Changeable Qualitative Characteristics of Mold Aerosols on Each Occasion of Dust Episodes (2000 ~ 2002) in West Korea

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Abstract - Conidia of molds within the Asian dust were captured in the ambient air of mid-west Korea, in springtime of 2000~2002. An eight-stage Cascade impactor and 0.22 μm pore size membrane filters were used for the dust samples. Several kinds of molds grown from the samples were identified to the genus level. Those are *Aspergillus, Basipetospora, Epicoccum, Fusarium, Monotospora* and *Penicillium*. Relatively diversified mycelia of hyphomycetes were grown on the fine dust sample (1.1~2.1 μm) in the first year Asian dust episode (23~24 March, 2000). On the other hand, some fluffy molds and dark molds aggregations were grown on even the backup particle sample less than 0.43 μm during the second year episode (24~26 April, 2001). The result of the last year episode (21~22 March, 2002) showed various mycelia grown on the sample contained from 1.1 to 2.1 μm sized particles, just like the result of the first year episode (23~24 March, 2000). These variations between the episodes might be caused by the difference of the dust origins.

Key words : conidia, mold, Asian dust

INTRODUCTION

Fungal aerosols including conidia and hyphae occur in great numbers in outdoor air. It was estimated by Kendrick (1990) that there are over 100,000 sorts of fungi whose conidia may become airborne. Many parameters influence airborne fungal conidia concentrations. These include geographic, meteorological and human factors. Generally, there are higher airborne concentrations in rural and semi-rural sites, when compared to large towns and cities. Three groups of fungi which are of primary concern to aerobiologists and allergists are: Fungi Imperfecti (including the conidia of many types of fungi including molds); Ascomycota (including cup fungi and mildews) and Basidiomycota (including mushrooms, puff balls, jelly fungi, rusts and smuts) (Woolcock *et al.* 1995). In general, mold and mildew are different names for the same thing, a very simple life form that lacks the ability to photosynthesize. Essentially mold consists of fungi that grow in filamentous forms.

Asian dust storm (Yellow sand storm) blown from deserts in China and Mongolia caused much damage to the east China as it passed through and onto the middle region of the Korean peninsula to record undesirable meteorological phenomenon due to the particles. Wind blown dust originating from the arid deserts 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 (Husar *et al.* 2001). Yeo and Kim (2002a) reported that several sorts of fungal spores were transported by the Asian dust storm and qualitatively more

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diverse hyphomycetes were grown on sample contained 1.1~2.1 μm sized particles than on the other sized samples in the dust episode of 2000. And also, no mold was observed on the sample contained from 1.1~2.1 μm sized particles during the non-Asian dust period, May 2000 (Yeo and Kim 2002a). On the other hand, some molds were grown even on the back up filter which contained particles less than 0.43 μm of aerodynamic diameter during the episode of 2001 (Yeo and Kim 2002b). This present study was focused to elucidate changeable qualitative characteristics of conidia within Asian dust the passing of years (2000~2002).

MATERIALS AND METHODS

Mold aerosols samplings were performed in Seosan (126° 35′E, 36° 42′N), mid-west coast of Korea, during the Asian dust episodes 2000~2002. The first year dust episode occurred 23~24 March 2000, the second year episode was 24~26 April, 2001 and the third year episode was 21~22 March, 2002, respectively.

A few accepted methods for measuring the size distribution of airborne dusts and mineral particles are also suitable for sizing bioaerosols. The best method of bioaerosol size separation is that which is simplest, provides the required size information, and is compatible with the assay system to be used (Macher *et al.* 1995). A widely used multi-stage impactor collects particles in six size fractions (Gillespie *et al.* 1981). In this study, an eight-stage Cascade impactor (Andersen Instrument, Model 20-800, USA) and 0.22 μm pore size membrane filters (80 mm diameter, Hi-Fil Seoul Science Co.) were used for the dust samples including molds conidia. All the filters contained conidia were cultured on the M-endo broth media, and some conidia were isolated and cultured on malt extract agar plate for identification. The dark incubation of the conidia continued for 96 hours at 25°C, and a light microscope (Nikon E600; maximum 1000 ×) was used for the examination and the identification of molds which had grown. References used in taxonomical study are as follows; Funder (1968),

