



Life-Swapping Scenarios for Earth and Mars

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Evidence is mounting that the time-weathered red planet was once a warm and water-rich world. And a Mars awash with water gives rise to that globe possibly being fit for habitation in its past - and perhaps a distant dwelling for life today.

As sensor-laden orbiters circle the planet, NASA's twin Mars rovers -- Spirit and Opportunity -- have been tooling about and carrying out exhaustive ground studies for nearly a year.

The Opportunity robot at Meridiani Planum, for instance, has found telltale signs that water came and went repeatedly within that stretch of Martian real estate. While that intermittent water at Meridiani Planum is thought to be highly acidic and salty, its ability to sustain life for some period of time cannot be ruled out.

What scientists now see is a Mars different in its first billion years of geologic history than once thought - and conceivably an extraterrestrial address for home-grown life.

Rainfall: From years to decades

Mars is one complex and perplexing world.

That was strikingly evident at the *Second Conference on Early Mars: Geologic, Hydrologic, and Climate Evolution and the Implications for Life*, held Oct. 11-15 in Jackson Hole, Wyoming. Nearly 140 terrestrial and planetary scientists took part in that seminal meeting hosted by the Lunar and Planetary Institute (LPI), NASA, and NASA's Mars Program Office.

"One of the most significant new findings reported at the meeting was that it appears Mars underwent many of its most important changes much earlier in its history than previously thought," said Steve Clifford, an LPI planetary scientist. That includes core formation, the development of the crustal dichotomy, a rapid decline in geothermal heat flow, and the loss of a planetary magnetic field.

"Surprisingly, all of these events appear to have occurred within the planet's first 50 million to 100 million years of existence," Clifford explained. A related discovery is the potential role played by large impacts during this same period, he said, a topographic record of which is preserved in the ancient cratered highlands and has now also been detected beneath the planet's northern plains.

Clifford said simulations indicate that the very largest of these impacts may have blown away a significant fraction of the early Martian atmosphere. Impacts that produced craters greater than some 60 miles (100 kilometers) in diameter might have affected the climate on a regional and global scale, creating transient environmental conditions capable of sustaining continuous rainfall lasting from years to decades, he said.

Water-rich world

"There now appears to be overwhelming evidence that early Mars was water-rich - and may have possessed standing bodies of water and ice that ranged from large seas to a primordial ocean, perhaps covering a third of the planet," Clifford said.

Supporting evidence ranges from orbital observations of extensive layered terrains within, and possible paleoshorelines surrounding, the northern plains to on-the-spot investigations of the mineralogy and sedimentary record recently discovered by the Opportunity rover in Meridiani Planum.

"The implications of these findings are just beginning to be absorbed by the Mars community, yet they have already substantially revised our understanding of the planet's early evolution. They are sure to be a continued focus of attention as the intensity and scope of Mars exploration increases over the next decade," Clifford observed.

Now mix in recent findings about the origin and range of life here on our own planet.

"Life is incredible and the envelope for what we know about where life can live -- data from planet Earth -- is ever expanding and is far beyond what we might have hypothesized," suggested Lynn Rothschild, a scientist in the Ecosystem Science and Technology Branch of NASA's Ames Research Center, Moffett Field, California.

"There is a difference in perspective between planetary folks and biologists regarding where life might thrive. Organisms don't look for a global average. As a microbe, just give me 100 microliters of liquid water and I am happy. In any case, I certainly don't need an ocean! So think microenvironment," Rothschild advised.

Water and energy for microorganisms

Given the wealth of Mars Exploration Rover (MER) data, the likelihood that life could have existed on Mars -- or still does -- is viewed as more probable according to Carrine Blank, Assistant Professor of Molecular Geobiology in the Department of Earth & Planetary Sciences at Washington University, St. Louis, Missouri.

The MER results indicate that there were both large bodies of liquid water on Mars and there were fluids carrying redox (oxidizing and reducing) gradients through the near surface which resulted in precipitation of the blueberries, Blank told *SPACE.com*. "Life not only requires liquid water, but it also needs a source of metabolic energy," she added, "and redox gradients are great sources of energy for microorganisms.

