Microbiological research on James Ross Island focused on rock-inhabiting fungi

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2007 started activities

- study the diversity, taxonomy, physiology, biochemistry and phylogenetic relationships of heterotrophic bacteria and microscopic fungi from various substrates

- CCM (Czech Collection of Microorganisms)
James Ross Island
- Semiarid climate
- UV irradiation
- Annual mean T below -7 °C; min T below – 30°C; max T over 10 °C
- Oligotrophy
- Winds up over 100 km/h
- regolith, rocks, ornithogenic soil
- microscopic filamentous fungi
- heterotrophic bacteria
- porous rocks
- rock-inhabiting fungi (RIF)
Overview of sample locations
hyaloclastite breccia
basalt
RIF - rocks - James Ross Island
granite
hyaloclastite tuff
Lichens, algae

RIF
- cryoconite
- psychrophilic bacteria
- lakes and lake sediments
- psychrophilic bacteria
...go away!

- gastrointestinal tracts of Antarctic animals
- 147 rock fragments
- 37 lichen samples
- 40 water samples
- 10 cryoconite water
- 84 swabs of Antarctic animals

Sampling 2018
samples were stored at 5 °C
transported in portable refrigerator
Microbiological analysis of samples

- isolation of microorganisms
- basic characterization of cultures (morphology, biochemical and physiological)
- genotyping of selected strains
- long-term storage of isolated cultures in the CCM

Isolation

Slide culture

Light microscopy

Morphology

Genotyping

Maintenance
Basic characterization of cultures

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native slide  black fungi
Methods of isolation
- dilution method
- directly plating

Cultivation conditions:
- fungi: 15 °C, up to 4 weeks
- bacteria: 15 °C, up to 1 week
Media for isolation
- MYEA - Malt Yeast Extract Agar with chloramphenicol
- DRBC - Dichloran Rose Bengal Chloramphenicol Agar
- R2A, PCA
- MRS, MCC, EndoA, MSA, BEA
Results of mycological analysis
2007 - 2009: 67 samples, 12 localities

Total: 286 isolates of microscopic fungi

Identified to species: 137 isolates
- 25 species
- 18 genera

Identified to genus: 25 isolates

Unidentified: 124 isolates

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**Geomyces pannorum**

Classification: Fungi, Ascomycota, Pezizomycotina, Leotiomycetes, Geomyces, Geomyces

Ecology: common soil fungus
Antarctica: mosses, lichens, soil, water foam, CaCO$_3$ sediments, wood

Occurrence:
- Canada, Alaska, Spitsbergen, higher altitude
- do not occur in tropical and subtropical region

Antarctica - South Georgia, Signy Island, King George Island, Casey, McMurdo Sound, MacRobertson Land, W. Ongul Island, Gondwana Lake, Cape Irizar, Starr Nunatak, Cape Reynolds, Kay Island, Kohler Head, Harrow Peaks, Victoria Land, Ross Sea region, Edmonson Point, Vestfold Hills, Cabo Primavera, James Ross Island
Phoma herbarum Westend. 1852
Classification: Fungi, Fungi, Ascomycota, Pezizomycotina, Dothideomycetes, Pleosporomycetidae, Pleosporales, Phoma

**Ecology:** soil, air and other substrates
**Antarctica:** mosses, soil

**Occurrence:** cosmopolitan, wide spread

Antarctica - Casey, Schirmacher Oasis, MacRobertson Land, Victoria Land, Gondwana Lake, Prior Island, Bruce Point, Adelie Cove, Tinker Glacier, Snowy Point, Edmonson Point, Cape Irizar, Camp Icare, Starr Nunatak, Cape Reynolds, Inexpressible Island, Cape Satsrugi, Kay Island, Harrow Peaks, Ross Sea region
**Thelebolus microsporus** (Berk. & Broome) Kimbr. 1967

Classification: Fungi, Ascomycota, Pezizomycotina, Leotiomycetes, Leotiomycetidae, Thelebolales, Thelebolaceae, Thelebolus

- ornithogenic soil
- psychrophilic
- spread by mammals and birds

**Ecology:**
- excrements of cows, horses, sheep, deer, hens, reindeer, dogs, rabbits, grouse and human excrements
- soil contaminated by bird droppings
- the gastrointestinal tract and bird feathers
- organic matter from the Antarctic lakes

**Occurrence:**
Europe, North America and Antarctica, especially in cold regions.
Rock-inhabiting fungi (RIF)

**Characteristics:**
- Clumpy colonies
- Heavily melanized
- Meristematic growth
- Slow growing
- Poor morphology
- Ecology: extremes-lovers

