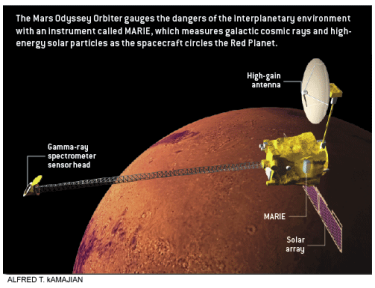
PLANETARY PROTECTION
PROTECTING EARTH & PLANETS AGAINST ALIEN MICROBES

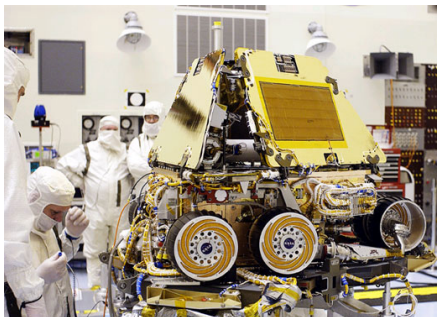
Background

Protecting Earth and planets against the invasion of 'alien life forms' is not military science fiction, but it is the peaceful daily job of engineers and scientists of space agencies. 'Planetary Protection' is preventing microbial contamination of both the target planet and the Earth when sending robots on interplanetary space mission. It is important to preserve the 'natural' conditions of other planets and to not bring with robots 'earthly microbes' (forward contamination) when looking for 'spores of extra terrestrial life'. The Earth and its biosphere must be protected from potential extraterrestrial biological contamination when returning samples of other planets to the Earth (backward contamination).

The NASA–Caltech Laboratory for Planetary Protection of Dr. Kasthuri Venkateswaran at the Jet Propulsion Laboratory (JPL) (California, USA) routinely monitors and characterizes the microbes of NASA spacecraft assembly rooms and space robots prior to flight. They have repeatedly isolated *Cupriavidus* and *Ralstonia* strains *pre-flight* from spacecraft assembly rooms (floor and air) and surfaces of space robots such as the Mars Odyssey Orbiter (La Duc *et al.,* 2003). *Cupriavidus* and *Ralstonia* strains have also been found *in-flight*, in ISS cooling water and Shuttle drinking water (Venkateswaran *et al.,* Pyle *et al*., Ott *et al.*, all unpublished).



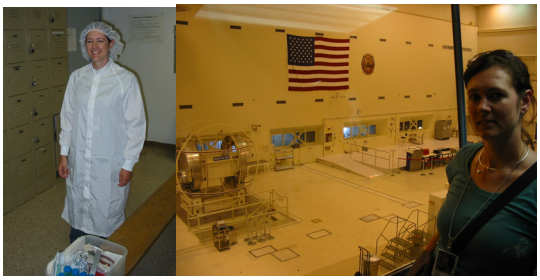
The NASA Mars Odyssey Orbiter, from which surface a cleaning resistant Ralstonia pickettii strain 31V3 was isolated after the robot had undergone aseptic assembly and severe cleaning prior to flight.



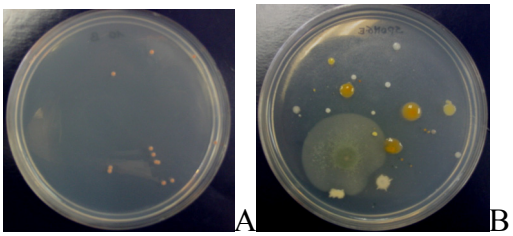
Aseptic integration of the NASA Mars Rover Spirit in the Payload Hazardous Servicing Facility (PHSF), Kennedy Space Center, Florida, USA. From the air taken in the north east corner of the PHSF a cleaning resistant Cupriavidus metallidurans strain NE12 was isolated.

Objectives

The main objective of this study is to characterise the *Cupriavidus* and *Ralstonia* strains isolated at JPL and compare them to the *Cupriavidus metallidurans* CH34^{T} model strain, isolated from a Belgian contaminated soil and studied since 25 years at SCK•CEN and to enhance our knowledge by performing additional tests at JPL and gathering information regarding the environmental conditions and the cleaning and isolation methods used in such spacecraft assembling facilities.



The Spacecraft Assembly Facility (SAF) at Jet Propulsion Laboratory, (Pasadena, California, USA) where space robots are build and tested and the 'dress code' for all personnel entering this facility.



Some microbes isolated from (A) the floor and (B) the air of Spacecraft Assembly Facility (SAF) at Jet Propulsion Laboratory, (Pasadena, California, USA).

Principal results

We showed that these *Cupriavidus* and *Ralstonia* 'space' isolates have accumulated an extraordinary variety of resistances to physical and chemical antimicrobial cleaning agents such as UV-irradiation, heavy metals, organic solvents (ethanol, acetone), organic acids, halogens (iodine), oxidizing reagents (hydrogen peroxide), quaternary ammonium compounds, surfactants, antibiotics, etc. Some of them are able to form biofilms, i.e. attached organized layers of microbial cells, on plastic and metal materials used for space robots. Some of these resistances were encoded in 'mobile' DNA fragments (plasmids), i.e. pieces of DNA that can be passed on from one bacterium to another. This suggests that these 'resistances' have been collected from other bacterial cells over time and can be passed on to the next generation or neighbours.

This bacterial survival strategy, to accumulate a whole variety of moderate resistances in stead of being resistant to only one specific environmental parameter to the extreme, is certainly an advantage to survive different 'life-threatening' acute and chronically stresses in harsh and constantly changing man-made environments such as clean rooms. Similar, multi-resistant bacteria survive also in ultra clean hospitals.

Future work

The further study and characterization of such 'cleaning resistant' β-Proteobacteria is of importance to improve contamination prevention, monitoring and disinfection tools for the future. These results could also be applicable to a hospital environment

It is difficult to predict whether such cleaning resistant bacteria, going to space stowed away in a space robot, would be able to survive the trip (space vacuum, cosmic radiation, cold temperature, etc.). And when finally reaching their destination (e.g. Mars), if they would be able to adapt and survive in an extraterrestrial (e.g. Martian) environment. It is even more difficult to predict, what the impact of such alien microbe could be on the planet environment.

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Main reference

Leys N., Dams A., Coninx I., Bossus A., Provoost A., Mergeay M., Venkateswaran K. (2005) *Comparison of strains isolated from an American space craft assembling clean room with environmental metal resistant strains.* Poster presentation, 3rd International Workshop on Space Microbiology (SM2005), 22-25 May 2005, Mol, Belgium.