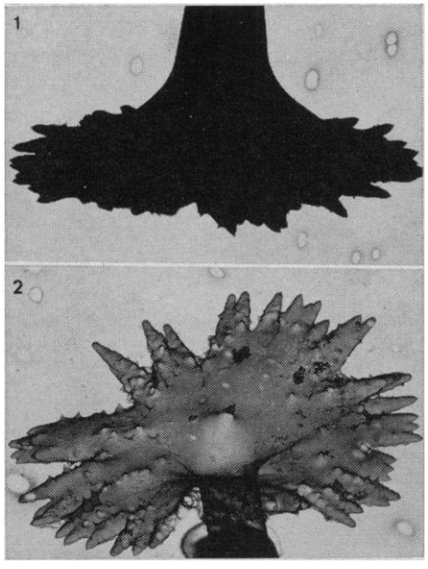

Fig. 1. Rotulate end of a birotulate microsclere from a gemmule of the freshwater sponge *Heteromyenia* sp. (× 3000). Fig. 2. Carbon replica of a rotulate end similar to that in Fig. 1. The surface appears smooth, and the microspines are clearly seen (× 3000).

Much of sponge taxonomy relies on spicule structure for identification of different taxa. Because many spicules are composed of amorphous silica, they are difficult to examine rigorously in the light microscope due to inherent chromatic and spherical aberrations. The microspines in Fig. 2 are not clearly seen with even oil-immersion phase contrast. Because of the importance of spicule structure in sponge taxonomy, precise images of spicules are essential for definitive classification and identification. This technique offers a convenient means of obtaining accurate pictures of spicules. It has also been used with great success to study frustule structure, shell structure in foraminifera and radiolarians, and opaline phytoliths in higher plants. It can probably be used to study any siliceous particles of biological origin and perhaps siliceous minerals as well.

RYAN W. DRUM
Department of Botany,
University of Massachusetts,
Amherst 01003

References and Notes

1. R. W. Drum and J. T. Hopkins, *Protoplasma* **62**, 1 (1966); B. E. Reimann, J. C. Lewin, B. E. Volcani, *J. Phycol.* **2**, 74 (1966).
2. D. C. Pease, *Histological Techniques for Electron Microscopy* (Academic Press, New York, 1964).
3. I thank Dr. W. D. Hartman, Yale University, and Dr. T. L. Simpson, Tufts University, for valuable discussion regarding this work.

5 June 1967

Irradiated Parabiont Animals

The report by Carroll and Kimeldorf (*1*) interested me because they are apparently surprised by finding "a remarkable degree of survival for irradiated members of parabiont rat pairs if the partner were shielded." While the details of their experiments differ somewhat from those obtained in our laboratory, we have been working with such parabiont rats and taking advantage of this protective effect for some 17 years.

Our first mention of protection of irradiated parabiont rats by their shielded partner was made in the "Semi-Annual Progress Report of the New England Deaconess Hospital to the United States Atomic Energy Commission November 30, 1950." Edwards and Sommers reported from this laboratory (*2*) that in irradiated rats protected by parabiosis there was increased resistance of parabionts to radiation when one of the pair was shielded.

Warren, Chute, and Farrington (*3*) demonstrated protection of the hematopoietic system in irradiated rats by parabiosis and demonstrated that leukocytes were supplied temporarily by the shielded partner.

It is of interest that Carroll and Kimeldorf have used a pathogen-free strain of rats and that they have used a skin-to-skin anastomosis rather than the coelomic one which we employ.

SHIELDS WARREN
Cancer Research Institute,
New England Deaconess Hospital,
Boston, Massachusetts 02215

References

1. H. W. Carroll and D. J. Kimeldorf, *Science* **156**, 954 (1967).
2. J. L. Edwards and S. C. Sommers, *J. Lab. Clin. Med.* **40**, 342 (1952).
3. S. Warren, R. N. Chute, E. M. Farrington, *Lab. Invest.* **9**, 191 (1960).

6 June 1967

We were aware of the two published papers cited by Warren but not of the semiannual progress report from the New England Deaconess Hospital to the AEC. The two published papers are relevant from the point of view that the investigators used parabiosis to analyze for the existence of a toxic factor affecting radiation-induced pathology.

