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MONITORING OF THE SPECIES DIVERSITY OF LIVING ORGANISMS IN TEACHING AGROECOLOGY TO BIOLOGY STUDENTS

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Abstract
The article provides materials on mathematical processing of data obtained during monitoring of the species diversity of living organisms under the influence of anthropogenic or man-made press on biocenoses, as well as calculations of concentrations of man-made pollutants. The necessity and timeliness of their inclusion in the curriculum of biology students are substantiated.

Keywords Botany, ecology, monitoring, living organisms, agroecology, biology.

INTRODUCTION

The problem of environmental safety has gone beyond the national and regional and has become a global problem for all mankind... Humanity has really felt the threat it faces, the result of anthropogenic impact on the environment"). Intensive human economic activity has brought the world to the brink of environmental disasters. The human impact on the environment is multifaceted. The main anthropogenic factors that destroy the habitat are: urban growth, mining, automobile transport, industry, and the chemicalization of agriculture.

In environmental degradation, chemical exposure takes the first place. The role of chemicals in human life is difficult to overestimate. They are assigned one of the important places in the fight against pests, diseases and weeds of crops, but the effects of pesticides are never unambiguous. Pesticides used in agriculture are organic compounds that are toxic not only to harmful organisms, but also to humans and animals. Humans use

pesticides to destroy a limited number of organisms that make up no more than 0.5% of the total number of species inhabiting the biosphere, while pesticides, when used, affect all living organisms. When carrying out protective measures, pesticides are always directed against populations.

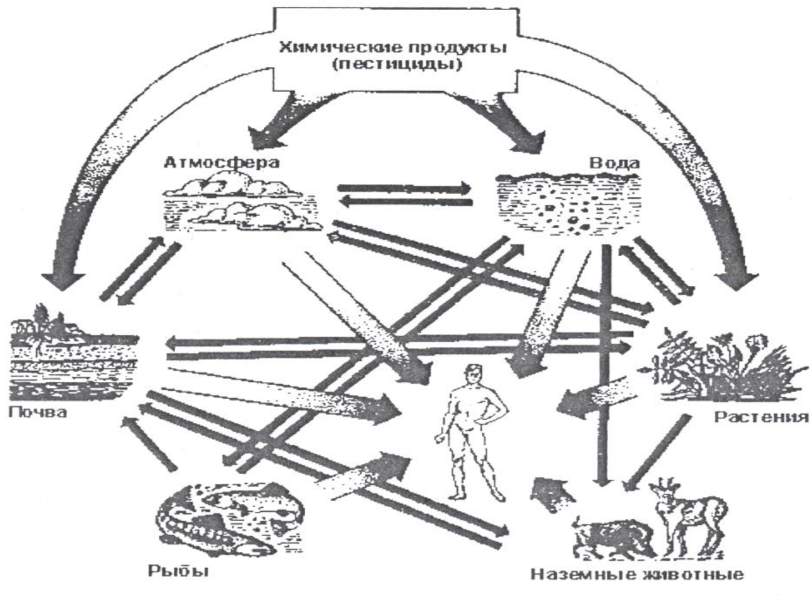

Fig.1 . Circulation of chemical products (pesticides) in the environment.

In addition, pesticides spread far beyond the agroecosystems where they are used. Even if the least volatile components are used, more than 50% of the active substances pass directly into the atmosphere at the time of exposure (Fig.1).

It has also been established that up to 25% of pesticides used in agriculture end up in aquatic ecosystems. Water drainage from fields treated with pesticides pollutes not only small reservoirs, rivers, but also the estuary (a wide estuary flowing into the sea or ocean). This problem is quite acute in our region as well.

Thus, the use of pesticides has negative consequences for individual species and biocenoses in general. Therefore, they pose a danger to the entire environment. The pesticide causes profound changes in the entire ecosystem into which it has been introduced. The situation is often complicated by the fact that much more pesticides are used than is necessary to destroy the pest: deliberate over-cultivation of fields is explained by "reliability".

In these conditions, the problems of regulating the human impact on the biosphere, searching for equally effective and at the same time safe and natural means of pest control, creating favorable natural conditions, and achieving balance in the society–environment system are becoming more urgent. At the same time, it became obvious that without objective information about the state of the environment and trends in its change, the practical implementation of protection measures is impossible. In this regard, local monitoring is of particular importance, on the basis of which the necessary data on the state of the region and the flora and fauna in this region are obtained, as well as the ability to make accurate calculations of the concentration and activity of man-made pollutants. This is exactly what we were guided by when including materials on monitoring data processing and calculation in the agroecology training program for biology students.

