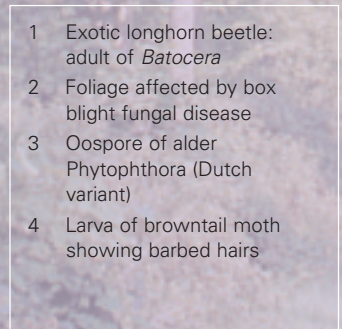
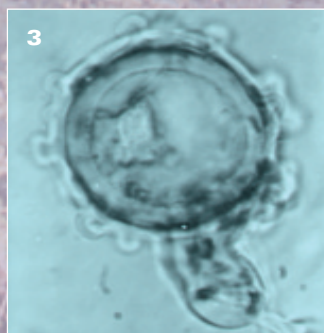


Pests and Diseases

by Hugh Evans and Joan Webber



- 1 Exotic longhorn beetle: adult of *Batocera*
- 2 Foliage affected by box blight fungal disease
- 3 Oospore of alder *Phytophthora* (Dutch variant)
- 4 Larva of browntail moth showing barbed hairs

Introduction

Awareness of the threats posed by both native and, especially, exotic pests and diseases is a core requirement. Entomology and Pathology Branches devote considerable efforts to improving Pest Risk Assessment (PRA) methods and are frequently in touch with other scientists and Plant Protection Organisations worldwide. During the past year a new panel of the European and Mediterranean Plant Protection Organisation (EPPO) has been evaluating the risks posed by pests from the former Soviet Union. Meetings in Helsinki (Finland), Perm (Russia) and Paris (France) have concentrated on determining the pests and diseases of most significance. The panel is now carrying out full PRAs on the list of organisms identified by experts from the Soviet Union. This approach has the benefit of including expertise from both the importing (the PRA area) and exporting countries. Consensus on the listing of prospective pests and on the risks that they pose will benefit exporting and importing countries alike.

In relation to PRA technology, scientists from both Branches have been active in assessing risks and in developing new methods for evaluation of the threats posed by organisms of plant health significance in international trade. One such high profile example is the risk posed by a new fungal pathogen, *Phytophthora ramorum*, which is causing widespread and sudden death of oaks in California, USA (see www.suddenoakdeath.org), but has also been found sporadically in parts of Europe causing a disease of rhododendrons. Clive Brasier has been involved in advising on the problem in both Europe and the USA. More generally, Hugh Evans was co-organiser with the USDA Forest Service of an international symposium on the threats posed by movements of pests internationally, at the IUFRO World Congress in Malaysia. The symposium title, Biological Invasions of Forest Insect Pests - Agents of Global Change, and the 12 papers presented by speakers from eight countries, reflected the threats posed by rapid and increasing international trade in all commodities that involve,

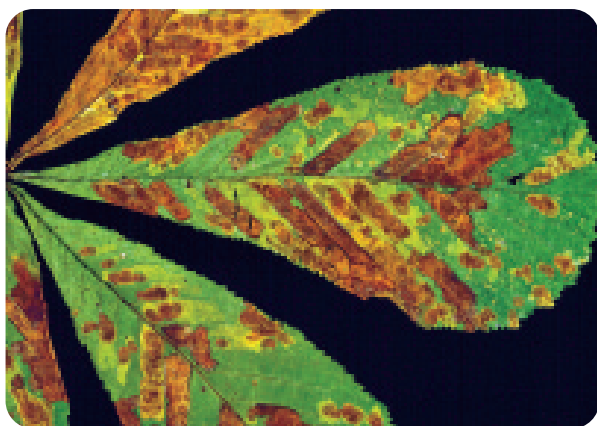
in some form, wood or wood products. In a similar vein, Forest Research has been active in a new venture on plant health in which internationally renowned authors provide key papers for an on-line workshop designed to initiate debate on the threats posed by international movements of pests and diseases. Hugh Evans has acted as co-ordinator of a session on the biology of quarantine pests and diseases and a joint paper by Joan Webber and Clive Brasier provides insight into the threats posed by sapstain and vascular pathogens. Uniquely, the papers from this symposium will be accessible on the internet and there will be opportunities for both experts and lay participants to contribute to the debate on this important plant health topic. Undoubtedly, knowledge will be increased but at the same time new questions will be posed that require further efforts by researchers in Forest Research and elsewhere.

