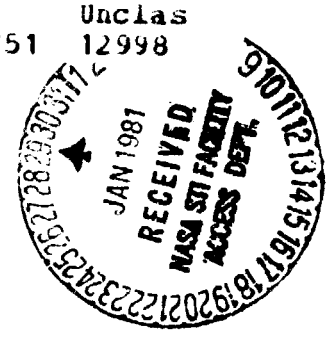
NASA TECHNICAL MEMORANDUM

NASA TM- 76289

BULGARIAN CONTRIBUTIONS TO THE DEVELOPMENT OF SPACE BIOLOGY AND MEDICINE

K. Serafimov

Translation of "Bulgarski prinosi za razvitieto na kosmicheskata biologiya i meditsina," Bulgariya i Kosmosut [Bulgaria and Space], Narodna Mladezh Publishing House, Sofia, 1979, pp. 93-100



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. AUGUST 1980

STANDARD TITLE PAGE

1. Report No. NASA TM-76289	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle BULGARIAN CONTRIBUTIONS TO THE DEVELOPMENT OF SPACE BIOLOGY AND MEDICINE		5. Report Date August 1980 6. Performing Organization Code
7. Author(s) K. Serafimov		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		11. Contract or Grant No. NASw-3199 13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Bulgarski prinosi za razvitieto na kosmicheskata biologiya i meditsina," **Bulgariya i Kosmosut** [Bulgaria and Space], Narodna Mladezh Publishing House, Sofia, 1979, pp. 93-100

16. Abstract Studies of the effects of anoxia, positive radial acceleration in Bulgarian designed and built centrifuges and its effect on cardiovascular indices and body adaptation to it, the effects of various degrees of athletic conditioning and drugs on tolerance of space flight factors, apparatus for the electronic analysis of handwriting for evaluation of effects of space flight factors on performance and the development and testing of radiation protection drugs by Bulgarian scientists, as well as their development of cleaning materials and Bulgarian foods for cosmonaut use, are discussed.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22.
Unclassified	Unclassified	10	

BULGARIAN CONTRIBUTIONS TO THE DEVELOPMENT OF SPACE BIOLOGY AND MEDICINE

K. Serafimov

We have a small book entitled Mezhduplanetnite problemi i organizmut / na choveka [Interplanetary Problems and the Human Body]. Its author is senior scientific worker K. Zlatarev. Undoubtedly, the book is current and interesting today. Yet, if one looks at the year of publication, it will be seen that it is . . . 1959!

Two years before the first flight of man in space, in little Bulgaria, work already was being done on problems of space medicine! This activity had its valid foundation in the excellently developed Bulgarian medical science, the traditions of our higher educational institutions and institutes, and in the age-old high medical culture of our people! Immediately after the flight of the dog Layka, our scientists, such as academician Asen Khadzhiolov, senior scientific worker K. Zlatarev, Prof. I. Nikolov and others, began a thorough study of the effect of weightlessness, pentrating radiation, movement control and other space flight factors on man. These studies were the direct continuation of our traditionally well developed studies of physiology, morphology, biomechanics, radiology and other fields. It is not at all strange that academician Khadzhiolov and Dr. Zlatarev are associate members of the International Astronautical Academy in Paris. Their successes reflect the good development of space medicine and biology in Bulgaria.

The work of D. Matveev and Kh. Petrov, which deals with the so-called gravitational shock, must be emphasized. In 1962, at the International Astronautical Congress in Varna, A. Khadzhiolov and D. Matveev gave a series of papers on the problems of space medicine. The work of academician A. Khadzhiolov in the fields of actinobiology and fluorescence cytology merits attention. His studies of the effect of cosmic rays on

---

*Numbers in the margin indicate pagination in the foreign text.

the cells and tissues of various organs (lungs, kidneys, nervous system, etc.) were carried out in animal tests, by irradiation with doses of from 400 to 3000 roentgens or with small, but chronic doses of from 10 to 20 roetgens, was well received by the international scientific society.

