Analysis of Bioaerosols: DNA and Ice Nucleation Potential

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Interdisciplinary Renewable & Environmental Collaborative REU

Objectives

- To collect biological atmospheric Particulate Matter (PM) that is less than 2.5µm
- To culture, isolate, amplify, and sequence DNA from aerosol bacterial samples.
- To perform ice nucleation experiments to observe the potential of individual bacterial samples to freeze water at higher temperatures relative to ultrapure water.

Background

- Atmospheric PM is comprised of dust, soot, pollen, bacteria, and fungi less 10µm in diameter.
- PM that function as ice nuclei are integral to cloud formation, precipitation production, and have potential for applications in agriculture and climate manipulation.

http://techalive.mtu.edu/envengtext/ch12_health.htm

Methods

- Aerosols were collected via roof-mounted inlets on quartz filters at regulated airflow in long (7 day) and short (2 day) exposures.
- Samples were cultured on LB agar, isolated, and amplified for a region of the 16S ribosomal subunit. DNA was then sequenced and characterized against the NCBI database via BLAST searches.
- Ice nucleation tests were performed on all identified bacteria cultures relative to ultrapure water.

Aerosol Collection

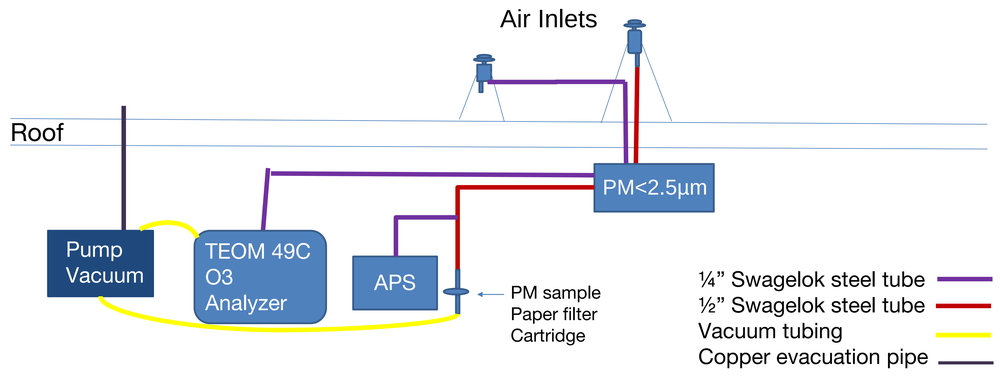


Figure 1: Bioaerosol : Collection of PM less than 2.5 µm

Results

Table 1: Bacteria Identification: BLAST results showing the closest matching species and percent sequence identity

Culture Number	Closest Match	Sequence Identity
Culture A1	*Bacillus aquimaris*	100%
Culture A2	*Erwinia billingiae*	99%
Culture B1	*Bacillus pumilus*	99%
Culture B2	*Bacillus pumilus*	99%
Culture B3	*Bacillus pumilus*	99%

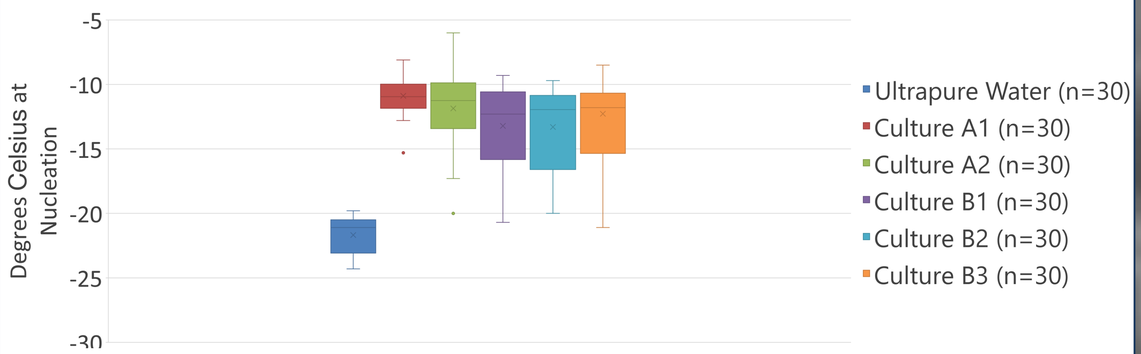


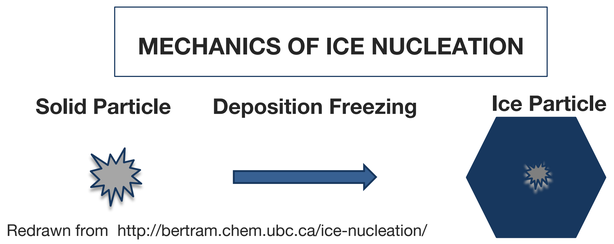
Figure 2: Temperature at ice nucleation (C°). Samples with cultured bacteria formed ice nuclei at slightly higher temperatures.

Conclusions

- Most bacterial samples were identified as *Bacillus* as previously reported (Bowers, et al. 2013).
- Unfortunately, sampled bacteria was limited to aerobic species that could be cultured on LB agar.
- Ice nucleation results were not statistically significant but do imply a higher nucleation temperature for samples containing these bacteria.

FUTURE WORK:

- Illumina sequencing would allow for a more comprehensive view of atmospheric bacteria.
- These methods could be employed using aerial sampling of cloud bacteria in active storm conditions
- More sophisticated nucleation testing would improve consistency in measurements.



Redrawn from http://bertram.chem.ubc.ca/ice-nucleation/

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References

- Robert M. Bowers, Nicholas Clements, Joanna B. Emerson, Christine Wiedinmyer, Michale P. Hannifan, and Noah Fierer. Seasonal Variability in Bacterial and Fungal Diversity of the Near Surface Atmosphere. *Environmental Science and Technology.* 2013. 12097-12105.