

Anatolii P. Tertyshnyi

BOTANY
CURRENT SYSTEM OF FLOWERING PLANTS
PART III
METHODOLOGICAL RECOMMENDATIONS
for higher education applicants of the educational degree «Bachelor» of the
specialty H1 Agronomy (Agronomy)

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Зміст методичних рекомендацій відповідає навчальній дисципліні «Ботаніка». Вони розроблені для підготовки здобувачів першого (бакалаврського) рівня спеціальності H1 Агрономія (Агрономія) англомовних груп закладів вищої освіти. У них подано відомості щодо сучасної системи 11 родин 6 порядків квіткових рослин клад Monocots та Eudicots.

Методичні рекомендації будуть корисними здобувачам та викладачам закладів вищої освіти.

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The content of methodological recommendations corresponds to the discipline «Botany» for the bachelors in specialty H1 Agronomy (Agronomy). The methodological recommendations includes data of the current system of 11 families belonging in 6 orders of Monocots and Eudicots clades.

The methodological recommendations will be useful for applicants and university teachers.

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PREFACE

The methodological recommendations corresponds to current syllabuses of higher education institutions and is in line with the «Botany» discipline for the bachelors of the specialty H1 Agronomy (Agronomy).

The material of the methodological recommendations gives possibility for applicants to use received knowledge in fundamental directions of related sciences and agricultural practice. The goal of the methodological recommendations is to give information about the current system of flowering plants and ways of using in agriculture.

The first chapter describes methods and history of plant systematics, peculiarities of APG system. The second chapter gives information about location of flowering plants in the current system of the organic world. The third chapter is about the current system of flowering plants. The remaining chapters contain information about 11 families belonging to 6 orders of Monocots and Eudicots clades.

The basis of the methodological recommendations is the lectures on botany given by author on Agrobiological, Plant Protection, Biotechnology and Ecology, Veterinary Medicine, Livestock Raising and Water Bioresources faculties, Education and Research Institute of Forestry and Landscape-Park Management of NULES.

INTRODUCTION

Botany is the study of plants. The main task of botany is to obtain the comprehensive knowledge of plants: their structures, vital signs, diffusion, an origin, evolution.

Food production is the global problem nowadays. The population increase of the world is the reason of maximum intensification of agricultural production: raising the level of crop yield and the efficiency of animal husbandry. Technological sciences solve this problem: plant cultivation and animal husbandry based on the achievements of fundamental biological disciplines and the botany takes the first place among them. The role of plants is also in providing the people with wood, fibre, crude drugs etc. Botany like the biological science in general has undergone seismic shifts in the last thirty or so years. Of course science is always changing and metamorphosing, but these shifts have meant that modern plant science has moved away from its previously more agricultural and botanical context, to become a core biological discipline in its own right. Two key factors have been responsible: the rise of molecular biology and the digital revolution. The first has meant that the sorts of answers we seek to plant questions – whether they are about physiology, development, ecology, evolution or plant breeding presented now most commonly as explanations at the molecular and cell biological level. The second has meant that the sequence-driven world of genomes and expression data have moved the centre stage and this, together with the new emphasis on more global, synthetic and systems-based approaches to data, attracts funding streams and, increasingly, large-scale collaborative research.

We now understand the plant development at molecular and cellular level. Today's scientists know the ways of affecting environmental and internal signals of the plant growth and development. Nowadays the mechanism is revealed how cells of meristem give rise to roots, shoots and flowers, the mechanisms that determine the diversity of plants, the complex interactions between plants and their pathogens and symbionts, how the energy of light is captured to fix carbon, and how plants and their genomes evolved. This is all good news, and plant science is currently in a remarkable phase of discovery and innovation. Plants are vital for our continued existence on Earth. They provide us, directly or indirectly, with our fuel, our food, our wood, paper and fibres, and the raw materials for future products like biofuels. Paradoxically though, at a time when the importance of plant science for our world food and energy security has never been greater (highlighted of course by our more urgent appreciation of climate change), our need to recruit and encourage new plant scientists has become correspondingly acute. The sheer amount of information that is accumulating about plant science, and the difficulty of grasping it all, understanding it and evaluating it intelligently, has never been harder for these recruits or, for that matter, old hands.

The methods handbook contains data of the current system of 4 families (Amaryllidaceae, Asparagaceae, Asphodelaceae, Iridaceae), 1 order (Asparagales) and 56 species. The description of the plant contains information about distribution

in the world (Флора України, 1938–1965; Екофлора України, 2000–2010) and in Ukraine (Определитель высших растений Украины, 1987), economic uses and the conservation status (Перелік видів рослин..., 2021). The species are arranged alphabetically within genera, genera – within families, families – within orders. The orders are located as in APG system (2016), Latin names of species are given in accordance with POWO, synonyms of families and orders – in accordance with James L. Reveal (2012), taxonomical structure and synonyms of genera – in accordance with NPGS and AP Web. The attention pays to the genera with the species given in the methods handbook. Synonyms are in the round brackets, possible and probable synonyms – in square brackets. The names of taxa of the higher rang are given in bold, homonyms – in curly brackets.

CHAPTER 1. PLANT SYSTEMATICS

Content and modern tasks of plant systematics

Plant systematics is one of the oldest biological sciences. The first scientists worked in this area were *John Ray* (1627–1705), who published “Synopsis of animals and reptiles” in 1693 and *Carl von Linné* (1707–1778), who published “Systema naturae” in 1735. The end of 18th and the beginning of 19th century be marked by the higher level of research. “Recently plant systematics is the same as taxonomy. This is the science of plant organisms. Not plant physiology, but its anatomy plays the key role and is the basis of plant classification or plant taxonomy.” This definition gave by *Augustin Pyramus (Pyramé) de Candolle* (1778–1841) in his “Théorie élémentaire de botanique” published in 1813. *George Gaylord Simpson* (1902–1984) in 1961 pointed that systematics is science research of different organisms, its diversity, relationships. *Mayr Ernst* (1904–2005) in his work “Principles of zoology systematic” (1971) pointed that relationships and connections can be found and exist not only in phylogenesis meaning, but more wider in all biological connections among living organisms and fossils. Modern plant systematics is fusion of many sciences. In the work “Flora of Yerevan. Manual of wild plants of the Ararat basin” (1972), written by *Armen L. Takhtajan* (1910–2009) and *Andrey A. Fyodorov* (1908–1987) it was pointed that plant systematics is the basis of biology, its beginning and end, α and ω .

Plant systematics as a science contains three main parts. The first part is the **subject** of study containing description, naming, classification, and making of evolutionary system of the plant world. The second part is the **tasks** of study that provide α -systematics of inventory of plants, β -systematics which is used for making of modern phylogenetic system of plants giving connections among different taxa. This method contains some difficulties such as parallel evolution and heterobathmy. The genetics of plant populations and research of genera formation use γ -systematics for plant data collection. The third part is the **methods** of research. Determining the phylogeny (evolutionary history) of plant world is the main task of the modern systematics. This task can be solved using biological; paleobotanical, topological and additional (math) methods of plant species research. Modern systematics is *evolutionary* and *phylogenesis* science. The important theoretical problem of systematics is the problem of species: namely how wide or narrow interpretation of species. For solving this problem, it is important to study ecotypes in nature and in experiment conditions and providing eco-geographical, phytocenological, endemic, and history of flora formation research.

General questions of plant systematics

In 19th century (1827), Robert Brown (1773–1858) divided the plant world into two main groups: low or thallus plant (Thallophyta) and high (embryo) plants (Embryobionta, Embryophyta) or leaf-stem plants (Cormophyta, Cormobionta).

Modern phylogenetic classification of plants contains the following taxa:

Superkingdom Procaryota

Kingdom Mychota

Subkingdom Cyanobionta

Superkingdom *Eucaryota*

Kingdom Plantae

Subkingdom Rhodobionta

Subkingdom Phycobionta

Subkingdom Embryobionta

All vascular seedless plants, Gymnospermae and Angiospermae have the following peculiarities:

- vegetative organs (root and stem);
- conductive tissue;
- mechanical elements;
- alternation of generations.

History of plant systematics

History of plant systematics contains the following periods: utilitarian, practical using of plants, till the end of XVI century; artificial morphological systematics on the basis of one morphological features; natural systematics, set of morphological features; evolutionary (phylogenetic) systematics, phylogenetic systems on the basis of evolutionary study.

Utilitarian, practical using of plants, until the end of XVI century characterized by the first information about medicine and practical using of plants. The Greek scientist *Aristotle* (384 BC–322 BC) investigated plants and thought they are living organisms and the important part of nature. The Greek scientist *Theophrastus* (c. 371 BC – c. 287 BC) had a significant influence on the development of botany and plant systematics. He was a student, a collaborator, and a successor of Aristotle. During his life, he wrote two large botanical treatises. The first one is ***Enquiry into Plants***” (c. 370–c. 285 BCE) and consists of nine books. These nine books contain information about trees, plants of particular regions, shrubs, herbaceous plants, cereals and about plant juices and medicinal properties of herbs. He was the first scientist who divides the plant world into trees, herbs, shrubs and dwarf shrubs, land and aquatic plants, evergreen and deciduous plants. In his works, he pays special attention to the woody plants.

The second work ***De Causis Plantarum***” contains information about plant physiology and consists of six books. The books 1 and 2 are about generation, sprouting, flowering and fruiting of plants, influence of climate on plant organism. The books 3 and 4 are about cultivation and agricultural methods. The books 5 and 6 contain information about plant breeding, diseases and other causes of death; and distinctive flavours and odours. *Marcus Porcius Cato* (234 BC – 149 BC) investigated agricultural plants. In his work ***De agri cultura***” it was given information about 120 agriculture plants.

Hippocrates of Kos (c. 460 BC – c. 370 BC) gave description of 236 medicinal plants. *Aulus Cornelius Celsus* (c. 25 BCE – 50 CE) investigated description and use of medicinal plants were by. Local flora of medicinal plants was researched by *Claudius Galenus* (129/131 – 200/217 CE). The turkey scientist *Pedánius Dioscorides* (40–90 CE) in his work “***De Materia Medica***” gave description of 600 medicinal plants and classified these plants using some morphological features, geographical distribution and way to use.

The Roman scientist *Gaius Plinius Secundus* (AD 23/24–79), better known as Pliny the Elder in his work “***Natural History***” consisting of 37 volumes devoted 15 volumes about plants in which it is given description of 1000 plants and its practical using. He thought the nature had created for human.

The scientist of Middle Asia *Avicenna* (980–1037) in his work “***Canon of medicinal science***” gave description of many new medicinal plants.

The German scientist *Albertus Magnus*, (1200–1280), treatises about plants consisting of seven books divided all plants into trees, bushes, herbs and gave description of species in alphabetical order. In 1309, the Italian scientist *Methew Silvaticus* formed the first botanical garden in Salerno. The first botanical garden in Ukraine grounded in Lubny (1721) as a botany garden of medicine plants. *Conrad Gesner* (1516–1565), a Swiss scientist in his works “*Historia plantarum et vires*” (1541), “*The Catalogus plantarum*” (1542) and “*Opera botanica*” (1754) gave the idea that flowers and fruits are important for classification of plant species.

Luca Gini (1490–1556), an Italian scientist, formed first herbarium for Boulogne University (1550).

Nowadays the biggest herbarium in the world is Kew in London (GB) with more than seven million preserved vascular plant specimens that have been collected around the world over the past 170 years. In Ukraine, herbarium of Kholodny Institute of Botany grounded in 1921 contains about 2000000 specimens. In Russia, Saint Petersburg, there is a herbarium with more than five million specimens.

Geographical events at the end of 15th century such as discovering America (1492) by *Columbus* (1451–1506), the creation of a waterway from Europe to South Asia (1497–1499) by *Vasco da Gama* (1460/1469–1524), conquering Mexico (1519–1521) by *Hernán Cortés* (1485–1547) and growth of capitalism encouraged an acceleration of development in Botany and plant systematics.

The second period in the history of plant systematics characterized by making of artificial morphological systematics based on one morphological features of plants.

Andrea Cezalpino (1519–1603), an Italian scientist, in his work “*De plantis*” (1583) consisting of 16 books gave the first system of the plant kingdom based on the structure fruits and seeds. He divided all plants in two groups: woody and herbal.

Carl Linneus (1707–1778), Danmark parish (outside Uppsala), a Sweden scientist, published “*Systema naturae*” (1735) in which he gave a new system for classifying of plants. In his work “*Philosophia Botanica*” (1751, p. 219) he pointed

out, that “A plant is completely named if it provided with a generic name and a specific name”. In 1737, he published “Genera of plants” with approximately one thousand genera and 7300 species using binominal nomenclature. In his two-volume work "Species of plants" (1753), he also used binomial, system for naming plants. In Linnaeus' system for plant classifying it is used number of stamens, its location and attaching, presence of male and female reproductive (sexual) organs (monecious and dioecious flowers). *Carl Linneus* named the father of biological classification.

Linnaeus divided the whole plant world into 24 classes. The first 23 classes contain stamens and carpels (*Phanerogamia*), the members of the last 24th class lack stamens and carpels (*Cryptogamia*). Linnaeus' system consists of four taxonomic categories: class (24), order (116), genera (c. 1000) and species (c. 10000). Different taxa contain different features – class: structure of flower, order: number of carpels and structure of fruits. Basis of Linnaeus' classification depends on species. This classification was artificial because in some classes there are genera without connections. The artificial system of plant classification based on one feature of species, not some common close ones. The main discoveries of Linneus are system of plants and animals, specification of species conception, clear separation of class, order, genus, species, introducing the definition of flora, development of binary (sexual) nomenclature.

A French botanist *Josef Pittone de Turnefort* (1656–1708), was the first scientist who gave clear definition of plant genus and distinction between genus and species. He also proposed a system of plants and collected 6963 specimens for herbarium.

Andrea Cezalpino, an Italian scientist, processed all information about the plants and published his work “De plantis” (1583), consisting of 16 books and gave the first artificial (morphological) system of the plant kingdom on the base of the structure of fruits and location of seeds (the carpology system). *Andrea Cezalpino* (1519–1603) divided all plants in two groups (divisions) – woody and herbal plants. His system contained 15 classes, to classify plants he used the number and character of a seed location. *John Ray* (1670–1705), an English naturalist, was the first who gave a biological explanation of the term species and genus close to modern definition.

Augustus Quirinus Rivinus (1652–1723), a German scientist, who classified the plants according to the structure of the flower. He was the first to apply consistently the rule that the names of all species in a genus should start with the same word (generic name). *Josef Pittone de Turnefort* (1656–1708), a French scientist, in 1694 created a new system of plants based on the corolla features. Turnefort's system contains the following taxa as class, section, genera and species. *Antoine-Laurent de Jussieu* (1748–1836), a French botanist, formed a system of plants (1789) based on free and grow together petals.

Natural systematics based on the set of morphological features for taxonomic categories

For plant classification, natural systematics uses set of morphological features for taxonomic categories. *Bernard de Jussieu* (1699 –1777), French naturalist, younger brother of Antoine de Jussieu in 1759 arranged the plants in the royal garden of the Grand Trianon in the Palace of Versailles, according to his own scheme of classification. This arrangement is printed in his nephew Antoine Laurent de Jussieu's "Genera plantarum secundum ordines naturalis disposita" (1789), and formed the basis of that work. *Antoine Laurent de Jussieu* (1748–1836) from France was the first who created a natural system of flowering plants based on an extended unpublished work by Bernard de Jussieu. He divided the plant world into six divisions (*Acotyledones*, *Monocotyledones*, *Dicotyledones apatetae*, *Dicotyledones monopetalae*, *Dicotyledones polypetalae*, and *Dicotyledones diclines irregulares*), 15 classes and 100 orders. The first class of the classification depended to spore plants, other classes differ by location of stamens relatively to carpel, way of stamen attaching, location corolla relatively to carpel. He gave the features for higher and lower taxonomic categories.

A Swiss botanist *Augustin Pyramus (Pyrame) de Candolle* (1778–1841) wrote "Systema regni vegetabilis naturale" (1835) and divided the plant world in two divisions:

1. *Plantae vasculares*. Cotyledonae (Exogenae Dicotyledoneae: Thulamiflorae, Calyciflorae, Corolliflorae and Exogenae Monocotyledoneae: Phanerogamae, Cryptogamae),

2. *Plantae cellulares*. Acotyledonae. Non-vascular (cellular) plants divided into leafy (Mosses), and non-leafy (Fungy, Lichen, Algae). De Candolle's system of plants based on new principles such as anatomical features for plant categorization and these features were more or less complete.

A Russian botanist *Pavel F. Goryaninow*, (1796–1865) created the system of plant world which contained 4 groups, 12 classes and 187 families. *Goryaninow's* system of plants consists of four groups: 1. Spore plants, 2. Gymnosperms, 3. Monocots and 4. Dicots. His philosophy nature conception based on spiral nature development and on the top of the system is located human.

The fourth period in history of the plant systematics was the period of evolutionary (phylogenetic) systematics and phylogenetic systems. This period based on evolutionary study. An English naturalist, geologist and biologist *Charles Robert Darwin* (1809 – 1882) is the best known for his works in the field of the species evolution.

He thought all species have descended over time from common ancestors. It was a scientific theory on the base of evolution, natural selection, and struggle for existence of species. Darwin in "On the Origin of Species" (1859) wrote the main ideas. A German botanist, *Alexander Carl Heinrich Braun* (1805–1877) researched morphology of plants and prepared the first phylogenesis (evolutionary) system (1864). He divided *Angiospermae* in three groups: *Apetalae*, *Monopetalae* and *Polypetalae* and looked at *Gymnospermae* and *Angiospermae* as discrete subdivisions of flowering plants.

A German botanist *Heinrich Gustav Adolf Engler* (1844–1930) worked in the field of plant taxonomy and phytogeography. In his works “Die natürlichen Pflanzenfamilien” (“The Natural Plant Families”), edited with Karl A.E. von Prantl and “Syllabus der Pflanzenfamilien” (1903) developed the most useful taxonomic system of plants. Most of European herbaria, Florae, (Flora of the USSR, Flora of Ukraine) are on Engler's system. In Engler's “Syllabus” (12th reprint, 1954), the whole plant world is divided in 17 divisions, the first 13 of them are low plants, 14th is mosses, 15th is *Lycopodiaceae*, *Equisetacea*, *Polypodiaceae*, 16th is *Gymnospermae*, 17th is *Angiospermae*.

An Austrian botanist *Richard Wettstein* (1863–1931) developed a taxonomic system, which was one of the earliest based on phyletic principles (1901). He divided all plant species 9 divisions. Eight low (thallus): algae, bacteria, fungi, 9th higher (leaf-stem plants) – two groups (archegonia plants: Bryophyta, Polypodiophyta and flower plants: *Gymnospermae* and *Angiospermae*). In Engler's system, Monocots are located after dicots, Bryophyta, Polypodiophyta form a separate group, *Gymnospermae* separated from archegonia plants. *Wettstein's* pseudanthium theory of flower based on bisexual flower formed by fusion of male and female flowers of some *Gymnospermae* (*Ephedra*).

A British plant morphologist and anatomist, *Agnes Robertson Arber* (1879 – 1960) was a philosopher of biology and a historian of botany. Her scientific research focused on the monocotyledon group of flowering plants.

A British plant morphologist *John Parkin* (1874 – 1964) with *Agnes Robertson Arber* developed the evant or strobilus theory. Due to the theory bisexual a flower of *Angiospermae* is not the inflorescence, it is the true flower originated from the strobilus of the *Bennettitales* fossils.

A Swiss naturalist, *Albrecht von Haller*, (1708–1777) created his own system of plant world (1901) on the base of the strobilus theory. In this system, *Angiospermae* originated from *Bennettitales* ancestors with indefinite number of an entomophilous flower with spirally located elements. *Bennettitales* gave rise to *Anonales* (multicarpels) from which developed *Polycarpicae* or *Protorogenae* from which formed Monocots and *Rosales* especially *Saxifragaceae* which created Dicots (*Saxuflagenaeae* named by Haller).

A Russian botanist *Nikolay I. Kuznezov* (1864–1932), divided all species of plant world into four main groups: Amoeboidea (one-celled organisms), Oogoniatae (one-celled and multicellular organisms with thallus), Archegoniatae (non-vascular and vascular plants), *Gymnospermae*, Antophytae (all *Angiospermae*). A new peculiarity of *Kuznezov's* system was that he put *Angiospermae* to Archegoniatae.

An American botanist *Charls Bessi* (1845–1915) created the system of flowering plants (1915).

An English botanist *John Hutchinson*, (1884–1972), a taxonomist and an author of a new classification system of plants published in 1926 in which *Polycarpicae* is an ancestor of *Angiospermae* divided into two orders: *Magnoliales* (woody plants) and *Ranales* (herbal plants).

A Dutch botanist, *August Adrian Pulle* (1878–1955) developed the system of plants (1938), in which connections among different orders of flowering plants are given graphically as a phylogenetic scheme with rings which mean orders and lines as connections among them. Shorter lines mean closer affinity between neighbor orders. He thought that monocots and dicots are different groups and have different origin.

A Russian Botanist *Nikolay A. Bush* (1869–1941) created a monophyletic system of plants. To his view, the ancestral group of Angiosperm plants was Protoanthophyta, a hypothetical group of plants, which gave rise to the three directions of development: multicarpels (central), unilateral, *Casuarinaceae*. This monophyletic system contains 44 orders.

A Russian botanist (born in Ukraine), *Alexander A. Grossgeim* (1888–1948) developed a phylogenetic based on evant monophyletic origin of flowering plants. The ancestral flowering plant group in this system is Polycarpels containing two orders: Anonales and Ranales.

Angiospermae in this system is without mono- and dicots containing two lines of monocot evolution (Anonales and Ranales). In his system the author marks the following categories of plant evolution: 1) stages, 2) ways (lines), entomophilous, anemophilous (older, but parallel), 3) time and temp, 4) territory and scale.

The first stage is the central ring containing species with indefinite number of flower elements, an apocarpous gynoecium and a simple perianth. The second stage is the middle ring containing species with definite number of flower elements, syncarpous gynoecium, and superior ovary as a rule, double perianth and free petals. Third stage is the outer ring of species with definite number of flower elements, often four ringed; a gynoecium is always syncarpous with an inferior ovary and a double perianth. Lines of evolution were insect, wind and water pollinating, heterotrophic species of secondary origin.

An Estonian botanist *August Vaga* (1893–1960) developed a scheme of organic world (1952). All organic world takes its origin from primitive organisms, which gave rise to primitive animals, plants and saprophytes. From these three groups it is begun the origin of animals, autotroph plants from Algae to Angiospermae and heterotroph forms (Fungi, Bacteria, Mycetozoa). The whole scheme consists of 38 types, 16 of them are autotrophic, five – fungi, 17 –animals.

In 1941 an Armenian botanist, *Armen L. Takhtajan* (1910–2009) created the system of Angiosperms (1941) containing the following divisions of higher plants subkingdom: Zosterophyllophyta, Bryophyta, Lycopodiophyta, Psilotophyta, Equisetophyta, Polypodiophyta, Pinophyta (Gymnospermae), Magnoliophyta (Angiospermae)

In 1954, *Takhtajan's* system of classification was published in “The Origin of Angiospermous Plants”. In 1980, *Takhtajan* published a new version of the plant classification system in Botanical Review. This system consisted of Dicotyledones (about 325 families, about 10000 genera, about 180000 species, seven subclasses) with subclasses: 1. Magnoliidae, 2. Ranunculidae, 3.

Hamamelididae, 4. Caryophyllidae, 5. Dilleniidae, 6. Rosidae, 7. Asteridae and Monocotyledones (about 65 families, about 3000 genera, about 60000 species, and three subclasses: 1. Alismatidae, 2. Liliidae, 3. Arecidae).

In 2009 it was published the Second Edition of Takhtajan's Flowering Plants in which there were the following taxa: Phylum Magnoliophyta, Class MAGNOLIOPSIDA, Subclass I. Magnoliidae, Subclass II. Ranunculidae, Subclass III. Hamamelididae, Subclass IV. Caryophyllidae, Subclass V. Dilleniidae, Subclass VI. Rosidae, Subclass VII. Asteridae, Subclass VIII. Lamiidae, Class LILIOPSIDA, Subclass I. Alismatidae, Subclass II. Liliidae, Subclass III. Arecidae, Subclass IV. Commelinidae.

Modern methods of plant systematics

Recently for study and research of phylogenetic connections among the plants it is used different methods such as 1) biological methods based on study of structure and functions of presently existing plants, 2) phylogenetic, physiological, ontogenetic, biomorphological, 3) topological methods: geographical, ecological, phytocenological, 4) additional methods: *mathematical, morphological, anatomical, paleobotanical, embryological, geographical*. For plant systematics, Decandol and Engler's conclusions are important. Decandol's conclusions are 1) species with the small area of distribution are younger than species with the wide distribution, 2) center of genus origin is located in the place of its numeral species concentration. Engler's conclusion are 1) mountain countries are the centers of endemic species, 2) monotype genera were with numeral species in the past. Modern classification uses fusion of botanical and geographical methods, biochemical methods, experimental, hybrid, method of physiologic immunity, teratology method, and entomological method.

Plant world development on the Earth history background

Due to evolutionary study, all living organisms are the result of long lasting historical development from simple to highly organized creatures. This development is in close correlation with environmental changes. In the Earth history, it took place gradual and sudden changes. History of the Earth development containing geologic eras, periods, epochs, ages has strong connection with plant world development. Earth's history development divides on eras, epochs, centuries. There are the following eras: Cenozoic, Mesozoic, Paleozoic, Proterozoic, Archean. **Archean** era is 1000 million years of duration, at the end of the era begun forming of simple life forms. **Proterozoic** era is 600 million years of duration. At the early stages of the Proterozoic era existed Algae, bacteria, and Fungi. **Paleozoic** era is 325 million years of duration. Early **Paleozoic** era characterizes by wide distribution of Algae. At the end of **Silurian** period it is appeared first terrestrial plants (Rhyniophyta). In **Devonian** period, it is existed Psilophyta and Archaeopteris flora, Lycopodiophyta, Polypodiophyta.

Carboniferous period characterizes by powerful development of Polypodiophyta, Calamites, Lepidodendron, Sigillaria, Cordaitidae, and Ginkgophyta. At the end of **Carboniferous** period, it was disappearance of Rhyniophyta. In the south Hemisphere due to cooling of the climate, it was appeared “*Glossopteris* flora”. **Permian** period characterizes of wide spreading of the first Pinophyta (nowadays fossils), Cycadophyta, Ginkgophyta, also giant Equisetophyta (*Calamites*), woody Lycopodiophytes (*Lepidodendron*, *Sigillaria*). At the end of **Permian** period, it was dry climate with *Sigillaria*, woody Equisetophyta, seed ferns, and further development of Pinophyta, Cycadophyta, and *Ginkgo*. In the south Hemisphere, due to cooling of climate and dry conditions, “*Glossopteris* flora” entered Europe.

During **Triassic** period, in Europe, and North America, it was increased climate dryness and Pinophyta, Cycadophyta, Ginkgophyta were wide spread and disappeared Cordaitidae. Lycopodiophyta, Equisetophyta were with limited spreading. **Jurassic** period was with even moisture climate. Pinophyta, Cycadophyta, Ginkgophyta were wide spread. In this period Bennettitales, which were ancestors of Angiospermae were wide spread. Upper **Jurassic** characterizes by appearance of Angiospermae. **Cretaceous** period characterizes by further development of Pinophyta and fading of Ginkgophyta. In the middle of **Cretaceous** period, Cycadophyta were extinct. It was time of quick spreading of Angiospermae, which dominated. Large areas were significantly occupied by Magnoliaceae, Lauraceae, Platanaceae, some of Fabaceae, Fagaceae, Salicaceae, *Eucalyptus*, some of Poaceae. Bennettitales were extinct.

Cenozoic is 70 million years of duration and contains three periods: **paleogene**, **neogene**, and **quaternary**. In **Paleogene** period mountains arose in Europe, North America. On the territory from Europe to Western Asia, there were mild climate and thermophilic flora of evergreen plants (*Myrtus*, *Laurus*, *Quercus*, *Ficus*, *Areaceae* tropical ferns). In the middle of Oligocene epoch, there was deciduous temperate flora (*Quercus*, *Fagus*, *Acer*, *Betula*, *Populus*, *Magnolia*, *Taxus*, *Sequoia*, *Metasequoia*). At the beginning of **quaternary** period, it was heavy precipitations with cooling and forming of glaciers. The biggest glacier was Dnieper's glacier existing in the second part of Pleistocene epoch. During that period, cold resistance flora containing herbal forms, bushes, Pinophyta and leafy woody plants (Ulmaceae, Betulaceae, Salicaceae, Aceraceae etc.) existed on the Earth. The **quaternary** period characterizes by appearance of human.

During the Earth history, flora and vegetation have been continuously changing. The flora and vegetation history contains five main phases. These are Algae time (end of **Archean**, **Proterozoic**, **Paleozoic** and later periods), Rhyniophyta time (end of **Silurian**, especially **Devonian**, beginning of **Carboniferous**), Lycopodiophyta, Equisetophyta, Polypodiophyta time (**Devonian**, especially **Carboniferous** and later periods), Pinophyta time (**Carboniferous**, especially Mesozoic and late periods), Anthophyta time (late **Jurassic** (maybe much earlier), **Carboniferous**, **Tertiary** (**Miocene**, **Pliocene**) and especially **Quaternary** periods).

Classification of plants

Plant systematics contains systematical units or taxa and nomenclature of plants. The main task of plant systematics is to classify groups (taxa) based on relationships. Modern systematics of plants contains 25 taxa. The main systematical units are division (*divisio* or *phylum*), class (*classis*), order (*ordo*), family (*familia*), genus (*genus*), and species (*species*). To the intermediate, smaller taxa added the prefix *sub-* (*subdivisio*, *subclassis*, *subordo*, *subfamilia*, and *subgenus*). Large families with many genera, except *subfamilia* contain tribe and subtribe (*tribus* and *subtribus*), and located between a subfamily and a genus. Within genera with many species, except *subgenera* it is formed section (*sectio*), subsection (*subsectio*), within section – *series* and *subseries*. Polymorphic species may divide into *subspecies*, *varietas*, and *forma*. In of plant systematics, not only dividing, but also integration of taxa uses. The main principle for plant taxon formation is similarity and relationship of external and internal structure features. On the base of these relationships, it is formed species, genera, family, orders, classes, divisions, kingdoms. The main taxon of plant classification is species, and the highest is division. **Carl Linné**, in his work «Species plantarum» (1753), used a binary nomenclature with double Latin name: the first word means genera, and the second is species. **Carl Linné** was the first who used binary nomenclature in its works. Developing of binary nomenclature principles depends on a German botanist **Auguste Rivinius**, (1652–1723). After species name the shorted name of author follows, who firstly characterized the plant: Bess. – Besser, Bge. – Bunge, Boiss. – Boissier, DC – De Candolle, Hook. – Hooker, Juss. – Jussieu, L. – Linné. In study literature, a name of a plant uses without shorted author's name, but in science works uses with author's name. Names of many alkaloids, glycosides, saponins, essential oils by plant origin derived from plant Latin name.

Principles of classification of Embryophyta

Until recently, two groups of Embryophyta have occurred. The first group was Archegoniatae (archegonia plants) and the second group is Anthophyta (flower plants) or Gynoeciatae (carpel plants). Archegoniatae as a systematic category, type or division consists of species with a multicellular female sexual organ, which called an archegonium. Botanist Ivan N. Gorjankin (1848–1904) firstly established this type of plants in 1900.

Due to current data, Archegoniatae contains some independent separate systematic units, which appear during evolution. This is Bryophyta with domination of gametophyte (1n) in the life cycle. The rest of Archegoniatae contains taxa with domination of a sporophyte (2n) in the life cycle and reduction of gametophyte, especially in heterosporous species of Lycopodiophyta, Polypodiophyta, and Pinophyta. Pinophyta is the group of plants with a naked seed. The seed of these species developed from seed embryo, which is a modified megasporangium of heterosporous Polypodiophyta. Species of Magnoliophyta

(Anthophyta or Angiospermae) propagate by seeds located within the fruit, absent in Pinophyta.

A fruit forms after fertilization from ovary. An ovary and a carpel are new organs. These organs are a specific feature of Angiospermae. All plants contain close phylogenetic relations with each other and common origin. In 19th century, division Pteridophyta based artificially. Pavel F. Goryaninov (1796–1865) in 1841 proposed the name of the division. In 1899, an American scientist Geoffrey Evans (1883–1963) shown difference between Lycopodiophyta and Pteridophyta, Pinophyta and Angiospermae. Lycopodiophyta is a special line of plant evolution without true leaves and with small outgrowths on the stem called phylloids that is why the stem lacks lacuns. Single sporangia are located in sinuses of phylloids or on the stem higher than sinus. Lycopodiophyta separated from Pteridophyta, which have leaves, thallus origin and different sporangia location.

A British botanist Dukinfield Henry Scott (1854–1934), on the base of his research of Sphenophyllales, Calamites, Equisetophyta and Psilotacea united into phylum Sphenopsida. In 1930, a German botanist Walter Max Zimmermann (1892–1980), concluded that Sphenopsida lacked Psilotacea.

