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Department of General Ecology, Radiobiology and Life Safety

GUIDELINES

for practical work on the discipline

ECOLOGY OF BIOLOGICAL SYSTEMS (ECOLOGY OF PLANTS)

for OS students Bachelor's degree in "101 Ecology"

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The main practical tasks for studying the discipline Ecology of biological systems (plant ecology), definition of ecological groups of plants in relation to the main abiotic factors, bases of selection of methods of bioindication and biotesting, definition of quantitative and qualitative indicators of plant groups are given.

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CONTENTS

Practice work 1.

Modern classification of representatives of the plant world

Purpose: Introduction to the modern classification of the organic world, the main taxonomic units of the plant kingdom.

Main definitions: taxonomy, kingdom, class, order, family, genus (plural: genera), and species.

Basic theoretical information

There are more than 500,000 species of plants, hundreds of thousands of species of fungi and many microorganisms on Earth. The science of taxonomy deals with the identification of plant diversity, their similarities and differences, classification by groups (taxa) of different ranks; comes from the Greek word "sistematos" - "ordered" or "refers to the system".

The foundations of taxonomy as a science were laid by the eminent Swedish naturalist K. Linnaeus (1707-1778). For the basic unit of classification K. Linnaeus took the form. He suggested that all species of plants and animals be called in Latin in two words: the first word (written in capital letters) is a noun; this is the name of the genus to which the species belongs; the second word (written in lower case) is an adjective that denotes this species (for example, chamomile - *Matricaria chamomilla*). This method of naming species is called double (binary) nomenclature.

Close relatives form families. Several families unite in a row, rows - in classes. The highest category of taxonomy is a type that includes several related classes. There are also intermediate categories such as: subtype, subclass, superclass, etc.

The highest taxon in biology is the Empire, the lowest - the species. Type is the basic unit of taxonomy.

A species is a set of individuals characterized by hereditary similarity of morphological, physiological and biological traits, in natural conditions freely interbreed with each other and occupy a certain area.

The empire of cellular life forms is divided into two superkingdoms: prokaryotes (prenuclear) and eukaryotes (nuclear).

The plant kingdom combines photosynthetic organisms that have the ability to synthesize oxygen and starch. Plants are conventionally divided into Lower and Higher.

In higher plants, the body is divided into organs (root, stem, leaf), they include mosses, plaunoids, horsetails, ferns, gymnosperms and angiosperms. The body of lower plants has no division into organs (algae, lichens).

The main taxa of the plant kingdom: Species --- Genus --- Family --- Order --- Class --- Division.

Tasks:

1. Explain the Science of Taxonomy (developed by Carolus Linnaeus)
2. Find out about taxonomy's terms "kingdom", "class", "order", "family", "genus" (plural: genera), and "species". Which is the basic taxonomic unit?
3. Difference between higher and lower plants.
4. Full the table 1.

Table 1. Characteristics of the plant kingdom

Type the kingdom of plants	**Groups of plant organisms**	**The main features**	**Habitat**	**The value of nature**	**Significance in human life**
Lower plants	Algae				
	Bryophytes				
Higher plants	Bryophytes				
	Pteridophytes				
	Gymnosperms				
	Angiosperms				

5. Make a conclusion about the importance of plants for the environment.

Practice work 2.

Ecological groups of plants according to the requirements for light and temperature

Purpose: To get acquainted with the adaptive features of plants to abiotic factors of light and temperature.

Main definitions: very warm-hearted, warm-hearted, moderately warm-hearted, a little warm-hearted.

Ecological group - a set of species characterized by similar needs in the magnitude of any environmental factor and arose as a result of its action in the process of evolution by similar anatomical and morphological and other features that are fixed in the genotype.

Ecological groups are distinguished in relation to organisms to one environmental factor (moisture, temperature, light, chemical properties of the environment, etc.). The boundaries between ecological groups are quite conditional, so there is a smooth transition from one ecogroup to another, due to the ecological individuality of each species.

Photoperiodism (from the Greek. Photos - light and periodos - rotation, bypass) - is the reaction of plants to the ratio of day and night, which is reflected in the processes of growth and development and is associated with the adaptation of plants to seasonal changes in external conditions.

Researchers have found that the seasonal rhythm of plant life processes is determined by the gradual reduction of daylight in autumn and increase in spring. Accordingly, organisms have developed a mechanism for responding to photoperiods (day length) and nocturnal periods (night length). In the process of phylogeny, plants have adapted to a certain length of day and night within their range. This property is inherited.

Reducing the length of daylight (photoperiod) in late summer reduces the intensity of plant growth, stimulates the deposition of spare nutrients and the transition to dormancy. Increasing the photoperiod in late winter - early spring, determines the timing of flowering plants (alder, hazel, mother-and-stepmother, etc.).

Photoperiodism in plants

1) Daily

- opening and closing of flowers at a certain time;
- folding leaves at night;
- return of the inflorescence in the sun (sunflower);
- photosynthesis.

2) Seasonal

- bud burst;
- flowering during fruit ripening;
- November;
- period of rest.

It is known that the duration of daily lighting varies depending on the latitude and season of the year. In the south in summer the light days are shorter than in the north. Therefore, there are two types of photoperiodism:

• short-day;

• long-term.

According to the hereditary photoperiodic reaction to the flowering phase, plants are divided (Shulgin, 1973) into several groups:

• **neutral plants**, the development of which is almost the same at any length of the day;

• **short-day plants**, the development of which is delayed by prolonged (more than 10-12 hours) day and shortened night;

• **long-lived plants**, the development of which takes place most rapidly at 22 - 24-hour day and is delayed with the reduction of the day and the increase of the night.