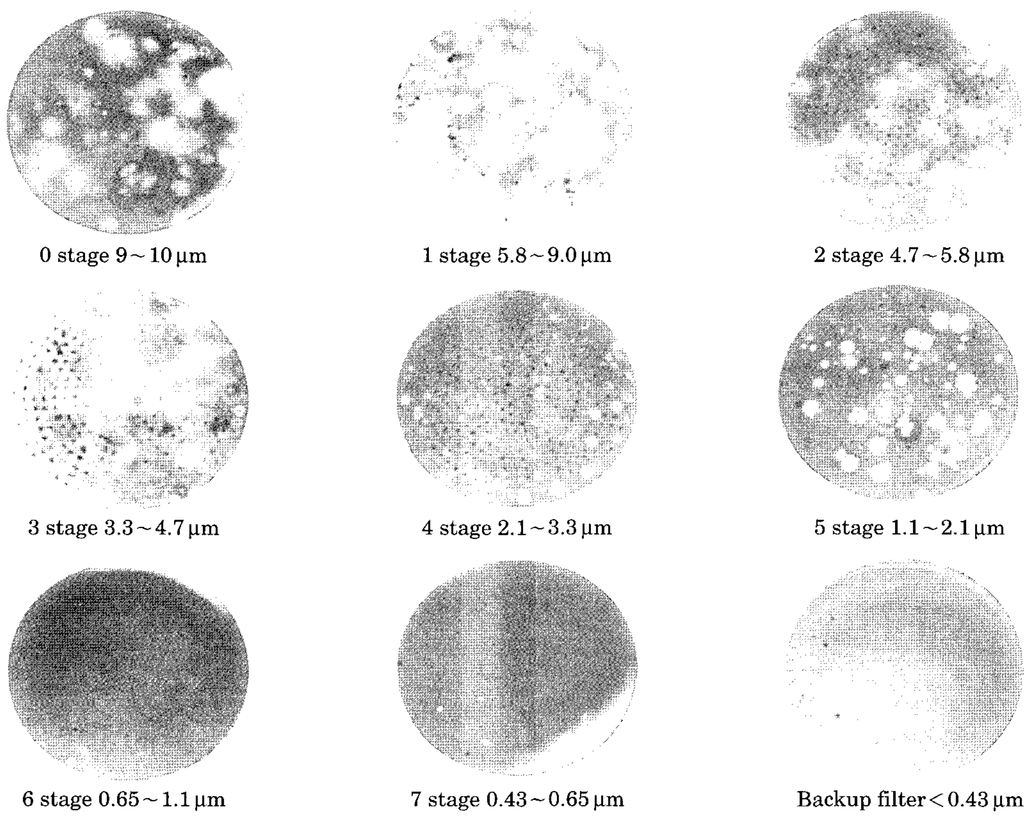

Fig. 1. Molds grown from dust samples (March, 2000; Asian dust period) (cited from Yeo and Kim (2002a)).

Barnett and Hunter (1998) and Kiffer and Morelet (2000).

RESULTS AND DISCUSSION

Conidia of molds are an ever-present component of the atmosphere with concentrations known fluctuate according to meteorological conditions. The distinction between dry-air conidia and wet weather conidia is well known (Troutt and Levetin 2001). Conidia types such as *Cladosporium, Alternaria, Epicoccum* and *Dreschlera* tend to be found in higher concentrations during warm, dry weather conditions, while ascospores and basidiospores tend to be more concentrated during wet or humid conditions (Burch and Levetin 2002).

Four sorts of molds grown from the dust samples during the first year dust episode (2000) were recorded in the previous study (Yeo and Kim 2002a). All the dry-air mold genera observed in 2000, *Fusarium, Aspergillus, Penicillium* and *Basipetospora* are hyphomycetes in the division Deuteromycota. A total 6 sorts of molds including above 4 taxa were grown from the dust samples in the second year episode (2001). The new observed taxa were *Epicoccum* and *Monotospora* (Yeo and Kim 2002b). However, no more new taxa were observed in the episode of 2002.

The Asian dust storms have been studied for decades to understand their sources, mechanisms of transport, and aerosol characteristics, including the effects on radiation (Mizohata and Mamuro 1978; Zhou *et al.* 1981; Wang *et al.* 1982; Iwasaka *et al.* 1983; Zaizen *et al.* 1995; Zheng *et al.* 1998; Zhang and Lu 1999). The dust events were observed through routine satellite sensors, lidar instruments, sun photometers, airborne samplers, and a large array of surface-based aerosol monitors on both sides of Pacific (Husar *et al.* 2001). The local sources of the dust storms could be changed on each occasion of dust episodes such as Gobi desert along the northern China and Mongolia border, Takla-makan desert, Tarim basin and other parts of desert China. However, quantitative understanding of individual dust events, e.g. the

