

N66 31808

2. STATUS REPORT ON THE BIOSATELLITE

DALE JENKINS

*Chief, Environmental Biology, Bioscience Programs
Office of Space Science and Applications, NASA*

GERATHEWOHL: Now I would like to ask Dr. Dale Jenkins to tell about the biosatellite project. He has been instrumental in organizing the biosatellite, in the early stages, has followed it, and will give us a picture of its present status and background.

JENKINS: The best way to give a status report of the biosatellite program would be to ask each of the various experimenters here to tell us the latest status of his experiment. A film will show you the status of the various experiments in the biosatellite program.

I would like to review the philosophy and the rationale of our biological program in space, to point out the rationale and philosophy of the Russian program to compare the two, and to point out why we are going the way we are. I shall summarize by pointing out what we are planning to do in the future, particularly the way the biosatellite program fits into the Apollo Applications Program.

In the environmental biology program, we are interested in all of the environmental factors of space. These can be studied better on the ground, with the exceptions of decreased gravity, radiation combined with weightlessness, and biorhythms in relation to changed periodicities with regard to the Earth's rotation.

We can study weightlessness, but not zero gravity. There is the gravity of the Earth and of the Sun. At about 200 nautical miles in orbit around the Earth, there is still 95 percent of the Earth's gravity. What we are studying in the spacecraft is weightlessness, or free fall caused by the velocity of the spacecraft traveling at a speed that equals the gravitational pull of the Earth.

We can duplicate the radiation in space with the exception of some of the high-energy, heavy-particle cosmic radiation. We can probably study the biological effects better in balloons in northern latitudes. We are interested in whether there is any synergism or antagonism between weightlessness and radiation. Since radiation effects are affected by oxygen, temperature, and other factors, there is a possibility, but no good rationale or hypothesis, that we would expect effects of combined weightlessness and radiation.

We are interested in the effects of weightlessness on a single cell, especially the physical processes, sedimentation within the cell, and lack of convection, which may or may not have any effect within or outside of the cell. We are interested in transportation of fluids, both in plants and in animals. Every organism on Earth is accustomed to an unvarying 1 G. If gravity is completely removed and we have a weightless state, it is possible that we may find extremely interesting changes in basic processes in biology. So far, however, nothing very exciting has appeared.

Plants are of interest because they are very sensitive to gravity. However, the response time is slow. It is possible to use a clinostat to rotate the plant to nullify the effects of gravity before the time threshold of response has been reached. The threshold of gravitational effects

is probably about 10^{-6} G so that spacecraft movement must not cause gravitational effects during orbit that would confuse understanding the effects on these plants. Animals are probably not as susceptible as plants to very low gravity, but they respond rapidly, and have an effective adaptation system.

A number of experiments on the biosatellite will be designed to study the effects of weightlessness on plants and animals, from the single cell to the primate.

The Russians have sent up a large quantity of biological materials. About sixty different species of plants and animals have been orbited in nine flights. There were four Russian ballistic suborbital flights during the period 1950 to 1958. In some flights biological experiments were the major component of the payloads, and in others, particularly some of the recent ones, they have been carried along with the astronauts.

The philosophy of the Soviet program is very different from the NASA program. They are attempting to study the effects of ambient space radiation on a variety of biological organisms. They have used parts of organisms, skin, fibroblasts, enzymes, amniotic tissue, a series of different types of eggs of animals, a number of species of insects and mammals, viruses, bacteria, yeast, various molds, algae, and a large number of different types of plants, including seeds.

In summary the results indicate that the vibration and acceleration involved in launching are very important and cause biological effects. They sent up a large number of experiments which had a relatively high threshold of radiation effects, but the maximum radiation that any experiments received was the 5-day flight, which gave about 60 millirad. These organisms did not receive sufficient radiation to obtain really significant radiation results. Some Russian scientists have claimed that some of their experiments do show significant results. For example, they claim that Tradescantia microspores do show certain mitotic aberrations correlated with time of weightlessness. Dr. Antipov was asked whether these results, correlated with time of flight, could be merely the amount of time following vibration. He did not think so. I recently suggested to Dr. Gazenko that they try a critical experiment. Instead of only fixing plants at intervals during flight, that they also leave some plants alive for periods of time after recovery to determine whether there is a continuation of the increased number of mitotic aberrations in 1 G after recovery.

In discussions with Dr. Gazenko and other Russians on irradiation experiments, they appear to view most of these experiments so far as baseline experiments to determine whether there are any special effects at very low levels, and also to determine the effects of vibration, acceleration, and other dynamic factors during launch and flight. The Russians sent up their experiments without having exposed the organisms to vibration and acceleration, and some of the other factors involved in flight. They found that there were a fairly large number of mutations and aberrations, and at first they blamed this on radiation. Now they are running a large number of experiments on detailed effects of vibration and acceleration, and particularly vibration. Dr. Antipov said that the major effects are caused in a range of about 80 to 100 cycles per second. They find that the vibration does cause effects similar to those observed from radiation.

In the NASA biosatellite program, we are exposing all experiments to the effects of vibration and acceleration, to work out the baseline information required before flight, so we will be able to interpret the data from the flights accurately. It is then possible to state in advance what is due to vibration and what is due to weightlessness.

The Russians are very interested in the experiments which they interpret as positive results either from radiation or weightlessness. These organisms are Tradescantia, bone marrow, and Drosophila which are the main organisms that they are interested in working with in the future.

Some of you know the NASA biosatellite program in detail. There are a number of published papers that give a summary of the philosophy and rationale of the program, as well as list all of the 19 experiments which are presently aboard the biosatellite. There were 187 experiments submitted to the biosatellite program, and about 40 of these were put in Category 1 recommended for flight. However, there were a very large number of excellent experiments, some of which could not go on the biosatellite program for some reason such as weight, and some of these have real potential for the Apollo Applications Program. These 187 experiments were considered for the Apollo Applications Program. Those experiments involving ambient radiation effects and engineering studies were deleted. About 116 of the 187 would be of interest with regard to the Apollo Applications Program. Some of these the various review groups have stated are very good, valid scientific experiments. A number of people, both those who have biosatellite experiments on board and those who have submitted experiments which are not on this series of six biosatellites, will be contacted and asked to revise these experiments.

GERATHEWOHL: In the next session we will discuss some of the last subjects which Dr. Jenkins just mentioned; namely, the possibility of converting some of the biosatellite experiments or some of the proposed biosatellite experiments into the experimental battery or the experimental program for manned spacecraft.

The American Institute of Biological Sciences has a NASA contract for helping us to define an inflight program, a scientific program in biology which will be conducted or can be conducted in manned spacecraft. Particularly, I am thinking here of the Apollo spacecraft and, to use the new stereotype again, of the AAP, the Apollo Applications Program.