Solar energy, which green plants absorb and use in the process of photosynthesis, is called physiologically active radiation (PHARE). period and also depends on the latitude. Plants on our planet grow in different light conditions

In response to light intensity (ie, the requirement for light) there are three main ecological groups of plants:

Heliophytes (light-loving), which require a lot of light and are able to tolerate only slight shading (light-loving include almost all cacti and other succulents, many representatives of tropical origin, some subtropical shrubs);

Scyophytes (shade-loving) - are satisfied on the contrary with little light and can exist in the shade (shade-tolerant include various conifers, many ferns, some ornamental and deciduous plants);

Sciogeliophytes (shade-tolerant or facultative heliophytes) grow mainly in shady places, where a small amount of direct sunlight, but they can also grow in the open. The boundaries of the groups are conditional, so many species of plants at different stages of development can be attributed to one or another group. Shade-tolerant plants are mostly inhabitants of the lower tier of the forest.

Especially many morphological types of plants are observed in tropical forests. Epiphytes and lianas grow here, capable of carrying the bulk of the vegetative and generative organs to the upper, lighted tiers of the forest.

Epiphytes are plants that settle on the trunks and branches of other plants and receive nutrients from the environment. Among the epiphytes of moisture-tropical forests there are epiphyls that settle on the leaves of trees (lichens, mosses, algae).

Epiphytes are found in various systematic groups of plants, even in the cactus family. Very few epiphytes in temperate latitudes.

Lianas are plants with long climbing, tenacious, twisted stems that use support to rise up to the light. Lianas can be woody and herbaceous, with tendrils (legumes, pumpkins, grapes), roots (ivy), thorns (roses), thorns (blackberries), etc. We also know the twists of vines - hops and birch. Lianas have mostly elongated internodes, and the flexibility of the stems is provided by the presence of broad rays of the parenchyma between the leading bundles.

Ephemeroids are perennial herbaceous plants with a short spring cycle and summer dormancy. The aboveground parts of these plants live only for a few weeks, and the rest of the year are dormant in the form of tubers, bulbs or rhizomes.

Plant growth is directly related to the temperature factor. Heat has different effects on different stages of plant life. At low temperatures, the root system develops better than the aboveground part.

In relation to temperature, the following ecological groups of plants are distinguished:

• **thermophilic (thermophilic)** - plants that require relatively high temperatures for normal growth and development. These are plants of tropical, subtropical and temperate zones under conditions of high temperatures. Individual parts of plants can be heated to +60 - +65 oC.

• **cold-loving** (cryophilic - from the Greek cryo - cold) - cultures that are confined to cold habitats;

• **mesothermal** (from the Greek meso - average) - plants that grow at average temperatures.

According to the degree of adaptation to high temperatures, plants are divided into:

• non-heat resistant (+ 30 - 40 oC)

• heat-resistant (eukaryotes) +50 - +60 oC

• heat-resistant - prokaryotes +60 - +70 oC

• pyrophytes - plants that can withstand fire temperatures.

By the nature of the reaction to low temperatures, plants are divided into cold- and frost-resistant. Cold and frost resistance are properties of plants that can change dramatically depending on many external and internal factors. For example, the resistance of woody plants to cold increases sharply during their dormancy.

Plants that are **resistant to low temperatures** close to 0 ° C, belong to the inhabitants of the tundra and highlands. Most of them are characterized by a low stem, which often spreads on the ground. Sugar accumulates in their cell sap, which lowers the freezing point of the cytoplasm.

Frost-resistant - plants that can tolerate sub-zero temperatures without much damage, they include some bacteria, lichens, mosses.

Tasks:

1. Explain the meaning of definition "ecological group".
2. How photoperiodism occurs in plants (daytime and seasons). What type of plants exist due to the length of night and day?
3. Identify the characteristics of plants in relation to light, filling in Table 1

Table 1. The characteristics of plants in relation to light

A group of plants	**Size of the leaves**	**Location of leaves**	**The color of the leaves**	**Area of species**	**Examples**
Heliophytes					
Sciophytes					
Shade- tolerant					
Xerophytes					

4. Explain the features of plants in relation to temperature (very warm-hearted, warm-hearted, moderately warm-hearted, a little warm-hearted).

Practice work 3.

Ecological groups of plants according to the requirements for water and soil

Purpose: Introduction to the adaptive features of plants to the abiotic factor of water and soil.

Main definitions: very warm-hearted, warm-hearted, moderately warm-hearted, a little warm-hearted.

Tasks:

1. What indicators determine the quality of the aquatic environment that affects plant organisms? (Write and explain every single one).

2. Identify the characteristics of plants in relation to the water, filling in Table1.

Table 1.The characteristics of plants in relation to the water

#	A group of plants	Features of adaptation	Distribution area	Examples
1.	Hydatophyte			
2.	Aquatic			
3.	Hygrophyte			
4.	Mesophyte			
5.	Xerophyte			

3. Describe plants in terms of their living conditions in the aquatic environment by filling in Table 2.

Table 2. Characteristics of plants in relation to their living conditions in the aquatic environment

#	A group of plants	Features of adaptation	Distribution area	Examples
1.	Periphyton			
2.	Benthos			
3.	Plankton			

4. Ecological groups of plants according to the requirements for the content of nutrients in the soil. (Write and explain every single one).

5. Determine the features of plant adaptation in relation to the reaction of the soil solution.

6. Identify the features of adaptation of plants in relation to the salinity of the soil.

Practice work 4.

