First records of soilborne Phytophthora species in Swedish oak forests

Jönsson Belyazid, Ulrika; Lundberg, L; Sonesson, Kerstin; Jung, T

Published in:
Forest Pathology

DOI:
10.1046/j.1439-0329.2003.00320.x

2003

For. Path. 33 (2003) 175–179

ISSN 1437–4781

First records of soilborne *Phytophthora* species in Swedish oak forests

By U. Jönsson[1], L. Lundberg[1], K. Sonesson[1] and T. Jung[2]

[1]Department of Plant Ecology, Ecology Building, Lund University, SE-223 62 Lund, Sweden. E-mail: ulrika.jonsson@planteco.lu.se; [2]Department of Forest Ecology and Forest Protection, Bavarian State Institute of Forestry (LWF), Am Hochanger 11, D-85354 Freising, Germany

Summary

Thirty-two oak stands in southern Sweden, 27 with predominantly declining trees and five with a higher proportion of healthy trees were investigated regarding the presence of soilborne *Phytophthora* species. *Phytophthora quercina*, an oak-specific fine root pathogen, was isolated from rhizosphere soil samples in 10 of the 27 declining stands. Additionally, *P. cactorum* and *P. cambivora* were recovered from one stand each. No *Phytophthora* species were isolated from the healthy oak stands. The soil conditions at the sites from which *Phytophthora* spp. were recovered ranged from mesic sediments to moraines, with clayey to silty textures and with soil pH ($BaCl_2$) between 3.5 and 5.0. The results show that *P. quercina* is geographically widespread in oak stands in southern Sweden and indicate that this pathogen may be one of the factors involved in oak decline in Northern Europe as has already been shown for western, Central and parts of southern Europe.

1 Introduction

During the past decade, several studies have demonstrated the involvement of soilborne species of the genus *Phytophthora* in European oak decline (Brasier et al. 1993; Jung et al. 1996, 1999, 2000; Gallego et al. 1999; Hansen and Delatour 1999; Vettraino et al. 2002). In Central Europe, *Phytophthora quercina*, an oak specific fine-root pathogen, seems to be of particular importance for the decline of *Q. robur* and *Q. petraea*, and a significant negative correlation between the presence of *P. quercina* in the rhizosphere, the condition of the fine roots (investigated only in Germany) and the crown transparency in mature oak stands have been found in Germany and Italy (Jung et al. 2000; Vettraino et al. 2002). Moreover, many *Phytophthora* species, including *P. quercina*, may cause substantial root rot on oak fine root systems under controlled conditions (Jung et al. 1996, 1999, 2002a,b).

Since the beginning of the 1990s, Swedish oak forests have experienced a dramatic deterioration in health (Sonesson and Anderson 2001). The causes for this development are uncertain. Therefore, a study was initiated in 1999 in order to investigate whether *Phytophthora* spp. may be involved also in the oak decline in southern Sweden. Here we present first data on the occurrence of *Phytophthora* species in oak forests of south Sweden.

2 Material and methods

A total of 32 oak stands in southern Sweden were investigated for the occurrence of soilborne *Phytophthora* species (Fig. 1). The sites were chosen based on the texture and pH of the soil, and on the degree of tree crown defoliation. Of the 32 sampled stands, 27 stands