Dukinfield Henry Scott, at the beginning of 20th century gave a proposal to form a new group of fossils Psilophyta that then renamed to Rhyniophyta. From Rhyniophyta it was formed separate division Zosterophyllophyta.

D.W. Bierhorst, in 1871 placed Zosterophyllophyta in intermediate location between Rhyniophyta and Lycopodiophyta.

Armen L. Takhtajan in 1941 gave a proposal for fusion of Psilotum and Tmesipteris in a new division Psilotophyta. As a result, subkingdom of Embryophyta contains nine divisions: Bryophyta, Rhyniophyta, Zosterophyllophyta, Lycopodiophyta, Psilotophyta, Equisetophyta, Polypodiophyta, Pinophyta, Magnoliophyta (Angiospermae).

Creating and development of APG system

In the last decade of the twentieth century in evolution systematics of the flowering plants the events that named as a molecular revolution has taken place. New collected material that gives opportunity to look at the systematics of flowering plants from another point of view. After permutations in orders of flowering plants, it seems that new orders formed. Group of scientists named as Angiosperm Phylogeny Group (APG) published the new system with a new vision of the orders of Angiosperm plants.

Systematics is a biology science studying all diversity of extinct and existing organisms. Carl Linnaeus (1751) firstly used systematics as a term. The main tasks of systematics are identification, description, classification and grouping of organisms in system. The main goal of systematics is to form the system of organisms with defined place for every taxon. Modern systematics as a science synthesizes all chapters of biology especially plant evolution that plays the key role in systematics. Systematics contains taxonomy (De Candolle, 1813) that is a

theoretical and practical base of organism classification. The main task of classification is to find the main differences and similarities among taxa for location of organisms in hierarchical system. Taxonomy is a theoretical base of classification and form rules for location of taxa in the system.

Forming the right names of organisms depend on nomenclature that is the second chapter of systematics. Nomenclature in modern botany consists of all names of taxa. The rules of botanical nomenclature are in International code of botanical nomenclature (Melbourne, Australia, 2011).

Phylogenetics as a part of modern evolutionary biology finds kinship of organisms in historical terms and historical evolution of living organisms as a whole and for individual systematics groups. There are different types of plant systems.

Artificial systems use one or some morphological features. Carl Linnaeus (1753) created the first artificial system. In **natural** systems, organisms are grouped using maximum of similarities among them. Michel Adanson (1763) was the first scientist who created natural system. Bernard de Jussieu (1699–1777) gave different meaning for different groups of diagnostic features. Modern **phenetic** systems (Sneath, Socal, 1973) pay attention to diversity on lower taxa levels as species and intraspecies. The principle of phylogeny in these systems as usual ignored. **Genealogical** systems created in the nineteenth century consider similarities, differences and phylogeny of species. There are two variants of genealogical systems. **Evolutionary** systems reflex the results of evolutionary process. These are the systems of flowering plants created by Engler, Wettstein, Hutchinson, and Takhtajan. Since the 1960s of 20th century **phylogenetic** system has formed. Phylogenetic system contains connections between its structure and phylogenesis of taxa.

Phylogenetic systematics has to show history of species phylogeny (Hennig, 1950). The **clade** is a group of organisms with one ancestor and offspring (Huxley, 1957). In 1960, Cain and Harrison named phylogenetic systematics as **cladistics**. **Paraphyletic** group contains a part of offspring of a common ancestor. **Polyphyletic** group consists of taxa originated from more than one ancestor and containing similarities occurred parallel or convergent. As the starting point of clade analysis is used a group of species, set of molecular, morphological, other features of these species, and condition of features. There are two states of features: the original (*plesiomorphic*) state and the derived evolutionary (*apomorphic*) state. The apomorphy is a new state of feature arisen during the evolution of researched group. Some members of group taken into consideration with concrete apomorphy are characterized *synapomorphy*. *Autapomorphy* is a unique apomorphy of only one researched group member. Plesiomorphy is an initial state of the feature for an analyzed group. *Symplesiomorphy* is plesiomorphy contained in two or more taxa. *Homoplasy* is a phenomenon of the evolution without the most economical character.

Electronic data processing provides the processing of huge amount of organism's characteristics. The method of polymerase chain reaction (**PCR**) uses cladistics for analysis of molecular-genetic data. Therefore, there was the

appearance of a new direction called **molecular phylogenetics**. Macromolecular data such as nucleotide DNA sequences and amino acid sequences of proteins have accumulated rapidly due to successes of molecular biology. For evolutionary biology, this data is very important. The results of DNA sequences comparison of different genes and unencrypted regions in different organisms can help solve problem of evolutionary relationships what is impossible by using of morphology and anatomy. One way of genome evolution is gradual accumulation of mutation. Genomes of organisms, which separated in the recent past, have fewer differences than the genomes of organisms, which separated from a common ancestor a long time ago. Among researched DNA, sequences it is dominated the DNA sequences of chloroplasts, but most of heritable information there is in nucleus genome. Furthermore, inheritance of DNA of chloroplasts in many plants occurs uniparental way. Therefore, phylogeny of close related species on the base of this sequence might be different from phylogeny of taxa. For a long time, genes of ribosomal RNA have been attracted attention of scientists.

The first global phyplogenetic system of flowering plants based on the molecular-genetic data was created by international group of scientists “Angiosperm phylogeny group” (APG) and published in journal “Annals of the Missouri garden” (1998) in the article “An ordinal classification for the families of flowering plants” by Kåre Bremer, Mark W. Chase, Peter W. Stevens at all. The system bases on the analysis of the nucleotide sequences of two genes of chloroplast DNA and one gene of nucleus genome. According to APG system, some evolutionary and phenetic systems, dicots is not monophyletic group unlike monocots. Dicots form two groups: grade of palaeodicots and clade of eudicots containing about 95% of dicots. This result also confirmed by the morphology analysis of pollen grains. APG I consists of 40 orders and 462 families. Currently the main phylogenetic system is APG IV published in Botanical Journal of the Linnean Society (2016) and containing 64 orders and 416 families of Angiosperms.

Questions for self-control

PLANT SYSTEMATICS

1. What are the main parts of plant systematics?
2. In what groups did Robert Brown divide the plant world?
3. What treatises did Aristotle write?
4. What the main works written by Carl Linneus do you know?
5. What eras of Earth's history development do you know?
6. What works written by Armen L. Takhtajan do you know?
7. What works written by Augustín Pyrámus (Pyráme) de Candólle do you know?
8. What works written by Mayr Ernst do you know?
9. What works written by John Ray do you know?
10. What works written by Heinrich Gustav Adolf Engler do you know?

CHAPTER 2. FLOWERING PLANTS IN THE CURRENT SYSTEM OF THE ORGANIC WORLD

The current system of the organic world contains two domains: Bacteria and Arkarya (Neomura or Archaea *sensu lato*). LUCA is the Last Universal Common Ancestor. Dotted lines show the origin of mitochondria and primary chloroplasts. Arkarya contains some groups of prokaryotic Archaea and Eukaryots (Figures 2.1, 2.2).

LUCA was an anaerobic autotroph with circular genome (Figures 2.3, 2.4), lived 3,48–4,28 billion years ago in hot (70–80°C) gas- and metal-rich environment, could fix N_2 , used Wood-Ljungdahl pathway fixation of CO_2 (Martin et al., 2016; El Baidouri et al., 2021).

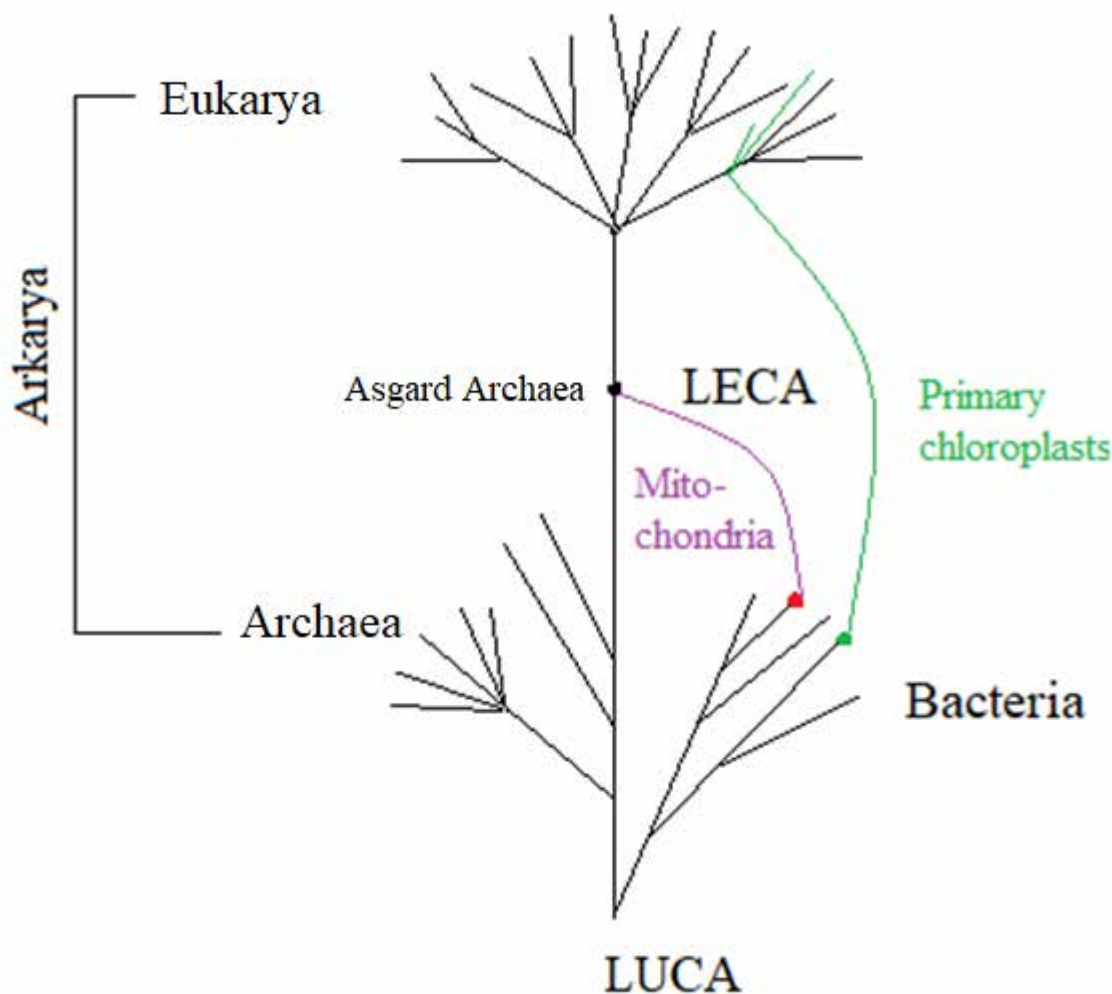


Figure 2.1. Current system of organic world, LUCA: Last Universal Common Ancestor, LECA: Last Eukaryotic Common Ancestor

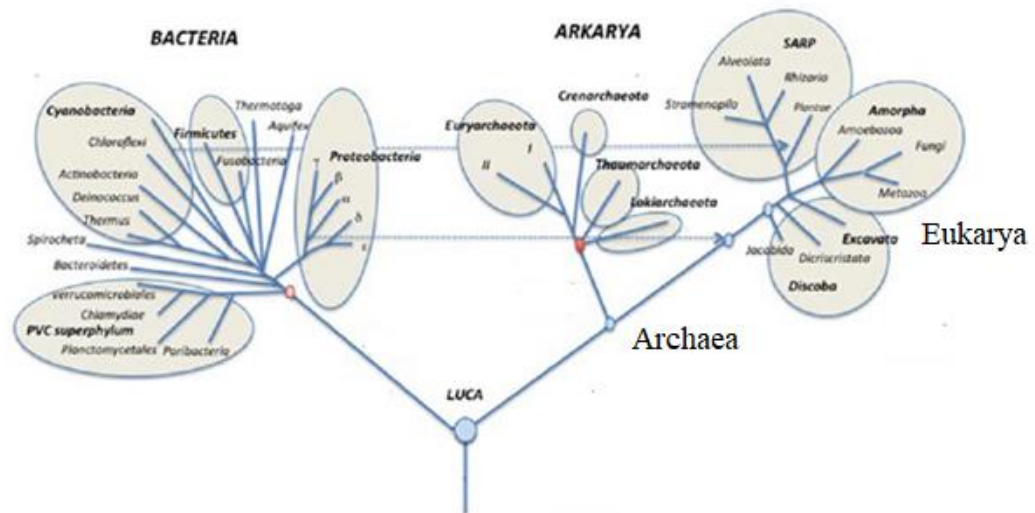


Figure 2.2. Two domains tree of life (Woese et al., 1990; Forterre, 2015)

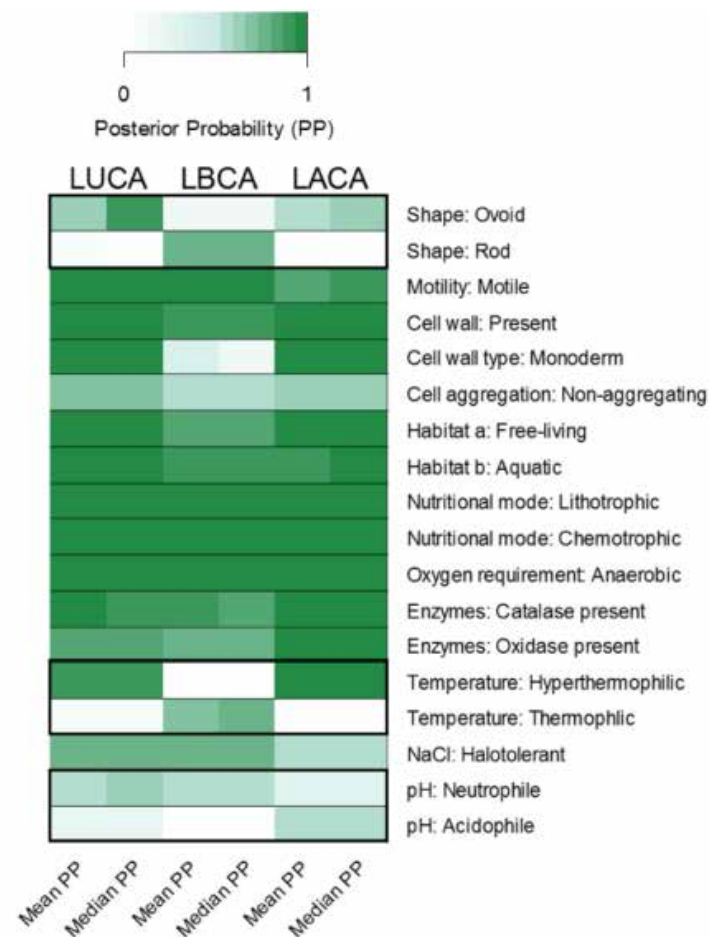


Figure 2.3. Categorical traits of ancestral cells (El Baidouri et al., 2021)

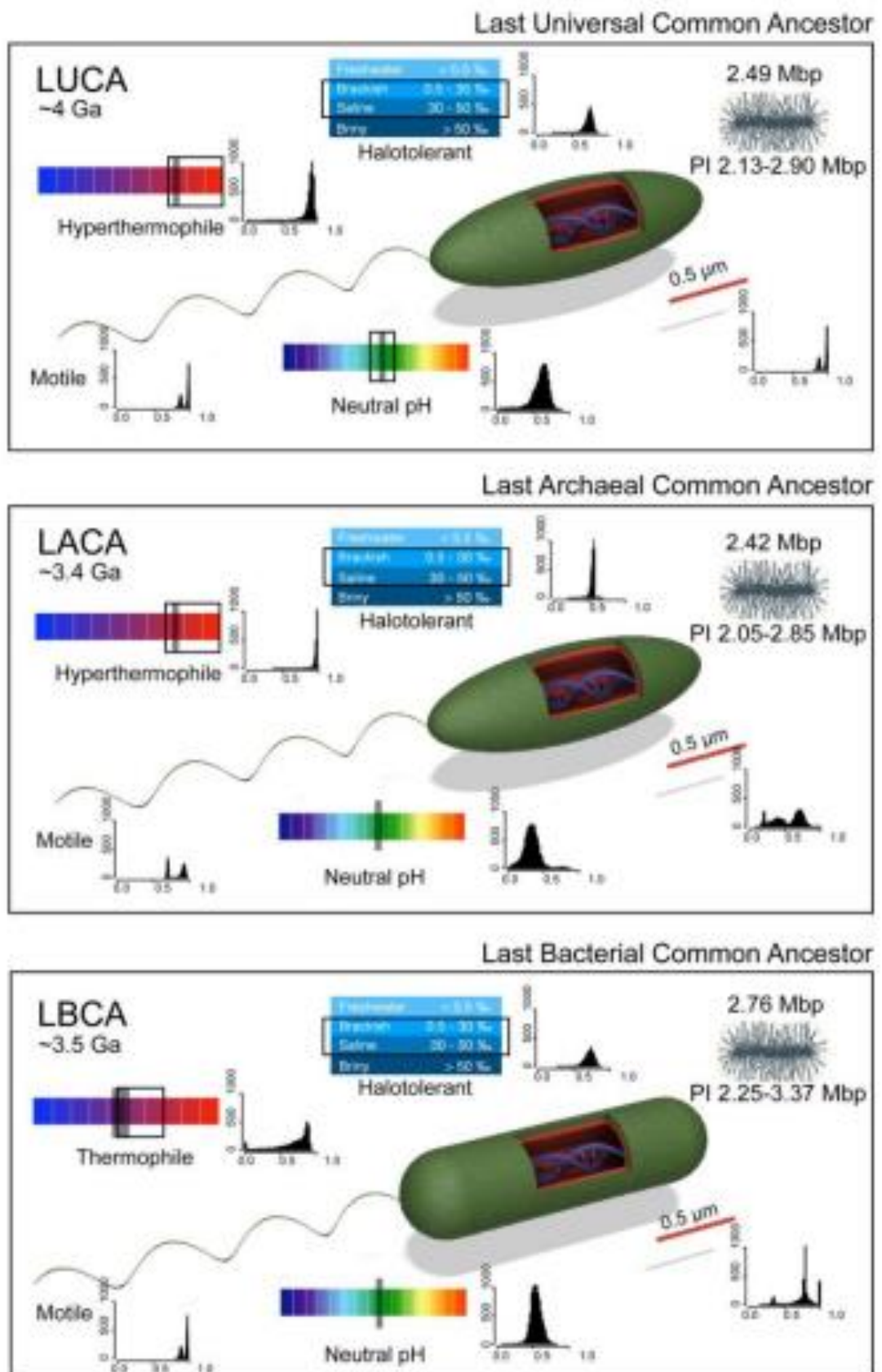


Figure 2.4. Phenotypic peculiarities of ancestral cells (El Baidouri et al., 2021)

Recent molecular-phylogenetic research (Castelle & Banfield, 2018) shows in the composition of two domains Bacteria and Archaea (Archaea and Eukarya) there are two basal groups of organisms with a highly reduced genome: CPR (Candidate Phyla Radiation) in Bacteria and DPANN (Diapherotrites, Parvarchaeota, Aenigmarchaeota, Nanoarchaeota and Nanohaloarchaeota) in Archaea. In these two groups there are no genes responsible for the synthesis of nucleotides, amino acids, lipids. DPANN and CPR lack Krebs cycle enzymes, electron transport chain proteins, and special ribosomes possibly encoding proteins (Figure 2.5).

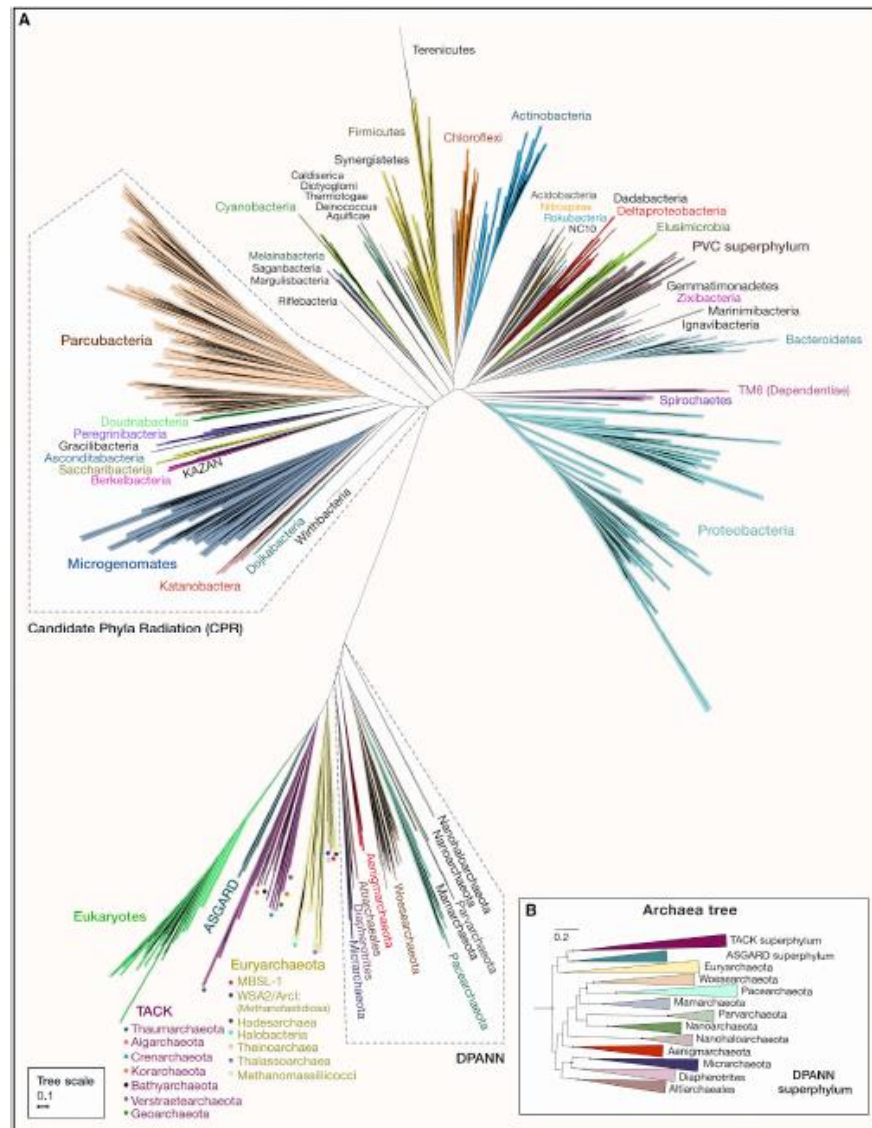


Figure 2.5. Tree of life (Castelle & Banfield, 2018)

On the base of analysis of core genes Williams et al. (2020) supports two primary domains, not three in the current system of organic world (Figure 2.6).

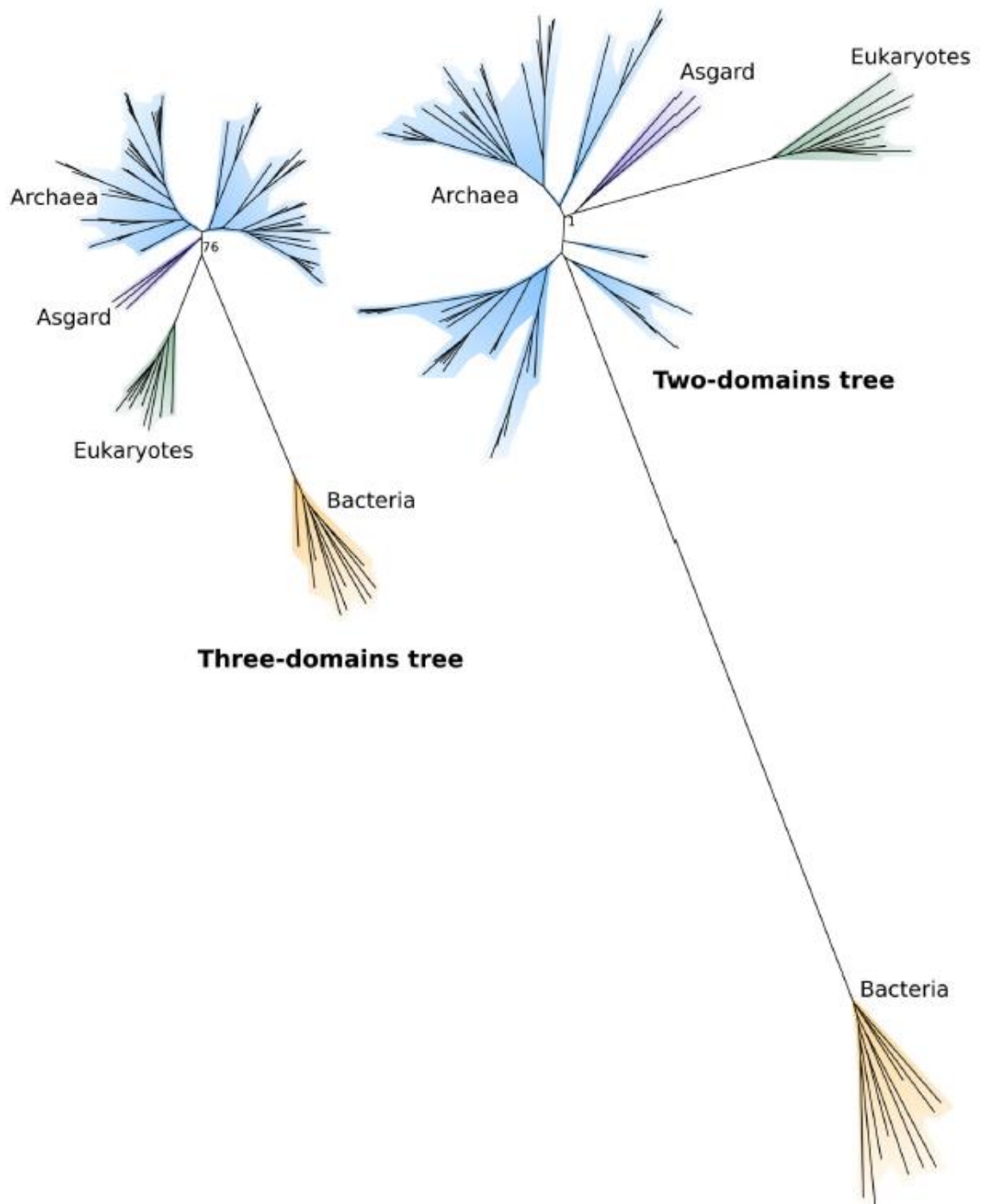


Figure 2.6. Three- and two-domains tree of life (Williams et al., 2020)

In the third edition of the system of Eukaryotes (Adl et al., 2018) the clades AMOEBOZOA, OBAZOA (including Apusomonadida and Breviatea), **Opistoconta** (including Nucleomyxa and Breviatea) form **AMORPHEA**. The clades Phaeophyta, SAR – Stramenopiles, Alveolata (with Apicomplexa, Dinoflagellata, Ciliata), Rhizaria, HAPTISTA, CRYPISTA, ARCHAEOPLASTIDA, Chloroplastida (synonym Viridiplantae), Embryophyta, Rhodophyceae form **DIAPHORETICKES**. The clade **CRuMs** contains Collodictyonidae, Rigifilida, Mantamonas. The system contains also **DISCOBA**,

METAMONADA and **Incertae sedis** clades – Malawimonadidae, Ancyromonadida, Hemimastigophora (Figure 2.7).

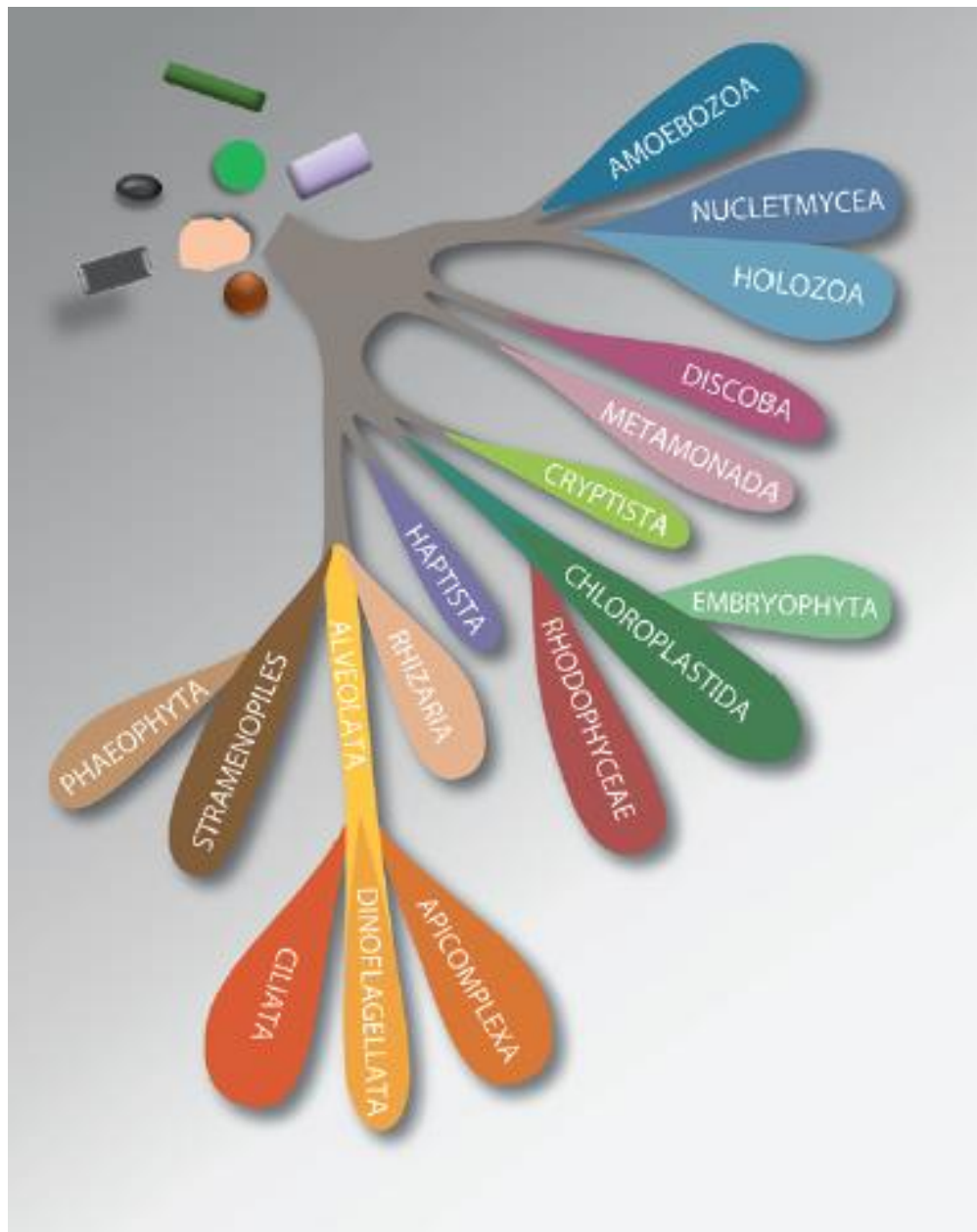


Figure 2.7. Phylogeny tree of Eukaryotes (Adl et al., 2019)

The system of the eukaryotes (Adl et al., 2019)

AMORPHEA (majority of them are heterotrophs, ameboid form, without certain morphology)

AMOEBOZOA (amoeba, zoon – animal)

OBAZOA

Apusomonadida

Breviatea

Opistoconta (flagellate cell possesses a single flagellum inserted posteriorly)

Nucleomycea (synonym Holomycota)
Holozoa (whole, all)

CRuMs

Collodictyonidae
Rigifilida
Mantamonas

DISCOBA (Discicristata, Jacobida)

METAMONADA (“developed monads”, meta – through, monada – motile cell)

DIAPHORETICKES (all unicellular autotrophs, except *Euglena* ssp.)

Phaeophyta

SAR

Stramenopiles
Alveolata
Apicomplexa
Dinoflagellata
Ciliata

Rhizaria

HAPTISTA (hapto – to attach, haptonema – a peg-like organelle attached near the flagella and unique to the group)

CRYPISTA (cryptos – secret, to hide)

ARCHAEPLASTIDA (archeo – ancient)

Chloroplastida (Viridiplantae)

Embryophyta

Rhodophyceae

Glaucophyta

Incertae sedis (groups with unclear taxonomical location)

Malawimonadidae, Ancyromonadida, Hemimastigophora

More deep research of phylogeny relations of Eukaryotes supergroups has shown Ancyromonadida related with Metamonada and Malawimonadida related with Amoebozoa+CRuMs (Lax et al., 2018). The independent group Hemimastigophora branches right from the base of the supergroup Diaphoretickes (Figure 2.8). The most oldest evolutionary branches of eukaryotic supergroups are Diaphoretickes, Discoba and Amorphea+ (including Metamonada, Ancyromonadida, Malawimonadida and CRuMs).