Biotic factors and their influence on plant organisms

Purpose: acquaintance with features of influence of biotic factors on plant organisms

Main definitions: autotrophs, heterotrophs, photosynthesis, epiphytes, symbiotrophs, saprophytes, parasites, semi-parasites.

Basic theoretical information

Ecological groups of plants by diet

Higher plants are divided into autotrophic organisms, which are characterized by photosynthesis in combination with soil nutrition, and heterotrophic organisms, which can feed on dead organic remains (fungi and bacteria).

However, higher (autotrophic) plants also have a few devices for the use of not only mineral but also organic substances of the substrate, which occurs in the epiphytic way of life or on poor soils.

Often higher plants capable of photosynthesis receive additional nitrogenous substances due to symbiosis with fungi (mycorrhiza) or bacteria (bacteriuric) present in their roots. These plants are called symbiotrophs, or symbiotrophic organisms.

Symbiotrophs are optional and obligatory. In the first case, both organisms can each live independently, and in the second - the independent existence of each of these organisms is impossible. Obligatory symbiotrophs include representatives of orchid and heather families, in which seed seedlings do not develop without symbiosis with the fungus.

Saprophytes are mycorrhizal symbiotrophs in which the higher plant loses chlorophyll and the ability to photosynthesis. Such plants are whitish, brown or pink, without leaves, only with scales and thick fleshy roots in which the fungus settles. These include nesting, coral, bream.

Parasites and semi-parasites are plants that live entirely or partially at the expense of other plants. Obligatory parasites lose chlorophyll, have very reduced stems and leaves, and instead of the usual roots - suckers-haustoria. It is a povitsya

(*Cuscuta*) that parasitizes on various plants, petrov cross, living on the roots of hazel, wolf, which settles on the roots of cultivated and wild plant species.

Semi-parasites can assimilate on their own, they have normal green shoots with leaves, and along with the usual roots or instead of these plants, sucker roots are formed. Semi-parasites are mistletoe, crossbow, bellflower, etc.

Insectivorous plants carry out photosynthesis on their own but can capture and partially digest insects with the help of proteolytic enzymes and organic acids. In this way, they compensate for the lack of nitrogen and other trophic elements in the substrate. They are found in forests, swamps, ponds, mainly in tropical areas. There are about 500 species of the family Rosychkov, Nepentes, Puhirnikov. Such plants have different hunting devices, formed mostly from modified leaves.

Allelopathy (from the Greek *allelon* - mutual and *pathos* - suffering, trials, influences) - the interaction of plants by releasing biologically active substances into the environment.

In a narrow sense, allelopathy is defined only as a negative impact, but there is a broader interpretation of this phenomenon - any biochemical effect of plants on each other. It is believed that the first scientific observations of allelopathic interaction were made by Dekandol (1832). The term "allelopathy" was proposed in 1937 by G. Molish. Chemicals released by plants into the environment are called exometabolites. They are divided into:

• **phytoncides** - substances that are released by higher plants and have a detrimental effect on microorganisms (separately isolated bactericides - those that act on bacteria);

• **kolines** - substances that are released by higher plants to inhibit the development of other higher plants.

Exometabolites have a variety of chemical nature, and their only classification is missing. The first attempt at generalization was made in 1957 by G. Grummer. He developed a kind of classification, which is quite informative, simple, but, according to many researchers, somewhat simplified.

Tasks:

1. Identify the features of biotic factors of interaction between plant organisms by filling in the table 1.

Table 1. Characteristics of biotic interactions between plant organisms

#	**The name of the interrelation**	**Type of the interrelation**	**Features of interrelation**	**Representatives of plants**
1.	Neutralism			
2.	Parasitism			
3.	Commensalism			
4.	Amensalism			
5.	Symbiosis			
6.	Competition			
7.	Grazing			
8.	Trampling down			

2. Describe the plants in relation to their diet, filling in table 2.

#	Name of ecological group	Features of adaptation to a certain type of food	Representatives of plants
1.	Symbiotrophs		
2.	Saprophytes		
3.	Parasites		
4.	Semi-parasites		

3. Explain the phenomenon of allelopathy and its significance for plants. Describe the types of phytoncides emitted by plants (their effect on plants, animals and humans) (1 page).

Practical work №5.

Analysis of anthropogenic impact on the environment by the reaction of plant organisms

Purpose: To get acquainted with the peculiarities of the influence of anthropogenic factors on plant organisms.

Main definitions: bioindication, biotesting, indicator plants.

Basic theoretical information

Bioindication is an assessment of the quality of the habitat and its individual characteristics by the state of its biota under natural conditions. One of the main requirements for bioindicators is their tolerance to a certain stress factor, in particular the content of pollutants in the soil, aquatic environment, or air.

This method is becoming more widespread, as indicator plants have the following advantages:

- · summarize biologically important data on the environment.
- · able to respond to short-term and volley emissions of toxicants.
- · respond to the speed of change in the environment.
- · indicate the places of accumulation of pollutants and ways of their migration.
- · make it possible to develop estimates of the harmful effects of toxicants on humans and wildlife in the early stages and to regulate the permissible load on ecosystems.

Several indicator plants respond to increased or decreased concentrations of micro- and macronutrients in the soil. This phenomenon is used for preliminary assessment of soils, determination of possible places of mineral search. Indicator plants show a reaction to the content of macro- and microelements in the soil, as well as the content of pollutants in physiological characteristics (taking into account the characteristics of chemical composition and metabolism, in particular, pigments, proteins, fats, osmotic pressure, water holding capacity, transpiration intensity) and phytocenosis features (associated with the peculiarities of the structure of vegetation - abundance and scattering, layering, mosaic).

