this, I assume that the investigators would employ reasonable methods to rule out cancers induced by radiation diagnosis or therapy and that no cases of previous pathology would be included.

However, Lengemann seems to have missed the main point of the report—namely, that the continental tests involve radiation dosage to humans in excess of any previously acknowledged levels. The single instance of Troy, New York (for which I managed to assemble some data), suggests the possibility that a thyroid survey might reveal evidence of radioiodine injury. But should this not be the case, other areas closer to the Nevada Proving Grounds, such as the Salt Lake City region, should be surveyed. I hope that the Public Health Service will undertake such surveys in the near future.

RALPH E. LAPP
1315 Park Terrace Drive,
Alexandria, Virginia

Life on Mars

The article by G. V. Levin *et al.* [*Science* **138**, 114 (1962)] on a device ("Gulliver") for detecting microorganisms on Mars is fascinating. There are so many parameters of the testing apparatus which might be changed to improve the chances of a successful test that I suspect the authors will be inundated with suggestions.

The article suggests that a solid medium may be used instead of broth. If this is done it should be possible to use several different media in separated compartments, with a single detector for radioactivity. This would be an important change, since the medium seems to me to be the point most susceptible to improvement.

The medium outlined by Levin *et al.* would be too rich for many terrestrial microorganisms. It might be worse for organisms on Mars. If Martian life forms originated there, their stereospecificity could be the reverse of that found on earth—D-amino acids and L-sugars. In this case—and in many others which can be imagined—the complex medium would probably be toxic. (Similarly, the solidifying agent in the medium should be one of the silicones rather than agar.) I suggest an inorganic salts medium whose only carbon is traces of labeled acetate, glycerol, and glycine.

The article on Martian environments by F. B. Salisbury [*Science* **136**, 17 (1962)] implies that Martian surface water may be of very high osmotic pressure, and this is a second parameter I should like to see varied. For example, if no radioactivity were detected after some reasonable period of incubation, it might be possible to release crystals of sodium chloride into the media.

It seems to me that it would be better to use all communication channels in "Gulliver" for experimental portions of the program than to reserve half of them for controls. A metabolic inhibitor (chloroform?) could be added to the entire system shortly before the end of transmissions, serving the same purpose as the control described by Levin *et al.*

Any biologist can think of many other variables which might be important: temperature, light, humidity, metabolite concentrations, and so on. To the men who will make the final decisions, I can only say: Happy hunting!

STANLEY A. ZAHLER
Laboratory of Bacteriology,
Cornell University, Ithaca, New York

I have just read about "Gulliver" in *Science*. This letter is an ecologist's plea to NASA and its foreign counterparts to refrain from landing anything on Mars (or on Venus) until they are able to send a man trained to look for evidences of life or to bring back a sample of Martian material.

The authors of the Gulliver piece recognize the danger that possible contamination with organisms from the earth might leave us forever in doubt about the nature or even the existence of indigenous Martian life. They feel that this project is important enough to justify the risk, if suitable precautions in the way of sterilization are taken. I disagree. Mars is the best single hope for exobiology (or xenobiology), and the questions that Martian organisms might answer are fundamental.

It is now widely believed that, on the earth, organic matter evolved gradually in quantity and complexity long before the origin of life. If Mars should be back in the "primeval soup" stage it might take only a fragment of DNA from a dead microorganism, or a spore or pollen grain that stuck to the rocket in its passage through the atmosphere, to initiate an earth-type evolutionary process.

If Martian organisms have discovered a self-replicating molecule that is not a nucleic acid, how much more fascinating this would be. Perhaps there are organisms there that need their sugars in the L-form and their amino acids in the D-form. If so, they will be unable to use Gulliver's culture medium. Not only that—they might not survive competition with contaminants from the earth.

Please NASA, shoot anything you wish at the moon but hold off on Mars and Venus!

LAMONT C. COLE
Department of Zoology,
Cornell University, Ithaca, New York

The article by Levin *et al.* was primarily concerned with the development of an optimum medium for culturing microorganisms which may live on Mars. The composition of the medium being used was given in Table 1 of the article. The authors state that this medium represents the most satisfactory degree of complexity for their purpose. I assume that the term *amino acid hydrolyzate* means the mixture of amino acids obtained by hydrolyzing proteins. Therefore, the authors are assuming that organisms on Mars will metabolize L-amino acids and D-glucose just as organisms happen to do on the earth. The simple inclusion of racemic mixtures of amino acids and sugars might increase the chance of detecting life on Mars by a factor of 2. Although D-amino acids may inhibit the growth of certain microorganisms, the increased chance of detection warrants preliminary terrestrial experiments along these lines. No such experiments were mentioned.

Levin and his associates emphasize that media have been tested under "natural conditions." Although it might be argued that the inclusion of D-amino acids is not "natural," the apparent fifty-fifty chance of life's evolving with either optical antipode (*1*) would increase the probability of positive results in what will be the most expensive biological experiment in history.

Later probes might be designed to be more selective regarding the type of life forms (if any) present on Mars.

ROBERT V. RICE
Mellon Institute,
Pittsburgh, Pennsylvania

Reference

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