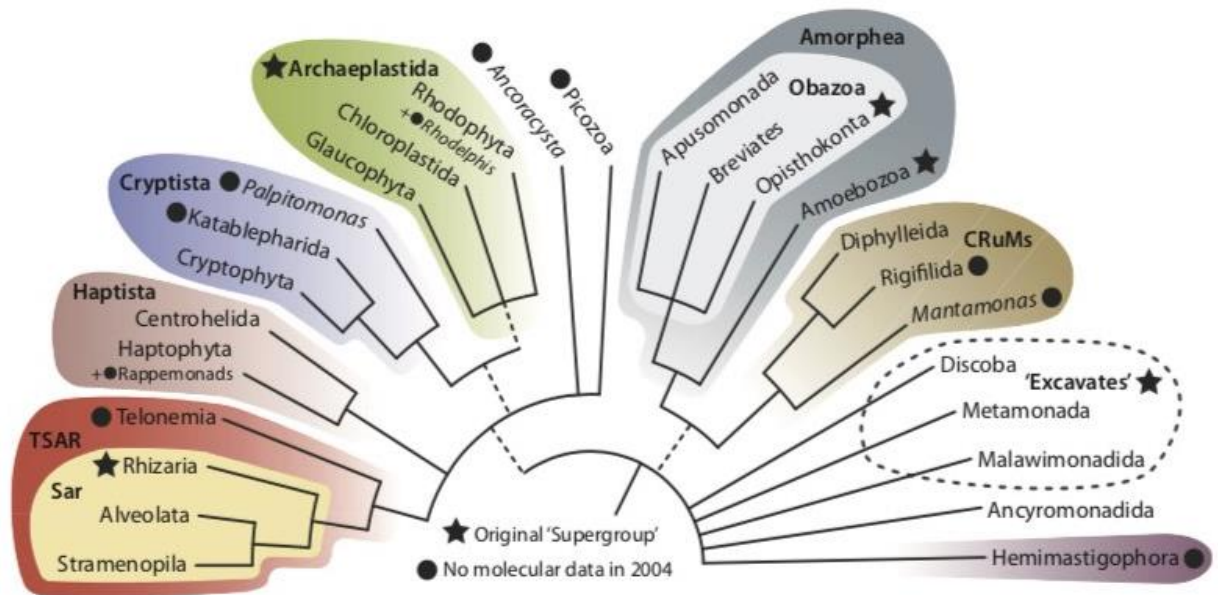


Figure 2.9. Phylogeny of Eukaryotes (Burki et al., 2020)

The **Chloroplastida** (=Viridiplantae, Chlorobionta, Plantae sensu stricto) or the green plants is a monophyletic group of Eukaryotes and form two main clades Chlorophytes (Chlorophyta) and Streptophytes (Streptophyta) with the group Land Plants or Embryophytes (Embryophyta, = Plantae sensu strictissimo). The cells of Chloroplastida members contain nucleus with linear DNA chains and membrane-bound organelles. These are mitochondria, GR (Golgi apparatus), ER (the endoplasmic reticulum) with two subunits: RER (rough endoplasmic reticulum) and SER (smooth endoplasmic reticulum) and others (Figure 2.10).

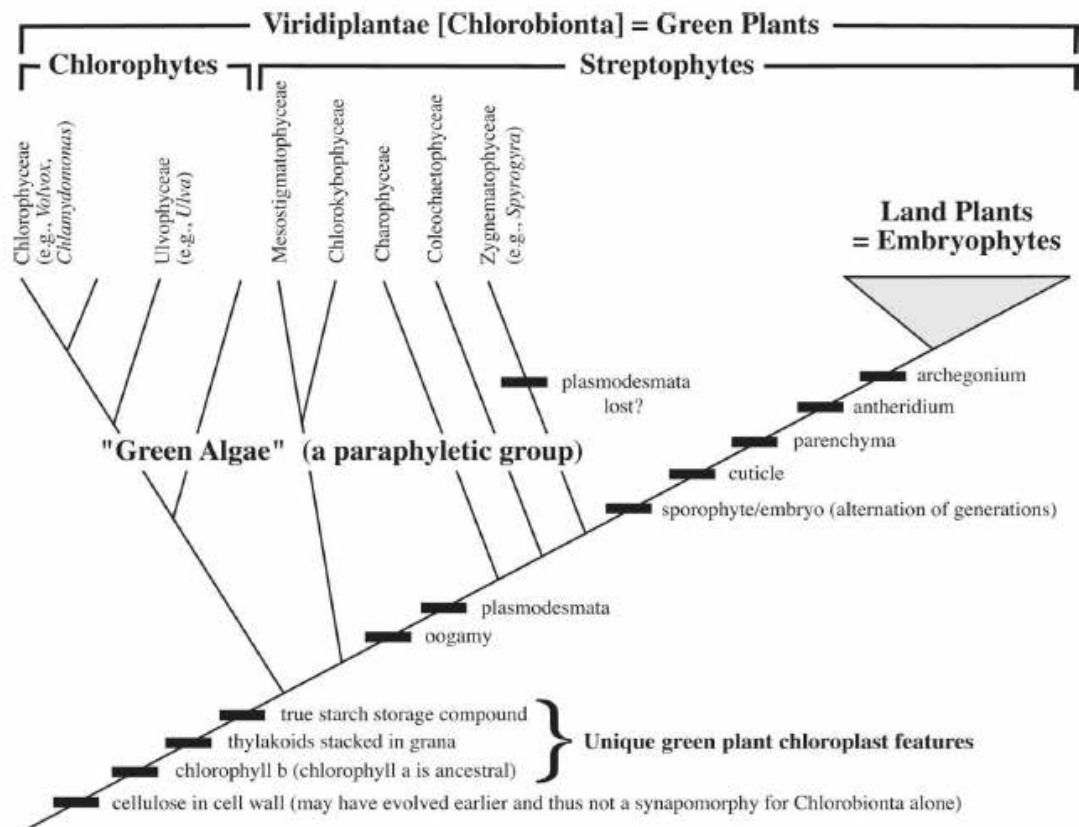


Figure 2.10. Major clades of Chloroplastida (=Viridiplantae, Chlorobionta, Plantae sensu stricto) or the green plants (Ruhfel et al., 2014; Simpson, 2019)

The closest groups containing ancestors of the Embryophyta are Zygnematophyceae and Coleochaetophyceae (Figures 2.12, 2.13). The Streptophyta are monophyletic, but streptophyta algae are paraphyletic because of having relations with the Embryophyta. The structure of cell walls of *Penium margaritaceum* (Zygnematophyceae) is similar to the cell walls of land plants (Figure 2.11) and contains mucilage for protection from terrestrial environmental conditions (Domozych et al., 2007; 2014; Sørensen et al., 2011; Jiao et al., 2020).

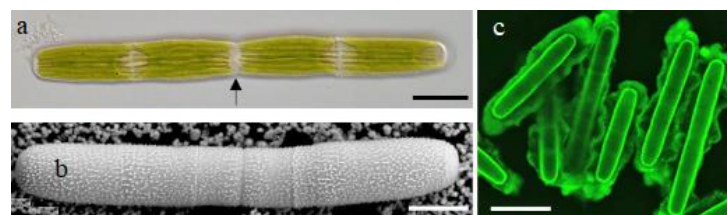


Figure 2.11. Morphology of *Penium margaritaceum* (Jiao at all., 2020): (a) two semi-cells with chloroplasts; (b) and (c) cell with micilage

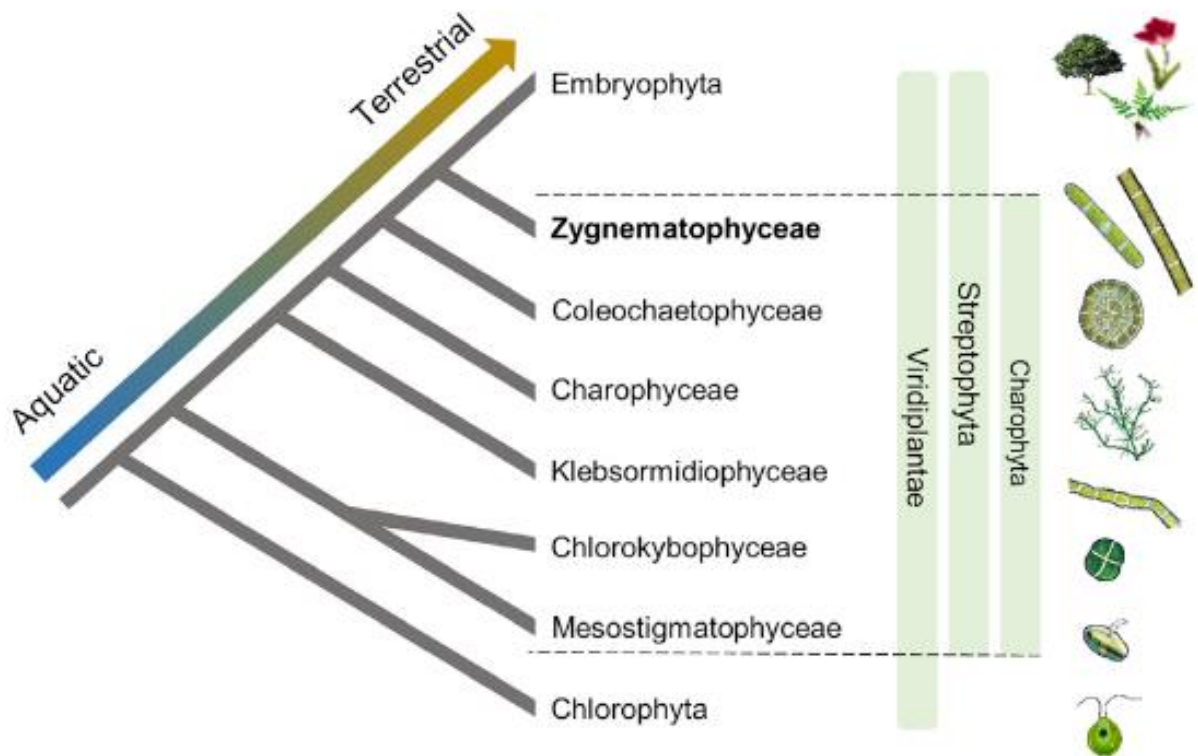


Figure 2.12. The closest ancestors of the Embryophyta (Jiao at all., 2020)

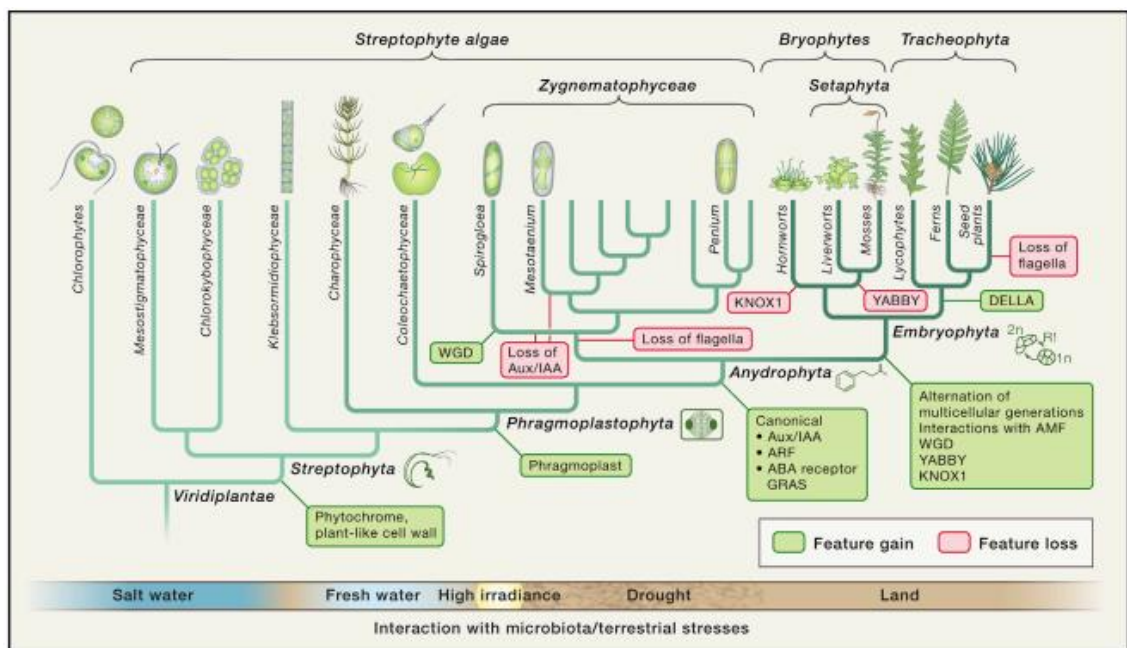


Figure 2.13. Phylogenetic relationships between Embryophyta, Zygnematophyceae and Coleochaetophyceae (Rensing, 2020)

Coleochaete (Coleochaetophyceae) is a lummelar multicellular organism occurs in littoral zone of reservoirs with many intermediate morphological peculiarities of Algae and Embryophyta (Figure 2.14). On the figure 2.15 there is a

gametophyte ($1n$) which forms gametes in male and female gametangia. The female gametangium (the oogonium) is strongly reminiscent the archegonium of Embryophyta with bottle-like form, a neck and a layer of the protecting sterile gametophytic cells as the protecting cells of an archegonium of Bryophyta. Among living green algae only *Coleochaete* possesses zygote on the mother plant (Graham, 1984; McCourt et al., 2004). The egg fuses with male gamete within the oogonium. After fertilization diploid zygote divides meiotically in oogonium and forms 16–32 nuclei. Meiosis occurs in zygote of *Coleochaete*. In Embryophyta meiosis takes place in diploid cells after mitosis of diploid zygote (Becker & Marin, 2009).



Figure 2.14. *Coleochaete* sp. (Guenther, 2016)

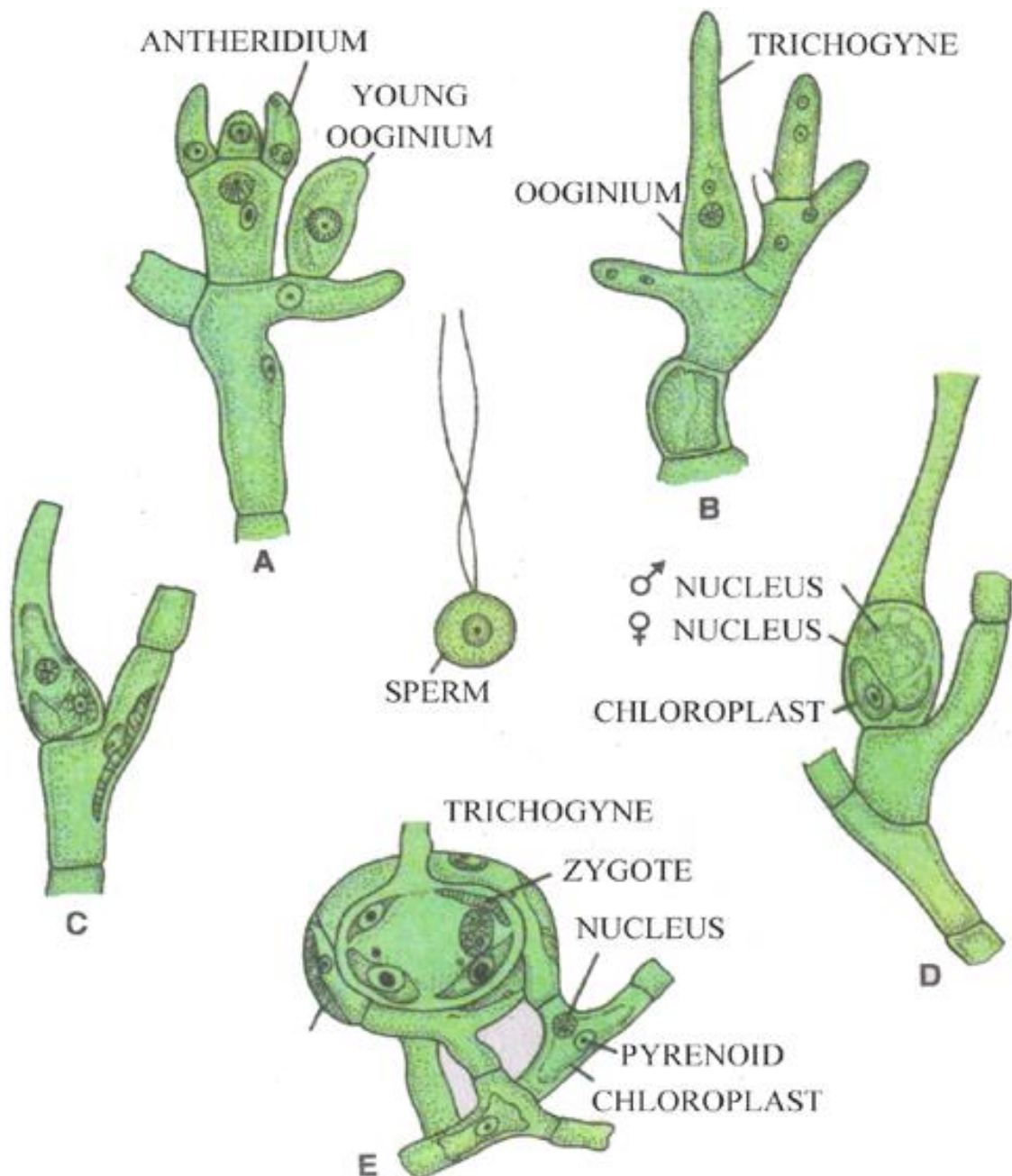


Fig 2.15. Sexual reproduction in *Coleochaete* sp.
<http://premaobotany.blogspot.com/2018/12/coleochaete-a.html>

Chloroplastida (=Viridiplantae, Chlorobionta, Plantae sensu stricto) or the green plants contain chloroplasts, thylakoids with bipartite structure consisting of cylindrical grana stacks and stroma lamellae (Pribil et al., 2014) and storage materials. Green plants divide into “Green algae” and Embryophyta (land plants). During evolution the land plants form an outer cuticle, gametangia with outer protective sterile cells, and an embryo (2n) developed on the previous generation (Figure 2.16).

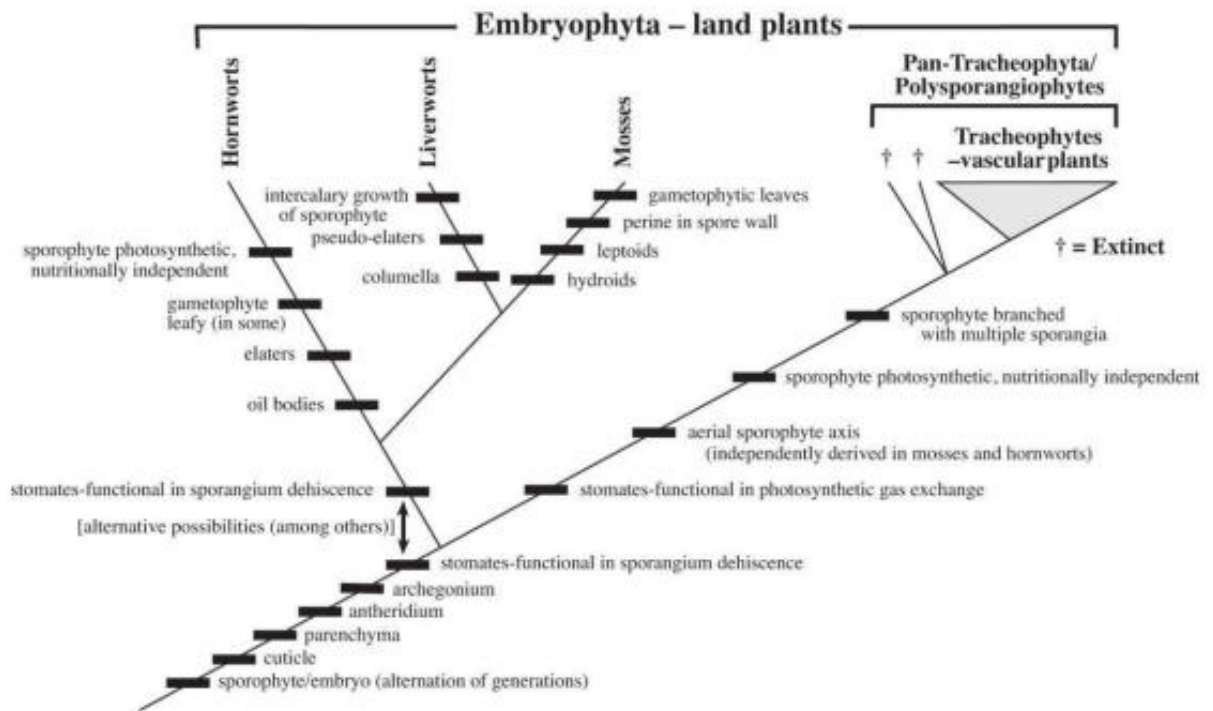


Figure 2.17. Phylogenetic connections in Embryophyta (Puttick et al., 2018; Simpson, 2019)

The Tracheophyta (tracheophytes or vascular plants) are a monophyletic clade of Embryophyta (Figure 2.18). Vascular plants contain an independent branched sporophyte with roots, vascular system, an endodermis and secondary lignified walls. The Tracheophyta contain the Lycopodiophyta, the Euphyllophyta (including Equisetopsida, Psilotopsida (including Ophioglossales, Psilotales), Marattiopsida, Polypodiopsida) and the Lignophyta (including the Spermatophyta).

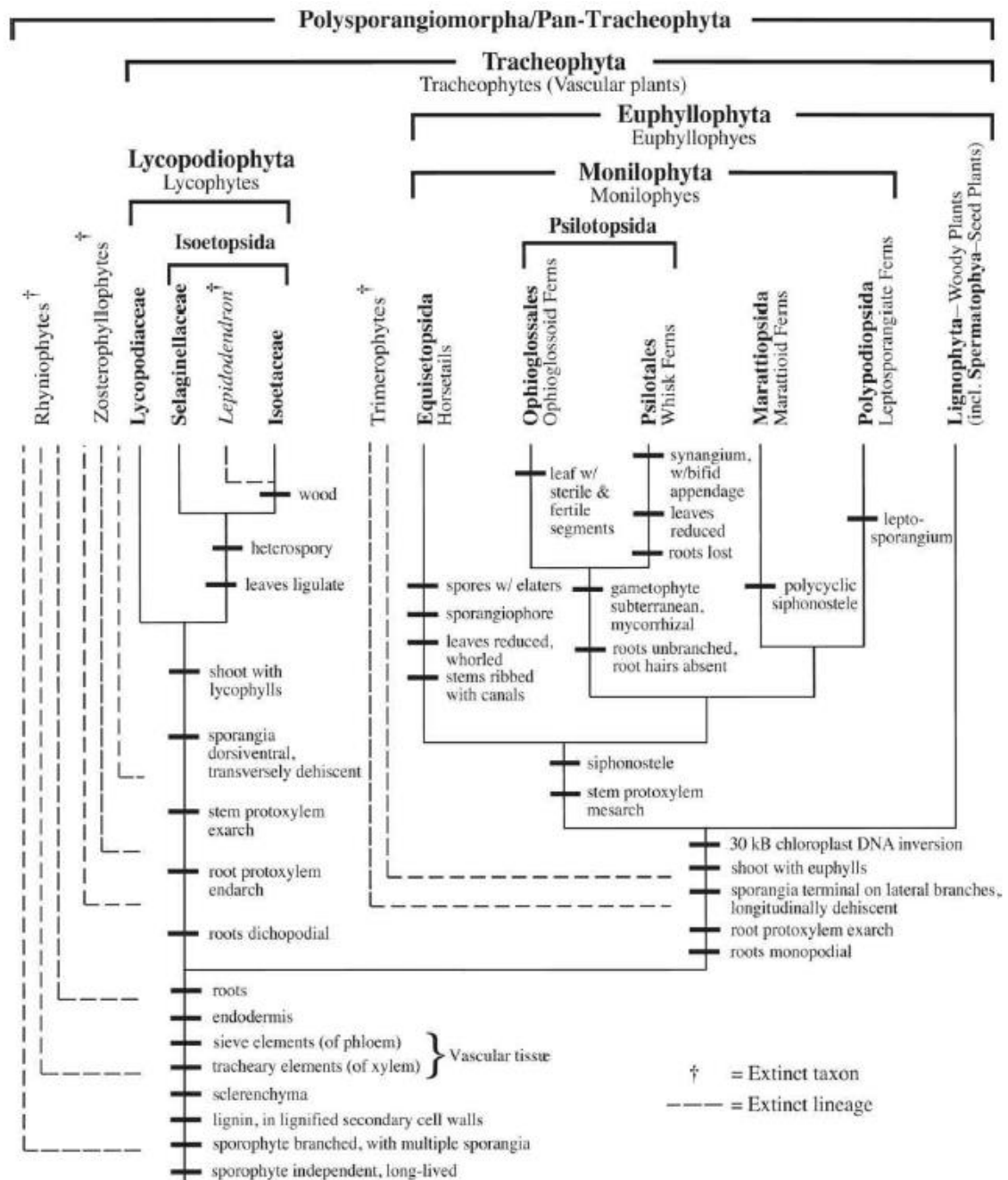


Figure 2.18. Phylogenetic connections in Tracheophyta (Pryer et al., 2001, 2004; Qiu et al., 2007; Rothfels et al., 2015, Simpson, 2019)

The Magnoliophyta contain the basal ANA grade (Amborellales, Nymphaeales and Ausrtobeyales), Mesangiospermae (including Magnoliids, Monocots, Ceratophyllales, and Eudicots). The Eudicots contain Ranunculales, Proteales, Buxales, Trochodendrales, Gunnerales, and Pentapetalae (including Dilleniales, Superrosids and Superasterids). The Superasterids contain Bereberidopsidales, Santalales, Caryophyllales and Asterids. The Superrosids contain Saxifragales, Vitales, and Rosids (Figures 2.19, 2.20).

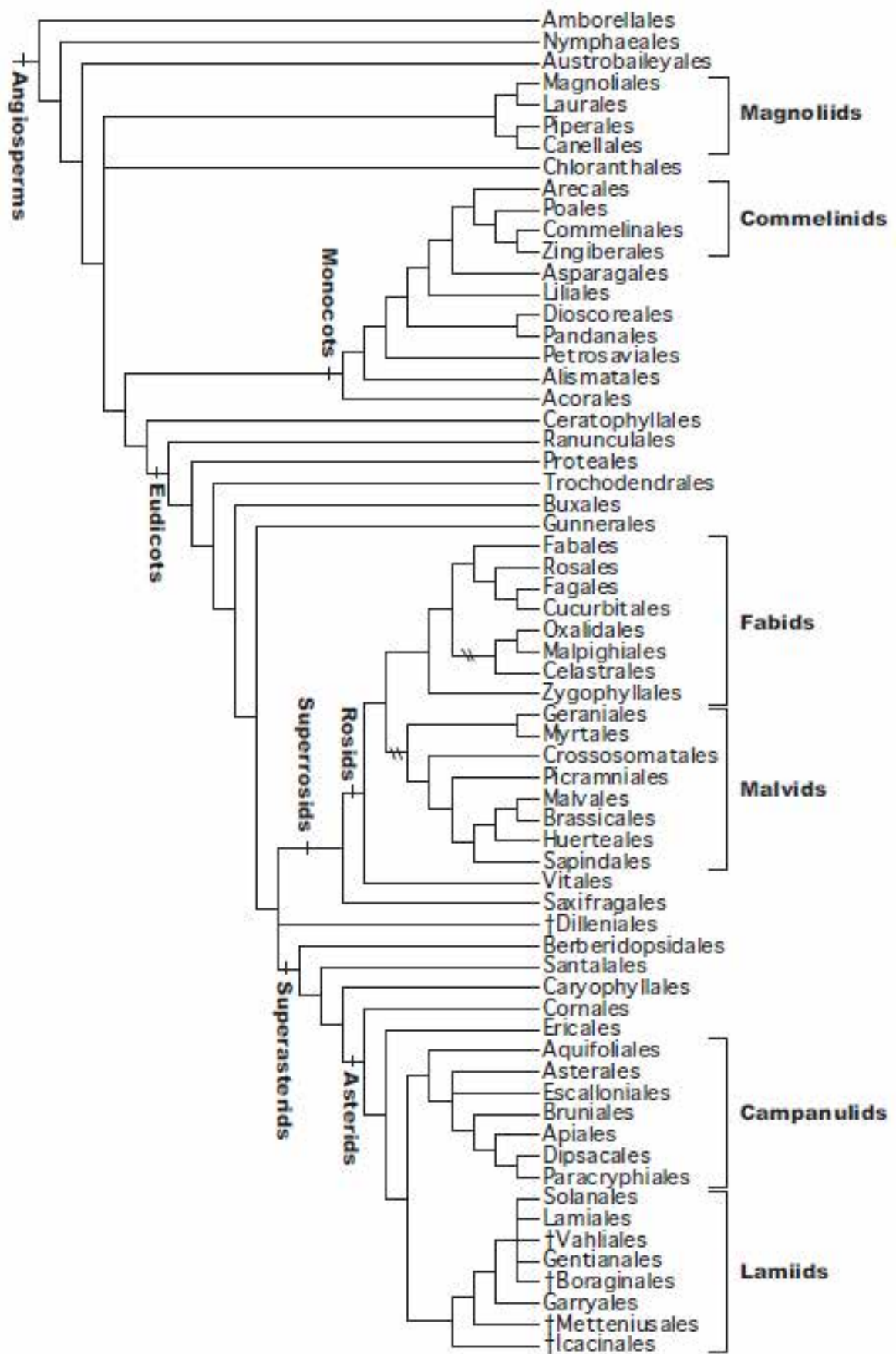


Figure 2.19. Phylogenetic relationships in flowering plants (APG IV, 2016)

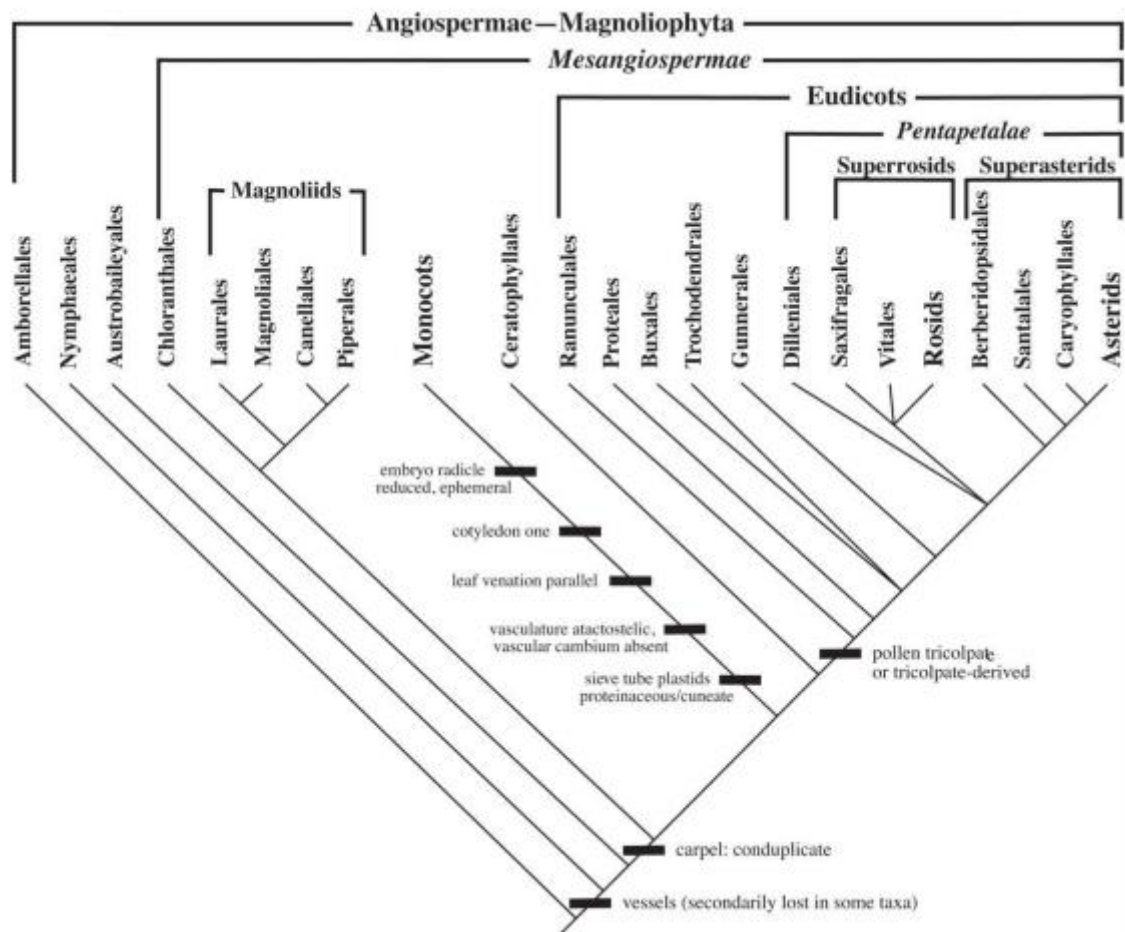


Figure 2.20. Phylogenetic connections in flowering plants (Moore et al., 2011; Soltis et al., 2011; APG IV, 2016; Sun et al., 2016; Givnish et al., 2018; Simpson, 2019).

