuga menziesii, Quercus rubra, Rhamnus, Sequoia* and *Vaccinium*. Also, in laboratory tests, some genera (e.g. *Sambucus*) have been found to be particularly susceptible and may become future hosts. Azalea species and varieties have not so far been found with *P. ramorum* infection in commercial or natural situations although laboratory inoculation studies indicate that some species, particularly deciduous types, are susceptible.

Table 1: Recorded hosts of *Phytophthora ramorum* in the UK (as at June 2005)

Family	**Species and cultivars of listed species**
Caprifoliaceae	*Viburnum davidii, V. farreri (syn. V. fragrans), V. lantana, V. opulus, V. plicatum, V. tinus, V. x bodnantense, V. x burkwoodii, V. x carlcephalum, V. x pragnense, V. utile*
Cornaceae	*Griselinia littoralis*
Ericaceae	*Arbutus unedo*
	Kalmia latifolia
	Leucothoe spp.
	Pieris formosa forrestii
	Pieris formosa forrestii x Pieris japonica
	Pieris japonica
	Rhododendron augustinii
	Rhododendron balfourianum
	Rhododendron brachycarpum
	Rhododendron ferrugineum
	Rhododendron ponticum
	Rhododendron hybrids (disease infection has been confirmed on a range of hybrids derived from various crosses)
Fagaceae	*Castanea sativa, Fagus sylvatica, Nothofagus obliqua, Quercus cerris, Quercus falcata, Quercus ilex*
Hamamelidaceae	*Hamamellis mollis, Hammamellis virginiana, Parrotia persica*
Hippocastanaceae	*Aesculus hippocastanum*
Lauraceae	*Laurus nobilis, Umbellularia californica.*
Magnoliacea	*Magnolia stellata, Magnolia x loebneri, Magnolia x soulangeana*
Oleaceae	*Fraxinus excelsior, Syringa vulgaris*
Salicaceae	*Salix caprea*
Taxaceae	*Taxus baccata*
Theaceae	*Camellia japonica*
	Camellia reticulata
	Camellia x williamsii (C. saluensis x C. japonica)
Winteraceae	*Drimys winteri*

Source: Defra Plant Health Division & Central Science Laboratory (CSL)

6. Symptoms

Disease symptoms vary depending on the host plant. Other diseases may produce similar symptoms to those of *P. ramorum* so care must be taken with diagnosis. *Viburnum tinus* is a good example where symptoms of *P. ramorum* are very similar to those of the leaf and stem pathogen *Phoma viburnii*. Also, other *Phytophthora* species can cause similar symptoms in *Rhododendron*, though prior to *P. ramorum*, foliage infections were uncommon. Root infection by other native or long-established *Phytophthora* species is a common problem in *Rhododendron*.

Symptoms due to fertiliser scorch, chemical (e.g. pesticide) injury, drought stress, freezing damage and sun scorch can also appear similar to *P. ramorum* infection on a range of hosts. Laboratory analysis is required for accurate diagnosis.

Rhododendron die-back

The principal symptom in both nursery stock and established plantings is blight of leaves and dieback of the shoots. Diseased shoots have brown to black lesions that usually start at the tip and move towards the base although cankers may also form on any part of the shoot or stem, spreading up or down. Tissue may be soft and water soaked and quite different from natural browning as shoots age. Cankers near ground level can result in rapid wilting of shoots and leaves. On woody stems, infected internal tissue takes on a light brown discolouration which is distinctively different to the usual off-white colour visible when the bark is peeled back.

The most characteristic leaf symptom is the blackening of the leaf petiole extending into the base of the leaf blade. This may spread along the midrib causing blackening of the leaf. Leaves can become diseased with and without shoot infection. Diffuse brown spots or blotches frequently occur at the leaf tip where moisture can accumulate and remain for extended periods encouraging infection. Such spots or blotches can also form elsewhere. Eventually, the entire leaf can turn brown to black and may fall prematurely.

Other *Phytophthora* species can attack *Rhododendron* causing various symptoms including leaf necrosis. However, unlike these, *P. ramorum* is not usually associated with causing significant rotting in the root tissue.

Rhododendron aerial dieback

Rhododendron petiole and leaf base necrosis

Rhododendron leaf tip-midrib infection

Infection spreading into *Rhododendron* leaf

Pieris die-back

Leaf symptoms are similar to those described for *Rhododendron* with brown lesions developing at leaf bases due to infections spreading down the shoot and along the petiole. Lesions also typically occur at the leaf tip or leaf edge where water accumulates. The leaf blade can also become blighted and individual stem cankers lead to further dieback. Leaf symptoms could be confused with those caused by the opportunistic leaf pathogens *Glomerella, Monochaetia* and *Pestalotiopsis* and laboratory tests are essential for accurate diagnosis. Other diseases of *Pieris* also include aerial *Phytophthora* species that can cause leaf lesions similar to *P. ramorum* and various other *Phytophthora* species that can also cause root rots (e.g. *Phytophthora citricola*).

