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Elbrus Medical-Biological Station of the National Academy of Sciences of Ukraine: development of biotechnical space technologies

The prospects of the future investigations in aviation and space exploring in Ukraine depend on our great traditions in these spheres, which are unknown often to majority of descendants. In materials below there is a brief description of the large-scale investigations and development of biotechnical space technologies at Elbrus Medical-Biological Station of NAS of Ukraine

Ukraine is an integral part of Europe, its culture, traditions, including the traditions of science, engineering, and education. The contribution of Ukrainian people to space exploring is great but not known enough in contemporary World and we would like to add some important facts to these knowledge. In the terms of the number of engineers of space technique, astronauts, scientists, groups of theoretical and computer professionals who work with the space-obtained data, our Ukraine plays ever one of the leading roles. Observing the prospects of the space exploring in Ukraine, it is important to know and remember the traditions of our achievements in the fields of space technique, avia- and space physiology – and this base defines our further prospects in these spheres.

One of the founders of our space physiology, Prof. Sirotinin M.M. began to deal with the space problems on 1940 [1, 2]. He organized the laboratory of the space medicine at the Institute of Physiology of the National Academy of Sciences of Ukraine for the first time in ex-USSR and in the World. Medical doctor from this laboratory, Prof. Beloshitsky P.V. became the first PhD and Doctor of Sciences who officially acquired the specialty "space physiology" after the graduating of pre-doctoral education and the work in this laboratory [1-3]. These investigations were spread to the Caucasus Mountains too. Ukrainian Academy of Sciences (further - National Academy of Sciences) organized in parallel the laboratory of space physiology with rehabilitation clinical department and unique thermobarochamber at Elbrus Mountain slopes (vil.Terskol, 2100 m a.s.l.) on 1972 [3, 4]. Later it was called Elbrus Medical and Biological Station NAS of Ukraine (EMBS NAS of Ukraine). It became an international center for hypoxia problems investigations and the implementation of these results in the practice of medicine, aerospace physiology, and sports. On 1966-1968 a part of laboratory was elevated to the top of Elbrus (5621 m a.s.l.), in which Prof Beloshitsky P.V. with colleagues conducted the secret research of modeling of living conditions on the Moon at the eastern top of Elbrus in its crater. Courage, skills of pilots and scientists allowed turning the highest peak of Europe into a scientific laboratory. They constructed a two-room laboratory house with a Plexiglas veranda (for solar heating) with a total area of 22 m. The panels for the house were three-layer

(duralumin, polyfoam, plastic). In it, and later in the created cave on top of Elbrus, the special medical and biological researches were carried out [3].

The development of astronautics is impossible without a parallel study of medical and biological problems. Many technical tasks require a combination of knowledge of different specialists – medical doctors, engineers, designers, astronomers and others, because the engineering constructions in space must be adapted for human presence. That is, astronautics began with the combined efforts of professionals in science and technique. This was perfectly understood by our great compatriot S.P. Korolev. Thanks to his initiative the Institute of Medical and Biological Problems (IMBP) was established in USSR on 1963, with which the groups of Ukrainian scientists cooperated actively (having the relevant approvals) during XXc.

In the laboratory of space physiology, in the Elbrus expeditions (1958-1970), at the Elbrus Medical and Biological Station (EMBS) of the NAS of Ukraine(1972-mid 2000th), the employees for the first time in Ukraine (and ex-USSR) conducted the researches of: the effects of acceleration on organism, adaptation to mountain meteorological factors to increase organism resistance to extreme factors of space flight, regeneration and utilization of wastes in isolated ecological system to ensure the organism viability during the long-term space flights; space dust in order to determine its composition and the possibility of growing lichens, fungi, algae on it; possibility of organism resuscitation during 16-25 min. after the clinical death due to explosive decompression, acceleration, electric shock, acute blood loss, drowning in sea water; the influence of partial weightlessness that occurs when organism was immersed in water, the possibility and prospects of the use of hypothermia, anabiosis during the outer space exploring; the effect of adaptation to alpine climate on the duration of hibernation, the thermal state was tested on volunteers, who were for an hour at the "altitude" of 6000 m a.s.l. with the temperature -50° C (in co-operation with the Institute of Biophysics and Institute of Medical-Biological Problems (ex-USSR); the peculiarities of pharmacological preparations' action at hypoxia conditions there were studied as well. The necessity of development of new science - space pharmacology was grounded, as well as modeling of "life at the Moon" in the crater of the eastern peak of Elbrus (these results were reported during the "closed" symposium on modeling of "living conditions on the Moon" that was held at Aragatz Mountain in Armenia on 1967; the report was highly estimated by the Head and Coordinator of research in the field of space physiology, Academician V.V. Parin) [3-5].

In addition, many other problems of space medicine and biology were studied there: the genesis of hypoxia under the action of factors specific to the conditions of space flight (overload, weightlessness; space, solar, electromagnetic radiation; isolated space, acoustic, vibrational factors; stress, exhaustion) There were developed the criteria for the selection of candidates for astronauts and forecasting of states of their organisms. Also there were found and studied the ways to increase the resistance of astronauts' organisms to space flight factors. The best option for the high-altitude training is the method of active step-by-step alpine adaptation - it was incorporated into a practice - special contingents were sent for training twice per year in the mountains of the Caucasus, Tien Shan). There were developed mathematical models of organism reliability in extreme conditions, telemetry systems, registration, processing,

transmission of physiological parameters and medical problems in the design and operation of orbital, lunar stations, rockets, as well as spacesuits.