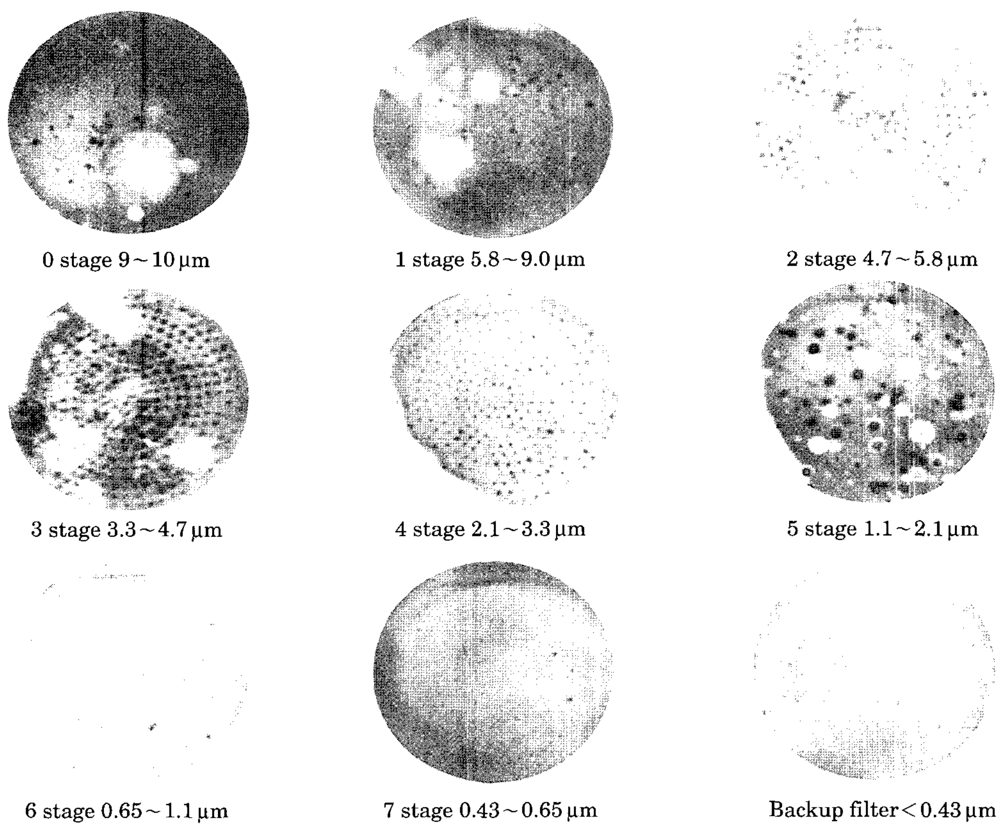

Fig. 2. Molds grown from dust samples (March, 2002; Asian dust period).

dust emission locations and rates as well as the details of long-range transport and removal, are still incomplete.

Kim *et al.* (2002) and Choi *et al.* (2003) reported the aerosol distribution characteristics and metallic composition of the Asian dust 2001. But both of the studies did not deal with a problem of bioaerosol. A large amount of several kinds of fine mold aerosols in the ambient air of this study area were transported by the Asian dust storms. Airborne mold conidia vary greatly in size, but most are in the range of 2~50 μm, which are larger than actinomycetes and other bacterial spores and generally smaller than pollens (Lin and Li 1998). Lin and Li (1996) reported that large numbers of ambient fungus spores isolated were in the size range of 2.1~3.3 μm in Taiwan, a subtropical region. However, in this study, relatively diversified mycelia of hyphomycetes were grown on the fine dust sample (1.1~2.1 μm) in the first year Asian dust episode (23~24 March, 2000) (Fig. 1). Furthermore, dark molds aggregations were grown on even the backup particle sample less than 0.43 μm during the second year episode (24~26 April, 2001). On the other hand, the result of the last year episode (21~22 March, 2002) showed various mycelia grown on the sample contained from 1.1 to 2.1 μm sized particles just like the result of 2000 (Fig. 2). This result is evidence for mold aerosols collected both in March, 2000 and 2002 in west Korea during the Asian dust periods to originate from same source. From this point of view, the origin of the dust storm in April, 2001 would be different from those two periods.

CONCLUSION

Mold aerosols within the Asian dust were collected at the west coast of Korea, during the Asian dust episodes of 2000~2002. Several sorts of molds grew from the dust samples. Relatively diversified mycelia of hyphomycetes were grown on the fine dust sample (1.1~2.1 μm) in March, 2000. And also, various mycelia were grown on the 1.1 to 2.1 μm sized particle sample of March, 2002, just as the result of 2000. However, the pattern of April, 2001 was obviously different. Dark molds aggregations were grown on even the backup particle sample less than 0.43 μm during the episode of April, 2001. The results of qualitative analysis also imply that the composition of mold aerosols collected in west Korea would be changed possibly by the Asian dust origins.