Threats from abroad

Horse chestnut leafminer, *Cameraria ohridella*

The appearance in Europe of the leafmining moth, *Cameraria ohridella* (Lepidoptera: Gracillariidae), on horse chestnut, *Aesculus hippocastanum*, is a cause of considerable concern, especially since it appears to cause both leaf damage and loss of growth in attacked trees. The precise geographical origin of *C. ohridella* has not been established but since the first reports of its appearance in Macedonia in 1985, it has spread rapidly across Europe. It has been suggested that this expansion of range is linked to human transportation, particularly accidental movement of infested leaves on vehicles. There have been no reported sightings of this insect in the UK but it is known to be present in western Europe including Belgium, The Netherlands and France.

The larvae of *C. ohridella* develop within the leaves, feeding between the upper and lower epidermises. The resulting serpentine mines, which are at first translucent, may reach 4 cm in length (Plate 1). On heavily infested trees with multiple attacks on the

**PLATE 1**

Leaf of horse chestnut showing damage by horse chestnut leaf miner. (J. Metzger, LWF)

same leaf, the mines often merge together leading to browning and drying of the leaves, which eventually curl upwards and inwards at the edges and fall prematurely. Early leaf-fall can affect 70–100% of the leaves on a single tree. At first glance, *C. ohridella* mines could be confused with the red-brown blotches caused by the fungus *Guignardia aesculi* (Plate 2).

**PLATE 2**

Damage caused by (a) *Guignardia aesculi* and (b) *Cameraria ohridella* on horse chestnut. (Th. Lohrer)

Life cycle of *Cameraria ohridella*

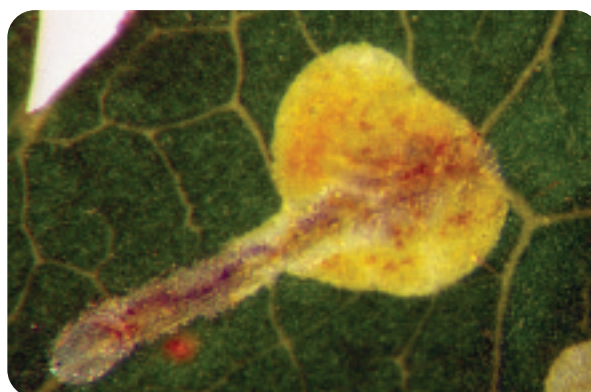
Depending on weather conditions and climate, up to five overlapping generations per year have been reported, especially in hotter and drier conditions. In Western Europe, up to three generations per year seems to be the average. Adults appear in April and are up to 5 mm long with metallic-brown wings

having transverse white stripes with black edges (Plate 3). Eggs are laid along the lateral veins on the upper side of the leaflet; between 200 and 300 per leaflet and 700 per compound leaf have been counted. Eggs hatch in 2–3 weeks.

**PLATE 3**

Adult of horse chestnut leaf miner. (P. Roose)

Larvae pass through five instars and complete their development in about 4 weeks (Plate 4). They feed inside the leaf tissue, leaving only the upper and lower epidermises intact. The final, pupal, stages develop in a silken cocoon in the mine, and generally complete development in about 2 weeks, but this stage can last for 6–7 months in the over-wintering generation. The over-wintering pupae are found among the fallen leaves and are known to be extremely frost tolerant, surviving temperatures as low as -23°C in Hungary. Throughout the summer it is possible to find all developmental stages present in attacked leaves.

