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# THE MYSTERIES OF MARS

## Just what *is* on the red planet?

By Lydia Dotto / *Illustration by Graham Bardell*

FORGET EVERYTHING you've ever read about canals, lush orchards and little green men. The Martians — if Martians there be — won't be men (or women); they probably won't even be green. If they exist at all, they are probably lowly creatures — bacteria and such like — sometimes familiarly, if inaccurately, known as "Mars bugs."

From our lofty perch at the top of the evolutionary ladder, it's hard for us humans to consider such creatures to be really important in the cosmic scheme of things. And so you might wonder why NASA, the US space agency, has spent some $1 billion to plunk two spindly spacecraft down on the Martian surface next year to search for the beasts, a quest that many scientists describe as a long shot, and that in their generous moments.

The point is that those bugs really are important. They would be the first true aliens, the first hard proof that life exists somewhere else but on Earth, this ordinary hunk of rock circling this mediocre star in the far reaches of this typical galaxy, this drop in the bucket of the universe. Psychologically, we've come a long way from the days when we thought we were at the centre of things. So far, in fact, that we figure there must be others out there, since all this cosmic grandeur can't possibly be for our benefit alone.

We want there to be life out there but we've never found even the faintest trace of it. Mars bugs would lend tremendous weight to scientific theories that say our sun, planet, our very bodies, are the result of processes which have happened countless times in the universe, processes that are happening out there now. They would make infinitely more credible the calculations that say there's intelligent life elsewhere, that there may be as many as a million technological civilizations in this galaxy alone. They would, in the words of American physicist Philip Morrison, "transform the origin of life from a miracle to a statistic."

And so, last August 20 and September 9, the two unmanned spacecraft of Project Viking were launched on their long journeys to the red planet. They are due to reach Mars in June and August of next year, when they will orbit the planet and release lander capsules onto its surface.

If the capsules do not land in the middle of a raging Martian dust storm with 250 mph winds; if they do not land on steep inclines or boulder-strewn fields that topple them over; if, further, they do not sink without a trace into pools of dust, or, on the other hand, land on solid rock that precludes the taking of soil samples, if all these things do not happen, then 10-foot retractable claws will scoop up fistfuls of dirt and dump them into the Viking biological experiment package, one cubic foot in size, 40,000 moving parts and, according to one Viking scientist, a "technological nightmare" to develop. There the putative Martian micro-organisms will be enticed with "Viking chicken soup," a mixture of water, sugar, vitamins and amino acids (the building blocks of protein). A limited menu, granted, and Earth fare to boot. "But it's all we can send," says Donald DeVincenzi of NASA's Ames Research Center, one of Project Viking's scientists.

The biological experiment packages are programed to look for evidence that the bugs are eating the food; the orbiting spacecraft will relay the information back to Earth. The package will also look for signs of photosynthesis, one of the most vital physiological processes on Earth. Since this experiment assumes many similarities between Earth micro-organisms and Martian ones, it's all terribly Earth chauvinist, but you've got to start somewhere. As DeVincenzi points out, "How can you design an experiment to detect life forces you don't know anything about?"

Viking will mark the first field test ever conducted in the fledgling science called exobiology, the study of extraterrestrial life. Despite the booming interest in UFO's and other chariots of the gods — or perhaps because of it — few people realize there's actually a genuine scientific discipline devoted to the subject. True, it's a subject that shares, with certain esoteric forms of physics, the dubious distinction of being a science which has yet to prove its subject matter even exists. Nevertheless, it is now attracting increasing attention from scientists once reluctant to become involved in a field tainted, in their view, by the all-too-active attentions of sundry kooks and crazies.

In 1971, the first international conference on extraterrestial civilizations was held in Soviet Armenia, sponsored by the American and Russian national academies of science. The conference concluded that "for the first time in human history it has become possible to make serious and detailed experimental investigations of this fundamental problem..."

