

**When germs fly:
What isolates collected from pre-launch
spacecraft can tell us about planetary
protection challenges**

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If the Mars rover finds water, it could be H₂ ... uh oh!

If Curiosity locates H₂O, a simmering NASA controversy will boil over. The rover's drill bits may be tainted with Earth microbes that could survive upon touching water.



By Louis Sahagun, Los Angeles Times *September 9, 2012*

Basic Questions

- Can organisms from Earth survive the trip to Mars?
 - Heat, desiccation, radiation, lack of nutrients
- Can organisms from Earth survive and grow in a Martian atmosphere?
 - Basic necessities for life
 - Limits of life (PP vs. Astrobiology)
 - Potential energy sources
 - Subsurface protection
 - Other considerations (ex. atmospheric pressure)
- What is on our spacecraft?
 - ID
 - Resistance/Survivability
 - Persistence
 - Human impacts

NASA Standard Assay:

- Swabs used to collect samples
- Placed into water and sonicated
- Heat shocked at 80°C for 15 minutes
 - Exception: Viking
- Plated onto Tryptic Soy Agar (TSA) and incubated for 3 days at 32°C
- Colony counts

Limitations:

- Liberation of organisms from swabs
- Selection of organisms
 - Heat resistant
 - TSA / 3 days / 32° C



Sampling of the MSL heat-shield blanket. Photo
Credit: NASA PHOTO NO: KSC-2011-7321

