Q&A: How life might expand in the universe

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Asparagus that Michael Mautner has grown in asteroid/meteorite soil in a VCU laboratory.

Michael Mautner, Ph.D., a research professor of chemistry in the Virginia Commonwealth University College of Humanities and Sciences, studies how life might expand beyond Earth, using meteorites to find how microbes and even plants might grow to develop an ecosystem in support of human settlers on asteroids or space colonies.

Mautner recently discussed his experiments at VCU and explained his belief that life will eventually expand in the galaxy.

You have been researching how life could expand in the universe. What led you to become interested in this topic?

Philosophers [have] realized since antiquity that life is special, and that we have strong bonds to other living beings. Science now gives an even deeper meaning to these ideas. We now know that every organism, from microbes to humans, share the beautifully complex mechanisms of biology, that the laws of nature precisely allow this complex life to exist and that all life pursues common goals of survival and reproduction.

We seek a higher meaning to our existence, and these insights allow us to define one. Belonging to organic gene/protein life implies that a human purpose is to safeguard and propagate life. This purpose is best achieved in space. Astroecology shows that with space resources, life can endure for trillions of future eons and expand greatly in the galaxy in quantity and diversity, and culturally.

How can we expand life in space?

We now have the technology to start expanding life in space on two levels. We can establish large human populations living in comfort in the solar system, and eventually far beyond. We can also seed new solar systems with our family of gene/protein organic life on the path to evolve into intelligent beings who expand life further in the galaxy.

Expansion in space involves technologies that are advancing rapidly. For example, sending microorganisms to new solar systems, or "directed panspermia," requires interstellar propulsion, identifying extrasolar target planets and precise astrometry for navigation. Biology is also key to human adaptation to space, and for developing microorganisms that can survive the long transits in deep space and then adapt to new environments.

How are you researching these subjects?

I study astroecology, the relation between life and its potential resources in space. As to human settlement of the solar system, we shall need in space to live and grow there. Carbonaceous asteroids can provide accessible in situ resources, as they contain complex organic carbon, mineral plant nutrients and extractable water.

I have been studying samples of these asteroids in meteorites to evaluate their soil fertilities and the responses of microorganisms and plant tissue cultures. A variety of soil bacteria, algae, and asparagus and potato tissue cultures grew well in these asteroid/meteorite soils and also in Martian meteorite soils.

Why do you think it's important that microbes, plants and humans be able to grow in extraterrestrial environments?

This is important in both aspects of expansion in space: establishing human settlements and seeding new solar systems. It is important that life can flourish on these resources when we seek to secure and propagate life.

Life on Earth is fragile, endangered by nuclear proliferation, genetic misengineering, runaway climate change or major asteroid impacts, and limited by depleting resources. Eventually, Earth will become uninhabitable by the expanding sun. In contrast, life in many independent worlds in space can secure life for trillions of eons.

How many humans, and how much life, can space support?

The first colonizers on Earth were blue-green algae (cyanobacteria) that formed the oxygen atmosphere for higher organisms. They can be similarly the first colonizers of asteroids and maybe Mars and other moons and planets, preparing soils for plants and humans.

We measured the nutrient contents of these materials. Given the estimated amounts of asteroid materials shows that these resources can support trillions of humans comfortably in our solar system, and eventually, in billions of other solar systems throughout the galaxy.

Are you conducting experiments in your lab at VCU that help us understand how life could be sustained off planet Earth? What do those experiments involve?

My work at VCU addresses two space topics. One, with Professor M. Samy El-Shall and Professor Scott Gronert, concerns basic chemistry and astrochemistry of complex molecules which may contribute to the origins of life.

My research on astroecology, space resources and the future of life, including VCU publications, is continuing in a new program in collaboration with Dr. Rima Franklin of the biology department. It aims for a bioassay of carbonaceous chondrite materials. We intend to test how well cyanobacteria and other environmental and soil microorganisms, and eventually hardy multicellular rotifers and tardigrades, can grow on the meteorite materials and under the effects of conditions such as temperature, lighting and the composition of nutrient substrates.

Are human settlements on asteroids or other planets feasible? How far off do you see that happening? And what are the biggest challenges to establishing human colonies in space or other planets?

I hope for a gradual expansion in space, that has already started. First, we need programs that serve human needs on Earth: communication and weather satellites, solar power collected by satellites and beamed to Earth, possibly a space sun shield against global warming, detection and diversion of threatening asteroids. These programs can start with lunar bases that provide the structural materials. We can then progress to pioneering outposts, followed by large in-space cities and on colonies on asteroids.

With this infrastructure, space settlement can proceed to exponentially. One colony builds two, then two build four that build eight, and so on to hundreds and thousands of settlements, with populations of trillions. These space-adapted generations will be then ready for interstellar expansion. Meanwhile, from these space bases they can easily launch colonizing organisms to new solar systems.

The basic technologies for these programs are available or advancing rapidly. It will require foresight and global cooperation to implement these programs, as we are approaching the sustainable limits of the Earth.

I hope that new generations and their leaders will learn to understand the importance of space for our survival and growth. Securing our family of life for eons, and expanding it throughout galaxy, can then give our human existence a cosmic purpose.