Pieris dieback and leaf necrosis

Pieris leafblight

Viburnum die-back

Infection usually occurs at the stem base causing plants to wilt quickly and collapse. Cambial stem tissue initially turns brown and then eventually dark brown. Leaf spots or blotches may also occur, especially on evergreen species whilst twigs and shoots may also be affected. Minor root rotting has also been noted. Symptoms can be confused with those of other *Phytophthora* species causing root death and also frost damage that may cause blackening of young shoots and branch dieback. With *Viburnum tinus* varieties, leaf symptoms are often very similar to those caused by *Phoma* infection and so are easily confused; for accurate diagnosis, laboratory tests are essential. *Botrytis cinerea*, the common grey mould pathogen, can also cause dieback in *Viburnum*.

Viburnum dieback and leaf base necrosis

Viburnum wilting symptoms

Kalmia & *Leucothoe* leaf blight

Infection usually occurs at the leaf tip and spreads through the leaf tissue towards the leaf base causing a brown to black discolouration. Other disease pathogens known to cause leaf infections in *Kalmia* are *Mycosphaerella* and *Phomopsis*. In *Leucothoe, Cylindrocladium* can cause leaf lesions but unlike *P. ramorum*, it can also girdle and kill stem tissue.

Kalmia leaf blight

Leucothoe leaf necrosis

Camellia leaf blight

Brown to black spots occur at the tips or edges of the leaves and can result in entire leaf death and rapid leaf drop. Stem dieback may also occur. Symptoms caused by the opportunistic wound pathogens *Pestalotiopsis* and *Glomerella* can be confused with those of *P. ramorum* and laboratory tests are essential for correct diagnosis.

Camellia heavy infection

Camellia leaf blight

P. ramorum infection on *Camellia*

Syringa (Lilac) leaf & bud blight

Leaf symptoms are very similar to those described for *Camellia, Kalmia* and *Leucothoe* with leaf necrosis starting at the tips and margins. Greyish-brown diffuse, water soaked lesions become evident later. Bud blight leads to a brown to black shoot discoloration as the infection spreads. Other, similar appearing diseases of *Syringa* include the well known bacterial shoot, stem and leaf blight *Pseudomonas syringae* although *P. ramorum* primarily affects the leaves of lilac rather than leaves and shoots.

Lilac leaf necrosis

Taxus (yew) leaf blight

Leaf blight caused by *P. ramorum* is uncommon but has been isolated from brown lesions on young leaves of container grown *Taxus baccata*. Yew is very prone to leaf bronzing due to a wide range of diseases and disorders but usually the leaf tips die first whilst with *P. ramorum*, the necrosis occurs more commonly in the leaf axils and appears more water soaked.

Taxus (yew) infected nursery stock

Taxus (yew) infected plant

Taxus (yew) needle blight of young shoots

Trees

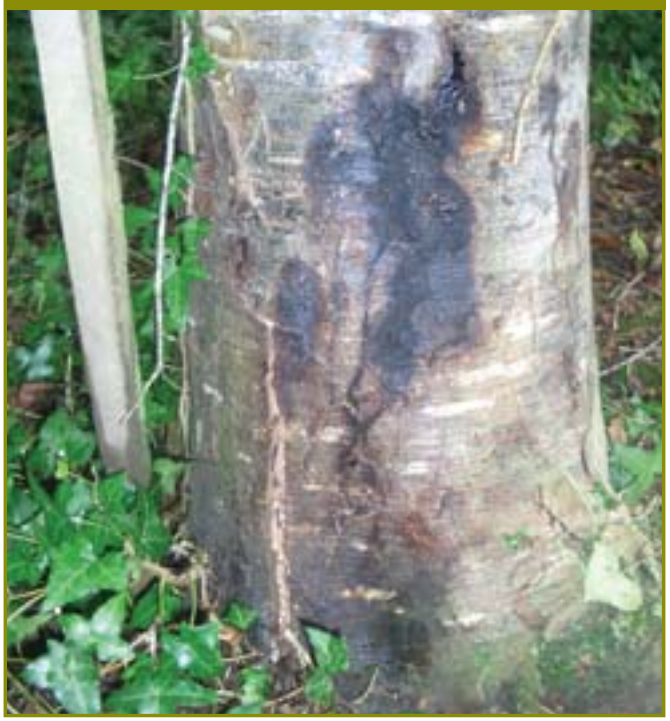
Trees display a range of symptoms depending on the host species. With beech for example, only the bark is infected whilst in other trees, so far only the leaves have been infected, (e.g. ash, sweet chestnut and holm oak). In the case of some species, several aerial parts of the tree can be affected: for example, leaves, shoots and bark of tan oak are all infected. Laboratory tests have indicated that bark of beech is more susceptible to infection than that of European oak spp.