Questions for self-control

FLOWERING PLANTS IN THE CURRENT SYSTEM OF THE ORGANIC WORLD

1. How many domains does the current system of the organic world contain?
2. What does LUCA mean?
3. What are the main groups of the system of the eukaryotes developed by Adl et al. (2019)?
4. What are the major clades of Chloroplastida?
5. What are the major clades of Embryophytes?

CHAPTER 3. CURRENT SYSTEM OF FLOWERING PLANTS

ANGIOSPERMS

MONOCOTS CLADE

ORDER

1. ASPARAGALES LINK (Agavales Hutch., Alliales Bercht. & J. Presl, Amaryllidales Link, Asphodelales Doweld, Gilliesiales Mart., Iridales Raf., Ixiales Lindl., Narcissales Dumort., Tecophilaeales Traub ex Reveal, Xanthorrhoeales Takht. ex Reveal & Doweld.)

FAMILY

1. Orchidaceae Juss. (Apostasiaceae Lindl., Cypridiaceae Lindl., Limnaceae Horan., Liparidaceae Vines, Neottiaceae Horan., Neuwiediaaceae R. Dahlgren ex Reveal & Hoogland, Ophrydaceae Vines, Pycnanthaceae Ravenna, Vanillaceae Lindl.)

SUBFAMILY

Apostasioideae

Cypripedioideae

GENUS

***Cypripedium* L.** (*Arietinum* Beck, *Calceolaria* Heist. ex Fabr., *Calceolus* Nieuwl., *Ciripedium* Zumagl., *Criogenes* Salisb., *Fissipes* Small, *Hypodema* Rchb., *Sacodon* Raf., *Schizopodium* Salisb., *Stimegas* Raf.)

SPECIES

1. *Cypripedium calceolus* L. (*Calceolus alternifolius* St.-Lag., *C. marianus* Crantz, *Cypripedium marianus* (Crantz) Rouy, *C. alternifolium* St.-Lag., *C. atsmori* C.Morren, *C. boreale* Salisb., *C. calceolus* f. *biflorum* Rouy, *C. c.* f. *triflorum* Rouy, *C. c.* var. *citrina* B.Hergt, *C. c.* var. *viridiflora* M.Schulze, *C. cruciatum* Dulac, *C. ferrugineum* Gray, *C. guttatum* subsp. *microsaccos* (Kraenzl.) Soó, *C. microsaccos* Kraenzl.)

GENUS

Paphiopedilum Pfitzer (*Cordula* Raf., *Menephora* Raf.)

Phragmipedium Rolfe (*Uropedium* Lindl.)

Selenipedium Rchb. f. (*Apedium* Chiron et al.)

Mexipedium V. A. Albert & M. W. Chase

Epidendroideae

TRIBE

Arethuseae

SUBTRIBE

Arethusinae

Coelogyninae

TRIBE

Collabieae

Cymbidieae

SUBTRIBE

Catasetinae

Coeliopsidinae

Cymbidiinae

Cyrtopodiinae

Eriopsidinae

Eulophiinae

Maxillariinae

Oncidiinae

Stanhopeinae

Zygopetalinae

TRIBE

Epidendreae

SUBTRIBE

Agrostophyllinae

Bletiinae

Calypsoinae

GENUS

Aplectrum (Nutt.) Torr.

Calypso Salisb. (*Calypsodium* Link, *Cytherea* Salisb., *Norna* Wahlenb., *Calypso* Salisb., *Orchidium* Sw.)

Changnienia S. S. Chien

Coelia Lindl. (*Bothriochilus* Lem.)

***Corallorhiza* Gagnebin** (*Cladorhiza* Raf., *Corallorrhiza* Gagnebin, orth. var.)

Cremastra Lindl. (*Hyacinthorchis* Blume)

SPECIES

2. *Corallorhiza trifida* Châtel. (*Coralliorrhiza innata* R.Br., *C. anandae* Malhotra & Balodi, *C. corallorhiza* (L.) H.Karst., *C. corallorhiza* (L.) MacMill., *C. c.* subsp. *coloradensis* Cockerell, *C. c.* var. *coloradensis* (Cockerell) Ames, *C. c.* var. *coloradensis* Cockerell, *C. dentata* Host, *C. ericetorum* Drejer, *C. halleri* Rich., *C.*

innata R.Br., *C. i.* subsp. *ericetorum* (Drejer) Nyman, *C. i.* var. *discolor* Rchb., *C. i.* var. *ericetorum* (Drejer) Rchb.f., *C. i.* var. *virescens* (Drejer) Farr, *C. intacta* Cham. & Schltdl., *C. integra* Châtel., *C. jacquemontii* Decne., *C. nemoralis* Sw. ex Nyman, *C. neottia* Scop., *C. occidentalis* Bach.Pyl., *C. trifida* f. *ericetorum* (Drejer) Soó, *C. t.* f. *integra* (Châtel.) Soó, *C. t.* f. *suaveolens* Bordz., *C. t.* f. *verna* (Nutt.) P.M.Br., *C. t.* subsp. *trifida*, *C. t.* subsp. *virescens* (Drejer) Løjtnant, *C. t.* var. *ericetorum* (Drejer) Rchb.f., *C. t.* var. *integra* (Châtel.) Schinz & Thell., *C. t.* var. *trifida*, *C. t.* var. *verna* (Nutt.) Fernald, *C. t.* var. *virescens* (Drejer) Farw., *C. t.* var. *virescens* (Farr) Fernald, *C. verna* Nutt., *C. virescens* Drejer, *C. wyomingensis* Hellm. & K.Hellm., *Corallorrhiza jacquemontii* Decne., *C. trifida* Châtel., *Cymbidium corallorrhiza* (L.) Sw., *Epidendrum corallorhizon* (L.) Poir., *Epipactis corallorrhiza* (L.) Crantz, *Helleborine corallorrhiza* (L.) F.W.Schmidt, *Neottia corallorrhiza* (L.) Kuntze, *Ophrys corallorrhiza* L.)

GENUS

Dactylostalix Rchb. f. (*Pergamena* Finet)
Danxiaorchis J. W. Zhai et al.
Ephippianthus Rchb. f. (*Hakoneaste* F. Maek.)
Govenia Lindl. (*Eucnemia* Rchb., orth. var., *Eucnemis* Lindl.)
Oreorchis Lindl. (*Diplolabellum* F. Maek.)
Tipularia Nutt. (*Anthericlis* Raf., *Didiciea* King & Prain, *Plectrurus* Raf.)
Yoania Maxim. (*Yunorchis* Z. J. Liu et al.)

SUBTRIBE

Laeliinae
Pleurothallidinae
Ponerinae

TRIBE

Gastrodieae
Malaxideae

SUBTRIBE

Dendrobiinae
Malaxidinae

TRIBE

Neottieae

GENUS

Aphyllorchis Blume
Aphyllorchis Blume (*Sinorchis* S. C. Chen)
Cephalanthera Rich.

***Cephalanthera* Rich.** (*Callithronum* Ehrh., *Dorycheile* Rchb., *Eburophyton* A. Heller, *Tangtsinia* S. C. Chen, *Xiphophyllum* Ehrh.)

SPECIES

3. *Cephalanthera damasonium* (Mill.) Druce (*C. alba* (Crantz) Fritsch, *C. alba* (Crantz) Simonk., *C. alba* var. *adenophora* R.Keller, *C. damasonium* f. *collina* (Zapał.) Soó, *C. d.* f. *gracilis* (Zapał.) Soó, *C. d.* f. *spicata* (W.Zimm.) Soó, *C. d.* *lusus ochroleuca* (Baumg.) Soó, *C. d.* var. *ochroleuca* (Baumg.) Soó, *C. lancifolia* (Murray) Dumort., *C. l.* f. *adenophora* (R.Keller) Soó, *C. l.* f. *collina* (Zapał.) Soó, *C. l.* f. *gracilis* (Zapał.) Soó, *C. l.* f. *pienena* (Zapał.) Soó, *C. l.* f. *spicata* (W.Zimm.) Soó, *C. lancifolia* Janch., *C. ochroleuca* (Baumg.) Rchb., *C. pallens* subsp. *ochroleuca* (Baumg.) Nyman, *C. pallens* var. *collina* Zapał., *C. pallens* var. *gracilis* Zapał., *C. pallens* var. *pienena* Zapał., *C. yuennanensis* Hand.-Mazz., *C. yunnanensis* Hand.-Mazz., *Cymbidium pallens* Sw., *Epipactis alba* Crantz, *E. alba* f. *spicata* W.Zimm., *E. lancifolia* (Murray) F.W.Schmidt, *E. ochroleuca* Baumg. DC (Ambiguous), *Serapias damasonium* Mill., *S. grandiflora* subsp. *lancifolia* (Murray) Ehrh., *S. g.* var. *lancifolia* (Murray) Merrem, *S. lancifolia* Murray, *S. lancifolia* Roth, *S. latifolia* Mill. DC (unacceptable) (Ambiguous), *S. ochroleuca* (Baumg.) Steud., *S. pallens* (Sw.) S.B.Jundz., *S. tota-alba* Gilib.)

GENUS

***Epipactis* Zinn** (*Amesia* A. Nelson & J. F. Macbr., *Arthrochilium* Beck, *Calliphyllon* Bubani, *Parapactis* W. Zimm.)

SPECIES

4. *Epipactis palustris* (L.) Crantz (*Amesia palustris* (L.) A.Nelson & J.F. Macbr., *Arthrochilium palustre* (L.) Beck, *Calliphyllon palustre* (L.) Bubani, *Cymbidium palustre* (L.) Sw., *Epipactis palustris* f. *ampla* Höppner, *E. p.* f. *elongata* Höppner, *E. p.* f. *ericetorum* (Asch. & Graebn.) Soó, *E. p.* f. *gracilis* Höppner, *E. p.* f. *longibracteata* Höppner, *E. p.* f. *macrostachya* Höppner, *E. p.* f. *pumila* Zapał., *E. p.* f. *rectilinguis* Höppner, *E. p.* f. *robusta* (Zapał.) Höppner, *E. p.* f. *silvatica* (Asch. & Graebn.) Höppner, *E. p.* f. *submersa* Glück, *E. p.* subsp. *salina* (Schur) K.Richt., *E. p.* var. *elatior* Pantu, *E. p.* var. *ericetorum* Asch. & Graebn., *E. p.* var. *ochroleuca* Barla, *E. p.* var. *parvifolia* Schur, *E. p.* var. *robusta* Zapał., *E. p.* var. *silvatica* Asch. & Graebn., *Epipactis salina* Schur, *Helleborine palustris* (L.) Hill, *H. p.* (L.) Schrank, *H. p.* f. *ampla* (Höppner) Soó, *H. p.* f. *ericetorum* (Asch. & Graebn.) Soó, *H. p.* f. *gracilis* (Höppner) Soó, *H. p.* f. *longibracteata* (Höppner) Soó, *H. p.* f. *parvifolia* (Schur) Soó, *H. p.* f. *rectilinguis* (Höppner) Soó, *H. p.* f. *silvatica* (Asch. & Graebn.) Soó, *H. p.* f. *submersa* (Glück) Soó, *H. p.* var. *ericetorum* (Asch. & Graebn.) Druce, *Limodorum palustre* (L.) Kuntze, *Serapias helleborine* var. *palustris* L., *S. longiflora* Asso, *S. palustris* (L.) Mill.)

5. *Epipactis purpurata* Sm. (*E. atrorubens* var. *viridiflora* (Hoffm.) Ducommun, *E. helleborine* *purpurata* (Sm.) H. Sund., *E. h.* subsp. *media* (Fr.) Syme, *E. h.*

subsp. *varians* (Crantz) O.Bolòs & Vigo, *E. h.* subsp. *varians* (Crantz) Soó, *E. h.* subsp. *violacea* (Dur.-Duq.) Tourlet, *E. h.* var. *purpurata* (Sm.) Syme, *E. h.* var. *viridiflora* (Rchb.) O.Bolòs & Vigo, *E. h.* var. *viridis* Syme, *E. latifolia* f. *praematura* (Krösche) Seeland, *E. l.* subsp. *media* (Fr.) Moore & A.G.More, *E. l.* subsp. *purpurata* (L.) All., *E. l.* subsp. *purpurata* (Sm.) Gand., *E. l.* subsp. *purpurata* (Sm.) K.Richt., *E. l.* subsp. *violacea* (Dur.-Duq.) Bertsch & F.Bertsch, *E. l.* subsp. *viridiflora* (Hoffm.) E.G.Camus, *E. l.* subsp. *viridiflora* (Hoffm.) Irmisch, *E. l.* subsp. *viridiflora* (Hoffm.) Seeland, *E. l.* var. *bracteis-longioribus* Lindl., *E. l.* var. *purpurata* (Sm.) Nyman, *E. leptochila* f. *tridentifera* Krösche, *E. media* var. *purpurata* (Sm.) Bab., *E. varians* (Crantz) Dalla Torre & Sarnth., *E. varians* Crantz, *E. viridiflora* (Hoffm.) Rchb., *E. v.* f. *acutiflora* Krösche, *Helleborine purpurata* (Sm.) Druce, *H. sessilifolia* (Peterm.) Vollm., *Serapias viridiflora* Hoffm.)

GENUS

Limodorum Boehm. (*Ionorchis* Beck, *Lequeetia* Bubani)
Neottia Guett. (*Archineottia* S. C. Chen, *Bifolium* Nieuwl., *Cardiophyllum* Ehrh.,
Diphryllum Raf., *Diplandrorchis* S. C. Chen, *Distomaea* Spenn., *Holopogon* Kom.
& Nevski, *Listera* R. Br., *Neottidium* Schltdl., *Nidus* Riv., *Pollinirhiza* Dulac)
Palmorchis Barb. Rodr.
Palmorchis Barb. Rodr. (*Jenmania* Rolfe, *Neobartlettia* Schltr., *Rolfea* Zahlbr.)

SUBTRIBE

Epipogiinae

GENUS

***Epipogium* J. G. Gmel. ex Borkh.** (*Ceratopsis* Lindl., *Epipogon* S. G. Gmel.,
orth. var., *Galera* Blume, *Podanthera* Wight)

SPECIES

6. *Epipogium aphyllum* Sw. (*Epipactis epipogium* (L.) All., *E. epipogium* (L.) Crantz, *Epipogium aphyllum* f. *albiflorum* Y.N.Lee & K.S.Lee, *Epipogium aphyllum* var. *stenochilum* Hand.-Mazz., *E. epipogium* (L.) H.Karst., *E. generalis* E.H.L.Krause, *E. gmelinii* Rich., *Epipogon aphyllus* (Sw.), *E. epipogium* H.Karst., *E. epipogon* (L.) A.Kern., *E. generalis* E.H.L.Krause, *Limodorum aphyllum* (F.W.Schmidt) Sw., *L. epipogium* (L.) Sw., *Neottia epipogium* (L.) Clairv., *Orchis aphylla* F.W.Schmidt DC, *Satyrion epipogium* L., *Serapias epipogium* (L.) Steud., *S. epipogium* (L.) Steud.)

GENUS

Stereosandra Blume

SUBTRIBE

Nerviliinae

TRIBE

Podochileae

Sobralieae

Thaieae

Triphoreae

SUBTRIBE

Diceratostelinae

Triphorinae

TRIBE

Tropidieae

Vandae

SUBTRIBE

Adrorhizinae

Aeridinae

Angraecinae

Polystachyinae

TRIBE

Wulfschlaegeliae

Xerorchideae

SUBFAMILY

Orchidoideae

TRIBE

Codonorchideae

Cranichideae

SUBTRIBE

Chloraeinae

Cranichidinae

Discyphinae

Galeottiellinae

Goodyerinae

GENUS

Aenhenrya Gopalan

Anoectochilus Blume

Aspidogyne Garay

Chamaegastrodia Makino & F. Maek.

Cheirostylis Blume
Cystorchis Blume
Danhatchia Garay & Christenson
Dossinia C. Morren
Erythroides Blume
Eurycentrum Schltr.
Gonatostylis Schltr.
***Goodyera* R. Br.**

SPECIES

7. *Goodyera repens* (L.) R.Br. (*Elasmatium repens* (L.) Dulac, *Epipactis chinensis* (Schltr.) Hu, *E. mairei* (Schltr.), *E. repens* (L.) Crantz in Stirp., *E. r.* var. *ophioides* (Fernald) A.A.Eaton, *Gonogona repens* (L.) Link, *Goodyera brevis* Schltr., *G. chinensis* Schltr., *G. mairei* Schltr., *G. ophioides* (Fernald) Rydb., *G. pubescens* var. *repens* (L.) Alph.Wood, *G. repens* f. *ophioides* (Fernald) P.M.Br., *G. r.* subsp. *ophioides* (Fernald) Á.Löve & W.Simon, *G. repens* var. *japonica* Nakai, *G. r.* var. *ophioides* Fernald, *Neottia repens* (L.) Sw., *Orchiodes repens* (L.) Kuntze, *Orchiodes resupinatum* Kuntze, *Peramium repens* (L.) Salisb., *P. r.* var. *ophioides* (Fernald) A.Heller, *Peramium secundum* (Raf.) House, *Satyrium hirsutum* Gilib., *Satyrium repens* L. in Sp. Pl., *Serapias repens* (L.) Vill., *Tussaca secunda* Raf.)

GENUS

Halleorchis Szlach. & Olszewski
Herpysma Lindl.
Hetaeria Blume (*Cerochilus* Lindl., *Etaeria* Blume, orth. var., *Rhamphidia* Lindl.)
Hylophila Lindl. (*Dicerostylis* Blume)
Kreodanthus Garay
Kuhlhasseltia J. J. Sm. (*Vexillabium* F. Maek.)
Lepidogyne Blume
Ludisia A. Rich. (*Myoda* Lindl.)
Macodes (Blume) Lindl.
Macodes (Blume) Lindl. (*Argyrorchis* Blume, *Pseudomacodes* Rolfe)
Microchilus C. Presl (*Physurus* Rich. ex Lindl.)
Myrmechis (Lindl.) Blume (*Ramphidia* Miq., *Tubilabium* J. J. Sm.)
Odontochilus Blume (*Cystopus* Blume, *Evrardia* Gagnep., *Evrardiana* Aver.,
Evrardianthe Rauschert, *Pristiglottis* Cretz. & J. J. Sm.)
Orchipedum Breda (*Philippinaea* Schltr. & Ames, *Queteletia* Blume)
Pachyplectron Schltr.
Papuaea Schltr.
Platylepis A. Rich. (*Moerenhoutia* Blume)
Platythelys Garay
Rhamphorhynchus Garay
Rhomboda Lindl.
Schuitemanian Ormerod

Stephanothelys Garay
Vrydagzynea Blume
Zeuxine Lindl. (*Adenostylis* Blume, *Haplochilus* Endl., *Heterozeuxine* T. Hashim.,
Monochilus Wall. ex Lindl., *Psychechilos* Breda, *Strateuma* Raf., *Tripleura* Lindl.)
Zeuxinella Aver.

SUBTRIBE
Manniellinae
Pterostylidinae
Spiranthinae

TRIBE
Diurideae

SUBTRIBE
Acianthinae
Caladeniinae
Cryptostylidinae
Diuridinae
Drakaeinae
Megastylidinae
Prasophyllinae
Rhizanthellinae
Thelymitrinae

TRIBE
Orchideae

SUBTRIBE
Brownleeinae
Coryciinae
Disinae
Orchidinae

GENUS
Aceratorchis Schltr.
Afrorchis Szlach.
Alinorchis Szlach.
Amitostigma Schltr. (*Mitostigma* Blume)
***Anacamptis* Rich.** (*Herorchis* D. Tyteca & E. Klein, *Anacamptis* Rich.,
Paludorchis P. Delforge)

SPECIES

8. *Anacamptis coriophora* (L.) R.M. Bateman, Pridgeon & M.W. (*Anteriorchis coriophora* (L.) E.Klein & Strack, *Herorchis coriophora* (L.) D.Tyteca & E.Klein, *Orchis coriophora* L., *O. c.* subsp. *carpetana* (Willk.) Landwehr, *O. c.* subsp. *carpetana* (Willk.) Malag., *O. c.* subsp. *cimicina* (Arcang.) E.G.Camus, *O. c.* var. *genuina* Cout., *O. c.* var. *nervulosa* Bordz., *O. c.* var. *strypiensis* Zapal., *O. fragrans* var. *polliniana* (Spreng.) Pollard)

GENUS

Androcorys Schltr.
Arachnaria Szlach.
Bartholina R. Br.
Bartholina R. Br. (*Lathrisia* Sw.)
Benthamia A. Rich. (*Rolfeella* Schltr.)
Bhutanthera Renz
Bonatea Willd.
Brachycorythis Lindl. (*Gyaladenia* Schltr., *Phyllomphax* Schltr., *Schwartzkopffia* Kraenzl.)
Centrostigma Schltr.
Ceratopetalorchis Szlach. et al.
Chamorchis Rich.
Cynorkis Thouars (*Acrostylia* Frapp. ex Cordem., *Amphorchis* Thouars, *Arnottia* A. Rich., *Barlaea* Rchb. f., *Bicornella* Lindl., *Camilleugenia* Frapp. ex Cordem., *Cynorchis* Thouars, orth. var., *Cynosorchis* Thouars, orth. var., *Helorchis* Schltr., *Imerinorchis* Szlach., *Lemuranthe* Schltr., *Lowiorchis* Szlach., *Microtheca* Schltr.)
***Dactylorhiza* Neck. ex Nevski** (*Coeloglossum* Hartm., *Dactylorchis* (Klinge) Verm., *Lindblomia* Fr., *Satorkis* Thouars)

SPECIES

9. *Dactylorhiza incarnata* (L.) Soó (*C. comosa* Tineo, *C. rubra* f. *comosa* (Tineo) Robatsch, *C. rubra* f. *latior* Zapal., *C. rubra* f. *parviflora* (Harz) Soó, *C. rubra* f. *tenczyniensis* (Zapal.) Soó, *C. rubra* var. *comosa* (Tineo) Nyman, *C. rubra* var. *leucantha* Bordz., *C. rubra* var. *tenczyniensis* Zapal., *Cymbidium rubrum* (L.) Sw., *Dorycheile rubra* (L.) Fuss, *Epipactis purpurea* Crantz, *E. rubra* (L.) F.W.Schmidt, *E. rubra* var. *parviflora* (Harz) W.Zimm., *Helleborine rubra* (L.) Schrank, *Limodorum rubrum* (L.) Kuntze, *Serapias rubra* L.)

SUBSPECIES

D. i. subsp. *coccinea* (Pugsley) Soó
D. i. subsp. *cruenta* (O.F.Müll.) P.D. Sell
D. i. subsp. *gemmana* (Pugsley) P.D. Sell
D. i. subsp. *lobelii* (Verm.) H.A.Pedersen
D. i. subsp. *ochroleuca* (Wüstnei ex Boll) P.F.Hunt & Summerh.
D. i. subsp. *pulchella* (Druce) Soó

SPECIES

10. *Dactylorhiza maculata* (L.) Soó (*Dactylorchis maculata* (L.) Verm., *Dactylorhiza fuchsii* subsp. *transsilvanica* Frohner, *D. maculata* subsp. *arduennensis* Zadoks, *Orchis angustifolia* var. *schurii* Klinge, *O. basilica* L. ex Klinge (unacceptable), *O. basilica* subsp. *maculata* (L.) Klinge, *O. ericetorum* (E.F.Linton) E.S.Marshall, *O. maculata* L. DC, *O. maculata* subsp. *transsilvanica* Domin)

11. *Dactylorhiza majalis* (Rchb.) P.F. Hunt & Summerh. (*Dactylorchis majalis* (Rchb.) Verm., *D. comosa* subsp. *majalis* (Rchb.), *D. latifolia* (L.) H.Baumann & Künkele, *Orchis latifolia* subsp. *majalis* (Rchb.) Klinge, *O. l.* var. *immaculata* Harz, *O. l.* var. *majalis* (Rchb.) Kitt., *O. l.* var. *majalis* (Rchb.) Nyman, *O. majalis* Rchb.)

SUBSPECIES

12. *Dactylorhiza majalis* subsp. *cordigera* (Fr.) H.Sund. (*Dactylorchis cordigera* (Fr.) Verm., *Dactylorhiza bosniaca* (Beck) Aver., *D. cordigera* (Fr.) Soó, *D. c.* f. *albiflora* Landwehr, *D. c.* subsp. *bosniaca* (Beck) Soó, *D. c.* subsp. *graeca* (H.Baumann) Kreutz, *D. c.* subsp. *siculorum* (Soó) Soó, *D. c.* var. *graeca* (H.Baumann) Presser, *D. c.* var. *grisebachii* (Pant.) Soó, *D. c.* var. *rhodopeia* Presser, *D. c.* var. *rochelii* (Griseb. & Schenk) Soó, *D. c.* var. *vermionica* B.Willing & E.Willing, *D. graeca* H.Baumann, *D. lagotis* (Rchb.f.) H.Baumann, *D. majalis* subsp. *cordigera* (Rchb.) P.F.Hunt & Summerh., *D. m.* subsp. *siculorum* (Soó) E.Nelson, *D. richteri* B.Bock, *D. serreana* H.Baumann, *D. siculorum* (Soó) Kreutz & Bobocea, *Orchis blyttii* (Rchb.f.) Soó, *O. bosniaca* Beck, *O. cordigera* f. *banatica* Asch. & Graebn., *O. c.* f. *grisebachii* (Pant.) Soó, *O. c.* f. *macrobracteata* (Schur) Soó, *O. c.* f. *rivularis* (Heuff. ex Schur) Soó, *O. c.* f. *rochelii* (Griseb. & Schenk) Klinge, *O. c.* f. *simonkaiana* Soó, *O. c.* f. *subtriloba* Soó, *O. cordigera* Fr., *O. c.* *lusus immaculata* Klinge, *O. c.* prol. *rochelii* (Griseb. & Schenk) Asch. & Graebn., *O. c.* subsp. *blyttii* (Rchb.f.) K.Richt., *O. c.* subsp. *bosniaca* (Beck) Klinge, *O. c.* subsp. *siculorum* Soó, *O. c.* var. *bosniaca* (Beck) Klinge, *O. c.* var. *foliosa* Klinge, *O. c.* var. *grisebachii* (Pant.) Klinge, *O. c.* var. *klingei* E.G.Camus, *O. c.* var. *macrobracteata* Schur, *O. c.* var. *rocheliana* Klinge, *O. c.* var. *siculorum* (Soó) Pauca, *O. cruenta* Rochel DC, *O. c.* subsp. *blyttii* (Rchb.f.) Soó, *O. foliosa* Schur DC, *O. grisebachii* Pant., *O. hungarica* Pant. ex G.Keller & Soó, *O. lagotis* Rchb.f., *O. latifolia* f. *densa* (Harz) Soó, *O. l.* f. *gracilis* Schur, *O. l.* f. *inaequiloba* (Harz) Soó, *O. l.* var. *abbreviata* Harz, *O. l.* var. *blyttii* Rchb.f., *O. l.* var. *brevibracteata* Harz, *O. l.* var. *comosa* Harz, *O. l.* var. *conica* Lindl., *O. l.* var. *cordigera* (Fr.) Rchb.f., *O. l.* var. *densa* Harz, *O. l.* var. *densiflora* Harz, *O. l.* var. *elata* Harz DC, *O. l.* var. *humilis* Harz, *O. l.* var. *inaequiloba* Harz, *O. l.* var. *lagotis* Rchb.f., *O. l.* var. *lanceata* Harz, *O. l.* var. *laxiuscula* Harz, *O. l.* var. *macilenta* Harz, *O. l.* var. *macrochlamys* Asch. & Graebn., *O. l.* var. *obtusata* Harz DC, *O. l.* var. *orbiculatus* Zapal., *O. l.* var. *parviculcarata* Harz, *O. l.* var. *pyramidalis* Harz, *O. l.* var. *rochelii* Griseb. & Schenk, *O. l.* var. *sparsiflora* Harz,

O. l. var. *traunsteineriiformis* Harz, *O. l.* var. *trifida* Harz, *O. l.* var. *trilobata* Harz, *O. l.* var. *vulgaris* Harz, *O. monticola* Klinge (unacceptable), *O. monticola* subsp. *bosniaca* (Beck) Klinge, *O. monticola* subsp. *cordigera* (Fr.) Klinge (unacceptable), *O. rivularis* Heuff. ex Schur, *O. rocheliana* (Klinge) Klinge, *O. sicularum* (Soó) Soó, *O. traunsteineri* var. *grisebachii* (Pant.) E.G.Camus)

SPECIES

13. *Dactylorhiza viridis* (L.) R.M. Bateman, Pridgeon & M.W. Chase (*Chamorchis viridis* (L.) Dumort., *Coeloglossum bracteatum* (Muhl. ex Willd.) Schltr., *C. b.* var. *majus* (Maxim.) Nakai, *C. nankotaizanensis* (Masam.) S.S.Ying, *C. vaillantii* (Ten.) Guss., *C. viride* (L.) Hartm., *C. v.* subsp. *bracteatum* (Muhl. ex Willd.) Hultén, *C. v.* subsp. *eurasiaticum* Selander, *C. v.* subsp. *viride*, *C. v.* var. *bracteatum* (Muhl. ex Willd.) K.Richt., *C. v.* var. *brevibracteatum* Asch. & Graebn., *C. v.* var. *dentatum* Zapal., *C. v.* var. *grandiflorum* Zapal., *C. v.* var. *longibracteatum* Asch. & Graebn., *C. v.* var. *macrobracteatum* Schur, *C. v.* var. *microbracteatum* Schur, *C. v.* var. *viride*, *Dactylorhiza viridis* var. *virescens* (Muhlenberg ex Willdenow) Sprengel, *Entaticus viridis* (L.) Gray, *Gymnadenia bracteata* (Muhl. ex Willd.) C.Presl, *G. viridis* (L.) Rich., *G. viridis* var. *brevibracteata* (Bréb.) Bréb., *Habenaria viridis* (L.) R.Br., *H. viridis* var. *viridis*, *Himantoglossum viride* (L.) Rchb., *Orchis viridis* (L.) Crantz, *Peristylus bracteatus* f. *major* Franch. & Sav., *P. viridis* (L.) Lindl., *P. viridis* var. *bracteata* (Muhl. ex Willd.) Rchb.fil. ex Kurtz, *Perularia virescens* (Muhl. ex Willd.) A.Gray, *Platanthera coreana* (Nakai) Nakai XR, *P. viridis* (L.) Lindl., *P. viridis* var. *bracteata* (Muhlenberg ex Willdenow) Reichenbach f., *Satyrium viride* L., *Sieberia viridis* (L.) Spreng.)

GENUS

Diplomeris D. Don (*Diplochilus* Lindl., *Paragnathis* Spreng.)

Dracomonticola H. P. Linder & Kurzweil

Galearis Raf. (*Amerorchis* Hultén, *Aorchis* Verm., *Chondradenia* Maxim. ex F. Maek.)