Two years ago, the University of Toronto started an exobiology course, thought to be the first of its kind at any Canadian university. Run jointly by the botany and astronomy departments, it focuses on the formation of planets, the chemical evolution of life and the possibility that these processes have occurred throughout the universe.

Robert Garrison, an astronomy professor who teaches part of the course, said that in the first year students seemed to want a gee-whiz course in science fiction. "They were disappointed we didn't talk about the pop-culture topics. Last year, I didn't sense that at all. They were quite a bit more serious."

Mars has a special place in our folklore. It was just 100 years ago that the Italian astronomer Giovanni Schiaparelli spotted what appeared to be straight lines crisscrossing the Martian surface; these he called *canali*, which loosely translates into English as "canals." His discovery gave rise to a rich mythology concerning a technologically sophisticated but dying civilization on Mars. Later, astronomers attributed a seasonal wave of darkening on the planet to greenery blooming along the canals.

But the myths died under the continual assault of scientific investigation. The dark features are now thought to be the result of Mars' frenzied dust storms. There is no greenery. There are no canals. Indeed, when the first space probes flew past the planet in the late 1960s, they revealed a bleak, crater-pocked, moon-like surface — a world

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# Should we take the chance of bringing back to Earth organisms that may bring disaster?

seemingly as dead as it could be — and hopes for life on Mars dwindled. Those hopes were revived in 1971 by Mariner 9, the first American spacecraft to go into orbit around Mars. Mariner 9 gave evidence which persuaded some scientists that liquid water may once have existed on the planet's surface, although it's unlikely there is any there now.

Mars is clearly no holiday resort for even the hardiest of micro-organisms. It is deathly cold and its surface is bombarded with lethal ultraviolet radiation. But neither is it so awful that scientists can arbitrarily reject the possibility of life. After all, micro-organisms adapt to some pretty grim conditions on Earth (in the Antarctic, for example) and some have even survived in "Mars jars," which represent scientists' best attempts to simulate the Martian eviromment in the lab. If this is the case, some researchers argue, how much better adapted might the native bugs be to the vagaries of the Martian world? Cornell University astronomer Carl Sagan, a leading exobiologist, persistently preaches against Earth chauvinism in these matters. "What's a hostile environment and what's not depends on who's talking," he says.

It's hard to get anyone to put figures on the odds of finding life on Mars. Richard Young, NASA's chief of planetary biology, says the mood of scientists swings from "lukewarm optimism to wild pessimism." Still, there's always that urge to try, because the payoff would be the first example of life resulting from a separate biological evolution.

Ponder for a moment the fact that, on Earth, we're all made up of the same chemicals, mainly carbon, nitrogen, oxygen, and hydrogen (the most abundant elements in the universe), plus minute traces of a few rarer things thrown in. We are mostly water. The chemistry of our bodies depends crucially on the versatility of carbon in forming bonds with other substances.

The genetic molecule, DNA, which passes the code of life from generation to generation, is made of the same constituents in all organisms. All life on Earth uses about 20 amino acids to build proteins, although it's easy to visualize a virtually infinite number of possible ones. Despite the great diversity of life forms on Earth, despite the fact that we live in a world that accommodates everything from earthworms to elephants, when you get right down to the chemical fundamentals, biologists actually have only one example of life to study.

"This enormously limits the imagination," says Jack Dainty, chairman of botany at the University of Toronto and one of the professors teaching the exobiology course. He says that tremendous advances would result from the knowledge of another biology.

Not that scientists expect Mars bugs to be completely different. Some even suggest that there may be similarities. Carl Sagan, for example, admits to carbon chauvinism, the belief that Martian organisms would have a chemistry based on the carbon bond, as ours is. Nevertheless, Richard Young says it would be the most mind-boggling thing of all if, after three or four billion years of separate evolution, Mars organisms were to be exactly like us, were to use these basic chemicals in precisely the same way we do.

