Final Report to Partnerskap Alnarp

Project 954

"Hur Skånes landskap påverkas av spridningen av den sjukdomsalstrande svampen Phytophthora"

Amount awarded: 232,000 kr

Main applicant contact information: Michelle Cleary, SLU, Southern Swedish Forest Research Centre, Box 49, 23053 Alnarp, 040-415181

Duration of the project: 2016-01-01 - 2017-12-31

Sammanfattning

Phytophthora species are major pathogens of trees that can cause severe economic losses to forests and reduce the stability of forest ecosystems. These pathogens are a potential threat against a broad range of tree species, including both conifers and broadleaves. Starting in 2010-2011, extensive Phytophthora-damages were noted on European beech (Fagus sylvatica) trees in recreational forests and parks and Horse chestnut (Aesculus hippocastanum) trees in urban settings around Skåne. Alarmingly, there are now indications that the disease front for these invasive, alien pathogens is advancing into natural forests and landscapes. By destroying the trees' fine roots, these pathogens disturb nutrient and water uptake, thereby reducing the fundamental vitality of trees, leading to instability and premature death of trees. As a consequence, we have in recent years witnessed a dramatic increase in the number of inquiries from forest managers, stakeholder representatives, and concerned citizens, requesting advice on how to manage *Phytophthora*-damages in amenity trees and forests. At present, there is an urgent need to develop baseline knowledge of the distribution and diversity of *Phytophthora* species on trees to determine the nature of its establishment in natural and managed areas. Detection and accurate identification of forest pathogens is one of the most important strategies for controlling forest diseases and to support decisions regarding preventative or curative treatments to minimize losses. The use of reliable detection assays combined with sensitive molecular techniques, allows for rapid and specific detection of *Phytophthora* from environmental samples. The overall aim of this project was to provide new scientific information, with high practical relevance, on the genetics, spatial distribution and diversity of newly established Phytophthora pathogens located in Skåne.

During 2016-2017 we conducted a systematic sampling from plant tissues and soil in a large number of locations (e.g. forests, parks, amenity plantings, churchyards, nurseries, and orchards) in order to i) identify which *Phytophthora* species are attacking which host trees and ii) reveal the patterns of species distribution and genetic diversity of the populations across Skåne. At each site location, field sampling was conducted whereby soil around the perimeter of infected trees and tissue samples (infected bark from the trunk to trees) were collected from targeted (symptomatic) trees and plants. The samples have been analyzed using molecular biological approaches to identify the occurrence of *Phytophthora*-species. Information about the species presence has been used to identify relevant areas for focused studies and prioritize new areas to conduct further sampling in the future, in collaboration with various stakeholder groups. We report several invasive Phytophthora species associated with beech (Fagus sylvatica) and horse chestnut (Aesculus hippocastanum) trees, the most notable and aggressive ones being Phytophthora plurivora, P. cambivora, and P. cactorum. The work also revealed the presence of a new Phytophthora species (P. gonapodyides) killing beech trees - this species of Phytophthora had not previously been described in Sweden. The funding from Partnerskap Alnarp, and co-financing provided by Region Skåne and Länsstyrelsen i Skåne, also enabled us to launch a Citizen Science platform in which public engagement is encouraged to help us map the locations of these tree-killing disease agents. It has become clear through initiating this work that there is much more to be done on the invasive front of *Phytophthora* diseases in southern Sweden. The project has been critical for the further development of knowledge on the distribution and diversity of invasive Phytophthora species affecting Skånes natural landscapes and management to mitigate potential losses causing by these tree-killing pathogens.

Project Implementation

During 2016-2017, we conducted a comprehensive sampling (both soil and plant tissue) from several locations representing a variety of different sites (see Table 1).

Table 1. List of surveyed sites

National Parks Söderåsen Dalby Söderskog Stenshuvud

Nature Reserves

Kullaberg

Recreation Forests

Torup Pålsjö Skog

Churchyards

Stora Köpinge Öja Kyrkogård Tranås Skurups chuchyard Lyngby chuchyard Råå kyrkogård

Nurseries

Ramlösa Flyinge plantshop Ystad plantskola Ulriksdals trädgård på Kivik Vasaholms trädgård Cedergren & Co plantskola

Urban Parks/areas

Malmö Pildammsparken Alnarp Helsingborg Sofiero Adelsnäs slott Höganäs Börringe Kloster

Forests

Lomma Slättängsdammarna Björnstorp

Orchards

Juleboda Helenelust Juleboda Gård We conducted field surveys and collected plant and soil samples from infested sites (see Figures 1, 2, and 4). Using a laboratory protocol comprised of both traditional isolation and molecular techniques (Figure 3), we identified numerous *Phytophthora* pathogens, some of which are known to be very serious and aggressive in nature elsewhere in the world. Our results suggest at least five *Phytophthora*-species are commonly associated with diseased broadleaved trees in southern Sweden (Figure 4), and in some cases a complex of several organisms may be present.