The work of Finerty and his colleagues (see *1*, for example) could have been cited as well. Indeed, Barnes and Furth (*2*) used parabiosis in mice to study radiation injury as early as 1943. Some degree of protection may be inferred from all of the studies cited, although none have described the remarkable survival rates, noted by us in our report, over the much higher dose range of 1200 to 2400 roentgens. The major point of the results and discussion in our report was that parabiosis could be used to prolong survival and even override the gastrointestinal syndrome that leads to death within 120 hours after irradiation.

H. W. CARROLL
D. J. KIMELDORF
U.S. Naval Radiological
Defense Laboratory,
San Francisco, California 94135

References

1. J. C. Finerty, *Radiology* **62**, 234 (1954).
2. W. A. Barnes and O. B. Furth, *Am. J. Roentgenol. Radium Therapy Nucl. Med.* **49**, 662 (1943).

14 June 1967

Contamination of Planets

The concern expressed by Horowitz *et al.* (*1*) is sufficiently important to the scientific community and the taxpaying public to warrant further examination. We were primarily concerned with the probability of growth of a terrestrial microorganism on Mars (P_m, Sagan-Coleman model).

While it is true that Horowitz *et al.* used the latest information regarding the physical environment of Mars, their data regarding the growth of organisms in a simulated Martian environment are limited. The question of whether a terrestrial microorganism will grow in the environment is the cardinal point regarding the possibility of contamination; it's importance demands more comprehensive treatment than theirs (*1*).

One must recognize that all interpretations of P_m are based on a limited number of organisms; it is possible that the sampling has omitted the organism that will tolerate the environment. Several observations not cited (*1*) must be taken into account before the probability of growth is established at a lower level than was originally suggested.

Studies (*2*) have demonstrated that *Bacillus cereus* survives but does not grow in a simulated Martian environment under the following conditions: 100-percent CO_2 at 10 mb; diurnal temperature cycle, with 20 hours at

−60°C and 4 hours at 25°C; felsite-limonite soil; and soil moisture between 0.970 and 0.975 a_w. Inhibition of growth, although erratic, was related to gaseous composition and barometric pressure, since growth occurred under Earth's atmosphere at 98 mb (*3*).

Other of our data demonstrated that the facultative anaerobe *Staphylococcus aureus* grows 2 to 3 log factors in a similar environment within 28 days; such growth was hastened by decreasing the concentration of CO_2 and increasing the barometric pressure (*4*). This organism commonly contaminates clean rooms and so must be considered a potential planetary contaminant.

Of particular interest is the observation that the diurnal temperature cycling aids in conservation of water and its availability to the microbial cell. Specifically, in simulated environments low in soil moisture and maintained constantly at 25°C, staphylococcal organisms survive with no increase in number; imposition of diurnal temperature cycling initiates growth.

Furthermore it has been demonstrated with several microorganisms that, after maximum growth is achieved, growth can be reinitiated if the soil containing the organisms is mixed with fresh soil. This fact implies that the colony can spread over a wider area than the immediate vicinity of the spacecraft.

We completely agree with the statement that water is the most critical factor for the initiation of growth in the Martian environment. As has been stated, the water near the polar cap may contain high concentrations of salt; however, it is known that facultative anaerobic staphylococci grow very well in medium containing 10 percent NaCl. Furthermore, Siegel and Roberts (*5*) have reported a bacterial ecology at still higher concentrations of salt, and Cameron *et al.* (*6*) have reported bacterial ecologies in alkaline-type soils from the Atacama Desert, Chile.

We believe that, pending further data on the moisture contents of the Martian atmosphere and soil, any attempt to modify the probability-of-growth statement expressed in the Sagan-Coleman equation is premature.

