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## Contamination from the Moon

Recently a few scientists, as well as the *New York Times*, have questioned the adequacy of procedures attending the return of astronauts and samples from the moon. They suggest that forms of life resident there might contaminate the earth catastrophically. This is extremely unlikely.

Molecules such as H<sub>2</sub>O, N<sub>2</sub>, and CO<sub>2</sub> disappear rapidly once they reach the atmosphere. The unprotected surface of the moon, where the astronauts will touch down, is bombarded by the solar wind, x-rays, and ultraviolet light, and the temperature varies between about 100° and 400°K. Because of radiation and thermal degradation, nucleic acids and proteins would not remain intact very long. The environment beneath the surface of the moon is less harsh but still not conducive to life. At depths of a meter or more the temperature always remains much below the melting point of H<sub>2</sub>O. Near the surface there is a level where temperatures vary above and below the freezing point in response to the influence of the lunar cycle. In this region, however, free H<sub>2</sub>O, O<sub>2</sub>, and CO<sub>2</sub> quickly diffuse to the surface. Without renewable energy sources, life perishes, for the degradation of organic matter proceeds slowly but inexorably even at 273°K.

There remains, of course, a formidable collection of hobgoblins. They include such types as life based on silicon and living forms as yet undescribed. Given the vague nature of such organisms, logic is a poor weapon. You can't prove a negative. One argument is that a form of life adapted to the absence of H<sub>2</sub>O, O<sub>2</sub>, and organic compounds could scarcely be expected to survive on earth, much less infect earth's creatures. The most compelling argument, however, is that the lunar-return experiment has been conducted many times in the past. It has been estimated that millions of tons of unsterilized lunar material have reached the earth as a consequence of meteor impact.

Once the specter of contamination from the moon had been raised, quarantine procedures were inevitable and justifiable. The Public Health Service, the Department of Agriculture, and the Department of the Interior are charged with protecting humans, agriculture, and wild life. For example, "Whereas the unregulated movement of means of conveyance, their stores, . . . earth, stone and quarry products . . . into . . . the United States from places outside thereof . . . may disseminate plant pests. . . . No soil shall be moved . . . into the United States except as authorized. . . ."

A large number of scientists have devoted much effort to the quarantine problem during the past 5 years. Sterile containment of lunar specimens during the journey to Houston is assured. At Houston a Lunar Receiving Laboratory (*Science*, 3 February 1967) has been specially constructed to house astronauts during a 3-week quarantine period and to facilitate extended examination of the lunar samples. Attempts will be made to culture organisms on many different media, and various living forms will be exposed to powdered portions and extracts of the returned samples.

Procedures involving the astronauts are more controversial. Careful effort to keep to a minimum the amount of adventitious material returned to earth is a substantial factor in the procedures that have been adopted. The astronauts face a difficult and dangerous mission. Were their procedures to be made even more complex because of panicky, last-minute objections, their chances of a safe return could be needlessly jeopardized.—PHILIP H. ABELSON