SPACE

Germs and the Space Age

Mars, the moon, even the earth itself could be overrun with strange new diseases unless spacecraft are sterile—By Jonathan Eberhart

➤ IN THE 18TH CENTURY, several European explorers sailed around the tip of South America and continued onward to visit the islands of the South Pacific. On at least one of these journeys, in addition to the usual ship's complement of mapmakers, adventurers and able seamen, went a few microscopic creatures carrying nothing with them but a relatively mild children's disease called measles.

The islanders in their Polynesian paradise had long been isolated from outsiders and so lacked the immunity to measles that the Europeans had been building up for hundreds of years. The mild disease became a rampaging killer, accounting for thousands of deaths and almost completely depopulating some of the islands. Today, lack of immunity poses a similar problem. The distances are greater, however—millions of miles instead of thousands—and at stake, instead of islands, are entire planets.

What happens, for instance, if a harmless little unmanned space vehicle from earth lands on Mars carrying 10 lone bacteria that the planet is not equipped to fight? Well, if each bacterium reproduces about every 30 days, in 10 years Mars will be overrun with 1,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 (120 zeroes) bacteria, more than earth is estimated to have itself! Needless to say, unwanted microorganisms are a matter of considerable concern. The National Aeronautics and Space Administration has been studying the matter for almost as long as it has been launching satellites.

Early Investigations

Early investigators passed the matter off by saying that the vacuum of outer space would surely kill any germs that survived both clean room assembly procedures and the friction of the ascent through earth's atmosphere.

Then in 1961, a team of U.S. Army Chemical Corps scientists at Fort Detrick, Md., exposed some bacteria samples to various hostile environments, including a calcium sulfate atmosphere, a vacuum, a nitrogen atmosphere and other conditions. They reported, with some concern, that ultra-high vaccum was among the environments "most conducive for the preservation of microbial viability."

NASA then started on a search for a way to sterilize any and every piece of equipment that would ever set "foot" on another planet. Of the three chief means available—heat, poison gas and radiation—all had their drawbacks. Radiation was dangerous, gas (usually ethylene oxide) was not always effective, and heat often damaged delicate equipment, especially electronic gear.

NASA was forced to make a choice, however, as more and more studies led to the conclusion that bacteria could be found capable of surviving almost anywhere and of breathing almost anything (or nothing). On Sept. 13, 1963, NASA announced a general version of its sterilization requirements, but even before that time there had been a policy that "under no circumstances will an unmanned spacecraft destined for landing on the planets be launched until sterility has been assured."

Heat Selected

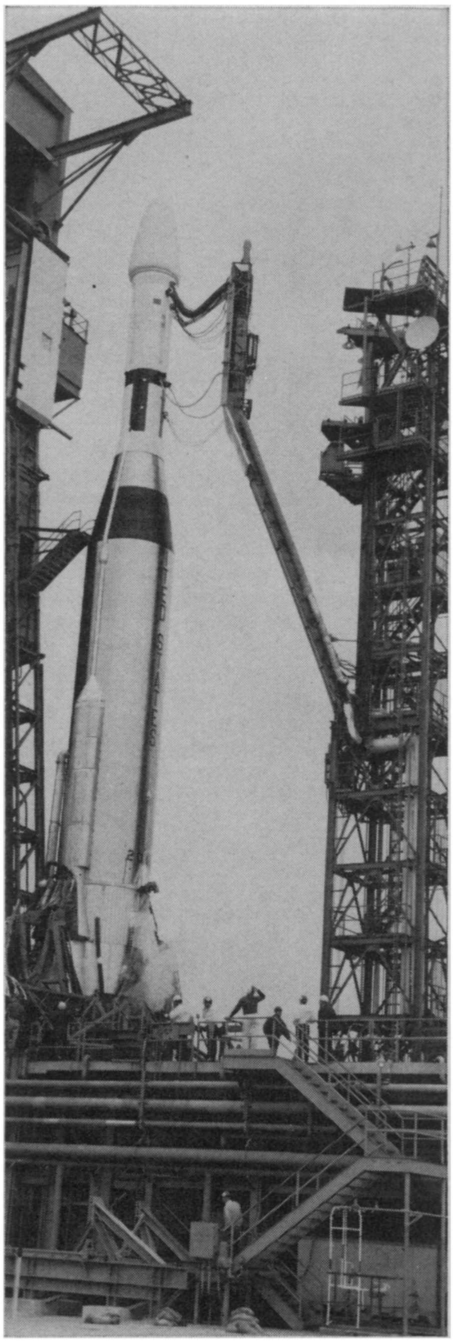
The general statement said, in effect, that heat had been selected as the best treatment, and that components that could not take it would just have to be improved. Only if redesigning did not help would the other methods be used.

