STANFORD RESEARCH INSTITUTE

SOUTHERN CALIFORNIA LABORATORIES
820 MISSION STREET, SOUTH PASADENA, CALIFORNIA
Telephone: 799-0501 (Area code: 213)

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A BRIEF--LIFE DETECTION ON OTHER PLANETS

Submitted to:

National Aeronautics and Space Administration
Headquarters Building
Washington 25, D.C.

Attention: Dr. O.E. Reynolds, Director
Biosciences Division

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Objective

The objective of this investigation would be to study, investigate, and demonstrate techniques and instrumentation concepts that could lead to the construction of an optimum life-detection space capsule package that would have minimum weight and volume together with maximum operational reliability and accuracy in determining life on other planetary bodies.

Method of Approach

In view of the immense cost in materials and technical personnel that is required to place missile loads on other planets and the Moon, it is suggested that attention be given to the potential of an analytical and instrumental study that could result in a maximum amount of critical life-detection information being obtained from a missile payload which may be landed on a planetary body in the near future. The immense cost and the low probability of success at the present time suggest that each missile payload be optimized to provide a maximum number of independent bits of information which can be telemetered from the planetary object back to the Earth. From the viewpoint of life detection on distant planetary bodies, it is suggested that the biological authorities consider the basic experiments that could be performed remotely with a high degree of reliability and which could establish the outlines of a type of life that exists or could exist on a distant planetary body.

Philosophically we tend to consider that the world we live in may be somewhat typical of other planetary bodies and, therefore, we consider that the life system, as we know it, may exist on other planetary bodies. However, it is conceivable that a life system exists in other environments that have characteristics chemically, physically, and biologically different from those on Earth. Thus we need to consider what, essentially, is life and what are the fundamental measurements that describe life, even though such life may not be the type that exists on Earth. While elaborating in detail many of the experiments that are proposed for life-detection

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systems to be landed on other planetary bodies, it may be well for the biological authorities to consider some fundamental experiments that could be conducted simultaneously or consecutively in a single life-detection package that would clearly define differences between the basic life cycle that may exist on other planetary bodies and the type of life cycle that exists on this Earth.

It is not the intent of the writer to outline or to detail the type of basic experiments that should be done; however, it is his belief, judging from some technical discussions and from the comments in some technical journals, that the approach proposed herein may provide a somewhat different, and significant, viewpoint from which to consider the life-detection packages that are being designed and constructed. With the limited probability of success that is involved in launching and guiding a space capsule to a distant planetary body, successfully operating the life-detection package remotely on a hard or soft landing, and telemetering the experimental results back to the Earth, it would be well to consider the fundamental experiments (necessarily quite limited in number) that can establish the nature of life or lack of life on a distant planetary body.

In an optimization study designed to produce a maximum amount of information on life detection, it is suggested that the biologists list a reasonable number of basic experiments that would be useful in determining whether life of any type exists on other planetary bodies and whether life as we know it on this Earth can exist on the planetary body. These lists of proposed basic experiments should then be examined from the viewpoint of the instrumentation that would be required to implement the experiments. The instrumentation analysis should include efforts to minimize both the weight and volume of the experimental equipment, to maximize the reliability of the experiments, and to maximize the simplicity of the telemetered data that must be transmitted to the Earth. It is obvious that the total life-detection system complex would be no better than any one of the links in the system--the quality of the basic nature of the experiment, the reliability of the instrumentation, and the simplicity of the data that must be telemetered to the Earth.

