SPM AND CONIDIA OF MOLDS DURING THE ASIAN DUST EPISODES

Hwan-Goo Yeo and Jong-Ho Kim

Dept. of Environmental Engineering, Hanseo University, Seosan, Korea, 356-706
yeohg@hanseo.ac.kr ; kimjh@hanseo.ac.kr

ABSTRACT: High SPM concentrations(199.8~249.4㎍/㎥) were detected in the west Korea during the Yellow Sand Periods, 2000. Majority of the total SPM were composed of about 5㎛ sized coarse particles over the periods. However, fine particles sized about 1㎛ and coarse particles sized about 5-6㎛ showed peaks at the graph of SPM size distribution in the Non Yellow Sand Period.
Airborne fungal spores at the SPM samples were cultured and identified. Full-grown colonies during the Yellow Sand Periods, *Fusarium*, *Aspergillus*, *Penicillium* and *Basipetospora* are hyphomycetes in the division Fungi imperfecti(Deuteromycota). And morphologically more diversified mycelia of hyphomycetes were grown on the sample captured from 1.1~2.1㎛ sized SPM than on other sized samples during the Yellow Sand Period. But no mold was observed on the sample of 1.1~2.1㎛ sized SPM in the Non Yellow Sand Period. It was thought that several sorts of fine sized fungal spores were suspended in the atmospheric environment of the west Korea during the Asian dust episodes.

INTRODUCTION

Yellow Sand (Asian Dust Storm) blown from deserts in China and Mongolia caused much damage to the east China as it flew over the middle region of the Korean Peninsula to record undesirable meteorological phenomenon due to the particles. The transport of Yellow Sand from China to the North Pacific atmosphere was documented and reaches the maximum aerosol loading each springtime[1~7]. Compelling geological evidence of global scale, transport of Yellow Sand emerged from the chemical analysis of samples in the Greenland ice core[8] and Hawaiian soil studies[9~12]. The chemical and radiological fingerprints of deposited dust at both locations were most consistent with the composition of the Yellow Sand.

Husar et al. reported the formation, transport and other characteristics of two Yellow Sand Storms in April 1998. The focus was on the dust storm that occurred on April 19, 1998 over Mongolia and North-Central China which crossed the Pacific causing aerosol concentrations near the health standard in USA(150 ㎍/㎥) over much of the West Coast of North America[13]. Up to now, several observers in Korea, Japan and North America have monitored the unusual dust cloud scrutinizingly. Although several papers in Korea include physicochemical characteristics of Yellow Sand Storm, hardly known bioaerosol concerned with SPM(Suspended Particulate Matter) during the Asian dust episodes.[14~18].

The term "bioaerosol" refers to airborne particles containing (1) intact living or dead microorganisms (as single units, in homogeneous or heterogeneous groups, or attached to other particles), (2) microbial spores (resistant reproductive structures produced by many fungi and some bacteria), (3) fragments of microorganisms and larger organisms (body parts of arthropods, skin scales from mammals, and pollen and plant debris), and (4) other particles from living or dead organisms (excreta from arthropods, such as dust mites and cockroaches; allergens from microorganisms, plants, and animals; and microbial toxins) [19]. Airborne viable microorganisms are not regarded as air pollutants but should be considered as an important factor affecting air quality and human health. Bioaerosols enter and are dispersed into the atmosphere from a variety of sources. The survival of these airborne microorganisms depends on the meteorological factors and chemical composition of the atmosphere[20~22].

The Kingdom Fungi includes some of the most important organisms, both in terms of their ecological and economic roles. By breaking down organic material, they continue the cycle of nutrients through ecosystems.

Fungi may be unicellular or multicellular and are often divided into broad two categories. "Yeasts" are unicellular fungi that reproduce primarily by budding and, in culture, pasty colonies similar to those of bacteria. The multicellular fungi are formed microscopic branched filaments. Most persons are familiar with "molds" which are among the most common multicellular fungi.

