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Dieback of Pedunculate Oak

INFORMATION NOTE

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SUMMARY

Dieback of pedunculate oak *(Quercus robur)* is a complex disease in which a number of damaging agents interact variously to bring about a serious deterioration in tree condition. Broadly similar symptoms have been recorded from many European countries. Initially there is a deterioration in the appearance of the foliage, and then, over several years, a progressive death of the branches. In some cases this leads on to the death of the whole tree. In the UK there was a major dieback episode during the 1920s in which defoliation by caterpillars of the oak leaf roller moth *(Tortrix viridana)* and damage due to oak mildew *(Microsphaera alphitoides)* were thought to play a critical role. Serious dieback occurred again in the 1989–1994 period and at this time drought damage was considered to be a key factor. Attack on weakened trees by the buprestid beetle *Agrilus pannonicus* contributed to tree death. Fresh occurrences of the disease were reported from 1997 onwards.

A wide ranging European research programme into oak dieback has been initiated from which, it is hoped, new insights into the problem will be gained. The principal effort is being directed towards understanding the importance of the killing of fine roots by fungi in the genus *Phytophthora*.

INTRODUCTION

1. In the context of tree diseases, the word ‘dieback’ is usually used for a problem of complex cause. ‘Dieback’, or the similar term ‘dying back’, has been used in relation to diseased pedunculate oak *Quercus robur* in the UK for at least 75 years. This Information Note outlines the history of the problem and evaluates available data on cause. The question of disease management is discussed. A more detailed consideration of the literature can be found in a review by Gibbs and Greig (1997).

HISTORY OF OAK DIEBACK IN THE UK

The disease episode of the 1920s

2. It was during the early 1920s that the dieback of woodland oak first aroused widespread concern in England (Day, 1927). Damage was thought to begin with the defoliation of trees in early summer by caterpillars of the oak leaf roller moth *(Tortrix viridana)*, an insect which was very abundant in the years after the end of World War 1. By 1924 reports were coming in that oaks were dying in alarming numbers in certain sections of the defoliated woods. Considerable emphasis was also placed on the role of oak mildew *Microsphaera alphitoides* (then known as *M. quercina*), a fungus which had first appeared in Europe some 20 years earlier (Figure 1). The effects of this disease were particularly severe on the second crop of leaves that was formed after the first had been eaten by the caterpillars. A striking feature of many of the dead trees was the conspicuous presence on the roots of honey fungus *(Armillaria* sp.*)* but Day thought that

Figure 1

Oak mildew caused by *Microsphaera alphitoides.*

the role of this fungus was principally to kill off trees that were already 'irretrievably damaged'. By 1925, many sickly oaks, which had been kept under observation, showed a decided improvement in condition and it appears that this coincided with a marked reduction in the abundance of *T. viridana*.

Dieback in the UK during the period 1989–1994

3. After the late 1920s, there were no reports of oak dieback in the UK for over 30 years. In 1958 death of young *Q. robur* occurred in several woods near the Norfolk coast, with adjacent sessile oak *Q. petrea* being unaffected. Drought and exposure were thought to be important, together with the effects of defoliating insects and mildew. There were also accounts of damage in the early 1980s in Surrey and in the Forest of Dean. However, it was not until the years after 1989 that large numbers of reports of damage to oak were received by the Forestry Commission Research Division and a new project to examine the problem was initiated. During this period, the first symptom to be observed on a declining tree was usually an overall deterioration of the foliage. The leaves, which were often smaller than normal were pale green or yellow and might be rather sparse. Over the next year or so, the death of fine twigs was followed by the death of small branches, at which time the foliage was very thin. In some cases the process continued through the death of large branches to the death of the whole tree (Figure 2). However, other trees made partial recovery through the production of epicormic shoots on the trunk and surviving branches (Figure 3).