Gennaria Parl. (*Nujiangia* X. H. Jin & D. Z. Li)

***Gymnadenia* R. Br. (*Nigritella* Rich.)**

SPECIES

14. *Gymnadenia conopsea* (L.) R.Br. (× *Dactylodenia comigera* (Rchb.) Aver., × *Dactylogymnadenia comigera* (Rchb.) Rauschert, × *Orchigymnadenia comigera* (Rchb.) Asch. & Graebn., *Gymnadenia alpina* (Turcz. ex Rchb.f.) Czerep., *G. angustifolia* Ilse, *G. anisoloba* Peterm., *G. comigera* Rchb., *G. conopsea* f. *albiflora* Moldenke, *G. c.* f. *albiflora* Y.N.Lee, *G. c.* f. *comigera* (Rchb.) Rchb.f., *G. c.* f. *crenulata* (Beck) Soó, *G. c.* f. *elatio*r Zapal., *G. c.* f. *gracilis* Zapal., *G. c.* f. *lapponica* J.E.Zetterst., *G. c.* f. *monticola* Schur, *G. c.* f. *niphobia* Engenst., *G. c.* f. *ornithis* (Jacq.) Neuman, *G. c.* f. *praecox* (Schönh.) Soó, *G. c.* f. *schurii* Soó, *G. c.* f. *serotina* (Schönh.) Soó, *G. c.* f. *subdensiflora* C.G.Westerl., *G. c.* f. *sublobata*

Zapał., *G. c. f. transsilvanica* Soó, *G. c. f. trifida* (Zapał.) Soó, *G. c. f. unicuspis* C.G.Westerl., *G. c. lusus albiflora* (Zapał.) Zimm., *G. c. lusus leucantha* (Schur) Soó, *G. c. monstr. foliosa* Verm., *G. c. proles alpina* (Turcz. ex Rchb.f.) Rouy, *G. c. proles pseudoconopsea* (P.E.Parm.) Rouy, *G. c. proles pyrenaica* (Philippe) Rouy, *G. c. subsp. angustifolia* (Asch. & Graebn.) Zimm., *G. c. subsp. comigera* (Rchb.) K.Richt., *G. c. subsp. montana* Bisse, *G. c. subsp. peloria* (Foucault ex Poir.) K.Richt., *G. c. subsp. pyrenaica* (Philippe) K.Richt., *G. c. subsp. serotina* (Schönh.) Dworschak, *G. c. var. aestivalis* W.Foelsche, *G. c. var. alba* Gray, *G. c. var. albiflora* Zapał., *G. c. var. alpina* Turcz. ex Rchb.f., *G. c. var. angustifolia* Asch. & Graebn., *G. c. var. bieczensis* Zapał., *G. c. var. caucasica* Schltr., *G. c. var. clavata* Rchb.f., *G. c. var. comigera* (Rchb.) Rchb.f., *G. c. var. crenulata* Beck, *G. c. var. ecalcarata* Rchb.f., *G. c. var. euroalpina* W.Foelsche, *G. c. var. flavida* Kurt.Wagner, *G. c. var. graminea* (Dworschak) Kreutz, *G. c. var. inodora* Fr. ex Rchb.f., *G. c. var. lapponica* (J.E.Zetterst.) J.E.Zetterst., *G. c. var. latifolia* Schltr., *G. c. var. leucantha* Schur, *G. c. var. montana* (Bisse) Soó, *G. c. var. neglecta* Vöth, *G. c. var. odorata* (Dworschak) Kreutz, *G. c. var. ornithis* (Jacq.) Nyman, *G. c. var. platyphylla* Rchb.f., *G. c. var. praecox* Schönh., *G. c. var. pyrenaica* (Philippe) Nyman, *G. c. var. serotina* Schönh., *G. c. var. sibirica* (Turcz. ex Lindl.) Rchb.f., *G. c. var. trifida* Zapał., *G. c. var. ussuriensis* Regel, *G. densiflora* var. *candida* G.Foelsche & W.Foelsche, *G. graminea* Dworschak, *G. ibukiensis* Makino, *G. odoratissima* subsp. *longicalcarata* C.E.Hermos. & Sabando, *G. o. subsp. pyrenaica* (Philippe) Moreno Mor., Rodr.Berd. & Carlón, *G. o. var. pyrenaica* (Philippe) P.Delforge, *G. ornithis* (Jacq.) Rich., *G. pyrenaica* (Philippe) Giraudias, *G. sibirica* Turcz. ex Lindl., *G. splendida* Dworschak, *G. splendida* subsp. *odorata* Dworschak, *G. splendida* var. *odorata* (Dworschak) W.Foelsche, *G. transsilvanica* Schur, *G. vernalis* Dworschak, *G. wahlenbergii* Afzel. ex Rchb.f., *Habenaria conopsea* (L.) Benth., *H. gymnadenia* Druce, *Orchis conopea* Gras, *Orchis conopea* var. *albiflora* Tinant, *O. c. var. major* Tinant, *O. conopsea* L., *O. c. var. comigera* (Rchb.) Marcet, *O. cornopica* Mill., *O. ornithis* Jacq., *O. peloria* Foucault ex Poir., *O. pseudoconopea* Gren., *O. pseudoconopsea* P.E.Parm., *O. pyrenaica* Philippe, *O. setacea* Gilib., *O. suaveolens* Salisb. *Satyrrium conopseum* (L.) Wahlenb.)

GENUS

Habenaria Willd. (Ate Lindl., *Bertauxia* Szlach., *Bicchia* Parl., *Bilabrella* Lindl., *Centrochilus* Schauer, *Choeradoplectron* Schauer, *Denslovia* Rydb., *Digomphotis* Raf., *Diplectraden* Raf., *Dissorhynchium* Schauer, *Dithrix* (Hook. f.) Schltr. ex Brummitt, *Entaticus* Gray, *Fimbrorchis* Szlach., *Glossaspis* Spreng., *Glossula* Lindl., *Habenaria* Nimmo, *Habenella* Small, *Habenorkis* Thouars, *Hemiperis* Frapp. ex Cordem., *Itaculumia* Hoehne, *Kraenzlinorchis* Szlach., *Kryptostoma* (Summerh.) Geerinck, *Kusibabella* Szlach., *Macrocentrum* Phil., *Medusorchis* Szlach., *Montolivaea* Rchb. f., *Nemuranthes* Raf., *Ochyrorchis* Szlach., *Odisha* S. Misra, *Phaniasia* Blume ex Miq., nom. inval., *Plantaginorchis* Szlach., *Platantheroides* Szlach., *Platycorynoides* Szlach., *Plectoglossa* (Hook. f.) K.

Prasad & Venu, *Podandriella* Szlach., *Pseudocoeloglossum* (Szlach. & Olszewski)
 Szlach., *Pseudoperistylis* Szlach. & Olszewski, *Pseudoperistylus* (P. F. Hunt)
 Szlach. & Olszewski, *Smithanthe* Szlach. & Marg.)
Hemipilia Lindl. (*Shizhenia* X. H. Jin et al.)
Herminium L. (*Aopla* Lindl., *Aspla* Rchb., *Chamaerepes* Spreng., *Frigidorchis* Z.
 J. Liu & S. C. Chen, *Monorchis* Agosti)
Himantoglossum Spreng. (*Barlia* Parl., *Comperia* K. Koch, *Hymanthoglossum*
 Tod., *Loroglossum* Rich.)
Holothrix Rich. ex Lindl. (*Bucculina* Lindl., *Deroemera* Rchb. f., *Monotris* Lindl.,
Saccidium Lindl., *Scopularia* Lindl., *Tryphia* Lindl.)
Hsenhsua X. H. Jin et al.
Macrura (Kraenzl.) Szlach. & Sawicka
Megalorchis H. Perrier
Mirandorchis Szlach. & Kras-Lap.
Neobolusia Schltr.
Neotinea Rchb. f. (*Odontorchis* D. Tyteca & E. Klein, *Tinea* Biv.)
Ophrys L. (*Arachnites* F. W. Schmidt, *Myodium* Salisb.)
Orchis L. (*Aceras* R. Br., *Androrchis* D. Tyteca & E. Klein, *Galeorchis* Rydb.,
Strateuma Salisb., nom. inval., *Zoophora* Bernh.)
Pecteilis Raf. (*Parhabenaria* Gagnep.)
Peristylus Blume
Physoceras Schltr.
Platanthera Rich. (*Blephariglottis* Raf., *Diplanthera* Raf., *Gymnadeniopsis* Rydb.,
Limnorchis Rydb., *Lysias* Salisb. ex Rydb., *Lysiella* Rydb., *Mecosa* Blume,
Perularia Lindl., *Piperia* Rydb., *Pseudodiphryllum* Nevski, *Sieberia* Spreng.,
Tulotis Raf.)
Platycoryne Rchb. f.
Ponerorchis Rchb. f. (*Chusua* Nevski)
Porolabium Tang & F. T. Wang
Pseudohemipilia Szlach.
Pseudorchis Ség. (*Leucorchis* E. Mey., *Polybactrum* Salisb., *Triplorhiza* Ehrh.)
Roeperocharis Rchb. f.
Schizochilus Sond.
Schlechterorchis Szlach.
Senghasiella Szlach.
Serapias L. (*Lonchitis* Bubani, *Serapiastrum* Kuntze)
Silvorchis J. J. Sm. (*Vietorchis* Aver. & Averyanova)
Sirindbornia H. A. Pedersen & Suksathan
Sirindhornia H. A. Pedersen & Suksathan
Stenoglottis Lindl.
Steveniella Schltr. (*Stevenorchis* Wankow & Kraenzl.)
Thulinia P. J. Cribb
Trachypetalum Szlach. & Sawicka
Traunsteinera Rchb.

Tylostigma Schltr.
Veyretella Szlach. & Olszewski

SUBFAMILY
Vanilloideae

TRIBE
Pogonieae
Vanilleae

ORDER

2. POALES SMALL (Aegilopaceae Martinov, Agrostidaceae Bercht. & J. Presl, Alopecuraceae Martinov, Andropogonaceae Martinov, Anomochloaceae Nakai, Anthoxanthaceae Link, Arundinaceae Döll, Arundinellaceae Herter, Asperellaceae Link, Avenaceae Martinov, Bambusaceae Bercht. & J. Presl, Bromaceae Bercht. & J. Presl, Cenchraceae Link, Chaeturaceae Link, Chloridaceae Bercht. & J. Presl, Chondrosaceae Link, Coleanthaceae Pfeiff., Cynodontaceae Link, Cynosuraceae Link, Echinariaceae Link, Ehrhartaceae Link, Eragrostidaceae Herter, Festucaceae Spreng. in J. Sadler, Glyceriaceae Link, Gramineae Juss., Holcaceae Link, Hordeaceae Bercht. & J. Presl, Laguraceae Link, Lepturaceae Herter, Loliaceae Link, Melicaceae Martinov, Miliaceae Link, Nardaceae Martinov, Olyraceae Bercht. & J. Presl, Ophiuraceae Link, Oryzaceae Bercht. & J. Presl, Panicaceae Bercht. & J. Presl, Pappophoraceae Herter, Parianaceae Nakai, Paspalaceae Link, Phalaridaceae Link, Pharaceae Herter, Phleaceae Link, Saccharaceae Bercht. & J. Presl, Sesleriaceae Döll, Spartinaeae Link, Stipaceae Bercht. & J. Presl, Streptochaetaceae Nakai, Triticaceae Link, Zeaceae A. Kern., Zoysiaceae Link)

FAMILY

2. Cyperaceae Juss., nom. cons. (Kobresiaceae Gilly, Mapaniaceae Shipunov, Papyraceae Burnett, Scirpaceae Batsch ex Borkh., Scleriaceae Bercht. & J. Presl)

SUBFAMILY
Cyperoideae

TRIBE
Abildgaardieae
Bisboeckelereae
Cariceae

GENUS

Carex L. (*Blysmocarex* N. A. Ivanova, *Cymophyllus* Mack. ex Britton & A. Br., *Diplocarex* Hayata, *Elyna* Schrad., *Hemicarex* Benth., *Kobresia* Willd., *Schoenoxiphium* Nees, *Uncinia* Pers., *Vesicarex* Steyererm.)

SPECIES

15. *Carex rostrata* Stokes (*C. ampullacea* Gooden., *C. ampullacea* f. *elator* Blytt, *C. ampullacea* f. *maxima* Andersson, *C. ampullacea* f. *pendulina* Blytt, *C. ampullacea* f. *planifolia* Norman, *C. ampullacea* subsp. *hymenocarpa* (Drejer) Nyman, *C. ampullacea* var. *altissima* Andersson, *C. ampullacea* var. *borealis* Hartm., *C. ampullacea* var. *brunnescens* Andersson, *C. ampullacea* var. *longifolia* (Thuill.) Steud., *C. ampullacea* var. *nutans* Knaf, *C. ampullacea* var. *robusta* Sond., *C. bifurca* Schrank, *C. catteyensis* A.Benn., *C. hymenocarpa* Drejer, *C. inflata* Huds., *C. inflata* Suter, *C. inflata* V. Krecz., *C. inflata* var. *ambigens* Fernald, *C. inflata* var. *borealis* Laest., *C. longifolia* Thuill., *C. obtusangula* Ehrh., *C. rostrata* f. *elator* Lange, *C. rostrata* f. *furcata* Junge, *C. rostrata* f. *laeta* Norman, *C. rostrata* f. *longipalea* Neuman, *C. rostrata* f. *pendulina* (Blytt) Kük., *C. rostrata* f. *plumosa* Norman, *C. rostrata* f. *rostrate*, *C. rostrata* f. *sommieri* Christ, *C. rostrata* f. *sparangiformis* Murr, *C. rostrata* f. *umbrosa* Junge, *C. rostrata* subsp. *hymenocarpa* (Drejer) K.Richt., *C. rostrata* var. *borealis* (Hartm.) Kük., *C. rostrata* var. *brunnescens* (Andersson) Kük., *C. rostrata* var. *cliftonii* Farw., *C. rostrata* var. *hymenocarpa* (Drejer) Christ, *C. rostrata* var. *latifolia* Asch., *C. rostrata* var. *rostrate*, *C. rotundata* var. *elator* Lange, *C. rotundata* var. *major* Meinsh., *C. torfacea* J.F.Gmel., *C. vesicaria* var. *inalpina* Laest., *Trasus ampullaceus* Gray)

16. *Carex vulpina* L. (*C. brotherorum* Christ, *C. compacta* Lam., *C. glomerata* Gilib., *C. mertensis* Weihe ex Kunth, *C. muricata* Jungh., *C. reflexa* D. Dietr. ex Kunth, *C. spicata* Thuill., *C. vulpina* f. *aristata* Asch., *C. vulpina* f. *capitulata* (Peterm.) Soó, *C. vulpina* f. *elongata* Andersson, *C. vulpina* f. *laeviuscula* Sanio ex Asch. & Graebn., *C. vulpina* f. *minor* Peterm., *C. vulpina* subsp. *stribrnyi* Velen., *C. vulpina* var. *compacta* (Lam.) Velen., *C. vulpina* var. *crassinervis* (Schur) Kük., *C. vulpina* var. *divulsa* Celak., *C. vulpina* var. *gracilis* Gaudin, *C. vulpina* var. *litoralis* Nolte ex Asch. & Graebn., *C. vulpina* var. *longibracteata* Beck, *C. vulpina* var. *pallidior* Meinsh., *C. vulpina* var. *remotiflora* Lange, *C. vulpina* var. *stribrnyi* (Velen.) Kük., *C. vulpina* var. *tenuior* Ledeb., *Edritria vulpina* (L.) Raf., *Vigna vulpina* (L.) Rchb., *V. vulpina* f. *capitulata* Peterm., *V. vulpina* var. *crassinervis* Schur)

TRIBE

Cladieae

Cryptangieae

Cypereae

Dulichieae

Eleocharideae

Fuireneae

Rhynchosporae

Schoeneae

Scirpeae

Sclerieae
Trilepideae

SUBFAMILY
Mapanioideae

TRIBE
Chrysitricheae
Hypolytreae

FAMILY

3. Juncaceae Juss., nom. cons.

GENUS

Distichia Nees & Meyen
***Juncus* L.** (*Microschoenus* C. B. Clarke)

SPECIES

17. *Juncus compressus* Jacq. (*Agathryon compressum* (Jacq.) Záv.Drábk. & Pročkův *Juncus bulbosus* subsp. *compressus* (Jacq.) Syme *J. bulbosus* var. *alpinus* Schur *J. b.* var. *compressus* (Jacq.) Jess. *J. b.* var. *compressus* (Jacq.) Regel *J. compressus condensatus* Asch. & Graebn. *J. c.* f. *alpinus* (Schur) Soó *J. c.* f. *elongatus* Asch. & Graebn. *J. c.* f. *euxinus* (Velen.) Hayek *J. c.* f. *laxus* (Asch. & Graebn.) Borza *J. c.* f. *longirepens* Zapał. *J. c.* f. *nanus* Neuman *J. c.* f. *tenuifolius* Zapał. *J. c.* f. *tereticaulis* (Vollm.) Suess. *J. c.* *laxus* Asch. & Graebn. *J. c.* *metzleri* (F.W.Schultz) Asch. & Graebn. *J. c.* var. *alpinus* Schur *J. c.* var. *dianthelus* K.Koch *J. c.* var. *euxinus* Velen. *J. c.* var. *metzleri* (F.W.Schultz) I.Grint. *J. c.* var. *nudiculmis* F.W.Schultz *J. c.* var. *porphyrocarpus* Murr *J. c.* var. *pseudogerardii* Jafri *J. c.* var. *pumilus* Schur *J. c.* var. *tenuifolius* Zapał. *J. c.* var. *tenuis* Schur *J. c.* var. *tereticaulis* Vollm. *J. c.* *viridiflorus* Asch. & Graebn. *J. c.* *viridis* Asch. & Graebn. *J. gramineus* Dumort. *J. g.* var. *compressus* (Jacq.) Dumort. *J. metzleri* F.W.Schultz *J. soranthus* A.K.Becker)

GENUS

***Luzula* DC.** (*Ebingeria* Chrtek & Krísa, *Juncoides* Ség.)

SPECIES

18. *Luzula pilosa* (L.) Willd. (*Juncoides pilosa* (L.) Kuntze, *J. nemorosus* Lam., *J. pilosus* L., *J. p.* subsp. *cymosus* Schrank, *J. p.* var. *vernalis* (Reichard) Pers., *J. vernalis* Reichard, *Luciola pilosa* (L.) Sm., *Luzula cechica* Domin, *L. nemorosa* Dulac, *L. pilosa* f. *pallida* A.Dyring, *L. pilosa* f. *slendzinskii* Racib., *L. p.* var. *brevicapsula* Kožuharov, *L. p.* var. *simplex* Sond., *L. vernalis* (Reichard) DC., *Nemorinia vernalis* (Reichard) Fourr., *Pterodes pilosus* (L.) Börner)

GENUS

Marsippospermum Desv.
Oxychloe Phil. (*Andesia* Hauman)
Patosia Buchenau
Rostkovia Desv.

FAMILY

4. Poaceae Barnhart, nom. cons. (Aegilopaceae Martinov, Agrostidaceae Bercht. Alopecuraceae Martinov, Andropogonaceae Martinov, Anomochloaceae Nakai, Anthoxanthaceae Link, Arundinaceae Döll, Arundinellaceae Herter, Asperellaceae Link, Hort. Avenaceae Martinov, Bambusaceae Bercht. & J. Presl, Bromaceae Bercht. & J. Presl, Cenchraceae Link, Chaeturaeae Link, Chloridaceae Bercht. & J. Presl, Chondrosaceae Link, Coleanthaceae Pfeiff., Cynodontaceae Link, Cynosuraceae Link, Echinariaceae Link, Ehrhartaceae Link, Eragrostidaceae Herter, Festucaceae Spreng. in J. Sadler, Glyceriaceae Link, Gramineae Juss., Holcaceae Link, Hordeaceae Bercht. & J. Presl, Laguraceae Link, Lepturaceae Herter, Loliaceae Link, Melicaceae Martinov, Miliaceae Link, Nardaceae Martinov, Olyraceae Bercht. & J. Presl, Ophiuraceae Link, Oryzaceae Bercht. & J. Presl, Panicaceae Bercht. & J. Presl, Pappophoraceae Herter, Parianaceae Nakai, Paspalaceae Link, Phalaridaceae Link, Pharaceae Herter, Phleaceae Link, Saccharaceae Bercht. & J. Presl, Sesleriaceae Döll, Spartiaceae Link, Stipaceae Bercht. & J. Presl, Streptochaetaceae Nakai, Triticaceae Link, Zeaceae A. Kern., Zoysiaceae Link)

SUBFAMILY

Anomochlooideae

TRIBE

Anomochloae
Streptochaeteae

SUBFAMILY

Pharoideae

TRIBE

Phareae

SUBFAMILY

Puelioideae

TRIBE

Atractocarpeae
Guaduelleae
Puelieae

BOP clade

SUBFAMILY

Oryzoideae

TRIBE

Ehrharteae

Oryzeae

SUBTRIBE

Oryzinae

Zizaniinae

TRIBE

Phyllorachideae

Streptogyneae

SUBFAMILY

Bambusoideae

TRIBE

Arundinarieae

SUBTRIBE

Arundinariinae

TRIBE

Bambuseae

SUBTRIBE

Arthrostylidiinae

Bambusinae

Chusqueinae

Guaduinae

Hickeliinae

Melocanninae

Racemobambosinae

TRIBE

Olyreae

SUBTRIBE

Buergersiochloinae

Olyrinae
Parianinae

SUBFAMILY
Pooideae

TRIBE
Ampelodesmeae
Brachyelytreae
Brachypodieae
Bromeae
Brylkinieae
Diarrheneae
Littledaleae
Lygeae
Meliceae
Nardeae
Phaenospermateae
Poeae

SUBTRIBE
Agrostidinae
Airinae
Alopecurinae
Ammochloinae
Anthoxanthinae
Aveninae
Brizinae
Calothecinae
Cinninae
Coleanthinae
Cynosurinae
Dactylidinae
Holcinae
Loliinae
Miborinae
Miliinae
Parapholiinae
Phalaridinae
Poinae
Puccinelliinae
Scolochloinae
Scribneriinae
Sesleriinae

Torreyochloinae

TRIBE

Stipeae

Triticeae

SUBTRIBE

Hordeinae

NOTHOGENUS

×*Agroelymus* E. G. Camus ex A. Camus = *Agropyron* × *Elymus* (×*Agrositanion*
Bowden = *Agropyron* × *Sitanion*)

×*Agrohordeum* E. G. Camus ex A. Camus = *Agropyron* × *Hordeum*

GENUS

Agropyron Gaertn. (*Costia* Willk., *Kratzmannia* Opiz, nom. inval.)

Anthosachne Steud. [*Elymus* L.]

Asperella Humb. [*Elymus* L.]

Australopyrum (Tzvelev) Á. Löve [*Elymus* L.]

Cockayneana Zotov [*Elymus* L.]

Connorochloa Barkworth et al. [*Elymus* L.]

Crithopsis Jaub. & Spach

Elymus L. Mitch. (*Braconotia* Godr., *Campeiostachys* Drobow, *Chretomeris* Nutt.
ex J. G. Sm., nom. inval., *Clinelymus* (Griseb.) Nevski, *Crithopyrum* Steud., nom.

inval., *Cryptopyrum* Heynh., nom. inval., ×*Elysitanion* Bowden = *Elymus* ×
Sitanion, *Goulardia* Husn., *Gymnostichum* Schreb., *Hystrix* Moench, *Polyantherix*
Nees, *Semeiostachys* Drobow, *Sitospelos* Adans., *Terrellia* Lunell)

Elytrigia Desv. [*Elymus* L.]

Eremopyrum (Ledeb.) Jaub. & Spach (*Cremopyrum* Schur, orth. var.)

Festucopsis (C. E. Hubb.) Melderis [*Elymus* L.]

Henrardia C. E. Hubb.

Heteranthelium Hochst. ex Jaub. & Spach

NOTHOGENUS

×*Hordale* Cif. & Giacom. = *Hordeum* × *Secale*

GENUS

Hordelymus (Jess.) Harz (*Cuviera* Koeler, *Leptothrix* (Dumort.) Dumort.,
Medusather (Griseb.) P. Candargy, *Orostachys* Steud., nom. inval.)

Hordeum L. (*Critesion* Raf., *Critho* E. Mey., *Zeocriton* Wolf)

SUBGENUS

Hordeastrum

SECTION

Marina
Nodosa
Stenostachys

SUBSECTION

Critesion
Sibirica

SUBGENUS

Hordeum

SECTION

Hordeum
Trichostachys

GENUS

Kengyilia C. Yen & J. L. Yang [*Elymus* L.]

NOTHOGENUS

×*Leydeum* Barkworth = *Leymus* × *Hordeum*

GENUS

Leymus Hochst. (*Aneurolepidium* Nevski, *Anisopyrum* (Griseb.) Gren. & Duval, nom. inval., *Eremium* Seberg & Linde-Laursen, *Malacurus* Nevski)

NOTHOGENUS

×*Pascoleymus* Barkworth = *Pascopyrum* × *Leymus*

GENUS

Pascopyrum Á. Löve [*Elymus* L.]
Peridictyon Seberg et al. [*Elymus* L.]
Psathyrostachys Nevski

NOTHOGENUS

×*Pseudelymus* Barkworth & D. R. Dewey = *Pseudoroegneria* × *Elymus*
(×*Pseudotrigia* ined.)

GENUS

Pseudoroegneria (Nevski) Á. Löve [*Elymus* L.]
Roegneria K. Koch [*Elymus* L.]
***Secale* L.** (*Gramen* Ség.)

SPECIES

19. *Secale cereale* L. (*Secale aestivum* Uspenski, *S. ancestrale* (Zhuk.) Zhuk., *S. a.* var. *aidinum* Zhuk., *S. a.* var. *arenosum* Zhuk., *S. a.* var. *karaburun* Zhuk., *S. a.* var. *spontaneum* Zhuk., *S. arundinaceum* Trautv., *S. cereale* f. *brevispicatum* (Waisb.) Soó, *S. c.* f. *montaniforme* (Waisb.) Soó, *S. c. indoeuropaeum* Antropov & Antropova, *S. c. rigidum* Antropov & Antropova, *S. c.* subsp. *aestivum* Schübl. & G.Martens, *S. c.* subsp. *ancestrale* Zhuk., *S. c.* subsp. *tetraploidum* Kobyl., *S. c.* subsp. *tsitsinii* Kobyl., *S. c.* var. *aestivum* (Schübl. & G.Martens) Alef., *S. c.* var. *aestivum* (Schübl. & G.Martens) Wirtg., *S. c.* var. *ancestrale* (Zhuk.) Kit Tan, *S. c.* var. *arduennense* Lej., *S. c.* var. *arundinaceum* (Trautv.) Peterm., *S. c.* var. *badium* Antropov & Antropova, *S. c.* var. *biflorum* Peterm., *S. c.* var. *brunneum* Antropov & Antropova, *S. c.* var. *caducum* Antropov & Antropova, *S. c.* var. *compositum* Koeler, *S. c.* var. *fuscum* Körn., *S. c.* var. *hepaticum* Antropov & Antropova, *S. c.* var. *hybernum* Aiton, *S. c.* var. *hybernum* Linnaeus, 1753, *S. c.* var. *multicaule* Metzg. ex Alef., *S. c.* var. *piliferum* Antropov & Antropova, *S. c.* var. *ramosum* Peterm., *S. c.* var. *rubellum* Antropov & Antropova, *S. c.* var. *rufescens* Antropov & Antropova, *S. c.* var. *rufum* Antropov & Antropova, *S. c.* var. *setosobrunneum* Antropov & Antropova, *S. c.* var. *setosocaducum* Antropov & Antropova, *S. c.* var. *setosoclausopaleatum* Antropov & Antropova, *S. c.* var. *setosofuscum* Antropov & Antropova, *S. c.* var. *setosohepaticum* Antropov & Antropova, *S. c.* var. *setosorufum* Antropov & Antropova, *S. c.* var. *setosovulpinum* Antropov & Antropova, *S. c.* var. *setosum* Antropov & Antropova, *S. c.* var. *spontaneum* Zhuk., *S. c.* var. *triflorum* Döll, *S. c.* var. *triflorum* Lej., *S. c.* var. *tuberculatoarticulatum* Antropov & Antropova, *S. c.* var. *tuberculatofuscum* Antropov & Antropova, *S. c.* var. *tuberculatorufum* Antropov & Antropova, *S. c.* var. *tuberculatovulpinum* Antropov & Antropova, *S. c.* var. *tuberculatum* Antropov & Antropova, *S. c.* var. *tuberculocaducum* Antropov & Antropova, *S. c.* var. *velutinorubellum* Antropov & Antropova, *S. c.* var. *velutinorufum* Antropov & Antropova, *S. c.* var. *vernum* Aiton, *S. c.* var. *vernum* Kunth, *S. c.* var. *vernum* L., *S. c.* var. *vulgare* Ser., *S. compositum* Poir., *S. creticum* Sieber ex Kunth DC, *S. hybernum* Poir., *S. montanum* subsp. *balcanum* (Gancev) Kožuharov, *S. m.* var. *balcanum* Gancev, *S. sibiricum* Georgi (not established), *S. spontaneum* Fisch. ex Steud., *S. strictum* subsp. *balcanum* (Gancev) Valdés & H.Scholz, *S. triflorum* P.Beauv., *S. turkestanicum* Bensin, *S. vernum* Poir., *Triticum cereale* (L.) Salisb. DC, *T. c.* f. *brevispicatum* Waisb., *T. c.* f. *montaniforme* Waisb., *T. c.* var. *montaniforme* Waisb., *T. c.* var. *triflorum* (Döll) Asch., *Triticum ramosum* Weigel DC, *Triticum secale* Link)

GENUS

Sitanion Raf. [*Elymus* L.]
Stenostachys Turcz. [*Elymus* L.]
Taeniatherum Nevski
Thinopyrum Á. Löve [*Elymus* L.]

SUBTRIBE

Triticinae

PACMAD clade

ПІДРОДИНА
Aristidoideae

TRIBE
Aristideae

SUBFAMILY
Panicoideae

TRIBE
Andropogoneae

SUBTRIBE
Andropogoninae
Anthrastiriinae
Arthraxoninae
Chionachninae
Coicinae
Dimeriinae
Germainiinae
Ischaeminae
Rottboelliinae
Saccharinae
Sorghinae
Tripsacinae

TRIBE
Arundinelleae
Centothecae
Chasmanthieae
Cyperochloae
Gynerieae
Paniceae

SUBTRIBE
Anthephorinae
Boivinellinae
Cenchrinae
Dichantheliinae
Melinidinae

Neurachninae
Panicinae

TRIBE
Paspaleae

SUBTRIBE
Arthropogoninae
Otachyriinae
Paspalinae

TRIBE
Steyermarkochloaeae
Thysanolaeneae
Tristachyideae
Zeugiteae

SUBFAMILY
Chloridoideae

TRIBE
Centropodieae
Cynodonteae

SUBTRIBE
Aeluropodinae
Boutelouinae
Cteniinae
Eleusininae
Farragininae
Gouiniinae
Gymnopogoninae
Hilariinae
Monanthochloinae
Muhlenbergiinae
Orcuttiinae
Pappophorinae
Perotidinae
Scleropogoninae
Traginatae
Trichoneurinae
Triodiinae
Tripogoninae

TRIBE
Eragrostideae

SUBTRIBE
Cotteinae
Eragrostidinae
Unioliinae

TRIBE
Triraphideae
Zoysieae

SUBTRIBE
Sporobolinae
Zoysiinae

SUBFAMILY
Danthonioideae

TRIBE
Danthonieae

SUBFAMILY
Arundinoideae

TRIBE
Arundineae
Molinieae

SUBFAMILY
Micrairoideae

TRIBE
Eriachneae
Hubbardiae
Isachneae
Micraireae

FAMILY
5. Typhaceae Juss., nom. cons. (Sparganiaceae Hanin)

TRIBE
Sparganieae

GENUS
***Sparganium* L.**

SPECIES

20. *Sparganium emersum* Rehmann (*S. acaule* (Beeby ex Macoun) Rydb., *S. chlorocarpum* Rydb., *S. c. f. acaule* (Beeby ex Macoun) E.G.Voss, *S. c. var. acaule* (Beeby ex Macoun) Fernald, *S. diversifolium* Graebn., *S. diversifolium* var. *acaule* (Beeby ex Macoun) Fernald & Eames, *S. diversifolium* var. *wirtgeniorum* Graebn., *S. emersum* f. *angustifolium* (Morong) Soó, *S. e. f. gracile* (Meinsh.) Soó, *S. e. f. simile* (Meinsh.) Soó, *S. e. f. submersum* (Glück) Soó, *S. e. f. subvaginatum* (Meinsh.) Soó, *S. e. subsp. acaule* (Beeby ex Macoun) C.D.K.Cook & M.S.Nicholls, *S. e. subsp. emersum*, *S. e. var. acaule* (Beeby) A.Haines, *S. e. var. beckmannii* A.V.Grebenjuk & Czepinoga, *S. e. var. multipedunculatum* (Morong) Reveal, *S. e. var. simile* (Meinsh.) Graebn., *S. gracile* Meinsh., *S. longissimum* (Fr.) Fritsch, *S. multipedunculatum* (Morong) Rydb., *S. simile* Meinsh., *S. simplex* Huds., *S. s. f. angustifolium* C.L.Beckm., *S. s. subsp. emersum* (Rehmann) K.Richt., *S. s. var. acaule* Beeby, *S. s. var. angustifolium* Morong, *S. s. var. emersum* (Rehmann) Nyman, *S. s. var. fluitans* Godr. & Gren., *S. s. var. gracile* (Meinsh.) Graebn., *S. simplex* var. *inundatum* Graebn., *S. s. var. longissimum* (Fr.) Graebn., *S. s. var. multipedunculatum* Morong, *S. s. var. natans* Glück, *S. s. var. submersum* Glück, *S. s. var. subvaginatum* (Meinsh.) Graebn., *S. subvaginatum* Meinsh., *S. wirtgeniorum* (Graebn.) Rouy)

TRIBE
Typheae

GENUS
Rohrbachia (Kronf. ex Riedl) Mavrodiev [*Typha* L.]
***Typha* L.**

SPECIES

21. *Typha angustifolia* L. (*Massula angustifolia* (L.) Dulac, *Typha angustifolia* f. *foveolata* (Pobed.) Mavrodiev, *T. a. f. submersa* Glück, *T. a. var. calumetensis* Peattie, *T. a. var. elatior* (Boenn.) Nyman, *T. a. var. elongata* Wiegand, *T. a. var. longispicata* Peck, *T. a. var. spathacea* Borbás, *T. elatior* Boenn., *T. foveolata* Pobed., *T. glauca* Seg.-Vianna, *T. gracilis* Rchb., *T. media* C.C. Gmel., *T. minor* Curtis, *T. pontica* Klovov f. & Krasnova)

PROBABLE SISTER OF EUDICOTS

ORDER

3. CERATOPHYLLALES LINK (Ceratophyllanae Takht. ex Reveal & Doweld, Ceratophyllidae Doweld)

FAMILY

6. **Ceratophyllaceae Gray** (Ceratophylleae Dumort., Ceratophylloideae Arn.)

