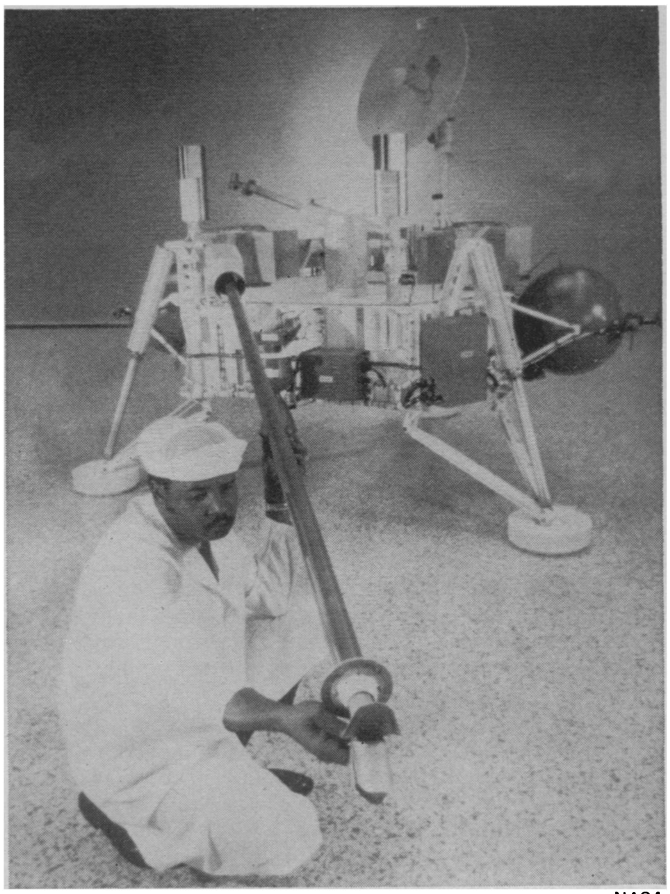
Toward a universal biology: The search for life on Mars

Looking for Martian microflora could become the Russian-American space race of the decade



NASA

Viking Mars lander will extend scoop to pick up soil.

by Dietrick E. Thomsen

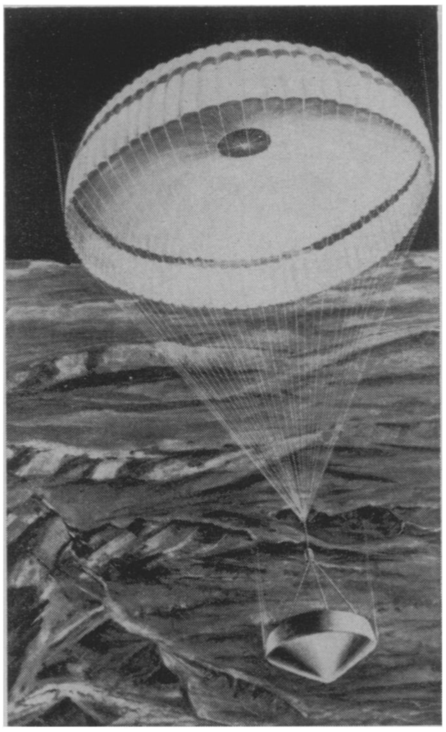
Biology is a provincial science. The only examples of life known so far are those found here on earth. Yet earth is dwarfed to insignificance by the rest of the universe and scientists generally agree that the existence of life elsewhere is almost a certainty.

But biologists, limited for now to only the forms on earth, are hindered in making generalizations about life. Discovery of living organisms in other places—or proof of the absence of life on certain other planets—would vastly expand the biologists' perspective. The immediate target in the search for extraterrestrial life is the planet Mars.

In the words of Dr. Wolf Vishniac, chairman of the department of biology and associate director of the Space Science Center at the University of Rochester, biologists could be happy if they find life on Mars and they could be happy if they do not find life on Mars. "If we find living organisms on Mars," he says, "it will be a great discovery." It will precipitate a rush "to see whether the proteins are the same," and otherwise to compare terrestrial and Martian forms.

