WOLF VISHNIAC application

Application for a Grant to the National Science Foundation

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Title: Detection of Microorganisms on Other Planets: Development of Suitable Instruments

Approved by:

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Introduction. On December 19 and 20, 1958, a meeting was held at the Massachusetts Institute of Technology, chaired by Professor Bruno Rossi, under the auspices of the N.A.S.-N.R.C. Space Science Board, for the purpose of discussing ways and means of detecting extraterrestrial life. In the course of this meeting Dr. Thomas Gold of the Harvard University Astronomy Department inquired as to the feasibility of constructing a device, weighing less than 30 pounds, which when placed on a solid surface would detect and signal the presence of microorganisms. I volunteered to design and supervise the construction of such an apparatus, and I am applying for $4,485.00 to make this construction possible.

Purpose. It is proposed to develop a device which will automatically sample, detect, and signal the presence of bacteria, and which can serve as the prototype of a device which could be included among the instruments to be landed on Mars or Venus. This device, for the purposes of this proposal to be called a Bug Detector, will illustrate the feasibility of letting bacteria signal their own presence by making use of the changes which bacteria bring about in the environment in which they grow. The present device is expected to work on Earth only, but is meant to indicate in what fashion life on other planets may be studied.

Principles and Methods. In principle the apparatus shall consist of a hollow evacuated cylinder from which a fragile probe extends in the direction of the expected impact. Upon impact the tip of the probe will shatter, and the internal vacuum will draw dust from the surface into the interior of the cylinder. In the cylinder there will be exposed media in which bacteria might grow, or at least in which some of the bacteria present might grow. After the cylinder interior has reached atmospheric pressure, the opening will be closed by a spring-loaded valve to prevent evaporation of culture media and contamination of the planetary surface by terrestrial organic matter. Bacterial growth will have at least two likely results: the turbidity of the medium will increase and the acidity of the medium change. Both these changes can be easily detected, the change in turbidity by a photoelectric cell and the change in acidity by a pair of pH electrodes. Either

or both of these changes may trip a relay which in turn may activate some signaling device. This principle of the Bug Detector is susceptible to a variety of modifications. At first it is planned to build the simplest possible device, which will provide only one medium for bacterial growth, and which will give only a yes- or -no answer. After the successful construction of such a model it is planned to elaborate it, all within the suggested weight limit of 30 pounds, in the following directions: First, several media may be provided which may be made to select for different types of microorganisms, including photosynthetic bacteria; secondly, the response of the signaling device could be modified from a simple yes-or-no answer to a more complex response. The change in turbidity of the medium as a result of bacterial growth, which would result in a change in light intensity registered by the photoelectric cell, could be coupled to a change in frequency in the signaling device. In this case the variation of the signal would be a measure of the growth of the bacteria, from which it should be possible to plot a growth curve. Similarly, a change in acidity might be signaled in terms of a rate of change rather than as a simple yes-or-no signal.

Interpretation of Results. If we assume that a working model has been built and modified for inclusion in a space vehicle, how can we interpret the signals which the Bug Detector would emit? Let us assume that the device is successfully landed on Mars and that immediately upon impact the signals indicate a marked change in turbidity and a marked change in pH. Such a result would have no meaning, except that it might be interpreted in the sense that components of the atmosphere or of the soil were strongly acidic or basic so that they immediately changed the pH of the medium, and that the dust was so dense that it immediately obscured the vision of the photoelectric cell. However, if after impact none or only a few of the signals indicate any changes and if more changes are signaled in the course of several hours or days, then we may reasonably conclude that some gradual changes have taken place which may well be the result of the bacterial activity. Should a device be built which will signal a gradual change in turbidity of the medium, then

it will be possible to obtain a curve by plotting turbidity against time which might have the characteristic sigmoid shape of a growth curve. Such a result would be the most meaningful, and would be the most convincing evidence for the existence of microorganisms on other planets.

Materials and Construction. The Bug Detector will be built in such a fashion that portions of it can be evacuated and sterilized without effecting the electric components of the device. It is anticipated that plastic materials will be used, in particular the vessels for the medium may be made of polypropylene since it is almost transparent and yet chemically resistant and shatterproof. The electric components will contain no tubes or other fragile materials and will be housed in a metal shell. It is anticipated that one or several working models will be built within one year.

Other Support. No other application for funds to support this project has been made. The main work carried out in this laboratory, dealing with photosynthesis, chemosynthesis, and related problems in bacterial intermediate metabolism, is supported by N.S.F. (G7124) and N.I.H. (E1284).

BUDGET

The following budget is expected to cover the construction of one or more working models of the Bud Detector within one year.

Services of the machine shop (tool engineering, labor)	$1,200.00
Services of electronics shop (consultation, design, labor)	2,000.00
Materials	700.00
Sub total	$3,900.00
University overhead at 15%	585.00
Grand total	$4,485.00