Our scientists and specialists of the Institute of Radiology and Radiohygiene of the Medical Academy Sophia, under the direction of Prof. I. Nikolov, were most active. The Aviation Medicine Scientific Research Institute, under the direction of senior scientific worker K. Zlatarev, is conducting numerous fundamental studies of the vestibular system, and it has made significant practical contributions to selection, physical and mental preparation for flight and medical monitoring of them. The knowledge, experience and erudition of the specialists of this institute have been very useful in the selection and training of our candidates for space and in planning and conducting medical experiments with them. Excellent results have been obtained in this field at the Institute of Morphology of the Bulgarian Academy of Science (under the direction of academician Khadzhiolov), at the Institute of Mechanics and Biomechanics (director, academician G. Brankov) and other scientific groups. Bulgarian activity in space biology and medicine is strongly associated, moreover, with noted scientists, and with the creativity and organizational activity of Prof. G. Nastev, Prof. A. Gidikov, senior scientific worker D. Dimitrov, senior scientific worker Mitrana Stoyanova, Dr. K. K. Kunchev, Dr. D. G. Dimitrov, Dr. E. Ivanova Dr. S. Todorov, Dr. V. Ivanov, Dr. M. Mileva, Dr. I. Baev, Dr. I Bayrakova, Dr. A. Vuglenov, Dr. D. Benova, senior scientific worker T. Pantev, Dr. N. Bokova, Dr. M. Minkova and many others.

The first field of space biology and medicine developed in our country is

Space Physiology

In Bulgaria, a number of valuable studies have been made on the effect on the body of variation of the gas environment, variation of gravitational factors, vestibular stimulation, etc.

In normal and, particularly, in emergency situations in a space flight, cosmonauts are exposed to variation of the gas environment. Khr. Aleksandrov and K. Kunchev have studied the variation in blood circulation, respiration and oxygen saturation of the blood as a result of oxygen insufficiency, in order to use the parameters of the cardiovascular system as objective criteria of the adaptive capabilities of the body to a moderate degree of anoxia. Adaptation to an oxygen shortage is associated with variation in a number of basic body functions. The variation in blood circulation during anoxia has been studied in a barochamber, at 5000 m with a 30 minute exposure, which represents a moderate degree of anoxia. The pattern of pulse rate, maximum and minimum blood pressure, the stroke volume of blood and the minute volume of blood were studied. The study results show that the adaptive response of the cardiovascular system to a moderate degree of anoxia is characterized by a moderate rise in pulse rate, in maximum blood pressure and in the stroke and minute volumes of blood.

Inadequate adaption to anoxia, with manifestation of the collapse response, is characterized by a sharp drop in blood pressure (maximum and minimum), bradycardia and a moderate reduction in the stroke and minute volumes of blood.

When exposed to a moderate degree of anoxia, a decrease in the /9
percent oxyhemoglobin in the blood of the persons studied is observed. In this case, there are considerable individual differences.

Pulmonary ventilation and the depth and frequency of respiration increase as a result of anoxia. Respiratory disorders are not observed.

The studies conducted by Khr. Aleksandrov on collapse under anoxic conditions show that it is accompanied by profound disturbance of equilibrium of the basic cardiovascular indices. The leading symptoms are a manifest decrease in the maximum and minimum blood pressure and the development of progressive vagus bradycardia.

Changes in Gravitational Factors Affect the Body

This question concerns both space biology and medicine. Human tolerance of positive radical accelerations, in particular, the response of the cardiovascular system to the mechanical factors generated by acceleration in flight, are being studied.

An ingenious centrifuge has been built for study of the tolerance of positive radial accelerations. A feature of its design is that the initial rotation rate is transmitted through the dropping of a weight and, after this, it is maintained by means of low power motors. Remote, objective recording of the important physiological parameters for evaluation of tolerance of accelerations (pulse and respiration rates, blood pressure, rheography, simple and complex sensorimotor responses, etc.) is accomplished by means of modern electronics equipment.

D. G. Dimitrov is performing the studies by means of the centrifuge, and he finds that a significant position is occupied, in the pathophysiological mechanism of visual disorders and loss of consciousness in exposure to acceleration, by the redistribution of blood due to the hydrostatic factor.

By clinical rheography and rhecencephalography, the significant role of vascular compensation in the general readjustment of the body to conditions of gravitational stress is demonstrated.

To answer the question as to how much inadequate physical training and neurocirculatory and neuropsychic asthenization decrease body tolerance to positive radial accelerations, which has a direct relationship to the question of cosmonaut selection and building up a purposeful program and system for training them, D. G. Dimitrov performed a series of studies with the centrifuge. In them, he reached the conclusion that hypotensive type neurocirculatory dystonia and functional diseases of the central nervous system of the neurosis type, as well as vascular-vegetative instability, decrease body tolerance of acceleration. Tolerance is particularly reduced in persons with neuroses accompanied by vegetative dystonia. It is thought that general asthenization of the body in neuroses leads to discoordination of the pressor

and depressor processes, with the depressor predominant. Tolerance of acceleration is reduced to the highest degree in persons with vascular vegetative lability. In these cases, arterial pressure is kept at the optimum level very unsteadily, and it suddenly drops sharply to very low values. It follows from the Bulgarian studies that low tolerance of acceleration with vascular vegetative lability is due to vascular dysfunction and the lack of accurate, efficacious gas pressor compensation in vascular adaptation.