E. J. HAWRYLEWICZ
CHARLES A. HAGEN
Life Sciences Research, Illinois Institute of Technology Research Institute, Chicago, Illinois 60616

4 AUGUST 1967

References and Notes

1. N. H. Horowitz, R. P. Sharp, R. W. Davies, *Science* **155**, 1501 (1967).
2. Conducted by Illinois Institute of Technology Research Institute.
3. E. J. Hawrylewicz, C. Hagen, V. Tolkacz, R. Ehrlich, at COSPAR Symposium on Space Science, Vienna, 1966.
4. C. A. Hagen and E. J. Hawrylewicz, *Ill. Inst. Technol. Res. Inst. Quart. Status Rept. L6023-8*, 15 Nov. 1966–15 Feb. 1967.
5. S. M. Siegel and K. Roberts, *Proc. Nat. Acad. Sci. U.S.* **56**, 1505 (1966).
6. R. E. Cameron, D. R. Gensel, G. B. Blank, *Jet Propulsion Lab. Space Program Summary No. 37–38* (Calif. Inst. Technol., Pasadena, 1966), vol. 4, pp. 140–47.

24 April 1967

Under the conditions of the experiments described by Hawrylewicz and Hagen, the activity of water (that is, its vapor pressure relative to that of pure water at the same temperature) apparently could not fall below 0.97 at 25°C. Such experiments are of dubious relevance for Mars, whose atmosphere contains only traces of water and where the total atmospheric pressure is not much higher than the pressure of water vapor at the triple point. It is generally agreed that terrestrial microorganisms grow only in aqueous solutions. Given the dry atmosphere of Mars and the low boiling point of water on the planet (near 7°C at an atmospheric pressure of 10 mb), it seems clear that highly saline soils would provide the most favorable—if that is the word—environment for terrestrial microbes. We have discussed the implications of this conclusion [*Science* **155**, 1501 (1967)].

N. H. HOROWITZ
Biology Division, California Institute of Technology, Pasadena

3 July 1967

Visual Adaptation: Its Mechanism

I would like to raise some objections to the evidence used by Dowling in his attempt to establish the important point that visual adaptation occurs in the retinal bipolar cells (*1*).

Dowling assumes that the rat's visual receptors are probably all rods, and the relationships presented are therefore for a rod system. I seriously doubt the validity of this assumption. Dowling's curves for the increment thresholds of the rat electroretinogram (ERG) show that the logarithm of the threshold increases linearly with the logarithm of the background over about 7 logarithmic units of adapting light. What is especially surprising is that, even when more than 90 percent of their rhodopsin has been bleached away, rat rods can still respond and that at this point the Weber relation ($\Delta I/I$ = constant, where ΔI = change in intensity and I = background intensity) still holds. This is difficult to believe when one compares rat rods with human rods since the latter obey this function over only about 4 logarithmic units above the point at which background light first begins to affect their sensitivity (*2*). Brighter adapting lights completely saturate the human rod mechanism at a concentration of rhodopsin which is only a few percent of the amount in dark-adapted rods.

Human psychophysical experiments cannot be easily compared with electrophysiological ones in the rat. Therefore, I submit the following experimental evidence to show the differences between the rod mechanisms contributing to the rat and human ERG's are also great.

Figures 1 and 2 show how adaptation to light affects the human ERG. Both the stimulus and the adapting light in these experiments cover the subject's visual field completely and homogeneously. The stimulus is a 10-μsec flash obtained from a Grass stroboscope recessed in a diffusing sphere behind the subject's head. The adapting lights, similarly placed, come from tungsten filament lamps powered by a wet-cell battery. Two chromatically different stimuli are used, one from each end of the visible spectrum and obtained by means of wave-band filters. In Fig. 1 these stimuli are balanced to have equal effects on human rods (*3*). The stimulus of short wavelengths produces only rod components, whereas the stimulus of long wavelengths elicits both rod and cone components in the ERG (*4*). In the presence of a background light of 10 mlam, a response can only be evoked by the latter stimulus. This response must result from the activity of cones since the scotopically equivalent stimulus of short wavelengths produces no response at all.

Figure 2 shows that in the presence of the same background light, even a much stronger stimulus to the rods is incapable of eliciting any components of the rod system in the ERG. The stimuli, in this case, are balanced to have equal effects on the photopic or cone receptor system of the human eye. The stimulus of long wavelengths is the same as in Fig. 1; that of short wavelengths is six times stronger than