Potentially pathogenic microfungi in soils of Kola Arctic

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INTRODUCTION

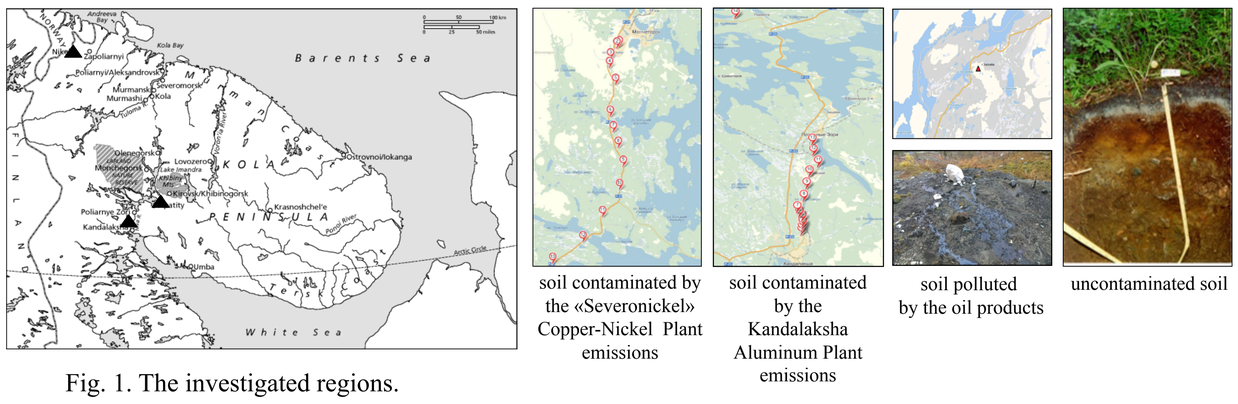
The Murmansk region is characterized by a unique combination of natural and anthropogenic factors: severe climatic conditions and intensive industrial development. As a rule, industrial plants (Kandalaksha Aluminum Plant, Copper-Nickel plants «Pechenganikel», «Severonikel») are located near settlements or within their territory, and, consequently, plant emissions may have a negative impact on the health of people living in these areas.

***The potentially pathogenic fungi* = *opportunistic fungi* (OF) are fungi that are able to provoke various mycotic diseases, allergic reactions for immunocompromised humans, and in the meantime retaining the ability to develop in other environments.**

Hoog et al. classified three groups of fungi according to their potential danger to the human health: **BSL1, BSL2** and **BSL3**. The most dangerous mycoses are caused by the **BSL3** group. Opportunistic fungi of the **BSL2** and **BSL1** groups can be found much more frequently in the environments, as most of them utilize a wide range of substrates. The important environmental factors for the growth of opportunistic fungi of these groups are: the availability of organics, the favorable range of moisture, the temperature, and the pH value in their habitat. The typical way of getting an infection by deep mycoses agents in the environment is breathing in their spores. In case of skin injuries the agents may get in also through wounds, often from soil.

The **goal** of this research is to study the species diversity and the structure of opportunistic fungi communities within the polluted soils of the Kola Peninsula, and to determine the potential pathogenicity degree of the fungi strains on the basis of proteasic and phospholipase activity, and the growth ability at a temperature 37°C.

OBJECTS & METHODS



soil contaminated by the «Severonickel» Copper-Nickel Plant emissions

soil contaminated by the Kandalaksha Aluminum Plant emissions

soil polluted by the oil products

uncontaminated soil

Fig. 1. The investigated regions.

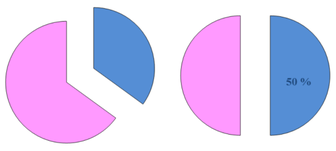
- Soils samples were collected in the summer-autumn period in 2000–2011 (Kandalaksha Aluminum Plant), in 1999-2010 («Severonickel» Copper- Nickel Plant), in 2006-2011 (soil polluted by the oil products). In total, the mycological investigation of 424 soil samples has been carried out.
- Strains were isolated from the organic horizon of the forest Albic Podzol soils and from 0–10cm layer of the Hortic Arthrosol soil, using wort agar media with adding lactic acid.
- The fungal biodiversity analysis was carried out on the basis of cultural-morphological characteristics with the use of keys [*Raper and Thom 1968, Domsh et al. 2007, Seifert et al. 2011*].
- We have used three literature sources [*Hoog et al. 2011, Satton et al. 2001, Sanitary… 2008*] to determine whether the fungus belongs to the group of opportunistic.
- The fungi protease activity was fulfilled on the nutrient media with the bovine serum albumen adding [*Fotedar R., Al-Hedaithy S.S.A.* 2005].
- The phospholipase activity was determined on the nutrient media with the egg yolk addition [*Price M., Wilkinson I.D., Gentry L.O.* 1982].
- The activity ratio counting was carried out using the formula:

I=1-Dc/Dc+3p,

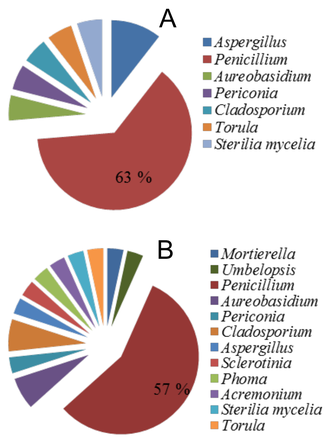
where **I** is an index of protease/phospholipase activity; **Dc** is a colony diameter, **3p** is the zone of lucid interval/precipitation.

RESULTS

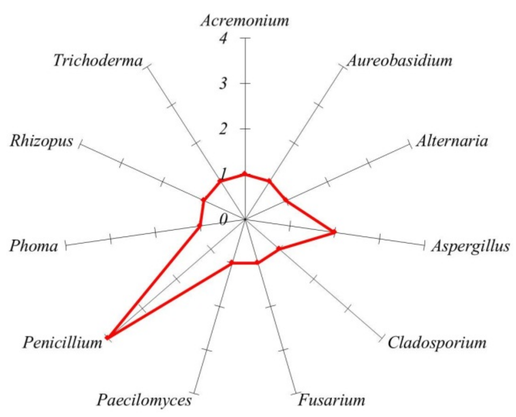
Opportunistic fungi in the area of the Aluminum Plant emissions



The share of the opportunistic fungi in the background soil (right) and contaminated soil (left)



The soil fungi diversity at a level of genera (in number of species by which the genus is presented) in the impact (A) and background (B) zones



The opportunistic fungi distribution in accordance with genera in the polluted soil.

Fig. 2. Fungi in the area of the Aluminum Plant emissions.

In the polluted soil of the Aluminum Plant emissions,17 opportunistic fungi species (belong to 11 genera) were isolated. In the polluted soils, the share of the OF increased up to 50% compared to the background soil, where it made 35% of the total number of the identified species (Fig. 2). Among them, there are agents of mycoses and also the fungi causing diseases of respiratory and digestive systems from genera presented on this slide *(Acremonium, Alternaria, Aureobasidium, Aspergillus, Cladosporium, Fusarium, Paecilomyces, Penicillium, Phoma, Rhizopus, Trichoderma*) (Fig.3). The largest number of species belonged to g. Penicillium (4); the other genera were represented with 1–2 sp

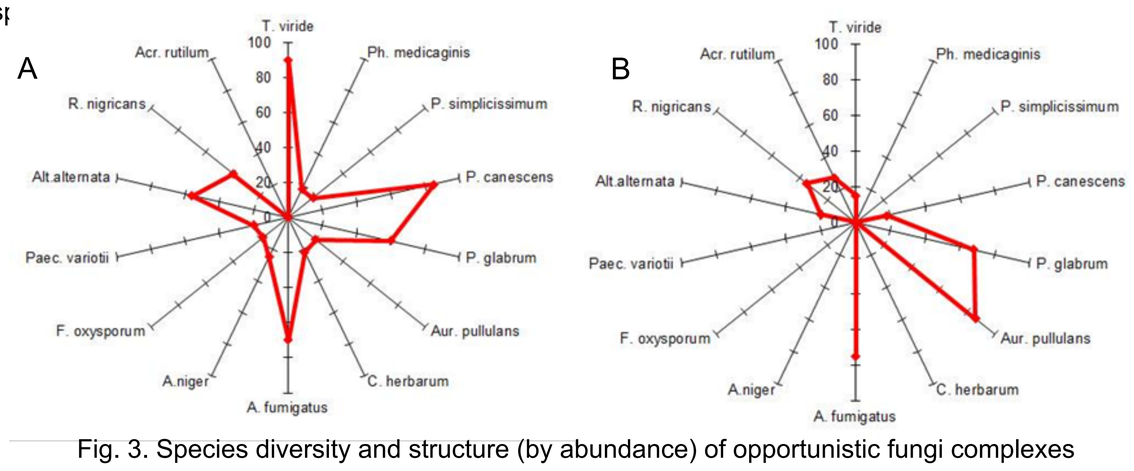
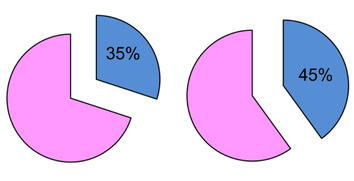
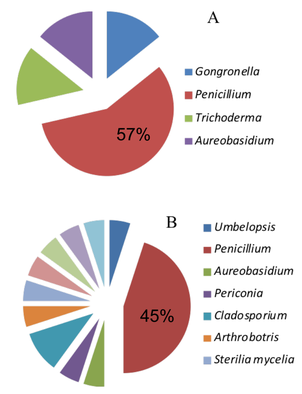


