Measurement of temperature that fungal spores form ice nuclei

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1. Background

Aerosols act as condensation nuclei and ice nuclei for the cloud particle formation in the atmosphere. In recent years, it was discovered that some bioaerosols can be ice-nuclei at relatively high temperatures of -15 ˚C or higher, indicating the possibility they could form ice clouds and precipitation at lower altitudes where formation mechanism of ice clouds has not been understood, and their significance in the meteorology and climate has been recognized. Although there have been many studies that measure ice nuclei formation temperature for general aerosols, it has been measured for very limited number of fungal spores in those studies. Thus, it has been not yet understood what kind of fungal spores can work as ice nuclei at relatively high temperatures.

In this research, we measured ice nucleation of spores of various kinds of fungi sampled in Japanese forests and examined the relationship between ice nucleation temperature and biological classification. We also classified patterns of ice nuclei formation, which may have information on ice nuclei formation temperature and process.

2. Method

In this research, spores were sampled from fungi collected during fungi surveys conducted every month from May to October in various types of woods in the Tsukuba Botanical Garden. Some fungi were also collected in the forests of Namie Town, Fukushima Prefecture. Using an optical microscope equipped with a cooling stage, ice nuclei form of generation of ice nuclei is observed.

3. Results and discussion

The ice nucleation temperatures of fungal spores showed large diversity, depending on their species. The ice nucleation temperature depends on the biological classification of fungi. Although there were a large variation, ice nucleation temperatures of spores of *Russulales*, ranged from -20 to -30 ˚C. The temperatures of *Boletales* spores were about -30 ˚C, and they of *Polyporales* spores were -22 ˚C. *Agaricales* can be divided into two groups: spore ice nucleation temperature was about -15 ˚C and about - 30 ˚C. The generation form of ice nuclei in spores can be categorized into 4 groups: A: ice grows from the whole spore surface after its swelling, B: ice grows suddenly from the spore surface, C: ice grows from a particular part of spores, D: ice generated around spores. Although there are a few exceptions, most of the spores that could be classified as “A” became ice nucleus at a relatively high temperature of -15 ˚C or higher. For other developmental forms, the relationship with ice nucleation temperature is not clear. Measuring the ice nucleation temperatures of various kinds of fungal spores this study found that some

fungal spores can become ice nuclei at a relatively high temperature of -15 ˚C or so, showing a possibility that fungal spore can produce ice clouds in relatively lower atmosphere. It is also found that fungal spores forming ice at relatively high temperature mostly classified as *Agaricales* , and that they swelled just before they made ice particles. These results may have information on factors determining the ice formation temperature of spores.

Keywords: bioaerosol, fungal spore, ice nuclei

