OAK DECLINE IN AUSTRIA AND EUROPE

by Christian Tomiczek

Abstract. Oak decline has been reported periodically in Europe. In most cases it has been caused by a complex of abiotic and biotic factors. At present it is decreasing in Austria and in many other European countries. The most recent oak decline differs from former oak decline problems mainly because of its enormous extent, which reaches from England in the west to the Ukraine in the east and from Sweden in the north to Italy in the south and affects a high percentage of natural white oak stands.

Reports of oak decline first came from Rumania in the mid - 50s, followed by the former USSR in the 1960s, France, Hungary, CSFR during the 1970s and from other European countries, including Austria, at the beginning of the 1980s. The highest rate of oak mortality in Europe was registered between 1985 and 1986. In subsequent years a significant decrease in tree mortality and a slow recovery was registered, but dying oaks can be seen still in parts of Austria.

Mainly sessile oak (*Q. petraea*) and pendunculate oak (*Q.robur*) are affected by the decline. To a lesser extent other white oak species such as *Q. cerris, Q. penduculiflora, Q. slavonica, Q. polycarpa, and Q. dalechampii* are also affected (9) in both natural and planted oak stands.

In Austria, three different phases of decline can be observed (10).

Phase "1" is characterized by a typical defoliation, observed especially in summer. At the beginning of defoliation, a loss of small twigs is often seen, described as "twig-abscission". In addition, water sprouts occur frequently in the lower parts of the crown or on the main stem. Leaves are smaller than normal and exhibit chlorotic symptoms. Annual ring analyses have shown a significant reduction in increment width.

Phase "2" coincides with attack by secondary insect parasites, such as *Scolytidae, Cerambycidae* and *Buprestidae,* which leads to further defoliation. During this phase sapwood nematodes are observed in increasing numbers.

Phase "3" is often a lethal phase and is characterized by the dying of heavily damaged oak trees. In nearly all cases *Armillaria* fruiting bodies can be found on the dead trees.

From the first appearance of apical branch necrosis to the stages of complete crown death may take only a few months. Generally, however, the period lasts 2 - 4 years and ends with the death or recovery of the affected trees.

The mode of action of individual factors corresponds to the Delatour - Scheme (4), which agrees with that designed by Falck (7) and is described by Alexe (1) as the *classic - scheme.* Following this scheme, those factors that lead to the first weakness of a single tree or forest stand by reducing assimilation and nutrient circulation are considered the "primary causal agents".

In the view of most forest scientists, the present oak decline in Europe is caused by an interaction of climatic extremes and biotic factors. A succession of dry years and droughths combined with a heavy increase in leaf feeding insects such as *Lymantria dispar* and arctic winter frosts without snow cover are seen as primary causal agents.

In numerous weather stations in eastern Austria, precipitation of less than 250 mm (10 in) during the growing season and less than 400 mm during the entire year was registered between 1975 - 1987. The decrease in rainfall has led to a lowering of ground water levels and to a drying out of the upper soil layers where most roots are concentrated. Older trees especially cannot adapt their root systems to new conditions. This leads first to the dying of small young roots and later to death of main roots, which can not be replaced. Annual ring increment depression and attack by secondary insects and fungi follow.

In this regard it should be noted that the oaks are wasteful of water, using up to 344 g of water per 1 g dry matter produced (9) whereas, by comparison, beech (*Fagus sylvatica*) needs only 160 g/g dry matter.

In many parts of Austria where oaks are found, the lowest temperatures of the century were recorded in January 1985, 1986 and 1987. The drop to these low temperatures occurred rapidly, within a few hours or days, following a warm period with temperatures slightly above or below 0° C.

Research

To confirm the hypothesis in question : " water stress and/or arctic frost has damaged parts of the root system" a certain number of oak root systems showing different degrees of vitality and damage were exposed by bulldozer activity and high pressure water flow. Observation of root degradation confirmed the connection between crown symptoms and root damage. Dead and *Armillaria* - infected roots were found varying directly with crown damage levels. Death of roots was determined by observing the cambial tissue. Armillaria infection was confirmed by searching for rhizomorphs or isolation from infected wood.

Dead root conditions indicate that root damage occurred prior to culmination of oak decline (1985/86). Something new to us was the identification of *Agrilus* galleries on oak roots up to 20 cm below the soil surface.