**PLATE 4**

Mine caused by larva of horse chestnut leaf miner. (J. Freise)

Spread of infestation and type of damage

Once established in an area, population densities can increase rapidly although the natural rate of spread in an undisturbed population is slow. However, passive carriage on vehicles from infested areas has been shown to be a highly effective and speedy method of dispersal.

The threat

In the UK most tree species have associated leaf miners. While infestations of these can be disfiguring, even severe attacks are not regarded as affecting the overall health of the host tree in a significant way. However, *C. ohridella* may prove to be of greater consequence to the health of *Aesculus hippocastanum* (and also *Acer platanoides* and *A. pseudoplatanus*, the other known hosts of *C. ohridella*) due to a combination of the following factors:

- Multiple, overlapping generations can result in rapid infestation of leaves and both the primary and the second flush may fall prematurely.
- Pupae appear to be extremely frost tolerant. This can lead to increasing populations from year to year even when winters are severe.
- Numbers can build up rapidly following establishment in a new location, e.g. the heavy damage in Brussels during 2000, even though the moth was not noted in the previous year.
- Rapid long distance dispersal arising from passive transportation on vehicles can lead to new infestations at locations remote from known centres of attack.
- The pest does extremely well in hot dry conditions when the tree may be already suffering drought stress. *C. ohridella* can, therefore, be a contributory factor in further tree decline.
- Spread via vehicles tends to favour establishment in urban areas where growing conditions are less than ideal and trees are less able to withstand the effects of additional stresses.

- Horse chestnut and the other known hosts are significant amenity trees in urban and suburban areas so that both visual damage and loss of growth are more serious than in rural locations.

Trees heavily attacked by *C. ohridella* are not reported to die, but reduced growth of young trees has been noted. Continuing repeated defoliation, especially when it occurs early in the growing season, may lead to an overall gradual decline in tree vigour. The long-term effects are not yet known.

Control options

Biological control: Approximately 15 species of natural enemy (mainly parasitic wasps) have been identified within the known distribution area of this pest. However levels of parasitism and predation within established populations appear to be low (1–8%).

Chemical insecticides: Various chemical agents have been tried but it seems unlikely that these can be used successfully or routinely in urban situations.

In areas where there has been removal and destruction of dead leaves in the autumn and winter (in cities for example) there has been reduced damage locally. However in the long term this could also decrease the numbers of natural control agents that over-winter in the leaves.

Quarantine measures

It is not practical to prevent spread using phytosanitary measures because of the known propensity for passive dispersal of infested leaves on vehicles. Transportation to Britain is therefore highly likely and it is important to be aware of the possible establishment of the moth. The Forestry Commission is increasing its vigilance to try to detect possible infestations as early as possible so that the biology and potential impact of the moth can be evaluated and the possible need for appropriate control measures determined. This information will be available as an Exotic Pest Alert and in electronic form on the Forestry Commission website (www.forestry.gov.uk) (Tilbury and Evans, in press).

Conclusions

It is unlikely that *C. ohridella* would be able to complete more than one or two generations even in a warm dry summer in the UK. However if this pest shows more climatic tolerance than observed to date, particularly combined with any increase in the frequency of hot dry summers, it may pose a greater threat than predicted on the basis of current knowledge.

Longhorn beetles, Coleoptera: Cerambycidae

Exotic cerambycids are imported frequently into Britain and some, including *Trinophylum cribratum* from India and *Nathrius brevipennis* from southern Europe, have become established here, although neither of these species causes any significant damage. Cerambycids are conveyed easily in timber mainly because larval stages live deep within the wood and can have a prolonged period of growth in sawn timber or in wooden packaging, eventually emerging as new adults in the destination country. Interceptions are regularly made on a variety of commodities from around the world.

The Asian longhorn beetle, *Anoplophora glabripennis*, is frequently associated with packaging wood from China (Evans and Gibbs, 1999). It causes considerable damage, both in its native range and in the USA, where it is present in street trees in New York and Chicago. Despite the introduction of EU legislation in 1999 governing the standard of solid wood packaging material entering Britain, live larvae and adult beetles continue to be intercepted, although in far fewer numbers than before the legislation. It remains a cause of considerable concern to us in Britain.