Biological indicators - organisms, the presence (presence), the number or intensive development of which is an indicator of natural processes or environmental conditions.

With the help of indicator plants, it is possible to give an approximate assessment of the quality of soil, atmospheric air and aquatic environment.

Biotesting is the assessment of the quality of environmental objects (mostly in the laboratory) using living organisms. In contrast to bioindication, test objects for biotesting are chosen from the species that are most sensitive to contaminants. Biotesting is performed using bacteria, algae, and higher plants.

Tasks:

1. Define the concept of "plant-indicator". What methods exist to detect plant indicators?

2. Describe stenotic and eurytopic plant species. What is their significance in the processes of phytoindication?

3. Identify indicator plants for environmental objects by filling in Table 2.

Table 1. Indicator plants for assessing the state of ecosystems

Environmental object	Indicator plants (2-3pcs)	Qualitative indicators that they determine
Atmospheric air		
Soils		
Water bodies		

4. To establish sources of receipt of polluting substance according to a variant (table 2). and its impact on the environment. Identify indicator plants to determine the presence of this pollutant in the environment.

Table 2. Variants for the task 4.

Variant	Contaminant
1	**2**
1	Magnesium (Mg)
2	Iron (Fe)
3	Kurpum (Cu)

1	2
4	Zinc (Zn)
5	Boron (B)
6	Molybdenum (Mo)
7	Cobalt (Co)
8	Chlorine (Cl_2)
9	Sulfur (S)
10	Lead (Pl)
11	Cadmium (Cd)
12	Nickel (Ni)
13	Manganese (Mn)
14	Chromium (Cr)
15	Arsenic (As)
16	A mixture of petroleum gases
17	Sulfur dioxide SO2
18	Hydrogen fluoride (HF)
19	Ozone (O3)
20	Magnesium (Mg)

5. Find and describe biotesting methods used to determine the toxicity of chemicals to plants.

Practical work 6.

Quantitative and qualitative relationships between species in phytocenosis

Purpose: To get acquainted with the peculiarities of the influence of anthropogenic factors on plant organisms

Main definitions: phenological observations, floristic composition, economic value, general projective coverage, abundance of the species, frequency of occurrence of the species, quality of wood, phytomass, primary products.

Basic theoretical information

Phenological observations of plant communities

Phenological observations are one of the most common variants of stationary observations of a plant community. Phenological spectra (graphical figures showing the sequence and duration of flowering species) and flowering curves (which reflect the dynamics of the number of flowering species during the growing season) are constructed. On this basis, phenologists assess the climatic features of a particular year and climate dynamics in different years.

In geobotany, phenological observations are of important phytocoenotic significance, as they can be used to detect the timing of any type of a particular phenological phase not only in a plant group in the geographical area, but also under certain ecological habitat conditions and varying degrees of anthropogenic impact.

The value of quantitative ratios of species

The species composition of the plant group allows to assess the available diversity of its components, as well as characterizes the structural and coenotic properties of their formation. The species present in the floristic composition of the phytocenosis will differ in quantitative and qualitative characteristics. Any phytocenosis is characterized by a certain species composition and its inherent ratio of species of different systematic categories (plants, fungi, algae, microorganisms, etc.). As a result of their combination and coexistence, stable plant communities are created. Quantitative relationships between species in the phytocenosis itself are their characteristic feature.

The ratio of species in the phytocenosis determines its economic value, which can be positive or negative. Positive economic value is determined by the presence in natural forests of populations of wild berry plants (raspberries, blueberries, cranberries, cranberries, blueberries, strawberries, etc.), edible mushrooms, stocks of medicinal raw materials (lily of the valley, swamp, thyme, belladonna, etc.). Field weeds on agricultural lands have a negative economic value, poisonous and harmful plants on hayfields and pastures. Parasitic fungi deplete host plants, thereby impoverishing the productivity of crops and natural biocenoses.

A characteristic feature of the plant community is the coating, which determines the quantitative and qualitative relationships between species and the general closedness of vegetation and its individual parts. In practice, the term "coverage area" is often used the area of the leaf blade; leaf surface area; the area occupied by stumps in forest areas; stubble area, etc.

The total projective cover is the total area of horizontal projections of individual plants, populations of the species or the entire vegetation cover on the soil surface. It is determined as a percentage of the surface of the test site.

Projective cover of a species is a partial cover created by individuals of one species.

In practice, the concept of projective cover of the species is more often used, because it determines not only the participation of a particular species in the phytocenosis, but its role in conenoses and formation of habitat conditions (microclimate, microrelief, etc.).

Individual projective coverage is a projection created by the aboveground parts of an individual species.

True or true cover is formed only by the bases of cut stems of herbaceous plants and tree trunks, it is clearly manifested in agrophytocenoses.

The degree of participation of each species in a plant community is called abundance. Abundance of species, according to V.M. Poniatowska (1964), is its number in the phytocenosis.

The structure and development of a plant group is significantly influenced not so much by the number of each species as by the quantitative and qualitative composition of phytocenotypes.

Under optimal conditions, the edificatory due to high viability and cenotic activity develops rapidly, forming a significant number of individuals that make it impossible or inhibit the penetration of other species into the phytocenosis.

Abundance is the number of individuals of one species inhabiting a certain unit of area or volume. The density or abundance of the phytocenosis is an important feature that significantly affects other factors of the phytocenotic and ecological environment. Due to changes in the density of the culture or dominant of natural groups in aboveground conditions changes the degree of light, air and heat regimes, transpiration levels, plant pollination, and in the soil - water regime, aeration, mineral nutrition, acidity, saturation of the rhizosphere with microorganisms, algae, fungi and more.

