Fiscal Year:	FY 2020	**Task Last Updated:**	FY 04/17/2021
PI Name:	Wang, Zheng Ph.D.		
Project Title:	Investigating the Roles of Melanin and DNA Repair on Adaptation and Survivability of Fungi in Deep Space		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:	United States Naval Research Laboratory	**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Cell & Molecular Biology (2) Microbiology		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Washington	**State:**	DC
Zip Code:	20375-0001	**Congressional District:**	1
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	2018 Space Biology (ROSBio) NNH18ZTT001N-Artemis1 (EM1). App A: Orion (Artemis-1) (formerly Exploration Mission-1)
Start Date:	07/15/2019	**End Date:**	07/15/2022
No. of Post Docs:	2	**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA KSC
Contact Monitor:	Freeland, Denise	**Contact Phone:**	321-867-5878
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	NOTE: Jilliam Romsdahl, Ph.D., was added as CoInvestigator.		
COI Name (Institution):	Schultzhaus, Zachary Ph.D. (Naval Research Laboratory) Romsdahl, Jillian Ph.D. (Naval Research Laboratory)		
Grant/Contract No.:	NNK19OB09A IAA		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Spaceflight to regions beyond low Earth orbit involves exposure to unique environmental hazards, most notably radiation. Humans traveling to these regions will be exposed to radiation from cosmic rays, which will cause DNA damage and oxidative stress. The extent of this damage, however, is unknown, and more basic research into the genetic effects of combined cosmic ray and microgravity exposure is needed. We propose to study these effects using a type of organism that is almost certain to inadvertently accompany astronauts on all of their flights – fungi. Fungi are remarkably stress-resistant and have been isolated several times from spacecraft. The objective of this proposal is to use the well-studied mold Aspergillus nidulans to test two mechanisms for space adaptation – DNA repair and the production of melanin. Mutants of this organism that cannot make melanin or are defective in a type of DNA repair associated with recovering from radiation will be used. When the samples return, the spores that these strains produce will be tested for their survival, and their protein and DNA will be analyzed to find molecular signatures of adaptation to deep space. The data we collect will tell us several things: whether melanin protects from the stresses faced during spaceflight, the types of DNA damage that occur in space, and what changes occur in fungi when they are adapted to prolonged spaceflight. The results will determine characteristics of the fungi that astronauts may have to control on future missions, including pathogenic species. Because fungi share many proteins with humans, the data collected on the proteins involved in adaptation can be applicable to astronaut health. Finally, determining whether melanin assists with survival in space will provide more evidence for it to be used as a protective material for several future NASA applications.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project focuses on the tools that fungi use to be resilient against stress. In this case, the stress of deep space, which consists of a unique composition of radiation and microgravity that has rarely, if ever, been experienced by humans. However, taking astronauts to locations in space far beyond the protection of Earth's atmosphere are aspirations of all space programs, and the stress that is associated with deep space radiation exposure (for instance, free-radical damage) overlaps in many of its biological effects with more routine stresses faced on Earth. Fungi, which thrive in extreme environments such as space, and possess a genetic makeup that is similar to humans but also much simpler, are also an ideal group of organisms for understanding and combating radiation and other stresses. This project addresses two components of stress resistance in the fungus Aspergillus niger – the production of melanin and DNA repair proteins, to determine the extent and nature of their importance in survival, adaptation, and damage protection during an extended flight in deep space. The data collected from the Artemis flight will inform our understanding of how cells and organisms resist, or can be made to resist, the stress of space and other damaging environments.
Task Progress:	Reporting as of May 16, 2020 (Ed. note: received April 2021) This project initiated in FY2020 so much of the work accomplished was focused on obtaining and verifying experimental components in preparation to run validation tests of the entire flight. The components that were prepared included: - We developed strains of the fungus Aspergillus niger in which the genes uvsC, nkuA, and fwnA were deleted, through standard mutagenesis protocols - The resistance of these mutants, as well as the parental strain, to UV-C light, and gamma radiation, were measured - Initial growth experiments were performed using the specific medium and the apparatus (50 mL centrifuge tubes) to be used on the actual flight, to determine the kinetics of medium depletion, the rate of production of spores in this medium, and the ease at which to collect cells for biomolecule extraction after a growth period similar to that expected on the flight (~60 d) - Processing of tissue samples from the Science Validation Test, including the measurement of spore survival after a 60 d test experiment, and extraction and quantification of proteins, DNA, RNA, and metabolites from biomass collected from the spores and tissue grown during the experiment, after removing the tissue from the medium through centrifugation and freeze-drying - One publication is in preparation and three presentations were completed in this first fiscal year.
Bibliography Type:	Description: (Last Updated: 06/06/2023)