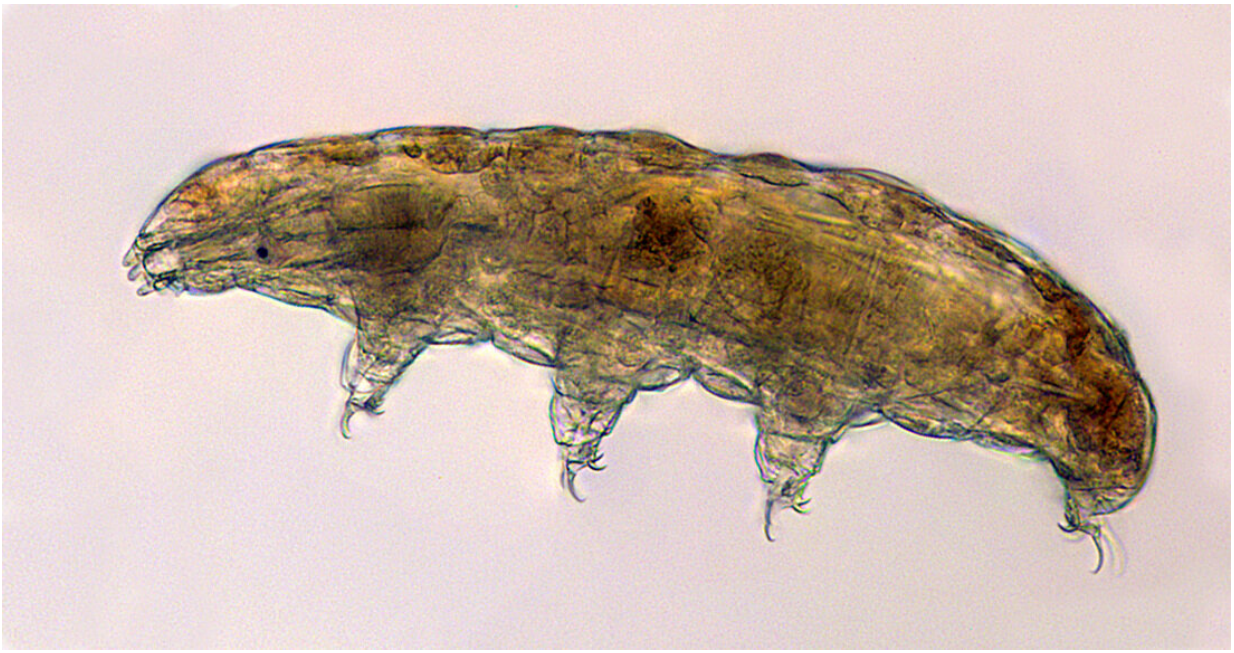
SpaceX CRS-22 mission to space station launches water bears, squid, solar panels

May 28 2021, by Melissa Gaskill



Cell Science-04 flies tardigrades, or water bears, to the space station for a study seeking to identify the genes involved in its adaptation and survival in high stress environments. Credit: Thomas Boothby, University of Wyoming

The 22nd SpaceX cargo resupply mission carrying scientific research and technology demonstrations launches to the International Space Station from NASA's Kennedy Space Center in Florida no earlier than June 3. Experiments aboard include studying how water bears tolerate space, whether microgravity affects symbiotic relationships, analyzing

