

## PANEL DISCUSSION, BIOLOGICAL OBJECTIVES OF UNMANNED EXPLORATION OF THE SOLAR SYSTEM

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The biological objectives of unmanned exploration of the solar system lead beyond the solar system. The ultimate objective must be approached through intermediate ones.

Remote observations have confirmed that the Earth-gained laws of physics and chemistry are applicable to the universe at large. On the other hand, our knowledge of biology has not yet advanced to that point, and our knowledge of extraterrestrial biology is essentially nil. Remote sensing, while providing considerable extraterrestrial chemical and physical information, has not been developed to the point where important biological data can be obtained.

The first objective of unmanned exploration of the solar system for biological purposes is to obtain direct evidence for or against the existence of extraterrestrial life. In the event such life is not found, we shall want to know why it has not arisen and whether the process of pre-biological evolution is operating. The information obtained may materially aid our theories concerning the origin of life on Earth.

Assuming that extraterrestrial life is found, the next objective would be to determine whether the life is similar to Earth life. If unmanned, biochemical laboratories demonstrate that the life forms found are similar to our own, the stage for the next objective is set. This will be to determine whether the extraterrestrial life arose independently or whether it and life on Earth are of common origin and, thus, whether the germ of life can be transmitted across the space void.

If the extraterrestrial life found is different from Earth life, the objective would then be to explore the variety and distribution of life forms and to investigate the biochemistry. A very important objective arising from this and related investigations would be to seek an explanation of the origin of life.

Sometime after the discovery of extraterrestrial life, a practical objective would undoubtedly arise. This would be to determine whether knowledge gained from studies of the alien life could be used for technological purposes or, whether the organisms might be utilized directly.

We have been able to sample only one planet for life, our own. The positive finding in such a small sample does not permit us to extrapolate to other planets. However, the finding of life on one or more additional planets in our solar system would greatly increase the statistical significance with which such an extrapolation might be made. Once we are assured that life exists on more than one planet and, particularly, if we find that the living systems arose independently, we would gain considerable confidence that life is widely distributed throughout the universe. Statistical considerations would now indicate that it is extremely unlikely that evolution on Earth began first, or that Earth life is the most advanced of the life forms populating the universe.

The time span of technological development in an intelligent society is very short when measured on a galactic time scale. It took man approximately three billion years to evolve on Earth, whereas almost all of his present technology was achieved within the past 200 years. Thus, some civilizations of intelligent beings would almost certainly have bridged the brief time span yet separating man from a complete or almost complete mastery of science and technology.

This, then, brings us to the ultimate objective of biological exploration of the solar system. It is to determine the likelihood of the existence of intelligent extraterrestrial beings from whom we can gain a knowledge of biology far beyond our own.

To benefit from this goal, of course, communicating with such beings would have to be established before we achieve this knowledge by our own direct efforts. Although, as stated, this interval is short on the galactic time scale, it is very long compared to the life span of man. The benefits to be obtained through achieving this ultimate objective would, therefore, have a tremendous impact on man.

Obviously, I have built upon many speculative hypotheses. The failure of any one of these hypotheses could render the ultimate objective impossible of attainment. However, any of the intermediate objectives discussed is, of itself, of sufficient scientific importance to warrant a vigorous prosecution of our search for extraterrestrial life.