Lecture
Topic: Class Liliopsida or Monocotyledones

Plan.

Class monocotyledons. General characteristics.
Subclass Alismatidae.
Subclass Liliidae.
Order Liliales.
Order Amaryllidales
Order Asparagales
Order Dioscoridales
Order Orchidales
Order Poales or Graminea
Order Cyperales
Subclass Arecidae
Order Arecales or Palmae
Order Arales

The monocotyledonous class or class Liliopsida includes 104 families, 3000 genera and about 63000 species. It is believed that the oldest monocotyledons evolved from primitive dicotyledons.

Monocotyledonous plants are characterized by fibrous root system, simple entire leaves, parallel or arched leaf veins, three-membered flowers, absence of arboreal forms. Anatomical structure of monocotyledons is characterized by absence of secondary thickening due to cambium, closed vascular bundles, which are located diffusely along the whole central axial cylinder, poorly developed primary cortex, absence of collenchyma in it.

Three subclasses belong to the monocotyledonous class:
Alismatidae
Liliidae
Arecidae

The subclass Alismatidae includes about 500 species from 18 families. Representatives of this subclass are close to primitive dicotyledons, in particular to Nymphaea. All representatives of this subclass are aquatic or near-water plants. The perianth of this subclass is arranged in two rings of 3 tepals each. The most primitive representatives have an indefinite number of androceum and gynoecium, more advanced ones have 6 stamens and pistils each. Some representatives of the gynoecium are apocarpous. The most famous representatives are the *Butomus umbellatus, Alisma plantago-aquatica, Sagittaria sagittifolia, and Elodea canadensis*

The Subclass Liliidae.

The largest class of monocotyledons includes 9/10 of the total number of species. It includes 21 orders and about 74 families. In contrast to the previous subclass, they are predominantly terrestrial, although sometimes inhabitants of humid places and wetlands are also found.

Order Liliales

This order includes 9 families.

They are perennial herbs or annual grasses. Leaves are entire, the vesels are mostly in roots only, while stems have tracheides. Perianth is usually simple, consisting of two rings of tepals. Stamens are usually 6, less common. Gynoecium is usually syncarpous, with 3 carpels. Flowers are solitary or aggregated in bothrioide inflorescences (racemes, spikes, compound spikes).

The Family Liliaceae

This family contains 45 genera and about 1300 species. They are perennial herbaceous bulbous plants. The structure of bulbs and the way daughter bulbs are formed are very diverse. The burrowing usually occurs due to special retracting (contractile) roots. The aboveground flower-bearing shoots can be foliated or leafless (arrows). Leaves are entire, with parallel veins. Flowers are actinomorphic. Perianth corolla-shaped, with 6 segments, in two rings. Segments of the outer ring usually do not differ significantly from those of the inner ring. Nectaries are primitive, located at the base of perianth segments or stamens. The gynoecium consists of 3 fused carpels. The ovary is an upper one. Flowers are often aromatic with a lot of nectar. Pollinated by insects. The fruit is a capsule. The best-known species are the *Lilium pensylvanicum*, the *Lilium lancifolium*, the *Tulipa gesneriana* (garden), and the *Fritillária ruthénica*.

Fritillária ruthénica $*P_{3+3}A_{3+3}\underline{G_{(3)}}$

The order Amarillidales

The order includes 15 families, of which in our country there are representatives of *Asphodeliacea, Hyacinthaceae, Alliaceae* and *Amaryllidaceae*.

The family Alliaceae.

This family includes about 30 genera and 650 species, distributed on all continents except Australia.

The Alliaceae are perennial herbs with bulbs, corms and sometimes rhizomes. Roots are usually thin, itchy but sometimes thickened, often contractile. Inflorescence is brought to the ground by a flower arrow, which sometimes looks like a foliated stem because leaves have sheaths covering the arrow almost to the top. Leaves of *Alliaceae* are terrestrial, alternate, simple tubular or flat, without petioles, with parallel or arcuate veins. Flowers are clustered in apical umbels. There are often bracts at the pedicel base. Before flowering, the umbels is wrapped

in a veil, which is formed from 1-3-5 merged bracts. Flowers are usually small, bisexual, actinomorphic. The perianth consists of 6 free segments arranged in two rings. The segments of the inner rings are sometimes smaller than the outer ones. Perianth segments are oblong with well-expressed veins, which contain chlorophyll. 6 stamens in two rings. Stamens of the inner ring often differ from those of the outer ring in the broadened flattened filament and the presence of teeth. Gynoecium is syncarpous, with 3 carpels; ovary is an upper one. Fruit is a triangular capsule. Nectaries are located at the base of the peduncles. Characteristic feature of the *Alliaceae* family is the presence of laticifiers, usually segmented, filled with milky juice, as well as the presence of garlic and similar volatile oils in all parts of the plant that contain sulfur-containing compounds and determine a specific garlic or onion scent. *Alliaceae* inflorescences often form bulbs at the base of pedicels that serve for vegetative reproduction.

