Department of Pharmacognosy and Botany

I.V. Zemlyanskaya

BOTANY FIELD PRACTICE

Handbook

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Compiler: Zemlyanskaya I.V.

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Educational and methodical manual contains recommendations for the summer field practice in botany. Examines the theoretical material on herbarium work, morphology and ecology of plants, which is necessary for the development of this section of the discipline "Botany". Contains instructions on safety during the field training practice of botany, tasks for students to perform independent work, a list of individual tasks performed by students in practice. The manual is illustrated with black and white pictures.

The manual is executed in conformity with FSES VO on the discipline "Educational field practice of botany" for students studying on specialty 33.05.01 "Pharmacy".

CONTENTS

1. INTRODUCTION

1.1 Aims and objectives of educational practice.

In the system of teaching the discipline "Botany" an important link is the practice in botany.

The purpose of practice in botany is to form students' systematic knowledge of botany, understanding of morphology of plant organs, ability to perform morphological description and identification of plants, representatives of different systematic groups, skills of description of plant communities taking into account plant ecology.

During the practice should be used, specified and replenished all botanical knowledge of students, so its tasks are diverse. The main task of the field practice is to familiarize with the diversity of plants inhabiting the territory of the region, its flora and vegetation.

A special task in practice is to study the morphological structure of the plant, which determines its life form, i.e. the structure of its shoots and root systems. It should be noted that the life form is not a frozen structure, but a dynamic system changing in time and space. The study of the life form in its dynamics, along with the understanding of ecological properties, allows us to see the plant as a living being in the living nature.

The number of higher plant species living in the study area is usually counted in several hundreds. Of these, students must learn to distinguish between 120 and 150 species during their field practicum. However, it is not enough just to see and name plants; a detailed analysis of the features that distinguish some species from others is needed. A full analysis of the diagnostic features of plant species can be found in the keys, so to consolidate this knowledge, we need to improve the work with the keys. Work on the definition of plants allows to identify similar species and establish common features for them. In practice, students get acquainted with the morphological and biological features of plants of some systematic

groups, which due to time constraints are not considered in laboratory classes. Thus, students get acquainted with the classification of plants and master the elements of systematics necessary for further mastering the discipline "Botany".

Practice in botany gives students the opportunity to gain practical skills in herbarium collection, drying and assembling techniques, as well as prepare herbarium and fixed material for laboratory and practical classes on botany in the academic year.

Students observe plants in nature, paying attention to the features of their habitat, highlighting the confinement of species to certain environmental conditions, the degree of dependence on these conditions, adaptations to them, reactions to changes in the environment. The notions of ecological groups of plants and ecological properties of individual species are formed.

One of the tasks of practice is the study of plant cover, which consists of plant communities. Students get learned with specific plant communities and their main types, learn to analyze their structure and life, their role in the composition of the vegetation cover of the investigated area. From concrete observations they pass to generalizations, mastering the concepts of phytosociology.

No less important task for students in field practice is to get an in-depth understanding of the ways and the main directions of evolution of the plant world, which is reflected in the botanical system itself, which is built according to the phylogenetic principle. The study of phylogenetic systematics allows students to get acquainted with some provisions of evolutionary theory and learn to illustrate them with concrete examples.

1.2 Main knowledge and skills acquired by students in the course of field practice in botany:

As a result of mastering the discipline the student should:

know: the basic biological laws of plant development and elements of plant morphology;

basics of systematics of prokaryotes, fungi, plants; the basic regulation of the doctrine of the cell and plant tissues;

diagnostic signs used in identifying plants;

basic physiological processes occurring in the plant organism;

basics of plant ecology, phytosociology plant geography.

be able to: work with a light microscope and dissecting microscope;

prepare temporary micro preparations;

perform anatomical and morphological description and identification of plants by identifiers;

herbarize plants;

conduct geobotanical description of plant communities.

know: botanical terms;

technique of microscopy and histochemical analysis of micro preparations of plant objects;

methods of determining the plant and its systematic position;

methods of collecting plants and their herbarization;

methods of description of plant communities and vegetation.

During the field training practice students should learn:

1. To work independently with botanical determinants of plants.
2. To give anatomical and morphological characteristics of plants and, on the basis of it, to be able to refer the plant to this or that ecological group; to distinguish signs of vegetative and generative organs necessary for diagnostics of medicinal plants
3. To collect and dry plants for herbarium, to make wet preparations
4. To make a herbarium specimens.
5. Identify the family, genus and species of a plant from the key for determined.
6. Be able to sort a herbarium with the arrangement of plants by family, genus, species, ecological groups, etc.

7. To carry out the geobotanical description of phytocenoses, necessary for recording the stocks of medicinal plants.

2. ORDER OF CARRYING OUT FIELD TRAINING PRACTICE IN BOTANY.

Before the beginning of practice, the organizational meeting on which the students are announced the schedule of practice, individual tasks are distributed, the technique of registration of the diary and results of independent work on practice is explained, safety briefing is conducted, the requirements for passing the credit on practice and the model of calculation of the rating of the student on practice are explained.

At the organizational meeting students are obliged to listen to instructions on safety in the field training practice, which must be recorded in the checklists on safety. Students who have not passed the safety briefing are not allowed to pass the practice.

2.1 Instruction on safety and labor protection during the field routes in the field training practice on botany.

When performing tasks in nature, being on excursions in the woods, fields, meadows, ponds, special attention should be paid to the observance of safety rules and labor protection:

1. On excursions students must go out in appropriate clothing and shoes. Shoes must be closed, comfortable, without heels, comfortable clothes if possible with long sleeves (shoulders must be closed from the sun), necessarily have a hat.
2. Strictly obey the rules of the road, especially when crossing highways, country roads, railroad tracks, when moving along country roads and asphalt roads. Particular caution should be exercised when working near power lines, if possible not to be under them.

4. Don't take shelter from thunderstorms under trees. Metal objects (shovels, diggers, knives etc.) must be put away from you. Do not use your cell phone or the internet during a thunderstorm.

5. It is strictly forbidden to smoke in the fields sown with cultivated plants, in steppe and forest communities.

6. It is forbidden to drink swamp or river water. Drinking water must be taken from home.

7. You should be especially careful when collecting poisonous plants as well as plants capable of causing local irritation and having a photosensitizing effect. You cannot try their fruits or bite off the shoots and leaves, let the juice of these plants on your skin. Remember that freshly picked plants are much more dangerous than dried ones. Lying on the grass can cause skin irritation.

8. You cannot take perishable food as a dry ration, take food with unwashed hands, especially after collecting poisonous plants, you cannot eat unwashed berries and fruits.

9. It is strictly forbidden to bathe in the open water, especially in places unsuitable for it.

10.It is forbidden to climb trees, and also to go down the steep slopes of ravines and steep riverbanks.

11. do not touch animals, including domestic animals (they can be carriers of infections). Do not tease animals, especially large animals (dogs, cows, horses, camels).

12.It is desirable to have repellent against insects and ticks, especially when visiting the places of their mass withdrawal.

13.If you are bitten by a tick, spider, insect, or snake, immediately report it to the instructor to provide first aid.

14. After the excursion, conduct a body examination in order to remove ticks.

2.2 Equipment and accessories needed during the field training practice.

1. Herbar press.
2. Herbar folder.
3. paper for drying plants (newspapers).
4. Botanical spatulas for digging up plants (they can be replaced with wide chisels or strong knives).
5. Pocket or garden folding knives for cutting branches from trees and shrubs.
6. Magnifying glasses.
7. Tweezers.
8. Dissecting needles.
9. Notebooks for field diaries.
10. Pencils and pens.
11. Paper for field labels.
12. Paper for herbarium mounting, cut to standard format, and for attaching plants, cut into thin strips.
13. Thread (preferably white or dark, fairly thick).
14. Sewing needles (thick).
15. Glue.
16. Scissors.
17. Label paper (labels can be printed).
18. Rulers.
19. Measuring tape for centimeters.

2.3 Conducting excursions into nature to collect botanical collections.

The field trip is the basis of botany field practice, so it requires serious preparation. Students are given a list of literature, as well as a list of necessary equipment and outfit. For greater efficiency, the students are divided into groups of 3-4 people.

Clothing and shoes should be comfortable and practical. It is necessary to provide equipment in case of rain.

During the practice, students on botanical excursions master the methods:

- phenological observation of plants;
- collecting, drying and herbarizing plants;
- full morphological description of plants;
- identifying plants in the field and in the lab;
- making thematic botanical collections.

On each field trip, students individually collect 5 fresh plants for anatomical and morphological characterization, which is done at home.

The rest of the work is done in teams of 3-4 people.

On each field trip, the team collects 30-35 plants for the herbarium, puts them in a botanical folder, labels and signs them. After the tour in the department, the collected plants are sorted, straightened out, transferred to dry paper and handed over to the duty team for further drying. The duty crew puts all the plants in the press. On all subsequent days, each team changes the drying mats (newspapers) in their collections until the plants are completely dry.

In addition to the herbarium, each team performs individual tasks and collects fresh material for wet preparations and plants for detailed study in the chamber as directed by the instructor. These plants are studied in the department by the entire group on days when there are no excursions into nature, sketched in a workbook and described as in laboratory practice classes.

On excursions, students are asked to make a mini collection in a diary depending on the theme of the excursion: simple and compound leaves, leaf blade shape, leaf margin shape, degree of dissection, etc., inflorescences, root systems, fruits, position of shoots in space. All this is dried with an iron, pasted into a diary and arranged in a certain way:

For exsample: Inflorescences. We write the classification of inflorescences, leaving after each name a free space for a picture and an object, against the name

of each inflorescence we make a schematic picture as on the table or in the manual and glue dried sample of such an inflorescence.

It is advisable to conduct this work in two stages. Stage 1 collection of morphological objects in nature, Stage 2 can be carried out on another day - classroom work with the teacher, when all collected objects are identified and sorted. At the end of each such work, the student receives grades, of which, eventually, the rating for the field practice is made up.

Such works are performed by absolutely all students, regardless of the chosen individual assignment. These are works on leaf morphology, inflorescence morphology, shoot morphology and root systems.

On each excursion students, with the help of the teacher, make a geobotanical description of plant communities in diaries. The key points in which the description of communities is obligatory are established. Such points should be: steppe community; forest community floodplain oak woodland, floodplain sedge woodland (poplar forest), ravines oak woodland with admixture of alder and aspen, dry ravines oak woodland; water and water-related plant communities, floodplain meadows. The communities are described according to the plan:

Plan for describing a plant community.

1. Name of the plant community. Here you should give an expanded name, which is a part of its characteristic (floodplain lily of the valley oakery, fescue- white sagebruch steppe, flooding hay meadow, etc.).

2. Habitat. An area occupied by a plant community and its character ecological conditions. Here it is necessary to specify 1) relief (elevation, depression, slopes, plain), groundwater occurrence (deep, shallow); 2) mechanical and chemical composition of soil (sandy, clay, gray, chestnut, saline, non-saline); 3) exposure to the sun (north, south); 4) susceptibility of the territory to flooding during high water; 5) degree and regularity of moisture (arid conditions, swampy, moderate humidification conditions); 5) location in space (nearest settlement, river, elevation and distance to them), geographical coordinates.

3. Species composition and quantitative participation of species in phyto-coenoses. Make a list of the higher plant species found in the community. Identify dominant species (represented by very large numbers of specimens).

4. Level structure of plants community. Determine the number of level in the plant community and describe each of them. When describing the level it is necessary to indicate which plants form it, its height, the degree of closeness (density). Identify dominant species for each level. Identify the phase of development of dominant species (flowering, fruiting, budding, blooming of leaves, death of the above-ground part, etc.). Identify to which ecological group the plants that make up each level of the community belong. Notes the out-of-level elements. Identify the main life forms of plants that make up each level (trees, shrubs, lianas, semi-shrubs, dwarf semi-shrubs, annual or perennial grasses)

5. Find objects indicating the parasitism of some plants at the expense of others.

6. Notes examples indicating human influence on a given community.

7. Notes the medicinal plants you have found in this plants communities.

After the plants collected on the field trips have dried, each team mounts them on herbarium sheets and provides them with a clean label and determinant. During the process of drying and mounting the herbarium, students identify plants using an identifier and memorize the Russian (English) and Latin names.

In practice, in addition to morphology, students must also become familiar with plant systematics. For this purpose, they describe every day in a diary 5 plants collected on the excursion. The plants should be from different systematic groups and preferably relation different life forms. The teacher recommends the plants to be described. The collected plants and (or) their fragments are dried, possibly with an iron through paper, and glued in the diary (herbarium notebook) next to the description. It is not allowed to describe plants that do not grow in the area of practice and not blooming (fruit-bearing) during the period of practice. This work can also be done in two stages: in the first stage students collect plants on the excur-

sion, in the second stage in the classroom in the presence of the teacher they make descriptions of these plants, using qualifiers (determined key) and reference books. For this work are also given marks, which form the rating of the student for the practice, in addition, as a result of the diaries of students are checked as they are filled out, and students can quickly correct errors, and take them into account in the future work.

2.4. Diary of botany practical training

The diary is designed in a general notebook by hand. The title page can be filled by hand or printed on a printer. On the second page of the diary is a table with the schedule of practice and a mark of the task execution by the student for each day of practice. (Date and the executed work are filled by the student, the mark of the fulfillment - by the teacher). Also the safety instructions are glued into the diary.

Sample design. Title page.

DIARY

botany practice

student _____

2st year student of_____ the group of pharmaceutical faculty of Volgograd State Medical University.

Time of practice:

from _____ to _____.

Sample design. Second page.

Date	**Work performed**	**Performance note**

Sample design. Third page.

Instructions
on safety and labor protection during the field routes in the field training practice on botany.

When performing tasks in natural conditions, being on excursions in the woods, fields, meadows, ponds, special attention should be paid to the observance of safety rules and labor protection:

1. On excursions students should go out in corresponding clothes and footwear. Shoes must be closed, comfortable, without heels, comfortable clothes with long sleeves if possible (shoulders must be closed from the sun), must have a headdress.

2. Strictly obey the rules of the road, especially when crossing highways, country roads, railroad tracks, when driving along country roads and asphalt roads.

Particular caution should be exercised when working near power lines, if possible not to be under them.

4. Do not take shelter from thunderstorms under trees. Always keep metal objects (spades, diggers, knives etc.) away from yourself. Do not use cell phones and internet during a thunderstorm.

5. It is strictly forbidden to smoke in the fields sown with cultivated plants, in steppe and forest natural communities.

6. It is forbidden to drink swamp or river water. Drinking water must be taken from home.

7. You should be especially careful when collecting poisonous plants, as well as plants capable of causing local irritation and having photosensitizing action. You must not taste their fruits, bite the shoots and leaves, or allow the juice of these plants to get on your skin. Remember that freshly picked plants are more dangerous than dried ones. Lying on the grass can cause skin irritation.

8. It is impossible to take perishable foodstuffs as dry rations, to eat food with unwashed hands, especially after collecting poisonous plants. It is not to eat unwashed berries and fruits.

9. It is strictly forbidden to bathe in the open water, especially in places not suitable for this purpose.

10. It is forbidden to climb trees, and also to go down the steep slopes of ravines and steep riverbanks.

11 It is forbidden to touch animals, including pets (they can be carriers of infections). Do not tease animals, especially big ones (dogs, cows, horses, camels).

12. It is desirable to have repellent against insects and ticks, especially when visiting the places of their mass withdrawal.

13. In case of tick, spider, insect or snake bite, immediately inform the instructor to provide first aid.

14. After the excursion, the body should be examined in order to remove ticks.

Herbarium notebook.

Then following the herbarium notebook on plant morphology (inflorescences, leaf morphology, root systems, position of shoots in space). The students make a mini-collection in the diary depending on the theme of the excursion: simple and compound leaves, the shape of the leaf blade, the shape of the leaf margin, the degree of dissected of leaf blade, etc., inflorescences, root systems, fruits, the position of shoots in space. All this is dried with an iron, pasted into a diary and arranged in a certain way:

For example: Inflorescences. The classification of inflorescences is written down, leaving after each name a free place for a drawing and object, opposite to the name of each inflorescence we make a schematic drawing as on the table or in the textbook and glue dried sample of such inflorescence and sign the name of the plant which you have glued as an example.

In the herbarium notebook should be drawn, glued and signed:

- types of root systems.
- types of shoot branching
- types of leaf arrangement
- types of leaves according to the number of leaf blades (simple, ternate, pairedpinnate, unpairedpinnate, palmate, etc.)
- leaf types according to the shape of the leaf blade
- leaf types according to the degree of leaf blade dissection
- leaf types according to the structure of the leaf base (petiolate, sessile, with stipules, with a sheath, with a ocrea)
- leaf types according to venation of leaf
- leaf types according to the shape of the base and the apex of the leaf blade.
- types of leaves according to the shape of the leaf blade margin
- types of inflorescences a) botryoid inflorescences, b) cymoid inflorescences, c) thyrses

- types of fruits (only dry and small fruits can be glued here, the rest can be replaced by pictures and photos)

In addition, on some excursions we collect objects to examine under a microscope. These objects are dissected in the laboratory, micropreparations are made of them, examined under a microscope, and sketched in a herbarium notebook. All tissues and structures that are visible under a microscope are marked in the drawings, as they were in the botany class.

The diary then describes the communities according to the plan above.

Next, the descriptions of the plants are posted. Descriptions of plants that do not grow in the practice area or are not vegetating during the practice period will not be accepted. The plant can be dried and glued at the beginning of the description, or you can glue a picture of it. A total of 5 plants are described for each practice day (including field trip days and classroom days).

The description of plants is carried out according to a plan:

Plan for describing a plant.

1. The name of the plant (Russian (English) and Latin). You can also give the folk name.
2. The systematic belonging of the plant (division, class, order, family, genus).
3. The confinement of a plant to a particular plant community and its role in this community.
4. Ecological groups to which the given plant belongs in relation to light, moisture, chemical and mechanical composition of soil, etc.
5. Life form according to classified of Raunkiaer (Christen Raunkiaer).
6. Life form accoding to classified of Serebryakov (Serebryakov I. G.)
6. Biological group by lifespan.
7. Overall size of the plant.
8. Morphological features:

a) Stem: stem type (erect, creeping, climbing, etc.); degree of woodiness; covering tissue and presence of lenticels, pubescence, cuticle, waxy plaque on it; form of stem cross section (round, tetrahedral, trihedral, etc.); length of internodes; presence of stem and shoot modifications (if any; notes which). Diameter of stem.

b) Leaves: type of leaf (if the plant has several types of leaves, all of them should be described); form of leaf blade; form of leaf margin; type of venation of leaf; type of attachment to stem; presence of stipules, sheath or ocrea; presence and type of pubescence; color of upper and lower surface; presence of leaf modifications (if any; notes which); leaf position on the plant. Size of leaves.

c) Root system: type of root system; degree of development; presence of modifications (if any; notes which ones); presence of symbionts (mycorrhiza, nodules of nitrogen-fixing bacteria). Size of root system.

d) Generative organs (for flowering plants):

1) Flower. Flower formula and diagram; presence of different types of flowers (bisexual, unisexual, sterile, cleistogamous); dioecious or monoecious plant; type of flower symmetry (actinomorphic, zygomorphic, irregular); type of pollination; adaptation to type of pollination; presence and color of corolla, number and shape of petals, presence and degree of their fusion, shape of corolla; presence and color of calyx, number of sepals, their shape and pubescence, presence and degree of their fusion. Presence of spurs, appendages, nectaries (indicate from what organs they were formed); number of stamens, their location in relation to petals of corolla, presence of their fusion; number of pistils, number of carpels forming each pistil (determined by the number of locules of ovary, styles or stigma); ovary type in relation to the place on receptacle (lower, upper, middle); flower size.

2) Position of flowers on the plant (apical, axillary, sessile, on pedicels, alone, put together in inflorescences); length of pedicels, presence of general or separate pedicels; type of inflorescences; presence of general and private

inflorescences; sizes of inflorescences, quantity of flowers in inflorescences (if their number is definite).

3) Fruit. Fruit type according to gynoecium type; dry or juicy; true or false; character of fruit surface (smooth, ribbed, pubescent); type of fruit (berry, knuckle, nut, etc.)

After that, students will take a credit.

Students must have:

1. Individual assignment (a mounted herbarium of 30 sheets on plant systematics or a thematic herbarium on plant morphology of 10 sheets, or fruit collections, etc.).

2. Practice diary, which must include:

- herbarium notebook on plant morphology (inflorescences, leaf morphology, root systems, position of shoots in space etc.).

- descriptions of 4 plant communities

- drawings of plants or pasted dried plants and their descriptions (5 plants for each day of practice)

- drawing of anatomical structure stems, roth and leaf plants.

3. From the herbarium students should name Russian and Latin names of plants, their systematic belonging, ecological groups of plants, their life forms, communities to which these plants are confined, their economic importance.

2.5 Recommendations on the organization of students' independent work in the educational and field practice on botany

During the independent work on educational and field practice students collect herbarium material and perform individual assignments on the systematics and morphology of plants on the following topics.

1. types of root systems.

