

Hardy Bacterium Isolated From Two Geographically Distinct Spacecraft Assembly Cleanroom Facilities

A new species merits further study.

NASA's Jet Propulsion Laboratory, Pasadena, California

Earlier studies have confirmed that a tenacious hardy bacterial population manages to persist and survive throughout a spacecraft assembly process. The widespread detection of these organisms underscores the challenges in eliminating them completely. Only comprehensive and repetitive microbial diversity studies of geographically distinct cleanroom facilities will bolster the understanding of planetary protection relevant microbes. Extensive characterizations of the physiological traits demonstrated by cleanroom microbes will aid NASA in gauging the forward contamination risk that hardy bacteria (such as *Tersiccoccus phoenicis*) pose to spacecraft.

Rigorous standards are in place for the cleaning and monitoring of spacecraft assembly environments to help minimize the inadvertent forward contamination by microorganisms during space missions. Cleanroom environments are oligotrophic (low-nutrient level), desiccated (humidity controlled), certified to a defined low particle concentration, and maintained at constant temperature. Yet despite these unfavorable conditions, a subset of tenacious microbes is known to exist in these assembly facilities.

This study reports on the isolation and identification of two gram-positive, non-motile, non-spore-forming bacterial strains from the spacecraft assembly facilities at Kennedy Space Center, Florida, USA and Centre Spatial Guyanais, Kourou, French Guiana.

DNA-DNA relatedness values between the novel strains indicates that these novel strains were indeed members of a same species. Phylogenetic evidence derived from a 16S ribosomal DNA analysis indicated that both the novel strains are less closely related to all other *Arthrobacter* species. Based on phylogenetic and phenotypic results, it is concluded that these strains represent a new species of the novel genus *Tersiccoccus*, for which the name *Tersiccoccus phoenicis* sp. nov. is proposed. The presence of *Tersiccoccus phoenicis* exclusively in the cleanroom environments from two distinct geographical locations suggests selective adaptation and a significant role for these microorganisms in these environments.

Microbes residing in the cleanrooms during the spacecraft assembly process

could gain access to a spacecraft, and possibly survive en route to extraterrestrial systems. *Tersiccoccus* and members of the *Arthrobacter* genus are metabolically versatile, producing many different enzymes allowing them to grow on a wide range of substrates, including agricultural pesticides, radioactive waste, and high concentration of toxic pollutant. Previously undescribed *Tersiccoccus phoenicis*, isolated from two distinct cleanroom facilities, may exhibit even greater resilience than other microbial strains due to their selective adaptation to cleanroom environments. Thus, it is in the best interest of NASA to characterize this organism thoroughly, which will further assess in determining the potential for forward contamination and development of more effective bioburden reduction, cleaning, and sterilization technologies.

This work was done by Parag A. Vaishampayan and Kasthuri J. Venkateswaran of Caltech; Petra Schwendner of the German Aerospace Center; and Christine Moissl-Eichinger of Regensburg University, Germany, for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48065