The abundance of the species is determined by various methods:

1) a rough estimate of the number of species.

2) direct calculation of the number of each species, the mass of synthesized organic matter, the spatial location of individuals of the species.

3) determination of the volume ratios of the species.

Approximate method of direct accounting is used in the case of route geobotanical studies of vegetation for the purpose of field survey of any of its objects and the removal of one-time information when it is possible to do without detailed research.

To do this, geobotanists usually use a scoring system or sharp scales of the number of species in the phytocenosis. The scale proposed by O. Drude (1913) is often used.

Table 1. Combined Brown-Blanke and O. Drude plant abundance assessment scale

Frequency of occurrence of the species, %	Projective coverage, %	Brown-Blanc scale	Drude scale
Very rare, <5%	Minor, <5%	1	Sol (solitaries) - plants grow singly;
Rare, 5-20%	Low, 5 -20%	2	Sp (sparsae) - plants rarely grow;
Diffused, 20-40%	Medium, 20-40%	3	Cop1 - plants grow quite abundantly;
Frequent, 40-60%	High, 40-60%	4	Cop3 (copiosae) - plants grow very abundantly; Cop2 - plants grow abundantly;
Abundant, 60 - 100%	Very high, 60 - 100%	5	Soc (socialis) - plants close aboveground parts

As shown by AA Uranov (1935), the gradations of the Drude scale correspond to absolute estimates, which can be expressed by the smallest average distances between species in the phytocenosis, so the scale of rough estimation is used only in the study of natural ecosystems.

Numerical methods of direct accounting - the method of estimating the abundance of the species is used in detailed stationary and temporary route studies in natural and cultural phytocenoses. It is considered one of the most objective methods of assessing the abundance of the species. At botanical estimation of phytocenoses count not quantity of copies, and quantity of shoots on unit of the area.

Determination of stand volume - used to determine the productivity of the phytocenosis in forestry practice, as well as the method of determining the volume of wood.

To establish this indicator, use mass tables, which are used to assess the productivity of forest stands. To do this, you need to know the average diameter of the tree trunk at chest level (1.2 - 1.3 m) and the height of the trees under certain conditions.

The quality of wood is determined by tables, as well as graphs, knowing the age of the trees and the average height. Quality is understood as an indicator of normal productivity, which is determined by the ratio of the intensity of tree growth in height over a period of age. In practice, there are 5 main classes of quality and are denoted by Roman numerals (l-V): Class I characterizes the best taxonomic performance of the stand, and Class V - low productivity of planting.

Determining the volume of herbaceous plants. Volumetric analysis of plants was first proposed by V.V. Alekhine (1910). Its practical application in phytocenological researches was proved by A.G .Voronov (1973).

Determining the volume of aboveground parts of plants growing in a certain area (1 m2, 100 m2), simultaneously measure the height that the plants reach. Multiplying the height by the area from which they were cut, get the volume of air in which the aboveground parts of plants of a particular species. By calculating the ratio of the volume of aboveground parts to the volume of the environment in which they are located (in percent), we obtain a value called the percentage of space filled with plants, or specific volume "(Ilyinsky, 1922).

Biomass, phytomass and products and their accounting

Quantitative ratios of species in the phytocenosis are determined not only by considering its specimens, but also by weight or product.

The weight method is used when it is necessary to determine the abundance of the species in economically valuable phytocenoses, to determine the productivity of natural forage lands, forest plantations, berry plantations, the amount of medicinal raw materials, etc. This method is also used in the case of determining the biomass of individual tiers or functional biogeohorizons: crown, branches, trunk wood.

Phytomass is the total amount of organic matter formed by living plant organs in an ecosystem. The biomass of ecosystems consists of the biomass of populations of all species of living organisms that form it: plants, animals, microorganisms, etc. There are biomass of a plant group and a species or group of species. The biomass of a particular plant species reflects its role in the phytocenosis and the ecosystem.

The mass of inanimate organic matter of the phytocenosis is formed by dead organic mass of animal and plant origin - precipitation, waste, last year's remains, dead roots, carcasses of insects, worms, and other organisms.

Plant organisms (phototrophs) in the process of photosynthesis create ***primary products***, which account for up to 80% of total biomass. Secondary products are synthesized by heterotrophic organisms. Even less organic matter is created by chemotrophs.

There are the following types of products: total primary, pure primary, growth, precipitation products, products of matter.

Total primary production, or gross output, is usually considered as the total increase in the phytomass of a group or population of a species per unit time (day, growing season, year, etc.) per unit area (m2, ha), including matter spent on respiration and growth, and also the amount of sediment and the substance used by heterotrophic organisms.

Pure primary products - net products of a plant group or population of a species - the actual increase in phytomass over a period per unit area, the amount of organic matter accumulated in plants after partial use for respiration.

Precipitation is a dead primary product - the amount of organic matter that has died over time in the aboveground parts of the phytocenosis per unit area (dead branches, bark, inflorescences, fallen leaves, flowers, fruits, etc.).

Species products are products created by a certain one species; gross output is the total output of the phytocenosis or agrophytocenosis, or its parts - grain, vegetables, fruits, valuable in economic terms.

Gross stock is the total stock of biomass that is economically valuable (wood in forests, grass mass in hayfields).

The concepts of biomass and phytomass used make it possible to assess it as a whole and individual components, as well as in relation to the species, its participation in the phytocenosis and in the ecosystem in general. At the same time, different plant groups are characterized by different aboveground and underground phytomass, inhomogeneous ratio of economically useful plants. Excellent results will be in the foothill associations and on the plains, due to different habitat conditions of certain taxa.