One of the proposed experiments is the sampling of the surface of the planetary body, collecting a small quantity of the planetary surface material, and bringing the material into a microscopic field or into a germination, or growth, chamber. It is intended that any organisms in the soil material be allowed to grow in a media containing C^{14} labeled glucose. If organisms grow in terms of the Earth's life cycle, they should then emit radioactive carbon dioxide. Obviously, other organisms may exist on other planetary bodies that do not grow in terms of the Earth's general life cycle. Institute personnel suggest that the reproductive bodies of plants (spores and seeds) may be found on other planetary bodies in the soil and air and

that spores of bacteria, algae, fungi, and the like, together with the pollen grains of seed plants, could all germinate with water. The spores would swell and the metabolic activity of the cells would be increased. If these spores require a cycle involving oxygen, the rapid increase in oxygen uptake could be detected. All of the spores and seeds existing in a life cycle similar to that on the Earth would take up oxygen and evolve carbon dioxide and water. If these growing organisms were placed in an oxygen O_2^{18} atmosphere, they should emit CO_2^{18} or H_2O^{18}. The Institute has developed a small mass spectrometer that might be adapted for the measurement of the evolved carbon dioxide or water. It is not intended to suggest that these particular experiments represent an optimum approach to the problem of life detection on other planets. These representative experiments are cited as typical of the proposed listing of basic measurements that should be considered.

It is suggested that consideration be given to an optimization study which could lead to a more suitable life-detection package in terms of the quality of life detection, the reliability of operation on distant planetary bodies, and the simplicity and reliability of unequivocal transmission of data back to the Earth. It is further suggested that the basic concepts of life detection initially be selectively tabulated in terms of a relatively small number of experiments that could be operated remotely. These proposed biological experiments should then be examined from the instrumentation viewpoint, broadly considering the instrumentation with the aim of minimizing weight and volume of the physical equipment to perform the experiments and providing relatively simple bits of information, which can be telemetered back to the Earth with a high degree of reliability according to information theory. It is expected that the study would involve the analytical analysis of the proposed experiments together with sufficient experimental construction to enable the verification of the probable performance of the proposed experimental equipment under specified conditions of hard or soft landings on distant planetary bodies. The life-detection package would give signals that could be processed, telemetered, and analyzed. Each bit of information received from the several experiments would be correlated and processed to determine the over-all validity of the results. The multiplicity of experiments and bits of information would permit cross-correlation and tend to establish validity of information. It is not proposed at this time that Stanford Research Institute proceed further than laboratory prototype construction of a life-detection package.

Qualifications of the Institute

Stanford Research Institute can provide an integrated group of biological experts together with chemical and instrumentational experts who could conduct the proposed optimization study as a coordinated team. The background of the author's group is in physical chemistry, instrumentation

design, and analytical chemistry, particularly as applied to the problems relating to trace concentrations of chemicals. The primary input of this group would be in the reduction of selected biological experiments to an integrated life-detection instrument package. The Institute's biologists would be expected to make valuable inputs during the selection of experiments and the continual monitoring of the progress of the construction of an optimum instrument package. (The author's biography is attached.) It is suggested that the team operate with the advice of an authority on the basic concepts of living matter.

It is proposed that the Institute form this team and assume the basic responsibilities for the analytical study and the construction of an initial life-detection package.

Proposed Action

In the event that this brief is favorably received, the Institute will prepare a formal proposal for the National Aeronautics and Space Administration.

J.L. Jones
Supervisor

J. Leslie Jones

Dr. J. Leslie Jones, Senior Physical Chemist, is a member of the Institute's Southern California Laboratories where he is Supervisor of Air Pollution.

He received a B.S. degree in chemistry and an M.S. degree in organic chemistry in 1934 from the University of California at Berkeley. His Ph.D. in physical chemistry was awarded by Stanford University in 1936.

Prior to joining the staff at Stanford Research Institute, Dr. Jones' experience included nine years as Head of the Propulsion Division of the U.S. Naval Ordnance Test Station in Pasadena. His particular fields of interest include propulsion, air pollution and related health problems, and physical chemistry.

Dr. Jones has had 13 papers published, prepared numerous classified reports, and has had 20 patents granted. He is a member of Sigma Xi, Phi Lambda Epsilon, American Chemical Society, Electrochemistry Society, and is a Fellow of the American Association for the Advancement of Science.