
W. Gabriel

From Extreme Biology to Real-World Impact: Bioprospecting, Innovation, and Undergraduate Training

Ms. Josephine Walton and Prof. Thomas Boothby

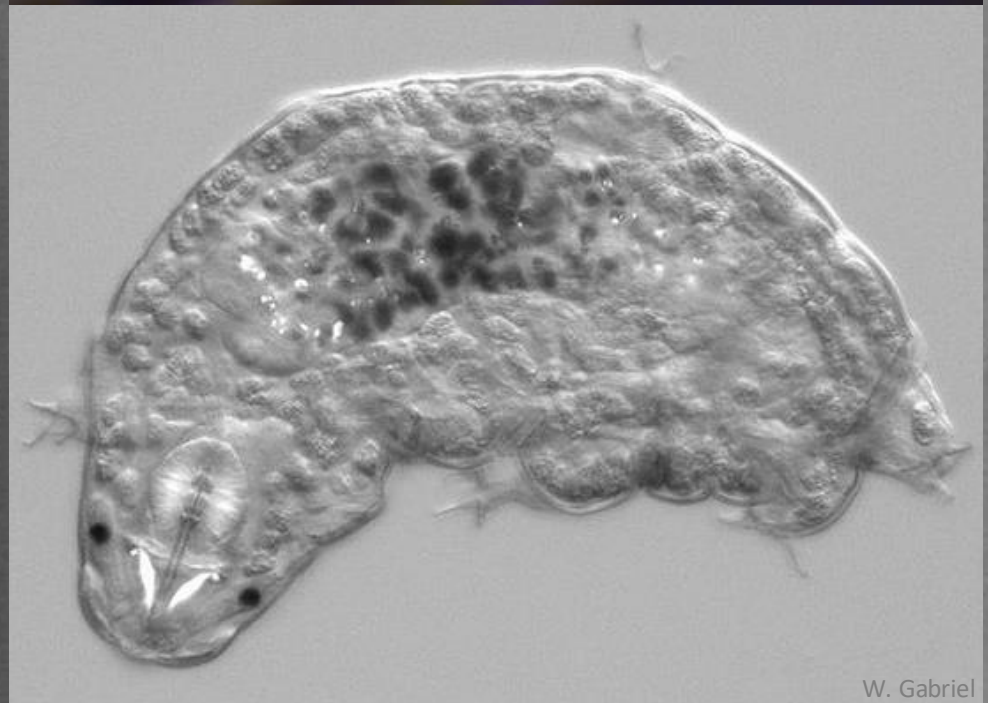
Department of Molecular Biology – University of Wyoming



How do organisms tolerate extreme conditions?



What's a tardigrade?




H. Hines

Tardigrades are extreme survivors:

Extremes in temperature (-272^{o}C to +151^{o}C)

Little or no oxygen

Intense ionizing radiation (>10,000 Gy)

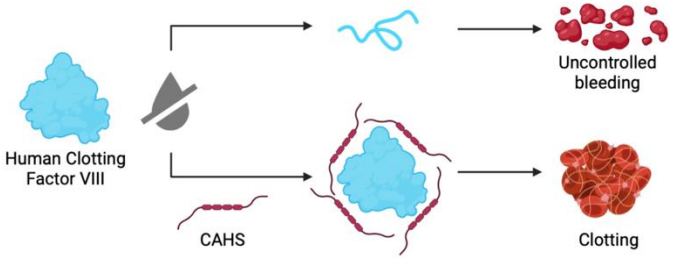
Extremes in pressure (vacuum of space)

Near complete desiccation (~1-2.5% water content)