This study focuses primarily on the collection and detection of fungal spores at SPM samples. Fungal spores may be actively or passively released for dispersal by several effective methods. The air we breathe is filled with spores of species that are air dispersed. These usually are species that produce large numbers of spores, and examples include many species pathogenic on agricultural crops and trees. Other species are adapted for dispersal within or on the surfaces of animals. Some fungi are rain splash or flowing water dispersed. In a few cases the forcible release of spores is sufficient to serve as the dispersal method as well. The function of some spores is not primarily for dispersal, but to allow the organisms to survive as resistant cells during periods when the conditions of the environment are not conductive to growth. Our current study was undertaken to investigate the ambient fungal aerosol characteristics in relation to SPM size distribution and Yellow Sand (Asian Dust Storm) in west Korea, a temperate region.

MATERIAL AND METHOD

Samplings were performed during 2 Yellow Sand Periods and Non Yellow Sand Period on the roof of 6 story office building which 18 meters above ground level in Seosan (126°35'E, 36°42'N), midwest region of Korea. The first, second and third sampling were done from 23 to 24 March (1st Yellow Sand Period), from 7 to 9 April (2nd Yellow Sand Period) and from 12 to 16 May(Non Yellow Sand Period), 2000, respectively.

In general, the physical methods including impaction, impingement, and filtration have been commonly applied to the collect bioaerosols. Although the impinger is widely used, the sampling performance of impingers was poorly characterized compared to impactors[23~24]. According to the fact, impactor than impinger and filter is more commonly used for bioaerosol sampling because of direct collection without post-collection sample processing[25].

In this study, an eight-stage Cascade impactor (Andersen Instrument, Model 20-800, USA) and 0.22㎛ pore size membrane filters (80mm diameter, Hi-Fil Seoul Science Co.) were used for SPM samples. Every SPM impactor samples contained fungal spores and collected on the membrane filters were cultured on the M-endo Broth media, and some spores were isolated and cultured on malt extract agar plate for identification. Dark incubation of fungal spores continued 96 hours at 25℃, and light microscope(Nikon E600; maximum 1000X) was used for examination and identification of grown molds.

RESULTS AND DISCUSSION

SPM Concentrations and Size Distribution

Dust storms are formed when the friction from high surface wind speeds (>5 m/sec) lifts loose dust particles into the atmospheric boundary layer or above[26]. Wind blown dust originating from the arid deserts of Mongolia and China is a well-known springtime meteorological phenomenon throughout East Asia. In fact, "Yellow Sand" meteorological conditions are sufficiently common to have acquired local names: Huangsha in China, Whangsa in Korea, and Kosa in Japan[13]. The Yellow Sand dust storms have been studied for decades to understand their sources, mechanisms of transport, and aerosol characteristics, including the effects on radiation[27~33]. However, quantitative understanding of individual dust events, e.g. the dust emission locations and rates as well as the details of long-range transport and removal, are still incomplete.

In this study, SPM concentration, mean temperature and mean relative humidity were 199.8㎍/㎥, 5.1℃ and 55.8% in the 1st Yellow Sand Period(March, 23~24). And these were 249.4㎍/㎥, 6.5℃ and 45.3% in the 2nd Yellow Sand Period(April, 7~9). On the other hand, reduced SPM concentration(98.9㎍/㎥), risen temperature(14.4℃) and relative humidity(77.7%) were detected in the Non Yellow Sand Period(May, 12~16). Although there was somewhat difference for total SPM concentration between the two Yellow Sand Periods, majority of the total SPM were composed of about 5㎛ sized coarse particles over the two periods. However, fine particles sized about 1㎛ and coarse particles sized about 5~6㎛ ultimately showed peaks, which is within typical bimodal pattern at the graph of SPM size distribution in the Non Yellow Sand Period.

Chun et al. measured SPM size distribution on Anmyon Island, Korea in the Yellow Sand Period, 1998[34]. The measured volume size distribution function showed a sharp peak between 1~5㎛, with a volume-mean diameter of 2㎛, and a logarithmic standard deviation of 1.6. Continuous monitoring of particle concentration in different size ranges exhibited a strong correlation between the particles in the SPM peak size range (2~3㎛) and virtually no correlation with particles below 0.8㎛ and above 10㎛. Hence, the size ranges below 0.8 and above 10 ㎛ have different origins than the coherent SPM size range between 1~10㎛ [34]. The absence of transported large particles implies that the SPM above 10㎛ were preferentially removed by gravitational settling during the 2~3day atmospheric transport time from Gobi to Korea[13].