Small discrete bleeding canker on the trunk of a mature beech tree

Extensive bleeding on the root flares of a mature beech tree

Bark infections usually appear as large cankers that have brown to black discoloured outer bark on the lower trunk that seep or, 'bleed' a dark red sap. Typically, these cankers occur on the lower part of the trunk. When the outer bark is removed, mottled areas of necrotic, dead and discoloured inner bark tissue with black zonal lines around the edge may be seen. Diseased trees may become colonised by bark beetles. When cankers girdle the trunk, death of the tree occurs resulting in wilting and a rapid change in foliage colour. In the USA, some oak species die quickly whilst others decline more slowly and may take several years to die: mature oaks can be killed in less than two years.

Stem lesions on *Nothofagus* sp (Southern beech)



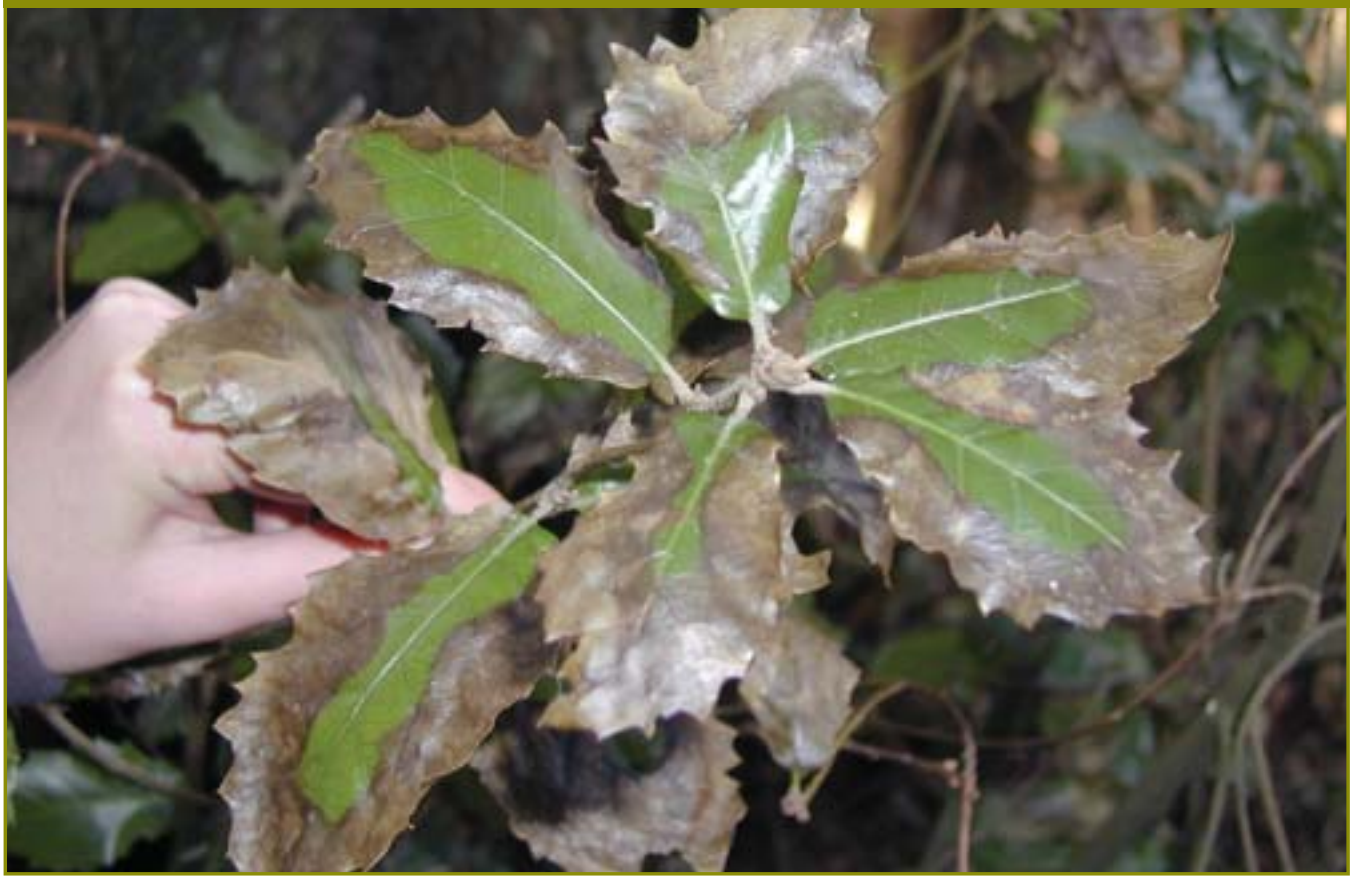
Bleeding canker on *Quercus falcata* (American southern red oak)