Received: 9.7.2002; accepted: 3.2.2003; editor: E. Donaubauer

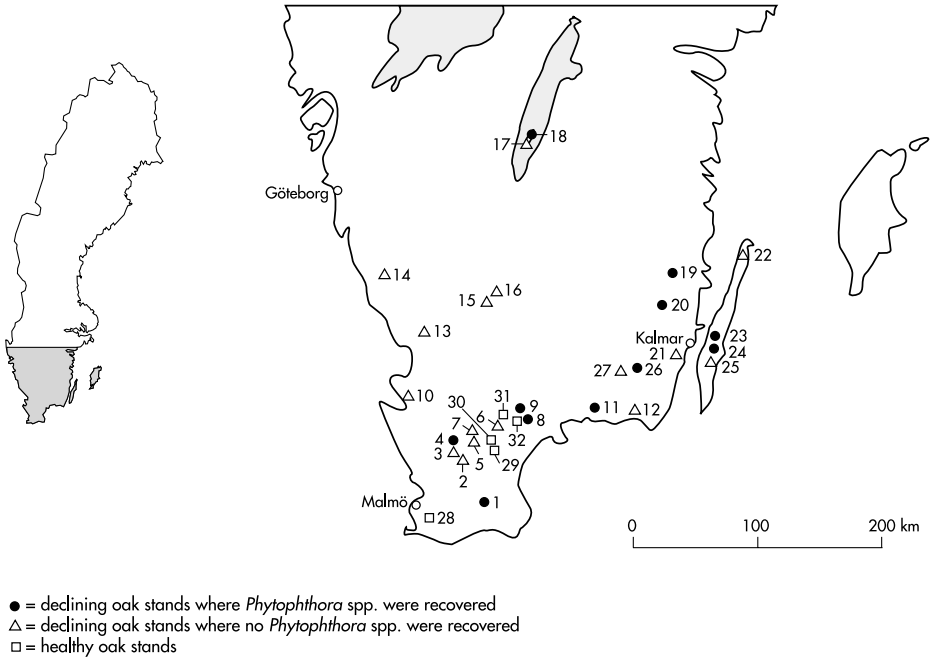

Fig. 1. Map of the studied region showing the location of the oak stands investigated and the distribution of sites infested with *Phytophthora* species

consisted of predominantly declining oak trees while five stands had a higher proportion of healthy trees. In the declining stands, five oaks with an estimated crown defoliation of 20–65% were selected. In the healthy stands, five trees with defoliation below 20% were sampled. Three to five soil monoliths with a size of 20 × 30 × 30 cm were taken around each tree, at a distance of 30–150 cm from the stem base and at a soil depth of 10–30 cm. Aliquots of rhizosphere soil together with oak roots (diameter ≤ 5 mm) from all monoliths were bulked, and subsamples were used for isolation tests and pH ($BaCl_2$) measurements. Samplings were carried out between October 1999 and October 2001, mainly during early spring or late autumn, as these are periods when the moisture conditions in the soil are favourable for *Phytophthora* isolation. Most of the sites were resampled on a second occasion during a different season. *Phytophthora* species were isolated using the soil baiting method as described in Jung et al. (1996, 2000).

3 Results

Three different *Phytophthora* species were isolated from rhizosphere soil in 11 of the 27 declining stands (Fig. 1). Among the *Phytophthora* species isolated, *P. quercina* was most frequently recovered and showed the widest geographical distribution (10 stands), while *P. cactorum* and *P. cambivora* (mating type A2) were recovered from only one stand each. On average, the isolation frequency of *P. quercina*, *P. cactorum* and *P. cambivora* in the *Phytophthora* infested stands was 35, 2 and 2%, respectively. At two sites, *P. quercina* was isolated from the rhizosphere of all sampled trees. No *Phytophthora* species were recovered from the five healthy stands. In addition to *Phytophthora* species, *Pythium anandrum* and

Table 1. **Occurrence of *Phytophthora* spp. in relation to soil type, moisture and pH. The numbers given are the number of sites. The numbers within parentheses represent the total number of sampled sites**

Occurrence of *Phytophthora* spp.	Soil type				Soil moisture[1]		pH ($BaCl_2$)		
	Sand (2)	Silt (19)	Loam (9)	Clay (2)	Moist (3)	Mesic (29)	pH < 3.5 (5)	≥ 3.5 < 4.0 (23)	pH ≥ 4.0 (4)
P. quercina	0	4	5	1	0	10	0	8	2
P. cactorum	0	1	0	0	0	1	0	1	0
P. cambivora	0	1	0	0	0	1	0	1	0

[1]No dry sites were sampled.

Py. undulatum were isolated from declining oaks in three stands each, and several *Pythium* species belonging to groups G, H and P were found in 12 declining stands and in one stand with healthy oaks.

The soil conditions of the stands from which the *Phytophthora* species were recovered ranged from mesic sediments to moraines, with clayey, loamy and silty textures and with soil pH ($BaCl_2$) between 3.5 and 5.0 (Table 1). No *Phytophthora* species were recovered from sites with soil pH < 3.5 (five sites), from sites with sandy soil (two sites) or from sites with moist soil conditions (three sites).

4 Discussion

This survey revealed the first records of soilborne *Phytophthora* species in southern Swedish oak stands. The oak specific fine root pathogen *Phytophthora quercina* was most frequently recovered and is geographically widespread in southern Sweden (Fig. 1). The presence of *P. quercina* extends the northern limit of this species and complements recent records of the pathogen in the UK, France, Italy, north-western Germany, Hungary, Austria and Turkey (Jung et al. 1996, 1999; Balci and Halmschlager 2002a,b; Delatour et al. 2002; Hartmann and Blank 2002), as well as unpublished findings in north-eastern Germany, Belgium and Serbia (T. Jung, unpublished data).