2. Structure and types of shoots.

3. Branching and growth.

4. Leaf, parts of leaf. Simple and compound leaves. Shape and margin of leaf blade, veining, metamorphosis.

5. Types of inflorescences.

6. Variety of fruits.

7. Herbarium on the systematics of the covered plants.

In addition, all students independently describe the plants collected in practice in diaries, describe plant communities and design a herbarium notebook on morphology.

This work is carried out in three stages.

- In the first stage, students collect plants on excursions. Then they dry them independently.

- during the second stage, in the department, they get advice from the teacher about the correct formatting of an independent work on the example of one of the collected plants

- on the third stage students independently make out the herbarium and the diary of practice taking into account the received knowledge.

The department has plant identifiers (determined key), which students can use when carrying out independent work.

3. HERBARIUM.

3.1 Rules for collecting, drying and assembling an herbarium

An herbarium is a collection of dried plants processed and pre-documented in a certain way

Herbarium sheet - a sheet of herbarium-sized paper with plants mounted on it.

Herbarium specimen (specimen) - that amount of material that can sufficiently represent a plant of the same species collected at one point at one time. A herbarium specimen should not be smaller than a herbarium sheet filled with dried plants. If the plants are large, one herbarium specimen may take up several herbarium sheets.

An ***herbarium samples*** it is all the material that the collector considers homogeneous, i.e. belonging to the same species, and which is collected at the same time in the same habitat. An herbarium samples usually include one or several specimens. Such specimens are called duplicates and may be transferred to central repositories or used for exchange.

Exsiccate (from Lat. exsiccatum - dried) is an herbarium specimen of a certain species with an indication of the place and time of collection, the author of collection and definition, used in taxonomic studies. Intended for distribution to botanists and/or scientific organizations. The exsiccate includes 20-100 herbarium specimens of the same species collected at the same time in one place by one botanist.

Care for the quality of the future herbarium must begin at the time of collection. An inattentive and wrong herbarium collection devalues all the work that follows, reduces the informative content of the herbarium, and even makes it hard to keep the herbarium itself. That's why you should be very careful when collecting plants. Do not take the first plant that comes to hand: shattered, sick, downtrodden. The plant you choose must be well-developed, healthy and as pretty as possible.

When collecting you should strive to ensure that the herbarium contains as many organs as possible, from roots to fruits and seeds.

For herbaceous plants, the herbarium should show the nature of the root and rhizome system or other underground or terrestrial formations. Collect rosettes and other types of non-flowering shoots, all stem and leaf tiers of flowering shoots, flowers, fruits, seeds, hibernating organs. For woody plants - various types of vegetative shoots (normal, shortened, shoots) with complete range of variability of leaf shape and pubescence, flowering shoots, fruits, shoots with hibernating buds, pieces of bark, young seedlings.

Digging up the plant, you need to carefully (so as not to damage the underground organs) shake off the soil, and if the soil is clayey and damp, if possible, wash. Freshly picked plants are immediately placed in paper, in a herbarium folder so that both the number and the arrangement of plants on the sheet remain unchanged until the final herbarium mounting. The sheet should be filled with plants or their parts as full and evenly as possible. Small plants should be put several in one sheet; only plants of one species should be on one sheet. Large plants have to be cut into parts and placed on several sheets. In especially large plants, you have to discard some parts and put only one to two segments of each type of organ. If the plant is tall but not very large and branchy, its stem should be bent at sharp angle so that the entire plant fits on the leaf. To fix these bends, put pieces of paper with a slit in them. It is important to bend the stems and leaves at an angle, not to bend them in an arc, so as not to give a false impression of their growth form. In a strongly branched or densely foliated plant, some of the branches and leaves can be removed, but so that the signs of removal are visible. Leaves should be arranged so that some of them are on the underside upwards. Do not try to lay the plant with its roots down. You should arrange the plants differently, so that the whole bundle is as uniform a thickness as possible.

The collected plants can stay in the folder from a few hours to a day. A piece of paper is inserted in each sheet with information about the place of collection and about the plant itself. For this purpose, it is necessary to have sheets or small tear-

off notebooks of thin paper prepared in advance. This information can also be written on the sheet in which the plants are placed. The loss of label data devalues any material, and confusion in labeling is directly detrimental to the purpose for which the herbarium is collected.

Herbarium press is used for drying plants. Plants must be properly pressed so that they do not become deformed in the drying process. Poorly pressed plants shrivel and wrinkle, they are unpleasant to see and difficult to examine, they crumble extremely easily and are not long-lived in storage.

To put the plants in the press from a drying folder do the following: put three or four sheets of paper on the frame of the press, put it upside down by the net (from four pages of newspaper you get two sheets of drying paper). The top sheet is opened and the plants are placed on it. The plants are usually transferred from damp paper to dry paper. When transferring it is necessary to correct everything that was missed during the collection, and also to correct deformations that arose during the time the plants were in the folder. It is useful to put pads of hygroscopic paper between the overlapping parts. Very large flowers should be unwrapped and covered with paper and absorbent cotton. Small individually collected parts (flowers, fruits) are dried in bags of drying paper of arbitrary shape. On a new leaf you need to transfer all the notes about the plant, made on the old leaf.

When stacking in the press, one leaf with the plant alternates with one spacer. More pads can be placed - the more there are, the better the drying.

The thickness of the pile of plants in the press depends on the press design and the drying method, but in any case it should be even and not less than 3 cm. If you feel lumps and hollows when feeling the surface, it is necessary to cover the hollows with crumpled drying paper.

Drying is accomplished by: 1) replacing damp pads with dry ones, 2) airing, and 3) heating. As a rule, these methods are combined. The faster the plants dry, the better they will retain their natural color. Therefore, the pads should be changed daily. Plants should not be removed from the sheet. The press is placed in a well-ventilated place in the sun during the day and near a heater at night. Some plants

can be dried with a hot iron, ironing them through special mats of hygroscopic absorbent cotton and tissue paper or filter paper. Remember that the high heat (above 30-40 ° C) can cause steaming and browning of plants.

Dry plants can be considered when they are not kinked if they are lifted by the root neck. A dried plant, when applied to the lips, does not cause a cold sensation.

Undried material, while retaining some moisture, quickly deteriorates, turns brown, and becomes covered with spots. If over dried, the plants lose their natural coloring and become too brittle.

The dried plants are mounted on standard herbarium sheets. In this case, as many plants of the same collection as will fit on it are placed on the sheet. Only space is left for the label. The label is glued on in any place, but care must be taken to ensure that this place is not the same on different sheets. This is to ensure that when storing the herbarium, the bundles are of uniform thickness, the sheets do not tilt to one side, and the plants do not break.

Arrange the plants on the leaf as nicely as possible and so that the thickest parts of them are offset from the center.

Thread down the thick stems and roots of the plants. Do not allow long stitches on the underside of the leaf. The place of attachment make one small stitch, knot on the top side of the leaf, the ends of the threads are cut. Thin parts of plants are attached to the sheet with strips of paper 1.5-2 mm wide, gluing their ends. Strips of paper are placed as parallel as possible to each other. In a well-assembled plant, no part of the stems and leaves should sag when the leaf is turned over.

The finishing label must contain the following information (see sample):

1. administrative region, district of the region, the nearest settlement (if the plant is collected in the city, then the district of the city). For example: Volgograd Region, Sredneahtubinsky district, 2 km to the north of the settlement of Sakharny; Volgograd city, Central district, Mamayev kurgan.

2. The location on the terrain, the distance from a settlement, river, large lake, some known object. For example: 300 m north of the railway station; surroundings of Gorky settlement.

Habitat description describing topography, substratum (soil, water, rocky outcrops, sands), vegetation type (floodplain oak woodland, flood meadow, dry steppe, birch forest).

4. Date of collection - date, month, year (the year is indicated in full: 1997).

5. Surname and initials of the collector.

6. As an addition, it is desirable to add the role of the collected plant in the community (very rare, frequent, predominant), an exact description of the color of the flowers when collected (in the herbarium they often change color).

In addition to the label, a determinant label (label with determined) - a label with the name of the plant (the first definition can be written in the collector's label, but necessarily with the authorship of the definition) is glued to the sheet. It should contain the following information:

1. The name of the family (in Russian (English) and Latin).

2. Name of genus and species (in Russian (English) and Latin, indicating the author who described the species).

3. Date of identification (as a rule it is different from the date of collection).

4. The name and initials of the person who identified the species.

Several labels with determined may be on a single sheet, but only one label with data collection.

Sample of label with data collection and of label with determined.

Department of Pharmacognosy and Botany
Russian (English) name _____
_____
Latin name _____
_____
Family _____
Location of collection _____
_____
Habitat _____
_____
Date of collection _____
Collector's name _____

Sample fillig of label with data collection and of label with determined.

Department of Pharmacognosy and Botany
English name____ Schrenk's tulip _____
_____(=Tulipa gesneriana)_____
Latin name_____ Tulipa gesneriana L.
_____(=T. schrenkii Regel)_____
Family ____ Liliaceae_____
Location of collection _Volgograd region, Pallasovsky district
area, 300 m south of the village of Presnyi Liman____
Habitat_desert wormwood steppe on salt
saline clay soils_____
Date of collection___ April 20, 2016_____
Collector's name Ivanov A.A.

3.2 Collecting fresh plants for further processing in the laboratory conditions and for wet preparations.

Fresh, not wilted plants are necessary for acquiring skills of work with determination key of plants, detailed cameral description and making wet preparations. In the summer heat in our climate, plants wilt almost immediately after collection, while you usually have to process the collected material a few hours after collection, and sometimes the next day. To keep the plants fresh, there are simple rules and techniques for harvesting.

If the weather is cool and humid, in the field the plants can be collected in a plastic bag and lightly sprayed with water. If you have to process the plants the next day, it is better to put them in the refrigerator (in the lower compartment) overnight.

In hot weather, it is better to collect the plants in the morning, before the onset of severe heat. In this case, they in no case should be put in a plastic bag, it can happen steaming. In the heat, the plants are wrapped in damp paper (e.g. newspaper) right in the field, trying not to crumple them. In this form they can be put in a plastic bag. It is important to keep these gatherings in the shade if possible. At night they should also be sprinkled with water and put in the refrigerator.

Freshly harvested plants should be treated as soon as possible, since under the most favorable conditions they can be stored for no more than 3 days.

To collect for wet preparations, as a rule, not whole plants, but their parts: leaves, stems, flowers, fruits nessesary. They in any weather must not be wet with water in any case. It is better to collect such material immediately in a fixing liquid (especially flowers with easily crumbling petals and soft crumpled fruits). If this is not possible, collect in paper bags made of heavy paper so that the material does not crumple if possible. It is better not to collect the material in plastic bags and in no case store it in them. As soon as possible, it should be placed in a fixing liquid. If this is not possible on the day of collection, the material is placed in the

refrigerator overnight (without wetting). In any case, it should not be stored for more than one day. In cold, damp weather, such material can also be collected in polyethylene bags, but it should not be stored in them anyway. Before fixing, such material should be slightly dried, so that rainwater does not dilute the fixing liquid unnecessarily.

4. FUNDAMENTALS OF THE MORPHOLOGY OF PLANTS

4.1. Morphology of vegetative organs of the Angiosperms or flowering plants.

Vegetative organs are the organs that keep a plant alive. The main vegetative organs are the shoot and the root.

The root is the axial vegetative organ of the plant, which has unlimited apical growth, positive geotropism, has a radial structure (symmetry), and never bears leaves. The main functions of the root are suction, mechanical, and storage of water and nutriens; it is an organ of vegetative reproduction.

Taking into account anatomical and morphological features of formation and structure of the roots, they are divided into tap, lateral and adventitious roots.

The tap root grows from the germinal root of the seed.

The lateral roots develop on the tap root and are established in the pericycle, from which the lateral roots of the second and subsequent orders begin to grow.

The adventitious roots are very diverse in structure and may be formed on stems, rhizomes, leaves, older lateral roots and adventitious roots. They appear due to the activity of cells of various secondary meristems (Fig. 1).

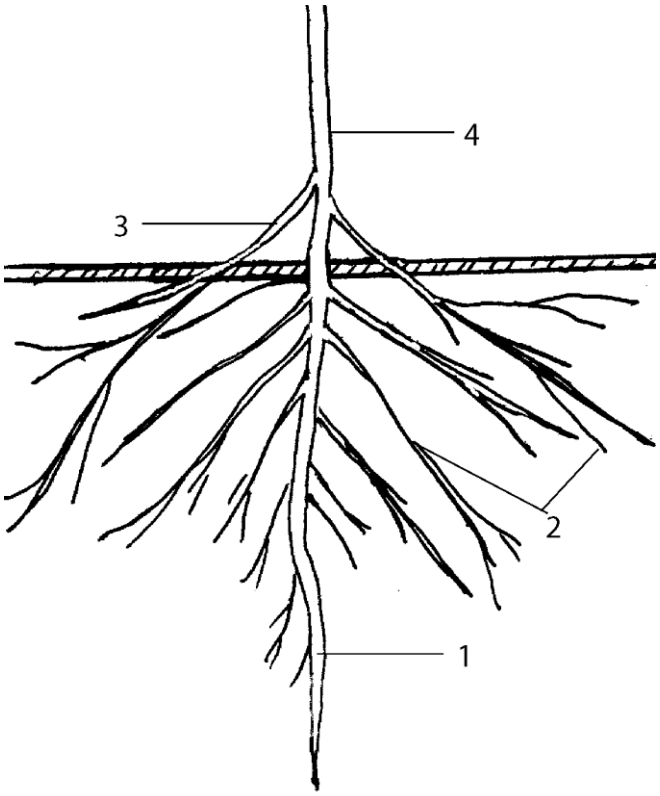

Fig. 1. Types of Roots (original): 1 – the tap root, 2 – the lateral root, 3 – the adventitious root, 4 – the stems.

All the roots of a plant form a root system. There are several types of root systems: **pivotal root system**, **fibrous root system**, **mixed root systems**. A root system that has a well-developed tap root, which is very visible in size and growth, and lateral roots that branch off from it, is called a pivotal root (taproot) system. These root systems are typical of dicotyledonous annual herbaceous and perennial plants. A root system consisting of adventitious roots and lateral roots is called a fibrous root system. Such a system is typical of monocotyledonous plants. A clear division of root systems into privotal and fibrous ones is not always possible. Root systems of mixed structure are also known, where the tap root is clearly visible, but lateral and adventitious roots are well expressed (Fig. 2).

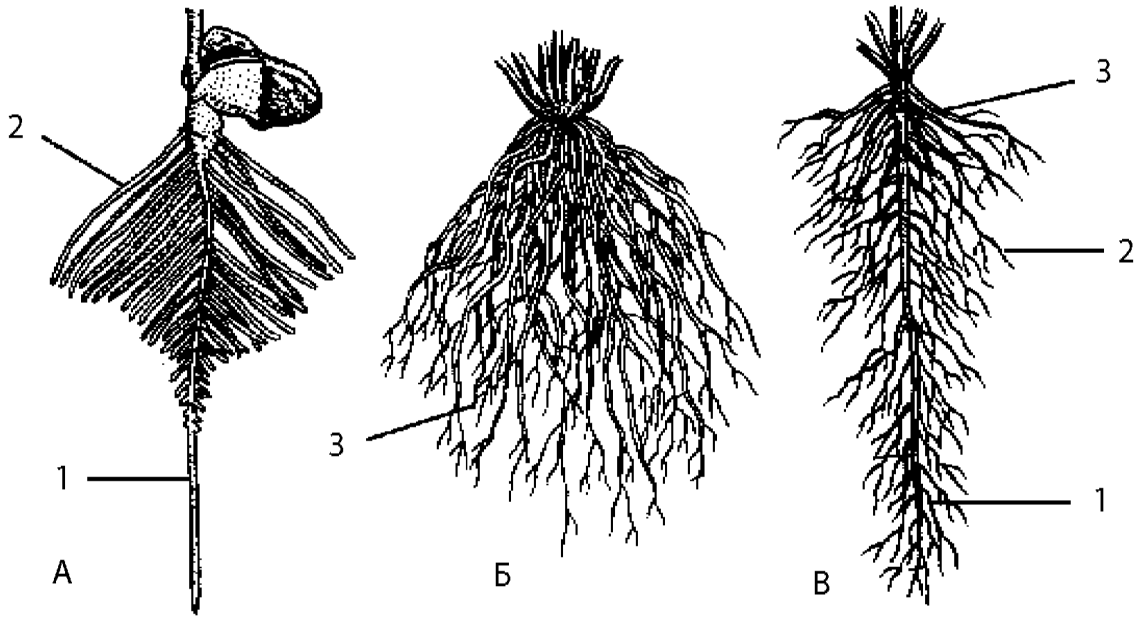

Figure 2. Types of root systems (original): А — pivotal root system, Б — fibrous root system, В — mixed root systems; 1 — tap root, 2 — lateral root, 3 — adventitious root.

Roots metamorfosis. A distinction is made between storing roots, aerial roots, respiratory roots, and support roots. Among storage roots, the best known are root vegetable (when the main root thickens), such as in carrots, and root tubers (when adventitious roots thicken), such as in dahlia.

A number of tropical plants (epiphytes) develop **aerial roots**. They hang down from the branches of the host plant and absorb moisture directly from the atmospheric air.

Breathing roots develop on underground lateral roots and grow vertically upwards out of water or from moisture-saturated soil. Within these roots there is a well-developed aerenchyma (air-bearing parenchyma) through which air enters the underground organs.

Supporting roots (buttress roots) provide stability to plants in unstable soil. Adventitious roots grow vertically downward from the stems, providing the ability to support a huge crown on many supports. Such roots are often found in tropical

trees growing along the shores of seas in the tidal zone.

A shoot is a stem with leaves and buds that forms during one summer.

The stem is the axial part of the shoot. It has radial symmetry, ability of unlimited apex growth and negative geotropism.

The main functions of the stem are conducting, storing, protective, it brings leaves closer to the light, and is an organ of vegetative reproduction. The parts of the stem where leaves develop are called nodes, and the parts of the stem between the closest two nodes are called internodes. The angle between the leaf and the upstream portion of the stem is the leaf axil.

The arrangement of leaves on a shoot is closely connected with the structure of nodes and location of axillary buds. If a single leaf comes from each node, the leaf arrangement will be **alternate distichous or spiral**, if two leaves, the leaf arrangement will be **decussate (opposite decussate)**, and if three or more leaves, the leaf arrangement will be **whorled**. If adjacent internodes are greatly shortened, the leaves are crowded in one place of the shoot, forming a rosette. Plants with root rosettes are known, less often rosettes are located at the top of the shoot (Fig. 3).

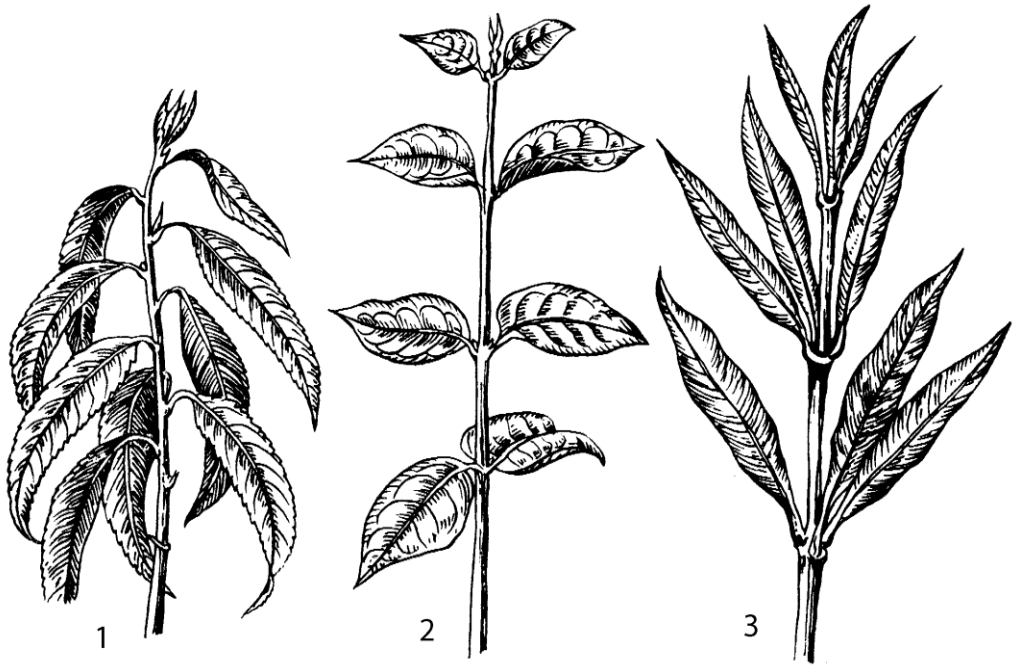

Fig. 3. Arrangement of leaves on the shoot (Yakovlev and Chelombitko, 1990): 1 – alternate, 2 – decussate, 3 – whorled.

