The diversity of bioaerosols in different environmental scenarios

Yang Yue[1,2], Viktoria Tepper[1,2], Yao Maosheng[3], Jing Wang[1,2]

[1]Institute of Environmental Engineering, ETH Zurich, Zurich, Switzerland
[2]Advanced Analytical Technologies, Empa, Dübendorf, Switzerland
[3]College of Environmental Sciences and Engineering, Peking University, Beijing, China

yyue@ethz.ch

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1. Project description

Bioaerosols are kinds of biological atmospheric particles, which are directly released from terrestrial and marine ecosystems into the atmosphere (Fröhlich-Nowoisky et al., 2016). Bioaerosols are speculated to impact public health, atmospheric chemistry, nucleation processes, climate, ecosystem development and so on (Haddrell & Thomas, 2017). Aerosol microbiology can interact with oceanic, atmospheric, and terrestrial environments by biogeochemical processes (Zhai et al., 2018). The compositions of biological fractions depend on specific environmental factors. Investigating the diversity of bioaerosols in different scenarios can provide important information of aerosol microbiology changes in temporal and spatial ways. As one of the highest altitude stations, the Jungfraujoch station can provide the unique high altitude and non-polluted air samples to study the specific bioaerosol, which can be an important reference or background samples in the urban bioaerosol research.

In the current work, we collected the airborne particulate matter (PM) and extract the DNA, which was used for 16s rRNA analysis. The unique samples from the Jungfraujoch station were compared with samples from urban environment, especially the heavy polluted city. We expected a unique bioaerosol community from the Jungfraujoch station. This result can also shed light on the research of bioaerosol in the urban environment.

Two kinds of PM samplers were used in the present work (Figure 1). LY2050 (Applied Technical Institute of Liaoyang, China) is a portable PM sampler, which can collect TSP (Total suspend particulate), PM10 and PM2.5 samples. As a medium flow rate sampler, LY2050 was used to collect TSP samples for every day. HighBioTrap (Beijing dBlue Tech, Inc., Beijing, China) is a portable high flow rate sampler to collect PM2.5, which was used to collect PM2.5 every 4 hours in order to check the aerosol microbiology changes during day and night during 22.01. to 25.01. of 2019.

As the PM10 and PM2.5 concentrations at the Jungfraujoch station were extremely low,0.1-1.8 μg/m^3 (Figure 2), we only select three samples for a preliminary DNA extraction and 16s rRNA sequence analysis.

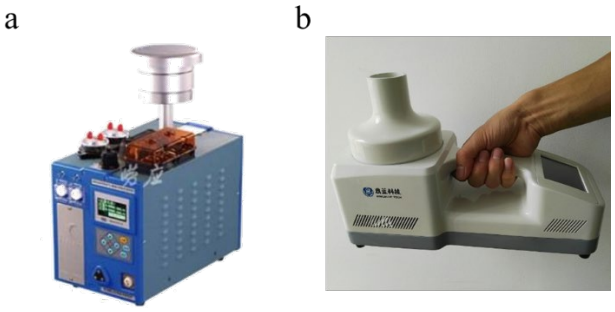

Figure 1. Panel a: LY2050 sampler, the air sampling flow rate is 100L/min (picture comes from www.hbyq.net). Panel b: HighBioTrap sampler, the air sampling flow rate is 1000L/min.

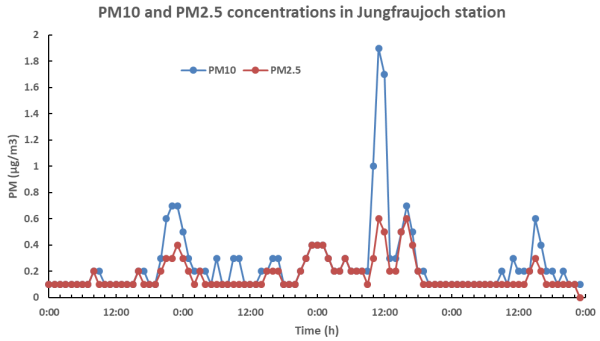

Figure 2. The PM10 and PM2.5 concentrations at the Jungfraujoch station. Data were acquired from Swiss National Air Pollution Monitoring Network (NABEL).

As the result showed in Figure 3, the diversity of bacteria, relative abundance of operational taxonomic unit (OUT, an operational definition used to categorize bacteria based on sequence similarity), was similar with BLA group, which was the blank group in the experiment. This means there were very few microorganisms in the collected samples and it was not possible to distinguish samples from background. Therefore, an optimized sampling plan or experiment need to be considered.