Allium cepa (Onion) $*P_{3+3}A_{3+3}\underline{G_{(3)}}$

The family Amaryllidaceae

The *Amaryllidaceae* family includes about 70 genera and 1000 species. They are perennial herbaceous plants with a bulb or (very rarely) a tuber bulb. The leaves are arranged in a ground-level rosette, usually sessile, less often with a pronounced petiole. Leaves are alternate. Most leaves are flat, linear or filiform, dense, leathery with a well-developed cuticle. Leaves often contain a large amount of mucus, which flows freely from the leaf if damaged. The mucus contains many raphides and alkaloids. The aboveground stem is represented by a flower-stalk, usually hollow inside or filled with parenchyma tissue. At its apex there are 2 bracts enclosing the base of each peduncle and forming a veil. The shroud remains on the peduncle until the fruits are fully ripe. Flowers are solitary or clustered in umbels. Many *Amaryllidaceae* flowers have special formations that appear as a tube or frilly tube above the pharynx of the perianth. They can have different origins. In *Narcissus, Pancratium* and *Eucharis* the floral tube (corona) is formed as a result of fusion of bases of staminate filaments, while in Snowdrop (*Galantus*) the tube is formed as a result of fusion of perianth inner segments. The gynoecium is syncarpous; the ovary is inferior. The fruit is a capsule, sometimes succulent (berry-like). *Amaryllidaceae* is pollinated by insects. They are very brightly colored, have a strong odor and release a lot of nectar. In some species, nectar completely fills the flower tube and often pours out of it, flowing down the stamen filaments (*Pancratium*).

Amaryllis $*P_{3+3}A_{3+3}G_{(3)}$
Narcissus $*P_{3+3}A_{(3+3)}G_{(3)}$
Galantus $*P_{3+(3)}A_{3+3}G_{(3)}$

The Order Asparagales

The order Asparagales consists of 8 small families, of which the most important are *Asparagaceae* and *Convalariaceae*. All members of this order are characterized by the presence of a fruit - a berry.

The family Asparagaceae.

In this family there are 2 genera and about 300 species. The size and treatment of the family *Asparagaceae* has repeatedly changed, and according to different sources very different as the number of genera and species, and the description of the main characteristic features. We consider this family in its narrowest sense.

They are perennial rhizomatous herbs. The main feature of *Asparagaceae* is that the leaves are reduced to dry filmy or prickly scales. The photosynthetic function has shifted to small stems modified into phyllocladia. Flowers are either solitary, appearing at the tip of the stem or in the axils of the leaves, or aggregated in brushes, panicles or bracts. Flowers are often unisexual, usually with three-partite rings. Perianth simple, fused-tepals; stamens two rings; pistil with upper trilocular ovary, short style and lobate stigma. The fruit is a single-seeded or multiseed berry.

Asparagus officinales $*P_{(3+3)}A_{3+3}G_{(0)}$ $*P_{(3+3)}A_0G_{(3)}$

The family Covallariaceae

This family includes 23 genera and about 230 species.

Representatives of the *Convallariaceae* are small perennial rhizomatous herbs. Their leaves are relatively large, ground or stem leaves. Flowers are usually bisexual, of medium size, arranged in racemes or spike-shaped inflorescences, rarely solitary. The perianth is bell-shaped or tubular, 3, less often 2 or 4 segments. Lobes of the perianth are fused. Stamens are 4, 6, 8 or 12. Stamen filaments are loose. The ovary is upper, usually trilocolar, less frequently 2 or 4-nestrous. Fruit is usually a juicy orange berry. Cardiac glycosides belonging to the group of cardenolides as well as steroid saponins are found in Convallariaceae.

