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EVOLUTION AND PRESENT STATUS OF EXPERIMENTAL MANNED ECOLOGICAL SYSTEMS FOR LONG-TERM HUMAN LIFE SUPPORT – BIOS, DEVELOPED BY THE INSTITUTE OF BIOPHYSICS OF RUSSIAN ACADEMY OF SCIENCES IN KRASNOYARSK (SIBERIA)

Abstract

Closed ecological systems are of two-fold interest – as models of the Earth's biosphere explorable in experiments and as a facility for long-term autonomous human life support beyond the Earth. Theoretical analysis and experimental implementation of highly closed manned systems has been the subject of studies at the Institute of Biophysics (Russian Academy of Sciences, Siberian Branch) for many years. BIOS systems of increasing complexity with complete regeneration of atmosphere, water and partially food have been realized. In BIOS-3 experiments the system inhabited by 2-3 researchers for 4-6 months maintained its metabolic equilibrium without any negative physiological effect on the crew, which proves its sustainable condition. Specific for BIOS-3 is internal control by the people inhabiting the system. So, BIOS-3 is the first experimental implementation of V.I. Vernadsky's idea about the noosphere – habitable Biosphere controlled by human intelligence. Contrary to predictions of many environmentalists the closedness of the ecosystem is a factor that does not reduce, but increases its sustainability and makes its use for reliable life support outside the Earth realistic. The system is sustainable owing to permanent feedback between the monitoring of few key parameters of the system and automatic corrective actions on them. Main object of control is photo- biosynthesis regenerating parameters of human habitat disturbed by his vital activities. This principle has been realized in BIOS system and proved its reliability in long-term experiments. A new challenge is specified –optimal increase of trophic closedness of the system by reproduction within it essential proteins (peptides and amino acids), lipids, vitamins and other essential compounds. Alternative lines of attack on this problem by state-of-the-art biotechnological methods, GMO including, are under analysis. Reduced BIOS version – without complete closure – can be a breakthrough instrument to improve the quality of life of people living under extreme conditions on the Earth – in polar latitudes (Arctic, Antarctic), in deserts, in high mountains.