Correlating Bioaerosol Load with PM2.5 and PM10 Concentrations

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ABSTRACT

Recent air analysis in the Phoenix metropolitan region has shown that particulate matter mass concentrations in urban areas are 3 to 7 times higher than in nearby rural areas. This increase coincides with a dramatic increase in the number of reported incidences of Valley Fever (caused by the fungus, Coccidioides immitis) in Arizona and provides a rationale for investigating the microbial fraction of airborne particulate matter. The goal of this research is to develop and test methodology to quantitatively correlate the mass or number concentrations of airborne fungal spores to the total mass of airborne particles. The development of these protocols and pilot data will be used to build a broad based research effort to correlate exposure of airborne microbial agents with commonly monitored (and regulated) PM10 and PM2.5. Specific research objectives within this pilot investigation include the following: (i) measure the outdoor airborne fungal concentration (total and cultivable) and total particle mass concentration in rural areas during seasons of high risk (June-October, November-February) in Arizona, (ii) measure the same ratio at urban areas containing high particulate matter concentrations (e.g. construction sites, highways, etc.) and, (iii) use rDNA gene-based technology to detect and identify the fungal spore C. immitis in airborne samples.

INTRODUCTION

The fungus, Coccidioides immitis, is only found in the soils of semi-arid regions of the southwestern United States and is the causative agent of Coccidioidomycosis or Valley Fever (Figure 1). Dust storms, natural disasters, prolonged drought, and other natural environmental conditions can lead to increased incidences of Coccidioidomycosis and other airborne diseases (CDC 2000; Fisher et al. 2000; Flynn et al. 1979; Schneider et al. 1997; Stevens 1995). Human activities that disturb the soil such as road construction and traffic substantially increase particulate matter (including aerosolized spores) concentrations in urban areas. Recent studies in the Phoenix metropolitan region have shown that particulate matter concentrations in urban areas are 3 to 7 times higher than in nearby rural areas (Figure 3).

The short-term objectives of this project include:

1. Estimating the biological fraction of dust particles 2.5 microns and 10 microns in size in Phoenix metro area and quantifying the biological fraction associated with urban areas.
2. Developing a protocol for detecting low airborne levels of C. immitis through DNA amplification and sequencing methods.
3. Conduct outdoor sampling in:
   - High risk rural areas during high risk seasons (June-October and November-February) in Arizona.
   - Low risk rural areas.
4. Identify the fraction of biological matter in PM2.5 and PM10 using epifluorescent microscopy. The risk of high airborne biomass occurring using DNA/RNA and fluorescent techniques or using epifluorescent microscopy (Figure 5).
5. Low risk urban areas (e.g., pavement and grass covered soil).
6. Isolate C. immitis from particulate matter by comparing sequences of ribosomal DNA using polymerase chain reaction (PCR) mediated amplification and gel agarose. Highly specific primers have already been developed that detect airborne biological and non-biological matter using a filter-based virtual impactor sampler.

EXPECTED DATA

High risk urban areas that contain the most disturbances to the soil are hypothesized to contain the highest biological fraction of the total particulate matter mass. A certain percentage of the particular matter should contain fungal organisms. C. immitis is expected to comprise a very small fraction, if any, of all of the fungal loading. It is hypothesized that PM10 will have a higher ratio of airborne fungal spore concentration to total airborne particle mass than PM2.5, in the space, themselves, are often larger than 2.5 microns.

REFERENCES