Cankers do not extend below the soil line and do not appear to infect root systems. Leaf infections most commonly appear as brown necrotic areas, often at the edge or tip of the leaf. On broad-leaved tree hosts in Europe, leaf and shoot infections have to date been found on several hosts including holm oak (*Q. ilex*) and sweet chestnut (*C. sativa*) and leaf infections observed on ash (*F. excelsior*).

Q.ilex (holm oak) aerial blight

Fraxinus excelsior (Ash) infected foliage

Q.ilex (holm oak) infected foliage



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7. Minimising risks in nursery situations and garden centres

Detailed below is a step by step guide to the measures that can be taken to reduce the risk of infection and spread of *P. ramorum*.

7.1 Assessing the risk

Assess the disease risk on your nursery and / or retail sale areas. Formulate a strategy to limit the chances of disease introduction and spread. In particular, such assessments and strategies should consider key hosts, methods of disease spread, plants posing the greatest risk (see panel overleaf) and all possible ways that *P. ramorum* may be transmitted to nursery stock on commercial sites and garden centres.

Introduce steps to manage these and limit disease risk. Use a well thought out Action Plan to control the movement of incoming plant material and potentially contaminated machinery, footwear and water on the nursery or garden centre. Review these steps regularly.

Plants posing the greatest risk to nurseries and garden centres:

- Plant consignments bought in for trading on / re-sale, particularly imported nursery stock including root-balled and bare-root subjects.
- Established plants bought in for potting as above.
- Young plants (plugs and liners) bought in for growing on.
- Plants returned from garden centres, trade customers and home gardeners, which may be carrying the disease but are NOT showing symptoms at the time.

7.2 Monitoring

Familiarise yourself with the disease and it's host range so that you are able to recognise symptoms promptly. Check the Defra website (www.defra.gov.uk/planth/ph.htm) regularly for updated host lists. Ensure staff are similarly trained and briefed to report any suspected problems at an early stage. Also, that they understand why precautionary and statutory control measures are required.

Check cut foliage crops and material of known hosts destined for sale via wholesale markets and retail outlets equally carefully; *Viburnum* is particularly significant in this respect.

Do not accept susceptible plant material without a plant passport (see Panel at section 8: Plant Passports At A Glance). If you are offered susceptible material without a plant passport or with an invalid passport, notify your Defra Plant Health & Seeds Inspector (PHSI). Follow up action by PHSI will reduce the risk of importing the disease. Note, un-passported plant material will need to be destroyed (by burning or deep burial).

Carefully inspect susceptible species for signs of the disease before introducing them to the production or retail sale areas. If you suspect the disease is present, contact your local Defra Plant Health & Seeds Inspector (PHSI) or PHSI HQ, York.

Tel: 01904 455174, **Fax:** 01904 455197
Email: planthealth.info@defra.gsi.gov.uk
Website: www.defra.gov.uk/planth/ph.htm

Note, the disease is notifiable and this is a legal requirement.

Monitoring – Best Practice

- Continue disease monitoring of known hosts once they are on the nursery or garden centre. A nursery layout map showing the locations of key hosts / potential hosts is a useful aid to routine monitoring. Include stock plants, liners and crops grown in modules when monitoring. Step up monitoring after bud break in spring and when environmental conditions favour disease infection and spread (damp, mild or rainy periods).
- When monitoring, pay particular attention to *Camellia, Pieris, Rhododendron* and *Viburnum*. Other disease pathogens may give rise to similar symptoms and accurate (laboratory) diagnosis is important. Bought in stock is high risk and should be monitored especially closely. Tests can be arranged by PHSI to verify the causal agent.

Monitoring – Best Practice (continued)

- Check nursery / garden centre boundaries for known hosts and monitor these regularly for early signs of *P. ramorum*, following the same notification procedure as that laid down for nursery stock if disease is suspected i.e. contact the PHSI straight away. Disease symptoms are likely to be easier to spot during the spring, summer and autumn months and so these are ideal times for regular monitoring.