Those involved in trading in non-wood commodities, where wood is used only as packaging, may be less aware of plant health controls than wood importers and considerable effort has gone into increasing the level of awareness among all importers. This has resulted in the reporting of an increasing number of species of cerambycids, as well as other wood boring beetles, in addition to the Asian longhorn

beetle. Included are species of *Monochamus*, which are prohibited on account of being known vectors of the potentially lethal pinewood nematode (PWN), *Bursaphelenchus xylophilus*. Notable among these is *M. alternatus*, a native of China and Japan, where it is the principal vector of PWN.

No exotic pest cerambycid species have been found outside harbours, timber yards or other premises where imported timber or wood products have been stored. This may be explained by factors affecting the likelihood of a species establishing, such as climate, lack of suitable breeding material or insufficient individuals to establish a pioneer population. However it is possible that a small population with a restricted distribution might be overlooked as was the case with the bark beetle *Dendroctonus micans* which appeared to have been present in the country for about 10 years before it was spotted.

Pinewood nematode

Pinewood nematode, *Bursaphelenchus xylophilus*, is a microscopic nematode worm that is native to North America where it lives mainly on dying or dead trees and rarely affects healthy living trees. The nematode is carried from tree to tree by longhorn beetles in the genus *Monochamus* (see the section on longhorn beetles). When trees are susceptible and average temperatures are high (July/August isotherm > 24–26 °C), nematodes introduced into the crowns of trees may enter the water conducting vessels, breed and, by increases in numbers and production of a toxin, eventually kill the tree. Tree death can be rapid and give rise to characteristic wilting in which needles redden within a few weeks of nematode introduction.

PWN has established in a number of new locations world-wide where extensive tree mortality has been observed. It is now a serious pest in Japan, China, Korea, Taiwan and in 1999 was also found in Portugal (Gibbs and Evans, 2000). One of the strategies adopted by the EU, in response to the outbreak in Portugal, was to ask Member States to carry out surveys to determine whether the

nematode is present in their territories and also to assess whether either the nematode or its vector is being carried to the EU on imported wood.

A standardised method for carrying out the surveys was developed by the EU. In the UK, 118 conifer samples were taken and checked for the presence of *B. xylophilus* infestation. Sampling was concentrated on the identification of 'high-risk' sites, primarily those associated with points of wood import (harbours) known to take material from countries having PWN.

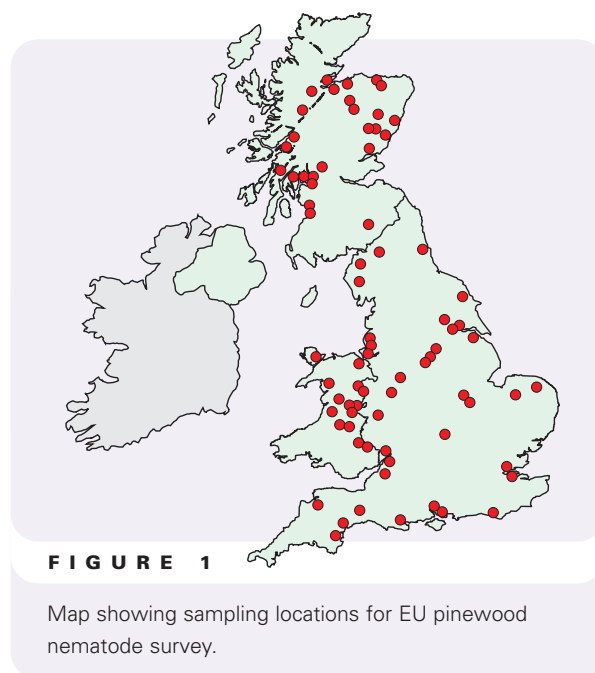
- *Sampling of direct imports at the point of landing*
 - Packing wood in the form of crates, pallets, packing cases, dunnage etc.
 - Imported timber bundles.
- *Sampling at premises where imported wood is handled or stored*
 - Sawmills and wood processing mills.
 - Warehouses and depots in the case of packing wood transported in sealed containers.
- *Forest and individual trees*

