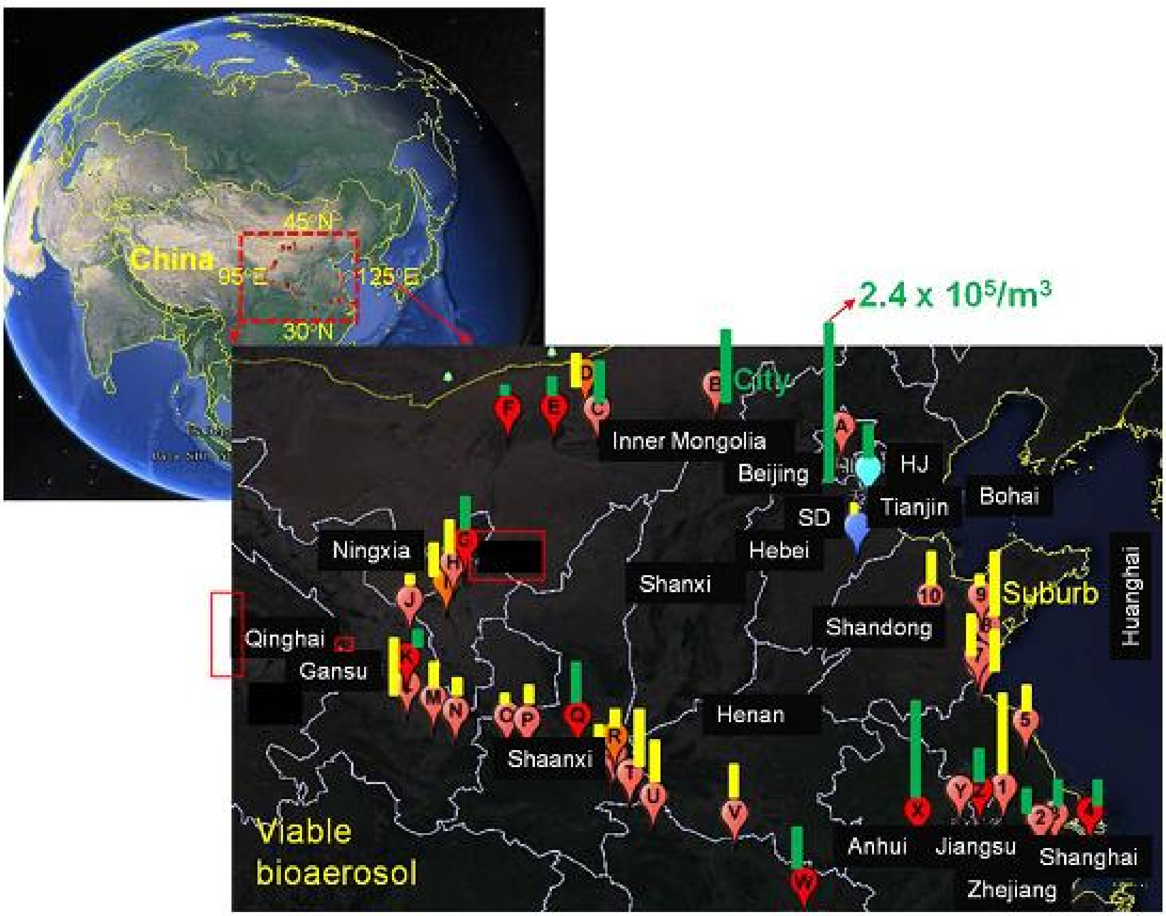
Chinese team studies airborne microbes across different environments

October 1 2015



The distribution of microbial aerosols across many parts of China. Credit: ©Science China Press

When people talk about air pollution these days, particulate matter with a diameter smaller than 2.5 microns (PM2.5) immediately comes to mind. Yet, we are often unaware that these tiny particles suspended in the air could be living microbes, such as bacteria, fungal spores, and viruses. Some of these living particles could be human pathogens that can cause serious health outcomes. In addition to health effects, these airborne microbes also have direct impact on cloud formation and climate arising from their special attributes. Virtually any microbes that originated from Earth surfaces—including sea, land, forest, agriculture, animals and humans—could be released into the air and remain airborne for a sustained amount of time.

Accordingly, humans are constantly inhaling microbes from the air. These microbes can be also transported far from their original sources because of atmospheric air movements. In recent decades, the chemical compositions of particulate matter have been extensively studied, especially in mega-cities; however, despite of their importance, few studies have been conducted of their biological counterparts, especially on a larger scale. Information about their size distribution and concentration is significantly lacking, especially in different climate zones.