In all Austrian oak stands, and in most East European oak territories, attack by *Loranthus europaeus* mistletoe has played an increasingly important role as stressor. It is assumed that this parasite has a significant effect on oak vitality, but no direct connection as a cause of oak decline has been found (5).

Damage symptoms and development of oak decline suggest that a tracheomycosis similar to oak wilt in America (caused by *Ceratocystis fagacearum*) may be responsible for the European oak decline. Inoculation tests with different *Ceratocystis* species (*C. piceae, C. stenoceras, C. prolifera*) isolated from oak trees showed no (3), or very little pathogenicity or severe water stress on young oak seedlings (6).

In addition to the aforementioned leaf feeding insects, *Buprestidae, Scolytidae and Cerambycidae* may be found in declining oaks with varying intensity. All three beetle genera are able to fullfil maturity-feeding in the crown of undamaged oak trees.

Sapwood nematodes of the genus *Bursaphelenchus* have been isolated (11) from wood samples of crown-, stem- and root-sections of damaged *Q. petraea and Q. robur.* Increasing numbers of nematodes were correlated with the severity of decline and reached a population density of up to several million per tree.

Sapwood nematodes in oak similar to those in the pine wilt disease in USA (13) and Japan (8,14) are transferred by insect vectors such as *Buprestidae, Scolytidae and Cerambicidae.* Investigations of sapwood nematodes have shown that they are able to transmit *Ceratocystis* spores. Inoculation tests in climatic chambers with sapwood nematodes on oak seedlings indicated that, combined with high temperature and drought, wilt symptoms could be induced.

MLOs and viruses are found in many broadleaf trees, especially fruit trees, and are able to cause yellowing and dwarfing of leaves. Some oak decline symptoms suggest that MLOs and viruses are participating in the disease, but there is no firm evidence of this as yet.

Tree diseases often occur as the result of a complex of factors. It is necessary therefore to consider all possible damaging factors in the complex, differentiate among them, and assign weights to the severity of each contributing component.

Control Measures

Because a water deficit seems to be a main causal factor of oak decline in Austria and in parts of Europe, we must make it possible for trees in cities and forests to possess an adequate root system. We must pay more attention to the root system at the time of planting and reduce the competition between trees in forest stands.

When oak decline occurs, the chain of biotic factors must be broken in order to enable weakened trees to recover and to minimize the possibility of disease spread. We must reduce the number of insect pests that function as vectors for fungi, sapwood nematodes, MLOs and viruses.

In Austria the application of insecticide-, fungicide- and fungispore-implants were tested on declining oaks. Holes of 12 mm in diameter were drilled into sapwood in the trunk near the main roots and filled with a granules containing either an insecticide (Ambush = Permetrine, 250 g/L), fungicide (Imazalil sulfate 250 g/L) or *Trichoderma* spores.

Insecticide and fungicide implants at the rate evaluated did not show any positive effect, but the application of *Trichoderma* spores seemed to have a positive effect on control of Armillaria.

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Résumé. Le dépérissement du chêne a été signalé à plusieurs reprises en Europe. Le chêne sessile (*Quercus petraea*) et le chêne pédonculé (*Q. robur*) sont les principaux affectés, mais les autres chênes blancs le sont aussi. Ceci est causé par un ensemble complexe de facteurs abiotiques et biotiques. Une succession d'années sans pluie et de sécheresses combinée avec une forte augmentation d'insectes broyeurs des feuilles comme le *Lymantria dispar* et des courants d'air froid de l'Arctique causant des geléese sans corverture de neige en hiver sont perçues comme les principaux facteurs en cause. Le dépérissement s'étend de l'Angleterre, dans l'Ouest, à l'Ukraine, dans l'Est, et de la Suède, dans le Nord, à l'Italie, dans le Sud.

Zusammenfassung. Über Eichenschäden in Europa wird seit Jahrzehnten immer wieder berichtet. Traubeneiche (*Quercus petraea*) und Stieleiche (*Q. robur*) sind hauptsächlich betroffen, aber auch andere Weißeichen zeigen Schäden. Verursacht werden sie durch ein Zusammenwirken abiotischer und biotischer Faktoren. Aufeinanderfolgende, trockene Jahre und Dürreperioden verbunden mit einer Zunahme blattfressender Insekten wie *Lymantria dispar* sowie extreme Winterfröste ohne Schnee werden als Hauptursachen angesehen. Die Schäden reichen von England im Westen bis zur Ukraine im Osten und von Schweden im Norden bis nach Italien im Süden.