Blank said in her mind the really big question is just how long was this liquid water and energy present on the surface of Mars. Be it brief or extended, so goes drawing the life line in the sands of Mars.

"If it was for just a brief time in the geologic history of Mars, then perhaps the potential for life is low," Blank said. "If, on the other hand, it was for an extended period of time, then the potential for life at the surface becomes much higher."

What is needed now, Blank noted, is more information about how widespread sedimentary deposits are on Mars, and then identify age constraints on the presence of liquid water at the surface.

Planet swapping microbes

The idea that the seeds of life hobnob between far-flung celestial localities is known as panspermia.

Could Mars be a domain for both microbes flung off Earth due to asteroid and comet impacts, as well as a planet where a "second genesis" might have also occurred? Furthermore, if this was the case, could external life and made-on-Mars biology co-exist?

"Absolutely," advised Blank, adding yet another scenario: That life originated on Mars and was transferred to the Earth, and then went extinct on Mars.

"At present, there is no geologic evidence that the origin of life occurred on the Earth. So one hypothesis is that the origin could have occurred elsewhere, like Mars, and then transferred to the Earth," Blank suggested. Alternatively, life could have originated on the Earth -- but left no evidence since we don't have any rocks for the first billion years of Earth history -- and then transferred to Mars, she said.

"If life was transferred between the planets, then Martian life, past and present, should have similar characteristics to early Earth life," Blank said. "On the other hand, if there was a second genesis, then life

on Mars should be very different than life on Earth, and may in fact be quite difficult to detect or even recognize as life...particularly if it has gone extinct!"

Deepest branches on the tree of life

Meanwhile back on Earth, Blank said that more research is needed to understand whether interplanetary transfer of life could have been possible. In particular, additional work on hyperthermophiles -- microbes that live at very high temperatures and that form the deepest branches on the tree of life -- is required, as they were the early inhabitants of the Earth and therefore were the ones most likely to have been transferred around the solar system by impacts, she said.

"We know very little about the origin of life on the Earth...how it happened, what kind of environment it might have happened in, and how long it took to go from the origin to the last common ancestor of life as we know it - a very complex organism very much like modern life," Blank said.

Casting her eye back on Mars, Blank also said an unknown is whether conditions on early Mars were similar to what they were like on the early Earth when the origin of life likely happened.

"If they were similar, then perhaps a 'second genesis' could have been possible on Mars. Even if conditions were different on Mars, there could still have been a second genesis only with a very different result than what happened on the Earth," Blank stated. "If these different life forms were spread throughout the solar system, then they might have co-existed if they could learn to depend upon each other. If, on the other hand, they were in direct competition for resources, then you might expect that one would 'win' and survive, and the other go extinct," she advised.

War of the worlds?

Jack Farmer, an astrobiologist at Arizona State University in Tempe, also contends that the chance for life having existed on Mars is definitely in the cards. He is a Mars Exploration Rover science team member.

"We now have what I consider to be definitive evidence for standing bodies of water on Mars and this has opened up a serious and focused discussion of habitable environments on Mars early in the planet's history. This discovery marks a first step in implementing a strategy for Mars exopaleontology," Farmer told *SPACE.com*.

Farmer said the idea that Mars could have played host to Earth-launched microbes, as well as being a planet where a second genesis might have also taken place "are both contenders for an origin of Martian life and deserve serious consideration."

"I also think the idea of a 'War of the Worlds' on Mars between life forms that originated there and those that arrived from Earth is a serious possibility," Farmer said. And that prospect, he continued, raises some key questions: Who would win? Is there the possibility for a competitive co-existence between life forms that originated on a different basis?

"The good news is [that] these alternative hypotheses appear to be testable in the context of future missions. But this discussion also points, again, to the importance of planetary protection and the potential for back-contamination arising from a Martian sample return," Farmer concluded.

This article is part of SPACE.com's weekly Mystery Monday series.