7.3 Quarantine

Establish a quarantine area for container grown and bare root nursery stock to isolate and hold bought in plant material away from the main production or retail areas (outer boundary locations are ideal). Ensure this area is at least 10m from any susceptible genera.

Check the plants carefully and monitor weekly. In nursery situations, plants should be held for at least two weeks (longer in cold or dry weather). In garden centre situations where this may be impractical, regular supplier inspections are recommended.

Quarantine Areas: Best Practice

- Limit the quarantine area to one entrance only.
- Limit access to trained, designated personnel only.
- Provide a loading / unloading area with direct access to the quarantine area that can be readily cleaned and disinfected.
- In nursery situations, place baths of soapy water and brushes for removing any soil at the entrance, together with disinfectant to treat footwear, and ensure these are properly maintained.
- Provide disposable leggings so that overalls do not become contaminated.
- DO NOT set down any incoming plants of known hosts in the main production or retail sale areas that may be carrying sub-clinical levels of disease. Such plants should be quarantined and screened for the disease presence (contact the PHSI).
- Keep tools and Danish trolleys for the quarantine area separate to those used in the main production or retail areas. Disinfect them regularly.
- Take appropriate measures to exclude animals that can spread the disease such as badgers, deer, foxes, rats, mice, squirrels, cats and dogs from the quarantine and nursery areas.
- Create a separate quarantine area for sale returns of known hosts and monitor for at least two weeks.
- Prevent water run-off to the main production / sale areas.
- Avoid overhead watering as much as is practicable.
- Where possible, use a concrete floor area to aid eradication action should the disease be found.
- Do not use fungicides that have *Phytophthora* activity on susceptible host plants for a minimum period of six weeks after taking delivery.

7.4 Records

Keep accurate records of all bought in plant material, such records should include source of supply, arrival date, previous cropping history / treatments (check with supplier), plant passport details (which must be retained for at least 12 months) and any batch or consignment numbers.

7.5 Hygiene

Good hygiene practice is also key to effective disease control. Remove and destroy (burning or deep burial) all plant and leaf debris from sale and production beds housing susceptible material on a regular basis. Implement routine hygiene measures to reduce the likelihood of spread by contaminated soil or growing media, tools, equipment or staff. Disinfect plant beds, pruning tools and trolley shelves regularly with appropriate products. Disinfect secateurs or pruning knives frequently and always between species and varieties / cultivars.

Hygiene: Best Practice

- Ensure any plant prunings and fallen leaf debris are picked up and removed from plant beds promptly. Avoid mixing growing media on bare soil, use a clean concrete area instead.
- Only propagate cutting material taken from disease free hosts as confirmed by regular examination of symptoms. If necessary, arrange laboratory diagnostic tests for stock plants of key hosts.
- Wounded leaves are much more susceptible to infection so handle plants and cutting material with care. Try to avoid handling host plants if they might be wounded or damaged when environmental conditions are particularly favourable to disease infection. Prune susceptible host plants in dry weather if at all possible.
- Avoid soil or growing media contact with the foliage of key hosts especially liners and young plants, or splashing water from soil to foliage. Where possible, use raised benches and isolated container beds to elevate susceptible plants above the soil. Wherever possible, the foliage of key host plants should not come into contact with the ground and any container grown plants that have blown or fallen over should be returned to an upright position as soon as possible.
- Periodic treatment of container / display beds (e.g. sand or gravel standing areas) with a suitable disinfectant particularly where known host plants have been or are due to be set down will help reduce disease risks. Use of a permeable membrane over the bed surface to enable them to be swept clean of fallen leaves and debris should also be considered. Such membranes should be disinfected periodically. Aim to rotate container crops so that known host plants are not located on beds previously occupied by susceptible species for at least six months.
- Keep blocks of susceptible plants separate and spaced at least 10m apart. Then, if the disease is confirmed on any plants, only the block immediately around them will be subject to statutory control measures. Plants within 2m will be destroyed and those within 10m held (as if) in a quarantine area for at least three months.

Consider reducing the number of highly susceptible species on site and, where practical, rotate crops on previously infected areas to non-susceptible genera.

7.6 Waste management

7.6.1 Disposal of infected waste

Plant material under Statutory Notice and known to be infected with *P. ramorum* should be destroyed by incineration in accordance with the Statutory Notice served by PHSI. Usually, this Notice will also require the destruction of associated containers and a requirement for all surfaces that have come into contact with infected plants to be treated with an appropriate disinfectant. Soil or growing media that has been used with the diseased plants and so may be contaminated with *P. ramorum*, should be removed, deep buried or appropriately sterilised before re-use. Enforcement of Statutory Notices will have a deadline for implementation.

