The weightless burden of space

Man's future in space hinges upon NASA's lagging efforts to fill gaps in biomedicine

Photos: NASA

The crew of Apollo 13 (Haise, Lovell, Mattingly) may reach endurance limit.

by Barbara J. Culliton

Charles Conrad and Alan Bean took two four-hour moonwalks during Apollo 12 (SN: 11/23, p. 470). Their physical performance was so good that in Houston their physician, Dr. Charles A. Berry, said that the men of Apollo 13 may be able to work on the moon's surface for five hours at a time.

But he also speculated that five hours may mark the limit of man's endurance. There were times when the Apollo 12 astronauts' heart rate hit a high of 170 beats per minute—too high to be safe for long.

Next April is the 10th anniversary of manned space flight. The goal that took shape in 1960, so spectacularly fulfilled this year when Neil Armstrong stepped onto the lunar surface, will have to be replaced with new ambitions for man in space. Ultimately, he may explore the planets. Before that, he may orbit earth in space workshops where he will be called upon to perform as a scientific investigator.

The question that now confronts the National Aeronautics and Space Administration is whether man is physically qualified for that role. At present, there is little information available for answering that question. According to the President's Science Advisory Committee's panel on Space Science and Technology, "The maintenance of a viable NASA manned-flight program may very well depend upon a strong and basically redirected biomedical effort."

The biomedical programs in NASA to date have been stepchildren to technology. Ever since 1960, official committees of scientists have urged NASA to pioneer in space medicine and biology, but their advice has been largely ignored. Now, with the space program at a crossroads, bioscience supporters are trying to put the pressure on space agency administrators in an effort to force NASA to become as sophisticated about man in space as it is about hardware.

The pressure is coming from the panelists of the President's Science Advisory Committee, headed by Dr. Lee A. DuBridge, science adviser to the President; from Congress where Rep. Joseph Karth (D-Minn.) recently concluded hearings on the future of biosatellite programs, and from scientists within NASA itself.

One of the clearest pieces of evidence of the urgency in filling the gaps in biomedical knowledge is the flight of Biosatellite 3, the mission that was aborted last July after only 8 of a planned 30 days because of the deterioration of the monkey Bonnie. Within hours of premature splashdown Bonnie died from the effects of weightlessness (SN: 11/1, p. 393). The early end of Biosatellite 3 signaled the last of NASA's planned flights for biomedical experimentation and at the same time raised questions about the long-term effects of zero gravity. It also provided scientists with some of the first hard data to confirm what were previously only theories about the toll weightlessness might take, and was an obvious stimulus to their desire to obtain more facts.

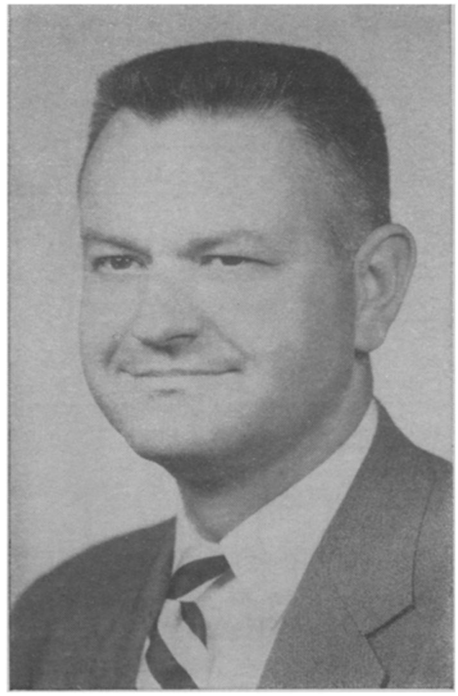
Challenged by the hostile environment of space, Bonnie lost excessive amounts of fluid through the skin, and blood pooled in his chest region from increased pressure in the veins leading to the heart. Finally the monkey died from cardiac fibrillation—an uncontrolled beating of the heart. According to Dr. Orr E. Reynolds, director of NASA's Bioscience Programs, the Biosatellite 3 experiment not only showed the predicted effects of weightlessness on the heart but also "showed that the increased pressure was long-lived and that the normal state does not return quickly." The increased venous pressure was observed in the 14-pound monkey shortly after lift-off and never stabilized.

