THE MICROBIOLOGICAL CHALLENGE IN SPACE

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It is the purpose of this paper to crystallize, within the allotted time, the possible potential position of the microbiologist on that team of scientists and engineers who are currently applying their several disciplines in meeting the challenges represented by today's astronomical frontier. As nautical became prefixed with astro-, so biology, zoology, botany, and microbiology can be expected to grow into the new experimental and applied areas which are connoted in the prefix astro-. Astromicrobiology, like any of the other new areas so created, will seem a little uncomfortable at first. This concept in microbiology may be subject to criticism, but evaluated it must be. The evaluation best comes from the microbiologist himself. It may be recalled that at the symposium of May 14-17, 1958, on "Possible Uses of Earth Satellites for Life Sciences Experiments," the biologist considering satellite uses was cautioned. My own notes on this read, "Biologists not yet ready to go into orbit. Keep your feet on the ground." From this memo we can abstract and build on the idea "not yet ready." What the state of readiness is, for the microbiologist in particular, represents an early challenge. What he does with his own state of readiness once he has determined it represents a portion of the opportunities associated with the expanding effort and must be his own decision. Opportunities here, however, do father a continuing host of additional challenges.

The nonbiological use of satellites and rockets, reflecting the engineering capabilities of contemporary missiles, has been reviewed and published in the proceedings of the symposium "Scientific Uses of Earth Satellites" (Van Allen, 1958). The 34 papers contained therein all concern themselves with the geophysical aspects of space probing and illustrate well the fundamental instrumentation, telemetry, and other factors involved in sensing and transmitting back to earth the data collected.

Approximately two years later, Dr. Pickering, presenting Dr. Froelich's paper, "The Army Rocket, Satellite, and Space Flight Program," at the "Biological Uses .... Symposium," indicated the following five factors as governing our ability to use successfully earth satellites in scientific exploration. These concern the adequate development of:

1. A rocket cluster of adequate size
2. Guidance and control systems
3. Environmental control
4. Communication
5. Production and operational capacity

The 15 intervening months have seen some marked advances in many of these areas. A summary of this progress has been reported by Medaris (1959).
list of space probe achievements, conducted for the National Aeronautics and Space Administration, can well be supplemented by achievements of the other services. In 1959 it is expected that, under the auspices of the Advanced Research Projects Agency, a cluster of booster rockets will be developed for Project Mercury which will produce a thrust of 1,500,000 lb. This can indicate for us what payload potentials exist. A good rule of thumb indicates that the launch to weight ratio may be estimated as 1000:1 and proved valid for example, in the Vanguard. This represents an advance in capabilities particularly since pre-Vanguard ratios were more nearly 2000:1. Assuming however that a 1,500,000-lb thrust is achieved, a payload of only 1500 lb would represent our capability in Project Mercury, where we expect to carry a man and all his supporting gear. The significance of biological probing, therefore, where microorganisms are proposed to act as environmental sensors looms high, in relationship to available payload. Properly miniaturized experiments can utilize with maximum efficiency any space on the payload dedicated to biological research. There is no contention here implied that data obtained with microorganisms as probes have a high transfer value in terms of studying spatial environmental effects on man. On the other hand, it is generally contended that man’s sensitivity to various types of radiation is higher than that of any other organisms, including other primates and therefore he would actually be his own best test animal. Microbiological space probes must be evaluated with the same reservations that exist for all bio-assays. Beyond this, the academic "need to know," what extraterrestrial environmental effects will be on biological systems is basic to the growth of biology.

The effect of environmental factors on bacteria and fungi is a study of fairly long standing and suggests parameters may well be used as a basis for comparative studies of limiting environments. The limiting environments would involve such factors as temperature, including high and low values, moisture, pressure, as in vacuums producing suntry outgassing phenomena. Outer space explorations would take us through various types of atmospheres. These may be enumerated as:

1. Chemical
2. Radiations
   a. nuclear, alpha, beta, gamma, x-rays
   b. solar
   c. cosmic
   d. magnetic
   e. auroral
   f. electrostatic
3. Particulate
   a. space dust, meteoritic grit
4. Gravity-associated
   a. zero and near zero
   b. accelerated, shock
5. Planetary (various combinations)

Table 1, for which I am indebted to Erik Linden of the Signal Corps, is an abridgement of an excellent compilation made by him in his studies on the effects