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Summary

While investigating the productivity of populations and communities one must evaluate both biomass B and specific production C . Production P may be considered as product B and C .

The C level depends on the life span and body size of animals. Correlation of C and B exist in relation to environment capacity and level of food resources.

The efficiency of exploitation is dependent on C and B of exploited population. Intensive industrial cultivation of small invertebrates is considered as possible way to increase basically the output of the animal protein.

Introduction

Comprehensive investigation of both population and community productivity allowed to specify some facts on the structure and functioning of the particular chains of natural ecosystems. So it became possible to work out the well-founded strategy on exploitation of valuable organisms.

Some years ago the biomass of the population have been considered as productivity index. Later in a number of approaches to productivity problem there was a tendency to discriminate the biomass data. But both biomass and production are equally valuable in connection with the productivity problem (Edmondson, 1961).

In this report some interrelation are discussed between production, biomass, and level of food resources in the cases where food resources are limiting the environment capacity.

A trophic level consisting of one or a number of species populations predating the same type of food is considered as basic unit of community.

Quantity of food as a factor limiting the environment capacity

Any locus of a natural environment may be characterized by some capacity in respect of any inhabiting population or total community. Quantification of the environment capacity can be based on the biomass of inhabiting organisms. The capacity depends on a number of factors, one of them limits the biomass. In unstable environment there is a reason to quantify an average and a maximum capacity in respect of particular population.

The maximum steady-state biomass of a

trophic level TL in any food web is limited often by the available total material that it can convert into its own biomass. Let us consider such situations where food resources are limiting the biomass.

If living organisms are served as a food, two trophic levels TL_1 (prey) and TL_2 (predator) are under consideration with biomass B_1 and B_2 respectively.

In a steady-state TL_2 is consuming such maximum quantity of food I_2 that B_1 is not lowered. Hence, the rate of food elimination is equal to the rate of food recovery.

Some basic remarks about productivity (after Zaika, 1972)

The productivity of population or TL is an ability of producing organic matter. Production P is a total amount of organic matter produced for a time unit by the given biological system irrespective of the fact whether it is within the system at the end of the period under study or is eliminated partially or completely. Specific production C is an amount of production for a time unit per unit of the biomass B .

Hence, it follows useful relation

$$P = CB \quad (1)$$

Value of C in the population is related strongly to the biotic potential of the species and to the turnover rate, and C is much more stable than B . In community total value of C is more variable, alteration of C is possible by means of changing of biomass ratio for the species with different C .

High C -values have species with a short lifetime, most of them having small individual weights.

Another useful relation is:

$$P = A - R, \quad (2)$$

in which A - the food absorption and R - expenditure on metabolism, both A and R in the same units as P .

Equations (1)-(2) are equally applicable to individuals, population and TL consisting of a number of populations.

Food resources, productivity and biomass of TL

If the food resources are limiting the consumption in steady-state system, then amount of food eaten I_2 is equal to production of food organisms P_1 . In any case P_1 may be considered as maximum I_2 . Assuming proportionality between I_2 and A_2 , and between A_2 and R_2 , it follows from (2) that I_2 (and B_1) is limiting P_2 .

It was mentioned above that the main regulator of P is B while value of C is rather stable in natural populations in which number and biomass of organisms are closely related to their growth and reproduction rates in foregoing years. But in agricultural systems where density of individuals is man-made, the value of C is limited by the environment capacity first of all.

Let us consider two predators with different values of C in separate environment with equal capacity. If food is limiting then higher biomass appears to be in species having smaller C. Indeed, some cultivation data indicate that populations of larger animals with longer lifetime reach higher biomass in a comparable conditions (Shpet, 1968).

In successive trophic levels a decrease of food resources take place, as from (2) it follows:

$$\begin{aligned} P_2 &= u_2 P_1 - R_2, \\ P_3 &= u_3 P_2 - R_3, \\ &\dots \dots \dots \end{aligned} \quad (3)$$

where u_2 and u_3 are coefficients of absorption of food ingested by organisms of TL_2 and TL_3 ($0 < u < 1$). Hence P is decreasing in successive TL. But if C is decreasing, too, inverted pyramid of biomasses can take place. If value of B is a measure of environment capacity then inverted pyramid is evidence of increasing capacity in relation to successive TL. Thus capacity is not function of environment only but depends in a sense on C value of population or TL.

It is well known that consumption of food depends strictly on food concentration (Ivlev, 1955; Zaika, 1973). The rate of consumption is not depending on food production as such. But production of TL_1 influences on consumption of TL_2 indirectly; the production of prey organisms is determining whether food concentration alters as the result of the consumption.

Biomass, specific production and population stability

A greater stability is typical to the populations of long living large organisms. Such species have usually stable high value of B. But on the other hand these organisms have low C.

A short living organisms have higher C but any change in environment even of short duration caused a great fluctuation of B. Such fluctuations are usually in many times greater than level of elimination by predators.

Optimum exploitation

The traditional catching is based on large organisms with relatively stable and high biomass as it is more profitable economically. The biomass itself is very important for the catching while values P and C are taken into

consideration mainly under the threat of overcatching and in agricultural systems.

If the ratio: output/biomass is close to C in its value then the amount of biomass equal production is removed. Such regime of exploitation usually undermines population. Besides catching natural elimination exists and it can't be completely excluded that is why total elimination exceeds production in this case.

Decrease of biomass as a result of catching is very dangerous for long-living large organisms as renewal of the population demands much time. It is desirable to compare output with B, P and C for these species not only for total population but for individual age groups as well.

One of the main obstacles in exploitation of short-living organisms is instability B in space and time. Overcatching is less dangerous for the species with short life duration (2-3 years) than for long-living organisms. In this case output equal production is permissible. The closer TL is to the primary producers the higher is the production. So it is advisable to intensify exploitation of initial chains of food web if biomass of corresponding population and individual size assume organising of economically profitable catching.

Culture of short-living animals of low trophic chains can give the highest values for harvest per unit of area. High value C of such species account for this.

To obtain high and stable production high and stable environmental capacity must be artificially created and maintained in particular in relation to food resources.

That problem involves at least three tasks:

1. The elaboration of industrial cultivation technology. All environmental factors must be strictly regulated, and a farm method is not applicable.
2. The junction of animal cultivators with a small algae or yeast cultivators, or another effective decision of the forage problem.
3. The elaboration of economically profitable technology of the utilization of the animal biomass.

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