Fig. 3. Species diversity and structure (by abundance) of opportunistic fungi complexes in the polluted (A) and background (B) soils.

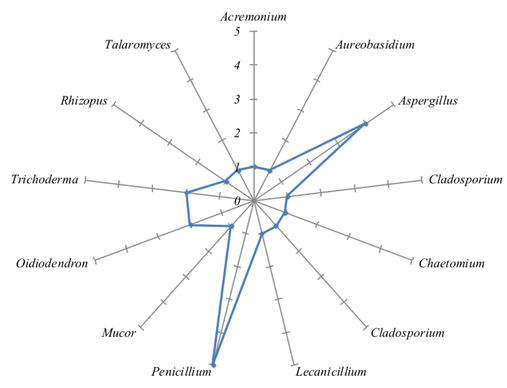
Opportunistic fungi in the area of the Copper-Nickel Plant emissions



The share of the opportunistic fungi in the background soil (right) and contaminated soil (left)



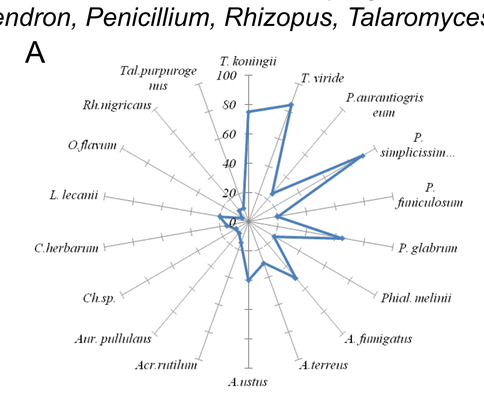
The soil fungi diversity at a level of genera (in number of species by which the genus is presented) in the impact (A) and background (B) zones



The opportunistic fungi distribution in accordance with genera in the polluted soil.

Fig. 4. Fungi in the area of the Copper-Nickel Plant emissions.

In the impact area of the Copper-Nickel Plant, 25 fungi species belong to OF were isolated. Their share in the polluted soil is 45%, and in the background soil is 30% of the total number identified species (Fig. 4). In the soils of both plots, the OF group is represented with the following genera: *Acremonium, Aureobasidium, Aspergillus, Chaetomium, Cladosporium, Lecanicillium, Mucor, Oidiodendron, Penicillium, Rhizopus, Talaromyces* and *Trichoderma* (Fig. 5).