Convallaria majalis $*P_{(3+3)}A_{3+3}G_{(3)}$

The order Dioscoreáles.

The order Dioscoreáles is an order of monocotyledonous plants. In the APG II classification system, it is included in the monocotyledonous group.

In the Cronquist classification system (1981), the order Dioscoreales is absent. The family Dioscoreaceae is in the order Liliales, and the family Burmanniaceae is in the order Orchidales. The family Nartheciaceae is absent in the Cronquist System.

In the Takhtajian classification system (1997), the order Dioscoreales is part of the suborder Dioscoreanae of the subclass Liliidae of the class Liliopsida.

We will consider the family Dioscoreae.

The Family Dioscoreaceae

The family includes 5 genera and 750 species. The great majority of *Dioscoreaceae* are tropical plants. The greatest number of species belong to the genus *Dioscorea*. These are perennial herbaceous and shrubby plants, most often climbing, with underground storage tubers. The tubers are massive. Stems are thin, annual, not having time to rise to a great height during the growing season. Leaves are alternate, sometimes larger in size, with palmate veining and anastomoses between veins of the first order, thus creating a reticulate characteristic, as a rule, of dicotyledons. Flowers are small, aggregated in inflorescences of various types. Flowers are unisexual (in this case the plants are dioecious), less frequently are bisexual, actinomorphic, three-membered. The perianth consists of 6 segments arranged in 2 rings, usually fused into a short tube. Stamens 6, arranged in 2 circles, with the stamens of the inner circle sometimes turning into staminodes or not developing at all. The ovary is upper; the fruit is usually a capsule. Many species have winged seeds.

The best known plants of this order are the food species of *Dioscorea*, known under the collective name of yam. The cultivation of yams in Africa and Asia, independently of each other, appears to have originated over 5,000 years ago. The importance of this crop in human life is demonstrated by the fact that yams are a staple food for more than half a billion people. The most famous species are Dioscorea roundica, or "white yam" (*Dioscorea rotundata*), Dioscorea cayenensis, or "yellow yam" (Dioscorea *cayenensis*) and *Dioscorea supronum*, or "Chinese yam" (*Dioscorea opposita*). In Russia, *Dioscorea caucasica, Dioscorea balcanica* and *Dioscoréa nippónica* are found. The latter is used in medicine as a source of an antisclerotic drug.

Dioscorea caucasica $*P_{(3+3)}A_0\underline{G_{(3)}}$ $*P_{(3+3)}A_{3+0}G_{(0)}$

The order Orchidales

This order includes the only family *Orchidaceae*, which is the largest among the monocotyledons. This family includes 750 genera and about 25000 species.

The Family Orchidaceae

The family *Orchidaceae* are widely distributed throughout the globe. All their diversity can be summed up in two ecological types: epiphytes and terrestrial orchids. The former are predominantly found in the tropics and subtropics, the latter in the temperate zone. Epiphytic orchids often have thickened shoots that are used for water and nutrient storage. Such thickenings are called pseudobulbs. In terrestrial orchids, the root tubers are the reservoir of nutrients. Some of them were used in medicine under the name of salep tubers. Leaves are simple, alternate, arranged in two-row patterns. Inflorescences are spike-like, raceme-shaped or panicle-shaped. Tropical orchids can reach several meters in length. The most charac-

teristic feature of orchids is their flower. The flower is zygomorphic and bisexual. The perianth lobes are 6, arranged in two rings, the outer ones are less bright and more or less identical. Inner ones are brighter and differ in size and form, while the middle one forms a labium. Most orchids have only one stamen of the outer ring. The thread of this stamen is united with the style and stigma into a single column, the gynostemium. The pollen is united in a common mass, the pollinarium, which has a special device, the adhesive attachment, through which the pollinarium is attached to the body of an insect pollinator. The gynoecium is syncarpous, consisting of 3 fused carpels. The ovary is lower, 1 or 3 sessile. Fruit is an opening capsule. Seeds are very small, dust-like, very numerous. Their germination requires an encounter with a symbiont fungus.

Phalaenopsis $\uparrow P_{3+3}A_1G_{(3)}$

The Order Sedges - Cyperales

This order includes one family.