In evaluating Biosatellite 3, Dr. Reynolds points out, it is important to consider the differences between that flight and manned missions. Constraint and the extensive surgery required to wire Bonnie for monitoring could have contributed to his deterioration, but NASA scientists place little emphasis on these factors. A third possibility lies in the difference between the surface-to-volume ratio of a man and small monkey. Though Bonnie lost water through the skin at the same rate a man would, he would have suffered more serious effects because of his proportionately smaller fluid reserves. Clear-cut extrapolation of data from Bonnie to man is out of the question, but the Biosatellite 3 findings "define certain questions that should provide clear guidelines for future experiments," Dr. Reynolds says.

Certainly, man has already proved from more than 5,000 hours in space that flights of two weeks or less take no such serious toll on him. But he has experienced to a milder degree

Bonnie: Unable to withstand space.

Karth: More money for bioscience.



Dr. Reynolds: Waiting for 1972.

some of the disorders that were observed in the space monkey: reduction in red blood cell mass, calcium loss, weight loss and difficulty in maintaining normal sleep patterns once outside the earth's day-night stimulus. It is difficult to extrapolate the Biosatellite 3 data to man, particularly because it involves only a single animal and a small one at that, but neither can it bo ignored. In the future, Dr. Reynolds would like to see an experiment similar to Biosatellite 3 involving a larger primate, an animal weighing perhaps 25 or 30 pounds.

Cost stands in the way. At the moment there are no plans—nor are there likely to be—for a duplicate of the Biosatellite 3 flight. If there were, Dr. Reynolds estimates it would cost only about $15 million but would take at least a year and a half to get under way. A twin experiment to Biosat 3 was canceled in June as an economy measure.

A mission accommodating a larger animal than Bonnie would be a considerably more expensive proposition because it would require a larger space capsule—one twice as heavy as the 1,500-pound Biosatellite 3—and a more powerful launch vehicle. The best chance now, as he sees it, is to put a monkey aboard the first Saturn workshop, scheduled for launch in 1972.

Until NASA has in hand the detailed physiological data of the sort that can come only from animal experiments (because it is neither possible nor ethical to wire and monitor a man the way you do a monkey), it cannot fairly state that it is safe for man to venture into space for 90 or 100 or 1,000 days. "But that does not mean," says Dr. Reynolds, "that a man cannot go into space for 28 days unless a monkey goes first."

Within the space agency, a fight, or at least the appearance of a fight, has emerged between the scientists on the bioscience side and those more directly concerned with the manned space flight program and the mission of the last decade.

Thus, in testifying before Karth's Subcommittee on Space Science and Applications, Dr. Berry and Maj. Gen. James Humphreys, Jr., director of Space Medicine, somewhat dismissed Biosatellite 3 as a "laudable scientific goal" but stressed, "We did not and do not now believe that the experiment was a necessary precursor to a manned flight of any particular duration."

In its report to the President, on the other hand, the PSAC panel emphasized that one important challenge before NASA today is integrating its various programs in space medicine and biology, with "greater emphasis upon innovative research which provides the foundation for biomedical programs both in manned space flight and in other fields of bioscience related to space." While not specifying the cost of expanded bioscientific research, the PSAC panel compared it to the cost of aborting a single Apollo mission for medical reasons and judged it to be worth the cost.

"A single Saturn 5-launched Apollo spacecraft is estimated to represent an investment of $300-$350 million. . . . Following the philosophy of the early manned programs, if a flight crew encountered serious biomedical difficulties, the mission would be aborted and the spacecraft returned to earth. Aborting a Saturn 5-launched mission for such a reason is an extremely expensive technique for solving a biomedical problem."

As it is, NASA spends a minute fraction of its budget for biomedical research. In fiscal year 1968, the Office of Manned Space Flight allocated only $80 million or 0.6 percent of its budget for life sciences research. Last year, Karth's committee attempted to raise the expenditures by providing additional money in the NASA budget, but those funds were cut by the Senate on the grounds that, according to a House spokesman, if NASA administrators were dragging their feet, there was little point in allocating additional funds.

Summarizing the views presented at the House hearings, Karth says. "I think that we must conclude . . . that there must be more biomedical and bioscientific experiments with the astronauts and also, of course, with primates. . . . The testimony we have received . . . indicates that this has not been planned, that we don't have the technology developed, and that it will, in fact, take from 5 to 10 years . . . before we can develop the technology to make sure we don't endanger U.S. astronauts on long-duration flights." Once again, he will attempt to provide NASA with the necessary funds for this. The final outcome in Congress and the Bureau of the Budget is, as always, in doubt. So, apparently, is NASA's response. □