1. Mathematical processing of data obtained by

monitoring the species diversity of living organisms under the influence of anthropogenic or man-made pressure on biocenoses. Due to the impact of negative factors, species, structural and genetic diversity in communities of living organisms is disrupted.

Species of living organisms in communities are divided into dominant, semi-dominant and rare.

Sometimes there are no dominant species, and many species are characterized by intermediate abundance.

Species diversity consists of two components:

- species richness or density of species, which is characterized by the total number of available species;

- equalization based on the relative abundance or other indicator of the importance of the species and its position in the structure of dominance.

The species diversity may increase with an increase in the size of the surveyed area.

When exposed to a negative impact on the community, species diversity may decrease, which occurs in agrocenoses that are subjected to pesticide treatments, or in biocenoses that are under pressure from man-made emissions, including motor vehicles.

Two approaches are used to analyze species diversity:

- comparison of curves of relative abundance or dominance of diversity;

- a comparison based on diversity indices, which represent the relationship of dependence between the number of species and their significance.

One of the main components of species richness (diversity) or species density is the total number of species, which for comparative purposes is usually expressed as the ratio of the number of species to the surveyed area or the number of species to the number of individuals.

The second important aspect of diversity is the equalization of the relative distribution of individuals by species. For example, there are two systems in a cotton field: scoop caterpillars and ticks, herbivorous and predatory, each system consists of ten species and 100 individuals. These systems may have different equalization indices depending on the distribution of 100 individuals among ten species.

To better imagine both components of diversity, it is necessary to construct a graph on which, on a logarithmic scale, the number of individuals (or biomass, or productivity) of each species is set aside on the Y axis, and on the X axis is a ranked sequence of species from the most numerous (abundant) to the least abundant. The line connecting the points or passing close to them is called the dominance-diversity curve by Whittaker (1965), and the species significance curve by Pianka (1978) (Fig.1).

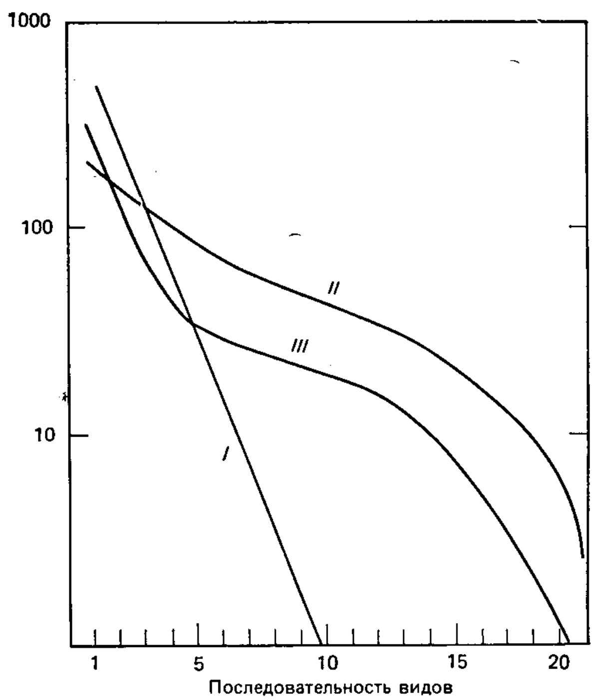

Fig.2 Dominance-diversity curves for a conditional sample consisting of 1000 individuals belonging to 20 species of scoops in a cotton field.

Note: the ordinate axis shows the number of individuals of each species, and the abscissa axis shows the ordinal number of the species in the sequence from the more abundant (bindweed scoop) to the less abundant (corn scoop). I - less abundant, II - more abundant; III - intermediate (intermediate system).

Another approach uses diversity indexes. They are characterized by the independence of the sample and the relative simplicity of the calculation.

1. Index of species richness (d). This index is calculated using the formula:

S-1
d = -------- (1. Index of species richness (d).
This index is calculated using the formula),
lg N

where: S is the number of species,

N is the number of individuals.

2. The Shannon Index (H).

The higher this index, the higher the species diversity.

