

Unknowns of the permafrost microbiome

What part do pathogens play? What part will they play in the future?

Jessica Ernakovich and the International Permafrost Microbiome Network



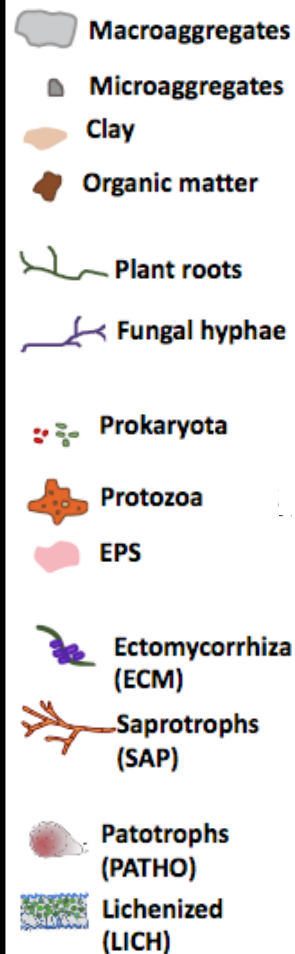
**University of
New Hampshire**

Thawed permafrost Warm-wet (ww) scenario

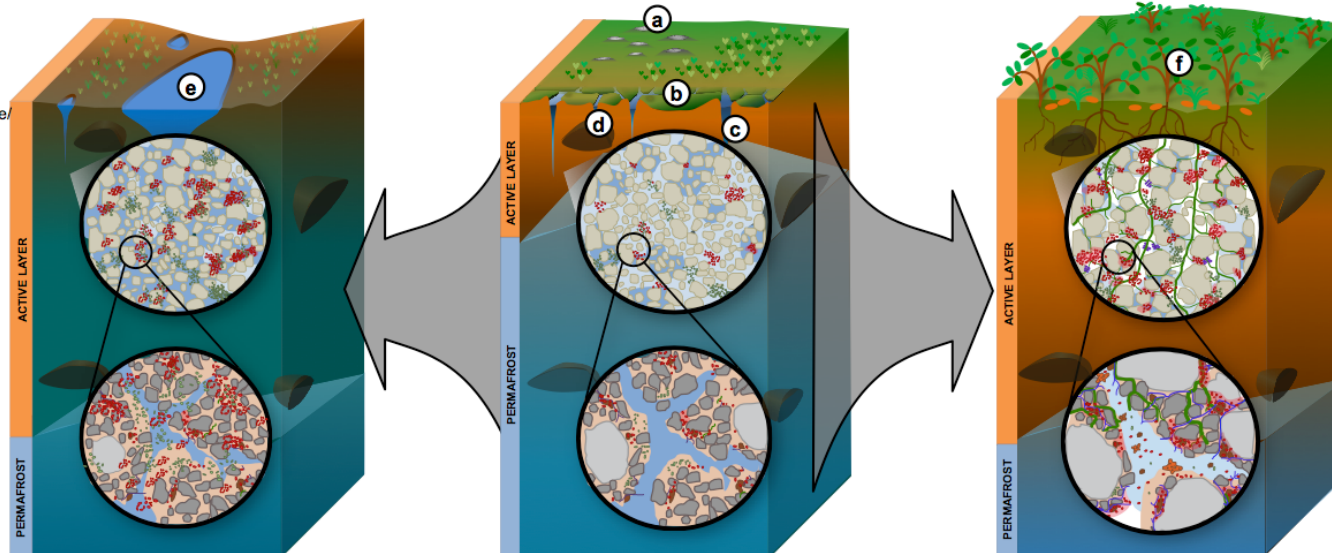
Undisturbed permafrost

Thawed permafrost Warm-dry (wd) scenario

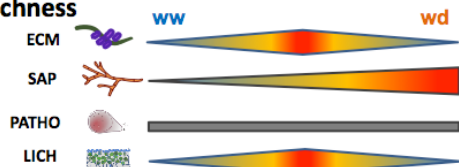
Legend



- a frost boils
- b ice wedges polygons
- c ice cracks
- d cryoturbated OM
- e increase in soil moisture potential flooding
- f shrubs, dwarf trees



Richness

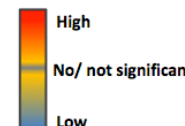


Methanogenes ?