GENUS

Ceratophyllum L.

SPECIES

22. *Ceratophyllum demersum* L. (*Ceratophyllum aquaticum* H.C.Watson, *Ceratophyllum aquaticum* subsp. *demersum* (L.) Syme, *C. asperum* Lam., *C. cornutum* Rich., *C. demersum*, *C. demersum* f. *adei* Vollm., *C. d.* f. *tuberculatum* (Cham.) Hook.fil., *C. d.* var. *commune* A.Gray, *C. d.* var. *commutatum* Zapal., *C. d.* var. *inflatum* R.E.Fr., *C. d.* var. *oxyacanthum* (Cham.) K.Schum., *C. d.* var. *oxyacanthum* L., *C. d.* var. *pentacanthum* L., *C. d.* var. *platyacanthum* L., *C. d.* var. *strypense* Zapal., *C. d.* var. *tricorne* Van Haes., *C. gibbum* Laforet ex Nyman, *C. indicum* Willd. ex Cham., *C. oxyacanthum* Cham. DC, *C. submersum* var. *demersum* (L.) Jess., *C. tricorne* Dumort., *C. tricuspidatum* Dumort., *C. tuberculatum* Cham., *C. verticillatum* Roxb., *C. vulgare* Schleid., *C. vulgare* var. *oxyacanthum* (Cham.) Schleid., *Dichotophyllum demersum* (L.) Moench)

23. *Ceratophyllum submersum* L. (*Ceratophyllum aquaticum* subsp. *submersum* (L.), *C. demersum* subsp. *submersum* (L.) Hook.fil., *C. d.* var. *laeve* Crép., *C. d.* var. *submersum* L., *C. granulosum* Schur, *C. inerme* Dumort., *C. laeve* Lam., *C. muticum* Cham., *C. submersum* subsp. *submersum*, *C. s.* var. *granulosum* (Schur) Nyman, *C. s.* var. *haynaldianum* (Borbás) Beck DC, *C. s.* var. *inerme* Van Haes., *C. verrucosum* Gray, *C. verruculosum* Rich.)

EUDICOTS CLADE

ORDER

4. RANUNCULALES JUSS. EX BERCHT. & J.PRESL (Berberidales Bercht. & J. Presl, Circaeasterales Takht., Fumariales Link, Glaucidiales Takht. ex Reveal, Helleborales Nakai, Hydrastidales Takht., Lardizabalales Leconte in D.W. Taylor & L.J. Hickey, Menispermiales Juss. ex Bercht. & J. Presl, Nandinales Doweld, Papaverales Juss. ex Bercht. & J. Presl, Podophyllales Dumort.)

FAMILY

7. *Berberidaceae* Juss., nom. cons. (Diphylleaceae Schultz Sch., Epimediaceae Menge, Leonticaceae Airy Shaw, Nandinaceae Horan., Podophyllaceae DC., Ranzaniaceae Takht.)

SUBFAMILY

Berberidoideae

TRIBE
Berberideae

SUBTRIBE
Berberidinae

GENUS
Alloerberis C. C. Yu & K. F. Chung [*Berberis* L.]
***Berberis* L. (*Odostemon* Raf.)**

SPECIES

24. *Berberis vulgaris* L. (*B. abortiva* P.Renault, *B. acida* Gilib., *B. aethnensis* Bourg. ex Willk. & Lange, *B. alba* Poit. & Turpin, *B. angulizans* G. Nicholson, *B. apyrena* K. Koch, *B. arborescens* K. Koch, *B. articulata* Loisel., *B. asperma* Poit. & Turpin, *B. aurea* Tausch, *B. bigelovii* Schrad., *B. corallina* G. Nicholson, *B. dentata* Tausch, *B. dentata* var. *capitata* Tausch, *B. dulcis* K. Koch, *B. dumetorum* Gouan, *B. edulis* K. Koch, *B. elongata* G. Nicholson, *B. globularis* G. Nicholson, *B. hakodate* Dippel, *B. heterophylla* K. Koch, *B. iberica* Sweet, *B. innominata* Kielm., *B. irritabilis* Salisb., *B. jacquinii* K. Koch, *B. latifolia* Poit. & Turpin, *B. marginata* K. Koch, *B. maxima* G. Nicholson, *B. maximowiczii* Regel, *B. microphylla* F.Dietr., *B. mitis* Schrad., *B. nepalensis* K. Koch, *B. nitens* Schrad., *B. obovata* Schrad., *B. orientalis* C.K. Schneid., *B. pangharengensis* G. Nicholson, *B. pauciflora* Salisb., *B. racemosa* Stokes, *B. rubra* Poit. & Turpin, *B. sanguinea* K. Koch, *B. sanguinolenta* K. Koch, *B. sibirica* Schult. & Schult.f., *B. sieboldii* Dippel, *B. sylvestris* Poit. & Turpin, *B. violacea* Poit. & Turpin, *B. vulgaris* f. *vulgaris*, *B. v.* subsp. *cantabrica* Rivas Mart. & al., *B. v.* subsp. *orientalis* (C.K. Schneid.) Takht., *B. v.* var. *acutifolia* (Prantl) C.K. Schneid., *B. v.* var. *alba* DC., *B. v.* var. *alpestris* Rikli, *B. v.* var. *apyrena* Schrad., *B. v.* var. *asperma* Willd., *B. v.* var. *flava* Schrad., *B. v.* var. *iberica* Steven & Fisch. ex DC., *B. v.* var. *lutea* DC., *B. v.* var. *nigra* DC., *B. v.* var. *orientalis* (C.K. Schneid.) Grossh., *B. v.* var. *orientalis* Papava, *B. v.* var. *purpurea* DC., *B. v.* var. *purpurifolia* Ahrendt, *B. v.* var. *rubra* Willd., *B. v.* var. *sanguinea* Schrad., *B. v.* var. *serotina* Schrad., *B. v.* var. *sulcata* Ahrendt, *B. v.* var. *violacea* Willd.)

SUBSPECIES

B. v. subsp. *australis* (Boiss.) Heywood
B. v. subsp. *seroi* O.Bolòs & Vigo

GENUS
Alloerberis C. C. Yu & K. F. Chung [*Berberis* L.]
Mahonia Nutt. [*Berberis* L.]
Moranothamnus C. C. Yu & K. F. Chung [*Berberis* L.]

NOTHOGENUS

×*Mahoberberis* C. K. Schneid. = *Mahonia* × *Berberis*

GENUS

Ranzania T. Itô

SUBTRIBE

Epimediinae

TRIBE

Leonticeae

SUBFAMILY

Nandinoideae

FAMILY

8. Papaveraceae Juss., nom. cons. (*Chelidoniaceae* Martinov, *Eschscholziaceae* Ser., *Fumariaceae* Marquis, *Hypecoaceae* Willk. & Lange, *Platystemonaceae* Lilja)

SUBFAMILY

Fumarioideae

TRIBE

Fumarieae

SUBTRIBE

Corydalinae

GENUS

Adlumia Raf. ex DC.

Capnoides Mill.

Corydalis DC. (*Cysticorydalis* Fedde, nom. inval., *Roborowskia* Batalin)

Dactylicapnos Wall. (*Dactyliocapnos* Spreng., orth. var.)

Dicentra Bernh. (*Diclytra* Borkh., *Dielytra* Cham. & Schltdl., orth. var.)

Ehrendorferia Fukuhara & Lidén [*Dicentra* Bernh.]

Ichtyoselmis Lidén & Fukuhara [*Dicentra* Bernh.]

Lamprocapnos Endl. [*Dicentra* Bernh.]

SPECIES

25. *Lamprocapnos spectabilis* (L.) Fukuhara (synonym: *Dielytra spectabilis* (L.) DC.) (*Capnorchis spectabilis* (L.) Borkh., *Corydalis spectabilis* (L.) Pers., *Dicentra spectabilis* (L.) Lem., *Diclytra spectabilis* (L.) DC., *D. spectabilis* (L.) DC., *D. spectabilis* (L.) G.Don, *Eucapnos spectabilis* (L.) Siebold & Zucc.,

Fumaria spectabilis L. DC , *Hedycapnos spectabilis* (L.) Planch., *Hedycapnos spectabilis* Planch.)

SUBTRIBE

Fumariinae

TRIBE

Hypecoae

SUBFAMILY

Papaveroideae

TRIBE

Chelidoneae

GENUS

Bocconia L.

***Chelidonium* L.** (*Coreanomecon* Nakai)

SPECIES

26. *Chelidonium majus* L. (*C. haematodes* Moench, *C. laciniatum* Mill., *C. laciniatum* var. *fumariifolium* DC., *C. luteum* Gilib., *C. majus* f. *laciniatum* Schube, *C. m.* f. *majus*, *C. m.* subsp. *laciniatum* (Mill.) Domin, *C. m.* var. *fumariifolium* (DC.) K. Koch, *C. m.* var. *grandiflorum* DC., *C. m.* var. *laciniatum* (Mill.) Lam. & DC., *C. m.* var. *laciniatum* Roth, *C. m.* var. *plenum* Latourr., *C. m.* var. *tenuifolium* Lilj., *C. murale* P. Renault, *C. olidum* Tarscher. ex Ott, *C. quercifolium* Willemet, *C. ruderale* Salisb., *C. umbelliferum* Stokes)

SUBSPECIES

C. m. subsp. *grandiflorum* (DC.) Printz

GENUS

Coreanomecon Nakai [*Chelidonium* L.]

Dicranostigma Hook. f. & Thomson

Eomecon Hance

Glaucium Mill.

Hylomecon Maxim.

Macleaya R. Br.

Sanguinaria L.

Stylophorum Nutt.

TRIBE

Eschscholieae

Papavereae

GENUS

Arctomecon Torr. & Frém.

Argemone L.

Canbya Parry ex A. Gray

Cathcartia Hook. f.

Meconella Nutt.

Meconopsis Vig. (*Cumminsia* King ex Prain, nom. inval.)

Oreomecon Banfi et al. (*Papaver* L. sect. *Lasiotrachyphylla*, *Papaver* L. sect. *Meconella*, *Papaver* L. sect. *Scapiflora*)

***Papaver* L.** (*Parameconopsis* Grey-Wilson)

SECTION

Argemonidium

Californicum

Carinatae

Horrida

Lasiotrachyphylla

Macrantha

Meconella

Meconidium

Papaver

Pilosa

Pseudopilosa

Rhoeadium

SPECIES

27. *Papaver rhoeas* L. (*Papaver rhoeas* var. *vulgare* Roth)

SECTION

Scapiflora

GENUS

Platystemon Benth.

Platystigma Benth. (*Hesperomecon* Greene)

Roemeria Medik.

Romneya Harv.

Stylomecon G. Taylor

FAMILY

9. Ranunculaceae Juss., nom. cons. (Aconitaceae Bercht. & J. Presl, Actaeaceae Bercht. & J. Presl, Anemonaceae Vest, Aquilegiaceae Lilja, Calthaceae Martinov, Cimicifugaceae Bromhead, Clematidaceae Martinov, Delphinaceae Brenner,

Glaucidiaceae Tamura, Helleboraceae Vest, Hydrastidaceae Martinov, Nigellaceae J. Agardh, Thalictraceae Raf., Xanthorrhizaceae Bercht. & J. Presl)

SUBFAMILY

Coptidoideae

TRIBE

Coptideae

SUBFAMILY

Glaucidioideae

Hydrastidoideae

TRIBE

Hydrastideae

SUBFAMILY

Isopyroideae

TRIBE

Isopyreae

SUBTRIBE

Isopyrinae

Thalictrinae

GENUS

Thalictrum L. (*Anemonella* Spach, *Piuttia* Mattei, *Schlagintweitiella* Ulbr.,
Stipularia Delpino, *Syndesmon* (Hoffmanns. ex Endl.) Britton)

SUBFAMILY

Ranunculoideae

TRIBE

Actaeaceae

GENUS

Actaea L. (*Actinospora* Turcz., *Pityrosperma* Siebold & Zucc.)

Anemonopsis Siebold & Zucc.

Beesia Balf. f. & W.W. Sm.

Cimicifuga Wernisch. [*Actaea* L.]

Eranthis Salisb. (*Shibateranthis* Nakai)

Souliea Franch. [*Actaea* L.]

TRIBE
Adonideae
Anemoneae

GENUS

Anemone L. (*Anemoclema* (Franch.) W. T. Wang, *Anemonastrum* Holub,
Anemonidium (Spach) Holub, *Anetilla* Galushko, *Arsenjevia* Starod., *Eriocapitella*
Nakai, *Jurtsevia* Á. Löve & D. Löve)
Archiclematis (Tamura) Tamura [*Clematis* L.]
Barneoudia Gay [*Anemone* L.]
Clematis L. (*Atragene* L., *Coriflora* Weber, nom. inval., *Viorna* Rchb.)
Clematopsis Bojer ex Hutch. [*Clematis* L.]
Hepatica Mill. [*Anemone* L.]
Knowltonia Salisb. [*Anemone* L.]
Metanemone W. T. Wang
Miyakea Miyabe & Tatew. [*Anemone* L.]
Naravelia Adans. [*Clematis* L.]
Oreithales Schltdl. (*Capethia* Britton), [*Anemone* L.]
Pulsatilla Mill. [*Anemone* L.]

TRIBE
Asteropyreae
Caltheae

GENUS

Calathodes Hook. f. & Thomson
Caltha L. (*Psychrophila* (DC.) Bercht. & J. Presl)

TRIBE
Delphinieae
Helleboreae
Nigelleae
Ranunculeae

GENUS

Aphanostemma A. St.-Hil. [*Ranunculus* L.]
Arcteranthis Greene [*Ranunculus* L.]
Beckwithia Jeps. [*Ranunculus* L.]
Callianthemoides Tamura [*Ranunculus* L.]
Ceratocephala Moench (*Ceratocephalus* Pers., orth. var.)
Coptidium (Prantl) Beurl. ex Rydb. [*Ranunculus* L.]
Cyrtorhyncha Nutt. [*Ranunculus* L.]
***Ficaria* Schaeff.** [*Ranunculus* L.]

SPECIES

28. *Ficaria verna* Huds. (*Caltha hiranoi* Tamura, *Chelidonium minus* Garsault, *Ficaria ambigua* Boreau, *F. aperta* Schur, *F. boryi* Heldr. ex Nyman, *F. bulbifera* (Á. Löve & D. Löve) Holub, *F. communis* Dum.Cours., *F. degenii* Harv., *F. ficaria* (L.) H.Karst., *F. holubyi* Schur, *F. intermedia* Schur, *F. peloponnesiaca* Nyman, *F. polypetala* Gilib., *F. pumila* Velen. ex Bornm., *F. ranunculiflora* Moench ex St.-Lag., *F. ranunculoides* Roth, *F. robertii* F.W. Schultz, *F. rotundifolia* Schur, *F. stepporum* P.A.Smirn., *F. transsilvanica* Schur, *F. varia* Otsch., *F. verna* f. *divergens* (F.W. Schultz) Soó, *F. v. f. marmorata* Priszter, *F. v. subsp. bulbifera* Á. Löve & D. Löve, *F. vulgaris* J.St.-Hil., *Ranunculus ficaria* L., *Ranunculus ficaria* var. *bulbifera* Albert, *Ranunculus vernus* f. *divergens* F.W. Schultz)

SUBSPECIES

F. v. subsp. bulbilifera Á. Löve & D. Löve
F. v. subsp. calthifolia (Rchb.) Nyman
F. v. subsp. chrysocephala (P.D. Sell) Stace
F. v. subsp. fertilis (A.R. Clapham ex Laegaard) Stace
F. v. subsp. ficariiformis (Rouy & Foucaud) B.Walln.

GENUS

Halerpestes Greene [*Ranunculus* L.]
Hamadryas Comm.
Krapfia DC. (*Aspidophyllum* Ulbr., *Rhopalopodium* Ulbr.)
Kumlienia Greene
Laccopetalum Ulbr.
Myosurus L.
Oxygraphis Bunge [*Ranunculus* L.]
Paroxygraphis W.W. Sm.
Peltocalathos Tamura [*Ranunculus* L.]
***Ranunculus* L.** (*Batrachium* (DC.) Gray, *Casalea* A. St.-Hil., *Gampsoceras* Steven)

SPECIES

29. *Ranunculus repens* L. (*R. clintonii* Beck, *R. intermedius* Eaton, *R. lagascanus* DC., *R. oenanthifolius* Ten. & Guss., *R. pubescens* Lag., *R. repens* f. *polypetalus* S.H. Li & Y. Hui Huang, *R. r.* var. *brevistylus* Maxim., *R. r.* var. *linearilobus* DC., *R. r.* var. *major* Nakai, *R. r.* var. *repens*, *R. r.* var. *villosus* Lamotte)

VARIETY

R. r. var. *flore-pleno* DC.

GENUS

Trautvetteria Fisch. & C.A. Mey.

ORDER

5. PROTEALES JUSS. EX BERCHT. & J. PRESL (Nelumbonales Mart.,
Platanales Mart.)

FAMILY

8. Platanaceae T. Lestib.

GENUS

***Platanus* L.**

SPECIES

30. *Platanus occidentalis* L. (*Platanus densicoma* Dode, *P. excelsa* Salisb., *P. hispanica* var. *pyramidalis* Vigouroux ex Geerinck, *P. integrifolia* K.Koch, *P. lobata* Moench, *P. occidentalis* f. *attenuata* Sarg., *P. o.* f. *occidentalis*, *P. o.* var. *densicoma* (Dode) Château & Chassignol, *P. o.* var. *occidentalis*, *P. o.* var. *palmeri* (Kuntze) Nixon & J.M.Poole ex D.Geerinck, *P. orientalis* var. *occidentalis* (L.) Kuntze, *P. o.* var. *palmeri* Kuntze, *P. pyramidalis* Dippel, *P. vulgaris* prol. *occidentalis* (L.) Cadevall, *P. v.* subsp. *occidentalis* (L.) R.C.V.Douin, *P. v.* var. *angulosa* Spach)

SUPERROSIDS CLADE

ORDER

6. SAXIFRAGALES BERCHT. & J. PRESL (Crassulales Link, Grossulariales DC. ex Bercht. & J. Presl, Haloragales Link, Iteales Doweld, Sedales Rchb., Sempervivales Juss. ex Bercht. & J. Presl)

FAMILY

9. Altingiaceae lindl.

GENUS

Altingia Noronha (Sedgwickia Griff.)
***Liquidambar* L.**

SPECIES

31. *Liquidambar styraciflua* L. (*Liquidambar barbata* Stokes, *L. gummifera* Salisb., *L. macrophylla* Oerst., *L. styraciflua* f. *pendula* Rehder, *L. s.* f. *rotundiloba* Rehder, *L. s.* f. *styraciflua*, *L. s.* var. *macrophylla* (Oerst.) Nied., *L. s.* var. *mexicana* Oerst., *L. tuberculata* Silba)

GENUS
Semiliquidambar Hung T. Chang

FAMILY
10. Crassulaceae J.St.-Hil., nom. cons. (*Cotyledonaceae* Martinov, *Rhodiolaceae* Martinov, *Sedaceae* Roussel, *Sempervivaceae* Juss., *Tillaeaceae* Martinov)

SUBFAMILY
Crassuloideae
Sedoideae

TRIBE
Kalanchoeae
Sedeae

SUBTRIBE
Sedinae

GENUS
Aeonium Webb & Berthel. (*Megalonium* (A. Berger) G. Kunkel)
Afrovivella A. Berger [*Rosularia* (DC.) Stapf]
Aichryson Webb & Berthel. (*Macrobria* (Webb & Berthel.) G. Kunkel)
Cremnophila Rose [*Sedum* L.]
Diamorpha Nutt. [*Sedum* L.]
Dudleya Britton & Rose (*Hasseanthus* Rose, *Stylophyllum* Britton & Rose)
Echeveria DC. (*Courantia* Lem., *Oliveranthus* Rose, *Oliverella* Rose, *Urbinia* Rose)
Graptopetalum Rose (*Byrnesia* Rose)

NOTHOGENUS
×*Graptoveria* G. D. Rowley = *Graptopetalum* × *Echeveria*

GENUS
Greenovia Webb & Berthel. [*Aeonium* Webb & Berthel.]
Jovibarba (DC.) Opiz [*Sempervivum* L.]
Lenophyllum Rose [*Sedum* L.]
Monanthes Haw. (*Petrophytes* Webb & Berthel.)
Mucizonia (DC.) Batt. & Trab. [*Sedum* L.]
Ohbaea V. V. Byalt & I. V. Sokolova (*Balfouria* (H. Ohba) H. Ohba), [*Sedum* L.]
Pachyphytum Link et al. (*Diotostemon* Salm-Dyck)

NOTHOGENUS
×*Pachyveria* Haage & Schmidt = *Pachyphytum* × *Echeveria*

GENUS

Phedimus Raf. [*Sedum* L.]

Pistorinia DC. [*Sedum* L.]

Prometheum (A. Berger) H. Ohba [*Sedum* L.]

Rosularia (DC.) Stapf (*Monanthella* A. Berger, *Sempervivella* Stapf)

Sedella Britton & Rose [*Sedum* L.]

NOTHOGENUS

×*Sedeveria* E. Walther = *Sedum* × *Echeveria*

GENUS

Sedum L. (*Aithales* Webb & Berthel., *Aizopsis* Grulich, *Amerosedum* Á. Löve & D. Löve, *Anacampseros* Mill., *Asterosedum* Grulich, *Breitungia* Á. Löve & D. Löve, *Cepaea* Fabr., *Chetyson* Raf., *Clausenellia* Á. Löve & D. Löve, *Cockerellia* (R. T. Clausen & N. W. Uhl) Á. Löve & D. Löve, *Congdonia* Jeps., *Corynephyllum* Rose, *Etiosedum* Á. Löve & D. Löve, *Gormaniana* Britton, *Helladia* M. Král, *Hjaltalinia* Á. Löve & D. Löve, *Keratolepis* Rose ex Fröd., *Leucosedum* Fourr., *Macrosepalum* Regel & Schmalh., *Oreosedum* Grulich, *Parvisedum* R. T. Clausen, *Petrosedum* Grulich, *Poenosedum* Holub, *Procrassula* Griseb., *Pseudorosularia* Gorgen., *Sedastrum* Rose, *Sedella* Fourr., nom. inval., *Spathulata* (Boriss.) Á. Löve & D. Löve, *Tetrorum* Rose, *Triactina* Hook. f. & Thomson)

***Sempervivum* L.** (*Diopogon* Jord. & Fourr.)

SECTION

Jovibarba

Sempervivum

ВИД

32. *Sempervivum ruthenicum* Schnittsp. & C.B.Lehm. (*S. globiferum* var. *ruthenicum* W.D.J. Koch)

NOTHOGENUS

×*Semponium* D. Michael = *Sempervivum* × *Aeonium*

PIД

Tacitus Moran [*Graptopetalum* Rose]

Telmissa Fenzl [*Sedum* L.]

Thompsonella Britton & Rose

Villadia Rose (*Altamiranoa* Rose)

SUBTRIBE

Umbilicinae

FAMILY

11. Grossulariaceae DC., nom. cons. (*Ribesiaceae* Marquis)

GENUS

***Ribes* L.** (*Botrycarpum* A. Rich., *Botryocarpium* Spach, *Calobotrya* Spach, *Cerophyllum* Spach, *Chrysobotrya* Spach, *Coreosma* Spach, *Grossularia* Mill., *Liebichia* Opiz, *Rebis* Spach, x *Ribelaria* Mezhen'skyj = *Ribes* × *Grossularia*, *Ribesium* Medik., *Robsonia* (Berland.) Rechb.)

SUBGENUS

Berisia

SECTION

Berisia

Davidia

Diacantha

Hemibotrya

SUBGENUS

Grossularia

SECTION

***Grossularia* (*Divaricata*)**

SPECIES

33. *Ribes uva-crispa* L. (*Grossularia glandulososetosa* Opiz, *G. grossularia* var. *reclinata* (L.) Wirtg., *G. grossularia* var. *uva-crispa* (L.) Wirtg., *G. hirsuta* Mill., *G. intermedia* Opiz, *G. pubescens* Opiz, *G. reclinata* (L.) Mill., *G. spinosa* Garsault, *G. uva* Scop., *G. uva-crispa* (L.) Mill., *G. uva-crispa* subsp. *lasiocarpa* (Gaudin ex Monnier) Dostál, *G. uva-crispa* subsp. *reclinata* (L.) Dostál, *G. vulgaris* Spach, *Oxyacanthus sativus* Chevall., *O. uva-crispa* (L.) Chevall., *Ribes aculeatum* Salisb., *R. caucasicum* Adams ex Roem. & Schult., *R. crispum* Dulac, *R. dubium* Jacques, *R. flavescens* Poit. & Turpin, *R. grossularia* f. *glanduligerum* H.Lindb., *R. grossularia* subsp. *austroeuropaeum* Bornm., *R. g.* var. *atlanticum* Ball, *R. g.* var. *besserianum* (Berland.) Loudon, *R. g.* var. *canescens* Wender., *R. g.* var. *glabrum* (Wallr.) Klett & Richt., *R. g.* var. *glabrum* W.D.J.Koch, *R. g.* var. *gymnocarpum* Wimm. & Grab., *R. g.* var. *hunyardensis* Simonk., *R. g.* var. *liberum* Wallr., *R. g.* var. *macrocarpum* (DC. ex Berland.) Loudon, *R. g.* var. *phoenicocarpum* Wimm. & Grab., *R. g.* var. *pubescens* W.D.J.Koch, *R. g.* var. *reclinatum* (L.) Berland. ex Loudon, *R. g.* var. *spinosissimum* (Berland.) Loudon, *R. g.* var. *subinerme* (Berland.) Loudon, *R. g.* var. *sylvestre* (DC.) Willk., *R. g.* var. *sylvestre* Wallr., *R. g.* var. *uva-crispa* (L.) Sm., *R. g.* var. *uva-crispa* (L.) Wender., *R. g.* var. *uva-crispa* (L.) Wimm. & Grab., *R. g.* var. *villosum* Klett & Richt., *R. g.* var. *vulgare* Jancz., *R. g.* var. *vulgare* Jess., *R. grossularium* St.-Lag., *R. hirsutum*

Münchh., *R. hunyadense* Simonk., *R. hybridum* Besser, *R. ianthinum* Poit. & Turpin, *R. lobatum* Poit. & Turpin, *R. longispinum* K.Koch, *R. macracanthum* Lodd. ex G.Don, *R. moschatum* Poit. & Turpin, *R. oxyacanthoides* Georgi, *R. purpureomajus* Poit. & Turpin, *R. purpureominus* Poit. & Turpin, *R. reclinatum* L., *R. r.* var. *sarmentaceum* Fr., *R. spinosum* Lam., *R. spinosum* var. *glabrum* Gray, *R. succineum* Poit. & Turpin, *R. tubulosum* Poit. & Turpin, *R. uva-crispa* f. *macrocarpum* (Kuntze) Soó, *R. u.-c.* f. *oblongum* (Kuntze) Soó, *R. u.-c.* subsp. *atlanticum* (Ball) Rivas Mart., Molero Mesa, Marf Ál & G.Ben Átez, *R. u.-c.* subsp. *austroeuropaeum* (Bornm.) Bech., *R. u.-c.* subsp. *austroeuropaeum* Bornm., *R. u.-c.* subsp. *hunyadensis* (Simonk.) Soó, *R. u.-c.* subsp. *pubescens* (W.D.J.Koch) O.Schwarz, *R. u.-c.* subsp. *reclinatum* (L.) O.Schwarz, *R. u.-c.* subsp. *reclinatum* (L.) Schübl. & G.Martens, *R. u.-c.* subsp. *reclinatum* Rchb., *R. u.-c.* subsp. *septentrionale* Maire, *R. u.-c.* var. *atlanticum* (Ball) Maire, *R. u.-c.* var. *besserianum* Berland., *R. u.-c.* var. *bracteatum* Berland., *R. u.-c.* var. *glabrum* Gren., *R. u.-c.* var. *glanduligerum* (H.Lindb.) Maire, *R. u.-c.* var. *inermis* Berland., *R. u.-c.* var. *macrocarpum* DC. ex Berland., *R. u.-c.* var. *pubescens* Gren., *R. u.-c.* var. *reclinatum* (L.) Berland., *R. u.-c.* var. *spinosissimum* Berland., *R. u.-c.* var. *subatlanticum* Maire, *R. u.-c.* var. *sylvestre* DC., *R. virenterotundum* Poit. & Turpin, *R. viridialbescens* Poit. & Turpin, *R. viridimajus* Poit. & Turpin, *R. viridiminus* Poit. & Turpin, *R. vulgare* K.Koch, *R. vulgatissima* Poit. & Turpin)

SECTION

Robsonia

SUBGENUS

Grossularioides

Parilla

SECTION

Andina

Parilla

SUBGENUS

Ribes

SECTION

Botrycarpum (*Ribes* L. subg. *Coreosma*)

SPECIES

34. *Ribes nigrum* L. (*Botrycarpum nigrum* (L.) A. Rich., *B. nigrum* (L.) Spach, *B. obtusilobum* Opiz, *Grossularia nigra* (L.) Rupr., *Ribes cyathiforme* Pojark., *R. nigrum* var. *europaeum* Jancz., *R. n.* var. *pauciflorum* (Turcz. ex Ledeb.) Jancz., *R. olidum* Moench, *R. pauciflorum* Turcz. ex Ledeb., *R. nigrum* (L.) Medik.)

SECTION
Calobotrya
Cerophyllum
Fargesia
Heritiera
Microsperma
Ribes (Ribesia)
Symphocalyx

Questions for self-control

CURRENT SYSTEM OF FLOWERING PLANTS

1. In what clade does the order Asparagales belong?
2. In what order does the family Orchidaceae belong?
3. In what family does the genus *Carex* belong?
5. In what family does the species *Juncus compressus*?
5. In what order does the species *Ficaria verna* belong?

CHAPTER 4. DESCRIPTION OF ORDERS AND FAMILIES OF FLOWERING PLANTS

ANGIOSPERMS

MONOCOTS CLADE

ORDER 1 ASPARAGALES LINK

Synonyms: Agavales Hutch., Alliales Bercht. & J. Presl, Amaryllidales Link, Asphodelales Doweld, Gilliesiales Mart., Iridales Raf., Ixiales Lindl., Narcissales Dumort., Tecophilaeales Traub ex Reveal, Xanthorrhoeales Takht. ex Reveal & Doweld.

Taxonomical composition: 14 families (Amaryllidaceae J.St.-Hil., Asparagaceae Juss., Asphodelaceae Juss. (including Xanthorrhoeaceae Dumort.), Asteliaceae Dumort., Blandfordiaceae R. Dahlgren & Clifford, Boryaceae M.W. Chase et al., Doryanthaceae R. Dahlgren & Clifford, Hypoxidaceae R. Br., Iridaceae Juss., Ixioliriaceae Nakai, Lanariaceae H.Huber ex R. Dahlgren, Orchidaceae Juss., Tecophilaeaceae Leyb., Xeronemataceae M.W. Chase et al.), 3291 genera and 41044 species.

FAMILY 1 ORCHIDACEAE JUSS.

Common name: Orchid family.

Synonyms: Apostasiaceae Lindl., Cypripediaceae Lindl., Limodoraceae Horan., Liparidaceae Vines, Neottiaceae Horan., Neuwiediaceae R. Dahlgren ex Reveal & Hoogland, Ophrydaceae Vines, Pycnanthaceae Ravenna, Vanillaceae Lindl.

Taxonomical composition: 2922 genera and 31067 species, including *Acianthera* (299 species), *Aerangis* (62 species), *Agrostophyllum* (135 species), *Anathallis* (149 species), *Andinia* (75 species), *Angraecum* (224 species), *Appendicula* (224 species), *Brachionidium* (82 species), *Brassia* (68 species), *Bulbophyllum* (2148 species), *Calanthe* (286 species), *Campylocentrum* (77 species), *Catasetum* (223 species), *Cattleya* (225 species), *Ceratostylis* (153 species), *Cleisostoma* (100 species), *Cleistis* (66 species), *Coelogyne* (596 species), *Comparettia* (80 species), *Coryanthes* (65 species), *Crepidium* (295 species), *Cymbidium* (110 species), *Cypripedium* (158 species), *Cyrtorchilum* (203 species), *Dendrobium* (1620 species), *Dichaea* (127 species), *Dracula* (147 species), *Dryadella* (61 species), *Elleanthus* (128 species), *Encyclia* (195 species), *Epidendrum* (1784 species), *Epipactis* (98 species), *Eulophia* (284 species), *Fernandezia* (98 species), *Gastrochilus* (66 species), *Gastrodia* (95 species), *Glomera* (155 species), *Gongora* (69 species), *Kefersteinia* (63 species), *Lepanthes* (1165 species), *Liparis*

(425 species), *Masdevallia* (655 species), *Maxillaria* (654 species), *Mormodes* (86 species), *Myoxanthus* (52 species), *Neottia* (74 species), *Nervilia* (79 species), *Notylia* (79 species), *Oberonia* (273 species), *Octarrhena* (53 species), *Octomeria* (167 species), *Oncidium* (368 species), *Ornithocephalus* (56 species), *Pabstiella* (133 species), *Paphiopedilum* (145 species), *Phalaenopsis* (87 species), *Platystele* (119 species), *Pleurothallis* (551 species), *Podochilus* (65 species), *Polystachya* (244 species), *Porroglossum* (55 species), *Prosthechea* (126 species), *Restrepia* (60 species), *Scaphosepalum* (56 species), *Scaphyglottis* (78 species), *Sobralia* (172 species), *Specklinia* (109 species), *Stanhopea* (83 species), *Stelis* (1332 species), *Taeniophyllum* (245 species), *Telipogon* (206 species), *Thrixspermum* (161 species), *Trichocentrum* (65 species), *Trichoglottis* (86 species), *Trichosalpinx* (111 species), *Trichotosia* (76 species), *Vanda* (90 species), *Vanilla* (119 species)

Features and representatives

The members of the family Orchidaceae are subcosmopolitan and occur chiefly in tropical and subtropical Asia, where representatives of all subfamilies and tribes are, and in tropical America. In the flora of Ukraine, there are 28 genera and 66 species. The floral formula is $\uparrow P_{3+3} A_{1-2} \overline{G(2)}$.