The family Cyperaceae

120 genera, 5600 species Almost all *Cyperaceae* are perennial rhizomatous grasses. Many of them contain silica, are very tough and have little value as fodder. Stems are usually triangular but may be rounded. Leaves are terrestrial, sheathing, embracing the flowering shoot. The latter does not have clearly expressed internodes. Flowers are bisexual or unisexual, aggregated in spikelets. Sedges with unisexual flowers have male and female spikelets, which are arranged on one plant. Perianth of 6 or 3 scales, often with changed bristles or hairs. Stamens are 3; the gynoecium is pseudomonocarpous, with 2-3 carpels. Fruit is a nut. Fruits are often spread by the wind and have hairs or special sacs.

Carex melanostachia $*P_0A_3G_{(0)}$ $*P_0A_0G_{(3)}$

The order Cereals - Poales

The order includes one family

The family of Cereals - Poaceae

900 genera, 11,000 species. Annual or perennial herbs. Branching occurs near the base - in the tillering zone. The features of tillering determine the life form of the cereal.

He stems of grasses range from fully erect to prostrate. They are solitary to densely clumped, as in the so-called bunch grasses. Many grasses produce horizontal stems, either below ground (rhizomes) or above ground (stolons).

Some of the structural strength required for grass plants to stand erect comes from the leaves, particularly the leaf sheaths. Arising at nodes and encircling the internode above, sheaths counter the tendency for the internode to bend at the basal growing point, where it is weakest.

The other major part of the grass leaf is the blade. Grass leaves are borne

singly at the nodes and, with minor exception, are arranged in two vertical ranks. Thus, a leaf, and most conspicuously its blade, is positioned directly under the blade two nodes above it. Structurally, this means that the point of leaf initiation alternates with each node; the leaf sheath grows to encircle the stem and overlap when the two points meet. Grass leaf blades are usually long and narrow, with parallel margins, but occasionally are in the shape of a lance, egg, arrow, or heart. The blades may be shorter than one centimetre or less than five metres in the larger bamboos. In grasses of such arid areas as the desert, the leaves may roll up to form long, thin tubes, thereby reducing surface area and water loss.

The leaf veins (vascular bundles that transport water and nutrients) run parallel to one another. Special cells in the outermost cell layer of grass leaves contain silica bodies, which range from saddle-shaped to crescent- or dumbbell-shaped. These shapes are often used to distinguish large groups of grasses from one another. While silica bodies occur in the epidermis of other monocots, such as sedges, they do not show the great variability of form found among the grasses.

The internodes, or stem regions between the nodes, are usually round in cross section and either hollow or filled with a spongy pith. What makes the grasses unusual, however, is their method of growth: they elongate by means of cell division and enlargement at the basal point of growth.

The primary inflorescence of grasses is the spikelet, a small structure consisting of a short axis, the rachilla, to which are attached chaffy, two-ranked, closely overlapping scales. There are three kinds of scales. The lowermost, called glumes, are usually two in number, and they enclose some or all of the other scales. The other scales, the lemma and the palea, occur in pairs. Generally the lemma is larger than the palea, which is hidden between the lemma and the spikelet axis. The lemma and palea surround and protect the flower, and all three of these structures form the floret. Grass spikelets then simply consist of usually 2 glumes and 1 to about 50 florets, depending on the species.

Spikelet structure is highly useful in the identification of grass species and genera, and it defines some large groups of grasses. *Rice* and its relatives, for example, produce spikelets without glumes. Spikelets of the *Panicoideae* contain two florets, a sterile or pollen-producing floret below a fruit-producing, and sometimes also a pollen-producing, floret. The entire spikelet breaks away from the plant as a unit for fruit dispersal. In contrast, the *Pooideae* often have more than two florets per spikelet—florets that do not produce fruit are located at the top rather than at the bottom of the spikelet—and the individual florets separate from one another for dispersal. Many bamboos develop pseudospikelets by the addition of scalelike structures at the base of the spikelet. These resemble glumes in not covering a flower, and they are thought to be leaves reduced to very small sheaths. Above these additional scales are the parts of a normal spikelet.

Spikelets are the units of the secondary grass inflorescence. All major inflorescence types occur in grasses, and a certain type or variant of that type is often characteristic of a species or group of species. In the wheats, for example, the spikelets are attached to a central axis without a stalk or pedicel. This kind of inflorescence also characterizes relatives of wheat, such as barley and rye. The blue-

grasses of the genus *Poa*, in contrast, have a panicle inflorescence, with the spikelets borne on distinct pedicels.