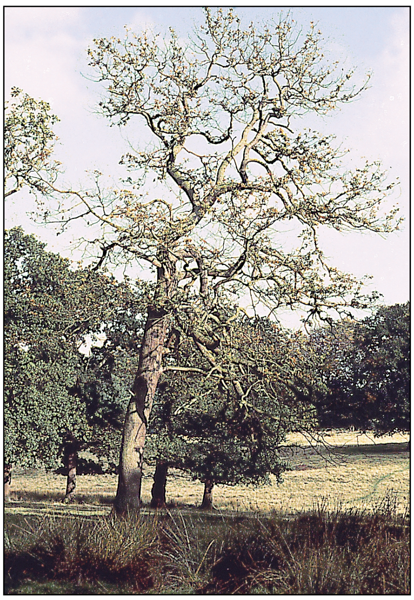

Figure 2

Oak in the final stage of decline at Tatton Park in Cheshire.

Figure 3

Sherwood Forest oak with severe dieback, but also showing evidence of recovery.

4. Dieback of this type occurred throughout the Midlands and southern England (Figure 4). On the sites reported to Forest Research, the trees ranged from 40 to 200 years of age. Approximately half were in woodland and half in parkland and they encompassed a range of soil types. The majority of the trees were *Q. robur* but, on a few sites, they were hybrids between *Q. robur* and *Q. petraea*. In order to obtain information on the development of the condition, ten plots, averaging 80 trees per plot, were established at affected sites to monitor changes in tree condition. These plots, set up either in 1990 or 1991, were surveyed each year until 1994, and Table 1 contains a summary of the data for various years in

Figure 4

Map of sites from which dieback was reported during the 1989–1994 period. Open circles mark the location of sites at which assessment plots were established.

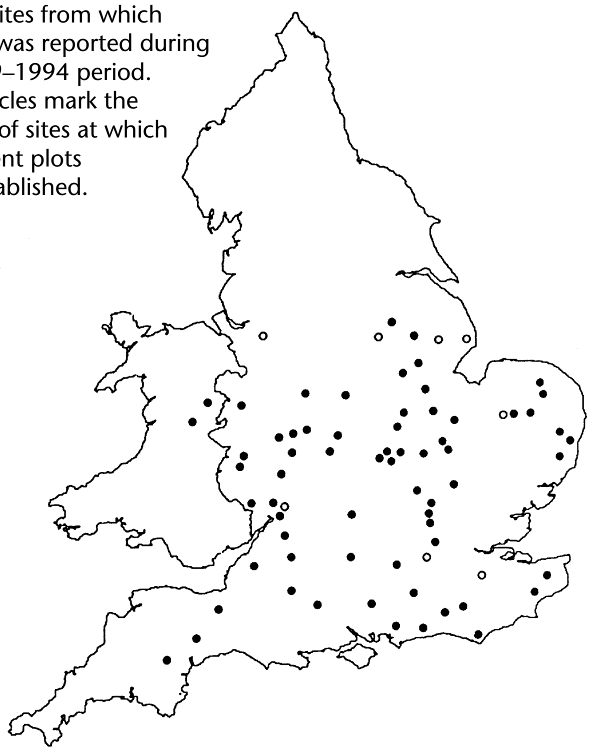

Table 1 **Summary data from ten oak dieback plots established in 1990 or 1991**
Assessments were conducted each year between establishment and 1994 and then again in 1997

Plot No.	Location	No. of trees	1990		1991		1994		1997	
			% dead	% dieback in live trees	% dead	% dieback in live trees	% dead	% dieback in live trees	% dead	% dieback in live trees
1	Sherwood, Notts	57	2	26	2	20	2	13	2	13
2	Fanny's Grove, Notts	117	1	15	1	9	2	5	2	4
3	Crickley Hill, Glos	159	4	10	4	8	6	6	8	6
4	Everlands 1, Kent	35	11	8	11	10	14	5	14	5
5	Everlands 2, Kent	30	0	16	0	11	3	8	3	7
6	Tatton Park, Cheshire	100	-	-	0	5	9	1	8	2
7	Richmond Park, Surrey	109	-	-	4	8	12	6	14	5
8	Stixwold, Lincs	100	-	-	12	3	12	3	13	5
9	Emily's Wood, Norfolk	28	-	-	0	12	0	27	4	14
10	Scremby Park, Lincs	99	-	-	2	3	2	1	2	3
	All plots	834	-	-	3.6	8.9	6.2	7.5	7.0	6.4

