Occurrence of Hyphomycete fungi from natural birch habitats and eroded land in sub-arctic Iceland and Faroe Islands

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Introduction

In the last decade there have been increasing efforts in afforestation and land reclamation in Iceland and to some extent also in the Faroe Islands. At present the majority of all tree seedlings in Iceland and the Faroe Islands are produced in containers, using sphagnum-based peat as the growth medium, before they are transplanted to disused agricultural land or eroded areas. However, high seedling mortalities (up to 70%) are recorded after transplantation. One of the main reasons for this high mortality has been attributed to soil dwelling insect larvae from the genus *Otiorhynchus*, especially *O. nodosus* (Fig. 1A) due to larval feeding on the bark layer of roots of various trees and shrubs (Fig.1B). It has, however, been shown that seedling mortality can be significantly reduced by inoculation of seedlings with soil from old forest stands before transplantation to the field.

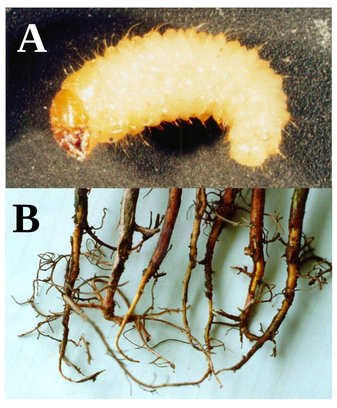

Fig.1: (A): Otiorhynchus nodosus *larvae (B): Damaged roots of birch.*

This indicates that beneficial soil organisms may play a crucial role in plant establishment. A newly initiated Scandinavian project aims to study the mechanisms of of the multitrophic interactions between birch seedlings, *O. nodosus*, Hyphomycete fungi and mycorrhiza. However, since the natural occurrence of Hyphomycete fungi until now has been unexplored in both Iceland and Faroe Islands, the first step towards such studies has been to determine the occurrence of entomopathogenic fungi from (1) natural birch habitats (2) disused agricultural land, (3) eroded areas and (4) sphagnum-based peat from Iceland and the Faroe Islands. Furthermore, selected isolates of *Metarhizium anisopliae* were characterized by growth rate at different temperatures and PCR profile with focus on their adaptation to the sub-arctic environment.

Natural occurrence of Hyphomycete fungi

Samples of soil from birch habitats, disused agricultural land, eroded areas and sphagnum-based peat were collected in fall 2001 (Fig. 2 A, B, C). All soil samples were baited twice, once with *Tenebrio molitor* larvae (Fig 2D) and once with *Galleria mellonella* larvae.

Insect pathogenic fungi were isolated from all birch and grassland habitats in Iceland but from none of the soil samples originating from eroded land or in the sphagnum-based peat. Among the soil samples collected in the Faroe Islands insect pathogenic fungi were isolated from all localities except one. Altogether the following species of entomopathogenic fungi were identified from both countries: *Beauveria bassiana*, *Metarhizium anisopliae*, *Paecilomyces farinosus* The frequency of the three species is shown on figure 3.

From the birch habitats in Iceland the most dominant species was *P. farinosus* followed by *B. bassiana* whereas *M. anisopliae* was not documented from this habitat. In contrast, *M. anisopliae* was the most frequent species isolated from natural grass habitats in Iceland. In the Faroe Islands, *B. bassiana* was documented in all the birch habitats included in this study and *P. farinosus* was documented in all birch stands except one. In the two natural grass habitats no fungi were documented in experiments where the soil were baited with *Tenebrio* larvae, however, *P. farinosus* was documented when baited with *Galleria* larvae.

