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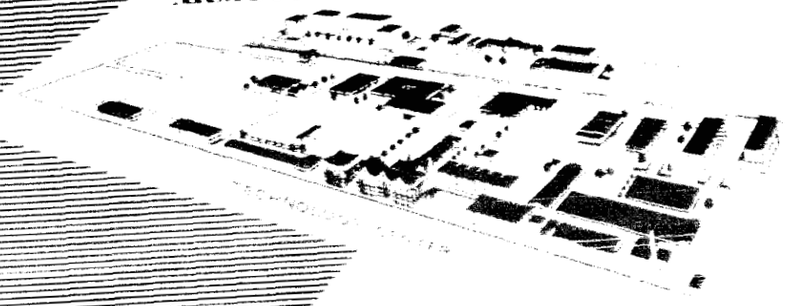

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS

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I. INTRODUCTION

The purpose of the program is to study the possibility of growing various forms of terrestrial organisms in simulated extraterrestrial atmospheres. The ability of certain forms of life to survive extremely adverse conditions is well known. With the advent of space flights and space exploration, it is necessary that this ability be examined within the framework of the environmental conditions existing on other planets of the solar system. The information derived from a study of this nature would be of importance in determining the ability of life to survive on other planets.

The objectives of the program are therefore as follows:

1. To provide information on the existence of life on other planets
2. To determine whether terrestrial life can contaminate other solar bodies
3. To consider the possible logistic application of microorganisms grown under extraterrestrial conditions
4. To obtain information on the physiology of specimens grown under these conditions and to apply this information to theories on the development of living "particles."

II. LITERATURE SEARCH

The initial step of this investigation was a literature search, undertaken to assemble data on conditions existing upon the planets. The paper and books reviewed are appended to this report as a reference list. Since numerous authors have expressed the opinion that Martian vegetation, if it exists, consists of lichenlike plants, literature regarding lichens was also reviewed.

III. LABORATORY STUDIES

Water and gaseous carbon dioxide are essential for photosynthesis, the basic energy source for most life on Earth. These two compounds are in their proper physical state in the atmosphere only if the planet remains at a prescribed distance from the sun. This distance is a function of the quantity, the quality, and the stability of the sun's radiation. The volume of space surrounding the sun in which radiation is optimal for photosynthesis is called an ecosphere. Only if a planet's orbit lies entirely with an ecosphere can that planet support life, as known on earth.

The ecosphere associated with the solar system contains the orbits of Venus, Earth, and Mars plus the natural satellites of the last two. Consideration of the environments of these six bodies led to the decision to make the initial studies on Martian conditions. Since lichens grow extremely slowly and are propagated by not too well-defined means, only the algal component of lichens was used in the present studies. A majority of lichens possess as the algal partner species of the genus Trebouxia, a unicellular green alga sometimes found living free in nature.

The following species of Trebouxia were grown on a medium consisting of inorganic salts, proteose peptone, soil extract, glucose, agar, and water: T. anticipata, T. impressa, T. gelatinosa, T. lambii, T. erici, and T. incrustata. Because of its relatively rapid growth rate and its hardiness, T. erici was selected for initial experimentation.

Present efforts are concerned with assembling the apparatus required to produce Martian environment in test tubes. Martian environment, as determined from the most recent literature, is defined for experimental purposes as follows:

1. Atmosphere: nitrogen, 95.7%; argon, 4%; carbon dioxide, 0.3%; pressure, 85 mm Hg
2. Temperature: daily variation, 12 hr at 25 °C and 12 hr at -60 °C
3. Soil: bright areas, felsite or limonite (aluminum silicate or hydrated ferric oxide, respectively); dark areas, solidified lava (basalt or igneous rock)
4. Water: none added; trace remaining after lyophilization or Martian conditioning will simulate the trace of water assumed to be in the Martian atmosphere; this is less than 1%
5. Light: 500 ft-candles; the blue and ultraviolet light are presumed to be excluded by the Martian atmospheric haze.

IV. FUTURE PROGRAM

In the coming period T. erici will be placed in the simulated Martian environment, with suitable controls used throughout the experiments. Two additional strains of algae, received from Dr. Vernon Ahmadjian of Clark University, will also be investigated. These were isolated from lichens

growing in the antarctic and are known for their ability to withstand adverse conditions in a desiccated state. In addition to the above, the literature on autotrophic bacteria in relation to extraterrestrial conditions will be reviewed. The bacterial studies will be initiated after the algal experiments have commenced.

V. RECORDS

The data from these studies are recorded in ARF Logbook C 11194.

Respectfully submitted,

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