There are some biologists, Dr. Vishniac says, "who would prefer not to find living organisms on Mars." They are intrigued by the idea of two planets of similar size and shape, one with life, one without. In that case one planet would be the experiment, one the control. In either case, biologists would understand a good deal more about life on earth by studying Mars.

Programs to investigate the possibility of life on Mars are being pursued by both the Soviet Union and the United States. They were described in June in Seattle at the 1 th Plenary Meeting of the Committee on Space Research of the International Council of Scientific Unions.



NASA

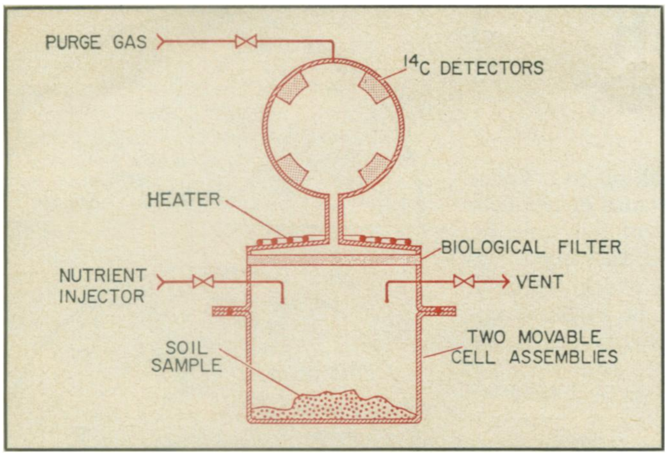
Mars lander will parachute to surface.

In all cases experiments are planned on the assumption that wherever life exists, its chemistry is based on the same elements—carbon, oxygen and nitrogen—as on earth. The sandmen of science fiction, whose existence is based on silicon chemistry, are not being seriously considered.

The expectation of carbon-based life is the simplest way to begin, and, says Dr. Vishniac, the discovery in the last few years that organic compounds like those on earth populate the interstellar dust clouds enhances the expection by showing that compounds of this type form readily in various parts of the universe. Whether or not the origin of life is in the interstellar dust clouds, the discovery of organic compounds there, he says, makes "biology very much a part of cosmology."

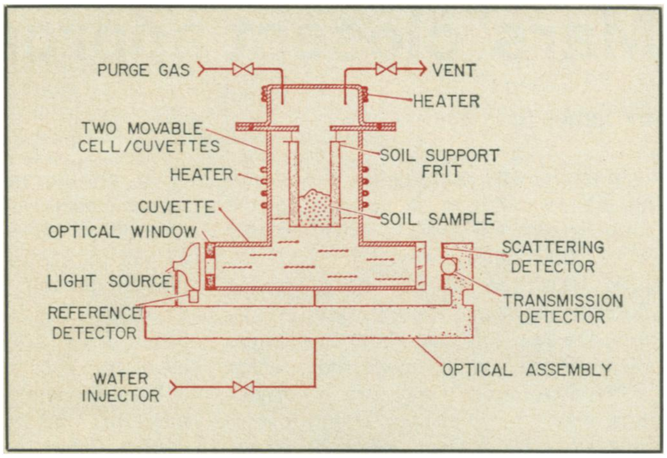
Because microorganisms are the most basic forms of life, the Mars experiments are all directed to the discovery of microorganisms inhabiting the Martian soil. Large plants and animals cannot exist without a flourishing microflora in the soil, but microflora can exist without larger forms of life.

If the microflora is there, one of the questions is who will be first to find it.



Klein, Vishniac

Monitoring radioactive CO_2 from Martian organisms.



Klein, Vishniac

Martian microorganisms in the water will scatter light.

There is much speculation about whether the Russian vehicles now moving toward Mars carry biological experiments. The craft are large enough to contain landers, and landers might carry biological experiments. The Russians aren't saying yes or no, but knowledgeable Americans tended to conclude that the current Mars probes do not carry such experiments after hearing negative-sounding reports on the subject by Russian investigators. (On the other hand, the Russians could be saving other reports till after their probe lands.)