Tardigrades survive desiccation by entering into reversible biostasis

Practical applications of our research

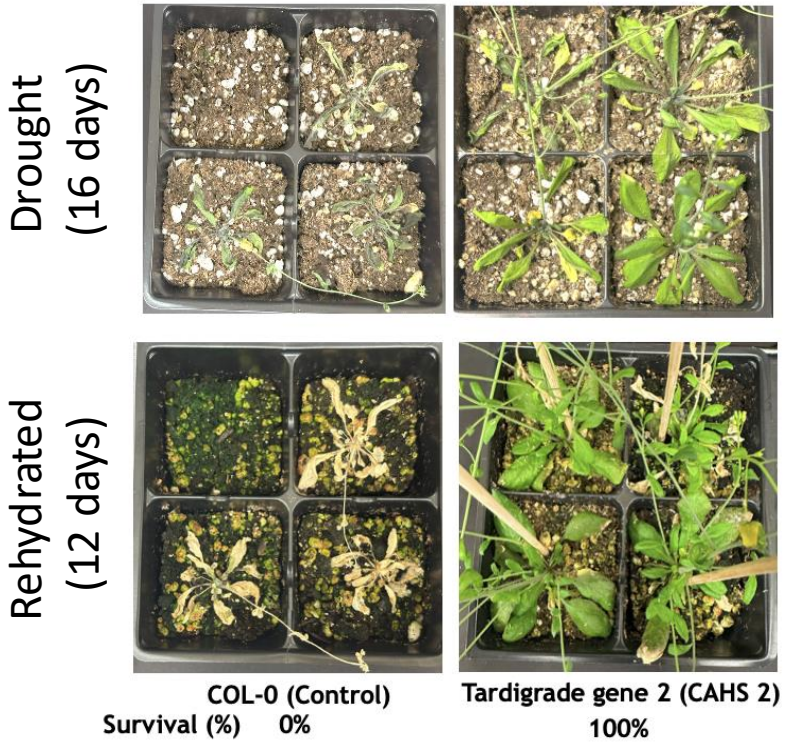
Cold-chain disruption for biomedical materials



SIGMA

CELLPHIRE THERAPEUTICS

Development of stress tolerant plants



NONE of this is possible without trainees

Undergraduate training: approach and philosophy

GENERAL

1 Experiential learning

- MOLB3320
- Undergraduate researchers

2 Independence, responsibility, and accountability

- Students do not work for me; we work together
- Funding
- Intellectual property development

3 Full integration with the scientific community

- Full lab citizens: lab meetings, lab jobs, grant and paper review
- Exposure and integration into the broader scientific community

JOSIE AS A CASE STUDY

Experiential learning:

- Tardigrade microbiome
- Metagenomics of extreme environments (Thermopolis, WY; Tunisia; Namibia)

Independence, responsibility, and accountability

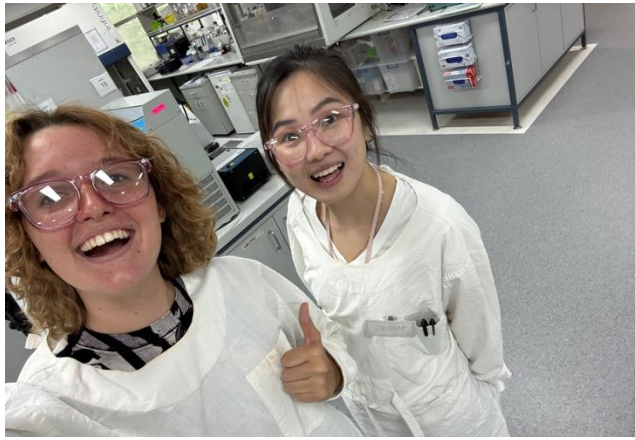
- Wyoming research scholar
- Wyoming NASA space grant undergraduate fellowship
- INBRE transition fellow and summer intern

Full integration with the scientific community

- NASA, Houston, TX, in person
- Women in Stem, Sheridan, WY, in person
- ISER, Houston, Virtual
- University of the Sunshine Coast Research Symposium, in person
- ACUR, Australia, in person
- University of Wyoming Research Symposium and INBRE Conference every year presenting/poster 2023–2026
- Microbiome R&D, San Diego, in person
- **Science Roadshow and Science Kitchen volunteer**

My Journey as a Researcher

- Wyoming → Sheridan College → University of Wyoming
- Geothermal microbiomes → extreme systems
- Mentorship → independent research
- NSF Graduate Research Fellow