Estimation of species occurrence

O.P. Shennikov (1964) describes the occurrence as follows: "an occurrence is the degree of probability of finding a particular species in any small area in the phytocenosis under study." R%) .The method of accounting for the incident was proposed by H. Raunkier. Its essence is as follows: in different parts of the phytocenosis under study, by throwing a ring of a certain area described numerous accounting areas, or evenly laid area of 0.1-1.0 m2 In meadow groups of such plots 10-20 are laid, in forest phytocenoses the sizes of experimental plots are 100-1600 m2, and the number of accounting plots of 1 m2 should be not less than 10.

At the described experimental sites note the presence or absence of each species. The results are recorded on forms or information of the appropriate form, which indicates the presence of the species in numbers - the number of copies, or a plus sign (+), and the absence - a minus sign (-).

Tasks:

1. To study the natural biocenoses of your locality, it is necessary to choose accounting sites within one forest phytocenosis. The size of plots for forest phytocenosis -5m^2.

2. Within the experimental plots to conduct phenological observations of plant groups represented in the experimental plot. To analyze the species saturation of the site; economic value, total projective cover, abundance of phytocenosis species (according to table 1), productivity of forest plantations and quality of trees. The research results are entered in table 2.

Table 2. Research of qualitative and quantitative characteristics of the biocenosis of the experimental site

Type of experimental site	**Phenological observations**	**General projective coverage of the species**	**Economic value**	**Frequency of meeting**	**Brown-Blanquet scale**	**Drude scale**

Practical work 7.

Estimation of phytocenosis stratification

Purpose: to study the concept of stratification of plant phytocenosis

Basic concepts: phytocenosis, morphological structure of phytocenosis, morphological structure of phytocenosis, tier, tier, sinus.

Basic theoretical information

Phytocenosis consists of a complex of structural components, acquiring a certain morphological structure.

The morphological structure of the phytocenosis is determined by:

1) the composition of plant species, their bioecological characteristics;

2) plant height, root length;

3) forms of aboveground and underground bodies;

4) quantitative ratios of species, etc.

The morphological structure of the phytocenosis is the selection of spatially demarcated structural parts (groups of plants) that differ in one or more features. Such features are the height of plants, their bioecological and coenotic features, population composition, abundance, vitality, projective cover of species, etc. Each morphological structural part of the phytocenosis occupies its own area or space, so the vertical and horizontal structure of the phytocenosis is distinguished.

The vertical structure is manifested through the aboveground and underground tiers. The concept of "tiered" appeared for the dismemberment of forest vegetation in the second half of the XIX century (Kerner's work - 1863, Pulta - 1881), terrestrial and underground meadow vegetation (Bazhanov's work - 1863).

In the same period (the end of the XIX century) the idea of horizontal inhomogeneity of phytocenoses - mosaic (works of A. Tensley, VM Sukachev) arises.

From this time a new direction in phytocenology begins - the study of the structure of groups. The vertical structure of the phytocenosis is manifested through stratification.

Layering is a structural vertical division of the phytocenosis into separate morphological parts, distinguished by the demanding plants to the action of environmental factors, in particular light.

Layering is a set of tiers of a certain phytocenosis.

The tier is an ecologically separated structural part of the phytocenosis. Each tier plays a role in the group. It is a historical, morphological-ecological, phytocenotic phenomenon. Layering allows plants to make the most of the phytoenvironment of the phytocenosis. Terrestrial tiers are established by the height of the physiologically active parts of plants, including all their aboveground parts. That is, the tiers are not placed one above the other, but one inside the other. For example, in the tree tier there is a tier of shrubs, and in the lower part of the tree and shrub - grassy.

Different researchers understand the volume of the tier differently. Therefore in a phytocenosis and establish from 4 to 10 tiers and their allocation is carried out by various methods:

a) the height of the plants;

b) on forestry grounds;

c) by plant biomorphs;

d) by biological (morphological-ecological-phytocenotic) features.

The clearest tier stands out in the woods. Yes, in the oaks can be noted: tree, shrub, grass-shrub tiers. Sometimes there are sub-tiers in the tiers - smaller variations of the tiers. The oak tree layer, for example, consists of an upper tier (trees of the first size) - oak and the lower tier (trees of the second size) - maple, linden.

There is a complex system of relationships between the tiers in the phytocenosis. Each tier occupies its ecological niche, changing its environment in its own way. This in turn affects the Phyto environment of the phytocenosis as a whole. The tier that has the strongest influence on the creation of the Phyto environment is called edificatory, and the other tiers of the phytocenosis are concomitant. Close relationships also exist between the components in the middle of the tier, the components of the different tiers, and so on. All of them are formed during the evolutionary development of the phytocenosis and determine its vertical structure.

In addition to microcenoses, sinuses are also distinguished in the horizontal structure.

Sinusia (from the Greek. Synusia - coexistence, grouping) - a spatial and ecological part of the phytocenosis, which reflects its intraphytocenotic association. Sinus is characterized by phytocenotic, morphological, floristic and biological isolation.

This term was first used by the Swiss geobotanist E. Rubel in 1917, and in 1918 it was published by the Austrian geobotanist X. Hams.

There are different types of sinuses:

1) *seasonal sinuses*, which exist only for a certain part of the growing season. For example, sinuses of ephemeroids in the forest or in the steppe.

2) *sinuses-tiers* - a set of plants that are in one tier. For example, in a deciduous forest, the trees of the second tier (heart-shaped linden, sharp-leaved maple) form a sinus-tier.