All that the Russians presented at Seattle were results of preliminary experiments in which certain terrestrial life forms were grown under simulated Martian conditions. They took bacteria from the Nubian Desert and from Arctic soil and grew them in simulated Mars soil under very low humidity. They then attempted to detect the presence of life in the cultures by the sort of sensors that can be sent on an automated Mars probe.

To detect life in such cultures, one might begin by looking for the energy-releasing compound adenosine triphosphate (ATP), but the Russians reject this with the remark that ATP may be synthesized spontaneously, and therefore its presence does not necessarily indicate life.

Another way is to introduce radioactively labeled organic compounds to the organisms as food. An example would be glucose that contained carbon 14. One then measures the radioactive carbon dioxide given off. But the Russians did not have good luck with this approach. They found that the evolution of $C^{14}O_2$ depends on the humidity, and that not very much of it is produced in a dry atmosphere such as Mars is supposed to have.

Russian pessimism notwithstanding, American scientists are going ahead with the preparation of experiments to be carried on the two Viking Mars landers scheduled for launch in August and September 1975. Congress recently authorized the first funds for the Viking project.

Viking's biological effort was described for the meeting by Dr. Harold R. Klein, director of life sciences at the National Aeronautics and Space Administration's Ames Laboratory at Moffett Field, Calif. First of all, he says, the lander will carry cameras for a close-up view of the terrain, and, he laughs, "we may see some Martians." More likely the cameras would show temporal changes in the color or other aspects of the soil brought about by the activity of microflora.

Another general experiment that may show evidence of life will sample the chemical content of the Martian atmosphere. If it should find oxidized and reduced gases together—carbon dioxide and methane for example—this coexistence could mean that organisms were producing them since in the usual procedures of inorganic chemistry oxidized and reduced gases should cancel each other out.

The heart of the biological effort is four experiments that will attempt direct detection of microorganisms in the Martian soil in four different ways. Dr. Klein calls this "shotgun effort" advisable because some Martian organisms may like it dry and some may like it wet. Some may like to eat the same food as terrestrial organisms; some may prefer native Martian nutrients.

The experimental package will have four chambers into which scoops will drop Martian soil. Different things will happen in each chamber.

The first experiment will attempt to find living matter by burning it out of the soil. Martian soil will be incubated in an atmosphere containing carbon dioxide and carbon monoxide labeled with carbon 14. After incubation the sample will be heated to 600 degrees C. to drive off remaining radioactive gas. Then it will be heated to 700 degrees, at which point organic matter in the soil should be oxidized. Any radioactive carbon oxides found after the second heating should represent carbon ingested by the organisms.

A dry regime is planned for the second chamber which will incubate Martian soil with very small amounts of nutrient (0.2 milliliter to a cubic centimeter of soil). The medium is still not decided; a mixture of carbon 14-labeled formate, lactate, glycine and glucose has been used in exploratory studies. Gas exchange in the atmosphere of the incubator would be monitored for evidence of life.

Organisms that like it wet will enjoy the third chamber, where they will be incubated in a very wet nutrient medium, a broth consisting of water, amino acids and other simple organic substances. A gas chromatograph would measure the uptake or release of hydrogen, oxygen, nitrogen, methane and carbon dioxide.

Lovers of native Martian cuisine will be at home in the fourth experiment, which will incubate Martian soil in distilled water but will not introduce any terrestrial nutrients. It will then examine the water for changes in optical properties brought about by the suspension of microorganisms in it.

Breadboard models of some of these experiments already exist, says Dr. Klein. The finished versions must go into a space 9.5 by 10 by 11.5 inches and weigh 20 pounds. Engineers assure him it can be done.

The two Viking spacecraft will consist of orbiters and landers coupled together. After the orbiters are established in an orbit around Mars, they will dispatch the landers. Data taken by the landers will be automatically recorded and sent to earth by automatic telemetry. The landers are planned to have a lifetime of 90 days, and each of the biological experiments is supposed to process several soil samples during this time. The results will be eagerly awaited by the world biological community—unless the Russians upstage the missions. □