Types of branching. Branching of a shoot can be **dichotomous**, in which growth point is forked and two equivalent legs are formed (Marchansia, Plaunus). **Monopodial** is branching in which growth of apex bud (spruce, fir) is maintained for a long time and main shoot has feeble lateral shoots. **Sympodial** is branching, in which apical bud dies off and growth goes by lateral bud (apple-tree, birch, etc.). Sympodial branching is given, if apical shoots of different generations exist at the same time since the apical meristem of each sympodial branch has either died or is differentiated into a flower, a thorn or a tendril and has thus lost its ability to grow. Sympodial branching of shoot can be by **type of monochasium**; by **type of dichasium** and by **type pleiochasium (polychasium)**. If only one of the apical shoots has the same direction as the main shoot would have had, then a monochasium results which may sometimes be difficult to distinguish from monopodial branching (Linden, aspen). But if two buds of a sympodial branch sprout at the same time, a more or less fork-shaped pattern, a dichasium, is formed (lilac, birch, etc.). Hardly ever do several buds put forth at the same time (pleiochasium) (milkweed) (Fig. 4).

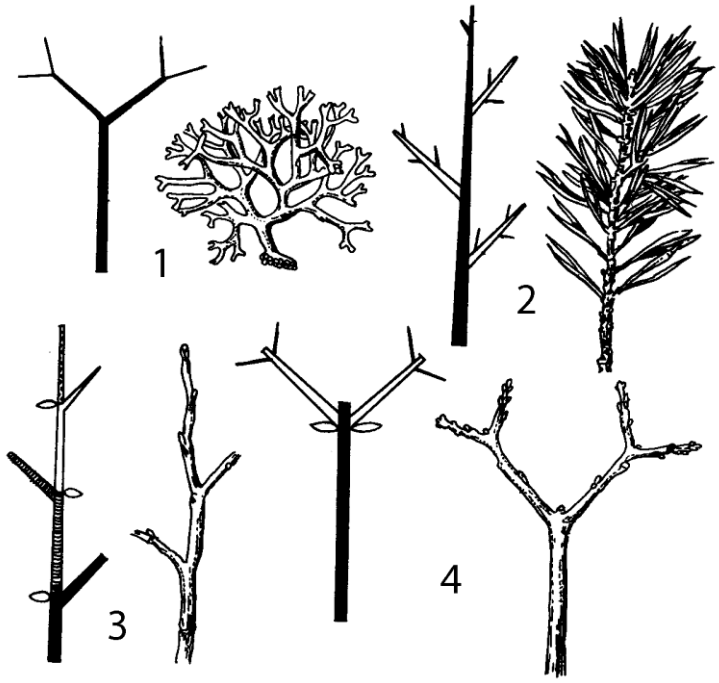

Fig. 4. Types of shoot branching (Yakovlev and Chelombitko, 1990): 1 - dichotomous (alga dictyota), 2 - monopodial (pine), 3 - sympodial by monochasium type (linden), 4 - sympodial by dichasium type (lilac).

A bud is a shortened embryonic shoot. Buds are divided into vegetative, generative or flowering, and vegetative-generative or mixed. **Vegetative buds** consist of an embryonic stem and embryonic leaves. **Generative (floral) buds** with buds of flowers or inflorescences. **Vegetative-generative (mixed) buds** consist of embry-onic leaves and flower or inflorescence buds (Fig. 5).

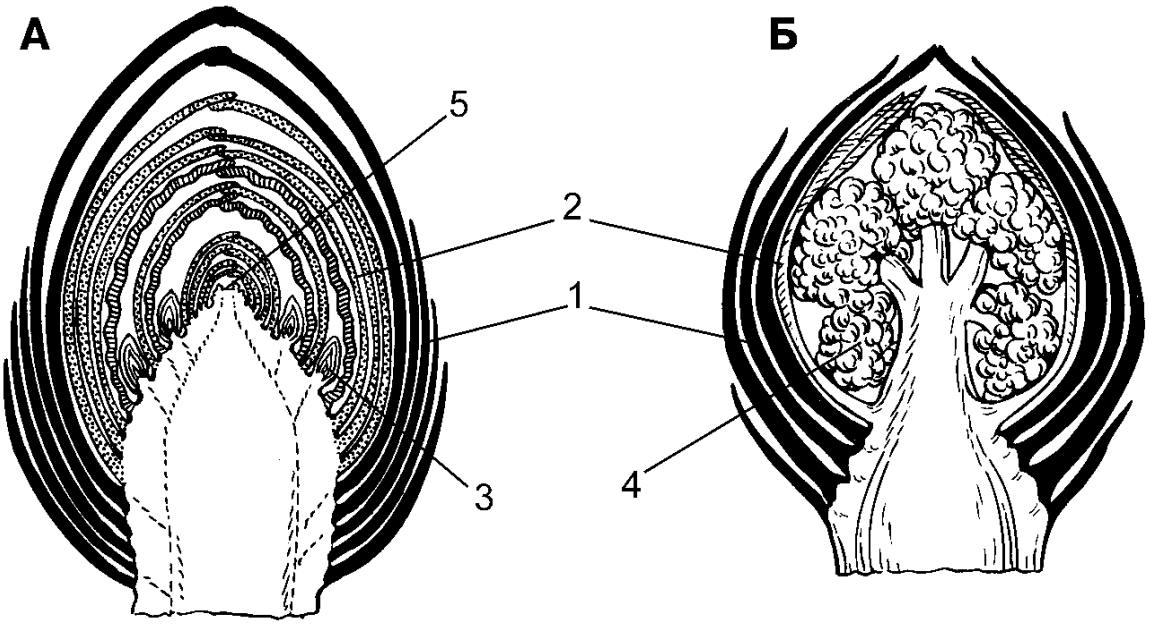

Fig. 5. Structure of buds of woody plants (Vasiliev A.E. et al., 1988): A - vegetative bud, B - flower bud; 1 - bud scales, 2 - leaf embryos, 3 - axillary buds, 4 - buds, 5 - growth cone.

Shoot modifications can be underground and above-ground. Under-ground modifications of a shoot include: rhizome, tuber, bulb. Above-ground modifications of a shoot include prickles, tendrils.

The rhizome is a perennial shoot with reduced leaves in the form of scales, in the axils of which there are buds (lily of the valley, lapdolta).

The tuber is a modified shoot with a pronounced hoarding function of the stem, having scaly leaves that quickly peel off, and buds called eyes (potato).

The bulb - a modified shoot with a shortened stem (base), succulent scale-like leaves and leaves, dry, covering the outside of the bulb and buds (lily, onion, tulip)

The spines are modified shoots that perform a protective function (hawthorn).

The tendrils are the modified shoots that ensure the position of the shoot in space (grapes).

A leaf is a lateral organ that has bilateral symmetry and grows at its base. The growth of the leaf is limited. The leaf performs the functions of photosynthesis, transpiration, and gas exchange. A leaf consists of a leaf blade (or several blades in compound leaves), a petiole (with which it attaches to the stem), and a base (the base part of the leaf articulated with the stem). Often, stipules (lateral paired outgrowths serving to protect the young leaf and axillary bud) can be seen at the base of the leaf (Fig. 6).

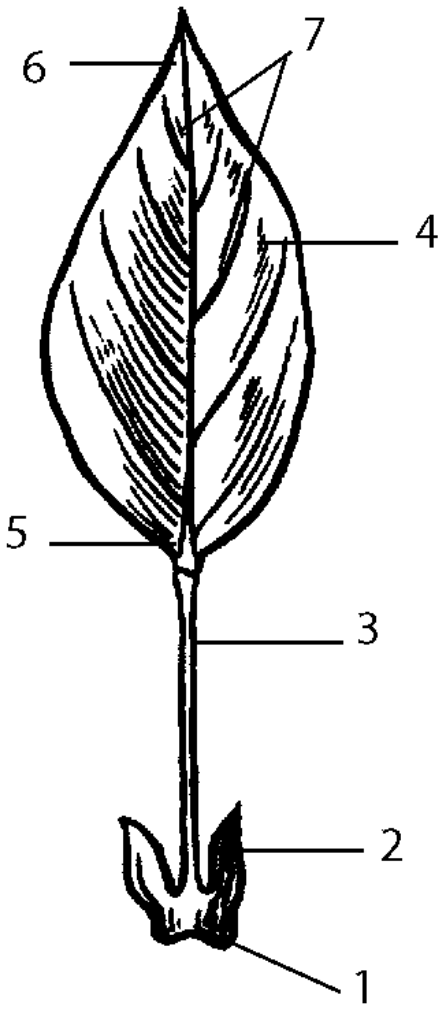

Fig. 6. Structure of a leaf (Original).

1 - leaf base, 2 - stipules, 3 - petiole, 4 - leaf blade, 5 - base of leaf blade, 6 - apex of leaf blade, 7 - leaf veins.

Leaves with petioles are called **petiolate** (in the apple tree). Leaves without petioles are called **sessile** (in flax). In cereals and umbrella plants, the base of the leaf extends and covers the stem to form a **sheath (sheath leaf)**. Many leaves have paired outgrowths at the base of the petiole that serve to protect the young leaf and axillary buds. They are called **stipules**. They may be loose (in this case, they fall off after the leaf matures) or adherent to the leaf base. When the stipules fuse together, a funnel-shaped or tubular morphological structure, the **ocrea** (Family Polygonaceae). It surrounds the stem not as densely as the sheath (Fig. 7).

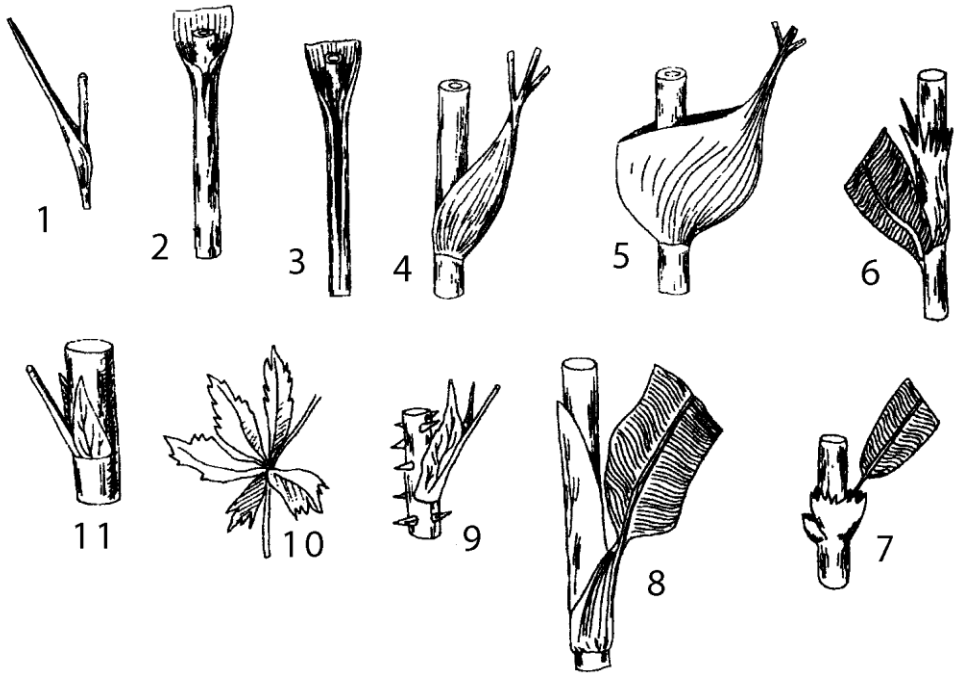

Fig. 7. Some forms of bracts, leaf sheaths and ocreas (Original): 1-5 - leaf sheaths: 1 - narrow, 2 - closed, 3 - open, 4 - swollen, 5 - cup-shaped; 6-8 - ocreas:6 - oblong-ruptured, 7 - shortened dentate, 8 - oblong; 9-11 - stipules: 9 - lateral, adherent to petiole, 10 - free leaf-like, 11 - free lateral.

Leaves are either **simple** or **compound**. **Simple leaves** are those with one leaf blade, while **compound leaves** have several leaf blades on one petiole and its continuation (rachis), which are called leaflets. Simple leaves can have a entire leaf blade or a dissected leaf blade. Among the compound ones, there are ternate, paired pinnate, unpaired pinnate, and palmate leaves (Fig. 8).

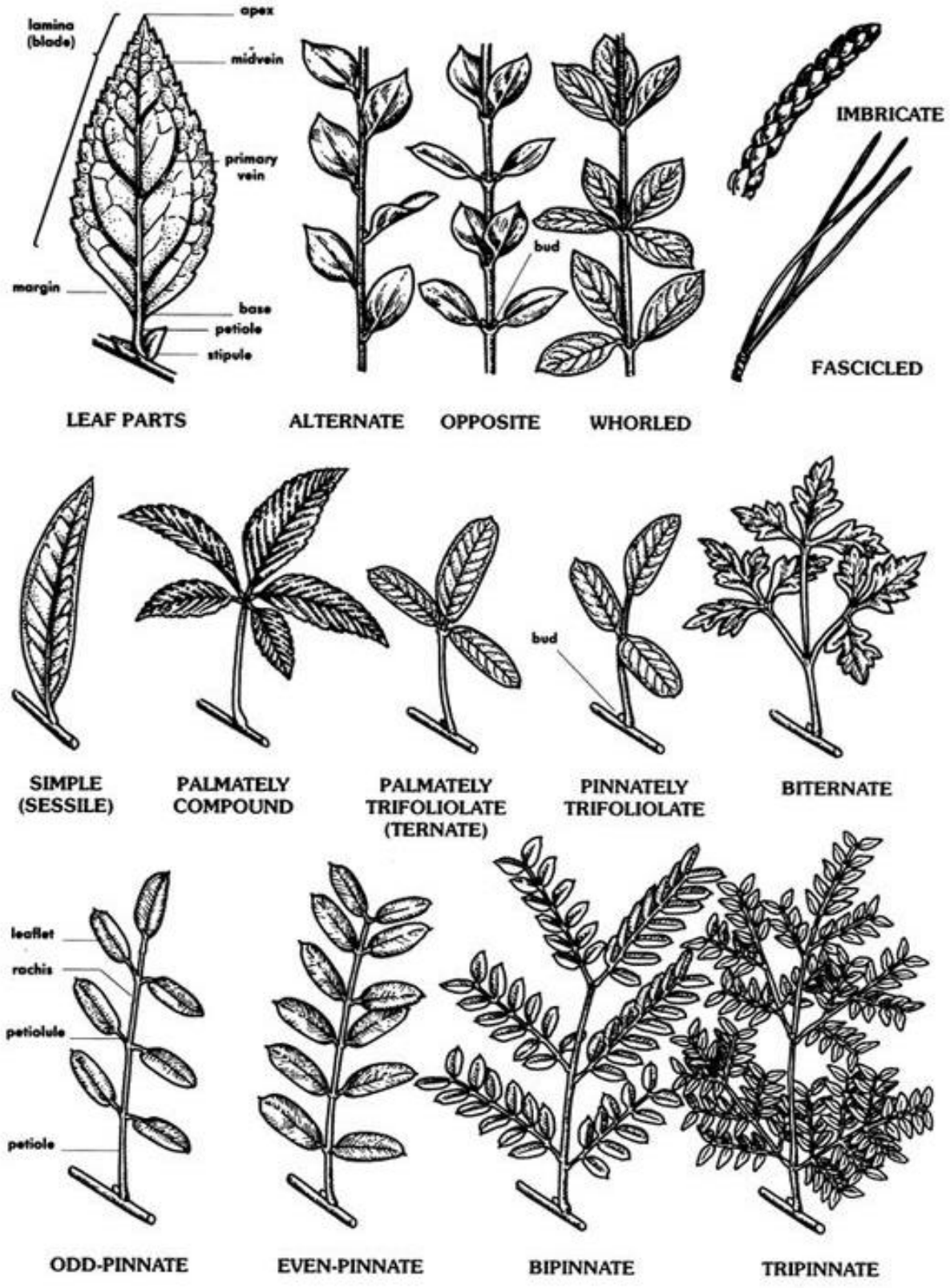

Fig. 8. Simple and compound leaves (by Swink F. et al. Plants of the Chicago region. – Indiana Academy of Science, 1994.)

The leaves are rounded, oval, lanceolate, heart-shaped, etc., according to the shape of the leaf blade. (Figure 9)

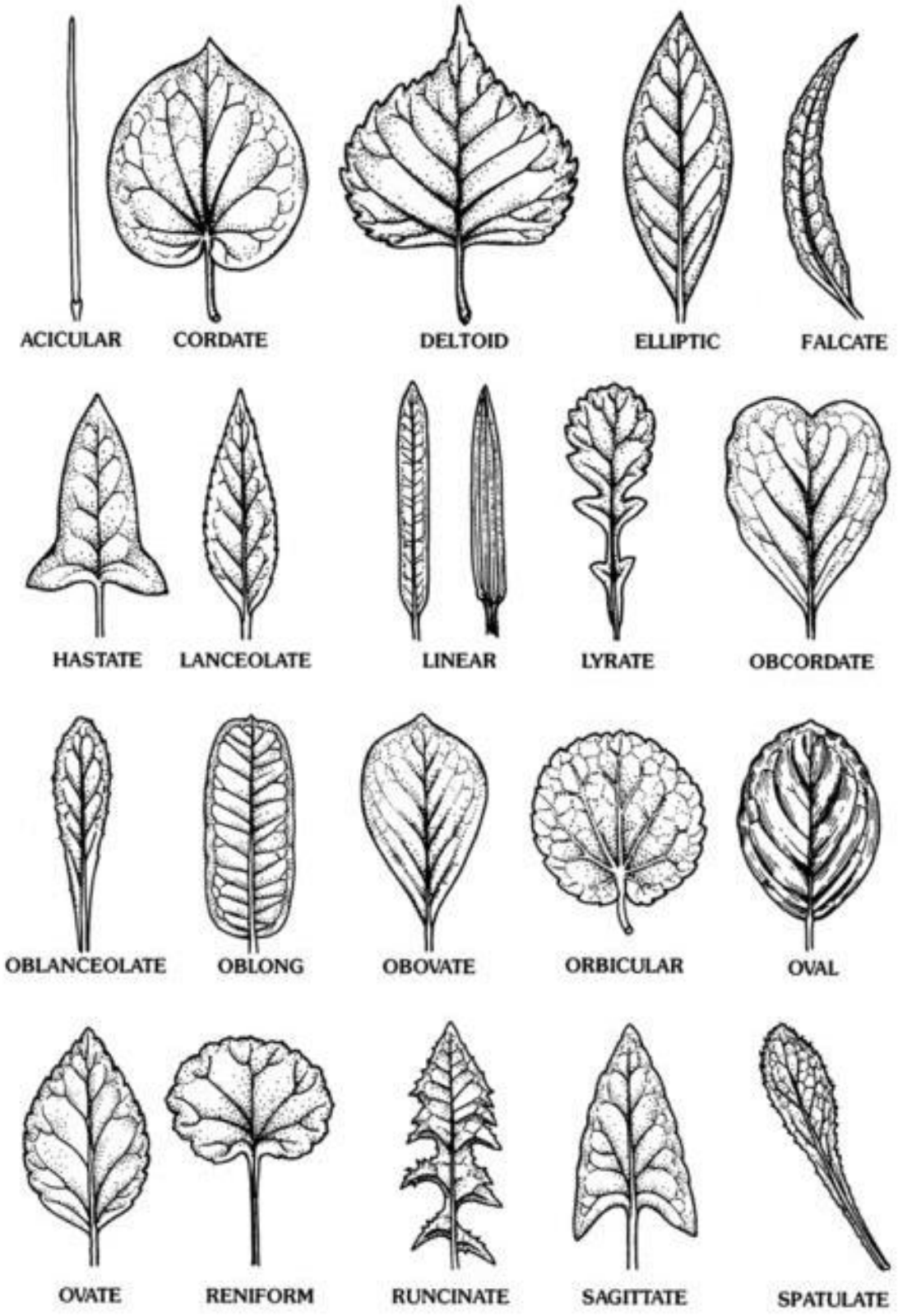

Fig.9 Various shapes of the leaf blade (by Swink F. et al. Plants of the Chicago region. – Indiana Academy of Science, 1994.)

In addition to the shape of the leaf blade, the shape of the apex and the shape of the base of the leaf blade are also important in classifying leaves. The shape of the leaf blade margin can be: entire edge, crenate, dentate, serrated, etc.

The following types of leaf veins are distinguished according to the way the veins are branched:

- **Dichotomous**, when the vein at the base of the leaf branches into two, which in turn also branch (ginkgo);

- **Parallel** where the veins run parallel to each other along the long leaf blade (grasses);

- **Arc-shaped**, when veins diverge from the base of the leaf blade in an arc-shaped bunch and meet again at the leaf apex (lily of the valley);

- **Palmate**, when several identical veins come from the petiole at the base of the lamina and pass along the leaf blade, branching (maple);

- **Pinnate**, when a well-defined midrib vein runs in the middle of the leaf blade and from it branches off to the sides, in turn, branching and often forming a whole network of the thinnest veins (sage) (Fig. 10).

The leaf blade may be whole or dissected to varying degrees. A leaf is called **entire** if the cuts do not exceed one quarter of the leaf blade.

A leaf is called a **lobes leaf** if the depth of the cuts is more than one-quarter and less than one-half of the leaf. The protrusions between the incisions are called lobes.