3) sinuses above ground

4) epiphytic (allocated on the ecological principle). For example, the sinus of ground mosses in a pine forest and the sinus of mosses of a tree trunk.

Task:

1. Describe the forest ecosystem of your locality (or the one closest to it) by geographical location, floristic composition with the definition of edificatory plants and dominant plants.

2. Determine the stratification of the forest phytocenosis of your locality and explain the ecological significance of each of these tiers.

3. Form a trophic chain (at least 3) that takes place in your forest ecosystem.

4. Identify the sinuses that are present in your forest ecosystem.

Practical work 8.

Study of zonation of plant formations

Purpose: Acquaintance with features of the organization and floristic structure of the basic phytocenosis of the world

Basic concepts: swamp phytocenosis, lowland swamps, transitional swamps, sphagnum bogs, steppe phytocenosis, meadow phytocenosis.

Basic theoretical information

Phytocenosis - a set of plant species that exists in areas with more or less the same climatic, soil and other conditions, is characterized by a certain species composition, structure and interaction of plants between themselves and the environment.

Plant association - the main classification unit of plant groups (phytocenosis), characterized by a homogeneous floristic composition, the presence of leading species, a certain quantitative ratio between individual species, as well as layering, sequence of phenological development of plants during the growing season and plant mass productivity.

Each association of plants is closely connected with environmental conditions - climate, soil, etc. In the plant association there are certain biological relationships between the species included in it, as well as between them and the environment. The names of plant associations are given by the names of leading species, which may be one or more (for example, sage-fireweed-feathergrass - in the steppes, lichen pine - in the woods.

Formation is an expression in vegetation of certain living conditions, independent of floristic composition.

Edificators - plant species that predominate in the phytocenosis, determine its features, form the natural environment in the ecosystem and play an important role in building its structure (for example, in a pine forest - a pine, in the steppe - feather grass). Edificatory satellites are called sub-identifiers (in hornbeam oak - hornbeam). Species that play a secondary role in the phytocenosis are called assectators (rowan, bird cherry).

The phytocenosis of Ukraine include: swamp phytocenosis, steppe phytocenosis, meadow phytocenosis, phytocenosis of mixed and coniferous forests. All of them are located depending on soil and climatic zones and are expressed by a certain zoning. The latitudinal and vertical zonation (from north to south) can be clearly traced, the following latitudinal botanical and geographical zones are distinguished: Polissya (Forest), Forest-steppe, Steppe, foothills and mountainous regions of the Carpathians and Crimea.

Swamp phytocenosis

Swamp phytocenosis are azonal and occur in places of strong soil waterlogging, in such cases the detrital trophic chain is shortened and does not end with the formation of humus. Vegetable precipitation accumulates and in a semi-decomposed state forms peat.

The total area of the Earth's wetlands is 350 million hectares. Peat mass is poor in minerals, so the vegetation of the swamps is not diverse and it is dominated by oligotrophic plants. Swamp soil is characterized by so-called physiological dryness. In relation to the humidity of the marsh plants are hygrophytes.

According to the main characteristics of wetlands, they are divided into three types:

- lowland;
- transitional;
- riding.

Lowland swamps are formed at the exit of groundwater or at the site of lakes. The vegetation of such swamps is formed of sedges, reeds and reeds, and may also have sparse stands, represented by willows and alders. In lowland bogs mineralization is quite pronounced, and bogs of this type are defined as eutrophic.

Milestones are formed on water-resistant rocks from precipitation, but can be formed from lowland swamps. The basis of the vegetation of the upper bogs are sphagnum mosses, which after death form peat. Sphagnum peat is poorly amenable to humification and mineralization, so the soils of such bogs are very poor in mineral composition. Such swamps are called oligotrophic. Sphagnum bogs can house sparse stands, as well as shrubs and bushes (adromeda, calender, cranberries and blueberries). Species diversity is extremely low, there are 2-5 species of plants per $1m^2$.

Transitional bogs are a stage of transition from lowland to upper bogs. Most often they are located around the upper bogs. According to the content of nutrients, they occupy an intermediate position and are called mesotrophic. Sedge predominates in the vegetation cover.

Meadow phytocenoses

According to VV Alyokhin (1925), meadows belong to azonal natural ecosystems, ie orgographic and edaphic factors play a leading role in their formation. Typical meadows are called floodplains because they are formed on floodplains of rivers in different natural and climatic zones. Along the northern rivers they reach the taiga and tundra zones, along the southern rivers - steppes and deserts. Depending on the floodplain of the river where they are formed, meadows can be located on both fertile and poor soil. According to the level of humidity, meadow ecosystems can be either dry or wet.

Meadow soils can be of any type, and in river floodplains they can even be saline. In the case of saline soils, saline meadows with typical halophytes are formed.

Vegetation of meadows is formed from perennial dicotyledonous grasses and cereals. In the central part of the floodplain there is a rich stand, which is represented by sod, legumes and grasses. The terraced floodplain is represented by sedges, reeds and reeds.

There are six main classes of bow formations:

- real mesotrophic meadows.
- devastated xeromesotrophic meadows.
- hollow meadows.
- swamp meadows with hydromesophytic vegetation.
- peat meadows.
- halophytic meadows.

Steppe phytocenosis

Steppe phytocenosis formed in the temperate zone in arid climates have an intracontinental location. The average temperature varies according to the conditions of the location of the steppes, the main factor determining the formation of vegetation of the steppes is the level of their humidity.

In the Northern Hemisphere, the steppe zone is located south of the forest zone and stretches in a wide strip through the center of Eurasia in the temperate zone. On the North American continent, the steppes are called prairies, where they have their own characteristics. In the Southern Hemisphere, the analogue of the steppes is the pampas, which is a steppe of the subtropical climate zone.