These guesses, educated though they may be, are still guesses. No one will know for sure if or what kind of life exists on Mars until Project Viking relays its findings. And no matter what it finds, scientists are still faced with problems. For although there are no firm plans at the moment, NASA is considering sending an unmanned spacecraft to Mars to pick up and return a soil sample for study on Earth. Such a mission is not likely before the late 1980s but many scientists are very keen on it and a NASA advisory committee has said that it should be assigned the highest priority of all future Mars missions.

The possibility of bringing Martian samples back to Earth is causing about as much controversy as the debate on the type of life that may exist there. But the moral dilemma is much greater. For, if Project Viking does find signs of life on Mars, it cannot tell what effect that life may have on our own planet. Should scientists take the chance of bringing back to Earth organisms that may bring us disaster? Should a soil sample be sterilized to kill bugs? Should it be held in Earth orbit? Or perhaps confined on Earth in a quarantine facility? And are such facilities good enough to ensure that micro-organisms don't get out?

And what if Project Viking finds no sign of life on Mars? That could simply mean that there are no bugs at that particular spot on the planet, or that they don't like Earth food, or that they don't respond in a way that Project Viking's instruments can measure. It *doesn't* mean that there are no bugs on Mars. As DeVincenzi puts it, "If the results are positive, the answer is clear. If they're negative, it doesn't tell us anything." The problem of what to do with a soil sample will still exist.

Some scientists argue that because Earth and Mars organisms have evolved separately for three to four billion years, Earth life will have no immunity to Mars bugs. Others argue that precisely because of this separation there would be no interaction between the two forms of life. Or, to put it another way, when was the last time you caught tobacco mosaic virus? Donald Hunten, an astronomer from Kitt Peak Observatory, points out that the tobacco mosaic virus is infinitely more closely related to us than a Martian organism

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Martin Marietta Aerospace — Canada Wide

*This Viking spacecraft will travel more than 460 million miles from Earth to a soft landing on Mars in 1976 to explore the surface and atmosphere of the planet. This package includes stereo cameras, a weather station, an automated soil analysis laboratory and an instrument to detect life.*

# Any civilization we contact will almost certainly be superior to ours

would be. Plant diseases share our biochemistry for all practical purposes, but humans don't catch them.

Nevertheless, no one knows whether we'd catch a Mars bug or not. Young says the biological community is greatly split on the issue of returning a sample and is likely to remain so, but if one is returned it's clear that few scientists would favor sterilizing it. "We'd lose too much data," he says. "I don't think we're going to bring back samples at a cost of $1 billion or $2 billion and destroy half the data before it gets here."

David Strangway, chairman of geology at the University of Toronto and former chief of geophysics at NASA, says, "The conservative view is to sterilize the heck out of it before it even leaves Mars, but many of us would be very distraught if they did that." Strangway is part of a committee advising NASA on the effect heat might have on the chemistry, magnetism and other physical properties of the Mars rocks.

Young predicts that a sample will be returned to Earth, whether or not it's certain there's life in it, but it will be treated as though it has life. That means it would be held in a quarantine facility. There are quarantine labs on Earth which are already handling pretty dangerous things and Young expresses great confidence that quarantine of the Martian soil sample can be done. Others are not so convinced. They admit that while the likelihood of a disaster may be extremely small, its potential consequences are extremely grave. Sagan is among those who feel that Martian samples should not be landed on Earth, period. However, he believes that after a period of experimentation with remote, automated space vehicles on Mars, it may be possible to relax these standards.

Dainty thinks a sample-return mission would certainly be worthwhile scientifically. "But public reaction may make it impossible," he says. "I don't think scientists should go against the general feeling of the public on an issue like this. They have every right to have a major say."

The final decision will involve not only NASA and its scientists, but US health and regulatory bodies and probably international agencies as well. Would the question be put to the United Nations? "It may come to that," Young says. "Any nation that decides on this unilaterally will have to be called to account."