Grass flowers are adapted for wind-pollination. There is an abundance of pollen contained in usually 3, less commonly as few as 1 or as many as 6, and exceptionally up to 120 (in *Ochlandra*), anthers. The smooth, lightweight pollen travels well on air currents, and two (less often three) feathery stigmas catch the airborne pollen. After pollen shedding and reception, the lodicules shrink and the floret closes to protect the developing fruit.

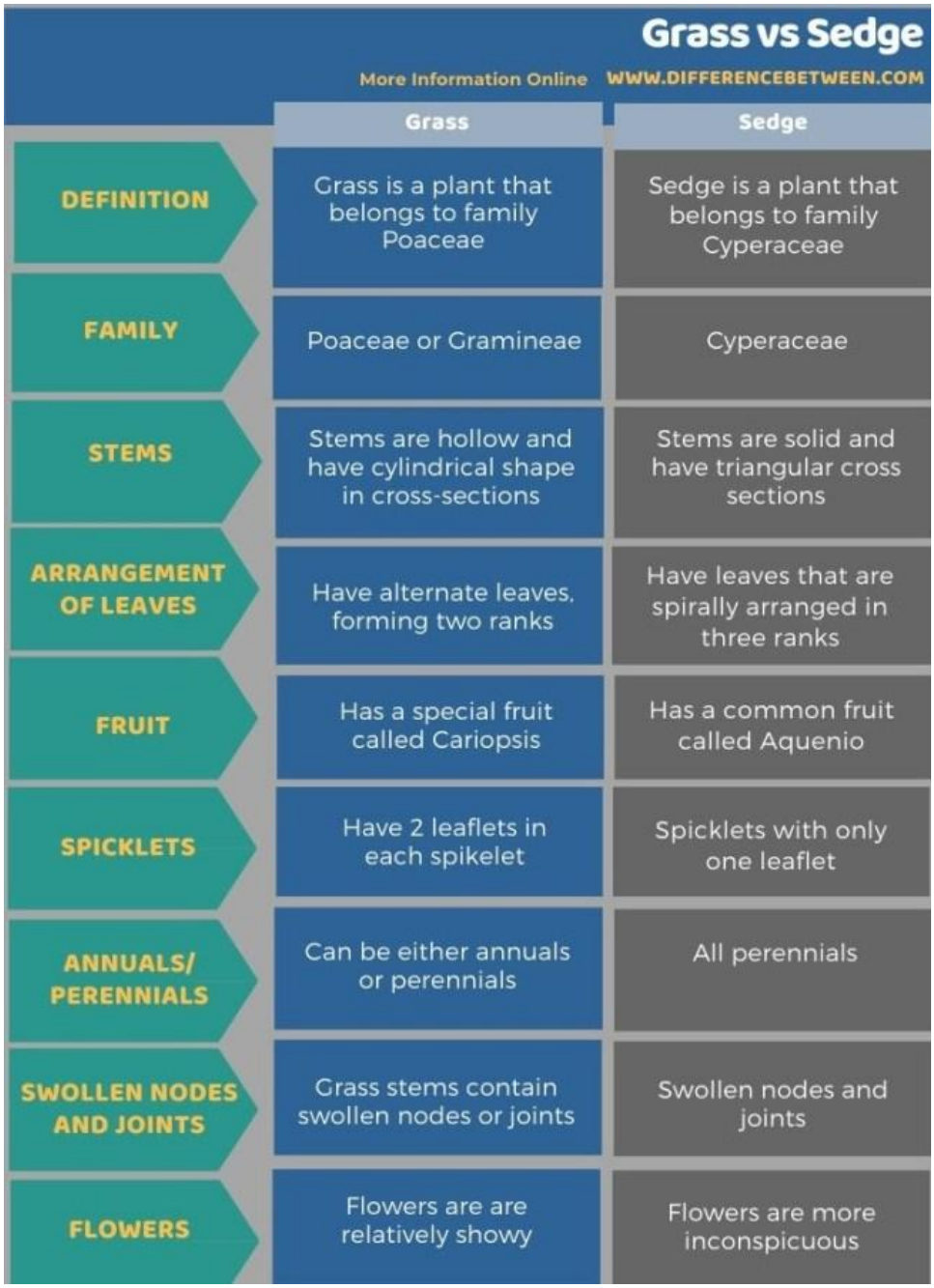
Grass flowers may be bisexual (with both pollen and ovules) or unisexual. The flowers of wheat, barley, oats, and rye are bisexual; the flowers of corn are unisexual, although inflorescences for pollen (the tassle) and others for fruit (the ear) are on the same plant.