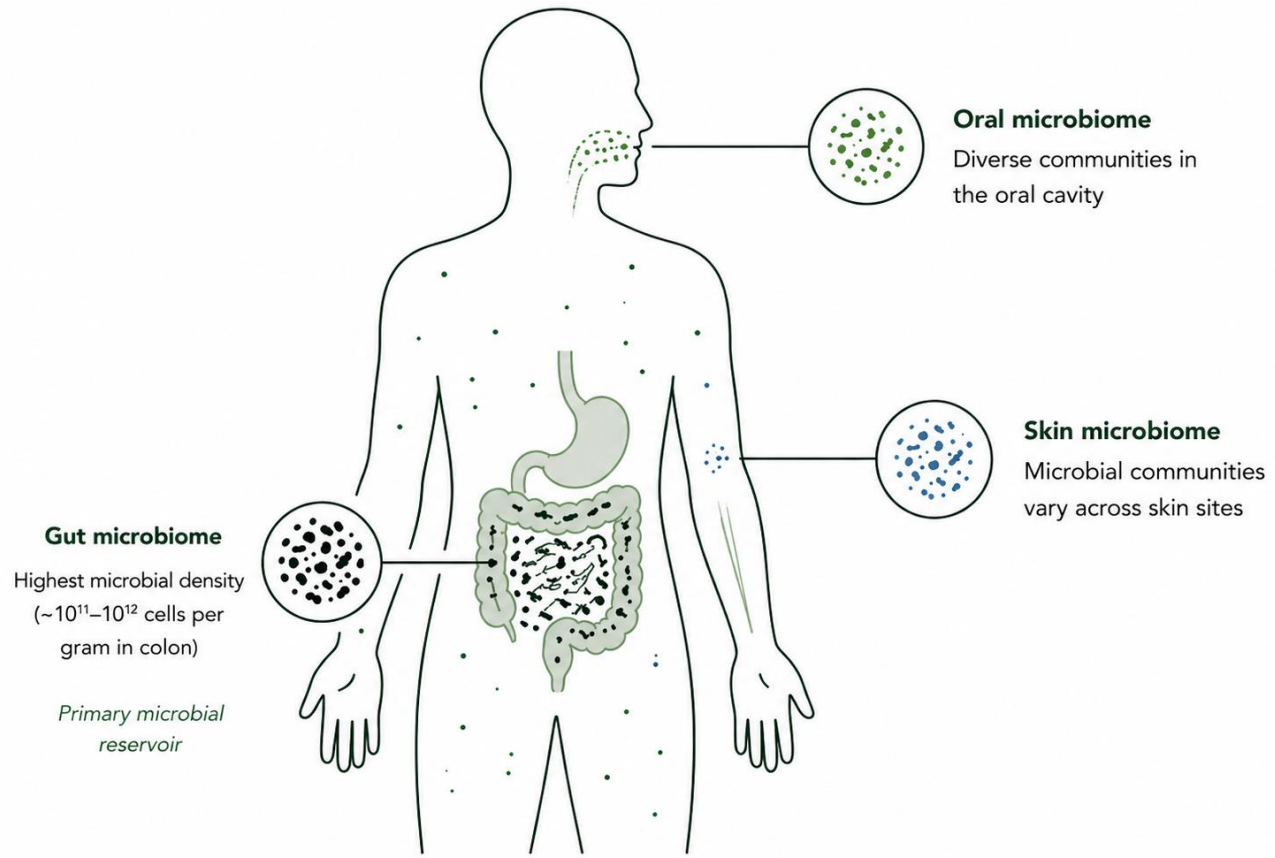
WYOMING NASA SPACE GRANT CONSORTIUM

Wyoming INBRE
IDeA Networks for Biomedical Research Excellence

WYOMING RESEARCH SCHOLARS PROGRAM
UNIVERSITY OF WYOMING

The Human Microbiome

- 10^{13}-10^{14} microbial cells integrated with host biology
- Microbiome regulates metabolism, immunity, and inflammation
- System disruption leads to disease and dysfunction
- Microbial communities shift system stability



If microbes can tune host metabolism, they can plausibly tune stress outcomes.

Expanding How We Study The Tardigrade

- *Ramazzottius varieornatus* – extreme stress tolerant
- Survives desiccation, radiation, vacuum
- Traditionally studied as an isolated organism
- My shift in approach: Going from the organism to a system
- Hypothesis: microbiome contributes to survival and recovery

Why Study the Tardigrade Microbiome?