Steppe soils are represented by chernozems, but in the southern part they are replaced by chestnut soils. Vegetation of the steppes is formed from perennial grasses, in most cases various cereals. The vegetation of the steppes is characterized by polydominance and multi-tiered grassland. Shrubs and shrubs are also present in sphere ecosystems, but they do not form a continuous tier. Most steppe plants have signs of xeromorphism, in particular, pubescence, wax on the leaves, deep root systems, and so on. Steppes are characterized by alternate flowering of different species of plants, which is manifested in a consistent change of aspects (during the growing season there are 8-10).

In the northern parts of the steppes, mesophilic cruciferous and rhizome cereals predominate, in the southern parts they are replaced by sod-like ones. The southern steppes are represented by cereal formations (herbaceous-fescue-feathergrass, fescue-feathergrass and wormwood-cereal). The southern steppes are characterized by sinusitis of ephemeroids, which undergo the main life cycle in the spring, ie during the period of greatest humidity.

P. Haltenort (1988) divides steppe ecosystems into two main categories:

a) high-grass steppes (located in places with an annual rainfall of more than 300 mm and have a thick horizon of humus);

b) low-grass steppes (formed mainly on chestnut soils and have a humus content of 2-3%).

Temperate forest ecosystems

The total forest area in the world is about 4.2 billion hectares, which is 37% of the land surface, where 1.7 × 1012 dry organic matter is concentrated. The vegetation of forests is dominated by trees. Depending on soil and climatic conditions and geographical location, forest ecosystems are divided into taiga, mixed and deciduous forests.

Mixed and deciduous forests of the temperate zone

Phytocenoses of mixed forests are distributed south of the taiga zone, they cover almost all of Europe, stretch more or less widely in Eurasia. The winter period lasts no more than 4 - 6 months, the summer is warm; 700 - 1500 mm of precipitation falls per year, the soils are podzolic.

Such ecosystems are characterized by a contrasting mode of illumination, in particular, in winter and spring the illumination at the soil level is high, and in summer it is characterized by high shading, which leads to the widespread use of spring ephemeroids.

The variety of species of trees and shrubs in the area of deciduous forests is very large. In Western Europe, oak forests with admixtures of pine, birch, aspen and maple predominate; in Central Europe - beech forests with admixtures of hornbeam and linden.

The tier structure of deciduous and mixed forests is complex: the upper tier is formed by tall trees, the second tier is a stand, the third tier is represented by shrubs (hazel, wolf's face, honeysuckle, viburnum and rowan). The moss cover is usually quite poorly developed due to the inhibition of its growth by large leaf litter.

Pine forests

Subors are common on mineral-rich soils, in which the first tier is formed by pine, the second - oak, undergrowth is represented by shrubs.

Types of boron depend on soil and climatic conditions of the environment, in moist boron species diversity is less than in dry boron. Wetlands are represented by a wide variety of species of plants, most of which are hygrophytes (calamus, lepeshnyak, kalyuzhnytsia, etc.). Wetland plants grow on boggy soils, which form continuous groups of herbaceous plants and shrubs (heather, cranberry).

Depending on the substrate, climatic conditions, local habitat conditions of grass and moss cover, pine forests are divided into the following groups according to the degree of moisture:

- lichen - common areas of mixed forests in the west on dune-hilly areas with deep groundwater, no undergrowth, grass cover is very sparse;
- green moss - occupy large areas in Polissya, where the climate prevails with sufficient humidity, represented by grassy-shrub cover;
- runny - common in depressions, swamps, dominated by grass (blueberries, blueberries);
- sphagnum - common on peat-gley and peat soils, represented by stands, grass and moss tier.

Spruce forests

Spruce forests are represented by dense stands that rise to a height of 1200-1600 m. In the undergrowth grow black honeysuckle, red elder, wolf's face, mountain ash. Blueberries and blackberries are found in grassy grasslands. In the area of mixed forests, pine and alder are mixed with spruce, the undergrowth is represented by hazel and yeast.

Wet spruces differ from others by the presence of grassy plants in wetlands. Spruce grows well and forms the basis of the stand. Edificator plants of such forests are: black alder, wolf's body, cranberry, etc.

Beech forests

Beech forests (beech) stands are represented by hornbeam, which is mixed with ash, sycamore, birch bark and linden. The shrub layer is represented by warty cowberry. The grass cover is liquefied due to heavy shading of the soil. Beech forests according to the degree of moisture are divided into: dry, fresh and moist forests, which stand out from north to south.

Tasks:

1. Identify phytocenosis that are part of the region of Ukraine according to your option (table 1).

Table 1. Initial data to work

Variants of tasks	**Region of Ukraine**
1	Autonomous Republic of Crimea
2	Vinnytsia oblast
3	Volyn oblast
4	Dnipropetrovsk oblast
5	Donetsk oblast
6	Zhytomyr oblast
7	Zakarpatska oblast
8	Zaporozhye oblast
9	Ivano-Frankivsk oblast
10	Kyiv oblast
11	Kirovograd oblast
12	Luhansk oblast
13	Lviv oblast
14	Mykolaiv oblast
15	Odessa oblast
16	Poltava oblast
17	Rivne oblast
18	Sumy oblast
19	Ternopil oblast
20	Kharkiv oblast
21	Rivne oblast
22	Kherson oblast
23	Khmelnytsky oblast
24	Chernihiv oblast
25	Chernivtsi oblast

2. Describe the plant formations that are part of the biocenosis of the studied region of Ukraine.

Recommended Literature List

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