Keeping mold out of future space stations

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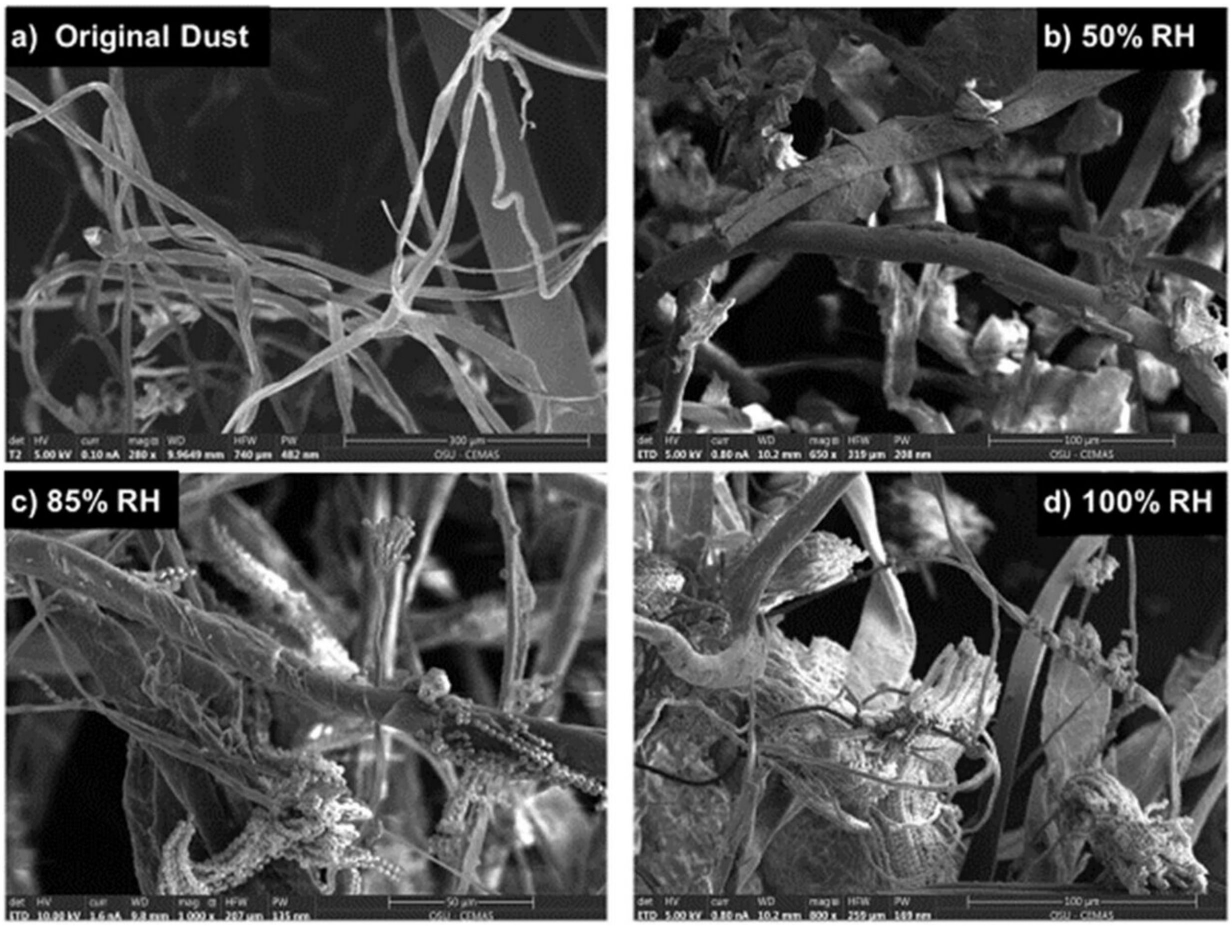

Scanning electron microscopy (SEM) images of ISS dust from the original dust (A) and incubations at 50% ERH (B) show fibrous dust materials, but no fungal growth. Fungal growth including spores, elongated hyphae, and different fungal propagules was observed in ISS dust incubated at 85% ERH (C) and 100% ERH (D) for 2 weeks at 25℃. Credit: *Microbiome* (2024). DOI: 10.1186/s40168-024-01864-3

Mold can survive the harshest of environments, so to stop harmful spores from growing on future space stations, a new study suggests a novel way to prevent its spread.