Project Tasks



Viking Landers



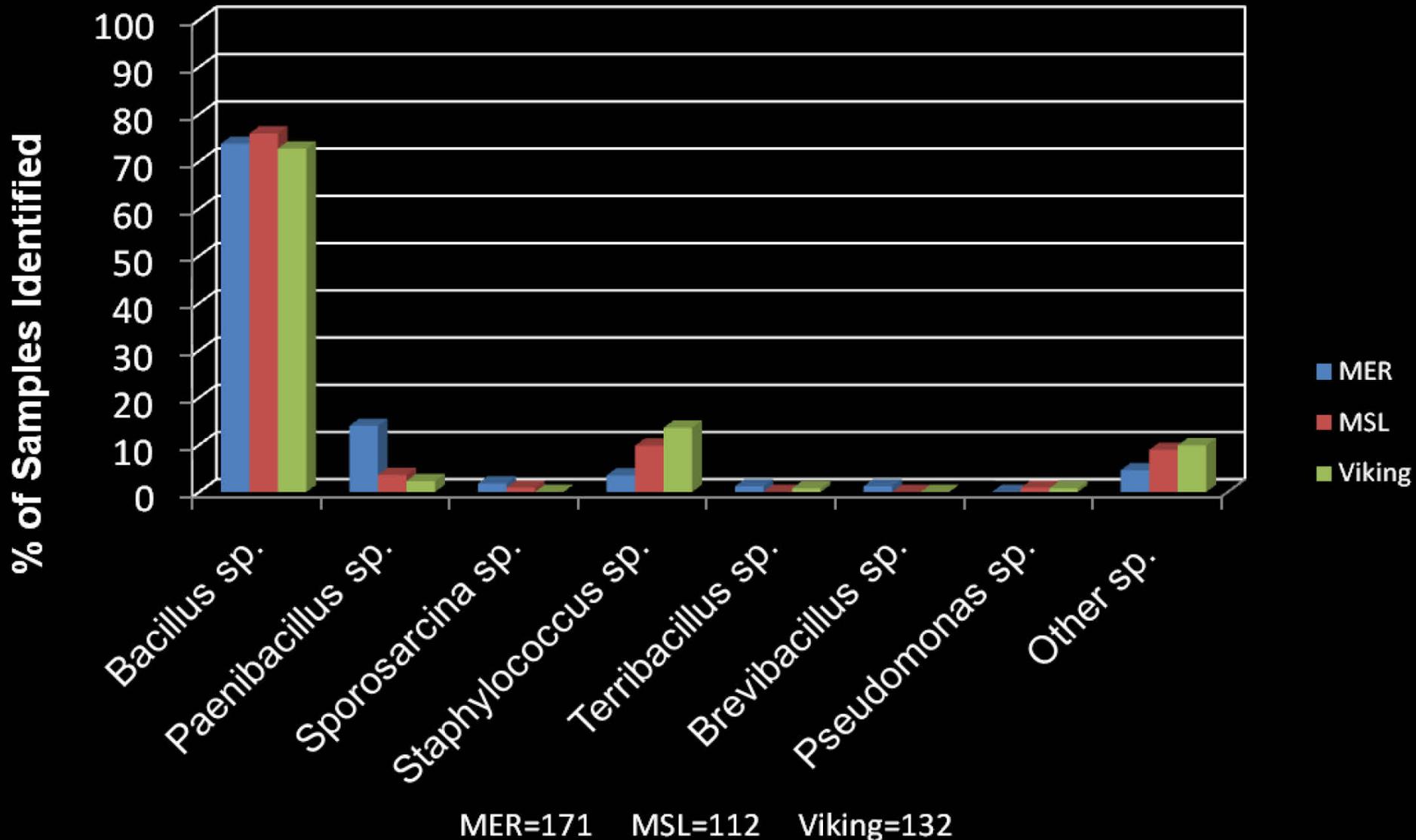
Curiosity

- Identify isolates
- Survival
 - Aerobic growth
 - Anaerobic growth
 - Desiccation
 - Radiation
- Whole genome sequencing
- Proteomics
- Biochemical ID and database (Biolog)