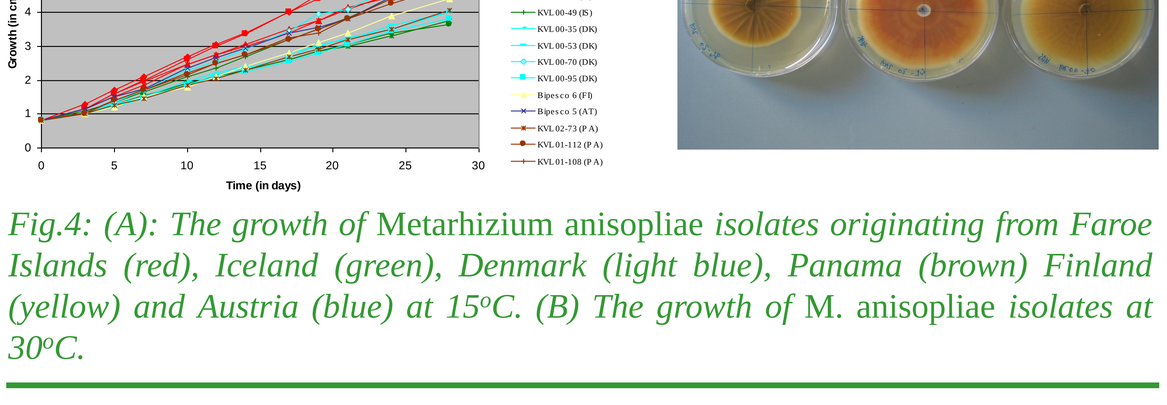

Fig.2: (A): Natural birch habitat (B) Eroded area (C) Seedling in sphagnum-based peat (D) Baiting soil samples with Tenebrio molitor *(E)* T. molitor *infected by* Metarhizium anisopliae.

Fig.3:Frequency of entomopathogenic fungal species found in soil from Iceland and the Faroe Islands as a function of locality. R-birch = Rótarmannatorfur birch habitat, Þ-birch = Þórsmörk birch habitat, V-birch = Vaglir birch habitat, H-birch = Hafnarskógur birch habitat, H-grass = Haukadalur natural grassland, S-grass = Skaftafell natural grassland.

Characterization of Hyphomycete fungi from the sub-arctic

Screening of *M. anisopliae* isolates from the Faroe Islands and Iceland has shown that these isolates have a faster radial growth rate at lower temperatures compared to isolates from Denmark and Panama (Fig. 4A) whereas the opposite was seen at higher temperatures (Fig. 4B). Furthermore, there was a correlation between UP-PCR profile and geographical origin of *M. anisopliae* isolates from Iceland, Faroe Islands, Denmark and Panama, respectively (data not shown).

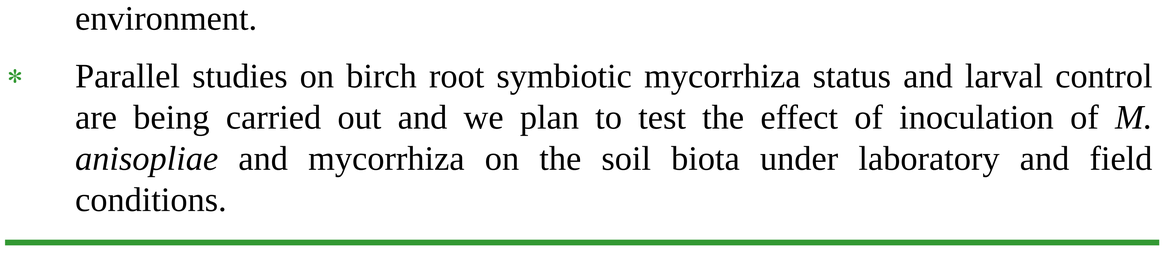

Fig.4: (A): The growth of Metarhizium anisopliae *isolates originating from Faroe Islands (red), Iceland (green), Denmark (light blue), Panama (brown) Finland (yellow) and Austria (blue) at 15ºC. (B) The growth of* M. anisopliae *isolates at 30ºC.*

Conclusions

- The lack of Hyphomycete fungi in eroded areas in Iceland and the Faroe Islands may be an important factor contributing to high mortality of young seedlings caused by the feeding of *O. nodosus.*
- These preliminary results documented that the requisite Hyphomycete fungi exist in un-eroded areas in Iceland and Faroe Island and that these native strains of Hyphomycete fungi might be better adapted to the sub-arctic environment.
- Parallel studies on birch root symbiotic mycorrhiza status and larval control are being carried out and we plan to test the effect of inoculation of *M. anisopliae* and mycorrhiza on the soil biota under laboratory and field conditions.

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