Figure 1. Diseased beech trees showing characteristic "bleeding" on the main trunk caused by *Phytophthora* spp. Damaged trees also show extensive crown symptoms (yellowing and thinning of leaves)



Figure 2. Sampling of symptomatic trees. The bark is uncovered to reveal the dead/diseased tissue. Soil cores are collected from four points surrounding symptomatic trees



Figure 3. Overview of methods involved in *Phytophthora* species determination via a combination of traditional culturing (isolation) and molecular detection techniques.



Figure 4. (left) Soil sampling and baiting in the lab using susceptible oak and beech leaves. Infected bark tissue is removed and isolated in culture. (right) Five of the most commonly detected *Phytophthora* species identified in various locations from Table 1. Note: *Phytophthora* gonapodyides is a new species to Sweden never before now known to cause lethal disease on beech trees.

Utvärdering.

We have established a strong network of partners comprised of both researchers (national and international) and representatives from various stakeholder interests across southern Sweden. This cooperation will be maintained as we continue the work in the future to map the distribution and diversity of *Phytophthora* species. To complement the field studies we also established greenhouse experiments during the project period whereby various tree species common to southern Sweden were assessed for their susceptibility to different *Phytophthora* pathogens identified in our surveys (Cleary et al. 2017).

The project has progressed precisely as we planned. Hired field and laboratory technicians and additional support obtained through students and staff at Länsstyrelsen i Skåne permitted the possibility to sample across a broad ranges of site types and locations. We developed new relationships with individuals from various authorities, forest managers and other stakeholders and have maintained those communications through email and face-to-face meetings. There has been excellent support and interest in this research by the public and stakeholders; our staff has received a warm welcome and have been accommodated nicely during surveys and field collections. During the last two years we have also built up our laboratory for molecular biological analyses, hence our research infrastructure for *Phytophthora* studies has developed significantly thanks in part to support from Partnerskap Alnarp. In addition, we have received numerous requests from various stakeholder groups for more specific forest health training for staff (e.g. in city parks). We consider this advantageous for the larger research project because it will enable us to have extra sets of "trained" eyes to continue monitoring the spread of these invasive tree diseases at various target locations (e.g. national parks) in the future.

Informationsspridning.

We have compiled the best possible information available on treatment, operations and management strategies to mitigate damage caused by invasive *Phytophthora* pathogens. Two examples of this are given here:

https://www.skogssallskapet.se/download/18.2ebe46a615a36cbb4313972/1486989798017/1314-124%20165-9%20Hantering%20av%20Phytophthora.pdf https://www.skogsstyrelsen.se/globalassets/mer-om-skog/skogsskotselserien/skogsskotselserien-12skador-pa-skog-del-2.pdf In these reports we indicate that forest damage caused by invasive *Phytophthora* species should be managed through an integrated management approach designed to 1) reduce the spread of new species and the incidence of new infections in the soil and using local plant stocks rather than imported ones, 2) reduce potential disease incidence by choosing hardier (i.e. less susceptible) plant species that are also capable of local adaptation of conditions and 3) through adjusted planning, with e.g. rotation harvest and appropriate tree species selection.

A complete list of communications is has been conducted during the project period and is available in various on-line and printed forms:

I. Reports

 Witzell, J. and M. Cleary. 2017. Hantering av Phytophthora i sydsvenska lövskogar SLU, Institutionen för sydsvensk skogsvetenskap, Alnarp 2017. Utgivare: SLU. ISBN: 978-91-576-9462-1 (elektronisk version) <u>https://www.skogssallskapet.se/download/18.2ebe46a615a36cbb4313972/1486989798017</u> /1314-124%20165-9%20Hantering%20av%20Phytophthora.pdf