Spacecraft destined for other planets would be assembled in dust-free, controlled-humidity clean rooms, then heat-treated and finally sealed in airtight cannisters, in which they would stay until they were out in space.

Lunar landings rated somewhat less-exacting procedures: after the clean room, "sporicidal agents" would be used to kill most of the microbes. No sealed containers would be used. NASA was betting that the moon's airless extremes of temperature would prove so hostile that nothing at all could survive.

Later on, the "official heat treatment" for all "landers" was set at one 24-hour period at 275 degrees F. Then some super-hardy bacteria made scientists nervous again and the required exposure was raised to three 36-hour doses of 293 degrees F. Spacecraft would be sealed in their cannisters before leaving the heatroom.

Despite these precautions, the most pessimistic men in the space business are the contamination officers. Almost every aerospace company has one, and none of them ever believes that



NASA

GERMLESS MOON SHOT—Ranger 9, the last of three spacecraft to crash on the moon after photographing it, is poised and ready for its germ-free ride through space. Assembled in an air conditioned clean-room, the craft was then exposed to ethylene oxide gas to kill any microorganisms that might possibly contaminate the moon. Once sterilized, it was sealed in an air-tight container and mounted atop the Atlas-Agena launch vehicle.

all the bacteria aboard a given vehicle are dead. Instead, they are gamblers trying to predict the odds that any microorganisms will be left alive after such-and-such a treatment. NASA has a full-time Special Assistant for Planetary Quarantine, despite the fact that scarcely a handful of U.S. spacecraft have actually touched down on another world.

An extreme example of the possible effects of planetary contamination is man. In fact, several authorities believe that all life on earth could be descended from a single spore that landed after years of floating through space, rather than from a freak combination of chemicals and environmental conditions. This theory was first suggested in 1908 by the Swedish chemist, Svante Arrhenius, who called it "pan-spermia." Imagine the effect of a few uninhibited bacteria turned loose on another planet after a flight aboard a contaminated spaceship.

When the Soviet spacecraft Venus 2 crashed on Venus this year, a cry of "Contamination!" rose until the Russians belatedly announced that they had sterilized the vehicle. Scientists were concerned despite estimates that the surface temperature of Venus reaches 800 degrees F.

Several experimenters, including some at Union Carbide Corporation, have succeeded in growing not just bacteria, but full-fledged plants under a wide range of unusual conditions. At Union Carbide, for example, winter rye, corn and several other cereals were grown from seed despite temperature variations from 65 degrees F. to four degrees below zero. In addition, the grains had to withstand a lava-like substance called Perlite instead of soil, as well as an atmosphere containing 97% oxygen and 3% carbon dioxide. Most plants are accustomed to an atmosphere that is about four-fifths nitrogen.

Other plants — succulents, some high-altitude conifers such as black pine and others—have endured similarly unfriendly environments for as long as 300 days, even when their initial growth was in normal terrestrial surroundings. Onions have prospered in an atmosphere primarily of methane, a major component of Jupiter's "air."