These were in locations adjacent to points of wood import, handling or storage of wood using the following criteria:

- Forest trees within a 5 km radius of points of wood import, handling or storage of wood. If there are no forest blocks within 5 km this should be increased to 25 km.
- Other sources of potential host trees, i.e. small woodlands, isolated trees, parkland trees around points of wood import, handling or storage of wood.
- *Selection of conifer species*

In Britain, Scots pine, *Pinus sylvestris*, is the only commercially grown species known to be highly susceptible to PWN. Surveys were therefore concentrated on Scots pine but other conifer species were included at some sites. A map summarising sampling locations is shown in Figure 1. In addition to these sites, three samples were received from Guernsey, two from growing

trees and the third from packaging wood from Japan. *B. xylophilus* was not extracted from any of these samples. Live nematodes were extracted from 65% of the samples. In no instance was *B. xylophilus* found to be present.



In both its native range in North America and in countries where it has become established, *B. xylophilus* is vectored (carried from tree to tree) by longhorn beetles in the genus *Monochamus*. Although nematodes have occasionally been found on other beetle genera in several beetle families, there is no evidence that they were effective vectors of the nematode. The risk of transmission from wood to trees without the presence of the *Monochamus* vectors is extremely small.

There are no native *Monochamus* species in the UK, therefore the risks of establishment are relatively low because both the vector and the nematode would have to be imported and successfully transfer to British trees. However, as indicated in the section on longhorn beetles in this report, interceptions of *Monochamus* species have been noted on a number of occasions and thus present a significant risk.

Established pest and disease problems

Great spruce bark beetle, *Dendroctonus micans*

The discovery of *D. micans* in Kent in the 1990s, and the subsequent programme of sanitation felling and release of the specific predator *Rhizophagus grandis*, has considerably increased the survey effort on this damaging bark beetle and has led to new assessments of management strategies.

Annual peripheral zone surveys on the eastern edges of the known infested area in Wales, the bordering counties of England and in Lancashire have provided information to confirm that natural spread occurs at an average rate of between 2 and 5 km per annum. These data have been used to carry out a financial appraisal of the current strategy, which comprises surveys on the periphery of the infested area, restriction of timber movement from the *Dendroctonus micans* Control Area (DMCA) into the uninfested *D. micans* Protected Zone, sanitation felling of any new infestations found and release of *R. grandis* (O'Neill and Evans, 1999). The appraisal confirmed that the current strategy was cost-effective at *D. micans*-induced tree mortality rates of 0.5% or greater and an annual natural beetle spread rate of 2 km or greater. However, during 2000, new infestations were discovered in both Westonbirt and Bedgebury Arboreta. Combined with the continuing outward spread of the known infested areas in the DMCA and Kent (Figure 2), this has led to a reappraisal of management options which includes consideration of changes to the DMCA boundary and also the form and frequency of surveys. In the meantime, intense management of the isolated infestations in Kent continues. This includes 100% surveys of all spruce, felling of infested trees, removal of bark to kill any *D. micans* present and release of *R. grandis* into all infested woodlands.