REFERENCES

Barnett HL and BB Hunter. 1998. Illustrated genera of imperfect fungi (fourth ed.) The American Phytopathological Society. St. Paul, MN, USA 218pp.

Burch M and E Levetin. 2002. Effects of meteorological conditions on spore plume. Int. J. Biometeorol. 46:107-117.

Choi GH, KH Kim, CH Kang and JH Lee. 2003. The influence of the Asian dust on the metallic composition of fine and coarse particle fractions. J. Korean Soc. Atmos. Environ. 19:45-56.

Funder S. 1968. Practical mycology: manual for identification of fungi. Hafner publishing company New York. 146pp.

Gillespie VL, CS Clark and HS Bjornson. 1981. A comparison of two-stage and six-stage Anderson impactors for viable aerosols. Am. Ind. Hyg. Assoc. J. 42:858-864.

Husar RB, DM Tratt, BA Schichtel, SR Falke, F Li, D Jaffe, S Gasso, T Gill, NS Laulainen, F Lu, MC Reheis, Y Chun, D Westphal, BN Holben, C Gueymard, I McKendry, N Kuring, GC Feldman, C McClain, RJ Frouin, J Merrill, D DuBois, F Vignola, T Murayama, S Nickovic, WE Wilson, K Sassen, N Sugimoto and WC Malm. 2001. The asian dust events of April 1998. J. Geophysical Res. 106(D16):18067-18074.

Iwasaka Y, H Minoura and K Nagaya. 1983. The transport and spatial scale of Asian dust-storm clouds: A case study of the dust-storm event of April 1979. Tellus. 35B:189-196.

Kendrick C. 1990. Fungal allergens. In Sampling and identifying allergenic pollens and moulds (Smith, EG, Ed; Blewstone Press) San Antonio.

Kiffer E and M Morelet. 2000. The Deuteromycetes: Mitosporic fungi classification and generic keys. Science publishers inc. Enfield. NH. USA. 273pp.

Kim KH, MY Kim, JY Shin, GH Choi and CH Kang. 2002. Insights into the factors determining the aerosol distribution characteristics of the Asian dust on the basis of the concurrent analysis of PM2.5, PM10, and TSP during the spring season of 2001. J. Korean Soc. Atmos. Environ. 18:419-426.

Lin WH and CS Li. 1996. Size characteristics of fungus allergens in the subtropical climate. Aerosol Sci. Tech. 25:93-100.

Lin WH and CS Li. 1998. The Effect of Sampling Time and Flow Rates on the Bioefficiency of Three Fungal Spores Sampling methods. Aerosol Sci. Tech. 28:511-522.

Macher JM, MA Chatigny and HA Burge. 1995. Sampling airborne microorganisms and aeroallergens. pp. 589-617. In Air sampling instruments for evaluation of atmospheric contamonants (eighth edition). American Conference of Governmental Industrial Hygienist (ACGIH).

Mizohata A and T Mamuro. 1978. Some information about loess aerosol over Japan. Japan Soc. Air Poll. 13:289-297.

Troutt C and E Levetin. 2001. Correlation of spring spore concentrations and meteorological conditions in Tulsa, Oklahoma. Int. J. Biometeorol. 45:64-74.

Wang MX, JW Winchester, TA Cahill and LX Ren. 1982. Chemical elemental composition of windblown dust, 19 April 1980. Beijing Kexue Tongbao. 27:1193-1198.

Woolcock AJ, JK Peat and LM Trevillion. 1995. Is the increase in asthma prevalence linked to increase in allergen load? Allergy 50:935-940.

Yeo HG and JH Kim. 2002a. SPM and fungal spores in the ambient air of west Korea during the Asian dust (Yellow sand) period. Atmos. Environ. 36:5437-5442.

Yeo HG and JH Kim. 2002b. Composition and size variation of airborne fungal spores in the Asian dust events (2000 ~ 2001). Korean J. Environ. Biol. 20:294-299.

Zaizen Y, M Ikegami, K Okada and Y Makino. 1995. Aerosol concentration observed at Zhangye in China. J. Meteoro. Soc. Japan 73:891-897.

Zhang D and F Lu. 1999. Winter sandstorm events in extensive northern China (in Chinese). Quat. Sci. 5:441-447.

Zheng X, F Lu, X Fang, Y Wang and L Guo. 1998. A study of dust storms in China using satellite data in optical remote sensing of the atmosphere and clouds. (Wang J, B Wu, T Ogawa and Z Guan eds.). Proceeding of SPIE. 3501:163-168.

Zhou M, Q Shaohou, S Ximing and L Yuying. 1981. Properties of the aerosols during a dust storm over Beijing area. Acta Sci. Circums. 1:207-219.

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