Biological Performance of Portable Impactors when Collecting Airborne Bacteria and Fungi

Maosheng Yao and Gediminas Mainelis
Department of Environmental Sciences, Rutgers, The State University of New Jersey, 14 College Farm Road, New Brunswick, NJ 08901, U.S.A.

Inhalation of airborne microorganisms and physical contact with biological contaminants in natural environments present a serious health concern both for public and private sectors. The situation is further complicated by the threat of infectious disease or potential release of biowarfare agents. To address these biohazards, newly available portable bioaerosol samplers are gaining popularity, however their sampling characteristics have not yet been intensively studied.

This study has investigated the biological collection efficiencies of seven portable microbial impactors (RCS High Flow, Millipore Air Tester, Microflow, BioCulture, SMA MicroPortable, SAS Super 180, and MAS-100) and two reference samplers (Button Aerosol Sampler using gelatine filter and BioStage impactor) when collecting both bacterial and fungal species of 0.61-3.14 μm in aerodynamic diameter. The test microorganisms included *Bacillus subtilis* (frequently used as a simulant of *B. anthracis*), *Pseudomonas fluorescens*, *Escherichia coli*, *Penicillium melinii*, *Cladosporium cladosporioides*, and *Aspergillus versicolor*. The test microorganisms were aerosolized and collected by each sampler in a controlled humidity environment (40-45%) with microorganism concentrations being monitored by an Optical Particle Counter. The portable samplers operate at sampling flow rates ranging from 100 to 180 L/min, while the Button Aerosol Sampler and the BioStage impactor operate at 4 and 28.3 L/min, respectively. Trypticase Soy Agar was used for collection of bacteria and Sabouraud Dextrose Agar was used to collect fungi. After sampling, the agar plates were incubated directly, while gelatine filter samples were dissolved into 2mL autoclaved water, and 200μL were plated onto agar plates. After incubation, the concentrations of culturable microorganisms were determined by applying statistical correction factors to the number of Colony Forming Units (CFU) counted.. For each test microorganism, five repeats were performed with every sampler in a randomized order.

Experimental results have shown that the biological efficiency of each sampler depended on the size and sensitivity of the microorganism sampled. When sampling hardy microorganism *Bacillus subtilis* of 0.86μm in diameter, Button Aerosol Sampler with gelatin filter performed the best; BioStage, SAS Super 180, RCS High Flow, and MAS-100 were found performing reasonably well, recovering about 80% of bacteria compared with Button Aerosol Sampler. For other samplers, the concentration levels of culturable *Bacillus subtilis* were less than 20% compared to Button Aerosol Sampler. When sampling aerosolized *E. coli* with aerodynamic size of 0.8 μm, BioStage was found to be performing the best, which was likely due to its lowest cut-off size among the samplers. None of *E. coli* collected by Button Aerosol Sampler was found culturable, most likely a result of desiccation during 5 min sampling. RCS High Flow and MAS-100 when sampling *E. coli* performed better than other samplers, although concentrations determined with these samplers were about 80% lower compared with BioStage. When sampling *P. fluorescens* bacteria, the trend was similar to that observed with *E. coli* bacteria. Data with fungal species have suggested that the biological efficiency of RCS High Flow, which utilizes centrifugal force, was substantially higher compared to other samplers. This result might be due to sampler's relatively higher collection efficiency and lower mechanical stress upon the microorganisms. The relative efficiencies of Button Aerosol Sampler, BioStage, SAS Super 180, and MAS-100 were found not to differ substantially when collecting fungal spores.

This study indicated that the biological efficiencies of portable microbial samplers vary from model to model, and depend on the microorganism of interest. In general, among the investigated portable samplers, RCS High Flow, Millipore Air Tester, SAS Super 180, and MAS-100 were found to be performing better than other portable samplers. We believe that the results from this research will help field professionals select portable microbial impactors that suit their projects the best.

Keywords: *Bioaerosols, Biological efficiency, Portable samplers, Bacteria and fungi*

This research was supported by the CDC/NIOSH under grant DHHS-CDC1-K01-OH008029.

7th International Aerosol Conference

September 10-15, 2006 • Crowne Plaza St. Paul Riverfront • St. Paul, Minnesota, USA

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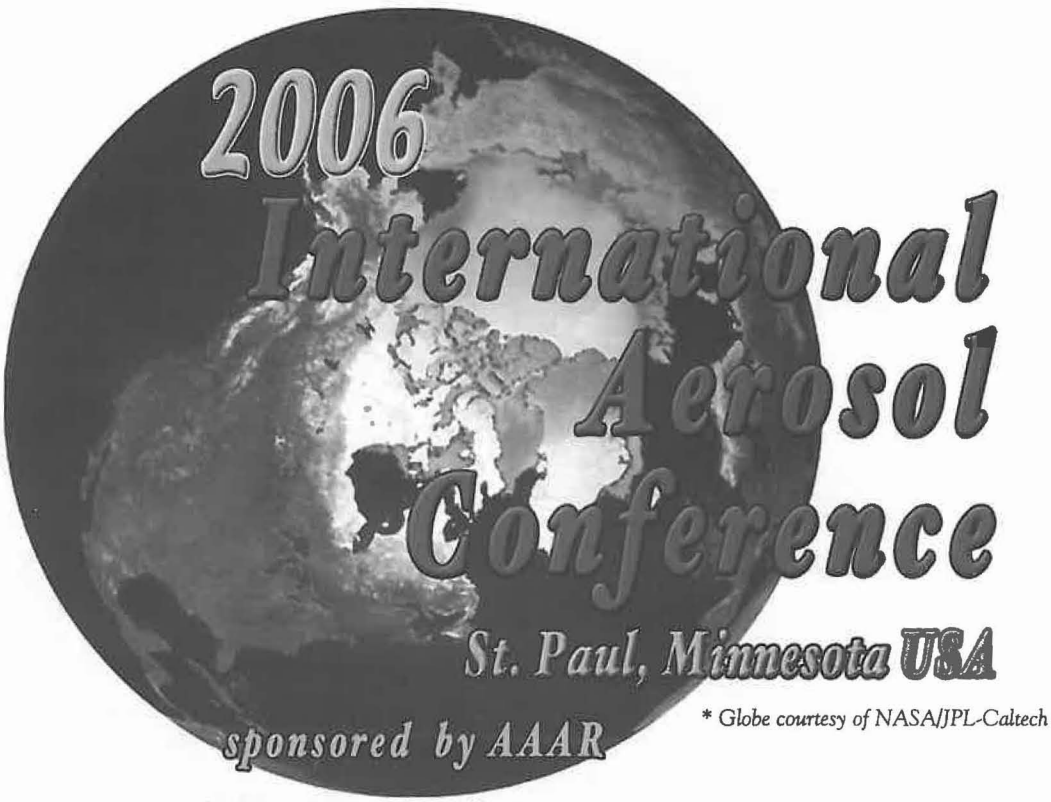
Volume 1