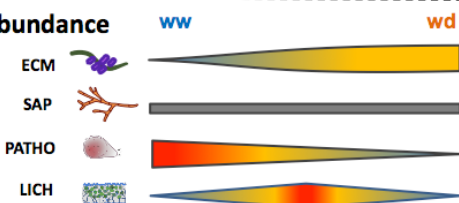
Methanotrophs ?

Viruses ?

Othergr fun. guilds (denitrifiers, amonia oxidizers,...)?



Abundance



Methanogenes ?

Methanotrophs ?

Viruses ?

Othergr fun. guilds (denitrifiers, amonia oxidizers,...)?

Figure credit: Jiri Barta
Ernakovich & the International Permafrost Microbiome Network, in prep

The permafrost microbiome: what do we know?

1. Active layer and permafrost communities are not the same
2. Diversity declines with depth (for bacteria and fungi; increases for archaea)
3. Microbes live in brine channels in frozen permafrost
4. Microbes selected for long-term survival in harsh conditions (Mackelprang et al., 2017; Bottos et al., 2018)
5. When permafrost thaws, community composition shifts
 - Can we predict how?

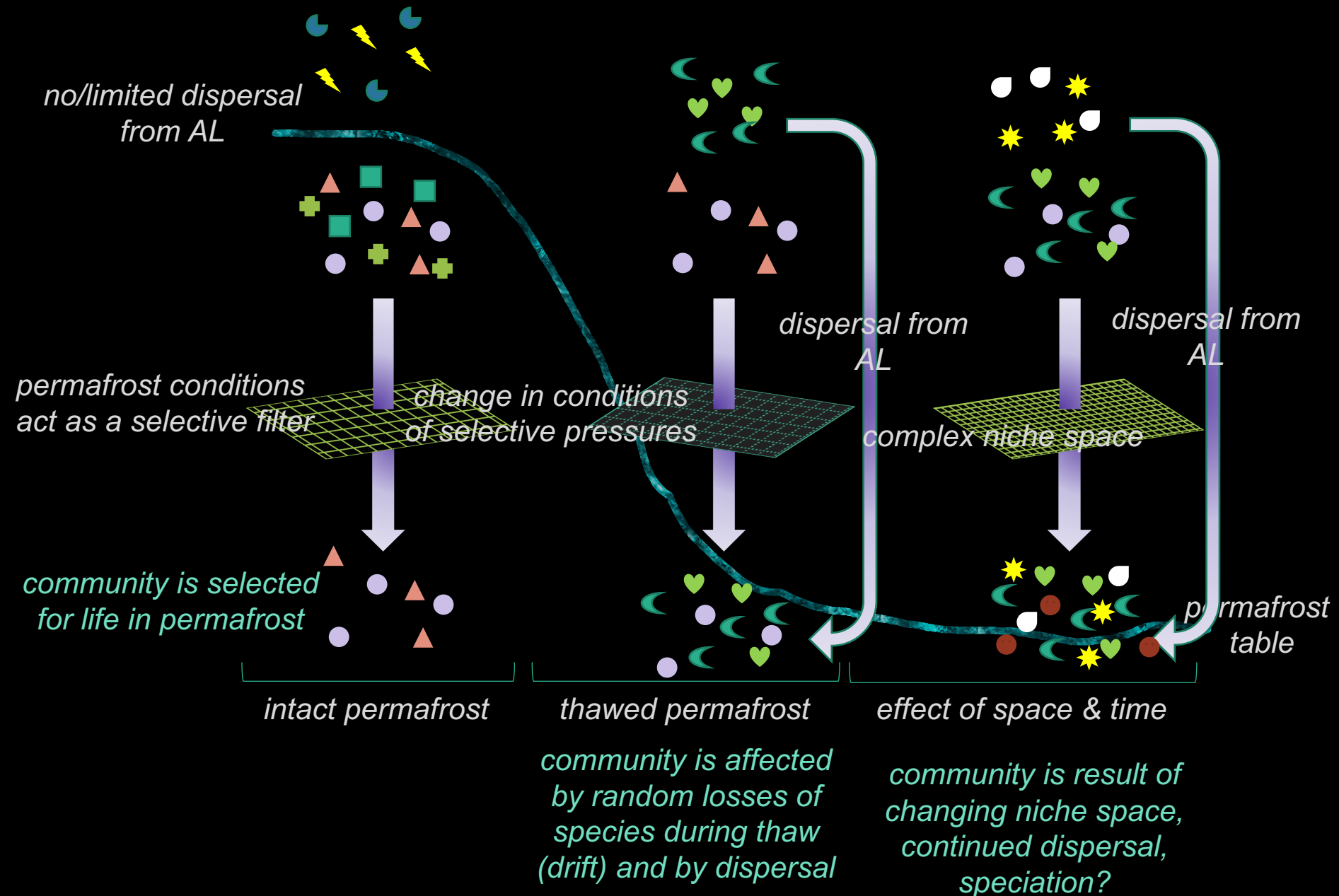
Ernakovich et al, 2017



The thawed permafrost microbiome: what don't we know?

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- A photograph of a person standing in a thawed permafrost landscape. The person is wearing a dark jacket, light-colored pants, and black boots, and is holding a white bag. They are standing in a shallow, muddy pond. The surrounding area is covered in low-lying vegetation, including mosses and lichens. In the background, there are mountains under a cloudy sky.
1. What proportion of the permafrost microbes survive the thaw? Is there a biological mechanism? Physical? Random?
 2. Given that permafrost microbes are selected for survival, can they compete with newly dispersed active layer microbes?
 - New temperature x substrate x redox niches?
 3. Do increasing biotic interactions affect community composition?
 4. How do these play out over space and time?

Why does community assembly matter in thawed permafrost?