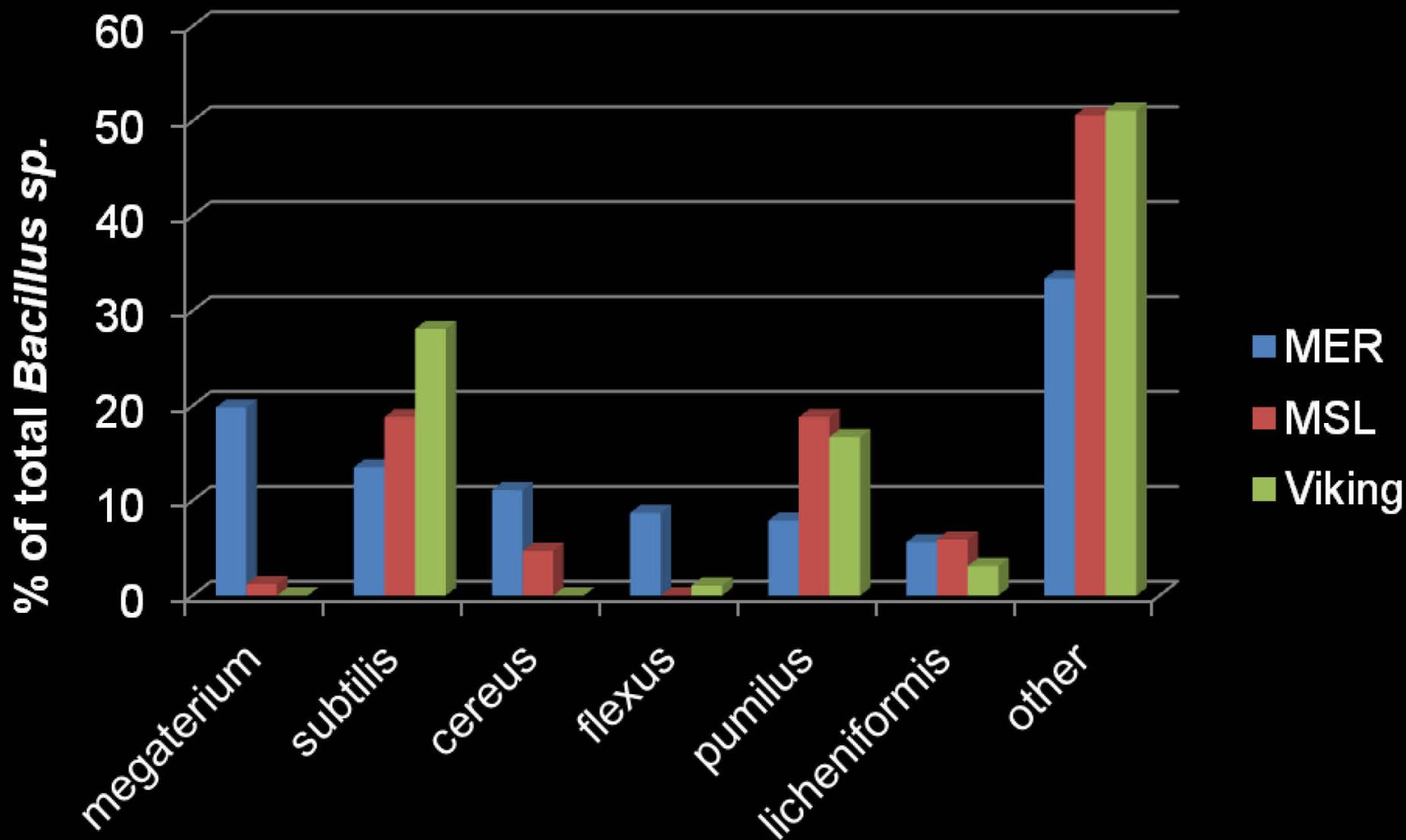


Mars Exploration Rovers- Spirit and Opportunity

Comparison of Isolates by Spacecraft



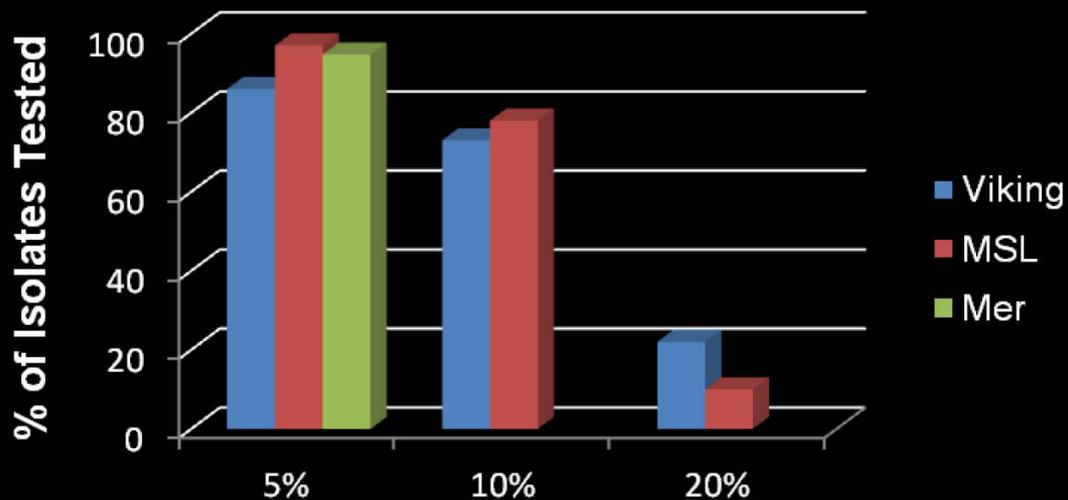
Comparison of *Bacillus sp.* by Spacecraft



Non-Spore Forming Isolates

Closest Relative	Spacecraft	NaCl			4° C	pH			H ₂ O ₂
		5%	10%	20%		7	8	9	
<i>Acinetobacter sp.</i>	MSL	+	+	-	+	+	+	+	+
<i>Agrococcus citreus</i>	Viking	+	-	-	+	+	+	+	N/A
<i>Brevibacterium frigoritolerans</i>	MSL	+	+	-	+	+	-	-	-
<i>Brevibacterium frigoritolerans</i>	MSL	+	+	+	+	+	+	+	-
<i>Brevibacterium casei</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Corynebacterium singulare</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Leclercia adecarboxylata</i> (3)	MSL	+	+	-	+	+	+	+	-
<i>Micrococcus luteus</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Micrococcus yunnanensis</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Staphylococcus warneri</i> (2)	MSL	+	+	-	+	+	-	-	-
<i>Staphylococcus warneri</i> (3)	MSL	+	+	+	-	+	+	+	-
<i>Staphylococcus hominis</i>	MSL	+	+	-	-	+	+	+	-
<i>Staphylococcus hominis</i>	MSL	+	+	+	-	+	+	-	+
<i>Staphylococcus hominis</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Staphylococcus epidermidis</i>	MSL	+	+	+	+	+	+	-	+
<i>Staphylococcus epidermidis</i>	Viking	+	+	-	-	+	+	+	N/A
<i>Staphylococcus sp.</i> (2)	Viking	+	+	+	-	+	+	+	N/A