In Central, western and southern Europe, a diverse *Phytophthora* population is usually present in the oak forests. Among the 13 *Phytophthora* species recorded in Europe, *P. quercina*, *P. citricola* and *P. cambivora* are widespread, while others seem to be restricted to sites with warmer climate (*P. cinnamomi*, *P. cryptogea*), wet sites (*P. gonapodyides*, *P. europaea*, *P. uliginosa*) or acid sites (*P. pseudosyringae* sp. nov., T. Jung, unpublished) (Brasier et al. 1993; Jung et al. 1996, 2000, 2002b; Robin et al. 1998; Hansen and Delatour 1999; Hartmann and Blank 2002; Vettraino et al. 2002). Additionally, *P. cactorum*, *P. megasperma*, *P. psychrophila* and *P. syringae* are occasionally isolated. In the present study, only three species were found, suggesting that either the climatic conditions or the predominantly acid soils of southern Sweden may not be suitable for more than a few *Phytophthora* species. Another explanation may be that other *Phytophthora* species have not yet been introduced to Sweden. However, more investigations on other deciduous tree species and repeated samplings are needed before firm conclusions can be drawn about the general presence or absence of yet unrecorded *Phytophthora* species in Swedish forests.

In Sweden, the *Phytophthora* species, mainly *P. quercina*, were recovered from a wide range of soil types (Table 1). This is congruent with data from 35 oak stands in Bavaraia (Jung et al. 2000) where *P. quercina* showed a high plasticity concerning geological substrate, texture, moisture and pH of the soil. In conformity with the Bavarian study, the

pathogen was not recovered from the most acidic sites (pH < 3.5) in southern Sweden. However, it was frequently recovered from sites with a pH ($BaCl_2$) below 4.0, which is usually considered as unsuitable for *Phytophthora* species.

Our findings indicate that *Phytophthora* may contribute to the southern Swedish oak decline. However, as most oak forests soils in southern Sweden are acidic (Sonesson and Anderson 2001) and pathogenicity of soilborne *Phytophthora* species has usually been tested on seedlings grown in sterile mixtures of peat, vermiculite and sand with pH values of 6.5–7.0 (Jung et al. 1996, 1999, 2002a), additional soil infestation tests with natural, acidic forest soils are necessary before defining the role of *P. quercina* in the complex phenomenon of oak decline in southern Sweden.

Acknowledgements

This project was funded by AB Gustaf Kähr, Gustafsborgs Säteri AB, the National Board of Forestry, Region Skånes Miljövårdsfond, the Regional Board of Forestry, Sparbanksstiftelsen Kronan and Tarkett Sommer. The authors are grateful to county chief forester G. Fredriksson for his generous help in raising financial support. S. Anderson (Regional Board of Forestry), colleagues and technical assistants at Lund University and the Technical University of Munich are acknowledged for their advice and skilful help. K. Sonesson initiated the project.

Zusammenfassung

Erste Nachweise bodenbürtiger Phytophthora-Arten in schwedischen Eichenwäldern

In Südschweden wurden 27 erkrankte und 5 gesunde Eichenbestände auf das Vorkommen bodenbürtiger *Phytophthora* – Arten untersucht. Dabei wurde *P. quercina*, ein für Eichen spezifisches Feinwurzelpathogen, aus Rhizosphären – Proben von 10 der 27 erkrankten Bestände isoliert. Zusätzlich wurden *P. cactorum* und *P. cambivora* in jeweils einem erkrankten Bestand gefunden. Im Gegensatz dazu konnte in den gesunden Beständen keine *Phytophthora* – Art nachgewiesen werden. Die Bodenverhältnisse der Bestände, in denen *Phytophthora* spp. gefunden wurden, reichten von frischen bis feuchten Böden aus Sedimenten und Moränen mit schluffiger bis toniger Textur und pH – Werten ($BaCl_2$) zwischen 3.5 und 5.0. Die weite Verbreitung von *P. quercina* in erkrankten Eichenbeständen in Südschweden spricht dafür, dass das Pathogen im Krankheitskomplex des Eichensterbens in Nordeuropa eine Rolle spielt, wie dies bereits für Mittel- und Westeuropa sowie Teile Südeuropas gezeigt worden ist.

Résumé

Première mention d'espèces de Phytophthora telluriques dans les chênaies suédoises

La présence d'espèces de *Phytophthora* telluriques a été recherchée dans trente-deux chênaies du sud de la Suède, 27 à dominance d'arbres dépérissants et 5 avec une plus forte proportion d'arbres sains. *P. quercina*, pathogène des racines fines et spécifique des chênes, a été isolé dans 10 des 27 échantillons de sol, prélevés dans la rhizosphère, des peuplements dépérissants. *P. cactorum* et *P. cambivora* ont également été isolés, chacun dans un de ces peuplements. Aucune espèce de *Phytophthora* n'a été isolée des peuplements sains. Les conditions édaphiques des sites d'où ont été isolés des *Phytophthora* spp. varient de sédiments mésiques à des moraines, avec des textures argileuses à limoneuses et un pH ($BaCl_2$) compris entre 3.5 et 5.0. Ces résultats montrent que *P. quercina* présente une large répartition géographique dans les chênaies du sud de la Suède et indiquent que ce pathogène pourrait être l'un des facteurs impliqués dans les dépérissements de chênes du Nord de l'Europe, comme il a déjà été montré pour l'Europe Centrale, de l'Ouest et certaines zones de l'Europe du Sud.

