Viking's Life Experiments: Pointing Toward Biology

The eyes of all the scientists, stargazers and Mars watchers of history seemed to look down more closely on the biologists of Project Viking this week, as they confronted the most impressive evidence yet in the search for life on the Red Planet. It does not answer the question—indeed, it is possible that Viking's instruments will not provide proof-positive either way—but for the first time, the scales have been tipped toward the idea that biology, rather than inanimate chemistry, may be the easier explanation for the data.

The center of attention was an experiment on the Viking 1 lander that looks for life by exposing a soil sample for five days to an atmosphere containing carbon-14-labeled carbon dioxide, then incinerating the soil to see whether the resulting gases indicate that resident microorganisms had incorporated the tracer into their bodies. The first of the instrument's two data peaks merely indicates the residual $^{14}CO_2$ being flushed from the system; it's the second, much smaller peak that counts. Two weeks ago, the instrument's initial soil test caused a stir when its second peak of 96 radioactivity counts per minute was more than six times the amount predicted from the 7,400-count first peak (SN: 8/14/76, p. 99). No simple nonbiologic explanation suggested itself even then, but the vital next step was a repeat run using another sample, sterilized this time, from the same scoopful of soil. If microorganisms had been responsible for the high second peak in the original run, presumably their death from the sterilization process would cause a lower second peak in the control experiment. A second peak from nonbiologic causes would be more likely to be the same both times.

This week the results came in. There was a bit of tense melodrama when, after the first peak reading was received in the Viking control center at the Jet Propulsion Laboratory, some spurious electronic "noise" threatened to make the anxiously awaited second peak unreadable. Soon, however, scientists and engineers had diagnosed the problem and were taking the first look at the provocative results.

The first peak was within 3 percent of that in the original, nonsterile, run. And the second peak—perhaps the most tensely awaited datum since the signal that the spacecraft had landed safely more than a month before—was *low*, about 21 counts per minute when corrected for the background radiation of the lander's nuclear power plant.

The instrument's chief experimenter, Norman H. Horowitz of the California Institute of Technology, was excited but careful. The peak was certainly low, but perhaps not so low as it might have been to make the strongest case. It did virtually rule out a number of possible technical malfunctions of the device itself, but an exotic chemical explanation is not out of the question on a never-before-sampled world, particularly one as chemically active as Mars. Perhaps, for example, the heat of the sterilization process destroyed some surface-catalysis capability of the soil. If such an ability were activated by light, the sample's 19-day wait in a dark hopper before being tested might have allowed its catalytic potential to "run down." The significance of the new data, however, is that theories are having to become increasingly strained to explain it. Next week, results will come in for a second nonsterile sample, in hopes that a high second peak will give added weight to the Martians.

Time after time, Horowitz was asked whether the odds of life in his instrument have improved. "In my opinion," he said, "it certainly increases the chance." He pointed out, however, that even the exotic chemical series must first be ruled out. "As long as there are credible alternative hypotheses," says chief Viking biologist Harold P. Klein, "they have to be tested."

Another of the biology instruments, a labeled-release experiment that seeks gaseous compounds containing a carbon 14 tracer released from a nutrient-treated soil sample, created its own stir last week. Its first run, two weeks before, had produced a sharply rising $^{14}CO_2$ curve. But the repeat version with sterile soil showed a plumeting one—much as though microorganisms had been alive the first time and dead the second, but also perhaps due to heat-released oxidants in the soil. The Viking lander's organic chemistry instrument by this week had pushed its detection limits down into the parts-per-billion range without finding any organics, but the signs of finding whole Martians keeps theories hopping to account for it.

Horowitz maintains that if there is life at the lander 1 site without a detectable residue of organic material, then the living microorganisms would have to have come from some other region where organic chemistry does exist. Project chief scientist Gerald Soffen points out that the instruments do appear to be looking at an "airborne-type" sample, suggesting that such transport is at least feasible. Also, he says, one might reasonably expect the more northerly site chosen for lander 2 to have a higher organic "inventory," since volatile-deposition processes may favor the near-polar regions. □

A Landing Site for Viking 2

Viking 2/NASA

Viking 2 landing site: Rough ground and impact craters are blanketed by thick dust.

