V. Summary and Conclusions

An account has been given of two experiments in which three monkeys were carried in Jupiter missiles 300 miles into space. In the first, a squirrel monkey survived in good condition till a mishap occurred to the vehicle on re-entry. In the second, an American-born rhesus and a squirrel monkey were recovered uninjured. Details have been furnished covering the construction of the biocapsules, the provisions for a closed life support environment, the equipment and arrangements for monitoring the responses of the monkeys, and the experimental findings.

These experiments were carried out on a "non-interference" basis in missiles not designed for biologic purposes. This necessarily imposed severe restrictions in space and weight and necessitated a long count-down time; sixty-four hours for the rhesus and eight hours for the squirrel monkeys. A short count-down period is a great advantage and a prime consideration in designing such vehicles for primarily biological purposes or for man.

The bio-technical features constituted the new and difficult aspect of the experiments. The specifications made demands quite beyond those ordinarily encountered in laboratory experiments. These differences are so great that not only should separate facilities be provided for carrying them out but also the aim should be to develop "specialists" in every phase of the work. The type of equipment and

standards of reliability in bio-techniques to meet minimal requirements for experiments in space might sometimes be useful but would usually be wasteful under ordinary conditions.

Only a few measurements were obtained. More were planned for the rhesus monkey but circumstances prior to flight voided some, and difficulties in flight the others. Our chief objective was to recover healthy animals. To obtain "maximum results" the maintenance of the animal in a satisfactory state is a prerequisite for all determinations.

Ambient temperature and pressure within the capsules were monitored throughout flight and the narrow limits of the variations observed demonstrated the adequacy of the equipment. Together with carbon dioxide and humidity control, the constancy of the animals' atmospheric environment was well ensured. This aspect of the experiment has direct application to man.

Chest sounds, respiratory rate, and the electrocardiogram were obtained on Old Reliable, the first two on Able, and the last two on Baker. Some difficulty was experienced in obtaining the respiratory signal during peak accelerations and the phasic respiratory variations observed in the other records substituted at a few critical points.

Although there were only small changes in body temperature throughout the short flight, Old Reliable had a rather low body temperature and exhibited a "cold response," Baker, with a rather high temperature, the "heat response," while Able was probably in the thermo-neutral zone. These differences were important in several regards. The shivering of Old Reliable produced artifacts in the recording of heart sound and electrocardiogram. The relatively high heart rate in the case of Baker may have affected the response to stress. At least these were factors which had to be taken into account in the evaluations.

Old Reliable and Able responded to the major events in flight with an increase in cardiac and respiratory rates during boost, a return to baseline values after cut-off, slight, brief increases at spin-up, and conspicuous increases at re-entry. These changes seem to be compounded of a startle reaction followed by a more prolonged response. The non-psychogenic influence was clearly evident during boost and re-entry. Neither Old Reliable nor Able exhibited a significant fall of cardiac or respiratory rate below baseline values.

The deviant pattern of Baker involved variations above and below the baseline level. The cardiac response was a slight, brief increase in rate followed by vagal inhibition. It was declared by an exaggeration of the normal sinus arrhythmia and twice by sino-atrial block. This was followed by lowering of the RS-T segment and T waves. An attempt was made to explain the findings on the basis of "fright without flight." This is thought to lead to a curious and ineffectual autonomic display characterized by reflex cardiac inhibition and peripheral vasodilation. This effect tended to mask the non-psychogenic component of the response to stress.

Through a mishap to the vehicle

on re-entry, Old Reliable was lost, but Able and Baker were recovered about two hours after impact. The preparations to render first aid were unnecessary; "treatment" was limited to an injection of penicillin. Four days later Able died during the induction of light anesthesia for the purpose of removing the electrodes. Autopsy revealed no evidence of flight-related injury. This had the value of establishing the fact that unrecognized injury had not occurred. Baker, as of this writing, is alive and well. The only post-flight medical treatment has been for intestinal parasites.

In conclusion, it may be appropriate to list some of the outstanding impressions gained from this experience:

1. The prodigious effort which went into the collection of relatively few data.
2. The almost innumerable opportunities for human error and material failure, and the feeling that it is a minor miracle if all arrangements work out satisfactorily.
3. The handicap of a long count-down period.
4. The high standards of bio-technical equipment and skills required.
5. The impossibility of making corrections or changes once the experiment is under way.
6. The need for additional experimentation with missiles and animals before man can be sent into space.

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