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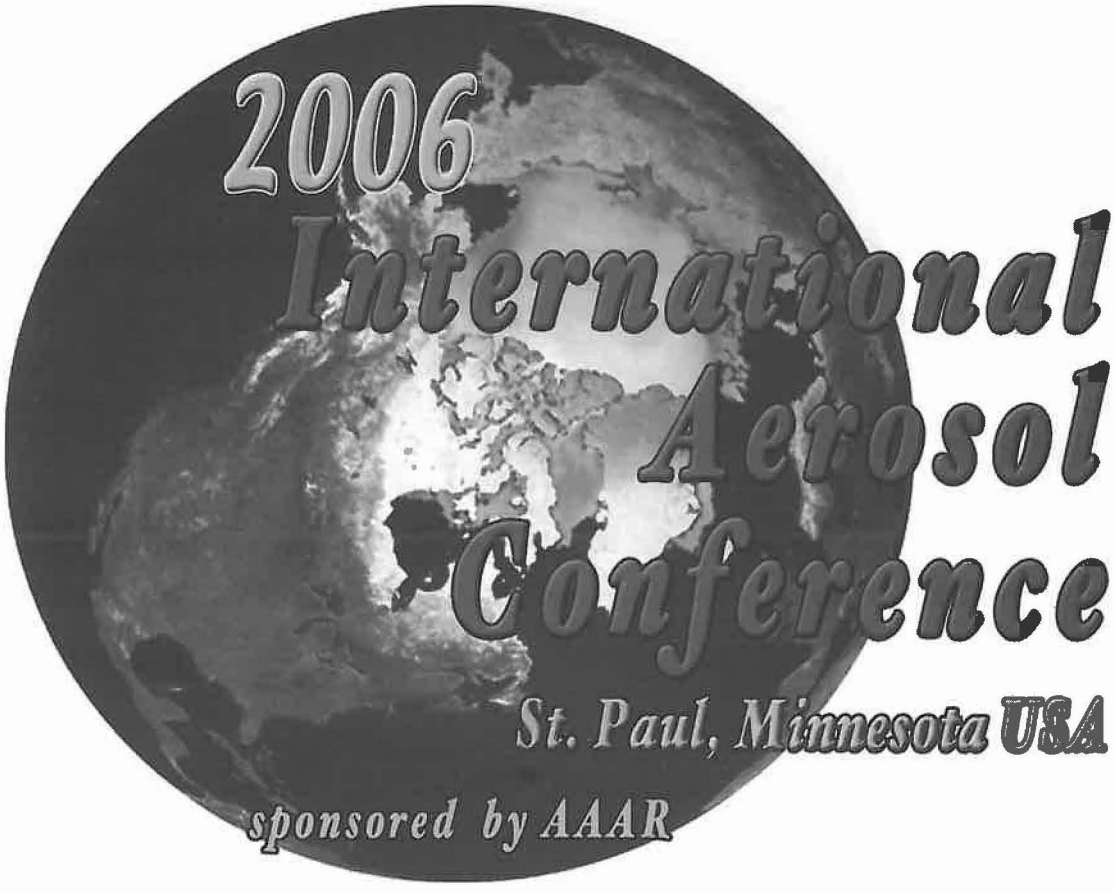
ISBN-13: 978-0-9788735-0-9 (2 volume set)
ISBN-10: 0-9788735-0-5 (2 volume set)

Proceedings of the 7th International Aerosol Conference



St. Paul, MN, USA
September 10-15, 2006

Editors:
Pratim Biswas*, Da Ren Chen*, and Susanne Hering+
* *Washington University in St. Louis*
+ *Aerosol Dynamics, CA.*

Sponsorship for the 7th International Conference was provided by the following United States Government Agencies: NASA, US Army and USEPA.

The Conference was partially supported by the US Army. The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

The Conference was partially supporterd by the National Aeronautics and Space Administration under Grant Number USP-SMD-06-008 issued through the SMD/Earth-Sun System Division.

The Conference was partially supported by the EPA Assistance Agreement No. X3-83313201-0 awarded by the U.S. Environmental Protection Agency. It has not been formally reviewed by the EPA. The views experessed in this document are solely those of the abstract authors and the EPA does not endorse any products or commerical services mentioned in this publication.