Although scientists don't yet have any evidence of other civilizations beyond Earth, their theories about the nature of stars, the formation of planetary systems and the chemical evolution of life lead them to conclude that life could well be common in the universe. According to one estimate, there could be as many as one million technological civilizations in the Milky Way Galaxy alone. The immediacy of Project Viking makes it scientifically one of the most interesting aspects of exobiology, but the most exotic aspect is undoubtedly the attempt to communicate with intelligent life elsewhere in the universe.

Earth has been considered a communicative civilization in the cosmic sense for only a few decades. A communicative civilization is one which can send and receive radio signals over interstellar distances; the first major radio transmission on Earth was in 1901, but major radio telescopes were developed largely in the 1960s.

The 1,000-foot Arecibo Observatory radio telescope in Puerto Rico is capable of sending a signal which could be received by an identical instrument anywhere in our galaxy. Last November, scientists used it to send out our first deliberate radio message to the stars. Directed to a star cluster some 24,000 light years away, the message contained information about the chemistry of Earth life, the nature of our solar system and the size and shape of humans.

Scientists have also listened for signals from outer space. The first attempt, Project Ozma, was made by Cornell University astronomer Frank Drake in 1960. Since then there have been half a dozen projects, including one by two Canadian astronomers, Alan Bridle of Queen's University and Paul Feldman of the Dominion Astrophysical Observatory in Penticton, British Columbia.

Using the 150-foot Algonquin radio telescope in Algonquin Park, Ontario, the astronomers have intensively studied 13 stars so far and Bridle says they are planning to scan some 200 in all. The study began in the spring of 1974 but the work is still in a very preliminary stage. "We have had no definite indication of signals," Bridle says, and adds cryptically, "however, I'm not saying we've had a completely uninteresting time on the telescope."

Perhaps the most ambitious proposal in the area of radio communications is Project Cyclops. Cyclops came out of a study sponsored by NASA's Ames Research Center. It proposes a vast array of 1,000 to 2,500 radio antennae covering 25 square miles, all electronically connected to make one giant radio telescope. It would cost $10 billion to $20 billion to build over 20 to 30 years, and could be used for regular radio astronomy as well as searching for signals from other life.

One has to be a bit of an optimist to believe that any of these projects will succeed, even if one accepts the possibility of there being millions of civilizations out there. There are so many stars and they are so far apart; even relatively optimistic calculations indicate that, short of an incredible stroke of good luck, it could take decades, perhaps centuries, of searching through literally millions of stars before we hit pay dirt. Yet some astronomers have dismissed even these calculations, arguing that the chances of contacting other life are exceedingly small. So why do we keep trying?

Well, the scientists attending the 1971 conference in Soviet Armenia concluded that the matter "may prove to be of profound significance for the future development of mankind...The effect on human scientific and technological capabilities will be immense and the discovery can positively influence the whole future of man."

The reasoning behind this optimism is that any civilization we contact will almost certainly be superior to ours — probably a good deal superior. This is because, technologically speaking, we're about as primitive as a civilization can be, and still be in the interstellar communications game. We're unlikely to make contact with any civilizations less advanced than we are, because they won't have the necessary technology.

This has led some scientists to speculate that when contact is made, these superior civilizations will be able to help us solve our problems; that they will, in effect, save us from ourselves. Carl Sagan comments that they may be able to give us some clever and simple machine to solve some general problems like the energy crisis, but they couldn't help us with anything intimately connected to our biology. "For instance, to ask for a cure for cancer would be completely fanciful," he says.

But we are a little ahead of ourselves. Before we can consider what benefits we might derive from a more advanced civilization in outer space, we must first make contact, and some scientists note that there are ominous implications if we don't. According to calculations, technological civilizations must survive for millions of years in order for there to be enough of them in the galaxy at any one time so that communication can occur. If ecological, political or technological disasters wipe them out within decades or centuries of the time they are first able to communicate, it may be a lonely universe indeed.◁

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