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Our Neighbor Mars

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LIFE ON MARS, as a poetic and philosophical counterpoise to human life here, has long been a speculative inference of scientific thinking about the solar system. So long as the earth was the center of the universe, its uniqueness as an abode of life was axiomatic. When we learned it was merely the third planet orbiting round a rather ordinary star, the Sun, we had to accept analogies to Earth—either other planets in our own solar system, or more remotely, the systems of other stars.

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If we scale the Sun-to-Earth distance as an inch, the whole solar system is an easy yard; but on this scale the next stars are a mile away.

The solar planets, then, are within reach of our existing space vehicles. For the other stars, we are limited to watching or listening until we have another thousand-fold extension of our exploration technology, which is the kind of leap the chemical rocket was over the jet plane, and that in turn over shanks' mare.

In its orbit around the Sun, Earth's most promising neighbor is Mars. The main problem mitigating against even primitive life on Mars is the lack of water. Mere traces of moisture have been detected in the atmosphere; the white polar caps are probably carbon dioxide snow, not water.

Together with the interpretations of Mariner IV photographs concerning the antiquity of unweathered craters, analyses have appeared to leave little room for a Martian life system that, like any reasonable extrapolation of Earthly life, needed water as an essential medium.

Certainly, this is a sobering corrective to some of the prescientific enthusiasms about Martians, like the claims for canals that have been long discredited.

However, after Mariner IV made its report, many editorials commented about "Mars—the Dead Planet" with an assurance as totally unjustified by current fact as was some previous exuberance that there just had to be life there.

Concrete facts about Mars are few, and our job now is to test alternative hypotheses. One problem in making a "model" of a planet is that most of the information we can hope to get at such a distance is global, whereas life tends to be local detail. Thus, a typical point on Earth would be ocean. Arguing from this global description (if not from other data), a Martian observer might deny the existence of life here.

Mariner IV was our first chance to look at surface detail on Mars. The statistics of craters was its most important message, but there are many fine features whose interpretation is a matter of imagination until we get a closer look.

The most important global fact about Mars is its steady subsurface temperature which is about 40 degrees Centigrade below freezing. This is so low that almost all of any moisture that may be on Mars must be trapped as a permafrost below the surface. Except at the winter pole it would be baked out of the surface during the day and eventually diffuse to the deeper cold trap.

Knowing this temperature, as we have for some years, we could deduce that little moisture would be perceivable in the atmosphere, and that we could not expect to find oceans on the surface. The temperature shows that we have no hope of telling the size of Mars's reservoir of permafrost water from general observations of the surface or the atmosphere. There might be mere traces; there might be seams of permafrost or ice-laden rock miles thick.

Does this help us very much in modeling any kind of Martian biology? Only if there are local exceptions to this frigid perspective—oases in the tundra. To support this speculation, we have to invoke local heat sources like volcanoes and earthquakes. There are some arguments against such events being as frequent as on Earth, but they are hardly ruled out altogether, although the theory is quite tenuous — based mainly on the absence of a magnetic field.

The analysis of the Moon along similar lines has gone through many contortions. The most recent observations from Lunar Orbiter give quite good evidence that volcanoes as well as meteorites are important in crater-building on the Moon, and if the Moon has had volcanoes, so should Mars.

Furthermore, there is growing evidence of local gaseous exhalations still occurring on the Moon. Its crust is not yet thoroughly baked out. Then, Mars should have even heavier deposits of primitive volatiles, including water—potential material for life to start with. And with its atmosphere, however tenuous, Mars would give some chance for life to flourish in scattered oases, a possibility we can confidently deny for the airless surface of the Moon.

On this model, the search for Martian life becomes translated into a search for local oases of warmth and moisture. This aim is well within the reach of the existing program—we need persistent reconnaissance of the Mars surface to find the cracks in the crust that might allow frozen subsurface moisture (which would be melted at greater depths) to communicate with the flow of energy from the Sun.

Our search has the advantage of a likely signature of the oases — clouds above them. One of the most interesting objects seen by Mariner IV, on photograph 14, looks like such a cloud, but we need a closer look.