Phylogenetically very diversified
Rock-inhabiting fungi (RIF) - morphology

# Rock-inhabiting fungi – physiological profile

## Temperature preferences (°C)

<table>
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<th>No. isolate</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
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<td>7,9</td>
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<td>3,3</td>
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<tr>
<td>2H</td>
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<td>4,1</td>
<td>3,3</td>
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<tr>
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<td>5,1</td>
<td>8,0</td>
<td>7,3</td>
</tr>
</tbody>
</table>

- **cultivation 1 month**
- **MEA**
- **0; 5; 10; 15; 20; 25; 30; 35 °C**
- **colony diameter in mm**

25; 30; 35 °C - do not grow
Rock-inhabiting fungi (RIF)

**Stress tolerance:**
- Extreme temperatures
- Acidity
- Osmotic stress
- Salinity
- Dehydration
- Solar and UV irradiation
- Freeze–thawing stress
Rock-inhabiting fungi (RIF) Locations – cold sites

- Svalbard
- Greenland
- K2
- Monte Rosa, Italy
- Mount Aconcagua, Argentina
- Linnaeus Terrace, Antarctica
- Battleship Promontory, Antarctica
- James Ross Island

Dothideomycetes, Capnodiales
Rock-inhabiting fungi (RIF)
Locations – hot sites

Eurotiomycetes, Chaetothyriales

Utah Parks
Atacama desert
Cliff, Sardinia, Italy
La Cabrera
Algerian desert
Monuments

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Rock-inhabiting fungi (RIF)
Antarctica - psychrophilic

James Ross Island

Northern Victoria Land
Southern Victoria Land
McMurdo Dry Valleys
RIF
2007 – 2008: 7 isolates
2018: 50 isolates

DNA sequences of nucLSU, RPB2, ITS and BT2

Elasticomyces elasticus
Oleoguttula mirabilis
Rachicladosporium antacticum
Elasticomyces elasticus

Classification: **Fungi, Ascomycota, Pezizomycotina, Dothideomycetes, Dothideomycetidae, Capnodiales, Elasticomyces**

Uncompleted disarticulation of artic conidia and hyphal fragments remaining joint by connectives.

**Ecology:**
- cold locations
- psychrophilic
- lichen (*Usnea antarctica*)
- rocks

**Occurrence:**
Europe, South America, Asie, Antarctica

**Oleoguttula mirabilis**

Classification:
Fungi, Ascomycota, Pezizomycotina, Dothideomycetes, Dothideomycetidae, Capnodiales, Teratosphaeriaceae, Oleoguttula

**Ecology:**
- rocks
- psychrophilic

**Occurrence:**
J. R. Island

Phialides with wide openings and very short collarettes and conidia aggregating in dense clusters at phialide tips. Scale bars 10 μm.

Rachicladosporium antacticum

Classification:
Fungi, Ascomycota, Pezizomycotina, Dothideomycetes, Dothideomycetidae, Capnodiales, Cladosporiaceae, Rachicladosporium

Ecology:
- rocks
- psychrophilic

Occurrence:
James Ross Island, Continental Antarctica

Torulose, branched hyphae.
Scale bars 10 μm.

Conclusion of mycological analysis

- The most microscopic fungi are isolated in the anamorphic stage.

- Mesophilic, cosmopolitan species capable of active growth at least during the Antarctic summer.

- Only one teleomorphic species is *Thelebolus microsporus*.

- The rock-inhabiting fungi are psychrophilic, indigenous species well adapted to Antarctic environment.
Results of bacteriological analysis

New bacteria
- *Pseudomonas proseki*i
- *Pseudomonas gregormendelii*
- *Rufibacter rubra*
- *Hymenobacter lapidarius*
- *Staphylococcus edaphicus*
- *Mucilaginibacter terrae*
- *Pedobacter jamesrossensis, P. lithocola, P. mendelii, P. petrophilus*
Gammaproteobacteria

- Gram-negative
- oligotrophic
- the most common with the dominant occurrence of fluorescent pseudomonads
Yellow and orange colored psychrophilic bacteria of *Flavobacterium*
**Pedobacter, Hymenobacter, Mucilaginibacter and Massilia**

- psychrophilic bacteria
- pink pigmentation

Escherichia albertii

- Gram-negative
- Zoopathogenic
- Penguin and seal excrements

Czech Collection of Microorganisms

http://www.sci.muni.cz/ccm
Although many new microorganisms have been isolated and described, it is only a fragment in the overall biodiversity of James Ross Island.

**Metagenomic approach**
- is used to study microbial communities in more detail, including many strains, that cannot be cultivated in the laboratory
- allows to analyze changes in microbial communities
- provides information about activities of microbial communities
Thank you for your attention