NaCl Tolerance



Viking Landers

9.8% grew at 4° C

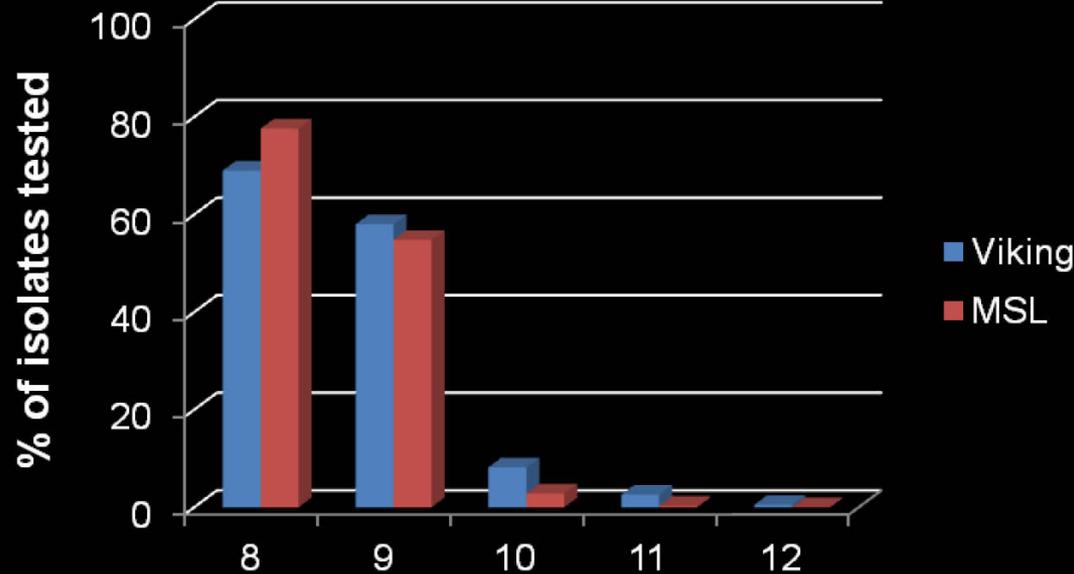
54% Survived desiccation

MSL

35% grew at 4° C

67% Survived desiccation

pH Tolerance



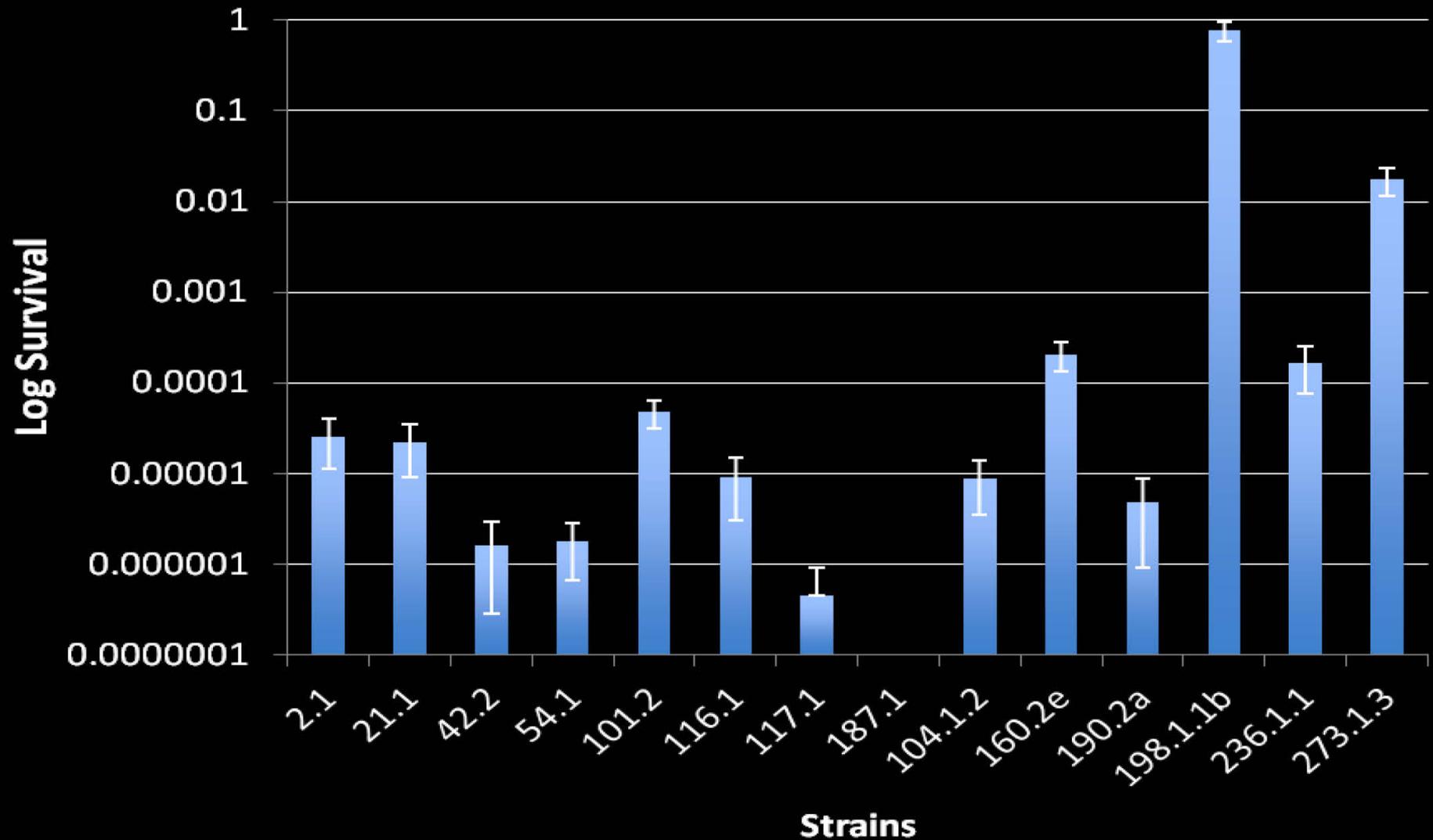
MER

20% grew in media with

8% NaCl

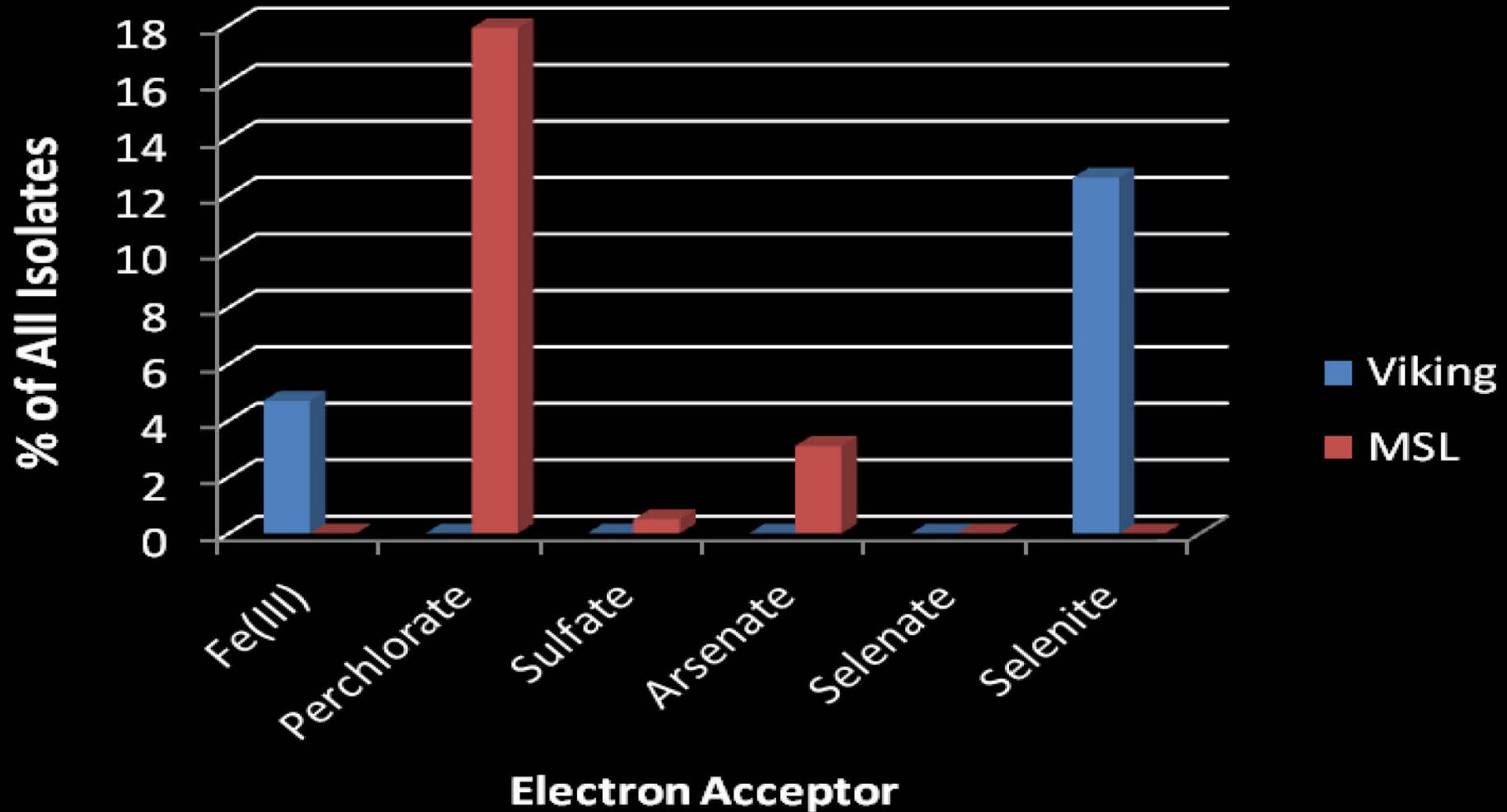
Preliminary UV Results (MSL)

100J/m² UV-C



Anaerobic Growth Results

Anaerobic Growth



Isolates of Special Interest

- **MSL**

236.1.1– sulfate, 20% NaCl, 5% H₂O₂, pH10

- **Viking**

Isolate	NaCl	pH	Fe(III)	Se(IV)
LA 124	20%	9	+	+
LA 148	10%	9	-	+
LA 374	10%	9	+	-
LB 130b	10%	9	-	+
OA 247	10%	7	+	+
OA 267	10%	9	+	+
OB 252	20%	9	+	-

Conclusions

➤ Data provides basic needed information

- What is in the archive
- Bolsters knowledge of organisms on spacecraft
- Resistance / Survivability
- Characterization of life in simulated conditions
- Growth under multiple extreme conditions
- Development of rapid biochemical ID
- Collaborations for scientific study and relevance

➤ Research currently underway

- Complete examination of the archive (including proteomics, genome)
- Populate database of archived isolates
- Collaboration with ESA - novel isolates

➤ Future goals

- Determine maximum resistance / survivability
- Further explore anaerobic growth mechanisms
- Application of results (spacecraft sterilization, forward contamination)

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