7.6.2 Best Practice

The Defra *Plant Health Code of Practice for the Management of Agricultural and Horticultural Waste* describes measures for minimising plant health risks from waste and, whilst voluntary, is a useful source of reference for implementing best practice.

The Code is aimed at all stages of the marketing chain prior to retail sale and includes ornamentals. It recommends that growers consider four key factors in assessing the risk of plant waste as regards potential disease spread:

Source of material – material from abroad or an area of Britain where a serious pest or disease (e.g. *P. ramorum*) is known, or is likely to occur generally represents a higher risk.

The crop – the nature of the crop or plants will provide some indication of likely pest or disease risks. In the context of *P. ramorum*, principal hosts such as *Camellia, Rhododendron* and *Viburnum* for example clearly represent a higher risk in terms of disease spread.

Pests / diseases – organisms producing resting bodies which are particularly resistant to treatment and which can survive for long periods in soil or growing media present a particular risk. This would include *P. ramorum*, given its ability to produce resting spores capable of long term survival.

Types of waste – waste containing soil or growing media which could harbour pests or diseases (such as *P. ramorum* for example) is a particular concern and risk.

The Code also recommends that growers should aim to minimise the amount of waste they have to dispose of and and wherever possible re-use it subject to statutory controls, and providing this can be done without compromising plant health. Solid waste such as soil or growing media for example may, in some cases, be treated (sterilised) for re-use. If such treatments are used, growers should be able to demonstrate to PHSI that they are effective in controlling plant pests and pathogens such as *P. ramorum*.

Copies of the Code may be obtained from PHSI HQ (see section 12, Contact Points for Advice and Further Information).

Agricultural waste, including that from horticultural production is also covered by new waste management regulations (Agricultural Waste Regulations). Essentially, these regulations require that waste is disposed of, or recycled in ways that protect the environment and human health. Agricultural waste includes plant material and, in some cases, soil / growing media. Currently under consultation, the new regulations are set to become law by the end of September 2005. Further details are available from Defra (www.defra.gov.uk). Another source of reference is the *Waste Minimisation Manual: Opportunities for saving money by reducing waste on your farm'* (ref. PB4819), also available from Defra.

7.7 Water management

Good water management is key to effective disease control in nursery and garden centre situations. Wherever possible, overhead irrigation should be avoided because splash dispersal by water (or rain) droplets of disease spores is one of the principal means by which *P. ramorum* can spread to infect other plants.

Water Management: Best Practice

- Where overhead irrigation is used, apply it in a controlled and measured way to minimise disease spread by water splash. Ensure uniform distribution, check regularly for leaking pipes or connections and correct any areas of poor drainage.
- For known host plants, avoid night time irrigation.
- Ideally, use a low level watering system such as capillary sand-beds, capillary matting or drip-point watering.
- Ensure any water collected for recycling from nursery or bed run-off is disinfected prior to re-use (e.g. by chlorination or slow sand filtration).
- Abstracted water taken from streams or ponds in areas of infected native hosts may also be contaminated with *P. ramorum* and should be tested periodically.
- Disinfect or replace capillary matting before re-using with other crops / plants.
- Do not use hosepipes from infected areas in uninfected areas.
- Ensure plants are not standing in water for any length of time by providing good drainage.

7.8 Customers

It is good practice for growers and garden centres to tell their customers that they have complied with the necessary legislation and advise them of the steps they have taken to minimise risk. Information boards clearly displayed in garden centres and retail nurseries demonstrate a responsible approach and inform the public. The option of offering customers an alternative, lower risk species can also be considered.

If in any doubt, contact your local PHSI for help and advice.

8. Plant Passports – what are they and how do they work?

Certain plants moving within and between EU states require a plant passport. This must always accompany the plant and include the words 'EC Plant Passport', a country identifier (e.g. UK/EW, NL or FR) and a reference number. It may include RP if the plants have a replacement passport. Ensure that your supplier is providing a valid passport; plants that do not have a valid document will be destroyed. The Plant Health Guide to Plant Passporting and Marketing Requirements can be viewed on the Defra website. Copies can also be obtained from the PHSI.