The orchid flower is so specialized that the illustrated species is needed for a description of its structures. In general, the flower is usually bisexual, has 3 sepals that may resemble the 3 petals in color and form, a column of fused stamens and stigmas, and an inferior ovary composed of 3 carpels. Flower colors and color patterns vary widely. Nectar, odor, and form of the flower attract pollinators (specific in many cases). The fruit is a capsule that contains very tiny seeds. Since the endosperm aborts as seeds mature, a mutualistic fungal relationship has evolved that provides a source of metabolites for seed germination.

The plants are generally leafy, sometimes leafless. Leaves are alternate, very rarely opposite, whorled or reduced to scales. They are simple, thickened, usually linear, strap-shaped or round, and basally sheathing the stem. They are terrestrial and saprophytic, deriving nutrients from soil and dead organic matter. They are also epiphytic, attached to the surface of another plant, where they obtain nutrients from the atmosphere and debris accumulations among the roots. Orchids have fungus-root (mycorrhizal) association.

Nutrient storage organs may be swollen stems (pseudobulbs) or swollen root-stem tubers, which the Greeks called “orchis” for their testiculate appearance; hence, the orchid name. Roots of most epiphytes are covered with a layer of white-colored dead corky cells called velamen. Habitats vary enormously from dry sand to acidic bogs and wet meadows, from temperate forest and mangrove swamps to tropical cloud forests.

In the confectionary industry, *Vanilla* (vanilla extract from capsules, commonly called beans) is used. Most wild orchids endangere and are legally protected in Ukraine. These are *Anacamptis coriophora*, *Cephalanthera damasonium*, *Dactylorhiza viridis* (synonym: *Coeloglossum viride*), *Himantoglossum comperianum* (synonym: *Comperia comperiana*), *Corallorhiza*

trifida, *Cypripedium calceolus*, *Dactylorhiza cordigera*, *D. fuchsii*, *D. iberica*, *D. incarnata*, *D. maculata*, *D. majalis*, *Epipactis palustris*, *E. purpurata*, *Epipogium aphyllum*, *Goodyera repens*, *Gymnadenia conopsea* and many others.

Dactylorhiza maculata grows in meadows, bushes, paludal forests with mosses, occurs on stream banks, in swamps. Common spotted orchid needs the moist soils of riparian or wetland environments. It grows both in open and in shadowed places. This plant occurs in Europe, Asia. In Ukraine *D. maculata* grows in Carpathians, in the forest and Forest steppe zones.

Cypripedium calceolus occurs in Europe, in the South of Siberia, in the South of the Far East, in the Eastern Asia (China, Mongolia). In Ukraine *C. calceolus* occurs in Polesye, Forest steppe, Carpathians and Transcarpathia. Yellow lady's grows in open, sunny locations in mixed and broad-leaved forests, on the edge of the woods, on glades of the forests, in forest meadows, bushes, forest slopes, needs the limestone soils (Fig. 4.1–4.17).

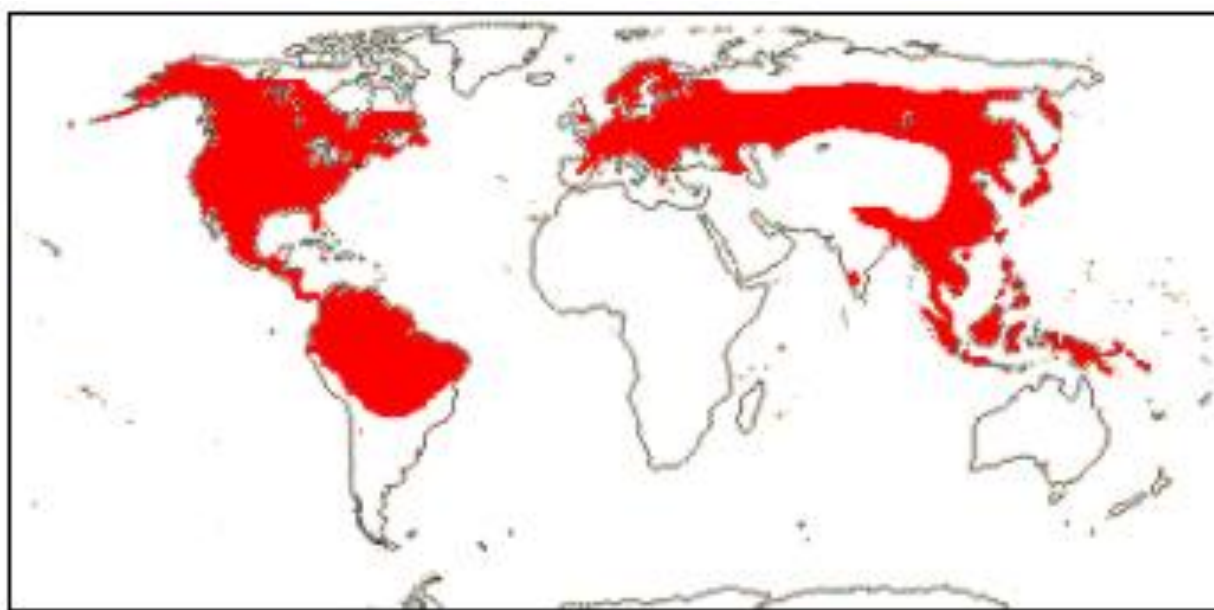


Fig. 4.1. The distribution of the species of the subfamily Cypripedioideae
Kosteletzky [Stevens, 2001]



Fig. 4.2. The distribution of the species of the subfamily Orchidoideae Eaton [Stevens, 2001]



Fig. 4.3. The distribution of the species of the subfamily Epidendroideae Kosteletzky [Stevens, 2001]



Fig. 4.4. *Anacamptis coriophora* (L.) R.M. Bateman, Pridgeon & M.W. Chase – Bug orchid [Schulze, 1894]



Fig. 4.5. *Cephalanthera damasonium* (Mill.) Druce – White helleborine [Schulze, 1894]



Fig. 4.6. *Corallorhiza trifida* Châtel. – Early coralroot, northern coralroot, yellow coralroot [Schulze, 1894]

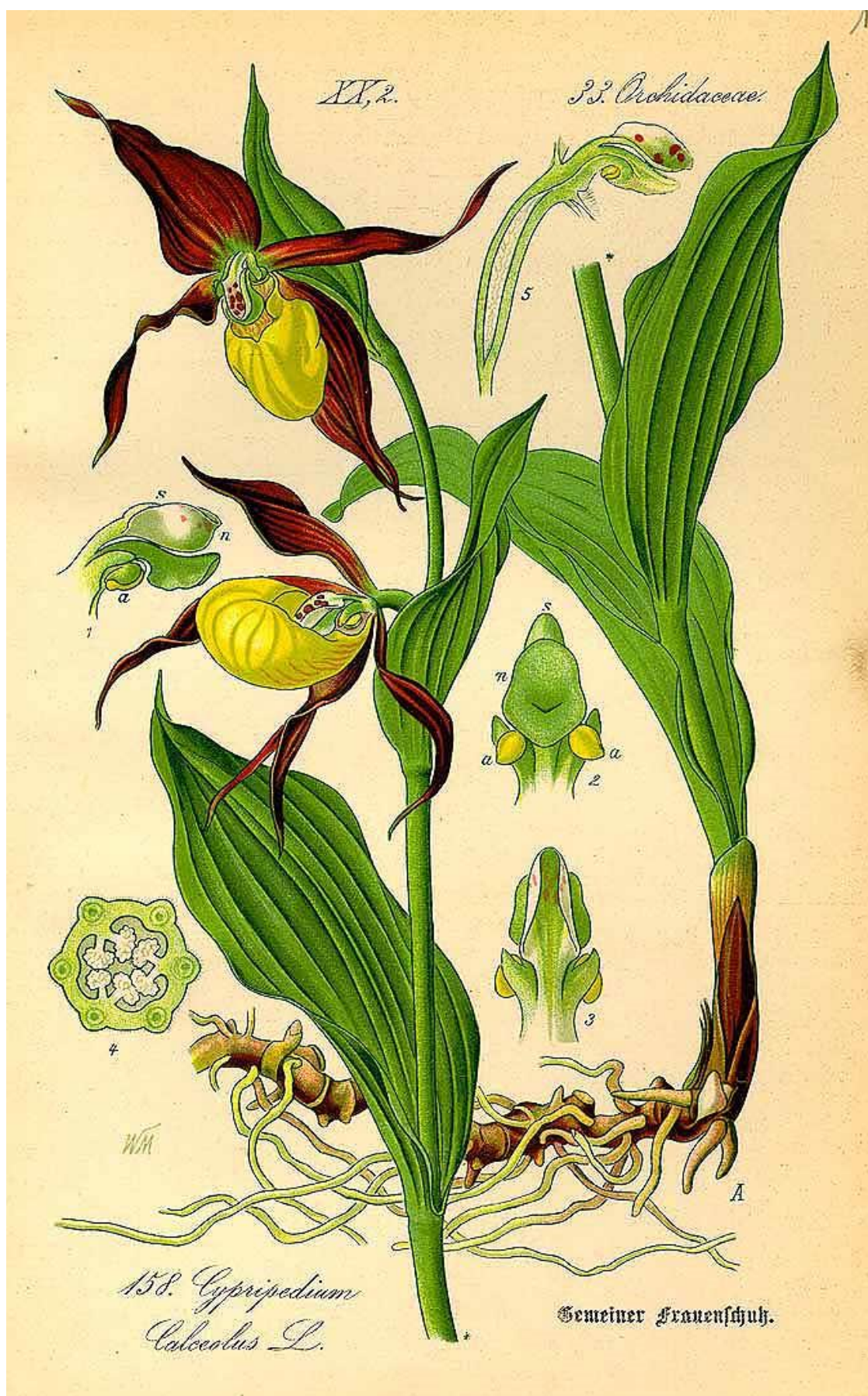


Рис. 4.7. *Cypripedium calceolus* L. – Yellow lady's slipper [Thomé, 1885]



Fig. 4.8. *Dactylorhiza incarnata* (L.) Soó – Flecked marsh-orchid [Masclef, 1893]



Fig. 4.9. *Dactylorhiza maculata* (L.) Soó – Common spotted orchid [Schulze, 1894]

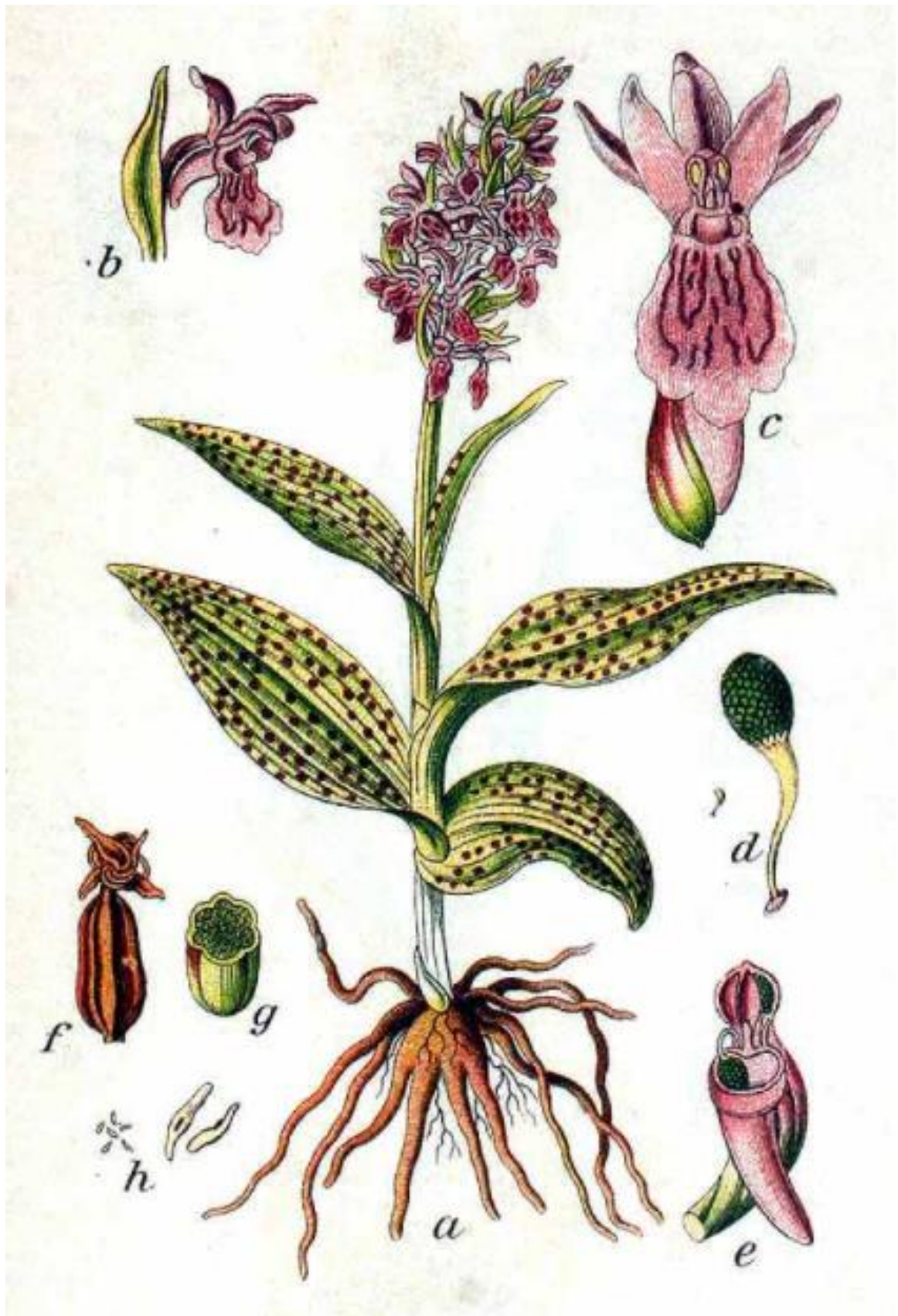


Fig. 4.10. *Dactylorhiza majalis* (Rchb.) P.F. Hunt & Summerh. – Broad-leaved marsh orchid or western marsh orchid, fan orchid [Sturm, 1905]

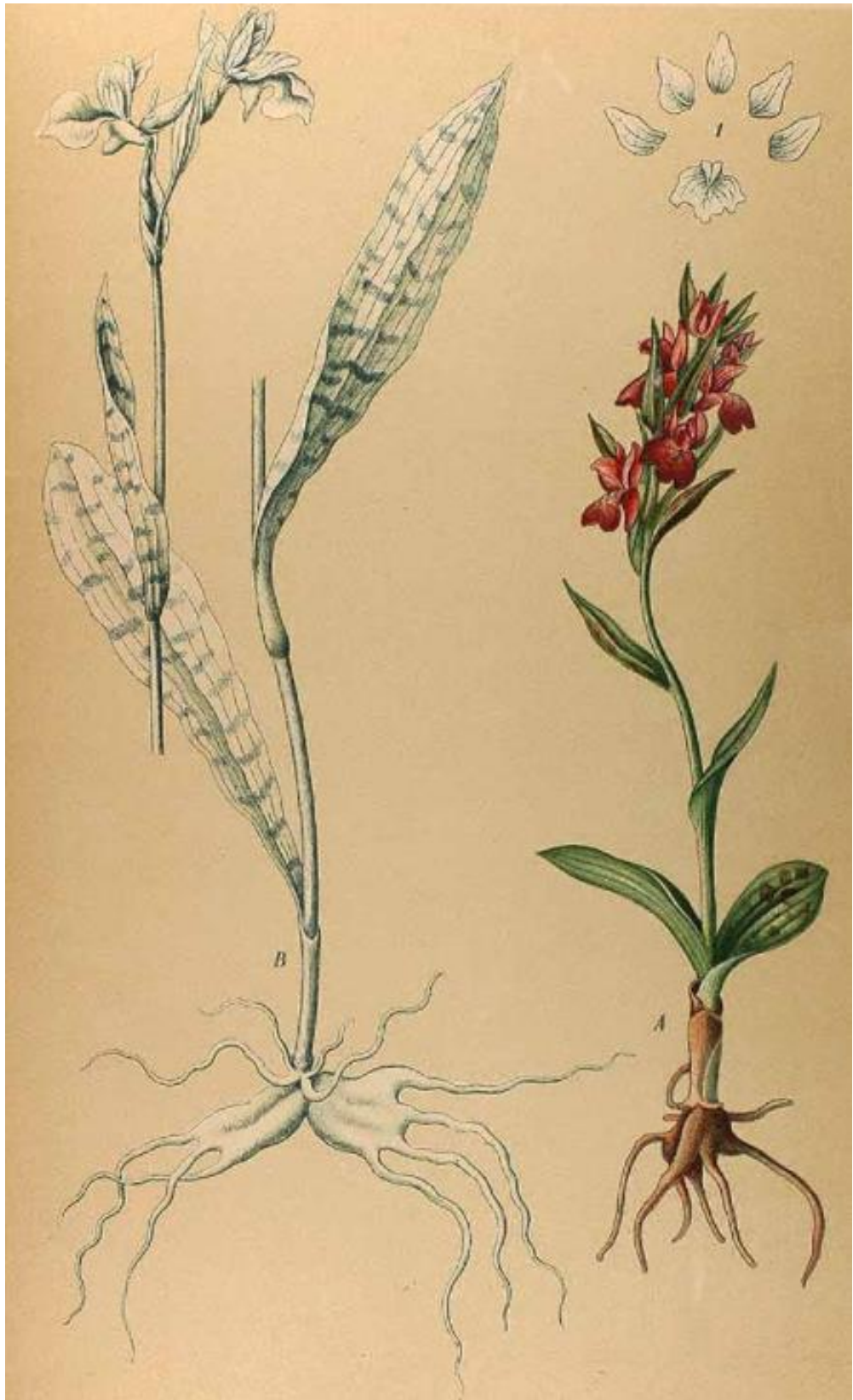


Fig. 4.11. *Dactylorhiza majalis* subsp. *cordigera* (Fr.) H.Sund. (*Dactylorhiza cordigera* (Fr.) Soó) – Heart-flowered marsh-orchid [Schulze, 1894]

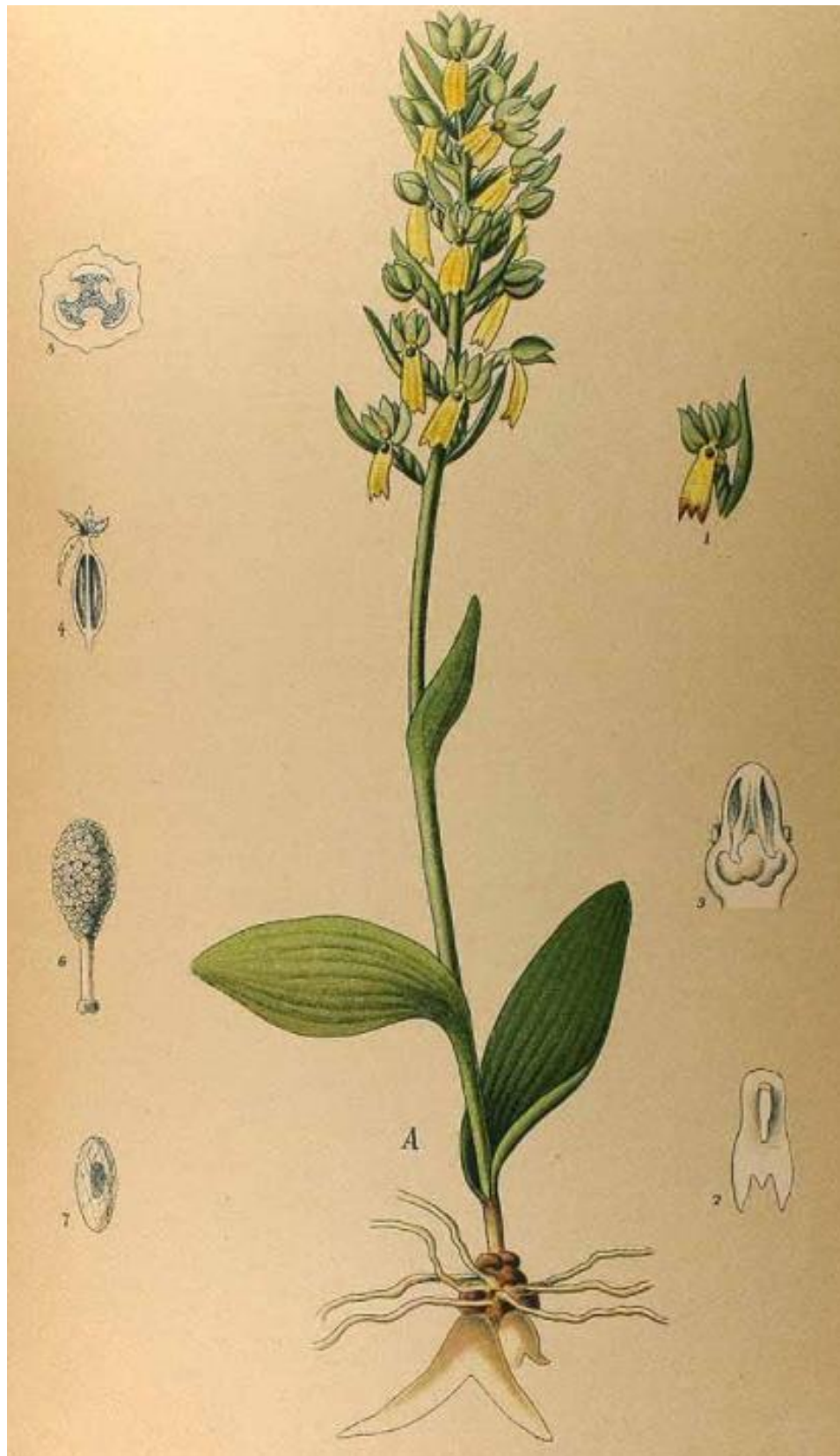


Fig. 4.12. *Dactylorhiza viridis* (L.) R.M. Bateman, Pridgeon & M.W. Chase (synonym: *Coeloglossum viride* (L.) Hartm.) – Longbract frog orchid [Schulze, 1894]



Fig. 4.13. *Epipactis palustris* (L.) Crantz – Marsh orchid, marsh helleborine
[Schulze, 1894]



Fig. 4.14. *Epipactis purpurata* Sm. – Violet helleborine [Schulze, 1894]



Fig. 4.15. *Epipogium aphyllum* Sw. – Ghost orchid [Curtis, 1854]



Fig. 4.16. *Goodyera repens* (L.) R.Br. – Creeping lady's-tresses, dwarf rattlesnake plantain, lesser rattlesnake plantain [Schulze, 1894]



Fig. 4.17. *Gymnadenia conopsea* (L.) R.Br. – Fragrant orchid, chalk fragrant orchid [Schulze, 1894]

ORDER 2

POALES SMALL

Synonyms: Avenales Bromhead, Flagellariales Takht. ex Reveal & Doweld

Taxonomical composition: 14 families (Bromeliaceae Juss., Cyperaceae Juss., Ecdeiocoleaceae D.W. Cutler & Airy Shaw, Eriocaulaceae Martinov, Flagellariaceae Dumort., Joinvilleaceae Toml. & A.C.Sm., Juncaceae Juss., Mayacaceae Kunth, Poaceae Barnhart (=Gramineae Juss.), Rapateaceae Dumort., Restionaceae R.Br., Thurniaceae Engl., Typhaceae Juss., Xyridaceae C.Agardh.), 1122 genera and 24542 species.

FAMILY 2

CYPERACEAE JUSS.

Common name: Sedge family

Synonyms: Kobresiaceae Gilly, Mapaniaceae Shipunov, Papyraceae Burnett, Scirpaceae Batsch ex Borkh., Scleriaceae Bercht. & J. Presl

Taxonomical composition: 94 genera and 5932 species, including *Bolboschoenus* (16 species), *Bulbostylis* (218 species), *Calyptracarya* (8 species), *Carex* (2267 species), *Carpha* (15 species), *Cephalocarpus* (20 species), *Chorizandra* (6 species), *Coleochloa* (8 species), *Cyperus* (958 species), *Diplacrum* (10 species), *Eleocharis* (303 species), *Eriophorum* (22 species), *Ficinia* (89 species), *Fimbristylis* (312 species), *Fuirena* (55 species), *Gahnia* (41 species), *Hypolytrum* (62 species), *Isolepis* (70 species), *Lagenocarpus* (17 species), *Lepidosperma* (81 species), *Machaerina* (53 species), *Mapania* (100 species), *Rhynchospora* (380 species), *Schoenoplectiella* (75 species), *Schoenoplectus* (24 species), *Schoenus* (158 species), *Scirpus* (50 species), *Scleria* (257 species), *Sumatrosclirpus* (4 species), *Tetraria* (44 species), *Trichophorum* (21 species).

Features and representatives

The species of the family are cosmopolitan, but spread mainly in cold and temperate regions. In the flora of Ukraine, there are 14 genera and 140 species. The floral formulae are ♂ $P_0A_3G_0$, ♀ $P_0A_0G_{\underline{3}}$.

The species of the family are small to tall perennial or annual herbs, rarely dwarf shrubs, or lianas, terrestrial or helophytic, rarely aquatic. The perennial are tufted, rhizomatous, stoloniferous, and tuberous. Stems are with solid internodes to with spongy internodes, or with hollow internodes. The vessels are with scalariform, or simple, or scalariform and simple perforations. The sieve-element plastids are plastids of P-type. The leaves are all basal or one to few cauline, rarely all cauline, alternate, distichous or tristichous, rarely spiral; flat or folded, sheathing, simple, entire, but commonly with prickly hairs. The inflorescences are terminal, more rarely pseudolateral, very rarely reduced to a single spikelet. The flowers are bracteate or ebracteate, bracteolate, usually small to minute, bisexual or (functionally) unisexual, and then spikelets bisexual or unisexual, rarely dioecious. The perianth segments are vestigial (represented by bristles or hairs) and than 6,

free, sometimes more or less sepeloid, or absent. The stamens are usually 3 (1 medio-anterior, 2 lateral), but sometimes reduced to 1–2 or 4–6, and even more numerous (to 22). The filaments are sometimes strongly elongated after anthesis, rarely connate. The anthers are introrse or latrorse, appendaged or unappendaged. The gynoecium consists of 2, or 3 (–4) carpels. The styles are 2–3, free to partially joined. The stigmas are (1–) 2, or 3 (–15). The ovule is solitary, basal, bitegmic, outer integument not contributing to the micropyle. Ovary is 1-locular. The fruits are achene-like or rarely drupaceous. Seeds are with thin testa (phytomelan lacking), raphe and chalaza usually conspicuous. The embryo is small, basal, surrounded by abundant mealy or oily endosperm. Alkaloids and proanthocyanidins are present or absent.

The most important genera are *Scirpus*, *Schoenoplectus*, *Eriophorum*, *Eleocharis*, *Cyperus*, *Carex*. The largest genus in the family Cyperaceae is *Carex*. In Ukraine there are 92 species of this genus. *Carex rostrata* is most common in wet meadows, marshes, edges of lakes, ponds, and streams, and other riparian areas. It is found everywhere in Ukraine (except the Steppe and the Crimea). In wet meadows and marshes *C. acuta*, *C. acutiformis*, *C. colchica*, *C. elongata*, *C. flava*, *C. humilis*, *C. leporina*, *C. nigra*, *C. riparia*, *C. pilosa*, *C. rostrata*, *C. vesicaria*, *C. vulpina* are sufficiently spread in Ukraine (Fig. 4.18–4.20).

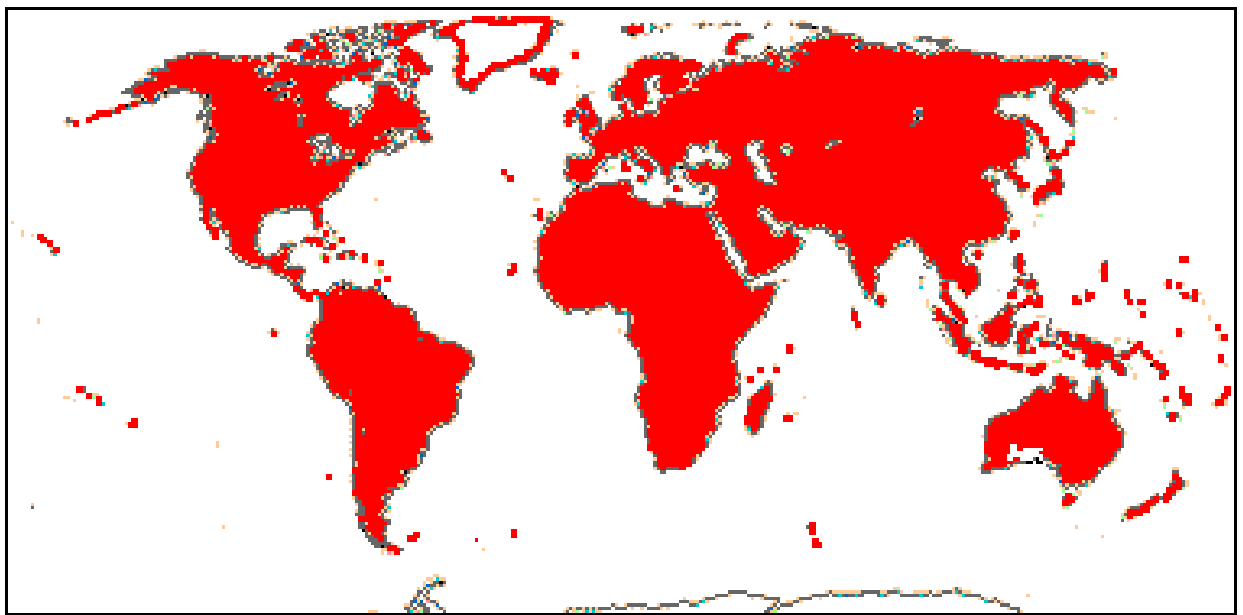


Fig. 4.18. The distribution of the species of the family Cyperaceae [Stevens, 2001]



Fig. 4.19. *Carex rostrata* Stokes – Beaked sedge [Lindman, 1922]



Fig. 4.20. *Carex vulpina* L. – Vulpine sedge [Kops et al., 1868]

FAMILY 3 JUNCACEAE JUSS.

Common name: Rush family.

Taxonomical composition: 8 genera and 523 species, including *Juncus* (360 species), *Luzula* (146 species).

Features and representatives

The species of the family Juncaceae are herbs, usually perennial. The leaves are long and narrow, with the sheathing base, sometimes reduced to scales. The flowers are actinomorphic, hermaphrodite, protogynous, usually crowded in monohasial cymes which are sometimes condensed into the heads, or solitary. The perianth segments six, in two whorls. The stamens are free, in (1–) 2 whorls of three. The ovary is superior, one- or three-locular. There are three, or numerous stigmas and ovules. The fruit is a dehiscent, loculicidal capsule. The seeds are endospermic, often with a basal appendage. In the world there are eight genera and 524 species. In Ukraine there are two genera *Juncus* and *Luzula* and 38 species of the family.

The species of the genus *Juncus* are glabrous, rhizomatous perennials or annuals. The inflorescence is sympodial, usually many-flowered. The ultimate divisions form cymes which are often contracted into heads. The bracteoles are absent, or one 2-fid and two or more are simple and form an involucre. The perianth-segments are in two whorls of three. The stamens are six or fewer. The anthers are basifixed, opposite and attached to the base of the perianth-segments. The pollen shed is in tetrads. The fruit is 1- or 3-locular capsule. The ovules are numerous. The testa is usually prominently sculptured. The embryo is small. In Ukraine there are 27 species of the genus *Juncus*. Many species of the genus *Juncus* inhabit moist and swampy meadows, saline soils along the coasts of seas, and salty lakes.

The species of the genus *Luzula* are perennial herbs, rarely annual. The leaves are mostly basal, with closed sheath, without auricles, flat or canaliculated, usually with a basal appendage. In Ukraine there are 11 species of the genus *Luzula*. Species of the genus rarely inhabit swampy meadows, foliage and forests (Fig. 4.21–4.23).

