An Example of Research Underway
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Cordillera Blanca Research Expedition

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Microbial Communities on Glacier Surfaces

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The glaciers of the world's alpine mountain ranges hold a remarkable collection of data that can tell us about climate change and its current impacts. The data can also provide us with a means to predict the rate of future change and the scale of its consequences.

Snow and ice, the main components of glaciers, are white and reflect nearly all light that reaches the glacier. This reflective capacity is an enormous factor in glacier growth and/or preservation. In contrast, everything else on glacier surfaces that absorbs the sun's radiant energy changes it to heat and speeds up the melting of glaciers.

Algae, fungi, and bacteria naturally occur on glacier surfaces in complex communities, and contribute to melt by decreasing the snow's reflectivity. As temperatures warm, snow melts earlier or more extensively. Surface melt conditions create hospitable environments for these organisms, and the faster they grow, the more quickly glacier mass is lost. That in turn affects things distant from mountain environments because the increasing melt changes water dynamics in glacial fed rivers and then can effect marine systems that are the destination of the glacial melt. Together, these impacts affect water supply for humans, flora, and fauna.

In order to study these tiny organisms that have such a big impact on glaciers, we must find ways to get data on whole communities that we can't see. Microbiomes, which can be defined simply as all of the microorganisms that exist in any environment, are becoming increasingly useful in understanding the functional relationships, resiliency, and fragileness of microbial communities.

A microbiome can include anything from our entire planet to a small patch of algae to the bacteria living inside a person's gut. These communities are excellent indicators of what's going on in their environment because these tiny, invisible-to-the-eye microorganisms are often facilitators and/or indicators of change in the environment.

The ways in which they are affected by their environment can also be informative not only about their own health but also regarding the acceleration of current impacts or the creation of new impacts on their surrounding environments. Important questions include such issues as:

- how the communities will respond to the increasing melt that supports their communities on the glaciers while simultaneously decreasing their available habitat, and

- how the rapidity of growth in algae communities can be a predictor of the speed of the loss of glacier mass and in turn a predictor of impacts on water supplies and the life

forms they support (e.g., for humans, loss of crops requiring irrigation and traditional food supply such as fish from high mountain lakes and ponds that are disappearing).

Alpine microbial environments have not been studied extensively, although their fragility and tendency to change very rapidly makes them good candidates for frequent sampling. From July 15 though August 12th, 2016, Robin Kodner (PhD Harvard; Assistant Professor of Biology, Western Washington University) and her research team collected samples of microbial environments in alpine lakes and streams and on the high altitude glaciers of Peru's Cordillera Blanca.

Dr. Kodner's lab is currently preparing their samples in order to run large DNA surveys called metagenomic surveys (metagenomes are the collective genome of many microorganisms) of these samples to determine which microbes are present and what their roles in the ecosystem are. There are many factors that affect the lives and diversity of these microbes, including seasonality, contaminants from human activities such as mining, and interactions with other microbes that live in the same environment.

While the relationships between microbes and their environments are not visible to hikers, climbers, and skiers who frequent the alpine and subalpine zones, those relationships are very significant and can be extremely useful in understanding visible, high-impact changes like rapid disappearance of glaciers.

"If we understand how snow algae relates to other organisms around it and how it responds to or creates change in the environment where it lives, we will be able to predict future change," Dr. Kodner noted. Once we can predict changes in these environments, we will be in a much better position to suggest action steps that can stabilize and preserve them. There is a lot at stake here. The issues involved are not just related to the algae itself but to major loss of glacier mass and annual water supplies – and in turn – to major harmful impacts on the sustainability of plant, animal, and human life.

On the Peru Research Expedition, the team took a very close look at those little patches of red-pink snow that can be found in alpine environments all over the world. These are called "watermelon snow" and they are a type of snow algae. Recent studies have shown that snow algae studies may play a huge part in researching climate change.

Watermelon snow darkens the snow slopes causing them to melt at a faster rate. However, since watermelon snow is also more likely to grow on snow that has started to melt, research has shown that this may cause a circular effect. As snow algae grows, snow begins to melt more quickly, and as the snow begins to melt more quickly, it creates a very hospitable environment and the growth of snow algae accelerates.

Scope of the Expedition's Research

The expedition research teams included scientists and educators in several fields. In addition to the algae studies described here, their range of research includes:

- the impacts of air pollution on the rate of melt of mountain glaciers
- the indicators that surface deposits on glaciers provide for air pollution and general health of the ecosystem
- methodologies for restoring alpine tundra from the effects of over grazing
- water quality and content assessment
- insect populations as indicators of ecosystem health

Our time in the mountains also included work with local communities and land managers on conservation projects within Huascaran National Park.

Current Activity

We are now analyzing the samples we took in the Cordillera Blanca in the Kodner Laboratory at Western Washington University. We are extracting DNA from the samples and amplifying the extracted DNA to make sequencing possible. We will soon be doing the actual sequencing. It is a long process but one which will provide a large amount of very useful data, and we will be providing updates as the work continues.