Grass fruits, also called grains or caryopses, are unusual among plants in that the fruit wall completely adheres to the single seed. Caryopses are generally dry. In some grasses, the fruit does not fuse with the seed coat, and in some bamboos the fruit is a berry since the fruit wall becomes juicy.

Cereals include the main grain crops of the globe: wheat, corn, rice, rye, oats, barley. Sugar cane is also of great importance.

Triticum aestivum $\uparrow P_2A_{3+3}G_{\underline{(3)}\text{ или }1}$ ($\uparrow P_2A_3G_{\underline{(3)\text{ или }1}}$)

Representatives of the families of cereals and sedges are widely distributed around the globe and are very similar to each other, so we will analyze them in comparison.



The Subclass Arecidae

The order Palms - Arecales

Includes one family.

The family Palms - Arecaceae (Palmae)

This family includes 210 genera and about 3,000 species. This is a tropical plant. In our country naturally palms do not grow, but about 10 species are cultivated on the Black Sea coast.

They are arboreal monocotyledons with a very characteristic form of growth. Palms have the largest leaves, inflorescences and seeds in the plant world.

The trunks do not branch and sometimes reach a height of 60 m. Some spe-

cies resemble bamboo and have thin stems, no more than 0.5 m, climbing palms are also known. The stems are smooth on the outside or covered with remnants of leaf sheaths and petioles. They have a narrow crustal layer and numerous vascular bundles. Stem thickness is achieved by a peculiar primary growth and by the division and distension of the parenchyma ring, a thickening characteristic only of the class. The division of parenchyma cells is slow, and vascular bundles, resulting from the division of this formation, are always of closed type. Leaves are alternate, separated into petiole and lamina. The lamina is always folded, fan-shaped, or pinnate. The leaves are set as entire and then split into separate segments. The crown of palms always has a strictly defined for each species number of leaves. Flowers are small, aggregated in highly branched inflorescences. In some species they reach 6-9 meters. Flowers are often unisexual, actinomorphic, with 6 perianth lobes in two circles. Male flowers also have 6 tepals in two rings. Carpels are 3, they are fused, ovary is upper. Fruits are syncarpous or pseudomonocarpous, most commonly monocarpic.

Palms are widely used by humans. They produce palm oils, edible fruits and seeds, starch from stems (sago), wood for construction, various technical raw materials.

Phoenix canariensis $*P_{3+3}A_{3+3}G_{(0)}$ $*P_{3+3}A_0G_{\underline{(3)}}$

The order Arales

The order includes 2 families, the Araceae and the Lemnaceae.

We will take a detailed look at the *Araceae*.

The family Araceae

This family includes 110 genera and about 2500 species. Most of them are distributed in the tropics and subtropics. In our country there are 16 species belonging to 7 genera.

Representatives of the family are swampy, rarely aquatic herbs with well-developed rhizomes and tubers. Tropical are often lianas and epiphytes. Epiphytes have a special tissue on their roots, a velamen, which absorbs atmospheric moisture. Many representatives have laticifiers with latex. Leaves are alternate, usually petiolate, sometimes arranged in a rosette. Ability to inset growth is retained for a long time at the place where the petiole meets the leaf blade. Leaf shape is diversified, often incised or pierced, veining palmate with anastomoses between large veins. Leaves are less often linear (at the calamus). Inflorescences are always spadix. Plants are monoecius. Male and female flowers are on the same spadix but do not open simultaneously, and the inflorescence first functions as a female and then as a male. At the base of the inflorescence there is often a brightly-colored veil, or spata, which is a modified bract. Flowers are actinomorphic, without perianth or with a 4-6-membered, unsightly perianth. Male flowers have 4-6 sta-

mens, which are either free or fused. Female flowers have 2-3 carpels, which form 1-3-locular of the upper ovary. When the flowers mature, a infructences is formed in the spadix, with individual fruits being syncarpic or pseudomonocarpic berries.

Many aroids are poisonous. Medical significance is the calamus, the rhizomes of which produce a number of medicines used in the treatment of the gastrointestinal tract.

Acorus calamus $*P_{3+3}A_6G_{\underline{(3)}}$