Once upon a time, the plan for choosing Viking's two landing sites was fairly straightforward. Lander 1: safety first. Lander 2: water first. But it hasn't been so easy. Getting the first spacecraft down in one piece was tricky enough. And though the second one was sent up to the northern 40s in latitude as planned, a search of millions of square kilometers of Mars left the mission's site-selection team desperate for almost any spot large enough to attempt a landing, let alone one tailored to specific conditions. The prime site, a region known as Cydonia, was rated "unacceptable" by Project Manager James Martin—too rough. The backup site, west of Alba Patera, was hard to verify because of its uninviting terrain. Clouds occluded the photographs from orbit, and temperature data—apparently very sensitive to surface variations, time of day and other factors—were available only near, not at, the tentative touchdown point. And last week, after a brief look at the first 20 photos of the last-resort third site spanning the plains of Utopia, Martin commented, "They don't look so hot either." Flight officials at the Jet Propulsion Laboratory were working themselves into the ground, pursuing parallel planning options for all these sites and four possible landing dates.

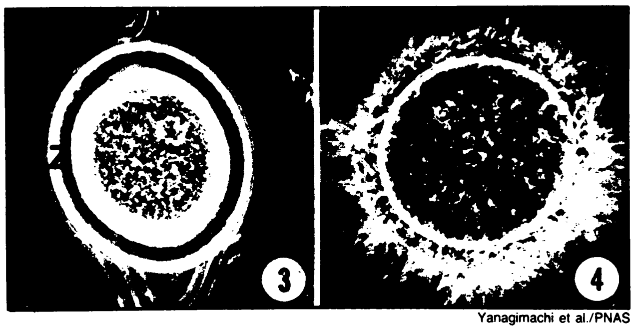
The choice—albeit a controversial one—has at last been made. The winner is in site 3—the "backup backup," says one geologist—up near Utopia's northeast corner at around 46°N and 226°W, about 200 kilometers south-southwest of a large crater named Mie. The deciding factors, says Martin, were the difficulty of parallel planning and the faith of some of the mission's geologists that the bumpy surface of the region is overlain by a thick layer of dust—padding for the lander's Sept. 3 touchdown at about 3:45 p.m., PDT.

The "safe" area chosen for the landing site is a tight fit indeed, largely because uncertainties about the descent path require allowing for touchdown anywhere within an ellipse about 100 kilometers wide and 260 kilometers long. As a result, the chosen region is virtually surrounded by more hazardous terrain, including Mie's ejecta blanket to the northeast, fault-ridden "polygonal ground" or "elephant hide" to the southwest, and a thinner dust blanket (with a corresponding rise in the number of small craters) to the south and west.

The site itself, says Harold Masursky of the U.S. Geological Survey, seems to be covered with as much as 10 to 25 meters of dust, sculpted into dunes by the Martian winds. The thickness is a critical item, since, besides the dunes, the blanket clearly preserves the outlines of pedestal craters, knobs, blocks ejected from Mie and other features of a generally unfriendly terrain underneath. Lander 2 could thus have a surprise in store, but some of the geologists are banking on comparisons with terrestrial dune fields with similar spacing and contour-softening as evidence for an adequate cushion.

At least there is likely to be more water, although still not necessarily in liquid form. Data from the orbiters has indicated that the amount of water in the atmosphere increases by about 10 times between the equator and the 22° latitude of the lander 1 site, and by another factor of three between 22° and lander 2's tentative destination in the high 40s. Along the edge of the now-minimal north polar cap, in fact, says Crofton B. Farmer of the Jet Propulsion Laboratory, the airborne water-vapor content is nearly 100 times that over the equator. In the lower latitudes, he says, most of the water vapor is concentrated in the bottom 1 to 2 kilometers of the atmosphere, but for the frigid near-polar air to hold as much water as it does, it must be saturated—100 percent humidity—virtually from bottom to top. Temperatures that encourage such voluminous release of water, Farmer adds, suggest that any frozen carbon dioxide from the cap must be long gone, meaning that the cap at its minimum extent must consist almost entirely of water ice. □

Immunizing against pregnancy: Advances



Yanagimachi et al./PNAS

Sperm can't penetrate egg coated with antibodies (l.) whereas they can penetrate the uncoated egg (r.).

