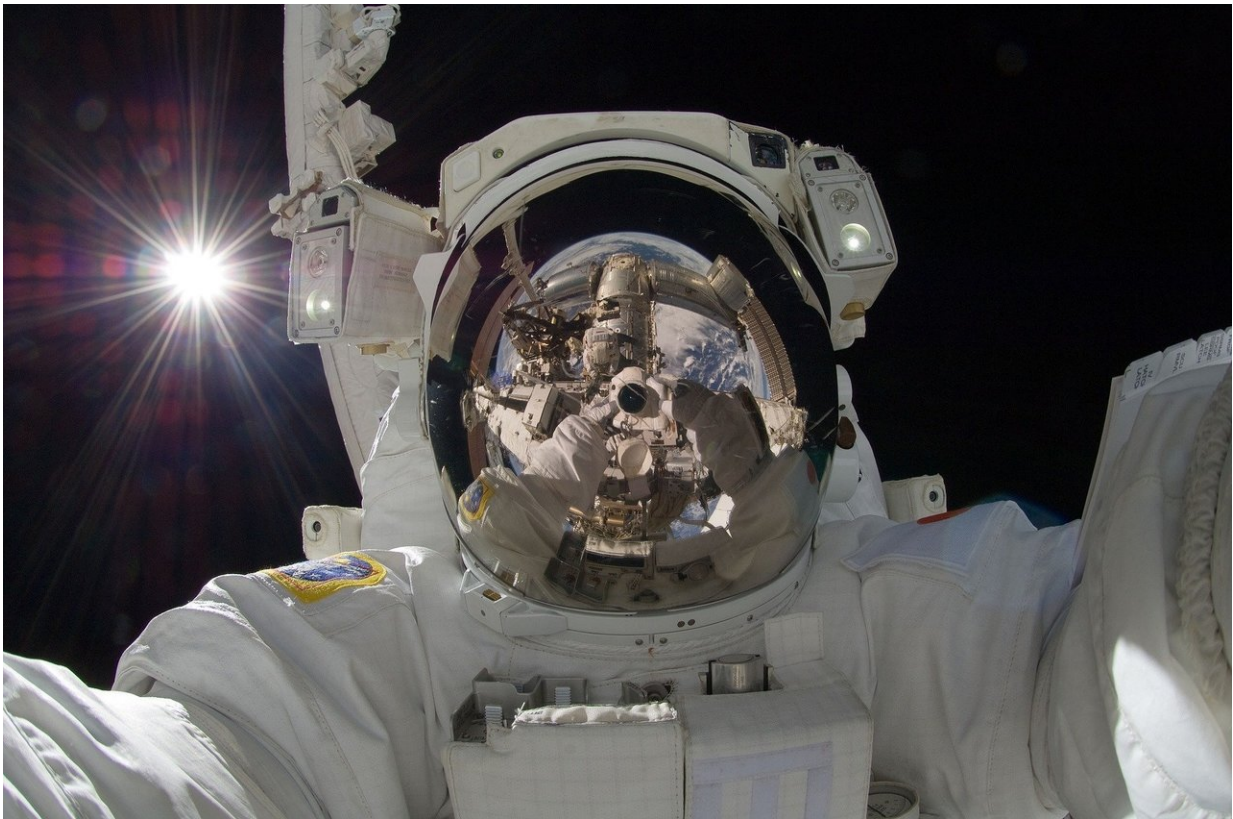


Monitoring microbes to keep Marsonauts healthy

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To guarantee a safe environment for astronauts on long-duration space missions such as a journey to Mars, it is important to monitor how microorganisms such as bacteria adapt to the confined conditions

onboard spacecraft, according to a study published in the open access journal *Microbiome*.

Dr Petra Schwendner, University of Edinburgh, corresponding author of the study said: "Until now, little was known about the influence of long-term confinement on the microorganisms that live inside habitats that may one day be used to travel to other planets, and whether the structure of the microbiota changes with time. Ours is the first comprehensive long-time study that investigates the microbial load, diversity and dynamics in a closed [habitat](#) - a mock-up spacecraft - for 520 days, the full duration of a simulated flight to Mars."

The team of researchers from Germany, UK and Austria, led by the German Aerospace Center (DLR), found that apart from the crew who were the main source of human-associated bacteria inside the habitat, confinement appeared to be the strongest trigger shaping the bacterial community - the microbiota - which remained highly dynamic over time.

Human-associated microorganisms, including *Bacillus* and *Staphylococcus* species were the most frequent, indicating that humans were the main source for microbial dispersal, according to the researchers. For example, *Staphylococcus*, which is frequently found in the nose, respiratory tract, and on the skin, was probably dispersed via skin flakes shed by the crew. Although *Staphylococcus* will not always cause disease, it is a common cause of skin infections, especially in individuals with weakened immune systems.

In order to find out which bacterial species may be present in the air and on the surfaces inside spacecraft and how the composition of the microbiota may change during human habitation, a crew of six male "Marsonauts" lived inside a mock-up spacecraft, located in Moscow, from 3rd June 2010 to 5th November 2011. During the isolation period the crew members remained fully confined - they never left the closed

habitat. Simulating conditions during a manned mission to Mars, they followed a strict diet and schedule, which included cleaning the habitat and conducting scientific experiments. They collected 360 [microbial samples](#) from 20 locations (9 air, 11 surface) at 18 time points, using air filters and swabs.

While a core microbiota of the same bacteria was present in all areas of the mock-up spacecraft, the authors noticed specific bacterial signatures for each individual area, or module, indicating that - much like in other indoor environments - microbial presence is associated with human presence as well as the type of activity that an area is used for. Communal areas, sleep areas, the gym, and the toilet had the highest numbers and greatest diversity of bacteria, while the lowest numbers of bacteria were found inside the medical module.

Dr Schwendner said: "We also saw the impact of cleaning agents. Although we located some microbial hotspots, where the number of bacteria was much higher than in other areas, we were quite relieved to find that the overall bacterial counts were within the acceptable limits. Due to appropriate cleaning measures, the microbial community inside the habitat was under control at all times with no or little risk for the crew."

The researchers also noticed that the microbial diversity decreased significantly over time which means that there were fewer different species of [bacteria](#) present. This may indicate potentially problematic developments within the microbial community during long-duration isolation, according to the authors. High microbial diversity is normally associated with systemic stability and health.

Dr Schwendner said: "In addition to potential health risks for the crew, some of these microorganisms could have a negative impact on spacecraft, as they grow on and might damage [spacecraft](#) material. To

ensure the systems' stability, countermeasures may be required to avoid development of highly resistant, adapted microorganisms, and a complete loss of [microbial diversity](#). Our study provides valuable insights into the quality of habitat maintenance and improves the selection of appropriate microbial monitoring approaches, allowing for the development of efficient and adequate countermeasures."

More information: Petra Schwendner et al, Preparing for the crewed Mars journey: microbiota dynamics in the confined Mars500 habitat during simulated Mars flight and landing, *Microbiome* (2017). [DOI: 10.1186/s40168-017-0345-8](#)

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