II. Journal Publications

- 1. Cleary, M., Blomquist, M., Vetukuri R.R., Böhlenius, H., Witzell, J. 2017. Susceptibility of common tree species in Sweden to *Phytophthora cambivora*, *P. plurivora* and *P. cactorum*. Forest Pathology 47: n/a, e12329. doi:10.1111/efp.12329.
- Cleary, M., Blomquist, M., Ghasemkhani, M., and Witzell, J. 2016. First report of *Phytophthora gonapodyides* causing stem canker on European beech (*Fagus sylvatica*) in southern Sweden. Plant Disease. 100:2174

III. Popular science articles:

- 1. Blomquist, M., Cleary, M., Witzell J. 2016. *Phytophthora* på frammarsch i sydsvenska lövskogar. Ekbladet. 31: p. 19-24 <u>http://www.ekframjandet.se/wp/wp-</u>content/uploads//2017/07/Ekbladet_31_Witzell_Phythopthora.pdf
- Witzell, J. Blomquist, M., Cleary, M. 2017. "Phytophthora". Skogsskötselserien nr 12, Skador på skog, del 2. Skogsstyrelsen. pp 47-52. <u>https://www.skogsstyrelsen.se/globalassets/mer-om-</u> <u>skog/skogsskotselserien/skogsskotselserien-12-skador-pa-skog-del-2.pdf</u>
- 3. "Ny skadegörare hotar svenska lövskogar" <u>http://www.atl.nu/skog/ny-skadegorare-hotar-svenska-lovskogar-2/</u>
- 4. *Phytophthora* en ny skogskadegörare i Skåne https://www.skogsstyrelsen.se/nyhetslista/phytophthora---en-ny-skogskadegorare-i-skane/

IV. Masters Theses (supervisor M. Cleary):

- 1. Blomquist, M. 2016. Invasive *Phytophthora* spp. affecting important broadleaved trees species in southern Sweden. Southern Swedish Forest Research Centre, SLU Alnarp. <u>https://stud.epsilon.slu.se/10072/1/blomquist_m_2017.pdf</u>
- Van Tour, A., 2016. Invasive *Phytophthora* spp. affecting beech (*Fagus sylvatica*) in Söderåsen National Park. Southern Swedish Forest Research Centre, SLU Alnarp. <u>https://stud.epsilon.slu.se/9931/1/tour_a_20170125.pdf</u>

V. Other communications

The project was communicated in oral presentations, among other things, at the following:

- SNS *Phytophthora* network meeting ""Assessing the role of climate factors in association with spread of invasive *Phytophthora* species in forests and from urban landscapes". Malmö, April 8, 2016. Participants from Sweden, Norway, Denmark, Finland, Estonia, Latvia, and Lithuania.
- 8th Meeting of the IUFRO Working Party 7.02.09. *Phytophthora* in Forests and Natural Ecosystems, Sapa Vietnam. March 17-25, 2017.
- Meetings with the city of Malmö parks staff, Länsstyrelsen staff, and on field excursions with the forest sector
- Undergraduate and master's level courses at SLU; invited talks to industry and to the community.

Målsättning/syfte.

Going forward, we intend to build up our Citizen Science platform even more. We have just now launched the Citizen Science website for this project <u>www.phytophthora.se</u> in which we will harness the interest of citizens to participate in our research by reporting to us the location of diseased trees and/or becoming a 'Specialized Volunteer' that will assist us in the collection of field samples to be sent to our lab for DNA analyses. Figure 5 shows various aspects of our Citizen Science program. This platform targets the public and stakeholders with a common interest to protect important broadleaved tree species in the natural and urban landscape.



Figure 5. The Citizen Science platform for the detection of invasive *Phytophthora* species in forests and the urban landscape in southern Sweden. Volunteers will aid in the detection of emerging invasive *Phytophthora* diseases by encouraging their interest and participation to report on, collect and submit samples to our lab. Through the on-site training efforts, citizens with little or no prior knowledge of plant pathology and *Phytophthora* will be just as capable as self-identified professionals in contributing positive samples. Test-positive submissions will be inputted into PhytoMap which will be made public, in real time to deliver immediate, relevant, fact-based (i.e. lab-verified) information to stakeholders, policy makers and the public. A strong educational effort to will be made to publicize and advertise the PhytoMap Mobile App via invited talks, major newspapers, forestry and nature magazines, and newsletters.

Future work in this area should include more surveys and DNA analyses to confirm species identification in new locations (brought to our attention by the public) in order to provide a better understanding of the landscape epidemiology and overall risk that new invasive *Phytophthora* species pose to Swedish forests, cities and landscapes.