A leaf is called **partite leaf** if the cuts exceed half of the blade, but do not reach the middle vein or base of the leaf. The spaces between the incisions are called parts.

A leaf is called a **dissected leaf** if the cuts reach the middle vein or base of the leaf. Their protruding parts are called segments.

Depending on the number and location of the protrusions, there are trifoliate, palmately and pinnately dissections leave. Leaves are often double or triple dissected if their lobes or segments are dissected (fig. 11).

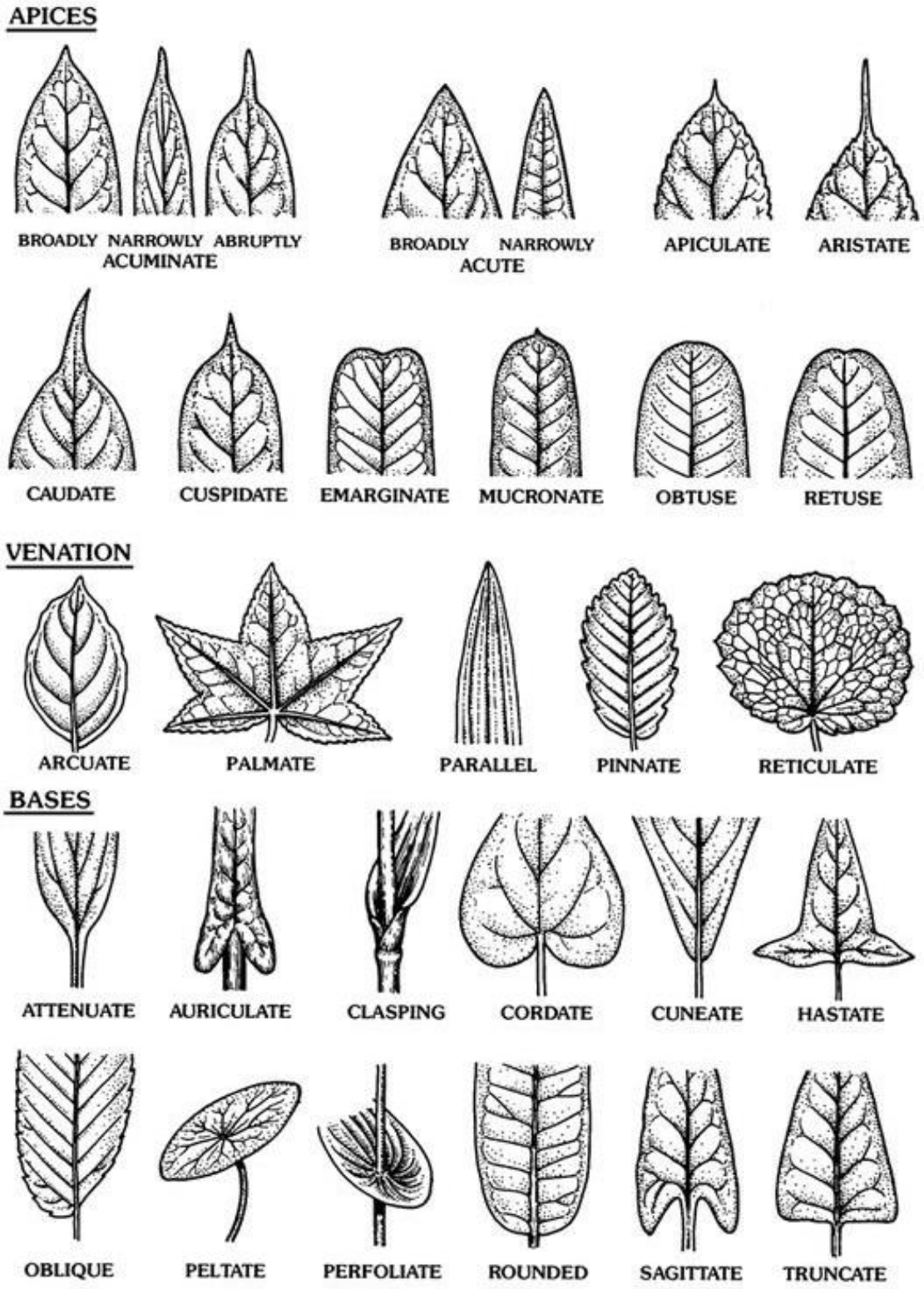

Fig. 10. Different forms of the base, apex, and veining of the leaf blade (by Swink F. et al. Plants of the Chicago region. – Indiana Academy of Science, 1994.).

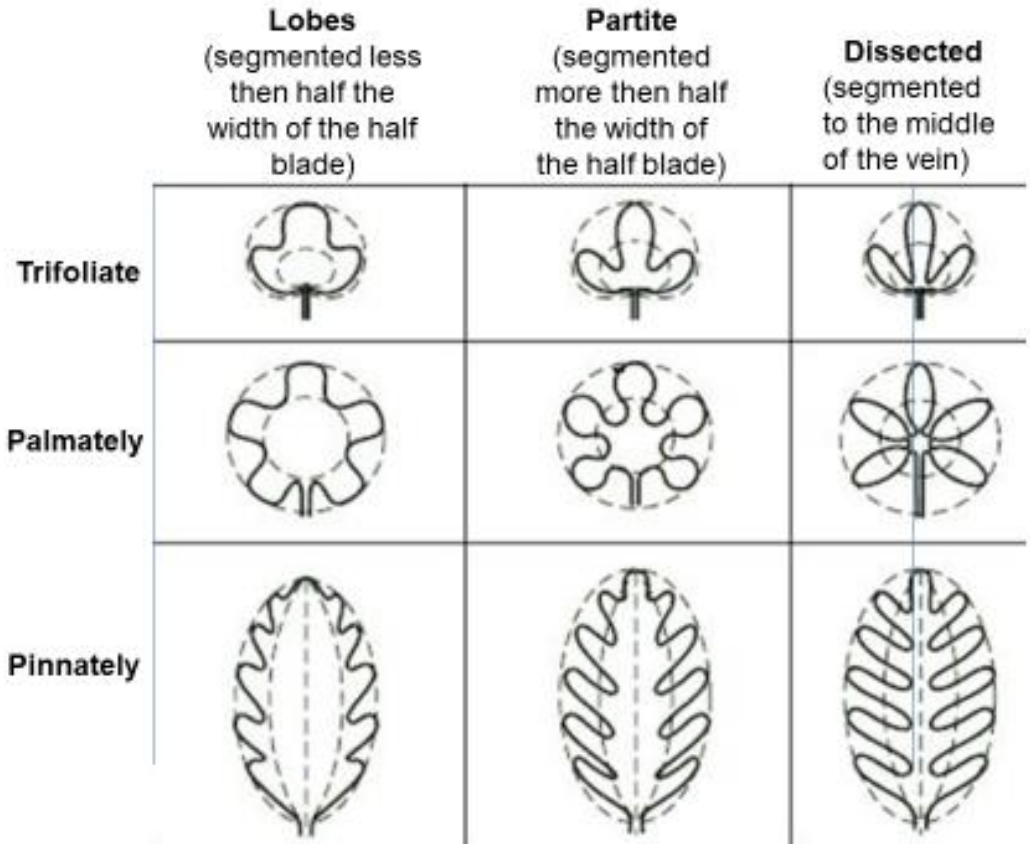

Fig. 11. Degree of leaf blade dissection (original).

The margins of leaves blades may be entire and smooth or they may be lobed in various dissecting (fig 12 - 13).

Leaf modifications:

The spines are an adaptation to reduce evaporation and a kind of protection from being eaten by animals (cactus, barberry).

The juicy scales of bulbs, store nutrients and water, and *covering scales* of buds protect embryonal shoot.

The catchers apparatus of some tropical plants associated with the peculiarities of feeding (in insectivorous plants).

The tendrils attach the climbing stem to a support (pea)

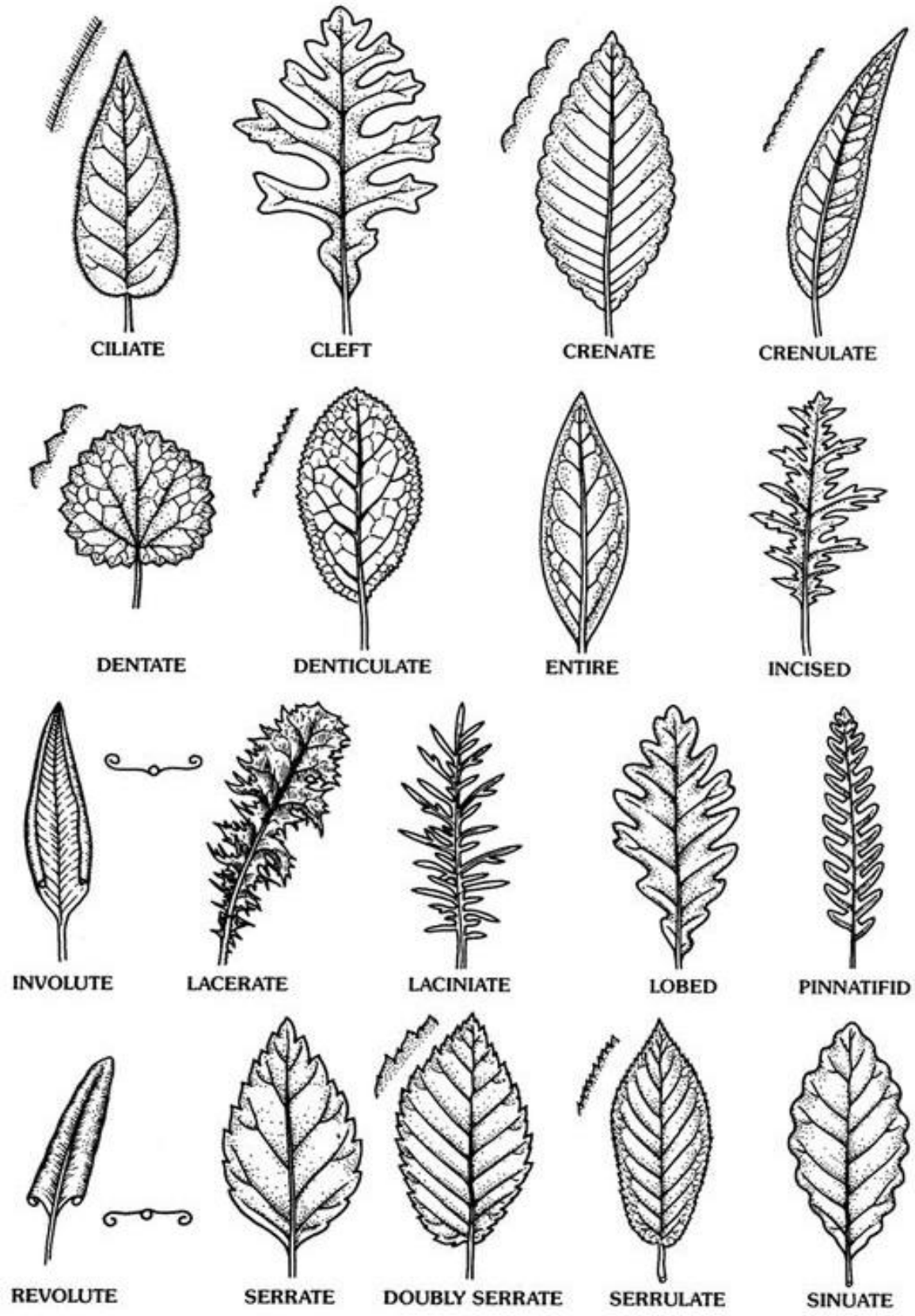

Fig. 12. Shape of leaf blade margin (by Swink F. et al. Plants of the Chicago region. – Indiana Academy of Science, 1994.).

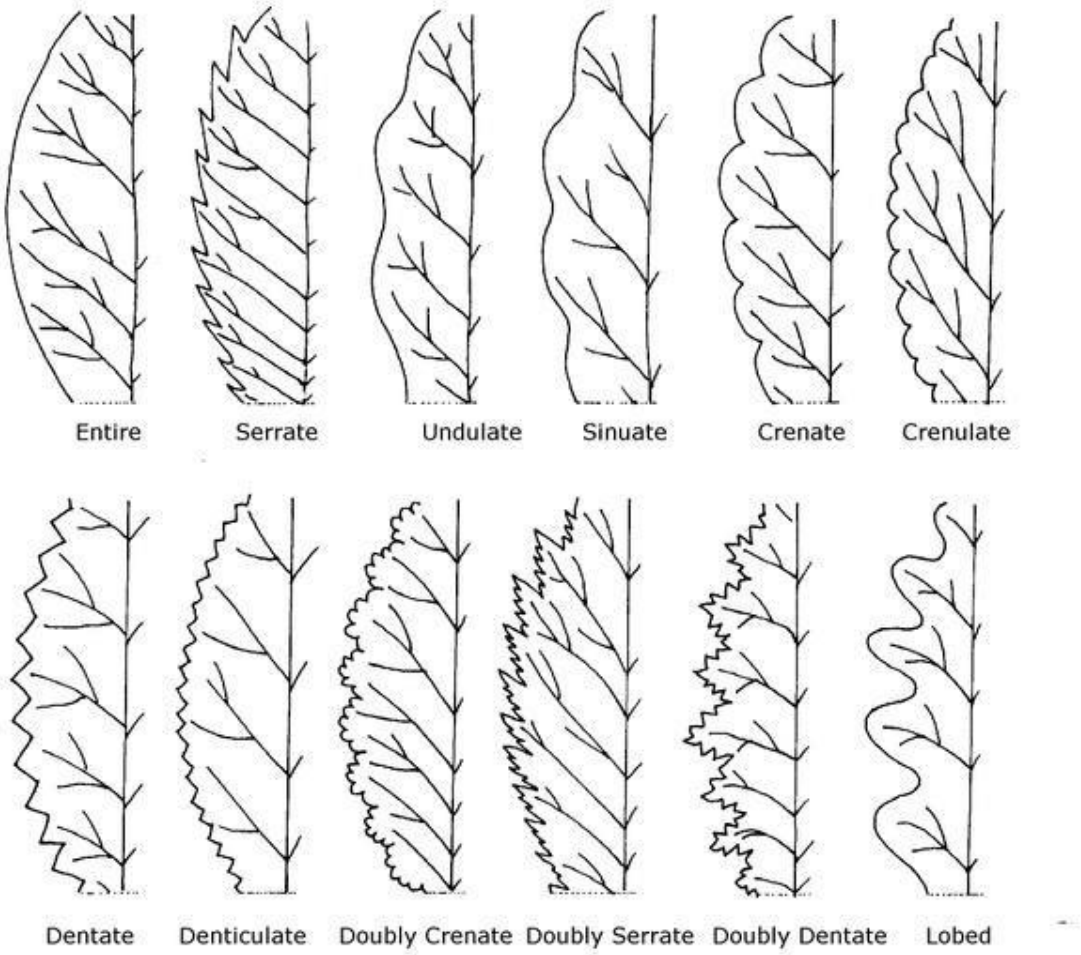

Fig. 13. Shape of leaf blade margin

4.2 Morphology of generative organs of Angiosperms.

Reproductive (generative) organs are organs performing the function of sexual reproduction. Flower, inflorescences, fruits and seeds are the generative organs of flowering plants.

An inflorescence is a shoot or a system of shoots bearing flowers. Inflorescences are provide within flowering or mixed buds.

The inflorescence has a main axis (rachis, peduncle) and lateral axes, which, in turn, are more or less branched. Flowers are located on the endmost ramifica-

tions - pedicels. At the nodes of the inflorescence axes there are leaves called bracts.

Depending on the degree of branching, inflorescences are divided into simple and compound (complex). In **simple inflorescences**, the lateral axes are not branched and are pedicels. In the **compound inflorescence**, the lateral axes bear partial inflorescences.

Inflorescences may be both **open** (the apical axis does not end in a flower) and **closed** (the apical axis ends in a flower).

Inflorescences usually have modified foliage different from the vegetative part of the plant. Considering the broadest meaning of the term, any leaf associated with an inflorescence is called a bract. A bract is usually located at the node where the main stem of the inflorescence forms, joined to the rachis of the plant, but other bracts can exist within the inflorescence itself. They serve a variety of functions which include attracting pollinators and protecting young flowers. According to the presence or absence of bracts and their characteristics we can distinguish:

Ebracteates inflorescences: No bracts in the inflorescence.

Bracteates inflorescences: The bracts in the inflorescence are very specialized, sometimes reduced to small scales, divided or dissected.

Leafy inflorescences: Though often reduced in size, the bracts are unspecialized and look like the typical leaves of the plant, so that the term flowering stem is usually applied instead of inflorescence. This use is not technically correct, as, de-spite their 'normal' appearance, these leaves are considered, in fact, bracts, so that 'leafy inflorescence' is preferable.

Leafy-bracted inflorescences: Intermediate between bracteates and leafy inflorescence.

If many bracts are present and they are strictly connected to the stem, like in the family Asteraceae, the bracts might collectively be called an involucre. If the inflorescence has a second unit of bracts further up the stem, they might be called an involucel.

If the inflorescence ends with a flower, it is called determined. If the inflorescence ends with the bud is called indetermined. The growth of the main axis of the indetermined inflorescence is unlimited. The growth of the main axis of the determined one is finite.

Plant organs can grow according to two different schemes, namely monopodial or racemose and sympodial or cymose. In inflorescences these two different growth patterns are called indeterminate and determinate respectively, and indicate whether a terminal flower is formed and where flowering starts within the inflorescence.

Depending on the type of branching of inflorescence axes, inflorescences are subdivided into botryoid or monopodial and cymoid or sympodial.

Botryoid (racemose) inflorescences are characterized by monopodial branching, in which the main axis, while continuing to grow, forms new flowers or lateral branches as it grows.

For **cymose inflorescences**, sympodial branching is characteristic at least for the terminal axes, in which the axis of the partial inflorescence forms a flower and stops its growth; below this axis, one, two or several axes of the second order, also stopping their growth with the formation of an apical flower, are formed.

Simple botryoidal (racemose) inflorescences (Fig. 14).

Raceme - all flowers sit on pedicels, which are attached to the main axis of the inflorescence in turn.

Spike - the sessile flowers are arranged alternately on the main axis.

Catkin differs from racemes and spike in the descending axis of the inflorescence, because the mechanical tissues in the axis of the inflorescence are poorly developed.

Spadix differs from the spike in having a sprawling thickened rachis of the inflorescence. The spadix is often surrounded by an inflorescent leaf called a spata.

Corymb is similar to the raceme, but in the corymb the lower pedicels are longer than the upper ones, so the flowers are at the same level, in one plane.

Umbel has all pedicels with bracteoles emerge from the apical point of the shortened axis of the inflorescence.

Head is a modified umbel with reduces of pedicels (or spike with reduces rachis) that has expanded the main axis in the form of a head, and on it are flowers on shortened pedicels or sessile.

Capitulum is the main axis of the inflorescence sprawling in the form of a bowl or bed, on which sessile flowers are arranged, surrounded on all sides (often in two rows) by modified bracts - an involucre and involucel.

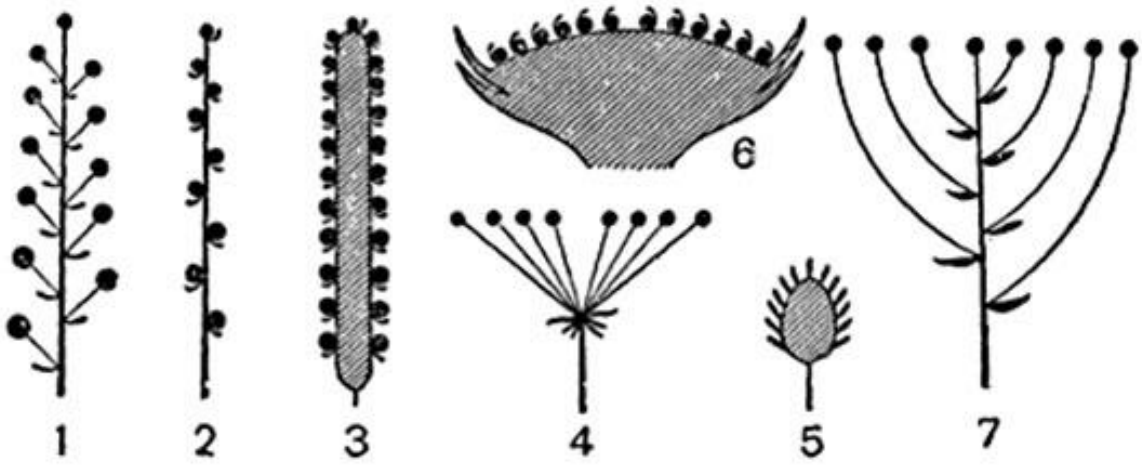

Fig. 14. Simple botryoid (racemose) inflorescences (Kursanov L.I. et al., 1966): 1 - raceme; 2 - spike; 3 - spadix; 4 - umbel; 5 - head; 6 - capitulum; 7 – corymb.

Complex botryoidal (racemose) inflorescences (Fig. 15).