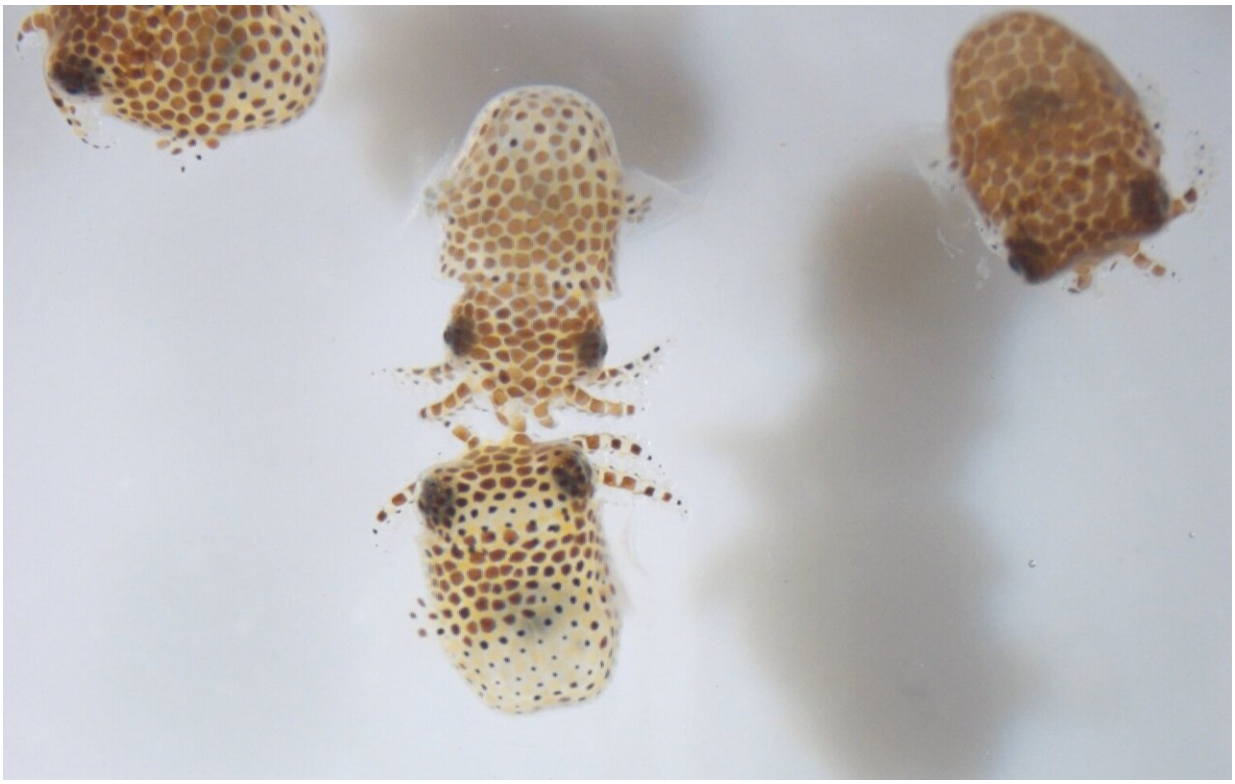
the formation of kidney stones, and more.

Highlights of the payloads on this resupply mission include:

Water bears take on space

Tardigrades, known as water bears due to their appearance under a microscope and common habitat in water, are tiny creatures that tolerate environments more extreme than most life forms can. That makes them a model organism for studying biological survival under extreme conditions on Earth and in space. In addition, researchers have sequenced the genome of the tardigrade Hypsibius exemplaris and developed methods for measuring how different environmental conditions affect tardigrade gene expression. Cell Science-04 characterizes the molecular biology of short-term and multigenerational survival of water bears, identifying the genes involved in adaptation and survival in high stress environments.

The results could advance understanding of the stress factors affecting humans in space and support development of countermeasures. "Spaceflight can be a really challenging environment for organisms, including humans, who have evolved to the conditions on Earth," says principal investigator Thomas Boothby. "One of the things we are really keen to do is understand how tardigrades are surviving and reproducing in these environments and whether we can learn anything about the tricks that they are using and adapt them to safeguard astronauts."



These immature bobtail squid (Euprymna scolopes) are part of UMAMI, an investigation that examines whether space alters the symbiotic relationship between the squid and the bacterium Vibrio fischeri. Credit: Jamie S. Foster, University of Florida

Symbiotic squid and microbes in microgravity

UMAMI examines the effects of spaceflight on the molecular and chemical interactions between beneficial microbes and their animal hosts. Microbes play a significant role in the normal development of animal tissues and in maintaining human health. "Animals, including humans, rely on our microbes to maintain a healthy digestive and immune system," says UMAMI principal investigator Jamie Foster. "We do not fully understand how spaceflight alters these beneficial interactions. The UMAMI experiment uses a glow-in-the-dark bobtail

squid to address these important issues in animal health."

The bobtail squid, Euprymna scolopes, is an animal model that is used to study symbiotic relationships between two species. This investigation helps determine whether spaceflight alters the mutually beneficial relationship, which could support development of protective measures and mitigation to preserve astronaut health on long-duration space missions. The work also could lead to a better understanding of the complex interactions between animals and beneficial microbes, including new and novel pathways that microbes use to communicate with animal tissues. Such knowledge could help identify ways to protect and enhance these relationships for better human health and well-being on Earth as well.

