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Principle of biosystem optimal diversity

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Introduction

Relationships between biodiversity and ecological functions are frequent subjects in ecological modelling. We propose the principle of biosystem optimal diversity and corresponding model of optimum diversity in two-level hierarchical biosystem .

This principle is based on assumption that diversity of biosystem elements is linked to its vital fundamental characteristics determining its viability (survival probability). These characteristics of biosystem tend to extremize (maximize or minimize) in the course of its development and diversity of elements corresponds to maximal biosystem vitality. It is the optimum level of diversity (fig. 1).

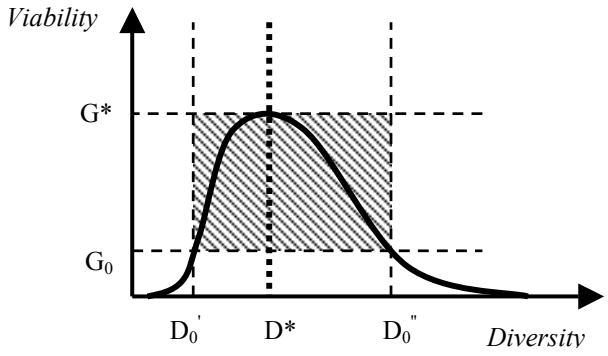

Fig. 1. Optimal and critical value of biosystem diversity. D* - optimal diversity value; D_0' D_0'' - critical diversity value; G_0 – critical viability value; G* - maximum viability; section lining – the area of system existence.

Some applications of this approach in the fields of biodiversity evolution and biodiversity conservation were examined earlier (Bukvareva, Aleshchenko, 1994, 1997).

Results and discussion

We have elaborated and studied a mathematical model of optimal diversity of a two-level biological system in stochastic environment. The subsystems of the lower level shall be regarded as populations, while the upper level being interpreted as a community of one trophic level made up by these populations.

The environment is characterized by intensity of resource flow and the degree of its stability. At the population level we adopted the model that was worked out earlier (Aleshchenko et al., 1991). Population consists of various phenotypes, which are able to reproduce with realization of various values of the environmental parameter. The objective function (optimization criterion) for population is its maximum number by a predetermined volume of the resource available (this is similar to the task of minimizing resource consumption by a set population number). With regard to community we applied the maximum of total number (biomass) of all populations by a predetermined volume of

available resource as an optimization criterion. Both optimization criteria correspond to maximum efficiency of resource utilization by biosystems, that can be interpret as biosystems vitality valuation.

Formation of optimal diversity by interaction of two hierarchy levels is an iterative process: 1) populations choose their optimum parameters and send to the upper level values of intrapopulation diversity and population number; 2) taking into account these values the upper level devides available resource between populations to solve its own task (maximization of total biomass); 3) the upper level send to populations their resource portion; 1), etc.

Conclusions

The analysis of this two-level model carries the following results:

- optimal intrapopulation diversity decreases while the environment stabilizes and is independent on the intensity of resource supply;
- optimal species diversity (the number of populations in community) and the total population number (biomass) increase while the environment stabilizes; also these characteristics increase while intensity of resource flow increase.

On the basis of these conclusions we may assume the following pattern of species and intrapopulation diversity values in different environments (fig.2)

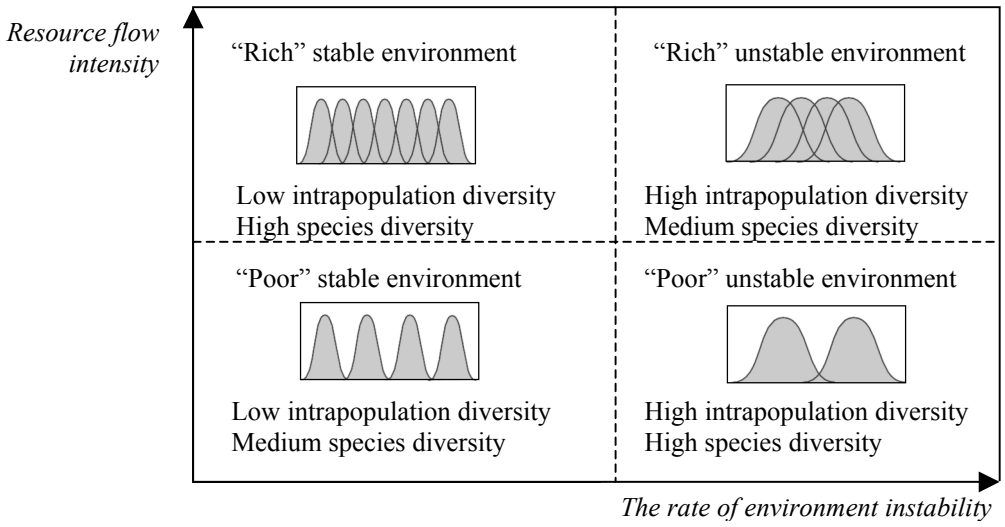

Fig. 9. Assumed levels of intrapopulation diversity as well as the species numbers in communities adapted to different environments.

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