The panicle (or compound raceme) - main axis branches, i.e. forms lateral shoots of the first or second order, on which flowers on pedicels are located (Sisymbrium volgense).

The complex spike - on the main axis, side shoots with flowers sitting on them, i.e. simple spikelets (rye), emerge from each node instead of flowers.

The compound umbel - simple umbels (carrots) emerge at the top of the main axis instead of flowers.

The compound corymb has shortened internodes of the rachis and strongly developed internodes of the lateral axes, with lateral flowers reaching the level of the apical flower.

The Antella is a modified compound corymb in which the marginal flowers in the inflorescence are higher than the median, resulting in a cup-shaped inflorescence.

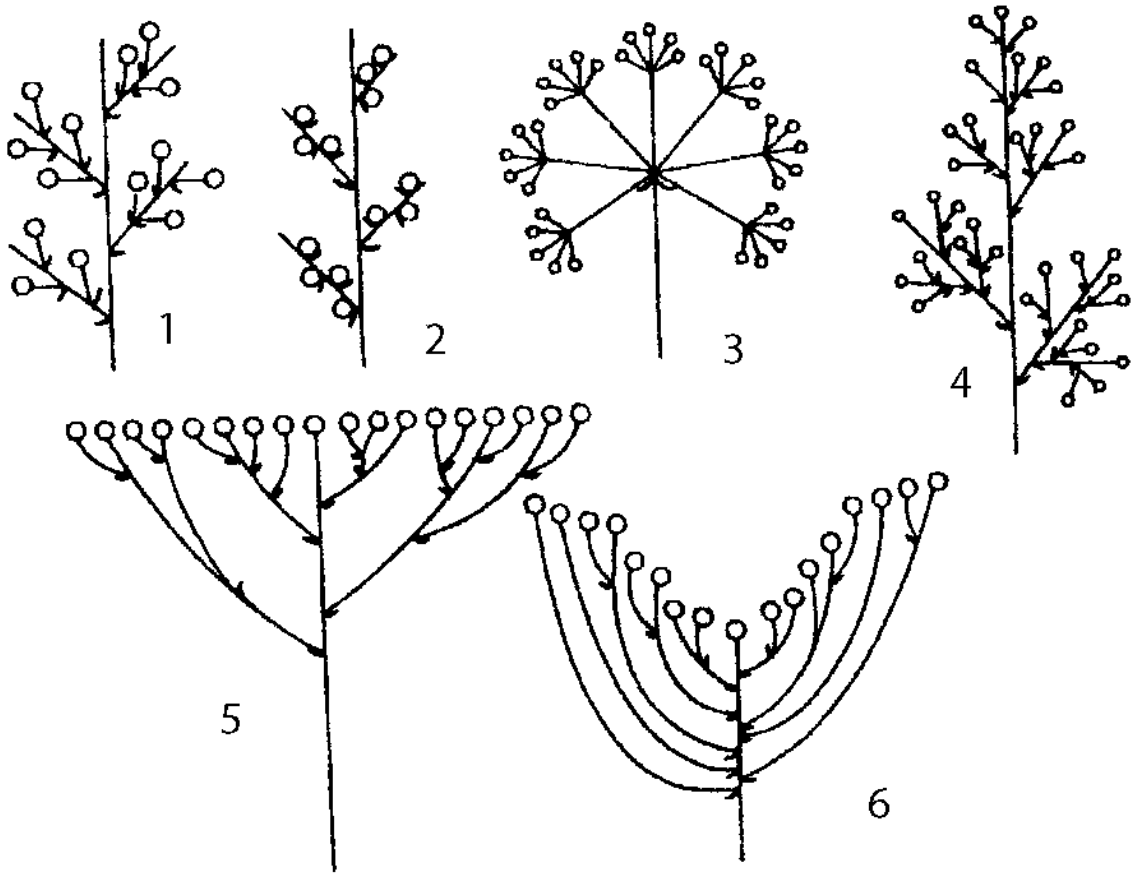

Fig. 15. Compound botryoidal (raceme) inflorescences (original). 1 - double raceme (compound), 2 - double (compound) spike, 3 - double (compound) umbel, 4 - panicle, 5 - compound corymb, 6 - antella.

There are a number of types of inflorescences in which the peculiarities of branching of the main axis differ from the peculiarities of branching of partial inflorescences. They are sometimes called aggregate inflorescences. For example, a panicle of umbels is a panicle-branching inflorescence bearing simple umbels on

its terminal axes (*Aralia elata* and *Aralia mandshurica*). The panicle of capitulums is a panicle branched inflorescence, bearing partial inflorescences - capitulums - on the terminal axes. There is also a raceme of capitulums (*Bidens cernua*) and a spike of capitulums (*Gnaphalium sylvaticum*). Other types of aggregate inflorescences are also possible (Fig. 16).

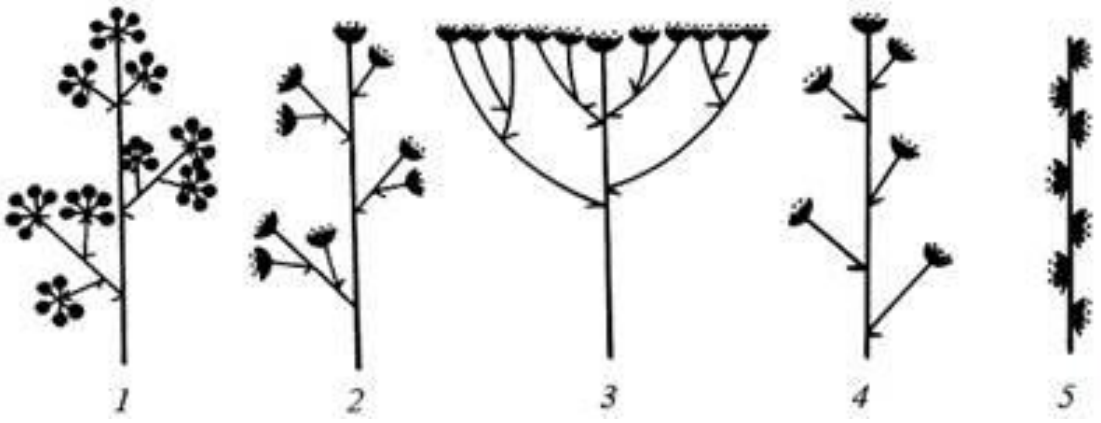

Fig. 16. Aggregate inflorescences (Yakovlev and Chelombitko, 1990): 1 - panicle of umbels, 2 - panicle of capitulums, 3 – corymb of capitulums, 4 - raceme of capitulums, 5 - spike of capitulums.

Cymose (sympodial) inflorescences (Fig. 17).

Depending on the number of developing lateral axes, three types of symphodial inflorescences are distinguished: monochasial, dichasial, and pleiochasial. Monochasial ones have one lateral axis replacing the main axis, dichasial ones have two, and pleochasial ones have several.

Monohasia.

Scorpioid cyme (or rhipidium) - from the main axis comes an axis of the second order, from the second third order, etc., from one side or the other (Buttercup causticum). It a zig-zag determinate cyme with branches developing alternately on opposite sides of the rachis, due to abortion of opposing paired bud.

Helicoid cyme (or bostryx) - a determinate cyme in which the branches develop only on 1 side, due to the abortion of opposing paired bud, the inflorescence thus appearing simple.

Drepanium - axis of the second order departs from the main axis, from the second third order, etc., but at the same time axes depart only in one direction, as if twisting into a cochlea, or a whorl (forget-me-not).

Cincinnus - It - a tight, modified helicoid cyme in which the pedicels are very short (Strelizia).

Verticil – flowers arranged in whorls at the nodes.

Dichasia.

Simple cyme or dichasium - a determinate inflorescence with 2 dichotomous lateral branches- beneath the flower of the main axis, suprotectively arranged branches (axes) are formed, ending with a flower. Subsequently, each of these axes also forms two subrotated axes (carnation).

Compound dichasium - a branched dichasium with pedicels of the same length.

Double helicoid cyme (**double drepanium, double cincinnus**) - below the flower of the main axis, two simple helicoid cyme are formed supropositely.

Pleiochasia several lateral axes (with flowers or inflorescences) that outgrow the main axis and are arranged in whorls develop below the flower that ends the main axis.

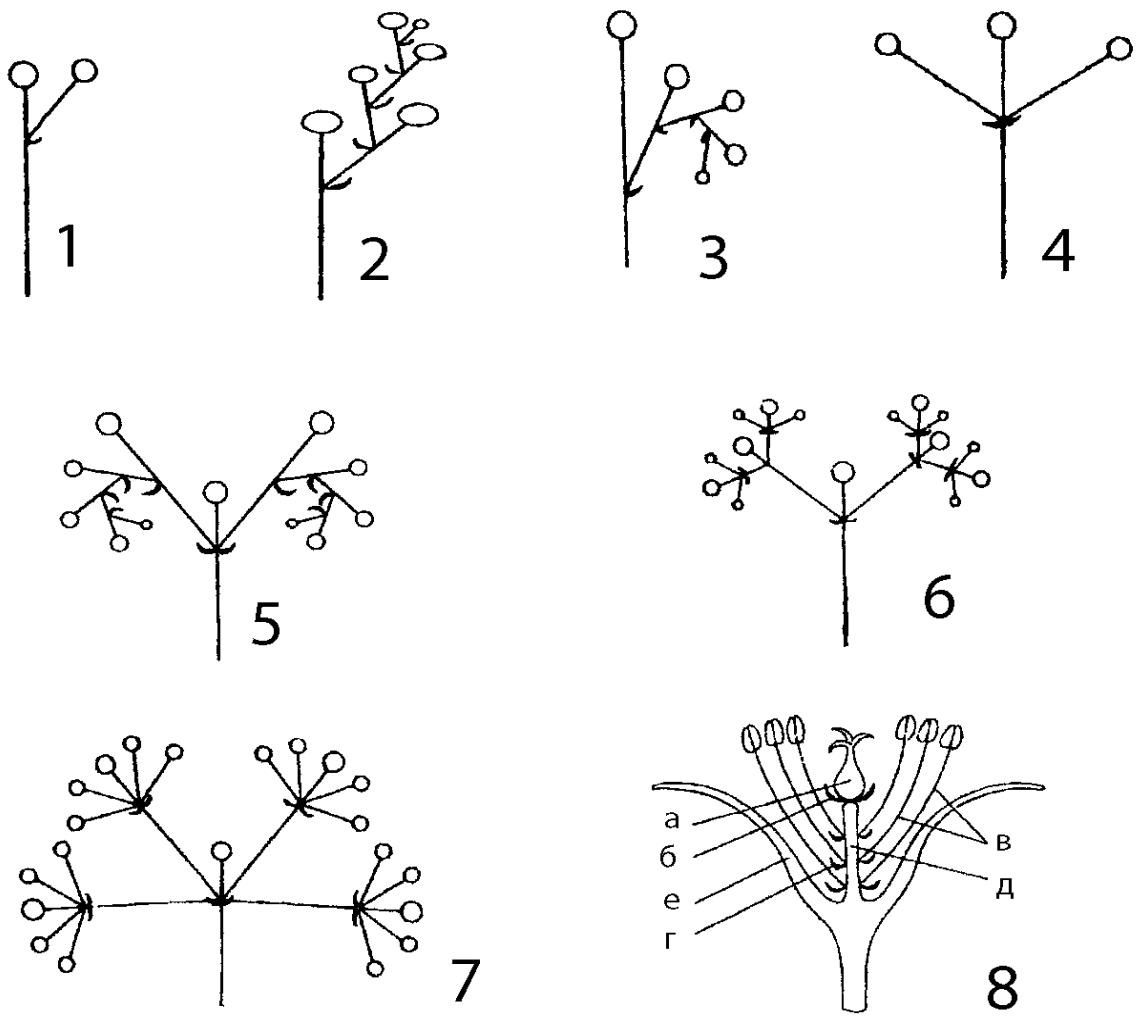

Fig. 17. Cymoid inflorescences (original). 1 – simple cyma, 2 – scorpioid cyme, 3 – drepanium, 4 – simple cyme or dichasium, 5 – double drepanium, 6 – compound dichasium, 7 – pleiochasia, 8 – cyathium: (а) ovary of a female flower with a reduced perianth, (б) modified bracts of female flowers, (в) male flowers, each of which is reduced to one stamen, (г) modified bracts of male flowers, (д) inflorescence axis, (е) involucre consisting of modified inflorescence leaves).

The thyrse are called a compact branching inflorescence, as of the lilac, in which the main axis is indeterminate and the lateral axes are determinate. They as though combine in themselves signs of botryoid and cymoid inflorescences. The main axis of thyrses grows monopodially. But lateral axes of thyrses are always

different cymoids.the degree of branching of lateral axes decreases from bottom to top; therefore, thyrses often have a pyramidal shape. Thyrses can be closed (the main axis ends with a flower) and open (the main axis does not end with a flower). According to the degree of branching of lateral axes, there are: pleiotyrses, dithyrses, and monotyrses (Fig. 18).

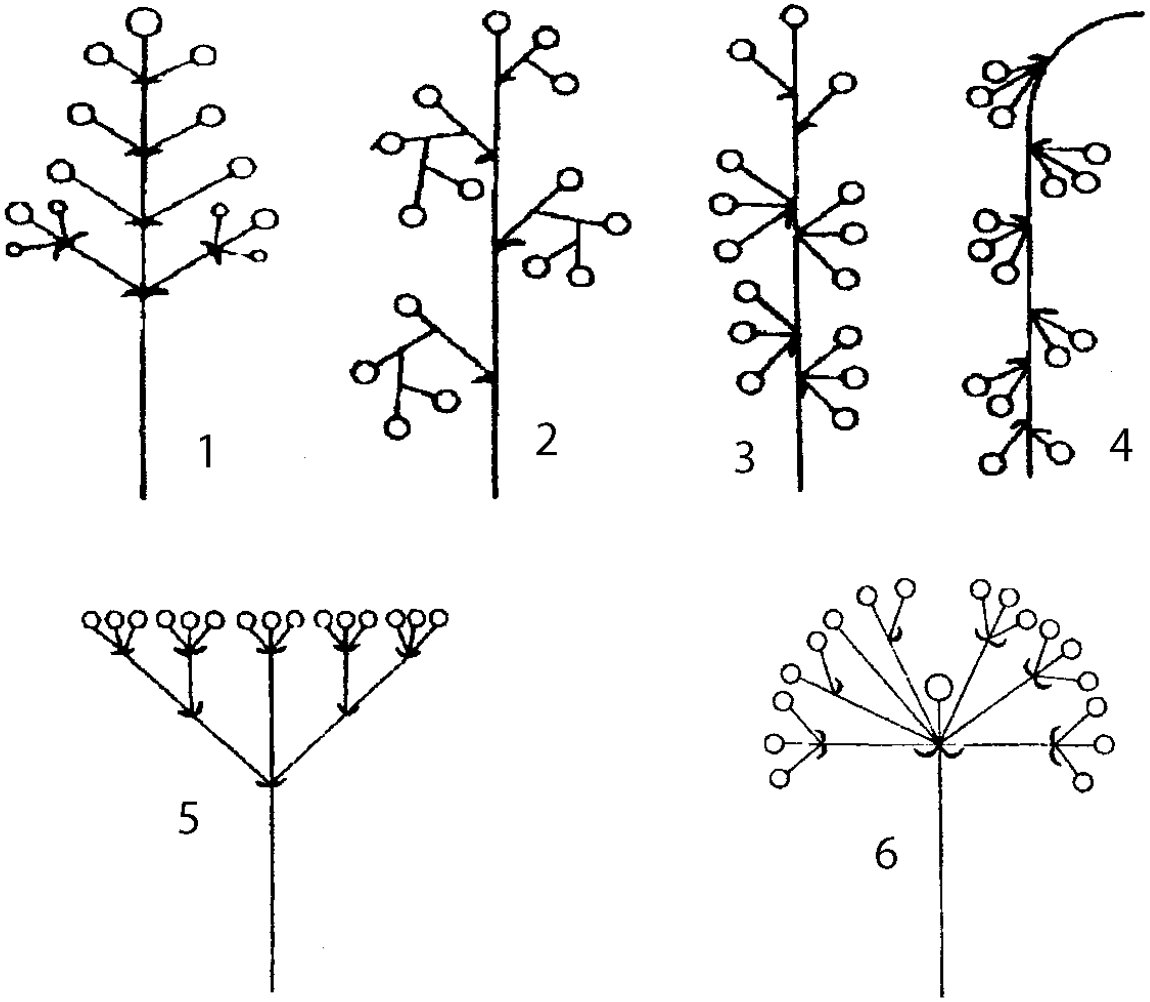

Fig. 18. Thyrses (original): 1 – monothyrse, 2 – raceme-shaped thyrse, 3 – verticillaster, 4 – catkin-shaped thyrse, 5 – corymb-shaped thyrse, 6 – umbel-shaped thyrse.

The fruit is an organ of the angiosperms that contains seeds and develops from a single flower. The function of the fruit is to form, protect, and propagate seeds. Fruits are found only in angiosperms plants. They develop after pollination and fertilization from the ovaries of pistils. The pericarp develops from the walls of

the ovary and the seeds develop from the ovules.

In some fruits the sepals, petals, stamens and/or the style of the flower fall away as the fleshy fruit ripens. However, for some fruits derived from an inferior ovary — i.e., one that lies below the attachment of other floral parts, — there are parts (including petals, sepals, and stamens) that fuse with the ovary and ripen with it. For such a case, when floral parts other than the ovary form a significant part of the fruit that develops, it is called an accessory fruit. Examples of accessory fruits include apple, rose hip, strawberry, pineapple.

The pericarp is usually distinguished in three layers: epicarp (exocarp) (outer layer), mesocarp (middle layer) and endocarp (inner layer). The pericarp usually constitutes the main mass of the fruit. Various protrusions are often formed on the pericarp surface: bristles, papules, hooks, wings. These outgrowths promote seed dispersal.

Fruits are extremely diverse in size, shape, pericarp structure, color, methods of dechiscenese, presence of outgrowths and appendages.

The principles of fruit classification are different: according to

- the number of seeds in the fruit (single-seeded and multi-seeded),
- pericarp consistency (dry and fleshy),
- dehiscent, indehiscent and lomentaceous (constricted between each seed and falling apart from the constrictions into single seeded units etc.

The modern classification of fruits is based on the structure of the gynoecium of the flower, so four types of fruits are distinguished:

1. Monocarpic.
2. apocarpic or apocarpia.
3. Syncarpic or syncarpia.
4. Pseudomonocarpic or pseudomonocarpia.

Monocarpic fruits are formed by a single peduncle (fig. 19).

The follicle is a multi-seeded fruit that dehiscence along the abdominal suture. The follicles can be dry (larkspur (*Consolida regalis*)) and juicy (*Actaea simplex*).

The legume is a multiseeded fruit, opened with two stitches (characteristic of the legume family) (bean, pea, peanut: botanically, the peanut is the seed of a leg-ume, not a nut). The legumes may be dry (beans (*Phaseolus*)) and juicy (*Sophora*), open (peas (*Pisum*)) and fractional (peanuts (*Arachis hypogaea*)).

The drupe is a juicy or dry one-seeded unopened fruit with a woody endocarp (juicy drupe in apricots (*Armeniaca vulgaris*), cherries (*Cerasus fruticosa*), plums (*Prunus domestica*), peaches (*Persica vulgaris*), dry in almonds (*Amygdalus communis (=Prunus dulcis)*)). Fibrous drupe – (coconut (*Cócos nucífera*), walnut (*Juglans regia*): botanically, neither is a true nut.)

The achene a one-seeded unopened fruit (up to 5 mm in diameter) with a woody pericarp (*Alchemilla vulgaris*).