terms of both the percentage of dead trees and the average percentage of dieback in the crowns of the remaining live trees. It can be seen that there was relatively little increase in the proportion of dead trees during the study period. On average, 3.6% of the trees were dead in 1991 and 6.2% in 1994. The mean percentage of dieback in the crowns of the live trees dropped slightly from 8.9% to 7.5%, but there was considerable variation between plots.

5. Defoliation by caterpillars did not seem to be a factor at most affected sites, although it had occurred at Sherwood in 1987 and 1988. Oak mildew also was not severe during much of the period – although it was conspicuous in 1993. It was concluded that drought was a much more important factor in placing the trees under stress, since the summers of both 1989 and 1990 were extremely dry. At five sites some severely-affected trees were winched out so that the root systems could be examined. Little evidence of root-rotting fungi was found, with the exception of one tree in which the Basidiomycete *Collybia fusipes* was present. Sampling for the fungus *Phytophthora*, which often kills fine roots, gave negative results but this may have been a matter of technique: these specialised fungi can extremely difficult to detect in diseased trees and in soil (see Brasier, 1999). The presence of yellow leaves on many of the affected trees suggested the possible involvement of a virus or related agent. However, when samples were examined, nothing conclusive was found.

6. One striking feature of the trees on many sites was the presence of the buprestid beetle *Agrilus pannonicus*. This insect was found at 14 of 20 sites visited, and at Sherwood was present on all 20 dead and 10 declining trees examined. Eggs are laid in the bark of declining trees and the resulting larvae tunnel extensively through the bark, often to the extent of girdling the trees. The early stage of attack by *A. pannonicus* on a tree that still possessed a residuum of vitality was often marked by the presence of a dark exudate on the bark surface (Figure 5). It was considered that there was little doubt that the insect had become much more common in the UK than formerly, and that it had become a new component in the oak dieback story. As recently as 1987 *A. pannonicus* was listed in the British Red Data Books as 'vulnerable', meaning that extinction was believed likely if current pressures on it continued to operate.

Figure 5

Tarry spots associated with points of attack by the beetle *Agrilus pannonicus* on a declining oak at Richmond Park in Surrey.

7. The scale insect *Kermes quercus* has been linked with conspicuous crown dieback in *Q. petrea* in the Forest of Wyre, West Midlands, where it is so conspicuous as to have acquired the local name of 'Wyre pox'. This insect was found at Sherwood (where at least some of the oaks are hybrids between *Q. robur* and *Q. petraea*) and at Richmond Park, but was not present at many other sites.

RESEARCH ON DIEBACK IN PEDUNCULATE OAK ELSEWHERE IN EUROPE

8. In France, the main recent episode of oak dieback occurred towards the end of the 1970s. The early symptoms (thin crowns, stunted yellowish-green leaves) were very similar to those recorded subsequently in the UK. Growth ring studies indicated that the very dry period 1974–1976 had provided the initial stress and it was concluded that various biotic agents of damage then became involved – most notably oak leaf roller moth and mildew. Continuing decline was due in part to root invasion by the root rot fungus *Collybia fusipes*.