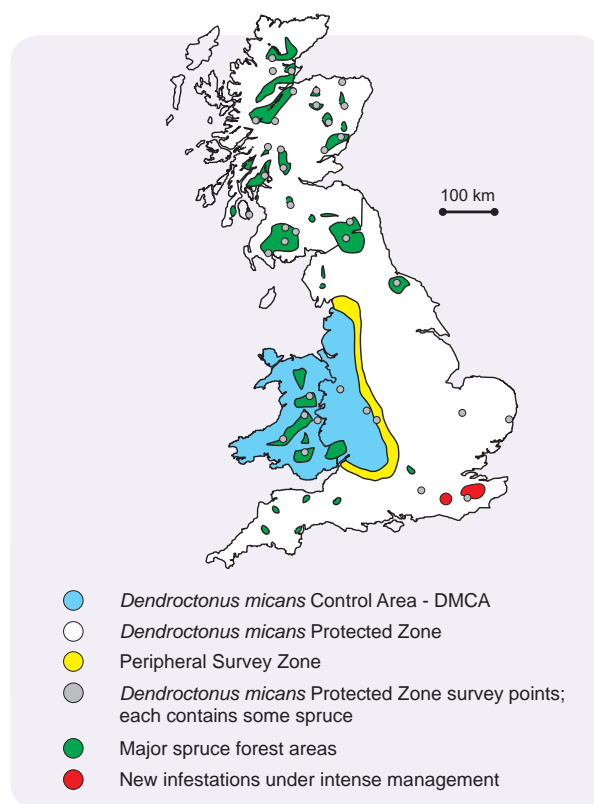


FIGURE 2

Map showing *Dendroctonus micans* control and survey areas in UK mainland.

Browntail moth

The browntail moth, *Euproctis chrysorrhoea*, is a member of the lepidopteran family Lymantriidae, which contains some of the most destructive moth pests world-wide. It was first reported as a pest species in Britain in 1720 by the naturalist Albin and since then numbers have fluctuated irregularly. Browntail moth is widely distributed in central and southern Europe but appears to be more a coastal and river-associated species in northern Europe. In Britain, populations occur in scattered localities predominantly in the south and east, but its range fluctuates from year to year and it can occur as far north as Yorkshire.

Browntail moth caterpillars (page 12) feed on leaves of many hardwood trees and shrubs and, at high population levels, may completely defoliate the host. Commonly infested trees and shrubs include hawthorn, blackthorn, ash, bramble, cherry, willow and privet. However, the principal concern arises

because of the human reaction, often severe, to contact with the caterpillar hairs. These hairs are barbed and hollow and contain chemicals that can give rise to allergic reactions in both humans and animals. Direct contact, especially with the larger larvae, produces the most extreme reactions because large numbers of hairs break off. In addition, the hairs are small enough to drift on the wind, thus affecting others not in direct contact with the larvae. Reactions include skin rashes and irritation, conjunctivitis and asthma attacks. Hairs can embed themselves in clothing leading to further sources of irritation. Repeated exposure can give rise to hypersensitivity and the necessity for hospital treatment.

There was a slight increase in the number of reports of problems from browntail moth during the summer months, which is consistent with the known fluctuations in numbers associated with this insect. However, direct control could prove to be more problematical in the future as there are now very few insecticides with specific approval for use against the caterpillars available to the professional, and those still remaining are most effective against young larvae. This could create difficulties because the problem is often not recognised until the larvae are well grown and thus less susceptible to the spray. The use of the bacterial insecticide *Bacillus thuringiensis* is still an option but this is also most effective when applied to young larvae, which must ingest the bacterial toxin to be killed. The alternative, non-chemical, strategy for dealing with these caterpillars involves cutting out and destroying the webbing nests in which young caterpillars aggregate to spend the winter months. The lack of larval activity means that far fewer hairs are released than when the caterpillars are active in the autumn and spring, although protective clothing is still required. The method is labour intensive and requires adequate survey to locate all the nests, and can only be of value in an area where the caterpillars have been previously identified.

Phytophthora disease of alder

This disease continues to cause concern, with new records in Scotland. An estimated 580 000 trees are now affected, comprising more than 12% of the alder population. There is also increasing evidence that the pathogen can be disseminated via young alder plants which have become infected in the nursery, either by watering with contaminated river water or through the importation of infected saplings. Many nurseries do not grow their own alders from seed but buy them in as young plants from other European countries and grow them on before resale. If such stock is then planted out to woodland and riverside sites, new infection foci may be established. This could account for the rapid dissemination of the alder *Phytophthora* to many parts of Europe. Evidence linking the disease with nurseries comes not only from the UK, but also from Germany, Italy and Sweden.