References

Balci, Y.; Halmschlager, E., 2002a: First confirmation of *Phytophthora quercina* in Asia. Plant Dis. **86,** p. 442.

Balci, Y.; Halmschlager, E., 2002b: First report of *Phytophthora quercina* from oak forests in Austria. Plant Pathol. **51** (in press).

Brasier, C. M.; Robredo, F.; Ferraz, J. F. P., 1993: Evidence for *Phytophthora cinnamomi* involvement in Iberian oak decline. Plant Pathol. **42,** 140–145.

Delatour, C.; Anselmi, P.; Barzanti, P.; Bianco, M. C.; Blaschke, H.; Brasier, C. M.; Capretti, P.; Desprez-Loustau, M. L.; Dreyer, E.; Hansen, E. M.; Heyne, C.; Jung, T.; Luisi, N.; Marcais, B.; Matyssek, R.; Maurel, M.; Osswald, W.; Paoletti, E.; Ragazzi, A.; Robin, C.; Vannini, A.; Vettraino, A. M., 2002: *Phytophthora* in the European oak forests – results of a European Union research project. In: Proc. Second Int. Meeting on *Phytophthora's* in Forests and Natural Ecosystems, Albany, Western Australia. September 29–October 5, 2001. Ed. by Hardy, G.; Tommerup, I. Perth, WA: Murdoch University Print (in press).

Gallego, F. J.; Perez de Algaba, A.; Fernandez-Escobar, R., 1999: Etiology of oak decline in Spain. Eur. J. For. Path. **29,** 17–27.

Hansen, E.; Delatour, C., 1999: *Phytophthora* species in oak forests of north-east France. Ann. For. Sci. **56,** 539–547.

Hartmann, G.; Blank, R., 2002: Vorkommen und Standortbezüge von *Phytophthora*-Arten in geschädigten Eichenbeständen in Nordwestdeutschland (Niedersachsen, Nordrhein-Westfalen und Schleswig-Holstein). Forst und Holz **57,** 539–545.

Jung, T.; Blaschke, H.; Neumann, P., 1996: Isolation, identification and pathogenicity of *Phytophthora* species from declining oak stands. Eur. J. For. Path. **26,** 253–272.

Jung, T.; Cooke, D. E. L.; Blaschke, H.; Duncan, J. M.; Osswald, W., 1999: *Phytophthora quercina* sp. nov., causing root rot of European oaks. Mycol. Res. **103,** 785–798.

Jung, T.; Blaschke, H.; Osswald, W., 2000: Involvement of soilborne *Phytophthora* species in Central European oak decline and the effect of site factors on the disease. Plant Pathol. **49,** 706–718.

Jung, T.; Blaschke, H.; Osswald, W., 2002a: Effect of environmental constraints on *Phytophthora*-mediated oak decline in Central Europe. In: Proc. Second Int. Meeting on *Phytophthora's* in Forests and Natural Ecosystems, Albany, Western Australia. September 29–October 5, 2001. Ed. by Hardy, G.; Tommerup, I. Perth, WA: Murdoch Univ. Print (in press).

Jung, T.; Hansen, E. M.; Winton, L.; Osswald, W.; Delatour, C., 2002b: Three new species of *Phytophtora* from European oak forests. Mycol. Res. **106,** 397–411.

Robin, C.; Desprez-Loustau, M. L.; Capron, G.; Delatour, C., 1998: First record of *Phytophthora cinnamomi* on cork and holm oaks in France and evidence of pathogenicity. Ann. Sci. For. **55,** 869–883.

Sonesson, K.; Anderson, S., 2001: Forest condition of beech and oak in southern Sweden 1999. National Board of Forestry Report 12. Jönköping: National Board of Forestry Publishing Company.

Vettraino, A. M.; Barzanti, G. P.; Bianco, M. C.; Ragazzi, A.; Capretti, P.; Paoletti, E.; Luisi, N.; Anselmi, N.; Vannini, A., 2002: Occurrence of *Phytophthora* species in oak stands in Italy and their association with declining oak trees. For. Path. **32,** 19–28.