In the late 1950th - early 1960th the necessary aerospace experimental conditions were reconstructed by adapting of various existing technical advances - prototypes. For example, for the studying of acceleration (up to 40 units) the animals were effected by centrifugation with a diameter of 5 - 10 m, and ECG recording and respiratory rate were performed for by means of mobile contacts in mercury; decompression was modeled in small pressure chamber ("barochamber" with V = 0.1 m3), which was connected to a large one (with 7 m3) obtaining a vacuum corresponding to a height of 16 km a.s.l. - opening the valve that connected barochambers (with diameter of the hole 4 mm) and during 25 sec the barometric pressure in the small chamber decreased to the same "height". In another "space" variant, decompression was induced in a small barochamber connecting it with a large one (8 m3), which was "raised" to "height" of 30 km - in a moment the atmospheric pressure in it decreased to "Marsian" one (2 mm Hg).

The study of simultaneous action of such factors as hypoxybaria and the influence of high and low temperatures were of particular importance in aviation and space physiology. As a result of such studies, a quantitative assessment of heat loss during freezing in hypoxibaria was done. The areas of the body that of the most at risk of frostbite (using thermotopograms) were identified. The highly effective method of non-specific resistance - thermobarotherapy was invented and patented (the author's certificate was obtained for it).

We also had a task of long-term registration (during several days) of animal body temperature, blood oxygen saturation and simultaneous automatic maintenance of these indicators at the required level. This was achieved in a special hermetic chamber with the help of devices that allowed the simultaneous use of such control devices as automatic regulators of the units maintained the required modes of cooling, heating, oxygen supply. In such a way was raised a problem of automatic regulation by technical means with the help of vital functions. There were problems that bionics and biotechnologists are currently dealing with in contemporary practice. But the concept of "reliability" we borrowed from the practice of engineers, and incorporated them (as well as "information diseases") in medical and biological circulation.

On Fig.1 there are photos of the realization of the Project "Landing on the Moon" from the top of Elbrus Mountain (1966). Prof. Dr.Sci. Beloshitsky P.V. was the Head of this project. The project realization was possible due to enthusiasm, understanding of the importance of the problem, the scientists' faith in victory, multiplied by the excellent flight qualities of the "MI-4" helicopter. The pilots Yu. Rakhmanov, M. Khasanshin, M. Teplov demonstrated great skills. At this time on their "MI-4" they became the absolute world record holders among helicopter pilots. It was the first landing on the top with a load of 400 kg on August 27, 1966. They successfully overcame the height of 5621 m a.s.l. eight times! And this was despite the fact that the aircraft designer M. Mill recommended to refuse from this idea because of its danger…

On Fig. 2 is a great barochamber of EMBS, were numerous investigations were done on the late 1980 – early 2000. A lot of professionals in aviation and space exploration, alpinism, rescuers in extreme conditions, special contingents, sportsmen

and others were trained in it. On the photo the participants of Ukrainian-American expedition were presented, Prof. Beloshitsky P.V. stayed in the second line, the third from the left among other bright young people.

…Thus, the achievements of "terrestrial" medicine and aviation greatly helped to the man penetration into outer space, and the solution of a number of the problems "initially" formulated as “biocosmic” were useful for the understanding of the essence of terrestrial life…

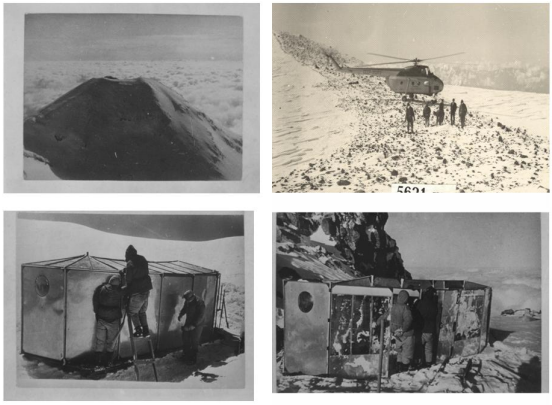

Fig. 1. Project “Landing on the Moon” realization: construction of scientific laboratory at the top of Elbrus Mountain (1966).

Fig. 3. Participants of Ukrainian-American expedition near the great barochamber of EMBS (1990th years)

Conclusions. In present materials were demonstrated that the prospects of the future investigations in aviation and space exploring in Ukraine depend on our great

traditions in these spheres, which are unknown often to majority of descendants. In these materials a brief description of the large-scale investigations and development of biotechnical space technologies at Elbrus Medical-Biological Station of the National Academy of Sciences of Ukraine was given. We hope that such publications of unknown pages of Ukrainian traditions in aviation and space exploring, engineering and scientific research will inspire the future achievements of contemporary young people in Ukraine.

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