A Chinese team led by Prof. Maosheng Yao from the College of Environmental Sciences and Engineering at Peking University has developed a better understanding of microbes by deploying a fluorescence-based microbial aerosol sensor, called the ultraviolet-aerodynamic particle sizer (UV-APS). It was transported using an automobile to many parts of China, including regions from 13 provinces. The UV-APS detects the size distribution and concentration level of viable microbial aerosol particles by measuring their emitted intrinsic fluorescence level. In previous studies, most of the monitoring was confined to a single location, often in pristine environments, thus documenting only the characteristics of natural emissions. For the current study, the researchers monitored the microbial aerosol levels in highly polluted major cities and their less-polluted suburbs (total 40 locations) in 11 provinces (7 different climate zones) of China. In addition, they also studied the bacterial aerosol structures using a gene sequence technique.

The team reported their findings in *Science Bulletin*. "on average, we have detected about 104 to 105 viable microbial aerosol particles per m^3 in the ambient air, and Bacillus was found to dominate the bacterial community. For different geophysical locations, the microbes in the air have strikingly different size distribution patterns, e.g., some of them have a peak size at 3 μm, e.g., Gansu province, the northwestern part of China, while others have fluorescent peaks at sizes close to 1, 1.5 or 4 μm. These differences are largely attributed to the different climatic conditions, e.g., temperature, humidity level and rainfall. These unique microbial aerosol distribution patterns might serve as a fingerprint for a particular region." says Prof. Yao.

In the past, scientists studied viable microbial aerosols in pristine environments like the Amazon basin using the same method, and detected an average viable bioaerosol concentration of 7.3 x $104/m^3$, which accounts for 24 percent of the total particle number and 47 percent of total mass. Yet, no studies have been conducted for microbial aerosol characteristics in mega-cities such as Beijing with high levels of air pollution.

Now, the team has discovered that locations with higher levels of air pollution also tend to exhibit a higher level of airborne bacterial diversity and concentration. "We also found that indoor environments have at least 10 to 100 times higher fluorescent particle concentration levels compared to the ambient air," Prof. Yao says. "However, due to the instrumentation limitation, the real microbial aerosol concentration could be overestimated as a result interference from chemicals such as polycyclic aromatic hydrocarbon (PAH)."

Jing Li, a Ph.D. student from the team, adds, "We have detected significant differences in bacterial aerosol community structures for different climate zones in China using an automobile air conditioning filter method. For example, Hainan has a lower bacterial aerosol diversity compared to that in Beijing."

"We are also puzzled that we saw a significant increase in the level of fluorescent bioaerosol particles at the right occurrence of a haze event in Beijing, but subsequently a decline in their concentration was observed over the progress of the haze. We are now investigating the relevant mechanisms in another work," says lead author Kai Wei, a Ph.D. student from the College of Environmental Sciences and Engineering at Peking University. Fangxia Shen, another member of the team who is now a postdoctoral researcher at Max Planck Institute for Chemistry in Mainz, Germany, says, "The viability of airborne microbes could be severely affected during an episode of heavy air pollution, especially those occurring in China. The microbial aerosol characteristics could be very different in Mainz from those in Beijing."

Coauthor Yunhao Zheng, another graduate student from the team, adds, "One of my projects is to find out if there is a link between air pollution and increased number of hospital visits, especially those related to respiratory infections, using a DNA-based multiplex pathogen detection method. We hope to provide clues to why people often get infected."

"Information on the viable bioaerosol levels in the ambient air in China could potentially be useful to speciation of the PM sources, especially for Chinese air pollution, and also helpful in understanding its impacts on local climate and ecology. The data obtained from the study can be also used to construct atmospheric models for bioaerosol emissions at various scales," says coauthor Chang-Yu Wu, a professor from the

University of Florida, U.S. "Certainly, it is exciting to have this type of information in the academic community."

"Although the results from this work are limited to short-term monitoring at each particular location, this is the first-ever attempt to understand the airborne microbial community on such a large scale. Certainly, more in-depth studies are needed to elucidate the impacts of these microbes from the air on our health, ecology and climate." Prof. Yao says.

More information: Kai Wei,Yunhao Zheng, Jing Li,Fangxia Shen, Zhuanglei Zou,Hanqing Fan, Xinyue Li,Chang-yu Wu, and Maosheng Yao (2015), "Microbial Aerosol Characteristics in Highly Polluted and Near Pristine Environments Featuring Different Climatic Conditions," *Science Bulletin*, (2015) 60(16):1439-1447. link.springer.com/article/10.1007%2Fs11434-015-0868-y

Provided by Science China Press

Citation: Chinese team studies airborne microbes across different environments (2015, October 1) retrieved 21 July 2024 from https://phys.org/news/2015-10-chinese-team-airborne-microbes-environments.html

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