Composition of Conidia of Molds (Fungal Spores)
The organisms of the fungal lineage include mushrooms, rusts, smuts, puffballs, morels, molds, and yeasts, as well as many less well known organisms[35]. About 70,000 species of fungi have been described; however, some estimates of total numbers suggest that 1.5 million species may exist[36, 37]. To date no perfect identification technique has been found for fungal spores. The two principle methods used are culturing and visual identification and there are advantages and disadvantages to both these methods. The major disadvantages with visual identification of spores are: (1) Many spores are morphologically similar and cannot be identified to genus level[38]. (2) In addition to morphological similarities many spores are small and hyaline (colourless) and can be extremely difficult to see.

The division Deuteromycota is divided into form-classes based upon morphological similarities. The criteria that are typically used are colour, shape, size and septation of the conidia (whether the spores are unicellular, or made up of multiple cells). An important fungi imperfecti group is the form-class hyphomycetes. Hyphomycetes are those fungi imperfecti which form a mycelium but lack a sporocarp and the spores are borne on conidiophores. Hyphomycetes are also called molds and a culture of hyphomycete can be recognized by the powdery or fluffy appearance of the colony. Many are also easily cultured so that more research has been conducted upon this group of fungi than for many other. The hyphomycetes genera, *Alternaria, Cladosporium, Curvularia, Drechslera, Epicoccum, Fusarium, Nigrospora* and *Stemphylium* were listed by Kendrick as the 'Big Eight' because of their allergenicity and frequency in the air[38].

In this study, four sorts of molds grown from airborne fungal spores were identified to the genus level during the Yellow Sand Periods. All the genera, *Fusarium, Aspergillus, Penicillium* and *Basipetospora* are hyphomycetes in the division Deuteromycota. Several species of the genera *Aspergillus, Penicillium* and *Fusarium* produce secondary metabolites such as aflatoxin, citrinin and trichothecenes that may be potent toxins and carcinogens[39], and *Basipetospora* spp. are frequent in arid soil environment. These molds taxa observed in this study are thought to be a general composition of dry season in temperate region.

Relation with SPM Size Distribution and Conidia of Molds (Fungal Spores)
Fungal spores vary greatly in size, but most are in the range of 2~50㎛, which are larger than actinomycetes and other bacterial spores and generally smaller than pollens[40]. On many days in some localities the number of fungal spores in the air far excess the pollen grains. Fungal spores also cause allergies; however, unlike seasonal pollen production, some fungi can produce spores all year long.

In this study, *Fusarium* sp. spores were formed fluffy molds at the relatively large sized SPM(>3.3㎛) aggregations. Lin and Li reported that large numbers of ambient fungus spores isolated were in the size range of 2.1~3.3㎛ in Taiwan[41], a subtropical region. However, in this study, qualitatively more diverse hyphomycetes were grown on the sample contained 1.1~2.1㎛ sized SPM than on the other sized samples in the 1st Yellow Sand Period. The diverse mold species might be belonged to the genera, *Aspergillus, Penicillium* and *Basipetospora.* While mean diameter of *Penicillium* spores was reported 2.32㎛ by Lin and Li, *Penicillium* sp. mold was grown on the 1.1~2.1㎛ sized SPM sample in this study[40].

Whereas about 5㎛ coarse particles were most part of total SPM in the Yellow Sand Periods, the molds grown from coarse particle samples were much less diverse than from fine SPM sample(1.1~2.1㎛). On the other hand, any mold was not observed on the sample contained from 1.1~2.1㎛ sized SPM in the Non Yellow Sand Period. From these results, it was evident that several sorts of fine sized fungal spores, not attached to the coarse Yellow Sand particles, were suspended freely in the atmospheric environment of this study area during the Asian dust episodes.

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