Only published data was used to produce the data plots.

To-face interviews around the U.S. and Germany (six months in DLR).

Publications including journal papers, conference proceedings, book volumes.

During the last four years, a literature review of over 400 (and counting) publications including journal papers, conference proceedings, book volumes on gravitational microbiology was conducted to identify which spaceflights carried bacterial experiments along with their respective testing details and findings. Experiments conducted in free-flying satellites, human spacecraft and space stations, and even onboard orbiting rocket stages, were considered. The ultimate objective of this investigation is to map how knowledge has evolved in this field. The compiled data include the bacterial species and strains that have been used as model organisms, protocols and data acquisition methods, results, conclusions, and new hypotheses formulated, as applicable. With few exceptions, the information was acquired directly from original source publications. This analysis also outlines how theories on spaceflight bacterial growth and antibiotic effectiveness have evolved during this half-century of space research. These statistical data and discussions will help researchers plan better future experiments and to more readily find applicable references. During the first two decades, the majority of bacterial space research was conducted by Soviet scientists. US research also began in this timeframe and additional international cooperation later allowed other countries to enter this research field, notably France and Germany. Some of the highlights of this analysis show that forty-four different bacterial species have been flown to space during the 171 experiments conducted onboard ~100 missions. Although P. aeruginosa and B. subtilis have been heavily used, E. coli is the species utilized the most as a model organism, and has been flown in over 50 individual experiments.

Rationale for this Investigation

When I started planning my Ph.D. work in gravitational microbiology, in spite of numerous thorough review papers available, no straightforward, concise answers to the following key questions were found:

1. What bacterial species and strains have been used as research models in space?
2. What antibiotics have been assessed in spaceflight and what antibiotics effectiveness?
3. During the 1960’s most of the spaceflight bacterial research was focused on macrophages and lysogeny. Thus far 23 antibiotic assessments in space have been identified.
4. Since 2005 there has been a boom in spaceflight bacterial research thanks to the ISS

Conclusions

1. The most commonly used bacterial models are E. coli (ATCC® 25922 and ATCC® 10536) and P. aeruginosa (ATCC® 27853)
2. At least ten antibiotic classes have been assessed in space. The most commonly used is Gentamicin
3. During the 1960’s most of the spaceflight bacterial research was focused on macrophages and lysogeny
4. Since 2005 there has been a boom in spaceflight bacterial research thanks to the ISS

Acknowledgements

Thank you to Dr. Gerda Horneck and Dr. Ralf Möller at the German Aerospace Center for the insightful conversations.

References

From the 400+ publications reviewed, over 100 have been used as references for this investigation. Proper referencing is impractical in this poster and therefore only certain key review papers are cited.


The First Fifty Years of Bacterial Growth and Antibiotic Effectiveness Research in Space

Luis Zea, Louis Stodieck, David M. Klaus, BioServe Space Technologies – University of Colorado, Boulder

American Society for Gravitational and Space Research (ASGSR) Conference, Pasadena, CA October 22-26 2014

Abstract

From the USSR’s launch of Korabl-Sputnik 2 in 1960 through 2010, numerous studies on bacterial proliferation and antibiotic effectiveness were conducted in space. A literature review of over 400 publications and international databases was conducted to identify which spaceflights carried bacterial experiments along with their respective testing details and findings. Experiments conducted in free-flying satellites, human spacecraft and space stations, and even onboard orbiting rocket stages, were considered. The ultimate objective of this investigation is to map how knowledge has evolved in this field. The compiled data include the bacterial species and strains that have been used as model organisms, protocols and data acquisition methods, results, conclusions, and new hypotheses formulated, as applicable. With few exceptions, the information was acquired directly from original source publications. This analysis also outlines how theories on spaceflight bacterial growth and antibiotic effectiveness have evolved during this half-century of space research. These statistical data and discussions will help researchers plan better future experiments and to more readily find applicable references. During the first two decades, the majority of bacterial space research was conducted by Soviet scientists. US research also began in this timeframe and additional international cooperation later allowed other countries to enter this research field, notably France and Germany. Some of the highlights of this analysis show that forty-four different bacterial species have been flown to space during the 171 experiments conducted onboard ~100 missions. Although P. aeruginosa and B. subtilis have been heavily used, E. coli is the species utilized the most as a model organism, and has been flown in over 50 individual experiments.

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