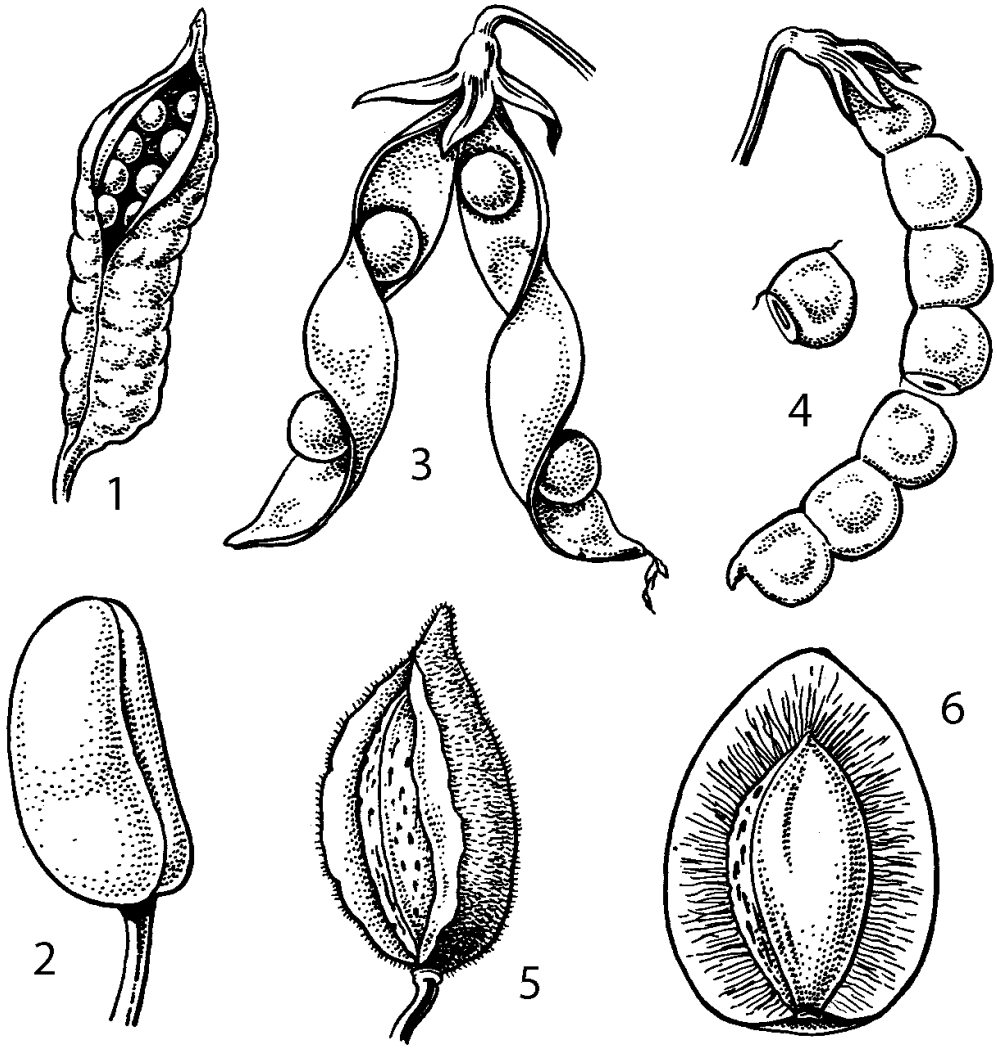

Fig. 19. Monocarpic fruits (Yakovlev G.P., Averyanov L.V., 1996). 1 - The dry follicle of *Consolida*, 2 - The fleshy follicle of *Actaea* , 3 - The legume of *Vicea*, 4 – the dry drupe of *Amygdalus*, 5 – the legume of *Hedysarum* , 6 – the fleshy drupe of *Prunus*

Apocarpic fruits are formed by two or many non-fused pistils (fig. 20). Apocarpic fruits called also an aggregate fruit is also called an aggregation, or etaerio. It de-velops from a single flower that presents numerous simple pistils. Each pistil con-tains one carpel; together they form a fruitlet. The ultimate (fruiting) development of the aggregation of pistils is called an aggregate fruit, etaerio fruit, or simply an etaerio.

An etaerio of achenes - 2 - many achenes from two - many pistils are formed on the receptacle of one flower (the *Ranunculaceae* species, including *Clematis* and *Ranunculus*).

Utricle is ат etaerio of achenes on a succulent sprawling flower head (strawberry (*Fragaria vesca*)).

Cynarrhodium is an etaerio of achene inside a jug-shaped, sprawling succulent receptacle (rose hips (*Rosa* species)).

An etaerio follicles - two or many follicles are formed on the receptacle of one flower. An aggregate follicle may be dry (peony (*Paeonia anomala*), magnolia (*Magnolia obovata*)) and fleshy (*Schisandra chinensis*).

An etaerio of drupelets - many drupelets are formed on a convex receptacle (raspberries (*Rubus idaeus*), blackberries (*Rubus caesius*))

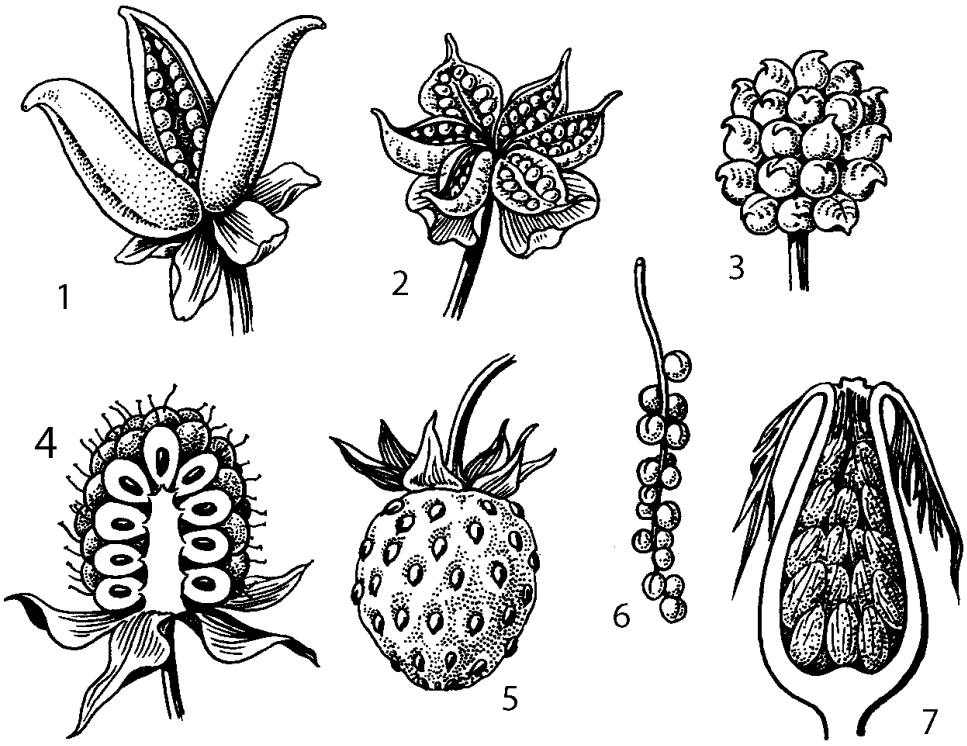

Fig. 20. Apocarpic fruits (Yakovlev G.P., Averianov L.V., 1996). 1 – A dry etaerio follicles of Paeonia , 2 - A dry etaerio follicles of *Caltha*, 3 - An etaerio of achenes of *Anemone* and *Ranunculus*, 4 - An etaerio of drupelets of *Rubus*, 5 - Utricle of *Fragaria*, 6 - A flashy etaerio follicles of *Schisandra*, 7 - cynarrhodium of *Rosa*.

Syncarpic fruits are formed by two to many fused carpels (fig. 21).

The berry is a fleshy multiseeded fruit, not opened, having no cavity inside (currants (*Ribes nigrum*), gooseberries (*Ribes uva-crispa*), potatoes (*Solanum tuberosum*), nightshade (*Solanum nigrum*)).

The pepo is a large multi-seeded fruit with a hard thick rind (exocarpium), formed from the lower ovary, which consists of three peduncles (watermelon (*Citrullus lanatus*), melon (*Cucumis melo*), pumpkin (*Cucurbita pepo*), cucumber (*Cucumis sativus)*). The watermelon is a good example of a pepo, a berry with a hard, thick rind. This is a triploid, seedless "yellow watermelon" (*Citrullus lanatus var. lanatus*). Although it is sold as "seedless," there are some seeds in the fleshy interior.

A pome (apple) is an accessory fruit; in addition to the ovary, the lower parts of stamens, petals, sepals, and pedicel take part in its formation. The seed-bearing ovary is sur-rounded by a thick, fleshy hypanthium that is not part of the pericarp. It de-rived from the fusion of the bases of the perianth segments (petals and sepals). Some references state that the hypanthium may also contain tissue from the recep-tacle. In the pome, the thickened, fleshy hypanthium is fused with the ovary wall or core. The outer skin of an apple is the multiseriate epidermis of the hypanthium surrounded by a waxy cuticle. The seeds are sur-rounded by cartilaginous endocarp tissue. Inside the endocarp containing from one to five pyrenes that resemble the "stones" of plums, peaches, etc., which are drupaceous fruit in the same subfamily. When you eat an apple, you are primarily biting into the hypanthium tissue. You may also consume some of the outer ovary (exocarp and mesocarp) that is fused with the thick hypanthium. Since the fruit contains tissue not derived from the pericarp, it is called an accesso-ry fruit. This is the typical fruit of certain members of the rose family (*Rosaceae*), including apple (*Malus domestica*), pear (*Pyrus communis***),** quince (*Cydonia oblonga*) and hawthorn (*Crataegus* spesies).

Pomegranate (*Punica granatum*), showing persistent calyx at the top of fruit. The calyx is cut away on right fruit to show the numerous stamens. The fruit

is technically a leathery-skinned berry containing many seeds, each surrounded by a juicy, fleshy aril.

The Silique (pod). A silique has 2 narrow pieces (valves) separated by a partition (replum). The length of the fruit is greater than the width (*Sinapis arvensis, Raphanus sativus, Sisymbrium species*). A rounded form is called a silicle (*Capsela bursa pastoris, Rorippa brachycarpa*). These are fruits of the mustard family (*Brassicaceae*).

The Capsule - dry multiseeded fruit, formed by two or c-numerous fused carpels. Capsules are classified by the mode of opening (dehiscence). The septicidal capsule opens in the plane of carpel union. A loculicidal capsule opens around a horizontal line. A poricidal capsule releases seeds through pores at the top.

The Schizocarp. Carpels of a compound ovary break apart into mericarps, which function as achenes in the schizocarp type fruit (fruit of Celery (*Apium graveolens*)). Schizocarp disintegrates into several mericarps (fruit of *Malvaceae*). The indehiscent schizocarp of musk mallow *Malva moschata* will later split into segments called mericarps.

The Coenobium - schizocarp that usually splits into four segments that resemble seeds disintegrates into four nutlets - erems, the calyx is preserved in the fruit (fruit of the *Cynoglossum*).

The Hesperidium is the fruit of citrus (orange, lemon), exocarpium is colored, with essential oil reservoirs, mesocarpium is dry, spongy, white, fleshy endocarpium. The lemon (*Citrus lemon*) is a hesperidium, a berry with a leathery rind. The exocarp (peel) contains volatile oil glands (essential oils) in pits. The fleshy in-terior (endocarp) is composed of separate sections (carpels) filled with fluid-filled sacs (vesicles) that are actually specialized hair cells.

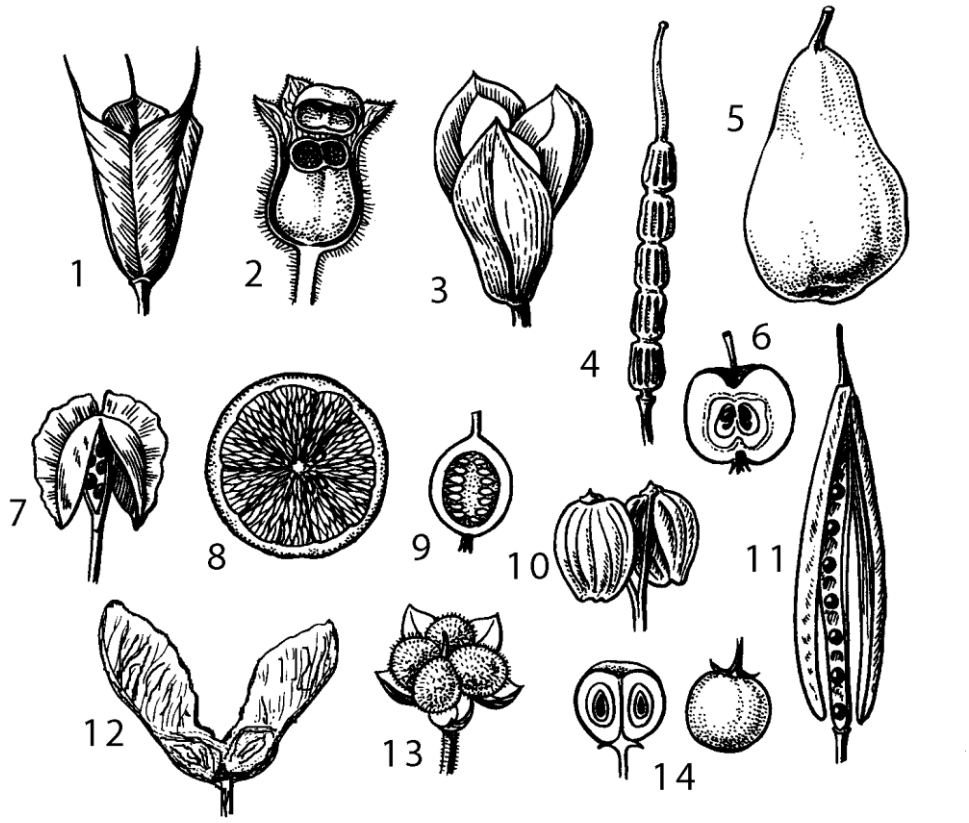

Fig. 21. Syncarpic fruits (Yakovlev G.P., Averianov L.V., 1996): 1. An etaerio follicles of *Aquilegia* ; 2 - loculicidal capsule of *Hyoscyamus* ; 3 - The septicidal capsule of *Tulipa*; 4 - lomentaceous silique (pod) of *Raphanus* ; 5 – pome of *Pyrus*; 6 - silicle ; 7 - Hesperidium of *Citrus* ; 8 – berry of *Ribes*, 9 – Schizocarp of *Apiaceae*; 10 – Coenobium of *Cynoglossum*, 11 – berry of *Arctostaphylos*; 12 - silique (pod) of *Brassicaceae*.

Pseudomonocarpic fruits are unopened single-seeded cenocarpic fruits (fig. 22).

A nut is a fruit with a single layer woody pericarp (hazelnut). Sometimes wing-shaped outgrowths are formed on its pericarp, then we speak about the winged nut (birch (*Betula pendula*)).

Acorn is a nut with a cup-shaped cupula (characteristic of the family *Fagaceae* for example *Querqus robur*).

Cypsela is a semi-woody or leathery pericarp (typical of the Nettle (*Urtica dioica*) and *Asteraceae* family for example *Helianthus annuus*).

The grain (caryopsis) is a leathery pericarp, fused with the seed skin (the fruit of the Cereal).

The samara is single-seeded fruit with large outgrowths (wings) by which such fruits are propagated by the wind for example elm (*Ulmus laevis*) and maple (*Acer platanoides*).

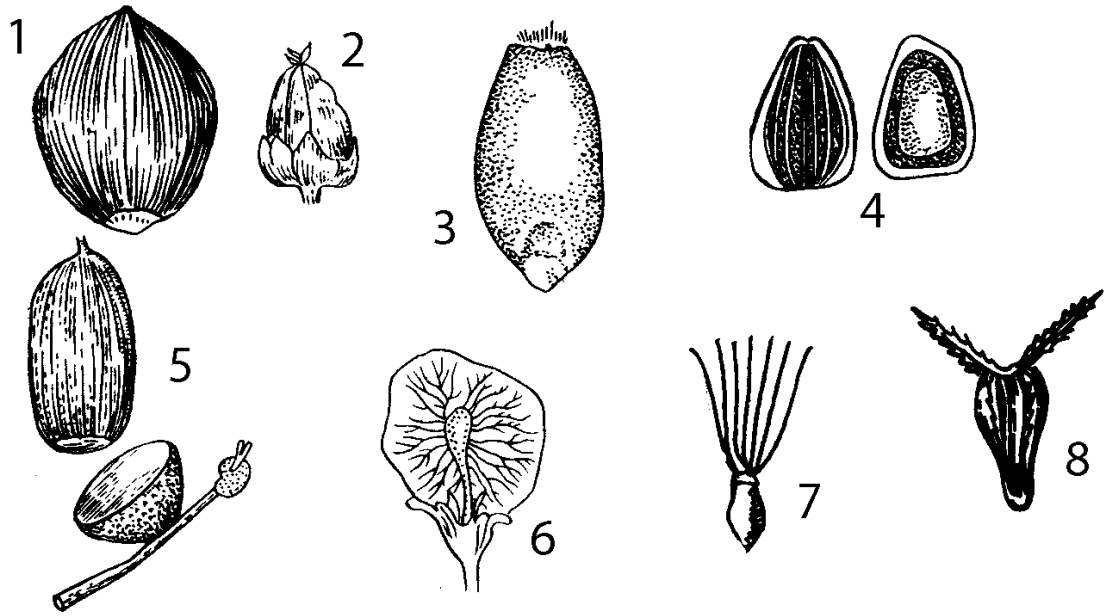

Fig. 22. Pseudomonocarpic fruits (Original). 1 – 2 – nut, 3 – grain, 4, 7, 8 – cypsela (achenes), 5 – acorn, 6 – samara.

5. BASICS OF PLANT ECOLOGY AND BIOGEOCENOLOGY.

Flora is a historically developed set of plant species growing on a certain territory.

Vegetation, or vegetation cover, is the totality of plant communities (phytocenoses) within a certain territory.

Flora and vegetation are historically related to each other, as the floristic composition determines the composition of phytocenoses that make up the vegetation.

Phytocenosis (plant community) is a set of plants on a homogeneous territory, characterized by a certain composition, composition and relations between plants and environment. The boundaries of communities are not clear, and one

gradually passes into another. The composition and structure of plant community depend on the complex of abiotic and biotic environmental conditions and the properties of the plants composing the plant community.

Plant community is a complex, dynamic, constantly evolving system that is sensitive to the slightest changes in environmental conditions. In phytocenosis, its seasonal and year-to-year variability is observed. The struggle for existence (competition for light, water, food, space) has a formative influence on the plant community. Plants themselves also take part in the formation of environment. For example, in the forest, trees intercept most of the light and create conditions of incomplete and spectrally filtered light under the forest canopy for grasses. There are direct influences of plants on each other (parasitism, semi-parasitism, allelopathy). Herbivorous animals, insects, pathogens, etc. can be regulators of relations in plant communities. Each plant species has its own distribution range for each environmental factor. But usually it does not occupy all the habitats in which it can grow, but those where it is most competitive.

Like any phenomenon in nature, plant communities emerge, develop and are replaced by similar young or other phytocenoses. Flora is more conservative and changes more slowly than vegetation consisting of phytocenoses, since the same species can take part in the formation of different phytocenoses.

In the process of evolution plants have developed various adaptations to the conditions of existence. A complex of conditions, consisting of different elements - environmental factors - acts on plants in nature. Influence of ecological factors affects all processes of vital functions of organisms, their dispersal and ability to enter into biogeocenoses. At the same time, the role of plants in environmental formation is very diverse and important. For example, a forest always has a special regime of moisture, light and temperature.

In relation to light, there are light-loving, shade-loving and shade-tolerant plants.

Light-loving plants are those that can normally develop only in conditions of high light. These are most steppe, grassland and desert plants. Among forest plants, only the uppermost level belongs to them. Their root system is usually strongly branched, leaf blades are often small, hard, thick, sometimes fleshy. Leaf mesophyll cells are well differentiated into palisade and spongy parenchyma, the palisade one is strongly developed, can be multilayered, almost without intercells. Leaf surface has many small stomata, often in fossae or covered with hairs. The network of veins is dense. Leaves are arranged at an angle or with an edge to the rays of light. Internodes are short. The osmotic pressure of the cell sap is very high.

Shade-loving plants thrive in low light, in strong light they can not live. They grow in the lowest levels of broad-leaved forests. Their root system is less developed than that of the light-loving plants; internodes are more elongated; leaf blades are larger, broader, thinner, soft; epidermis is monolayer, large-celled, cuticle is often missing. Cells of leaf pulp are poorly differentiated into palisade and spongy parenchyma. The network of veins is comparatively sparse. Leaves are arranged perpendicular to the incident light, forming a leaf mosaic for better light trapping. Osmotic pressure of cell sap is relatively small.

Shade-tolerant plants are the most widely represented in our forest communities. Basically all of them are light-loving, but they may thrive both under very high and very low light. In well-lit habitats, they exhibit photophilous properties, while in poorly-lit habitats they are shade-loving. Therefore, specimens of the same species grown under different conditions may differ greatly from each other.

The following groups of plants are distinguished in relation to moisture:

Hydrophytes are plants that grow fully or partially submerged in water. Hydrophytes develop relatively large surface area; the increase of leaf surface area is especially noticeable. Their organs are often covered with mucus. Mechanical tissues are poorly developed. All organs have strongly developed intercellular air-bearing cavities, often aerenchyma, epidermis and cuticle are very poorly devel-

oped. Stomata are absent on the side of leaves submerged in water. Root system is poorly developed. Vegetative reproduction is widespread.

Hygrophytes are plants adapted to living in an environment where air is saturated with water vapor, and soil contains much dripping-liquid water (for example, in flooded meadows, swamps, along the banks of rivers and lakes). They usually have thick, weakly branched roots, often have aerenchyma, and the stomata are located on both sides of the leaves and are usually open. Transpiration is poorly regulated. Leaves of many plants are broad, large, soft, with well-developed chlorenchyma.

Mesophytes are plants of moderately humid habitats. Most forest grasses and almost all deciduous trees belong to this group. All plants of this ecological group have well-developed root system. Leaves vary in size, but more often are large, flat, soft, not thick, with moderately developed tissues: covering, supporting, palisade and spongy mesophyll. Leaves of the majority are glabrous, pubescence is present, but moderate. Stomata are located on the underside of leaves.