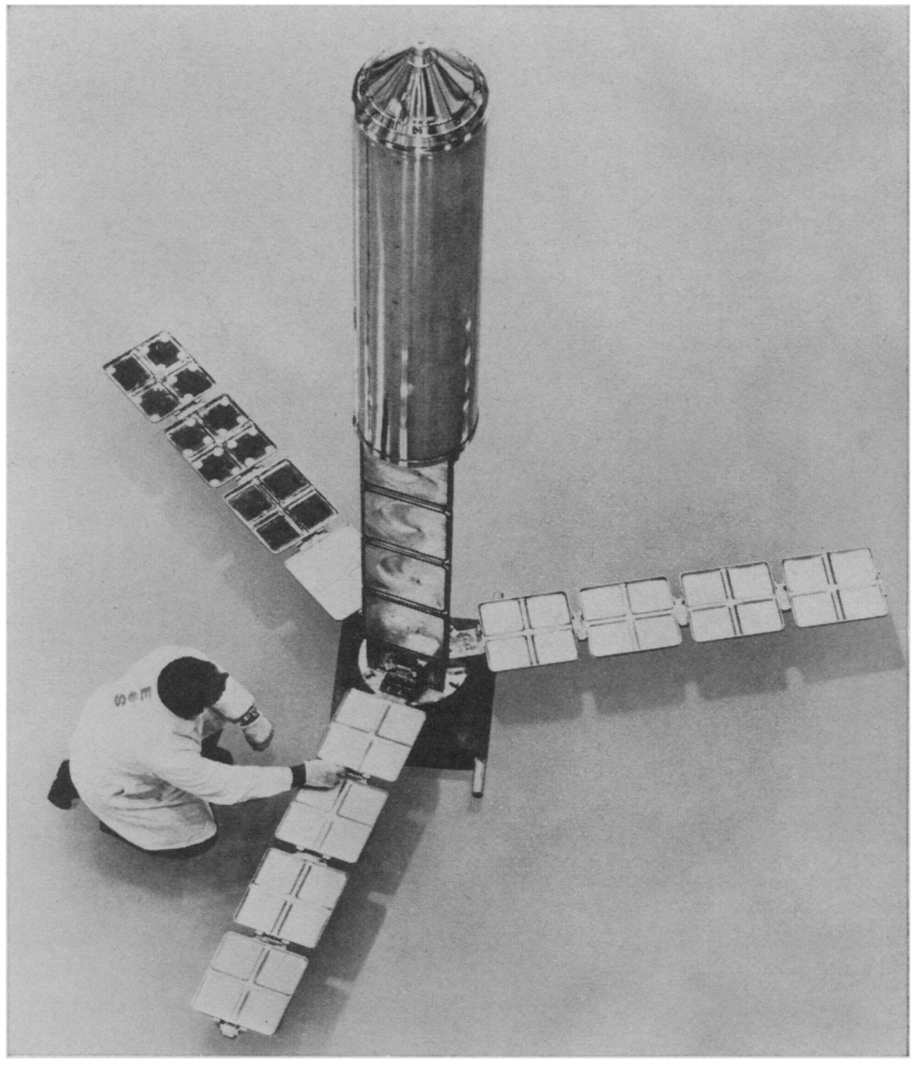
A plant is the product of generations of ancestors, each one more specialized than the one before. Many microorganisms, however, are very primitive, and therefore unspecialized. If an ordinary onion can adapt to methane, there surely must be a bacterium which, given half a chance, can adapt to anything.

Other planets are not the only ones in danger. What about strange microcreatures brought back on returning spacecraft and turned loose in a strange but tolerable environment?

Many bacteria have a reproduction time of less than 12 hours. One proposed round-trip Mars flight calls for a spacecraft to spend 40 days on the surface, enough time for some 80 generations of such bacteria—each larger than the last—to evolve into a variation which just might be able to live both on Mars and on earth.

As the Space Age progresses, sterilization will become ever more important, but, perhaps, more difficult. When orbiting space stations make it practical to construct larger spacecraft in orbit instead of on earth, individual parts will have to be sterilized before they are sent up to be assembled. To maintain their "purity," the construction tools, already in orbit, will have to be treated too. And so on back to the space stations themselves, even though they were never intended to leave their orbits.

The problem is a vast one. Even the customs officials who carefully inspect every plant or animal brought from one country into another have an easy job, compared to the men who have found themselves entrusted with guarding the very planets.



Electro-Optical Systems, Inc.

PROSPECTING "LUSTER"—"Luster" is the name of a prospecting space probe launched into space last year by an Aerobee 500 rocket. Built by Electro-Optical Systems, Inc., Pasadena, Calif., Luster automatically uncovered the sealed containers on its three arms and gathered valuable samples of microscopic space dust. The samples returned to earth with Luster and are being chemically analyzed.

TECHNOLOGY

Industrial 'Kidney' Cleans Pulp Water

➤ AN "INDUSTRIAL KIDNEY" that can clean up spent liquor from pulp mills and other wastes from industrial processes is being developed at the Sulphite Pulp Manufacturers' Research League, Appleton, Wis.

The pollution of streams by pulp and paper mills has long been a problem, and for many years manufacturers have been conducting research on methods to reduce it.

The new process involves the use of a synthetic membrane that removes wastes from water in much the same way as do living kidney membranes.

The process shows great promise, said Loren V. Forman, League president and also vice president of the Scott Paper Company.