Plant Passports at a Glance

The Plant Passport provides important documentary evidence that:

- The plants concerned have been grown by a registered grower whose premises are regularly inspected and who is authorised to issue plant passports.
- The plants are, to the best of the producers knowledge, free from all quarantine pests and disease pathogens and, where appropriate, grown in an environment which is also free from pests and disease pathogens.
- Plants imported from outside the EU have been landed by a registered importer, inspected on arrival in the UK or in another member state (or at an approved destination) and found to be free from quarantine pests and pathogens prior to being passported for movement within the EU.

The scheme aims to provide protection against the dissemination of harmful organisms including *P. ramorum*. Species/hybrids of *Camellia, Rhododendron* (other than *R. simsii* which has been shown to be resistant to *P. ramorum* in tests) and *Viburnum* are now subject to plant passporting requirements to the point of final retail sale. *Kalmia, Pieris* and *Syringa* may follow.

Note: import and plant passport controls have reduced substantially the amount of infected plant material moving in the trade and it is in the interests of all key stakeholders that the requirements of this scheme are upheld.

The conditions of the passport are that material originates in areas where *P. ramorum* is known not to occur or where there have been no signs of the pathogen at the place of production. In cases where signs of the pathogen have been found, appropriate procedures for eradication must have been implemented.

Plant passports no longer apply to cut foliage of *P. ramorum* hosts. The disease has not yet been found on such material used in floral or foliar decorations.

PHSI can ask to see original passports; photocopies or retrospective plant passports are not acceptable.

9. Management and control of *Phytophthora ramorum* – Best Practice

9.1 Notification

P. ramorum is a notifiable plant pathogen and so there is a legal requirement to notify the PHSI if you know or suspect that species of *Camellia, Rhododendron, Viburnum* or any other known host plant is affected by the disease. Contact your local PHSI office or, PHSI HQ, York (Tel: 01904 455174, Fax: 01904 455197, Email: planthealth.info@defra.gsi.gov.uk, Website: www.defra.gov.uk/planth/ph.htm).

Early detection followed by prompt quarantine action by PHSI is the basis of effective disease management. The origins of diseased nursery stock are traced to determine possible sources of infection and such sources may be from within the UK or elsewhere in Europe.

Prompt and effective eradication policies in the UK are important to minimise and eliminate the potential threat to native trees such as beech and oak species as well as heathland species and ornamental hosts (see Table at section 5). It is also important to control the spread of *P. ramorum* between other European countries and so the movement of *Camellia* sp., *Rhododendron* (except *Rhododendron simsii*) and *Viburnum* sp. is being controlled by Plant Passports (see Panel at section 8, 'Plant Passports At A Glance').

Control measures for *P. ramorum* linked to prompt notification and implementation of eradication procedures appear to be reducing the number of outbreaks in the UK; during 2004, 60% more inspections were undertaken by Defra and other plant health inspectors and there were 40% fewer confirmed outbreaks.

9.2 PHSI Eradication Policy

If the presence of *P. ramorum* is confirmed by a Plant Health Inspector all affected plants and known hosts within a 2m radius must be destroyed.

All known natural hosts within a 10m radius of affected plants will be held under Statutory Notice and cannot be moved for at least three months. Such plants have to be inspected by the PHSI at least twice during this period and found to be free of disease symptoms. If the disease is found again, the date of sale of plants within this area will be deferred for a further three months after infected plants are destroyed and the area may increase in size if the plants are close to the edge of the previous 10m quarantine area.

All known natural hosts must also be inspected and found to be free of disease and the Statutory Notice lifted before movement of plants off the site can take place.

Follow up PHSI inspections will take place every three months for nine months after eradication.

Please note!

The use of anti-*Phytophthora* fungicides on plants held under Statutory Notice is prohibited. It is also recommended that trading arrangements with suppliers stipulate a six week prohibition on the use of anti-*Phytophthora* fungicides on known host plants prior to despatch, other than where such fungicides are required to suppress other *Phytophthora* species.

10. Tests and Inspections – who pays what

Plant Clinic checks for *P. ramorum* – these are free of charge when submitted by PHSI and are usually undertaken at the Central Science Laboratory (CSL). PHSI Inspectors are now also able to carry out 'rapid tests' for *Phytophthora* on site.

Laboratory testing of water samples for *P. ramorum* – these are chargeable to growers and garden centre owners. Tests can be undertaken at CSL (price on application).

PHSI Inspections – Authorisation to issue passports is granted annually on the basis of an official inspection of the plants during the growing season and a check on record keeping. These official inspections are chargeable at the standard PHSI hourly rate (for full details please refer to the Plant Health Guide to Plant Passporting and Marketing Requirements, or contact your local PHSI).