Visualize a woman receiving an injection of antibodies, the antibodies keeping sperm from penetrating the eggs she releases during the subsequent year, and the antibodies not interfering with her ovulation, menstruation or other bodily functions. Sound like the ideal female contraceptive? Quite possibly, and researchers are moving ever closer to it.

The most promising and recent evidence that this concept is feasible, that it provides temporary contraception without side effects in live animals, is reported in the July PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES by Ryuzo Yanagimachi of the University of Hawaii School of Medicine, Jeff Winkelhake of the Medical College of Wisconsin and Garth L. Nicolson of the Salk Institute for Biological Studies. Temporary immunization against pregnancy could become clinically available in another five years or even less, these researchers estimate, provided scientists and science funders make an immediate, concerted effort.

This approach to contraception got its first major boost in 1972. C. Alex Shivers of the University of Tennessee showed that if an antigen of hamster eggs was injected into rabbits, the rabbits made antibodies to the antigen. If the antibodies were then placed in a test tube with a hamster egg and hamster sperm, they coated the egg and kept the sperm from penetrating and fertilizing it (SN: 2/10/73, p. 94).

Last year Yanagimachi showed that the same effect could be achieved in live animals. If antibodies to the hamster egg antigen in rabbits were injected into female hamsters, the antibodies prevented conception during several estrous cycles, showing that the method was both effective and temporary. Scientists had previously worried that antibodies might trigger permanent infertility.

Now Yanagimachi, Winkelhake and Nicolson have shown not only that one injection of antibodies prevents conception during several hamster estrous cycles, but also that the antibodies concentrate in the ovary and not in other organs. This suggests that the antibodies are selective in their action and would not disturb other physiological functions. Whether the antibody injections might somehow compromise future pregnancies or the health of future offspring is not yet known, but the researchers think it is unlikely since the antibody levels in the female hamsters fall off in a linear fashion and do not harm female reproductive organs.

The next step toward applying the concept in women depends on isolating an antigen on the human female egg that can be injected into rabbits to raise protective antibodies. These antibodies in turn would be injected into women. Winkelhake says this feat should not be difficult because scientists now have the technology to do it. Scientists would then have to see how long one injection of antibodies would protect a woman from conception. Since one injection protects a female hamster over four estrous periods (7 days each for a total of 28 days), it is likely that one injection would protect a woman for a comparable period or perhaps longer. In any event, one injection would offer much longer protection than birth control pills that have to be taken daily. And one injection would probably also offer fewer side effects than the pills do since the injection appears to interfere only with sperm penetration of eggs, not with female hormones.

When might such a form of birth control become commercially available to women? Winkelhake estimates it will be five years or even less, depending on how earnestly scientists set about accomplishing these goals and how much support is provided by interested funding agencies such as the World Health Organization.

Actually, some female subjects have already been successfully immunized against pregnancy for up to a year. They received antibodies raised against the human hormone that is necessary for the establishment of pregnancy—human chorionic gonadotropin (SN: 2/21/76, p. 117). Although this approach has proved its effectiveness in some human subjects, and immunization against an egg antigen has yet to do so, Winkelhake believes that the latter approach may eventually prove superior. The reason is that HCG may have some crucial physiological functions other than just establishing pregnancy. If so, knocking HCG out of commission for a year would jeopardize such functions.

Only time will tell whether one form of immunization against conception is more effective and safer than the other. In fact, still a third form of immunization against pregnancy may emerge from this field of research. Once an antigen from the human female egg has been isolated, it might be used alone to vaccinate women against conception. □