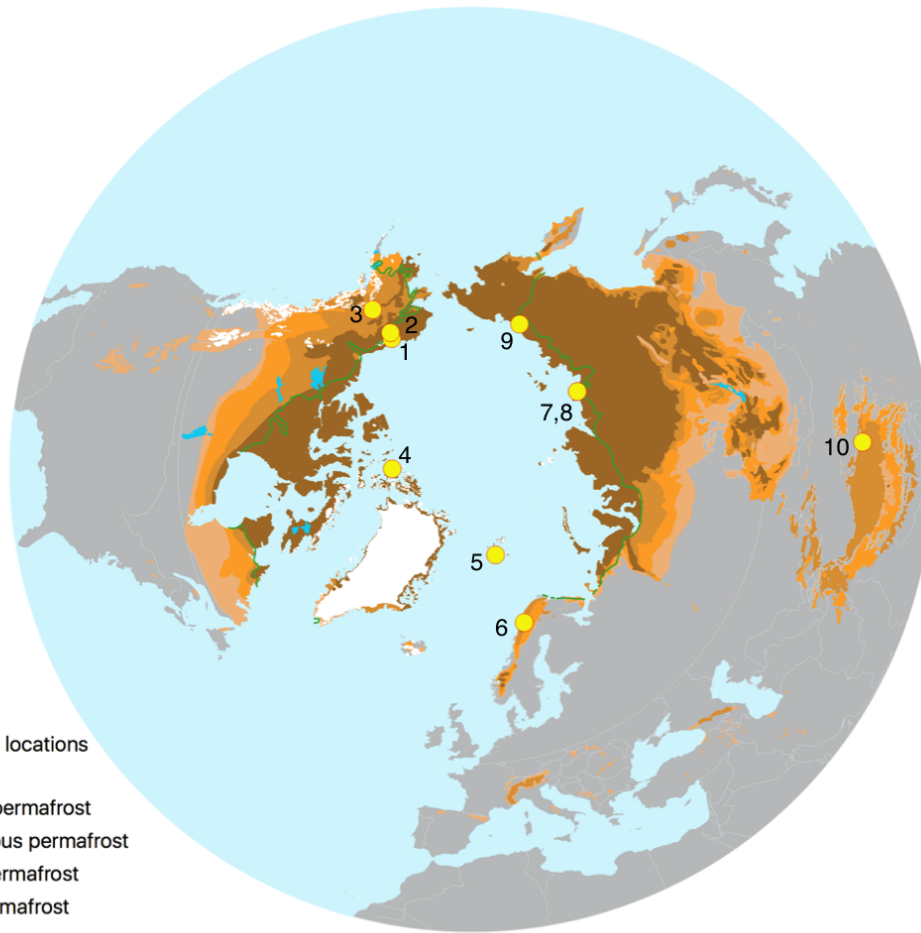


Using community theory to inform permafrost pathogen abundance

Assuming plant, animal, and human pathogens are in permafrost soil...

- Are pathogens in permafrost active or dormant?
 - This might tell us something about their ability to survive/thrive after permafrost thaw
- Will they be able to thrive and grow to required population size (to be effective pathogen)?
 - New temperature x moisture x substrate niches open
- Will pathogen populations be kept in check by effect of community?
- Or will low biomass & diversity of other community members immediately following allow them to get a foothold?
- Is pathogen dominance one of many alternate stable states?

International Permafrost Microbiome Network - Informing data gaps



- Microbiome locations
- Permafrost
 - Continuous permafrost
 - Discontinuous permafrost
 - Sporadic permafrost
 - Isolated permafrost
- Treeline

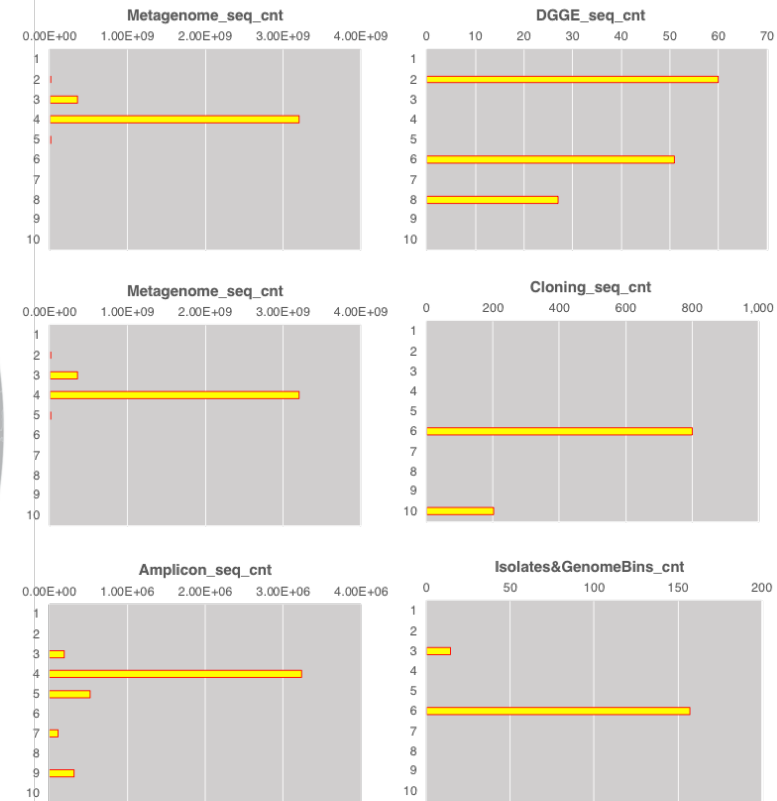


Figure credit: Maggie Lau
Ernakovich & International Permafrost Microbiome Network, in prep