11. Research

11.1 What is being done in the UK?

Defra, Forestry Commission, SEERAD (Scottish Executive Environment & Rural Affairs Division) and DARDNI (Department of Agriculture and Rural Development Northern Ireland) are undertaking extensive surveys across the UK to check for the presence of *Phytophthora ramorum* and swift statutory action is being taken wherever the disease is found. Additionally, Defra, the Forestry Commission, the Horticultural Development Council (HDC) and and EU have commissioned research to investigate the biology, epidemiology, management and control of *P. ramorum* including the screening of a range of plants to determine their potential susceptibility. Disinfectants and fungicides have been evaluated in HDC funded work at the Central Science Laboratory (CSL) (see section 11.2) and scientists liaise regularly with their counterparts in overseas research groups. Information between the various research programmes and bodies is quickly exchanged and utilised.

Information on research activities, including a summary of key research findings, can be found at: http://www.defra.gov.uk/planth/pramorum6.htm

11.2 Research on fungicides

Fungicide products effective against other *Phytophthora* species may provide some protection against *P. ramorum* but will not eradicate it if present. Once infection has occurred, the use of fungicides will only suppress the development of the disease and mask symptoms ***(such products should not be applied to plants under Statutory Notice)***. This has been demonstrated at various nursery sites where outbreaks have persisted despite regular fungicide treatment. Suppression of symptoms by fungicides seriously compromises the management of the disease.

Whilst the current policy for disease eradication and containment prohibits the use of fungicides when eradication is being attempted, as more information on pathogen epidemiology becomes available, this position may change. The measured use of certain fungicides may have a greater role to play in future control strategies in nursery situations. A number of fungicides with protectant and eradicant activity have been evaluated in HDC funded work (Ref: HNS 123) in addition to a range of disinfectants.

The work has identified several disinfectant and fungicide products with good efficacy against *P. ramorum*. Most notably, these include fungicide products based on metalaxyl-M, azoxystrobin and fenamidone + mancozeb. Each of these products completely inhibited growth of *Phytophthora ramorum* when applied as a protectant foliar spray to containerised *Rhododendron* either 4 or 7 days pre-infection. On *Viburnum*, metalaxyl-M was equally effective when applied either 4 or 7 days pre-infection whereas products based on azoxystrobin and fenamidone + mancozeb were less effective. Several fungicides also showed good eradicant activity including those based on metalaxyl-M, etridiazole, cymoxanil + famoxadone, azoxystrobin and, fenamidone + mancozeb although disease control was not 100% effective using these products as single applications.

Further details can be found in the project report available from the HDC (ref. HNS 123).

12. Contact points for advice and further information

In **England and Wales**, if you suspect an outbreak of the disease then your local office of the Defra Plant Health & Seeds Inspectorate (PHSI) should be notified immediately; or the Headquarters of the Defra PHSI located at York:
Tel: 01904 455174, **Fax:** 01904 455197
email: planthealth.info@defra.gsi.gov.uk
Website: www.defra.gov.uk/planth/ph.htm

To keep up to date with the latest developments and host species, visit www.defra.gov.uk/planth/pramorum.htm. The PHSI can also be contacted for details of the plant passport scheme and for advice on the disease eradication process. The Plant Health Guide to Plant Passporting and Marketing Requirements can be viewed on the Defra Plant Health website at: www.defra.gov.uk/planth/publicat/passport/pass.pdf

In **Scotland**, contact SEERAD (Scottish Executive Environment & Rural Affairs Division), Horticulture & Marketing Unit, Edinburgh:
Tel: 0131 244 6303, **Fax:** 0131 244 6449
email: hort.marketing@scotland.gsi.gov.uk

In **Northern Ireland**, contact DARDNI (Department of Agriculture and Rural Development Northern Ireland) at: DARD (NI) Quality Assurance Branch, Magnet House, 81-93 York Street, Belfast, BT15 1AD:
Tel: 028 9054 7106, **Fax:** 028 9054 7204
email: qab.admin@dardni.gov.uk
or, for **woodland enquiries Tel:** 028 9064 7263

The Horticultural Trades Association (HTA) can also be contacted by nursery and garden centre members for further information (Tel: 0118 9308940).

In **England, Wales and Scotland all tree and woodland enquiries** should be directed to the Forestry Commission Plant Health Service:
Tel: 0131 314 6414, **Fax:** 0131 314 6148
Website: www.forestry.gov.uk

If seeping cankers that could be caused by *P. ramorum* are seen on trees, contact the Forest Research Advisory Service:
Tel: 01420 23000 or 01420 22255

The Central Science Laboratory (CSL) can be contacted at:
Tel: 01904 462000, **Fax:** 01904 462111

Notes

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