Since the disease was first identified in 1993 (Gibbs *et al.*, 1994) our understanding of the status of the alder pathogen has changed markedly. Its hybrid origin has now been established beyond doubt – the parent species being *Phytophthora cambivora* and a fungus close to *P. fragariae* (Brasier *et al.*, 1999). However, the new pathogen is not a homogeneous unit but exists as a swarm of distinct hybrid types: a widely distributed 'standard type' with two sets of chromosomes – one from each parent – and several so-called 'variants' which have a more restricted distribution. The variants are morphologically and behaviourally distinct and may have been generated from the genetic breakdown of the standard type, or be the products of back-crosses or further hybridisation events. Frequently they are significantly less pathogenic to alder than the standard alder *Phytophthora* (Figure 3) and evolution of all the hybrid types appears to be a continuing process. It is striking that the hybrid pathogen is very damaging to alder and can cause significant levels of bark necrosis in just a few weeks, but the putative parent species cause little or no damage to alder although they are aggressive pathogens of other woody hosts.

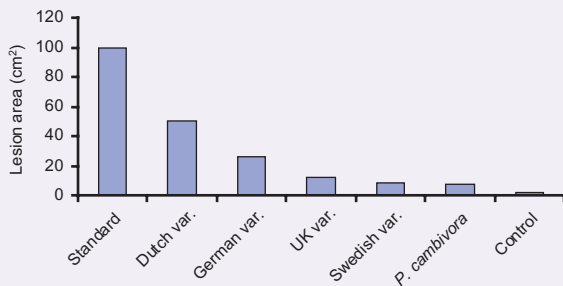


FIGURE 3

Lesions provided by different forms of alder Phytophthoras and *P. cambivora*, inoculated into freshly felled alder logs and measured after 6 weeks to quantify pathogenic potential.

Weather-related and periodic damage

Spring 2000 was very wet throughout the UK; rainfall was over three times greater than normal during April in England and this, combined with periods of cool weather, encouraged the development of a number of leaf and shoot diseases. The most prominent included willow scab *Pollaccia saliciperda* (Plate 5) and cherry leaf spot caused by *Blumeriella jaapii* (Plates 6 and 7).



PLATE 5

Willow scab caused by *Pollaccia saliciperda* on willow species *Salix alba vitellina*. (Forest Research Photo Library 41213)



PLATE 6

Cherry leaf spot on *Prunus avium*. (Forest Research Photo Library 41210)



PLATE 7

Detail of cherry leaf spot caused by *Blumeriella jaapii*. (Forest Research Photo Library 40667)

In some cases, willow scab was so severe on *Salix fragilis* that virtually no live foliage remained, raising the possibility of widespread dieback and even death of affected trees.

In England, the summer months continued to be wet and cool. Such conditions favour the development of *Phytophthora* diseases and these were widely reported, most notably on yew and silver fir, *P. cinnamomi*. There were also more cases of bleeding canker, *P. cactorum*, continuing the pattern of last year when this pathogen caused unusually severe damage to horse chestnut.

In contrast, July in Scotland was very dry with temperatures reaching 27 °C and these conditions exacerbated a problem of fertiliser scorch on a Fraser Christmas tree plantation. Browning of the current year's needles was noted within two weeks of the application of a granular fertiliser, and lack of rainfall combined with high temperatures enhanced the desiccating effect of the fertiliser residue which remained on the foliage.

A severe gale in the north and west of Scotland on 13 June caused physical damage to many trees in these areas; both conifer and broadleaf trees were affected. Wilted and dead shoots were visible on the current year's growth of some Sitka spruce and *Abies* species, while on other trees the damage was directional. Strong winds at the end of 2000 in England also caused a significant number of trees on roadsides and banks to blow over, but despite the exceptionally wet autumn and heavy rainfall in the following spring with accompanying floods, there have been few damage reports. However, the snowfall which affected central Scotland in February 2001 was heavy enough to cause snow break on some trees.

