

The Limits of Microbial Life

This year Dr. Jackie Goordial finished her PhD and began a Postdoctoral fellowship at McGill in Microbiology, with a focus on astrobiology. As part of her research, she went to University Valley, Antarctica, to study microorganisms living in the permafrost in one of the coldest and driest places on Earth.

What question were you trying to answer?

When we went to University Valley, we were hoping to find some extremely cold-adapted microorganisms. Our original questions were along the lines of: how many, and which microorganisms are present in the permafrost, and how cold-adapted are these communities?

When we started to get our results back, our questions shifted — Can we detect ANY microbial activity at in situ temperatures, and does the permafrost in University Valley host an active microbial ecosystem at all?

Why did you find this question interesting?

We are so used to microorganisms being present just about everywhere, including places where we actively try to eradicate them. This work was interesting to me because it touches on several fundamental questions: What are the limits of life on Earth? Are there places that are even too extreme for microorganisms to thrive? And finally- what are the limits to life on other cold planetary bodies, if there was life present, how could we detect it?

What did you find?

To our surprise we weren't able to detect any microbial activity in these soils, thus University Valley may represent an example of a natural ecosystem that is too harsh to support microbial life. This informs us about the limits of life on Earth, but also other cold planetary bodies.

What does doing your research look like?

This research involved a lot of different types of work: Field work (which is high up there in terms of things I love about this work), a lot of wet lab work - sitting behind a microscope, plating microorganisms on petri dishes, doing DNA extractions for molecular work, and countless hours behind a computer crunching the data. Sequencing data is huge, and a lot of my time was spent processing that, and trying to make sense of it in an ecological context.

Collaboration plays a huge part in my research. For example, NASA developed a prototype permafrost drill called IceBite which they wanted to test in a Mars like environment, such as University Valley. It's extremely hard to get to these remote environments and this provided the means to get us there to do some microbiology research.



Why this is important

Prior to this work, essentially all that was known about permafrost microbial communities in the Dry Valleys was that microorganisms are present. We greatly expanded what is known about the ecology of microorganisms that are found in Dry Valley permafrost at high elevations, by surveying the microorganisms using next generation sequencing techniques, by culturing the organisms, and more interestingly by doing activity assays both in situ and in the lab. Thus, greatly increasing our understanding of the microbial ecology in a rare spot on earth where the only potential living things are microorganisms.

This site is one of the best Mars analogue sites that we have on Earth, similar to the dry and ice-cemented permafrost found in the north polar region of Mars where Phoenix landed. Understanding what types of microorganisms could survive or be active in these types of soils, as well as detecting biosignatures (in the form of dormant or dead cells, and nucleic acids in our case), is important to understanding what we could be looking for in near surface water ice on Mars in the north polar regions.

Goordial, Jacqueline, Alfonso Davila, Denis Lacelle, **Lyle G Whyte**, et al. (2016b), *Nearing the cold-arid limits of microbial life in permafrost of an upper dry valley, Antarctica*, ISME J 10 (7), 1613–1624.

Hands-on Radio Interferometers

Dr. Sean Griffin is a postdoctoral fellow in the McGill Cosmology Instrumentation Laboratory. He leads a project to design hardware for small, portable radio interferometers.

Can you describe your project?

High-resolution radio astronomy is typically performed using arrays of many telescopes spread across a large area. The information from each telescope is combined in order to reconstruct the information about the part of the sky the telescopes are observing. In practice, this is called interferometry. Conceptually, this material is taught in undergraduate courses, but we wanted to produce a hands-on experiment that students could use to learn how interferometry is actually done in practice.

In addition to the teaching tool, this project can be adapted in order to build tools for identifying sites for future radio astronomy arrays (an “RF monitor”), or to use in conjunction with current tele-

scopes (such as CHIME) to make ultra-high-resolution measurements of transient events (such as fast radio bursts) using very-long-baseline interferometry (VLBI).

Why did you find this project interesting?

I think that hands-on experience learning “real-life-astronomer” skills is an important part of a student’s training; a tool like this one is something I would have appreciated having access to when I was an undergraduate.

What did you learn?

We’ve learned (unsurprisingly) that it is tricky to build a radio telescope in the middle of a big city like Montreal. There’s so much radio frequency (RF) noise around us that it makes measuring any astrophysical source difficult because their signals are much dimmer than those coming from FM radio, TV, and cellphone transmitters.