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CORRELATION BETWEEN CLOSURE DEGREE, TROPHIC NETWORK COMPLEXITY, AND STABILITY LEVEL FOR CLOSED ECOLOGICAL SYSTEMS DESIGNED FOR AUTONOMOUS FUNCTIONING IN SPACE

Abstract

This research suggests theoretical schematics to a description of Closed Eco-System (CES) which are considered as most advanced life support approach for manned space missions of long-duration. Concept of CES functioning manipulates such important terms as: closure index (metric for system closure degree), stability of material cycles functioning, trophic net/chain structure and complexity, and some others. Definitions based on math modeling approach for these terms are suggested. The non-linear correlation between numerical values of above mentioned parameters are demonstrated by mathematical methods. As it follows from analysis: - critical ranges of CES sizes exist, where system functioning becomes significantly unstable because rates of material recovery could not compensate system target organisms-humans Life Support (LS) demands; - these sizes are determined by trophic network complexity and system closure degree; - targeted control factors, distributed inside and/or outside of the closed system, if taken consciously, can increase stability of CES functioning; - Limits for man-made, more simplistic and reduced, CES, compare to Earth Biosphere analogs, functional and operational reliability are always less than 100Theoretical conclusions are supported by available data from real man-made CES operations and testing (BIOS-3, Russian Federation; BioPLEX, JSC NASA; Biosphere-2, USA; CEEF, Japan; Earth Biosphere as a system of reference). Suggested approach is expected to furnish a useful tool for autonomous space Life Support Systems (LSS) design and development.