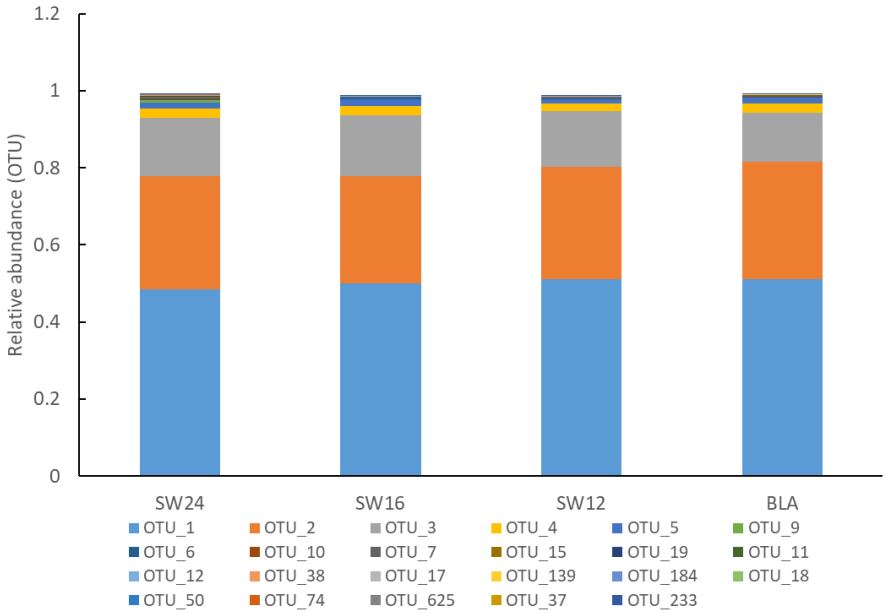

Figure 3. The bio-diversity of PM2.5 samples from Jungfraujoch station. PM2.5 samples were collected by HighBioTrap and the biodiversity were analysed by 16s rRNA sequence. SW24, SW16 and SW12 are PM2.5 samples. BLA is a blank sample.

References

Fröhlich-Nowoisky, J., Kampf, C. J., Weber, B., Huffman, J. A., Pöhlker, C., Andreae, M. O., ... & Su, H. (2016). Bioaerosols in the Earth system: Climate, health, and ecosystem interactions. Atmospheric Research, 182, 346-376, doi.org/10.1016/j.atmosres.2016.07.018.

Haddrell AE, Thomas RJ. (2017). Aerobiology: experimental considerations, observations, and future tools. Appl Environ Microbiol 83: e00809-17, https://doi.org/10.1128/AEM.00809-17.

Li, J., Cao, J., Zhu, Y. G., Chen, Q. L., Shen, F., Wu, Y., ... & Wang, J. (2018). Global survey of antibiotic resistance genes in air. Environmental science & technology, 52(19), 10975-10984. https://pubs.acs.org/doi/abs/10.1021/acs.est.8b02204

Yue, Y., Chen, H., Setyan, A., Elser, M., Dietrich, M., Li, J., ... & Yao, M. (2018). Size-resolved endotoxin and oxidative potential of ambient particles in Beijing and Zürich. Environmental science & technology, 52(12), 6816-6824. https://pubs.acs.org/doi/abs/10.1021/acs.est.8b01167

Zhai, Y., Li, X., Wang, T., Wang, B., Li, C., & Zeng, G. (2018). A review on airborne microorganisms in particulate matters: composition, characteristics and influence factors. Environment international, 113, 74-90, doi.org/10.1016/j.envint.2018.01.007.

Collaborating partners / networks

Prof. Maosheng Yao, College of Environmental Sciences and Engineering, Peking University, Beijing, China
Prof. Min Gao, Beijing Agro-Biotechnology Research Center, Beijing Key Laboratory of Agricultural Genetic Resources and Biotechnology, Beijing Academy of Agriculture and Forestry Sciences, Beijing, China

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Li, J., H. Chen, X. Li, M. Wang, X. Zhang, J. Cao, ... & G. Da, Differing toxicity of ambient particulate matter (PM) in global cities, Atmospheric Environment, **212**, 305-315, 2019.
https://www.sciencedirect.com/science/article/abs/pii/S135223101930353X

Zhang, T., X. Li, M. Wang, H. Chen, Y. Yang, Q.L. Chen, & M. Yao, Time-resolved spread of antibiotic resistance genes in highly polluted air, Environment international, **127**, 333-339, 2019.
https://www.sciencedirect.com/science/article/pii/S0160412019302089

Zhang, T., X. Li, M. Wang, H. Chen, & M. Yao, Microbial aerosol chemistry characteristics in highly polluted air, Science China Chemistry, **62**, 8, 1051-1063, 2019.
https://link.springer.com/article/10.1007/s11426-019-9488-3

Address

Laboratory of Air Quality and Particle Technology
Institute of Environmental Engineering, IfU
ETH Zürich
CH-8093 Zürich
Switzerland

Contacts

Dr. Yang Yue
Tel.: +41 44 633 3362
e-mail: yyue@ethz.ch