Researchers created a predictive approach for modeling unintended microbial growth in critical spaces and applied it to life on the International Space Station.

An analysis of dust samples obtained from the space station found that repeated elevated humidity exposures for even a short time can lead to rapid microbial growth and composition changes in dust that make it easier for microbes, such as fungi, to thrive.

The study provides important insight into how healthy environments might be maintained during future missions, especially as the commercial space industry begins to prompt more people to live and work above Earth, said Karen Dannemiller, senior author of the study and an associate professor of civil, environmental and geodetic engineering and environmental health sciences at The Ohio State University.

"It's really important to understand the exposures that happen in the space environment in part because we see immune system changes in astronauts," she said. "People who are normally healthy individuals may be especially vulnerable to microbes in space, more so than on Earth."

The study is published in the journal *Microbiome*.

Historically, many spacecraft have had issues with unintended microbial growth because, much like a typical home on Earth, they, too, are environments that tend to trap the moisture humans emit. On the ISS, dust is usually produced by people as they go about their daily activities, but left unchecked, these floating particles can cause a range of negative health issues for the crew, such as asthma or allergies, and degrade building materials and equipment.

To ensure that dust levels aboard the ISS are carefully controlled, every week astronauts must clean the protective screens that cover the filters of the space station's air ventilation system. In this study, four separate vacuum bag samples of the dust collected from these housekeeping chores were sent down to Dannemiller's team to be tested.

After incubating the samples for two weeks at different relative humidities to simulate a scenario where an unexpected event, such as a temporary air ventilation system failure, could cause bursts of moisture, analysis revealed that fungi and bacteria can grow in the same concentrated amounts as dust collected from residential homes on the ground.

"Spacecraft actually aren't that different from what we see on Earth in terms of having a unique indoor microbiome," said Nicholas Nastasi, lead author of the study and a postdoctoral researcher at Ohio State's Indoor Environmental Quality Laboratory. "If you put people in a space, there will always be microbes there, so it's important to prevent their spread because once it starts, it's often not too easy to get rid of."

Spacecraft are especially prone to microbial growth because they are enclosed environments where humans constantly exhale moisture. If that moisture builds up, mold can begin to grow, as seen in past space stations such as Mir. Although the ISS has much improved controls for moisture, unexpected situations can still easily occur, said Nastasi.

Additionally, while Earth and space environments are complex in their own unique ways, the two more often than not contain similar core microbial communities, Nastasi said. Moreover, staying knowledgeable about the evolution of these communities will make certain that vulnerable individuals both on- and off-world have the information needed to maintain a healthy indoor microbiome on the space station.

"In designing some of our current space station systems, we've already learned a lot of really important lessons in terms of how to keep moisture under control," said Dannemiller. "Now we're learning even more that we can use to advance these systems in the future."

In general, the study also suggests that the team's research could later aid the development of planetary protection protocols aimed at preventing contamination of Earth or any other celestial bodies humans may visit.

Next, the team will likely work to discover what effect other untested spaceflight variables, such as microgravity, radiation and elevated carbon dioxide levels, have on microbial growth in similar working space stations, like NASA's lunar station Gateway or other imminent commercial projects. Many of their upcoming projects will also benefit from Ohio State's terrestrial analog of the George Washington Carver Science Park, a replica of Starlab space station science park that will allow researchers to conduct parallel missions on the ground.

"There's a lot of other unique spaceflight factors we can potentially add to these microbial models to make them more accurate and useful," said Nastasi. "We'll keep refining what we do to maintain those healthy space environments and having unprecedented access to a platform such as Starlab will help immensely."

More information: Nicholas Nastasi et al, Predicting how varying moisture conditions impact the microbiome of dust collected from the International Space Station, *Microbiome* (2024). DOI: 10.1186/s40168-024-01864-3

Provided by The Ohio State University

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