The Concomitant Locomotion of the Microorganisms Inhabiting the Marine and Freshwater Niches of Antarctica's South Shetland Islands during the Summer

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Motivation

During the late summer, the author sailed to the Antarctic South Shetland Islands to survey the microorganisms living in marine (tidal pools) and freshwater (moss saturated with snow melt) environmental niches. Equipped with a microscope to take video of samples within hours of collection to capture a pristine condition, we found a dense and diverse ecology that included species with unique patterns of locomotion. The Ocean Tramp cruised for 12 days (beginning January 30, 2019) through 588 nautical miles 677 miles) of the South Shetland Islands, between -62.9 to -65.1 latitude and -60.5 to -64.1 longitude.

Methods

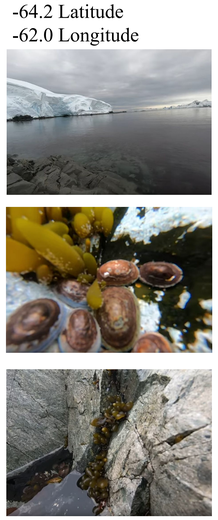
The experimental method included 3 tasks - collect, observe, and identify.

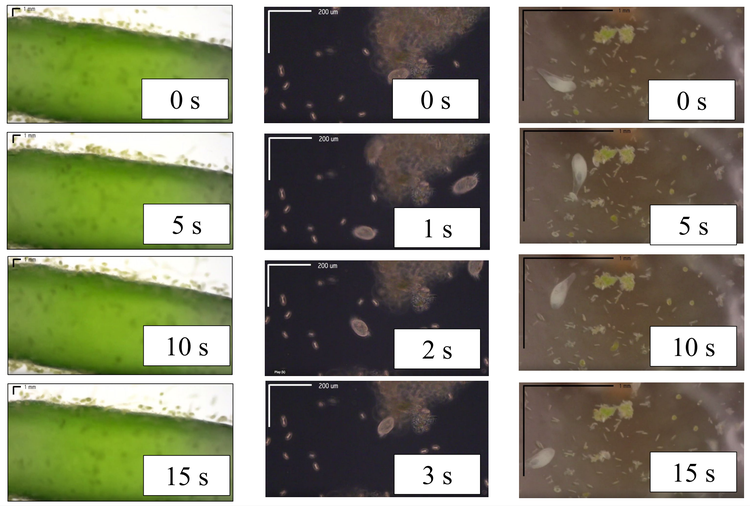
Collect. We collected samples in 6 places - as far northeast as Trinity Island (63.75° S, 60.67°W) and as far southwest as Pleneau Island (65.10° S, 64.06°W) from Jan 31 until Feb 8, 2019. Because Antarctic vegetation grows very slowly (the fastest species grows at a rate of 0.1 mm/year), we minimized disruption of the terrestrial plants by collecting the effluent in the plant, not the plant itself. We selected wet areas, places where melting snow formed streams flowing through moss beds next to rocks, or tide pools adjacent to the water. We gently pressed on the vegetation to release microorganisms nested in the niche and collected the water. To increase the ecological diversity, we also sampled area with evidence of recent bird activity – abandoned nesting sites of Gentoo penguins.

Observe. The vial was then transported back to the boat and inspected using a digital microscope (Dino-Lite Edge AM73915MZT) with variable magnification, the view window could be as large as >1.0 cm or as small as 1.0 mm to detect artefacts as small as 100mm.

Tide Pool Results: Swarm, Swim, Slide

Enterprise Island
-64.2 Latitude
-62.0 Longitude

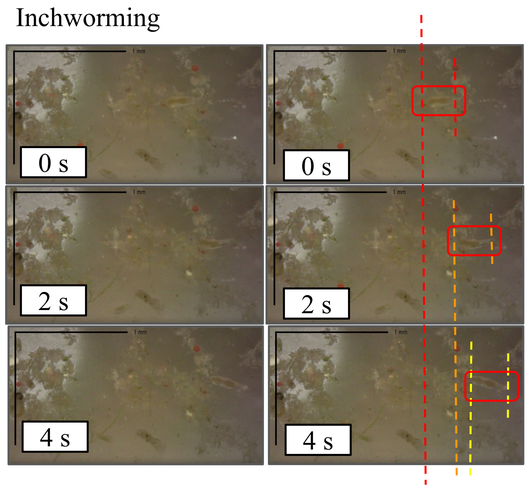




Moss Bed Results: Crawling and Inchworming

These samples were less diverse than the tidal pools. Terrestrial arthropods swept into the sample writhed uncomfortably when submerged in the water. Few rotifers were observed.

Challenger Island
-64.3 Latitude | -61.6 Longitude



Conclusions for Mission Design

Solving the evolutionary cat-and-mouse game between the organisms using their propulsion mechanisms could provide new insight into the ecological pressure on evolution. The broader impact of such findings could help the community ask – are we searching for life in the universe or ecosystems?

12.3 Mechanical Systems 12.3.3 Electro-Mechanical, Mechanical, and Micromechanisms	**12.3.3.1 Robotic Assembly Tools / Interfaces**
TECHNOLOGY	
Technology Description: Tools for robotic assets to cut, grasp, and turn for assembly and maintenance of structures.	
Technology Challenge: Complexity and sheer number of systems required for the wide array of tools and systems needed.	
Technology State of the Art: Multitudes of items have flown and are in development currently. Many are still required.	**Technology Performance Goal:** Complete development and testing of tools or interfaces allowing increased complexity of tasks.
Parameter, Value: Complexity of the task: currently able to complete simple tasks. **TRL** 2	**Parameter, Value:** Increase the complexity of tasks. **TRL** 6
Technology Development Dependent Upon Basic Research or Other Technology Candidate: None	

7.2 Sustainability and Supportability 7.2.4 Food Production, Processing, and Preservation	**7.2.4.1 Bioregenerative Food System**
TECHNOLOGY	
Technology Description: A food system that grows plants and stores until use.	
Technology Challenge: A food system that is safe, nutritious, and acceptable is not available for all Design Reference Missions (DRMs) due to shelf life and delivery limitations.	
Technology State of the Art: A portable pop-up greenhouse was taken to the International Space Station (ISS) in April. The system will grow lettuces to prove system concept; however, the vegetables will be flown to ground for testing to determine if they are safe to eat.	**Technology Performance Goal:** Development of a bioregenerative food system that meets the requirements for ingredient functionality/nutrition, bulk storage, equipment, processing and preparation procedures, and resource use.
Parameter, Value: Percentage of crew food intake derived from foods grown onboard: 0%. **TRL** 5	**Parameter, Value:** Percentage of crew food intake derived from foods grown onboard: > 10% **TRL** 6
Technology Development Dependent Upon Basic Research or Other Technology Candidate: The kinetics of vitamin losses through processing and storage of the food items and the amount of remaining nutrition at the end of five years is unknown. The effect of ingredient interactions and food matrices on nutrient stability in the food system is also unknown.	

https://www.nasa.gov/offices/oct/home/roadmaps/index.html

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