The conclusion of the studies of L. Minkovski et al. on the effect of gravitational moments (positive radial accelerations and the orthostatic factor) on the body is of definite interest in the medical selection and monitoring of cosmonauts, in connection with their resistance to the important factors listed in space flight.

Study of Effect of Vestibular Factor on the Body

It is in the sphere of interest of space medicine. Problems connected with the search for means and methods of protection against increased vestibular sensitivity under flight conditions are central to study in this field.

L. Yanchev, D. Paskov, Il. Belokonski, D. G. Dimitrov, P. Balukov, E. Ivanova and V. Genova are studying the effectiveness of a number of medicines in depressing vestibular sensitivity. In this case, they have determined that the pure preparation cyclizine hydrochloride has the greatest effectiveness in compensation of vestibular disorders.

D. G. Dimitrov, E. Ivanova and I. Balukov experimented with the removal of side effects (hypotensive and depressive) of the use of this medicine, and they studied the effect of the preparation stugeron. They found that, without having side effects, this preparation favorably reduces the manifestation of vestibulovegetative symptoms.

D. G. Dimitrov and E. Ivanova studied the effect of a number of kinds of athletic disciplines (free style wrestling, light athletics, water sports, basketball, volleyball and sports gymnastics) on the

reduction of vestibular sensitivity. They reached the conclusion that systematic exercises with various types of sports favor a reduction in vestibular sensitivity, and that they improve the compensatory adaptive mechanisms of the body. The most favorable effect is obtained from sports gymnastics, which shows that this type of sport has to be practiced more widely in cosmonaut training.

Study of Problems of Psychophysiology

Study of problems of the psychophysiology of cosmonauts are connected with the studies of K. Zlatarev, G. Radkovski and D. M. Dimitrov of operator type occupations, the activity of which occurs under difficult conditions, with the performance of complicated tasks.

A solidly interesting method of recording movement in writing has been proposed at the Institute of Physiology. The structure of the device consists of a Getinaks sheet, to which a resistive layer of special configuration, pen and amplifiers are applied. Two analog voltages proportional to the coordinates are obtained at the output of the device, which determine the position of the pen in the working field of the sheet. The special configuration of the sheet and the amplifier scheme selected reduce the contact noise and the effect of stray resistance to a minimum.

By means of this method, the movement in writing any letter is studied under normal conditions, in fatigue, anoxia and after vestibular stimulation. The two components of movement on the x and y coordinates during the writing of an individual letter consist of successive time intervals bounded by the extreme points. The characteristics of handwriting of different people are determined by different numbers of these intervals for each letter and, for some persons, and, basically, all persons, by different relationships of the amplitude of the changes in individual intervals. In fatigue, anoxia and following vestibular stimulation, statistically significant changes in the lengths of individual intervals and some amplitude relationships occur. In local fatigue of the wrist, these changes are mainly in the amplitude relationships of the vertical component. In anoxia and after vestibular

stimulation, the changes also are mainly in the amplitude relationships, but in both components.

There are abundant proofs of the cooperation between the Soviet and Bulgarian scientists in the fields of

Space Radiology and Radiation Protection

The results obtained from chronic gamma irradiation of mice, rabbits and other targets merits emphasis. Of special interest are Bulgarian-Soviet data on the low genetic effectiveness of chronic irradiation. In this area, the magnificent paper of academician Gazenko to the International Astronomical Congress in Prague in 1977 is recalled, in which he discussed the problem, will people change in permanent life outside the Earth in the expanse of the universe? This is what the Soviet and our scientists answered, at least on the radiation aspect of this question, as they answered that chronic irradiation under a certain threshold does not lead to damage to the spermatozoids or offspring. /98