9. In Germany, serious dieback, in this case affecting both *Q. robur* and *Q. petraea*, began in 1982–83 and reached a peak between 1985 and 1989. Work in northern Germany indicated that a key factor was the exceptionally cold weather of the winters of 1985–87, during which large areas of bark were killed. It was also noted that attack by *A. pannonicus* was very common, and this was considered to be the most important cause of death in weakened trees. There was some evidence that the frost sensitivity of the bark might have been increased either by prior insect defoliation or by high nitrogen inputs resulting from air pollution. More recently, work by Thomas Jung and colleagues (1996, 1999), mainly in southern Germany but extending to other countries also, has placed considerable emphasis on the role of *Phytophthora* spp. in causing damage to fine feeder roots and thus rendering the trees vulnerable to damage by other agents. Using specialised techniques, at least one new species has been discovered and this has been named *P. quercina*. It seems likely that, together with other species such as *P. cambivora*, *P. quercina* is playing a significant part in causing fine root damage on all but the most acid soils. As a result the trees are rendered more vulnerable to the effects of other damaging agents. In considering factors which may have exacerbated the damage potential of *Phytophthora* spp., the German scientists have speculated about a possible influence of increased nitrogen input to forests and of climatic changes resulting in the occurrence of very heavy winter rains.

RECENT INITIATIVES

10. In 1997, concern over oak dieback in eastern and central England was rekindled by the recognition that the problem had appeared at a number of previously unaffected woodlands. This led to a grant from the charity Woodland Heritage to Forest Research. The funds were principally used for a reassessment of the ten dieback plots and the data are also shown in Table 1. It was found that there had been little real change in condition, with few trees dying but virtually none of the surviving ones showing much recovery growth.

11. The results of this exercise, combined with data coming from the oak plots of the main forest condition survey (Redfern *et al.*, 1998) were regarded as justification for further work on the disease. This research was subsequently initiated within the context of a European Union 'Shared Cost' project that began on 1 January 1998, and involves joint studies with colleagues in France, Germany and Italy. With this arrangement, half the funds come from the European Union and the remainder from the participating member states. The project has various components and is designed to draw on the strengths of different research units; the results being available

to all partners as well as to the European Commission itself. One component is concerned with an analysis of decline and dieback processes and will bring together long-term ecological and short-term physiological studies. However, the main thrust is aimed at understanding the role of root pathogens and of the way in which the response of oaks to pathogens is influenced by factors such as drought and an imbalance in nitrogen nutrition. It also includes a study of the root pathogens that are associated with dieback in different areas, and this is the topic with which Forest Research is principally involved. A range of oak dieback sites is being investigated to determine the status of various *Phytophthora* spp., and this will be followed by an experimental evaluation of the pathogenic ability of such *Phytophthora* spp. as are found. This work is now well in hand (Brasier, 1999).

UNDERSTANDING AND MANAGING OAK DIEBACK

12. Oak dieback can be classified as a 'complex disease' or a 'dieback-decline' in which a series of damaging agents progressively alters the tree so that eventually it becomes vulnerable to 'organisms of secondary action'. These are principally insects and fungi which are not capable of invading a healthy tree but which are very destructive to a weakened one. In this context, it is important to recognise that different damaging agents can bring about the same final symptoms.

13. From time to time in recent years, attempts have been made to draw parallels between oak dieback and Dutch elm disease. These are inappropriate. When the epidemic of Dutch elm disease caused by a single pathogen, *Ophiostoma novo-ulmi*, developed across southern Britain in the 1970s, losses doubled each year for almost a decade and some 18 million trees died. New outbreaks of similar ferocity are now occurring in the regenerating elm population (Brasier, 1996). By contrast, the mortality due to oak dieback is sporadic and the situation in affected stands can remain static over long periods and sometimes improve.

14. This lack of similarity with Dutch elm disease should not be taken to imply that oak dieback is not a serious problem. It is entirely appropriate that it should be viewed with concern by woodland managers, and that research should be undertaken to determine the cause and to define approaches to management and control. At present, the advice to those managing woods for timber production is to adopt a 'salvage felling' policy whereby severely-diseased main-crop trees are removed in time to safeguard their timber value. Where woodland is principally managed for conservation and the benefits of dead wood are paramount, a more *laissez-faire* strategy may be appropriate.

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