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Radioisotope Techniques in Aerospace

Detection of Microorganisms on Other Planets*, Gilbert V. Levin, Allen H. Heim and Mary-Frances Thompson (RRI).

In connection with the National Aeronautics and Space Administration plan to land exploratory instruments on Mars this decade, a life-detection experiment and associated instrumentation utilizing radioactive isotopes has been developed. C-14-labeled substrates for utilization in cellular metabolism are added to a sample of soil. Cells present that metabolize any of the substrates evolve detectable $C^{14}O_2$ which, plotted as a function of time, yields a standard microbial population growth curve, exhibiting lag, exponential and stationary phases. Results can be ascertained long before visual evidence of growth is discernible. Furthermore, metabolism in the absence of reproduction can be detected due to the sensitivity of the method.

The device, named Gulliver, will be incorporated into an instrument capsule to be landed on Mars. After landing, small projectiles are fired from the capsule carrying adhesive sample-retrieval lines from the instrument to the Martian surface. The lines are then dragged back along the surface into a culture chamber in the instrument. During this procedure the culture chamber is exposed to the Martian atmosphere establishing ambient conditions for the development of any life that may be in the collected soil.

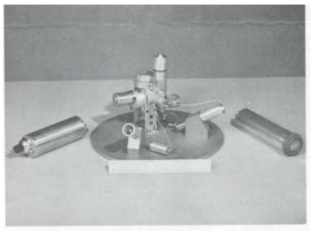

Fig. 1. Instrument for detection of microorganisms on other planets. The main body is shown in the center and the associated electronics on each side.

The culture medium is isolated in a separate chamber during the sample-collection procedure. After the retrieval lines are inside the culture chamber, the ports to the outside are sealed and the medium is transferred into the culture chamber. As the microbial cells metabolize the radioactive substrates (at present sodium formate-C-14 and glucose-C-14, uniformly labeled), $C^{14}O_2$ is evolved and collected on the surface of a solid, semiconductor detector coated with barium hydroxide as a getter. The radioactivity is monitored and the data are telemetered to Earth. Present plans utilize two identical chambers, one for encouraging metabolism and the second to serve as a control to prevent metabolism by the injection of a poison. A comparison of the two chambers will distinguish between metabolic response and possible chemical interference.

A medium has been developed that supports the evolution of $C^{14}O_2$ by representative bacteria, streptomycetes, fungi, and algae within a period ranging from minutes to several hours. The group that responds includes aerobes, anaerobes, facultative anaerobes, thermophiles, mesophiles, psychrophiles, heterotrophs, phototrophs, spore formers, and nonspore formers. Responses have been obtained within minutes from mixed populations in soils of various origins including some from desert areas.

Instrumentation, fabricated by the American Machine and Foundry Company, consists of a sample-collection system, body with culture chamber, programmer and detector and associated electronics. The entire unit weighs about 1½ pounds.

A second-generation instrument is shown in Figure 2. Although the soils were different, the curves are similar, all being readily identified as standard population-growth curves. However, different lag periods are discernible, indicating different types of organisms.

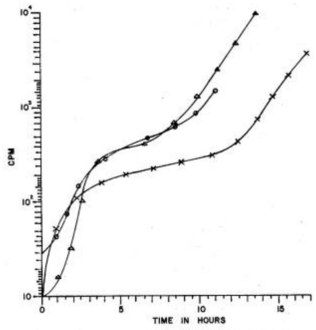

Fig. 2. Field Tests Radioisotopic Biological Probe.

Intensive study of the microbiological medium and instrument is continuing to increase sensitivity and reliability and simplify the experiment wherever possible.

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