In connection with execution of the basic tasks of the Intercosmos program, we have developed a broad study of the synthesis and investigation of new radiation protection means and their combined testing, under conditions which simulate radiation injuries in space flights. The purposeful development of new preparations was subject to tactical and engineering specifications for radiation protection means intended for spacecraft crews. Initially, purely radiation models were used, but, in subsequent years, the studies were conducted by means of combined models, which simulated the set of extreme factors of space flight. In the Laboratory of Pharmacochemical Protection of the Institute of Radiology and Radiation Hygiene, tens of antiradiation preparations have been synthesized and tested, of which the most effective proved to be citrifos and adeturon. The latter preparation underwent comprehensive study in USSR, Bulgarian People's Republic, Czechoslovakian SSR, Hungarian People's Republic and GDR. In all tests, acute, long-term and chronic irradiation with X-rays and gamma irradiation, neutrons, protons,

heavy charged particles, adeturon showed a very degree of protection. This preparation has low toxicity and a wide therapeutic range. It can be stated objectively that, today, adeturon is one of the most promising antiradiation means. Its characteristics are supplemented by recently obtained data that it increases tolerance of some dynamic factors of space flight, which simultaneously increases the dynamic and static performance of animals exposed to the combined effect of extreme space factors (acceleration, radiation, magnetic field, etc.).

The next, preclinical stage of the study of the adeturon was a joint Bulgarian-Soviet experiment on monkeys, irradiated with gamma radiation and protons (Sukhimi, Joint Institute of Nuclear Research, Dubna). In both acute and long-term experiments, the preparation insured great prolongation of the lives of the protected monkeys; the course of radiation sickness was relieved, and there was no or brief manifestation of any symptoms. In distinction from presently known radiation protectors, the application of adeturon is good, in cases when the nature of the radiation is not known. The clinical introduction of the preparation is imminent.

In 1977, our first participation in various biomedical space experiments was recorded. Changes in the system of heredity of somatic and sex cells of animals exposed aboard the Kosmos-936 biosatellite /99 were analyzed, in which the basic problem was to estimate the possibilities of decreasing the effects of prolonged weightlessness by the production of artificial gravity with a centrifuge. The resulting data showed that the changes observed immediately after landing are transient, and that they return to normal after a 25 day readaptation period.

The biomedical research we conducted in the Intercosmos program makes it possible to solve a number of central questions and to draw valid conclusions, as to the stability of the foundations and principles of biomedical support of prolonged human space flight.

Progress in space medicine has permitted the solution of some entire problems of ground based medical science. The precise definition of permissible changes under various radiation and other loads has

increased knowledge between the boundaries of the normal and the pathological. For maintenance of the cosmonauts, there have been improvements and the development of a number of new methods of recording latent pathological states, which was the basis of new expert approaches to evaluation of the condition of a healthy man. Some of these methods were developed by Bulgarian scientists, and people occupationally engaged in the sphere of ionizing radiation were brought into clinical monitoring.

Effective prophylactic and therapeutic antiradiation preparations have been developed for space flight purposes, and an increase in tactical and engineering requirements on them are foreseen, which permits their direct introduction into practical hygiene, in the radiation therapy of malignant neoplasms and the radiation protection of the population in the event of accident or other extraordinary circumstance.

Always, studies in fields at the boundary between various sciences produce surprising and radically new results. We have such a situation, in the field of flight radiation safety and the limiting radiation doses associated with it. Many were surprised when, at the end of 1967 the then young scientific worker, engineer P. Velinov, whose name we mention repeatedly in the section on space physics, proposed sending his work on limiting radiation doses and variations of penetrating space radiation to the United Nations Organization. This work was received and presented with unusual success at the Conference of Vienna in 1968. After presentation of the paper, Velinov was congratulated by academician A. A. Blagonravov, cosmonaut Leonov and many other scientists and specialists.

How versatile and broad is our space program, the readers can decide from the fact of the participation of our chemist-pharmacists and our doctors in the preparation of cleaning materials and food for the cosmonauts. Associate member Prof. L. Zhelyaskov and colleagues of Farmakhim developed an original washcloth, of the Bulgarska roza type, /10
which is widespread in daily life, which is suitable for cleaning the hands and faces of the cosmonauts. Their difference from those used on the Earth is that they do not contain alcohol or other substances which

were left out of the space flight vehicle cabins. The same group is developing a group of new preparations to freshen the air the cosmonauts breathe. Dr. Mitana Stoyanova and other specialists of the Medical Academy in Sophia have selected, revised and prepared our excellent, tasty foods for the Soviet and our cosmonauts. Thorough study of them in the Soviet Union has shown that other cosmonauts can be fed in the future with these appetizing and very healthful foodstuffs.