Extreme Ionizing-Radiation-Resistant Bacterium

Deinococcus phoenicis sp. nov. can be used as an indicator for sterilization processes in food, aerospace, medical, and pharmaceutical applications.

NASA's Jet Propulsion Laboratory, Pasadena, CA

There is a growing concern that desiccation and extreme radiation-resistant, non-spore-forming microorganisms associated with spacecraft surfaces can withstand space environmental conditions and subsequent proliferation on another solar body. Such forward contamination would jeopardize future life detection or sample return technologies. The prime focus of NASA's planetary protection efforts is the development of strategies for inactivating resistance-bearing micro-organisms. Eradication techniques can be designed to target resistance-conferring microbial populations by first identifying and understanding their physiologic and biochemical capabilities that confers its elevated tolerance (as is being studied in *Deinococcus phoenicis*, as a result of this description). Furthermore, hospitals, food, and government agencies frequently use biological indicators to ensure the efficacy of a wide range of radiation-based sterilization processes. Due to their resistance to a variety of perturbations, the non-spore forming *D. phoenicis* may be a more appropriate biological indicator than those currently in use.

The high flux of cosmic rays during space travel and onto the unshielded surface of Mars poses a significant hazard to the survival of microbial life. Thus, radiation-resistant microorganisms are of particular concern that can survive extreme radiation, desiccation, and low temperatures experienced during space travel. Spore-forming bacteria, a common inhabitant of spacecraft assembly facilities, are known to tolerate these extreme conditions. Since the Viking era, spores have been utilized to assess the degree and level of microbiological contamination on spacecraft and their associated spacecraft assembly facilities. Members of the non-sporeforming bacterial community such as *Deinococcus radiodurans* can survive acute exposures to ionizing radiation (5 kGy), ultraviolet light (1 kJ/m^2), and desiccation (years). These resistive phenotypes of *Deinococcus* enhance the potential for transfer, and subsequent proliferation, on another solar body such as Mars and Europa. These organisms are more likely to escape planetary protection assays, which only take into account presence of spores. Hence, presences of extreme radiation-resistant *Deinococcus* in the cleanroom facility where spacecraft are assembled pose a serious risk for integrity of life-detection missions.

The microorganism described herein was isolated from the surfaces of the cleanroom facility in which the Phoenix Lander was assembled. The isolated bacterial strain was subjected to a comprehensive polyphasic analysis to characterize its taxonomic position. This bacterium exhibits very low 16SrRNA similarity with any other environmental isolate reported to date. Both phenotypic and phylogenetic analyses clearly indicate that this isolate belongs to the genus *Deinococcus* and represents a novel species. The name *Deinococcus phoenicis* was proposed after the Phoenix spacecraft, which was undergoing assembly, testing, and launch operations in the spacecraft assembly facility at the time of isolation. *D. phoenicis* cells exhibited higher resistance to ionizing radiation (cobalt-60; 14 kGy) than the cells of the *D. radiodurans* (5 kGy). Thus, it is in the best interest of NASA to thoroughly characterize this organism, which will further assess in determining the potential for forward contamination. Upon the completion of genetic and physiological characteristics of *D. phoenicis*, it will be added to a planetary protection database to be able to further model and predict the probability of forward contamination.

This work was done by Parag A. Vaishampayan and Kasthuri J. Venkateswaran of Caltech, and Petra Schwendner of Institute of Aerospace Medicine, German Aerospace Center (DLR), Germany for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48008