Xerophytes are plants which have adapted to life in arid habitats. They are the plants of steppes and deserts. They are divided into two groups: **sclerophytes** and **succulents**.

Succulents are plants with succulent, fleshy stems or leaves that store water. Their stems and leaves are usually bare, covered with a cutinized layer. Osmotic pressure of their cell sap is very high. Stamens are located in holes and are almost always closed. Supply of carbon dioxide and oxygen is limited, so growth is very slow. For example: cacti (*Cactaceae* family species), aloe (*Aloe arborescens*), *Stapelia* species, *Sedum* species.

Sclerophytes in appearance are the complete opposite of succulents. They are hard, tough, do not lose their turgor, even with a very large loss of water. They have much mechanical tissue, well-developed cover tissues. Sclerophyte cytoplasm has the property of binding water into colloids. Osmotic pressure of cytoplasm is very high. Root systems often extend to great depths (up to the aquifer). Sclerophytes are usually stunted, above-ground parts of the shorter than underground.

Leaves are shallow, often dissected, rigid or leathery, often with strong pubescence, and may curl up into a tube. They may drop leaves and individual shoots in case of drought. For example: white wormwood (*Atremisia lercheana*), camel's-thorn (*Alhagi pseudalhagi*), fescue (*Festuca* spp.) and feather grass (*Stipa* spp.).

In addition, there are groups of plants that are adapted to survive the unfavorable conditions of drought and low light in a dormant state. Their whole cycle of development proceeds very quickly, in a short favorable period of the year. These are ephemer and ephemeroids.

Ephemeres survive most of the year as seeds. Their seed production is very high. Seeds of ephemeres can remain in the soil for several years without germinating or losing their germination. This allows them to maintain the population number even in years when the conditions are so unfavorable that ephemeres either do not germinate, or do not have time to fructify. Ephemeres are found mainly in steppes and deserts. For example: *Erophylla verna*, *Alyssum desertorum*, *Holosteum umbellatum*.

Ephemeroids are perennial plants, which spend most of the year in the form of rhizomes, tubers and bulbs, and in a short favorable period vegetate, bloom and bear fruit. They are often found in steppes and deserts as well as in forests. In arid conditions, it allows the plants to survive a period with insufficient moisture. For example: Tulipa gessneriana, Bulbocodium versicolor, Colchicum laetum, etc. In forest communities they blossom and vegetate before the leaves open, when there is plenty of light in the forest; ephemeroids can actively photosynthesize and accumulate storage matter; their flowers are more noticeable for insect pollinators. Most of them are very light-loving. For example: *Scilla siberica* and *Corydalis solida*.

Sometimes one may also distinguish a group of **hemiphemeroids** - plants that also start blooming very early, but after flowering their above-ground part does not die off, but continues to vegetate during the summer, sometimes until late fall. They are plants of broad-leaved forests. For example: *Glechoma hederacea*, *Viola suavis*, etc. Their early flowering allows them to attract the attention of a

greater number of insect pollinators, and for vegetation they need rather weak and scattered light, typical for this habitat.

In relation to the acidity of the soil, plants are divided into acidophiles, acidophobes and neutrophils. **Acidophiles** are species that prefer acidic soil reaction. Most marsh plants belong to them for example *Calluna vulgaris, Ledum palustre, Oxyccus quadripetalus*. **Acidophobes** are plants which prefer alkaline reaction, for example *Medicago falcata*. **Neutrophiles** prefer soils with neutral acidity. These include many vegetable crops, such as tomatoes (*Lycopersicum esculentum*) and potatoes (*Solanum tuberosum*). **Basophytic plants** - These are plants that grow in alkaline soils with a pH greater than 7.0. Examples are: chestnut (*Castanea sativa*), mustard (*Brassica juncea*), wormwood (*Artemisia lercheana*).

Plants which can exist only in habitats rich in nitrogen, easily assimilated by higher plants, are called **nitrophiles**. They include nettles (*Urtica dioica*) and raspberries (*Rubus idaeus*).

Easily soluble chlorides and sulfates are toxic to most plants, but some species are resistant to them and tolerate significant salinization. Such plants are called halophytes.

Two groups of plants can be distinguished regarding carbonates: **calcephytes** and **calcephobes**. The first grow on carbonate-saturated soils and chalk outcrops (*Hedysarum cretaceum, Thymus calcareus*), the second group cannot tolerate high carbonate content in soils (*Calluna vulgaris, Ledum palustre, Oxyccus quadripetalus*).

Lithophytes (Petrophytes) are plants of rocky surfaces. Among them, we can distinguish lithophytes proper, which are algae and lichens that take part in creation and formation of soil. Higher plants (ferns, flowering plants, etc.) settle on already formed elementary soils. Due to specificity of habitat, such lithophytes are characterized by dwarfism, cushion-like or shrub-like form of growth.

Chasmophytes are the higher plants of rubbly soils. They are characterized by a deep root system and contractile (contractile) roots, which contribute to their burial and retention of plants on loose soils (*Querqus petraea*, etc.).

Pelitophytes are plants of clay soils. Roots of such plants are characterized by osmosis, which promotes advancement in dense soils. Root systems are strong, buried, with well-developed mechanical tissues. White wormwood (*Artemisia lerchiana*, *A. pauciflora*) and others are pelitophytes.

Psammophytes have developed on light sandy soils, where plants need to adapt to wind blowing and getting covered with sand. These are *Helichrysum arenarium, Thymus pallasianus* etc.

An essential point in plant life is the peculiarities of the protection of buds of renewal during overwintering. An important factor of protection, besides bud scales, is the position of the buds relative to the soil level. On this basis, in 1929 C. Raunkiaer proposed a classification of ecologically determined life forms (ecomorphs):

1. **Phanerophytes** - plants in which the buds of renewal are located high above the ground and are not protected from the possible action of frost except for the bud scales. These are trees and shrubs.

2. **Hamephytes** - plants having buds of regeneration not higher than 20-30 cm above the ground, which are usually protected by a layer of snow in winter. These are evergreen and summer-green shrubs.

3. **Hemicryptophytes,** i.e. shoots of renewal are located on the very surface of the ground. Their above-ground shoots completely or almost completely die off during wintering. These are many perennial grasses, semi-shrubs and dwarf semi-shrubs.

4. **Cryptophytes** - the buds of renewal are in the soil (at a certain depth) or in water. These are tuberous, bulbous and rhizomatous plants. They are often ephemeroids and hemiphemeroids.

5. **Therophytes** are annual plants that die off completely in an unfavorable season and survive it as seeds.

In addition to ecological groups, there are biological groups based on life span:

1. **Annuals** - plants whose entire ontogeny takes place during a single growing season (*Hamomilla, Calendula*, etc.).

Winter annuals are plants which sprout from seeds in autumn, form a root rosette of leaves and hibernate in this form. In the spring, they quickly develop, flower and bear fruit, and then die off. These are *Capsella bursa pastoris*, winter wheat, etc. Many annual plants can behave as winter crops.

3. ***Biennials*** are plants that actively vegetate in the first year and accumulate nutrients in their underground organs. In the second year, they flower and bear fruit, using nutrients from their storing underground organs, and then die off. These are carrots (*Daucus carota*), parsley (*Petroselinum crispum*), beets (*Beta vulgaris*), burdock (*Arctium lappa*), digitalis (*Digitalis purpurea*), etc .

4. ***Perennials*** are plants that grow for many years, actively propagate vegetatively, and flower and bear fruit repeatedly during their lives: most wormwoods (*Artemisia* spp.), peonies (*Paeonia* spp.), ephemeroids, most trees, etc.

5. ***Perennial monocarpics*** - plants that grow for many years, actively propagate vegetatively, but flower and bear fruit only once in a lifetime, after which they die off. This includes bamboo and many palms. Biennials may behave similarly if, for some reason, they do not flower and bear fruit in the second year of life.

Using and summarizing the classifications proposed at different times, the Russian botanist I.G. Serebryakov suggested calling the life form the characteristic appearance of certain groups of plants resulting from growth and development under certain conditions as an expression of adaptation to these conditions.

I.G. Serebryakov based his classification on the criterion of lifespan of the whole plant and its skeletal axes. He distinguished the following life forms of plants:

A. Woody plants.

- Trees
- Shrubs
- Dwarf shrubs.

B. Semi-woody plants

- Semishrubs
- Dwarf semishrubs

C. Terrestrial grasses

- Polycarpic grasses (perennial herbs, bloom many times)
- Monocarpic grasses (live a few years, bloom once and die off)

D. Aquatic grasses

- Amphibious grasses
- Floating and underwater grasses

The difference between trees, shrubs, dwarf shrubs, semishrubs, dwarf semishrubs, and herbaceous plants consists, in addition to the different degree of woodiness of their stems, in the duration of life and the nature of the change of skeletal shoots in the overall shoot system.

Floral plants are the most diverse in their life forms. They are found in a wide variety of environments, from cold tundra to hot deserts.

6. EXCURSIONS

6.1 An excursion into a forest community.

A forest is a complex plant community. It consists of many different plants. All of them interact closely with each other and with their environment. Usually we can distinguish several plant layers in a forest community. Layering allow more plants to grow in a single area. Trees form the upper layer (canopy), followed by the shrub layer (understory) and then the herb layer (forest floor). Moreover, a for-

est has so-called "out of layer" vegetation. These are lianas climbing up tree trunks, mosses and lichens growing on the bark, etc.

In the Volgograd Region, broadleaved forests are mainly represented by oak forests. In addition, in the north of the region, birch (*Betula pendula*) and aspen (*Populus tremula*) forests are found along sandy massifs, as well as black poplar (*Populus nigra*) and white poplar (*Populus alba*) forests along river floodplains. In deep ravines with spring streams and rivers, alder forests are often found.

Coniferous forests in our area are only of artificial origin. These are crops of Scots pine (*Pinus sylvestris*), Crimean pine (*Pinus nigra subsp. pallasiana*) and yellow pine (*Pinus ponderosa*).

There are three types of oak forests in Volgograd region: floodplain, upland and ravine forests. Of course, this division is largely arbitrary. The poorest in floristic composition are the oak forests of the Volga-Akhtuba interfluves, the richest are the upland oak forests of the north of the region and the ravines oak forests in deep wet gullies. The dominant species in these plant communities is oak (Quercus robur). It often forms the basis of the upper layer.

In the oak forests of the Volga floodplain, the oak is the only species of the upper tier. Natural floodplain oak forests are mostly of undergrowth origin, often very sparse. Undergrowth in them may be completely absent, and then they are very light, and they form a dense grass cover, in which a large role played by cereals. If undergrowth is present, it often forms dense impenetrable thickets, in which case the herbaceous layer is formed by ephemeres, ephemeroids and shade-producing dicotyledonous plants with broad leaf blades.

The understorey in these forests is formed by: *Prunus spinosa, Crataegus ambigua, Euonymus verrucosus, Viburnum opulus, Rhamnus cathartica, Malus paecox, Pyrus communis, Ulmus laevis, Ulmus campestris, Morus alba, Acer tatarica, Amorfa fruticosa*.

Herbaceous layer is formed by: *Glechoma hederacea, Lisimachia nummularia, Chelidonium majus, Elitrigia repens, Rubus caesius, Agrimonia eupatoria, Alliaria petiolata, Convalaria majalis, Fritilaria ruthenicus, Thulipa biberschtein-*

iana, Gagea pusilla, Urtica dioica, Aristolochia clematitis, Lamia amplexicaule, Asperugo procumbens, Geum urbanum, Melandrium alba.

Ravine oak forests are characterized by a greater diversity of tree species and herbaceous plants, as well as a more complex arrangement of tiers. This is due to the fact that the distribution of plants by tiers depends not only on the illumination, but also on moisture and the steepness of gully slopes. In the gentlest ravines it is close to floodplain oak forests. In very deep ravines with spring streams and rivers, black alder usually grows at the bottom. Higher up the slope, it is replaced by oak with an admixture of aspen. Sometimes they are also joined by the common ash. These four species form the uppermost tier in these forests. The second tier (practically not found in floodplain forests) consists of linden (*Tilia cordata*), elm (*Ulmus* spp.), pear (*Pyrus communis*), apple (*Malus praecox*) tree, etc. The understory consists of *Acer tatarica, Prunus spinosa, Crataegus ambigua, C. monogina, Euonymus verrucosus, Viburnum opulus, Rhamnus cathartica, Lonicera tatarica*. This layer, as a rule, is located higher on the slope than the main one. A shrub layer is usually formed along the edge of ravines forests consisting of Spiraea hypericifolia, Amigdalus nana, Rosa spp. etc. Herbaceous layer consists of *Convalaria majalis, Polygonatum officinale, Viola suaves, Corydalis solida, Fritillaria ruthenica, Scilla siberica, Cystoprerix fragilis, Rubus caesius, Aristolochia clematitis, Equisetum arvense, Urtica dioica, Glechoma hederacea, Lysimachia nummularia, Humulus lupulus, Geum urbanum,* etc.

A plant that can be found in forest communities

Volgograd region.

1. *Acer tataricum* L.
2. *Agrimonia eupatoria* L.
3. *Alliaria petiolata* (Bieb.) Cavara & Grande
4. *Alnus glutinosa* (L.) Gaertn.
5. *Amorpha fruticosa* L.
6. *Arctium lappa* L.

7. *Arctium tomentosum* Mill.
8. *Aristolochia clematitis* L.
9. *Artemisia absintium* L.
10. *Artemisia vulgaris* L.
11. *Ballota nigra* L.
12. *Betula pendula* Roth
13. *Chelidonium majus* L.
14. *Convallaria majalis* L.
15. *Corydalis bulbosa* (L.) DC.
16. *Crataegus ambigua* C. A. Mey. ex A. Beck.
17. *Crataegus monogyna* Jacq.
18. *Euonymus verrucosa* Scop.
19. *Ficaria verna* Huds.
20. *Fritillaria ruthenica* Wikstr.
21. *Galium aparine* L.
22. *Galium rubioides* L.
23. *Geum urbanum* L.
24. *Glechoma hederacea* L.
25. *Humulus lupulus* L.
26. *Inula helenium* L.
27. *Lavatera thuringiaca* L.
28. *Lonicera tatarica* L.
29. *Lysimachia nummularia* L.
30. *Malus praecox* (Pall.) Borkh.
31. *Melandrium album* (Mill.) Garcke
32. *Morus alba* L.
33. *Padus avium* Mill. (= P. *racemosa* (Lam.) Gilib.)
34. *Polygonatum officinale* All. (*P. odoratum* (Mill.) Druce)
35. *Populus alba* L.
36. *Populus nigra* L.

37. *Prunus spinosa* L.

38. *Quercus robur* L.

39. *Rhamnus cathartica* L.

40. *Ribes aureum* Purch

41. *Rubia tinctorum* L.

42. *Rubus caesius* L.

43. *Scilla siberica* Haw.

44. *Scrophularia nodosa* L.

45. *Silene vulgaris* (Moench) Garcke (= *S. cucubalus* Wibel, *Oberna behen* (L.) Iconn.)

46. *Tulipa biberchteiniana* Schult. et Schult.

47. *Ulmus campestris* L. (*U. minor* Mill.)

48. *Ulmus laevis* Pall.

49. *Urtica dioica* L.

50. *Verbascum blattaria* L.

51. *Vincetoxicum scandens* Somm. & Levier

52. *Viola suavis* Bieb.

6.2. Excursion to the near-water community.

In the floodplain, forests are often bordered by creeks and small open areas that are flooded in the spring floods. Specific communities of hygrophytes and hydrophytes are formed in these places. The main role in these communities is played by sedges, rushes, cereals (*Elytrígia répens, Bromus inermis, Calamagrostis epigejos, Agróstis stolonífera*, etc.), *Stachys sylvatica, Lycópus exaltátus, Lycopus europaeus, Lythrum salicaria, Veronica longifolia, Gratiola officinalis, Inula brithanica, Ranunculus repens*. In the most depressed areas, where water is constantly standing, reed-cattail communities are formed. Here are often found *Iris pseudoacorus, Typha latifolia, Alisma plantago-aquatica, Persicaria hydropiper, Persicaria amphybia*.

Meadow is a broadly understood type of zonal and intrazonal vegetation characterized by the dominance of perennial herbaceous plants, mainly cereals and sedges, in conditions of sufficient or excessive moisture. A feature common to all meadows is the presence of grass stand and turf, due to which the upper layer of meadow soil is densely penetrated by roots and rhizomes of herbaceous vegetation.

Meadows vary greatly in position and composition of vegetation. There are mainland, floodplain and mountain meadows. In Volgograd region only floodplain and mainland meadows are found.

Mainland meadows are meadows located on plains outside the floodplains. Mainland meadows are divided into meadow steppe and lowland meadows, distributed in the forest, forest-steppe and steppe zones.

Dry meadows or continental meadows are located on plains and slopes, irrigated exclusively by moisture of atmospheric precipitation, are formed in place of retreating forests and are characterized by relatively weak herbage growing on poor brown soils and podzolic soils. Significant areas of such meadows are involved in economic activities and serve as perennial pastures.

Lowland meadows (**swampy meadow**) are formed in forest-steppe areas, have a developed herbaceous cover, developing on soils richer than dry meadows, have additional nutrition from water sources.

Floodplain meadows are meadows lying in river valleys, often flooded during high waters, forming flood meadows.

With increasing moisture, as well as decreasing soil temperature and oxygen content in the soil, meadow communities become marshes, where hygrophytic plants predominate. As soil dryness increases and temperature rises, steppe vegetation with a predominance of xerophilic species is formed. There are usually no sharp boundaries between meadows and other types of vegetation. Thus, between meadows and real steppes there are the so-called meadow, or motley grass steppes, in the herbage of which not xerophilous, but xeromesophilous and mesophilous species prevail. Meadows also include cenoses with the presence of halophytes with predominance of halomesophytes - solonchak meadows - developing in con-

ditions of dry climate with poor drainage, high content of easily soluble salts in soils and formed on seashores and terraces; they may be connected with solonetz and solonchaks by series of transitions.

Swamps are communities located on land areas excessively moistened by standing or running water, occupied by plants capable of growing in high humidity. Swamps are characterized by increased acidity and low soil fertility, standing or running groundwater coming to the surface, but without a permanent layer of water on the surface. A bog is characterized by the deposition of incompletely decomposed organic matter on the soil surface, which later turns into peat. The layer of peat in bogs is not less than 30 cm, if less, it is a swampy land.

Swamps arise either when lakes overgrow, at the bottom of which peat is formed from dead plants (**raised bogs**), or when the land becomes marshy, if green mosses and Sphagnum settle on the soil (**low-lying swamps**).

The number of plant species inhabiting the plant communities of bogs is quite diverse. There are different species of *Iris pseudoacorus, Typha latifolia*, *Alisma plantago-aquatica, Persicaria hydropiper*, *Persicaria amphybia* and many others.

In the Volgograd region only low-lying marshes and swampy lands of river valleys are found.

Plants of water bodies are a special group. They have a number of features associated with life in water. For example, roots and rhizomes of many aquatic plants have special tissue with cavities for air storage. Underwater organs have an enlarged outer surface, which is created by dissecting the leaves into numerous lobes, as in Ceratophyllum and water Ranunculus, or by the formation of band-like leaves, as in Potamogeton. Such a structure of the organs facilitates and increases the access of oxygen to the plant from air-depleted water.

At the very shore of the pond or lake, shore plants grow: *Alisma*, *Butomus*, *Carex*, *Ranunculus*. Later, at shallower depths, *Scirpus*, *Phragmites, Typha* and *Sagittaria*. Their roots and the lower parts of their stems are usually submerged in

water, while the upper parts form high thickets. Even deeper, at a much greater depth, aquatic plants with floating leaves grow. These are *Nymphaéa, Nufar, Nelumbo, Persicaria amphybia* live in the water, and among the flowering plants - *Ceratophyllum* and *Potamogeton*. In addition, there is a group of plants that float freely on the water surface. These are *Lemna, Salvinia, Utricularia, Nymphoides*.

Plants that can be found in meadows and near water bodies.

1. *Agrostis stolonifera* L.
2. *Alisma plantago-aquatica* L.
3. *Allium angulosum* L.
4. *Althaea officinalis* L.
5. *Artemisia abrotanum* L.
6. *Bidens cernua* L.
7. *Bidens frondosa* L.
8. *Bidens tripartita* L.
9. *Bromopsis inermis* (Leyss.) Holub
10. *Butomus umbellatus* L.
11. *Calamagrostis epigeios* (L.) Roth
12. *Elytrigia repens* (L.) Nevski
13. *Equisetum arvense* L.
14. *Equisetum fluviatile* L.
15. *Equisetum rammosissimum* Desf.
16. *Filaginella uliginosa* (L.) Opiz
17. *Galium ruthenicum* Willd.
18. *Gratiola officinalis* L.
19. *Inula britannica* L.
20. *Inula germanica* L.
21. *Inula helenium* L.
22. *Iris pseudacorus* L.
23. *Lycopus europaeus* L.