Microbes contribute to resilience across systems

Host- microbe interactions influence stress response

Potential roles:

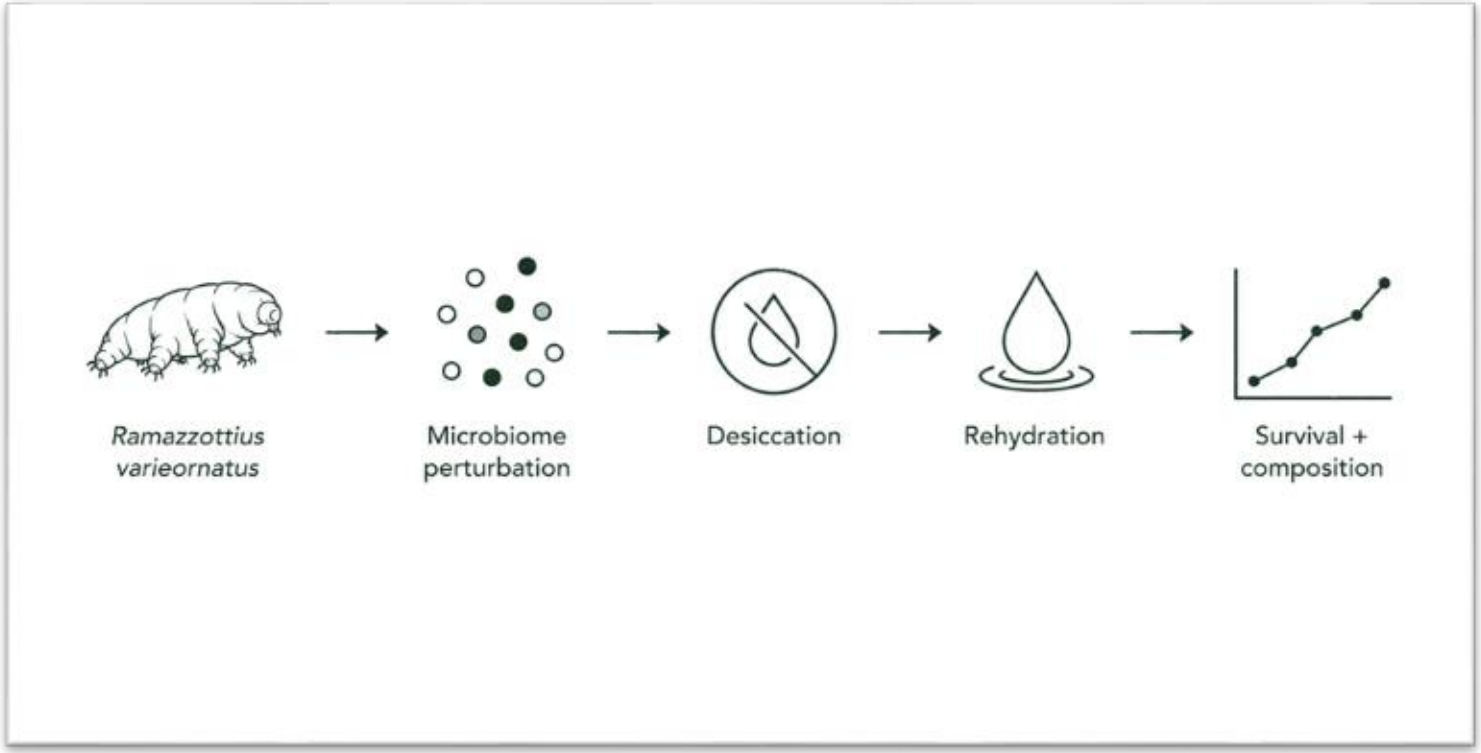
Stress tolerance

Metabolic stability

Recovery dynamics

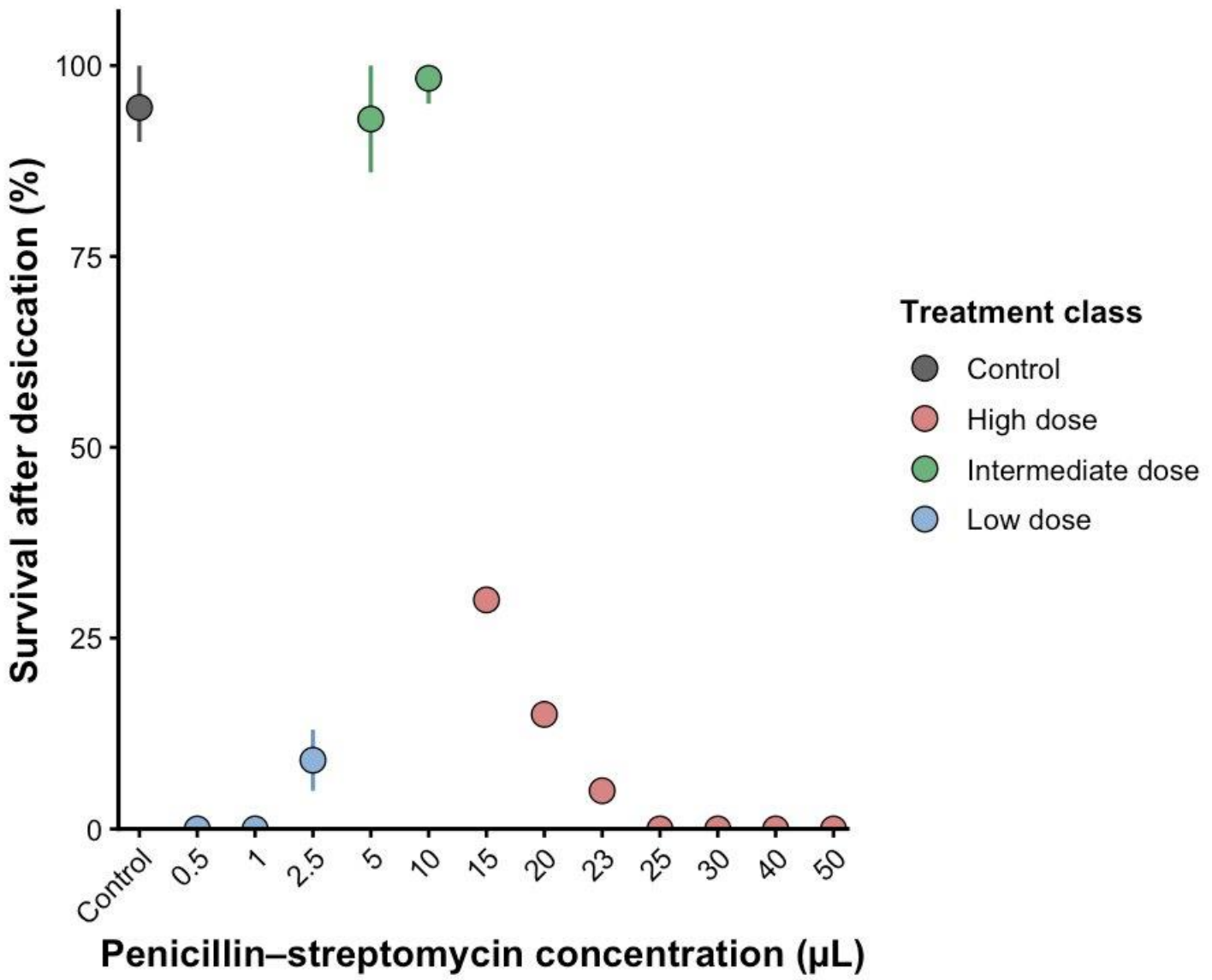
Testing Resilience at the Level of the System

- Perturb microbiome (antibiotic gradient)
- Apply desiccation stress
- Measure recovery over time
- Quantify microbial abundance(qPCR, sequencing)
- Test: How does the system state affect the survival outcome?



Resilience Reflects Interactions

- Survival depends on system state
- Non-linear (U-shaped) response
- Intermediate perturbation leads to high survival (85-100%)
- Low and high perturbation leads to reduced survival (<15%)
- Suggested conclusion: resilience depends on system structure



Building on This Work

Understanding resilience as a systems-level process

Developing independent experimental design and analysis

Recognized through NSF Graduate Research Fellowship

Advancing my work through PhD research in the Boothby Lab at the University of Wyoming

Thank you!

Questions?