On-the-spot ultrasound

Butterfly IQ Ultrasound demonstrates use of a portable ultrasound in conjunction with a mobile computing device in microgravity. The investigation collects crew feedback on ease of handling and quality of the ultrasound images, including image acquisition, display, and storage.

"This type of commercial off-the-shelf technology could provide important medical capabilities for future exploration missions beyond low-Earth orbit, where immediate ground support is not available," says Kadambari Suri, integration manager for the Butterfly iQ Technology Demonstration "The investigation also examines how effective just-in-time instructions are for autonomous use of the device by the crew." The technology also has potential applications for medical care in remote and isolated settings on Earth.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A cotton seedling for the TICTOC investigation prepared for flight. TICTOC studies how root system structure affects cotton plant resilience, water-use efficiency, and carbon sequestration during the critical phase of seedling establishment. Credit: Simon Gilroy, University of Wisconsin-Madison

Developing better robot drivers

Pilote, an investigation from the ESA (European Space Agency) and the Centre National d'Etudes Spatiales (CNES), tests the effectiveness of remote operation of robotic arms and space vehicles using virtual reality and interfaces based on haptics, or simulated touch and motion. Testing of the ergonomics for controlling robotic arms and spacecraft must be performed in microgravity, because designs from Earth-based testing would use ergonomic principles that do not fit conditions experienced on a spacecraft in orbit. Pilote compares existing and new technologies, including those recently developed for teleoperation and others used to pilot the Canadarm2 and Soyuz spacecraft. The investigation also compares astronaut performance on the ground and during long-duration space missions. Results could help optimize the ergonomics of workstations on the space station and future space vehicles for missions to the Moon and Mars.

Protecting kidneys in space and on Earth

Some crew members exhibit an increased susceptibility to kidney stones during flight, which could affect their health and the success of the mission. The Kidney Cells-02 investigation uses a 3-D kidney cell model (or tissue chip) to study the effects of microgravity on the formation of microcrystals that can lead to kidney stones. It is part of the Tissue Chips

in Space initiative, a partnership between the ISS U.S. National Laboratory and the National Institutes of Health's National Center for Advancing Translational Sciences (NCATS) to analyze the effects of microgravity on human health and translate that to improvements on Earth. This investigation could reveal critical pathways of kidney disease development and progression, potentially leading to therapies to treat and prevent kidney stones for astronauts and for the 1 in 10 people on Earth who develop them.

"With this study, we hope to identify biomarkers or 'signatures' of cellular changes that occur during the formation of kidney stones," says principal investigator Ed Kelly. "This may lead to novel therapeutic interventions. The rationale for conducting this study on the space station is that the microcrystals behave in a manner like what happens in our own kidneys, meaning they stay suspended in the kidney chip tubes and do not sink to the bottom, like they do in labs on Earth."

Producing tougher cotton

Cotton plants that overexpress a certain gene show increased resistance to stressors, such as drought, and yield 20% more cotton fiber than plants without that characteristic under certain stress conditions. This stress resistance has been tentatively linked to having an enhanced root system that can tap into a larger volume of soil for water and nutrients. Targeting Improved Cotton Through On-orbit Cultivation (TICTOC) studies how root system structure affects plant resilience, water-use efficiency, and carbon sequestration during the critical phase of seedling establishment. Root growth patterns depend upon gravity, and TICTOC could help define which environmental factors and genes control root development in the absence of gravity.

Cotton is used in a variety of consumer products from clothing to bed sheets and coffee filters, but the effects of its production include

significant water use and intensive use of agricultural chemicals. "We are hoping to reveal features of root system formation that can be targeted by breeders and scientists to improve characteristics such as drought resistance or nutrient uptake, both key factors in the environmental impacts of modern agriculture," says principal investigator Simon Gilroy. Improved understanding of cotton root systems and associated gene expression could enable development of more robust cotton plants and reduce water and pesticide use.

Bonus power

New solar panels are headed to station to increase the energy available for research and other onboard activities. The ISS Roll-out Solar Array (iROSA) is made up of compact panels, based on technology previously demonstrated on station, that roll open like unrolling a long rug. The Expedition 65 crew is scheduled to begin preparations for supplementing the station's existing rigid panels this summer with the first pair of six new arrays.

Provided by NASA