24. *Lycopus exaltatus* L.fil.
25. *Lysimachia vulgaris* L.
26. *Lythrum salicaria* L.
27. *Matteuccia struthiopteris* (L.) Todaro
28. *Nuphar lutea* (L.) Sm.
29. *Nymphaea alba* L.
30. *Phragmites australis* (Cav.) Trin. ex Steud.
31. *Polygonum amphibium* L.
32. *Polygonum hydropiper* L.
33. *Polygonum lapatipholium* L.
34. *Polygonum persicaria* L.
35. *Potentilla reptans* L.
36. *Ptarmica cartilaginea* (Ledeb. ex Reichenb.) Ledeb.
37. *Ranunculus repens* L.
38. *Rorippa brachycarpa* (C. A. Mey.) Hayek
39. *Sagittatia sagittifolia* L.
40. *Salvinia natans* (L.) All.
41. *Scutellaria galericulata* L.
42. *Setaria pumila* (Poir.) Schult. (*S. glauca* Auct.)
43. *Setaria verticillata* (L.) Beauv.
44. *Setaria viridis* (L.) Beauv.
45. *Sparganium stoloniferum* (Buch.-Ham. ex Graebn.) Buch.-Ham. ex Kom. et Aliss.
46. *Stachys palustris* L.
47. *Stachys sylvatica* L.
48. *Typha angustifolia* L.
49. *Typha latifolia* L.
50. *Typha laxmannii* Lepech.
51. *Veronica longifolia* L.

6.3 Excursion to the steppe community.

Steppes are interpreted by modern geobotanists as a type of vegetation represented by communities of drought- and frost-resistant perennial herbaceous plants dominated by turf cereals (*Stipa, Festuca, Agropyron*). Steppes are associated with chernozems and chestnut soils. Steppe zone is characterized by dry continental climate. In Volgograd region steppes are represented mainly by **feather grass and fescue steppe** (**dry steppe**) and **southern sagebrush white** – grass steppe (**desert steppe**). These communities are formed on chestnut and light-chestnut soils. They used to occupy very large areas, but now most of them are plowed up and steppes are preserved in small areas on inconvenient land.

Feather grass and fescue steppe. The main dominant species in this phytocenosis are dense turf grasses. These are various types of feather grasses (*Stipa*) and fescue (*Festuca)*. There are also some shrubs, but in small numbers. These plant communities are characterized by very high species abundance. It is possible due to non-simultaneous development of their constituent plants. Different species composing the community have different temp of growth of vegetative mass and periods of flowering and fruiting. This is reflected in the appearance of the community, when one plant or another regularly alternates in abundant flowering. This phenomenon is called a change of aspects or tiering over time. However, the general peak of flowering in the steppe occurs in late spring and early summer. During this period, the greatest number of species blooms, gradually replacing each other. With the onset of summer drought, community life seems to come to a standstill. There is also spatial tiering in steppe communities, although the tiers are not as distinct as in forest communities. If herbs develop leaves in the near-soil layer and carry only stems with flowers and fruits high above the surface, they are referred to the lower tier (e.g., *Verbascum phoeniceum, Plantago lanceolata, Salvia aephiopica*).

Plants with long stems well covered by the whole length are referred to the upper tier (*Hypericum perphoratum, Oreganum vulgare, Phlomis pungens*). In the

second tier grow most of the grasses, *Geranium linearilobum, Veronica multifida, Alyssum tortuosum, Thymus pallasiana*.

In micro depressions and ravines, other conditions of moisture and light are formed, and here the communities, as a rule, tend to change: more mesophytic species appear, even completely different communities may form, such as ravines forests.

Sagebrush white - grass steppes. These communities differ from feather-grass steppes communities in that in addition to turf grasses, wormwood (*Artemisia lercheana*, in particular) also dominates in them. There are two peaks of flowering in these communities: May-June and August-September. In spring, ephemeres, ephemeroids, and cereals bloom; in autumn, wormwood and Chenopods (*Chenopodiaceace* family species) bloom. There is a pause in the summer, dry season. The herb cover in the southern steppes is more sparse than in the feather-grass steppes, and the denuded areas are covered with lichens, which are almost absent in the feather-grass steppes. In the southern steppes of Volgograd region are often found saline and solonetzic areas. Here, too, a peculiar vegetation is formed: salt-wort, kermeks, and other galophytic plants appear.

Very characteristic vegetation is formed in the steppes on sandy soils. Here are often found *Leymus racemosus, Achilea micrantha, Thymus pallasianus, Euphórbia seguieriána, Jurinea polyclonos, Helichrysum arenaria, Artemisia arenaria, Gypsophila paniculata, Astragalus vulpinus, Astragalus longipetalus*. Dense turf cereals do not usually dominate the community.

Plants that can be found in steppe communities

1. *Achillea micrantha* Willd.
2. *Achillea nobilis* L.
3. *Alhagi camelorum* Fisch.
4. *Allium decipiens* Fisch. ex Schult. & Schult.fil.
5. *Allium inaequale* Janka
6. *Allium rotundum* L.

7. *Allium sphaerocephalon* L.
8. *Alyssum desertorum* Stapf.
9. *Alyssum tortuosum* Waldst. & Kit. ex Willd.
10. *Amygdalus nana* L.
11. *Artemisia arenaria* DC.
12. *Artemisia austriaca* Jacq.
13. *Artemisia lercheana* Web.
14. *Artemisia marschalliana* Spreng.
15. *Artemisia monogyna* Waldst. et Kit.
16. *Artemisia taurica* Willd.
17. *Astragalus longipetalus* Chater
18. *Astragalus rupifragus* Pall.
19. *Astragalus varius* S. G. Gmel.
20. *Astragalus vulpinus* Willd.
21. *Bassia prostrata* (L.) Beck
22. *Berteroa incana* (L.) DC.
23. *Bulbocodium versicolor* (Ker.-Gawl.) Spreng.
24. *Carex melanostachya* Bieb. ex Willd.
25. *Centaurea adpressa* Ledeb.
26. *Centaurea squarrosa* Willd.
27. *Colchicum laetum* Stev.
28. *Coronilla varia* L.
29. *Cytisus ruthenicus* Fisch. ex Woloszcz.
30. *Delphinium puniceum* Pall.
31. *Dianthus borbasii* Vandas
32. *Dianthus squarrosus* Bieb.
33. *Diantus andrzejowskianus* (Zapal.) Kulcz.
34. *Elaeagnus angustifolia* L.
35. *Elaeagnus argentea* Pursh
36. *Ephedra distachya* L.

37. *Erophila verna* (L.) Bess.
38. *Euphorbia seguieriana* Neck.
39. *Euphorbia undulata* Bieb.
40. *Galatella villosa* (L.) Reichenb.fil
41. *Geranium linearilobum* DC.
42. *Gypsophila paniculata* L.
43. *Helichrysum arenarium* (L.) Moench
44. *Hypericum perforatum* L.
45. *Iris pumila* L.
46. *Jurinea polyclonos* (L.) DC.
47. *Leymus racemosus* (Lam.) Tzvel.
48. *Limonium gmelinii* (Willd.) O. Kuntze
49. *Lotus corniculatus* L.
50. *Onobrychis arenaria* (Kit.) DC.
51. *Origanum vulgare* L.
52. *Phlomis pungens* Willd.
53. *Phlomis tuberosa* L.
54. *Plantago lanceolata* L.
55. *Plantago media* L.
56. *Poa crispa* Thuill.
57. *Ranunculus illyricus* L.
58. *Rosa canina* L.
59. *Rosa majalis* Herrm.
60. *Rosa rugosa* Thunb.
61. *Salvia aethiopis* L.
62. *Salvia nutans* L.
63. *Salvia tesquicola* Klok. & Pobed.
64. *Scorzonera mollis* M.B.
65. *Scorzonera pusilla* Pall.
66. *Scorzonera tuberosa* Pall.

67. *Silene viscosa* (L.) Pers.
68. *Spiraea hypericifolia* L.
69. *Stipa capillata* L.
70. *Stipa pennata* L.
71. *Stipa sareptana* A. Beck.
72. *Thymus marschallianus* Willd.
73. *Thymus pallasianus* H.Br.
74. *Tragopogon dubius* Scop.
75. *Tulipa biflora* Pall.
76. *Tulipa gesneriana* L. (*T. schrenkii* Regel)
77. *Verbascum phoeniceum* L.
78. *Veronica multifida* L.

6.4. Excursion to ruderal habitats.

Habitats in which natural vegetation has been subjected to strong anthropogenic impact and has been either completely destroyed (after which it has not recovered, or has not recovered completely) or heavily modified, are called disturbed (ruderal) habitats. Such habitats equally include ploughlands, wastelands, city parks and streets, railroads, construction sites of any objects (buildings, roads, canals), places subjected to artificial flooding, broken or partially overgrown ground roads, roadsides, landfills, cattle yards, etc. In these habitats, so-called weed plants settle. Weeds are divided into segetal and ruderal plants.

Segetal plants are plants that develop along with cultivated plants on cultivated land. They, in turn, are divided into occasional (colonizers) and true (specialized) weeds. Occasional weeds are plants that come into cultivated land only under particularly favorable conditions for their growth and development. These are plants of wild flora that accidentally enter fields and gardens. Some of them can become serious competitors to cultivated plants (for example, Elytrígia répens and Equisetum arvense). For these species, growing on cultivated land is not necessary

to preserve the species. Specialized weeds are plants whose existence is inextricably linked to the cultivated land. They are so adapted to living in cultivated plant communities that exterminating them in the fields is tantamount to destroying them in nature. They are unable to coexist with wild plants and die when entering the natural phytocenosis as unadapted ones.

Ruderal, or trash, plants are plants that settle in uncultivated areas devoid of wild natural cover. In nature, they are pioneer plants that are the first to occupy unoccupied areas of sandbanks, riverbanks and ravines, fires, trampled and dug up by digging animal's pastures, landslide zones, lava flows and rocky talus. As these areas are invaded by other plants, ruderal plants become non-competitive and fall out of the plant communities. As a result of human activity very often natural vegetation is completely destroyed and as a result favorable conditions for ruderal plants are created. They can be found in vacant lots, roadsides, dumps, construction sites, mineralized firebreaks.

Adventitious plants (lat. adventus) are plants introduced into a new territory (apart from their original area) as a result of direct or indirect human influence and settled in artificial or natural communities.

According to the time of introduction, there are **archaeophytes** - species that appeared in the territory before the 16th century; **neophytes** - species that appeared at a later time.

According to the method of introduction, as a rule, we distinguish: xenophytes - species introduced accidentally (this group includes the majority of adventive species); ergasiophytes - species introduced deliberately (a very large group of species, the most famous example - American maple (Acer negundo), long settled with human help).

According to the degree of naturalization among adventive plants, we distinguish **ephemerophytes** - species temporarily present in disturbed and semi-natural habitats for 1-2 years (for example, sunflower (Helianthus annuus), marigold (*Calendula officinalis*), potato (*Solanum tuberosum*)); **colonophytes** - species firmly established in disturbed habitats, but not spreading from them; **epecophytes**

- species that spread over disturbed habitats (included in ruderal communities, for example, species of the genus *Ambrosia* and *Xanthium*); **agriophytes** - species that invade natural communities (for example, *Amorpha fruticosa*, *Bidens frondosa* etc.).

Adventive plant species introduced into natural and semi-natural plant communities are called **invasive species**. The problem of invasive alien plants is acute around the world, causing enormous economic damage. Their invasion is a serious ecological problem; it leads to floristic pollution of an area.

They often become vicious weeds of fields and other lands; some pose a danger to human health.

Weeds and weed plants play a negative role in a country's economy. Controlling these plants is the most important task in agricultural production. On the other hand, many weeds and litter grasses have a number of useful properties and can be used as forage, food, medicinal, honey and tannin plants.

Plants of ruderal habitats

1. *Amaranthus albus* L.
2. *Amaranthus blitoides* S.Wats.
3. *Amaranthus retroflexus* L.
4. *Anisantha tectorum* (L.) Nevski
5. *Arctium lappa* L.
6. *Artemisia absinthium* L.
7. *Artemisia dracunculus* L.
8. *Artemisia vulgaris* L.
9. *Asperugo procumbens* L.
10. *Atriplex tatarica* L.
11. *Cannabis ruderalis* Janisch.
12. *Capsella bursa-pastoris* (L.) Medik.
13. *Cardaria draba* (L.) Desv.

14. *Centaurea cyanus* L.
15. *Centaurea squarrosa* Willd.
16. *Ceratocephala falcata* (L.) Pers.
17. *Chamomilla recutita* (L.) Rausch.
18. *Chenopodium album* L.
19. *Chorispora tenella* (Pall.) DC.
20. *Cichorium intybus* L.
21. *Cirsium arvense* (L.) Scop.
22. *Consolida regalis* S. F. Gray
23. *Convolvulus arvensis* L.
24. *Conysa canadensis* (L.) Cronq. (*Erigeron canadensis* L.)
25. *Crepis tectorum* L.
26. *Cyclachaena xanthiifolia* (Nutt.) Fresen.
27. *Cynoglossum officinale* L.
28. *Descurainia sophia* (L.) Webb ex Prantl.
29. *Echium vulgare* L.
30. *Equisetum arvense* L.
31. *Equisetum ramosissimum* Desf.
32. *Ficaria verna* Huds.
33. *Hordeum leporinum* Link
34. *Hyoscyamus niger* L.
35. *Kochia scoparia* (L.) Schrad.
36. *Lactuca serriola* L.
37. *Lactuca tatarica* (L.) C. A. Mey.
38. *Leonurus glaucescens* Bunge
39. *Leonurus quinquelobatus* Gilib.
40. *Lepidium perfoliatum* L.
41. *Lepidium ruderale* L.
42. *Linaria vulgaris* L.
43. *Lycopsis orientalis* L.

44. *Malva pusilla* Smith
45. *Medicago falcata* L.
46. *Medicago lupulina* L.
47. *Medicago sativa* L.
48. *Melilotus albus* Medik.
49. *Melilotus officinalis* (L.) Pall.
50. *Plantago major* L.
51. *Polygonum aviculare* L.
52. *Portulaca oleracea* L.
53. *Senecio jacobaea* L.
54. *Sisymbrium polymorphum* (Murr.) Roth
55. *Sisymbrium wolgense* Bieb. ex Fourn.
56. *Solanum nigrum* L.
57. *Sonchus oleraceus* L.
58. *Stellaria media* (L.) Vill.
59. *Tanacetum vulgare* L.
60. *Taraxacum officinale* Wigg.
61. *Tribulus terrestris* L.
62. *Tripleurospermum inodorum* (L.) Sch. Bip.
63. *Vicia tenuifolia* Roth.
64. *Xanthium albinum* (Widd.) H. Scholz
65. *Xanthium spinosum* L.
66. *Xanthium strumarium* L.

The Red Book

The Red Book is an annotated list of rare and endangered or extinct animals, plants and fungi.

The Red Book is the main document that summarizes materials on the current state of rare and endangered species of plants and animals, on the basis of which the development of scientific and practical measures aimed at their protection, reproduction and rational use is carried out.

The Red Book includes plant and animal species that constantly or temporarily grow, or live in natural conditions in a certain territory (mainly the territory of a single country), and are endangered. Species of animals and plants listed in the Red Book are subject to special protection throughout the entire territory, which is covered by a particular edition of the Red Book.

IUCN Red List. The International Union for the Conservation of Nature (IUCN) in 1948 united and led the work on the protection of wildlife of state, scientific and public organizations in most countries of the world. In 1949, among his first decisions was the creation of a permanent Species Survival Commission. Its tasks were to study the state of rare endangered plant and animal species, to develop and prepare draft international and interethnic conventions and treaties, to compile inventories of such species and develop appropriate recommendations for their further protection.

The main goal of the Commission was to create a worldwide annotated list (cadastre) of animals that are threatened with extinction for one reason or another. Commission Chairman Peter Scott suggested calling this list the Red Data Book in order to give it a capacious meaning, since red also symbolizes danger, among other things. The IUCN Red List is often referred to as the International Red Book . This name was used in the domestic popular science literature of the times of the USSR.

IUCN Red List editions. The first edition of the IUCN Red Book was published in 1963. It was a "pilot" edition with a small circulation. Its two volumes include information on 211 species and subspecies of mammals and 312 species and

subspecies of birds. The Red Book was sent according to the list to prominent statesmen and scientists. As new information was accumulated, as planned, additional sheets were sent to the addressees to replace the outdated ones.

Three volumes of the second edition of the book appeared in 1966-1971. Now she had a "book" format (21.0 × 14.5 cm), but, like the first edition, she had the appearance of a loose-leaf thick calendar, any sheet of which could be replaced by a new one. The book was still not intended for general sale, it was sent to the list of environmental institutions, organizations and individual scientists. The first volume of the book includes information about 236 species (292 subspecies) of mammals, the second - about 287 species (341 subspecies) of birds, and the third - about 119 species and subspecies of reptiles and 34 species and subspecies of aphibians.

Gradually, the IUCN Red List was improved and replenished. The third edition, whose volumes began to appear in 1972, already included information on 528 species and subspecies of mammals, 619 species of birds, and 153 species and subspecies of reptiles and amphibians. The heading of individual sheets was also changed. The first section is devoted to the characteristics of the status and current state of the species, the next - to the geographical distribution, population structure and abundance, characteristics of habitats, current and proposed conservation measures, characteristics of animals kept in zoos, sources of information (literature).

The last, fourth "type" edition, published in 1978 - 1980, includes 226 species and 79 subspecies of mammals, 181 species and 77 subspecies of birds, 77 species and 21 subspecies of reptiles, 35 species and 5 subspecies of amphibians, 168 species and 25 subspecies of fish. Among them, 7 restored species and subspecies of mammals, 4 - birds, 2 species of reptiles. The reduction in the number of forms in the latest edition of the Red Book was not only due to successful protection, but also as a result of more accurate information received in recent years.

Work on the IUCN Red List continues. This is a permanent document, as the living conditions of animals change and more and more new species can be in a catastrophic situation. At the same time, the efforts made by a person give good results, as evidenced by its green sheets.

Red List of Threatened Species (IUCN Red List)

The second branch of the "bifurcation" of the idea of the Red Book is the emergence of a completely new form of information about rare animals in the form of the publication of the "Red Lists of Threatened Species". They also come out under the auspices of the IUCN (International Union for Conservation of Nature), but officially and practically they are not a version of the Red Book, they are not similar to it, although they are close to it. Such lists were published in 1988, 1990, 1994 , 1996 and 1998.

The structural basis of the new system is formed by two main blocks: a) endangered taxa and b) low risk taxa (LC).

The first block is divided into three categories:

Taxa Critically Endangered (CR)

Endangered taxa (EN)

Vulnerable taxa (VU)

These three categories are the main ones, warning about the seriousness of the loss of representatives of the taxon in the near future. It is they who make up the main array of taxa listed in the red books of various ranks.

The second block includes representatives who do not belong to any of the categories of the first group, and consists of the following categories:

Taxa Near Threatened (NT)

Taxa of Least Concern (LC)

Previously, this block also included the status of taxa dependent on conservation efforts (CD, from Conservation Dependent), but since 2001 this status is no longer assigned - some taxa were reclassified as taxa close to vulnerable position (NT), for some reclassification has not yet occurred and the status is saved.

Two more categories that are not directly related to protection problems stand somewhat apart:

Extinct taxa (EX)

Taxa Extinct in the Wild (EW)

There are also two categories for taxa whose status has not been determined:

Taxa for which there is insufficient data to assess threat (DD, from Data Deficient)

Taxa not assessed for threat (NE, for Not Evaluated)

The IUCN Red Book, like the Red Lists, is not a legal (legal) document, but is exclusively advisory in nature. It covers the animal world on a global scale and contains protection recommendations addressed to countries and governments in whose territories a threatening situation has developed for animals.

Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, or **CITES**, is an international governmental agreement signed as a result of an International Union for Conservation of Nature (IUCN) resolution in 1973 in Washington. The SITES Convention is one of the largest wildlife conservation agreements. Participation is voluntary. Although compliance with the convention is mandatory for all signatory states (hereinafter referred to as "parties"), no special national laws are required.

Originally the Convention was signed by representatives of 80 countries, but by 2006 169 countries had already become parties to the agreement. Compliance with its provisions is mandatory for all its members, but it does not require the creation of additional national laws. Russia became a party to the Convention in 1992 as the legal successor of the USSR, which joined this document in 1976.

The convention was created to regulate international trade in wild animals and plants, ensuring that their survival is not threatened. There are more than 33,000 species on the CITES list. They are categorized into groups based on the degree of extinction risk and the measures taken.

Appendix I includes endangered species whose trade has or is likely to have an adverse effect on their existence; trade in them is particularly strictly controlled and only allowed in exceptional circumstances.

Appendix II identifies species which, although not necessarily endangered at the present time, may become so endangered if trade in specimens of such species is not strictly regulated so as to avoid uses which are incompatible with their survival; and other species which must be regulated so that trade in specimens of certain species from the first list may be effectively controlled.

Appendix III includes those animals and plants that any Party has determined are subject to regulation within its jurisdiction to prevent or limit exploitation and for which the cooperation of other Parties in controlling trade is necessary.