Green leaf weevils

A large number of enquiries were received during the spring and early summer from anxious callers requiring advice regarding the defoliation of recently established broadleaved trees. The insects responsible were a group of leaf-feeding weevils (Coleoptera: Curculionidae) belonging to the genus *Phyllobius*. A number of different species were involved, the most common being *Phyllobius pyri*, which can be found on a variety of tree species. Other species included *P. argentatus* and *P. roboretanus*, the latter being more frequently associated with damage to oaks. Although damage is most often seen on broadleaved tree species, conifers can also be attacked. The group has been given the common name of 'green leaf weevils' on account of the brilliant green or bronze-green colour of the adult beetles.

When the adults are present in high numbers they can completely defoliate young trees which seem especially vulnerable when they emerge from the tops of treeshelters. The damage occurs between April and July, after which time the adult weevils disappear quite suddenly and damage ceases. The young trees usually recover, although growth can be checked, and they are able to produce a second flush of leaves which are not attacked. Repeated annual attacks can lead to a loss of vigour and may result in bushy, multi-stemmed tops developing in some trees.

New or unusual records

Box blight

Box blight, *Volutella buxi*, has been known in England since the mid-19th century but reports of the disease are rare. During the year it was found in Scotland infecting *Buxus* in a newly planted millennium garden. Previously the disease has only been noted from scattered localities in England and once before in Scotland.

Dieback in birch and poplar

There has also been an increasing number of reports which relate to the failure of trees planted under the Woodland Grant Scheme, particularly in Scotland and northern England. Many of the failures occur during the establishment phase and in some cases the problem may not be primarily pathological but caused by a number of factors. Failure of birch is frequently associated with leaf spots and stem lesions or defoliation by rust, although this is unlikely to be the cause of extensive branch dieback that was reported. At another site severe dieback and death occurred on 7-year old poplar clones Beaupré and Boelare on a farm woodland scheme. This occurred possibly as a result of severe defoliation in the previous year followed by damage by unseasonal frosts in 2000.

Red band needle blight

Red band needle blight, caused by the fungus *Mycosphaerella pini* (syn. *Scirrhia pini*), led to widespread damage to Corsican pine in Thetford Forest Park and at least two private woods in southern England. This potentially serious disease (also known as Dothistroma needle blight) is listed in EC plant health legislation and was last recorded in the UK in 1989, but this is probably the most significant outbreak in England for 40 years. There has been a notable increase in the severity and distribution of the disease in France over the past few years (Villebonne and Maugard, 1999) and the outbreaks in England may herald a similar increase in intensity. The disease seems principally to affect stands between 15 and 30 years of age and can be particularly severe in dense, unthinned stands. Symptoms usually appear in autumn and become more conspicuous through the winter (Plate 8a and b). Pathology Branch has set up an FC internet page to alert growers of Corsican pine to the disease.

(a)



(b)

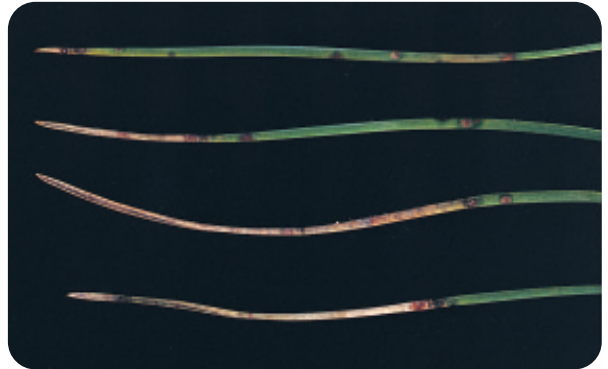


PLATE 8

Red band needle blight on Corsican pine showing (a) the reddish-brown necrosis of the foliage and (b) banding on individual needles. Note also the necrosis towards the needle tips. (a: John Gibbs; b: Forest Research Photo Library 39129)

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