The Shannon index is calculated using the formula:

H = - Σ n i / N log (n i / N) or H = - Σ P i log P i ,

where n i or Pi is the relative abundance of the species, reflecting the proportion of individuals belonging to the Pi species in the sample N or the number of individuals of the species relative to other species using abundance scores, that is, it is synonymous with "relative abundance" according to Yu.A.Pesenko (1982); n i is an assessment of the significance of each species, or where N is the total number of individuals in the sample; n i is the number of individuals of each species;

3. The Simpson Index (dominance index) (c), which reflects the concentration of dominance in individual species. The higher its value, the more

specimens from this sample belong to one or more species. The dominance index is calculated using the formula:

$$c = \Sigma (n_i / N)^2$$

or

$$c = \Sigma n_i \frac{n_i (n_i - 1)}{N (N - 1)} \quad \text{The dominance index}$$

$$1 - \Sigma (n_i / N)^2$$

$$c = \frac{1}{\Sigma (n_i / N)^2} \quad \text{diversity index,}$$

where: n i is the assessment of the significance of each species (abundance, biomass, etc.)

N is the sum of the significance estimates.

another formula is possible: $c = n_i P_i^2$,

where: Pi--- relative abundance of the species, reflecting the proportion of n individuals belonging to the P i-species in a sample of N; P - is determined by summing cubes of indicators relative to the abundance of species.

4. To determine the similarity between the components of species in different variants, the Chekanosky-Sorensen similarity index and the coefficient of generality proposed by Mountford and applied by T.S.Grigorieva and T.N.Zhavoronkova (1973) can be used.

The Ics similarity index is calculated using the formula:

$$I_{cs} = \frac{2a}{(a+b) + (a + c)},$$

where: a is the number of common species in both compared samples;

b is the number of species noted in only one sample;

c is the number of species noted only in another sample.

The Mountford community coefficient is calculated using the formula:

$$I = \frac{2j}{2ab - (a+b)},$$

where: a, b are the number of species in the matched samples;

j is the number of common species.

Monitoring will provide objective data on the diversity and dominance of various species of living organisms, which is very important, on the one hand, to maintain species balance, and on the other, to preserve and increase beneficial species (insect entomophages), which currently play an important role in pest control.

2. Calculations of concentrations of technogenic pollutants during experiments. When monitoring in laboratory conditions, it is often necessary to determine the toxicity for components of biocenoses (agrocenoses) of various toxic substances, for example, pesticides, in order to know the potential danger of these substances.

The following are the basic principles for determining the toxicity of substances and formulations of pesticides.

To conduct experiments, it is necessary to select the concentrations of working solutions depending on the bio-objects and the nature of the experiments. First, a series of 4-5 concentrations is prepared with a dilution step of 10. Acetone, ethyl alcohol or water should be used as solvents.

On the analytical scales, a sample of the substance or agent is taken and an initial working solution of a certain concentration (Cisx) is prepared, which can be calculated using the following formulas.

a) for substances according to the formula (1):

$$C_{исх} = \frac{A \times B}{C} \qquad (1)$$

where: A is the required concentration of DV, % (mg/l, mg/ml),

B - the required amount of solution (ml),

C is the concentration of DV in the substance, % (mg/l, mg/ml).

b) for the preparation form: in the event that it is necessary to prepare a solution of a given concentration to treat a certain area so as to obtain a given dosage, the calculation is performed according to the formula 2:

$$C_{исх} = \frac{D \times S}{C_{преп} \times V} \times 100\% \qquad (2)$$

where: Sprep is the concentration of DV in the product, % (mg/l, mg/ml),

Cisx is the concentration of DV in the initial solution, % (mg/l, mg/ml)

D is the prescribed dose, mg/m2 (g/m2),

S is the area of the treated surface, m2 (cm2, ha),

V is the volume of the preparation for the treatment of this surface, cm3 (ml, l).

Along with determining the concentration of man-made pollutants, in laboratory conditions, biology students are also invited to determine the insecticidal activity, which is estimated by the percentage of arthropod death in experimental versions compared with the control one.

Recently, an adaptive farming system has been increasingly proposed, which will reduce the consumption of anthropogenic energy and activate the vital activity of all beneficial organisms that make up the agroecosystem. Beneficial insect entomophages play an increasingly important role in reducing crop losses, which means that it is necessary to create conditions for their species and genetic diversity. Our proposed mathematical processing of data obtained by monitoring the species diversity of living organisms under the influence of anthropogenic or man-made press on biocenoses (agrocenoses), and calculations of concentrations of man-made pollutants will help to avoid undesirable consequences of negative factors, make the use of man-made pollutants strictly justified, reduce it to the necessary minimum, and therefore maintain balance in nature. Familiarization of biology students with the materials presented in the article will increase their professionalism and general environmental culture, which in the future, in the process of teaching biology, will influence the formation of the worldview of the younger generations.

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