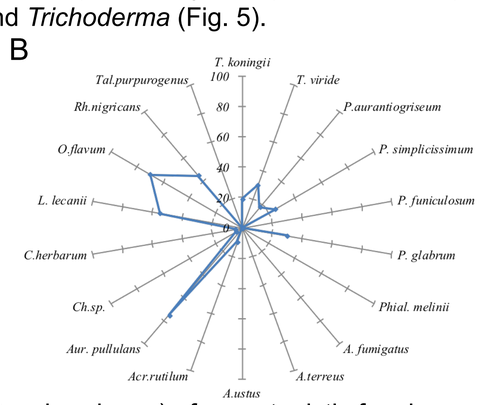
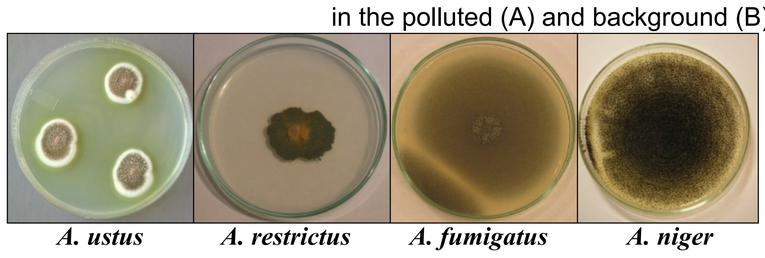
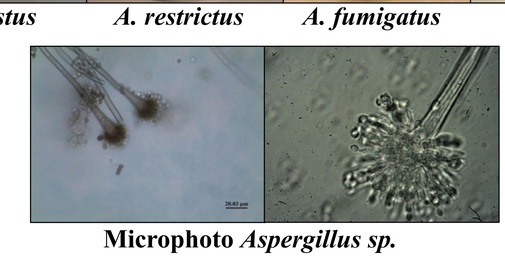


Fig. 5. Species diversity and structure (by abundance) of opportunistic fungi in the polluted (A) and background (B) soils.





Microphoto *Aspergillus sp.*

Fig. 6. Diversity of fungi genera *Aspergillus.*

The increase in the number of g. *Aspergillus* species in the soil polluted by the emissions from the Copper- Nickel Plant in comparison with the background soil have been revealed. The diversity of OF genera *Aspergillus* presented on Fig. 6. At the same time, different authors speak about the increase in the number of "southern" fungi in the polluted soils of the Northern part of Russia.

Opportunistic fungi in the soil polluted by oil product

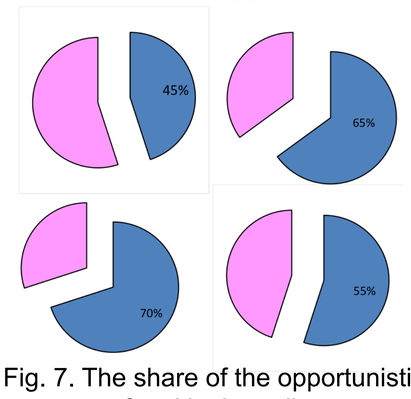


Fig. 7. The share of the opportunistic fungi in the soil:
A – uncontaminated; B – with diesel fuel;
C – with gas condensate; D – with mazut+diesel fuel.

Opportunistic fungi diversity in the soil polluted by oil products

Fungi genera	Diesel fuel		Mazut+diesel fuel		Gas condensate
	Concentration		Concentration		
	Low	High	Low	High	
Acremonium				+	+
Alternaria	+				
Aspergillus	+				
Aureobasidium	+			+	
Geomyces	+		+		+
Gibberella		+			
Fusarium	+	+			
Humicola	+				
Lecanicillium		+			+
Mucor	+	+	+	+	+
Penicillium	+	+	+	+	+
Phoma	+				+
Rhizopus	+		+		+
Rhodotorula				+	
Trichoderma	+	+	+	+	+
Ulocladium	+				

In the clean soil, the share of OF was 45% of the total number of species; in the soils both with low and high diesel fuel content, the share amounted to 65%; in the soils with gas condensate it was 70%; and in the soils with the mixture of mazut and diesel fuel, the amount reached 50–55%.

Potential pathogenicity of opportunistic fungi

Fig. 8. Most dangerous opportunistic fungi.

Judging by the research results, 7 fungi strains were the most dangerous for a human from the soils contaminated by the Aluminum Plant emissions and 4 fungi strains isolated from the soils contaminated by the oil products.

Conclusion

1. The share of the opportunistic fungi in the soils, contaminated by Aluminum and Copper Nickel Plants emissions, by oil products increased to 15-25 % in comparison with the background soil.
2. Most opportunistic fungi isolated in the polluted soils of the Kola Peninsula belong to gg. *Penicillium, Aspergillus, Mucor, Lecanicillium* and *Phoma* .
3. The increase in the number of g. *Aspergillus* species («southern» fungi) in the soil polluted by the Copper- Nickel Plant emissions in comparison with the background soil have been revealed.
4. The strains of the fungi isolated from the contaminated soil reveal the potential pathogenicity in a greater degree, than the strains isolated from the clean soil. 55% of the total amount of fungi strains isolated from the soils contaminated by the Aluminum Plant emissions had the potential pathogenicity.