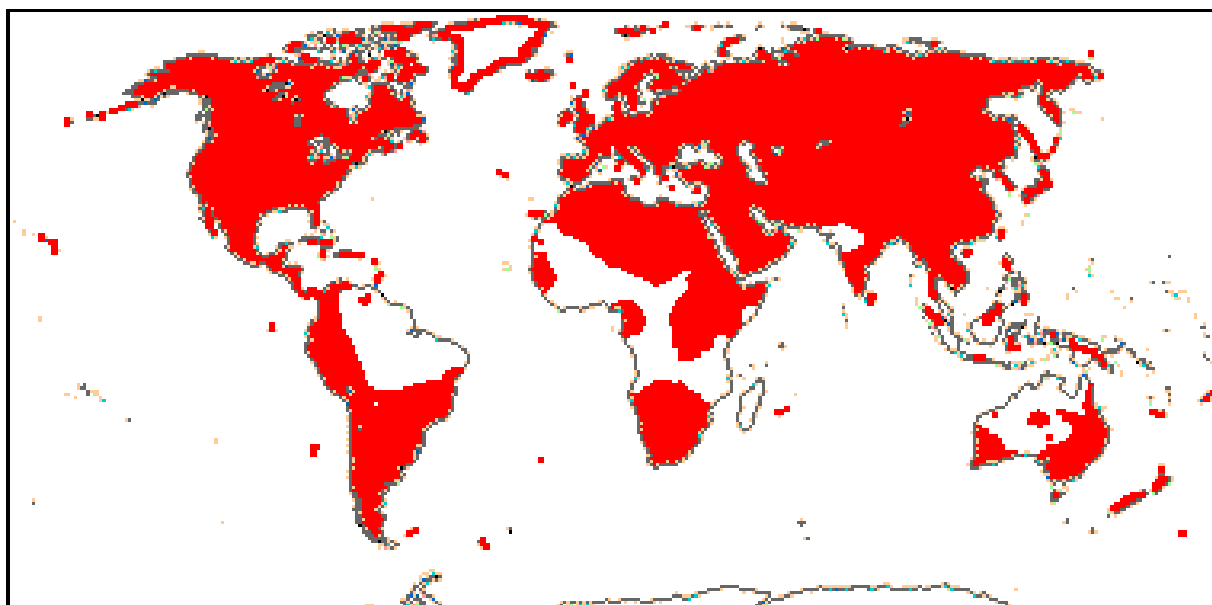
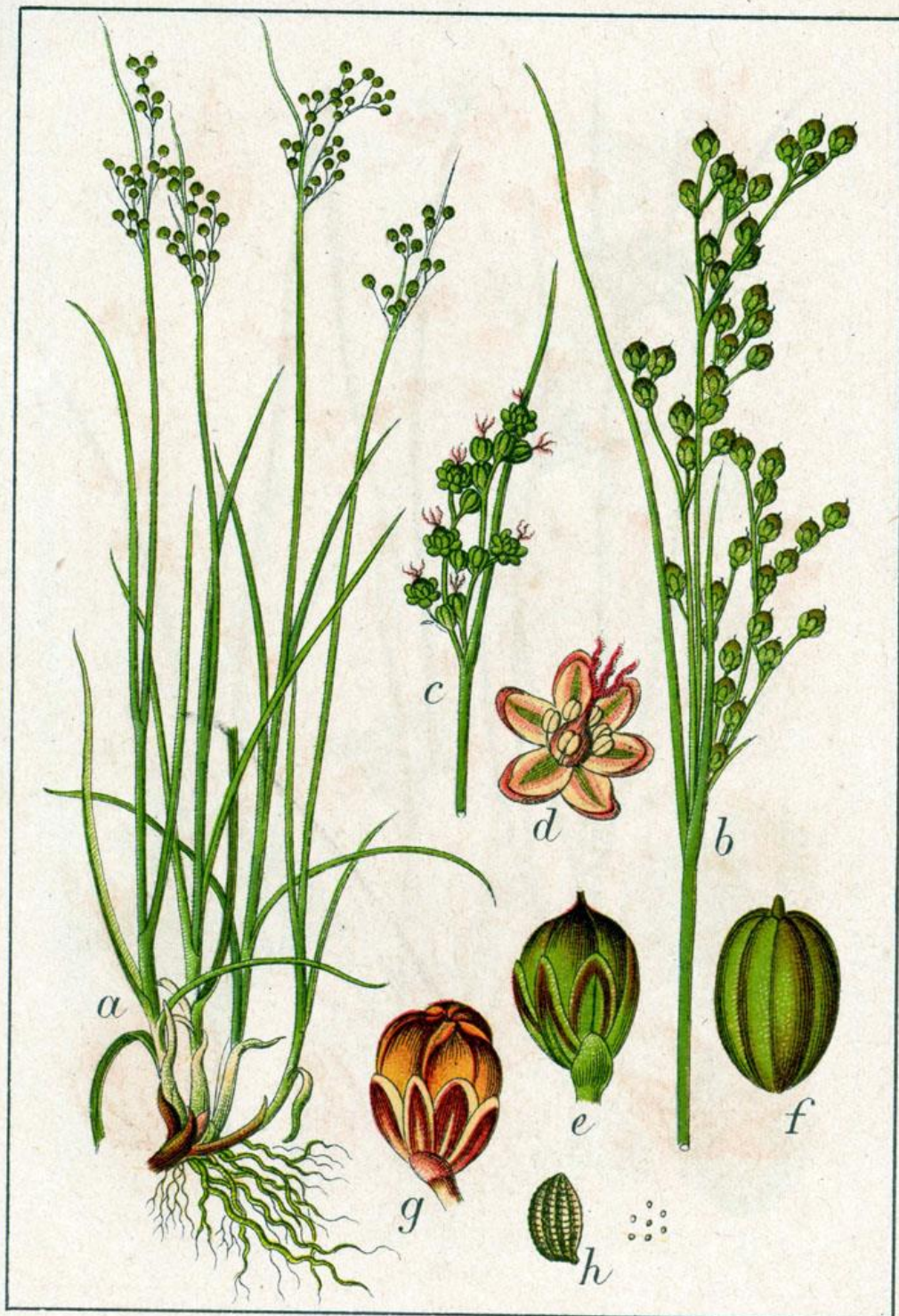


Fig. 4.21. The distribution of the species of the family Juncaceae [Stevens, 2001]



Weg-Binse, *Juncus compressus*.

Fig. 4.22. *Juncus compressus* Jacq. – Lesser Jointed Rush, Weg-Binse [Sturm, 1796]



Fig. 4.23. *Luzula pilosa* (L.) Willd. – Broad-leaved Hairy Wood-rush [Sturm & Krause, 1906]

FAMILY 4

POACEAE BARNHART

Common name: Grass family.

Synonyms: Aegilopaceae Martinov, Agrostidaceae Bercht. Alopecuraceae Martinov, Andropogonaceae Martinov, Anomochloaceae Nakai, Anthoxanthaceae Link, Arundinaceae Döll, Arundinellaceae Herter, Asperellaceae Link, Hort. Avenaceae Martinov, Bambusaceae Bercht. & J. Presl, Bromaceae Bercht. & J. Presl, Cenchraceae Link, Chaeturaeae Link, Chloridaceae Bercht. & J. Presl, Chondrosaceae Link, Coleanthaceae Pfeiff., Cynodontaceae Link, Cynosuraceae Link, Echinariaceae Link, Ehrhartaceae Link, Eragrostidaceae Herter, Festucaceae Spreng. in J. Sadler, Glyceriaceae Link, Gramineae Juss., Holcaceae Link, Hordeaceae Bercht. & J. Presl, Laguraceae Link, Lepturaeae Herter, Loliaceae Link, Melicaceae Martinov, Miliaceae Link, Nardaceae Martinov, Olyraceae Bercht. & J. Presl, Ophiuraeae Link, Oryzaceae Bercht. & J. Presl, Panicaceae Bercht. & J. Presl, Pappophoraceae Herter, Parianaceae Nakai, Paspalaceae Link, Phalaridaceae Link, Pharaceae Herter, Phleaceae Link, Saccharaceae Bercht. & J. Presl, Sesleriaceae Döll, Spartinaeae Link, Stipaceae Bercht. & J. Presl, Streptochaetaceae Nakai, Triticaceae Link, Zeaceae A. Kern., Zoysiaceae Link.

Taxonomical composition: 824 genera and 12080 species, including *Agrostis* (206), *Anthoxanthum* (53), *Aristida* (299), *Arundinaria* (3), *Axonopus* (78), *Bambusa* (154), *Bouteloua* (56), *Bromus* (170), *Calamagrostis* (215), *Chloris* (55), *Chrysopogon* (50), *Chusquea* (193), *Cymbopogon* (53), *Dichanthelium* (123), *Digitaria* (263), *Dimeria* (57), *Elymus* (196), *Eragrostis* (423), *Eriachne* (49), *Fargesia* (49), *Festuca* (664), *Hordeum* (40), *Isachne* (106), *Ischaemum* (87), *Leersia* (18), *Leymus* (63), *Melica* (95), *Merostachys* (56), *Muhlenbergia* (177), *Nassella* (112), *Oryza* (19), *Pariana* (35), *Pentameris* (81), *Phyllostachys* (62), *Poa* (601), *Rytidosperma* (74), *Sasa* (42), *Schizostachyum* (73), *Sesleria* (37), *Setaria* (136), *Sporobolus* (226), *Stipa* (174), *Stipagrostis* (56), *Urochloa* (88).

Features and representatives

The species of the family Poaceae are cosmopolitan. In the flora of Ukraine, there are 90 genera and 331 species. For the majority species of Poaceae the floral formula is $\uparrow P_{(2)+2} G_{(3)}$. Takhtajan (2009) divides grass family (Poaceae), into 12 subfamilies: Anomochlooideae, Pharoideae, Puelioideae, Bambusoideae, Ehrhartoideae, Pooideae, Aristidoideae, Danthonioideae, Arundinoideae, Micrairoideae, Chloridoideae and Centothecoideae. The subfamily Pooideae includes 13 tribes and 54 genera:

- 1) Brachypodieae – *Brachypodium*;
- 2) Triticeae – *Aegilops*, *Agropyron*, *Elymus*, *Elytrigia*, *Eremopyrum*, *Henrardia*, *Hordelymus*, *Hordeum*, *Leymus*, *Psathyrostachys*, *Secale*, *Triticum*;
- 3) Bromeae – *Bromus*, *Boissiera*;
- 4) Poeae – *Agrostis*, *Aira*, *Anthoxanthum*, *Arrhenatherum*, *Avena*, *Briza*, *Calamagrostis*, *Catabrosa*, *Cinna*, *Colpodium*, *Cutandia*, *Cynosurus*, *Dactylis*,

Deschampsia, *Eremopoa*, *Festuca*, *Helictotrichon*, *Hierochloe*, *Holcus*, *Koeleria*, *Lolium*, *Millum*, *Polypogon*, *Puccinellia*, *Trisetum*, *Vulpia*, etc.;

5) Meliceae – *Glyceria*, *Melica*, *Lophochlaena*;

6) Brylkinieae – *Brylkinia*;

7) Diarrheneae – *Diarrhena*;

8) Brachyelytreae – *Brachyelytrum*;

9) Ampelodesmeae – *Ampelodesmos*;

10) Stipeae – *Oryzopsis*, *Piptatherum*, *Stipa*;

11) Lygeae – *Lygeum*;

12) Nardeae – *Nardus*;

13) Phaenospermateae – *Phaenosperma*.

In Ukraine there are 39 genera of the subfamily Pooideae: *Aegilops*, *Agropyron*, *Elymus*, *Elytrigia*, *Eremopyrum*, *Agrostis*, *Aira*, *Anthoxanthum*, *Arrhenatherum*, *Avena*, *Brachypodium*, *Briza*, *Bromus*, *Calamagrostis*, *Catabrosa*, *Cynosurus*, *Dactylis*, *Deschampsia*, *Festuca*, *Glyceria*, *Helictotrichon*, *Hierochloe*, *Holcus*, *Hordelymus*, *Hordeum*, *Koeleria*, *Leymus*, *Lolium*, *Melica*, *Millum*, *Nardus*, *Piptatherum*, *Polypogon*, *Psathyrostachys*, *Puccinellia*, *Secale*, *Stipa*, *Trisetum*, *Triticum*, *Vulpia*.

The representatives of subfamily Pooideae are perennial or annual herbs, which are very seldom weakly ligneous. Its culms are hollow (rarely solid). Leaves are without a petiole, not deciduous, very seldom petiolate. Laminas are usually linear, seldom lanceolate or lanceolate. Spikelets are with a definite or indefinite number of flowers, not branched, provided with two glumes at the base, seldom without glumes or with only one. Lemmas are usually with (1–) 3–9 (–11) veins. Paleas are with 2 veins forming keels. Lodicules are two, seldom three, of various types, or sometimes wanting. Stamens are usually three, very seldom one, two, four, or six. Filaments are free. Stylodia are two, very seldom three or one, very rarely basally connate into a short style. Caryopsis are always with a thin pericarp, this generally adnates to the seed, more rarely free from it, sometimes saclike. Meristematic layer presents under the coleoptile, as a result of which the base of the plumule can elongate during germination and produce adventitious roots.

The grass flower is unlike any other plant family's flowers. Within a spike, the flower unit is called a spikelet. An exaggerated separation of the structures is shown in the spikelet diagram. For reference, the diagram and the spikelet drawing of *Secale cereale* (rye) have the same letter for a described structure.

The primary axis of the spikelet is called the rachilla. At the base of the spikelet are two bracts called first glume and second glume. The next bracts are called lemmas and may have a bristlelike appendage (awn). A soft inner bract is called the palea. The remaining parts comprise a floret. Each spikelet may have one or more florets, which are unisexual or bisexual.

There are no sepals or petals. Instead, there are 2 or 3 lodicules. Lodicules enlarge with turgor pressure and cause the lemmas and palea to expand, exposing the stamens and/or stigmas at pollination time.

Grasses are wind-pollinated. There are usually 3 stamens with freely moving (versatile) anthers and a single pistil with 2, usually feathery, stigmas. The pistil's ovary is superior and contains one ovule. The fruit is usually a grain (caryopsis, m) or a berry in some bamboos. Grasses are annual or perennial herbs except for bamboo, which is woody at maturity. Roots are fibrous and adventitious roots arise from stem nodes. The stems, called culms are usually hollow and round with one leaf to a node. Leaves are alternate in two rows (a distichous arrangement) up the culm. The leaf consists of a blade (lamina) has parallel venation. Where the leaf blade diverges from the culm is often an appendage, the ligule, and sometimes, as in rice (*Oryza sativa*) two sickle-shaped auricles that clasp the sheath. Economically, Poaceae is the most important plant family. Many species of the family are used as food crops. These are *Avena sativa* (oats), *Hordeum* (barley), *Oryza sativa* (rice), *Secale cereale* (rye), *Sorghum bicolor* (sorghum), *Triticum* (wheat), *Zea mays* (corn); fodder: *Agrostis* (bentgrass), *Dactylis glomerata* (orchard-grass), *Phleum* (timothy), *Setaria italica* (foxtail grass), *Cynodon dactylon* (Bermuda grass), *Festuca* spp. (fescue grass), *Poa* (bluegrass). In industry, it is used various grasses for production of insulation materials, newsprint, ethyl alcohol.

The *Triticum* (wheat) grains are the source of vitamins, nutrients, and metabolites that we utilize. Wheat bran, composed of pericarp, seed coat and protein-rich aleurone layer, contains vitamin B complex (thiamine, riboflavin, niacin, pyridoxine, pantothenic acid), cellulose, phosphorus, calcium, and iron. Endosperm is processed into flour that contains mostly starch and some protein. Wheat germ refers to the embryo and is a source of vitamin B complex, vitamin E, vitamin A, protein, iron, fat, sodium, copper, zinc, magnesium, and phosphorus.

Humans domesticated wild wheat about 10,000 years ago. There are now about 22,000 cultivars. There are two main categories: hard wheat to make bread and soft wheat to make pasta, pastry, crackers, cakes, cookies and cereal. Rice (*Oryza sativa*) is sold as either white or brown rice. White rice is "polished" with consequent removal of the protein-rich aleurone layer outside the endosperm. Brown rice has the aleurone layer left intact and is nutritionally far better than starch-rich white rice (Fig. 4.24, 4.25).

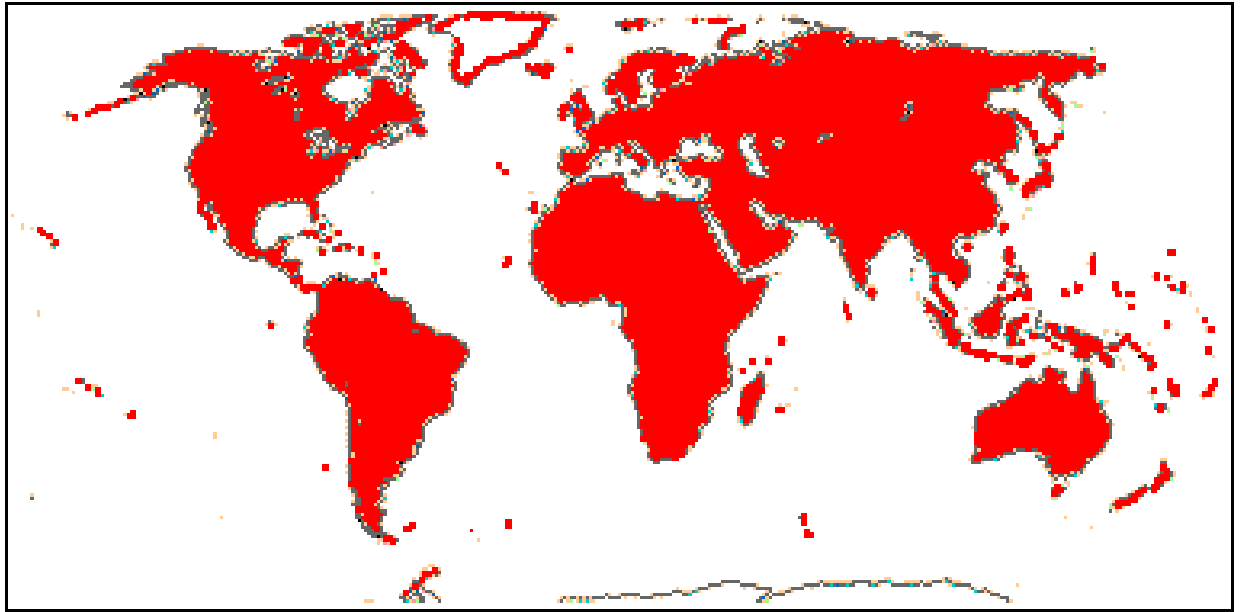


Fig. 4.24. The distribution of the species of the family Poaceae

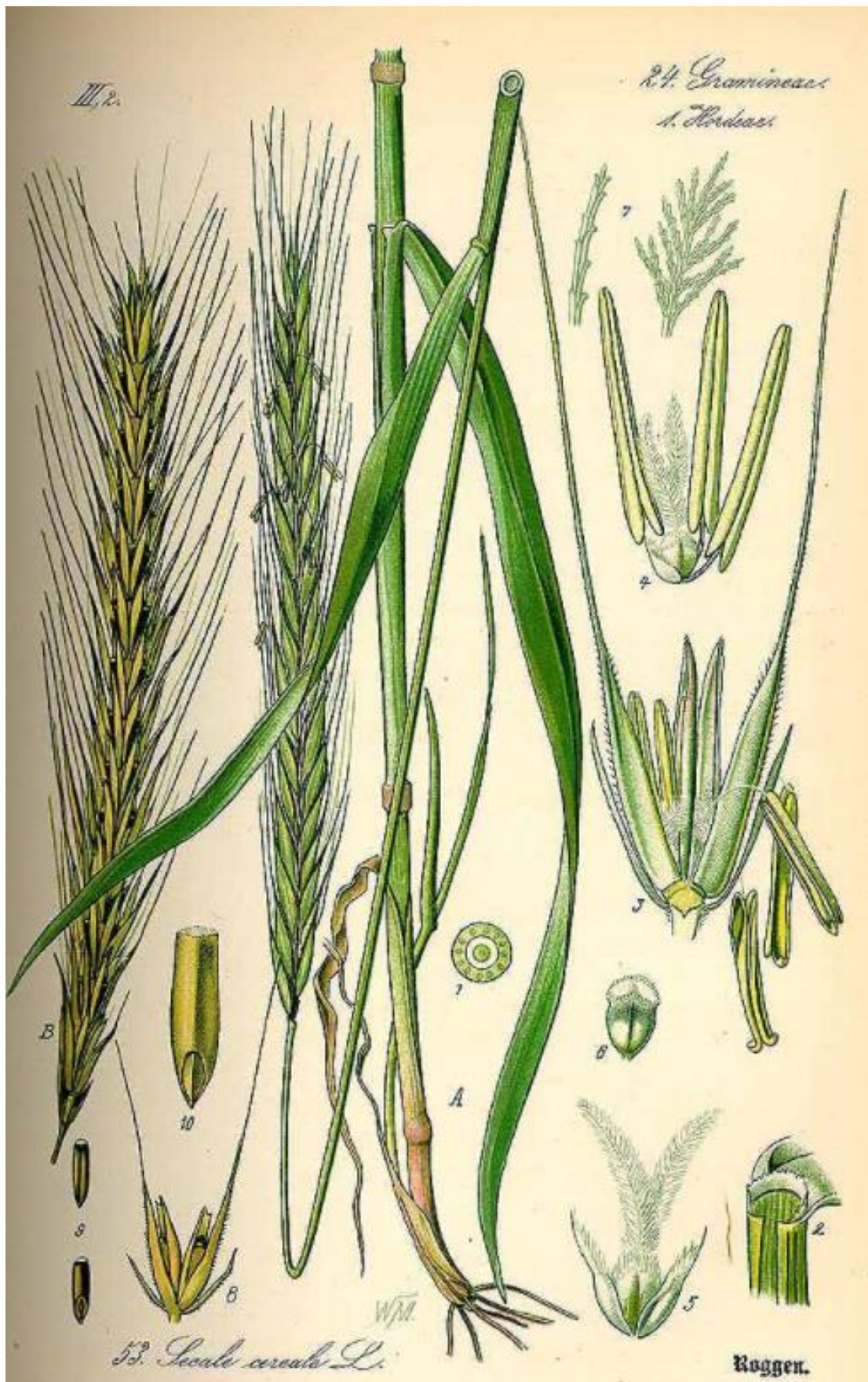


Fig. 4.25. *Secale cereale* L. – Rye [Thomé, 1885]

FAMILY 5 TYPHACEAE JUSS.

Common name: Cattail family.

Synonyms: Sparganiaceae Hanin.

Taxonomical composition: 2 genera: *Sparganium* (25 species) and *Typha* (49 species).

Features and representatives

The species of the family Typhaceae are perennial herbs, which inhabit fresh and slightly brackish wetlands. They are often emergent, rhizomatous, caulescent in flower, smooth, glabrous. The leaves are basal and cauline, 2-ranked, mostly ascending. The sheaths are open. The margins are overlapping, clear, summit tapered into blade or auriculate. The blades are twisted into loose helix, narrowly linear-attenuate, apex acute. The aerenchyma is prominent. The inflorescence is one, terminal, erect, equaled or exceeded by cauline leaves, cylindric, spikelike (hereafter “spikes”). The staminate spike flowers are deciduous but axis generally persistent. The staminate spike is distal to pistillate spike. The young spikes are subtended by early-deciduous bracts resembling reduced foliage leaves, one bract subtending pistillate spike, one bract subtending and several within staminate spike. The staminate spike flowers are deciduous but axis generally persistent. The staminate axis is with numerous simple or branched scales arising among flowers. The pistillate axis is with numerous projections which is also called “compound pedicels”, evident on denuded fruiting spike. Each of them bears several flowers. In some species the flowers are subtended by slender bracteoles. The flowers are unisexual, staminate and pistillate on same plants, numerous, densely packed in unisexual spikes, minute, wind-pollinated.

The stigmas are receptive several days before pollen is shed. The perianth is probably represented by staminate scales and by hairs on stipes of pistillate flowers. The staminate flowers are stipitate. The stamens are several, the filaments are connate; the anthers are basifixed, connective distally extended. The pistillate flowers are hypogynous, stipitate (stipe bearing numerous straight hairs, developing after flowering, acting in wind dispersal of fruits). The pistil is one, one-carpellate. The ovary is one-locular. The placentation is apical. The ovule is one. The style is one, unbranched. The stigma is one, whitish or green, drying brown, one-sided, smooth. The agamous flowers are numerous (the ovaries are modified after flowering as carpodia). The fruits are follicles, fusiform. The pericarp is clear, hyalinetransparent, splitting longitudinally in water to release the seed. The seeds have a starchy endosperm, oily. The embryo is cylindric.

The species of the Typhacea family are cosmopolitan plants, but mainly spread in Eurasia and North America. In the world there are 49 species of the genus *Typha*. In Ukraine there are 11 species of the genus *Typha*: *T. angustifolia*, *T. domingensis* (synonym: *T. australis*), *T. caspica*, *T. grossheimii*, *T. latifolia*, *T. laxmannii*, *T. minima*, *T. salgirica* (synonym: *T. pontica*), *T. shuttleworthii*, *T. krasnovae* (synonym: *T. sibirica*), *T. laxmannii* (synonym: *T. zerovii*).

The species of the genus *Typha* are glabrous, aquatic or semi-terrestrial perennial herbs, with fibrous roots and creeping rhizomes. The stems are erect, corm-like at the base. The leaves are mostly basal, linear, distichous, and erect. The stem is closely enveloped by the sheath. The sheath tapers or is auriculated above. The lamina is linear, elongate, and semi-cylindrical to flat. It is sometimes somewhat keeled below, with a layer of air-filled cavities. In Ukraine the most distributed species of the genus *Typha* is *T. latifolia*, which is a perennial water plant with wide leaves (1–2 cm). *T. angustifolia* is a perennial water plant with narrow leaves (0,5–1 cm) and not so widely spread as *T. latifolia*. The leaves of the species are used for making of paper, carton. The rhizomes have about 40% of starch.

The inflorescence of the species of the *Sparganium* genus is axillary, of dense globose units, each comprising twice-thrice-compound heads. The inflorescence system is basally female, apically male. The species of the family are marsh or aquatic perennial herbs. The leaves are emergent and floating, alternate, distichous, sessile, sheathing simple, and entire. The mesophyll contains sometimes mucilage cells (with raphides) and calcium oxalate crystals. The flowers are bracteate (female flowers) or ebrancheate (male flowers), small. The floral receptacle develops as an androphore. The perianth of the female flowers consists of (1–) 3–4(–6) small segments. The stamens are (1–)3(–6). The gynoeceium consists of 1–2 carpels, monomerous or syncarpous (and then pseudomonomerous, with one locule empty). The ovary is 2-locular. The fruits are 1-seeded, drupaceous or nucular, hydrochorous or endozoochorous, sessile or nearly so. The seeds are starchy, the epicarp consists of three layers: a firm exocarp, a spongy mesocarp and an thick and stony endocarp. The embryo is small. The endosperm is oily.

The species of the genus *Sparganium* are mainly spread in extratropical regions of the Northern Hemisphere, mountains of Sumatra and New Guinea, and southeastern Australia and New Zealand. There are 25 species of the genus *Sparganium* in the world. The species of the genus *Sparganium* are glabrous, aquatic or semi-terrestrial perennial herbs, with fibrous roots and creeping rhizomes. The stems are erect or floating. The leaves are linear, distichous, sheathing at the base, erect or floating, gradually passing into scale-like bracts. In Ukraine there are four species of the genus *Sparganium* (*S. angustifolium*, *S. emersum*, *S. erectum*, *S. natans* (synonym: *S. minimum*)), which inhabit basin banks or basins in the Polesye, the Forest steppe and rarely in the Steppe (Fig. 4.26–4.29).

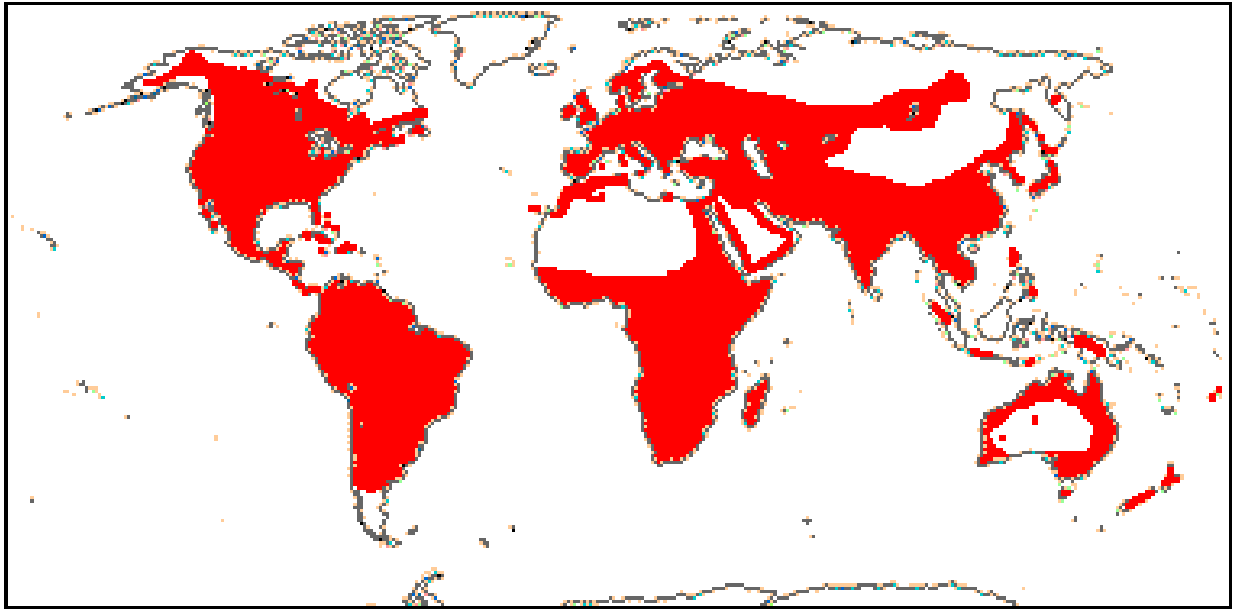


Fig. 4.26. The distribution of the species of the genus *Typha* [Stevens, 2001]

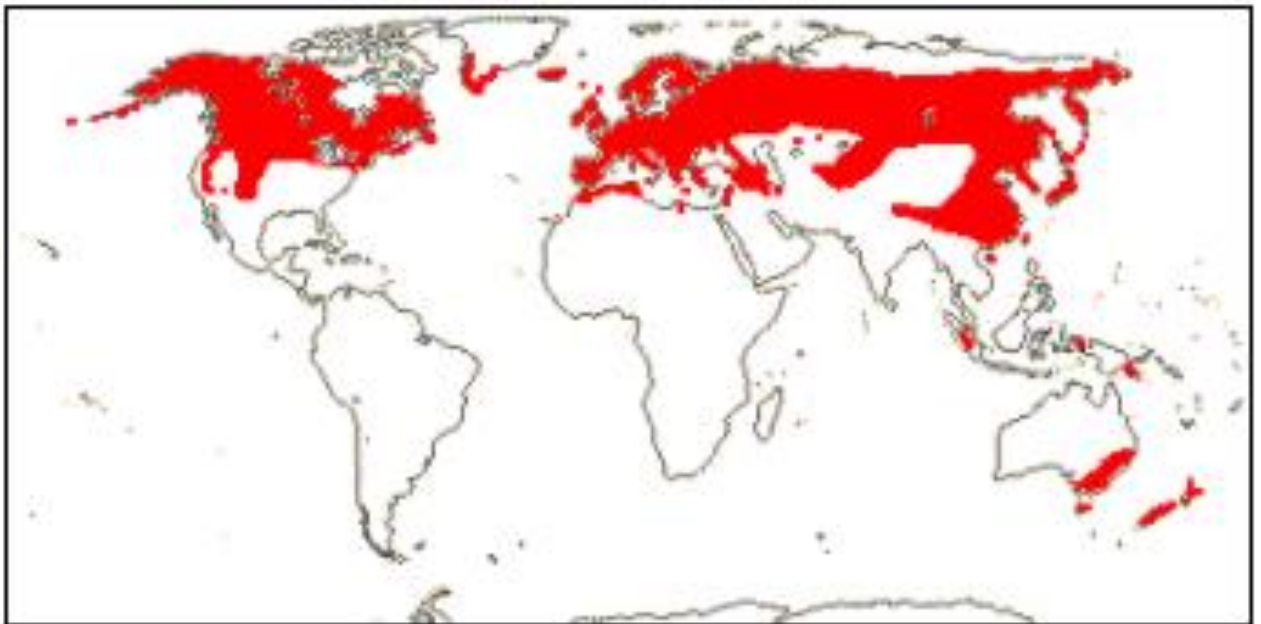


Fig. 4.27. The distribution of the species of the genus *Sparganium* [Stevens, 2001]

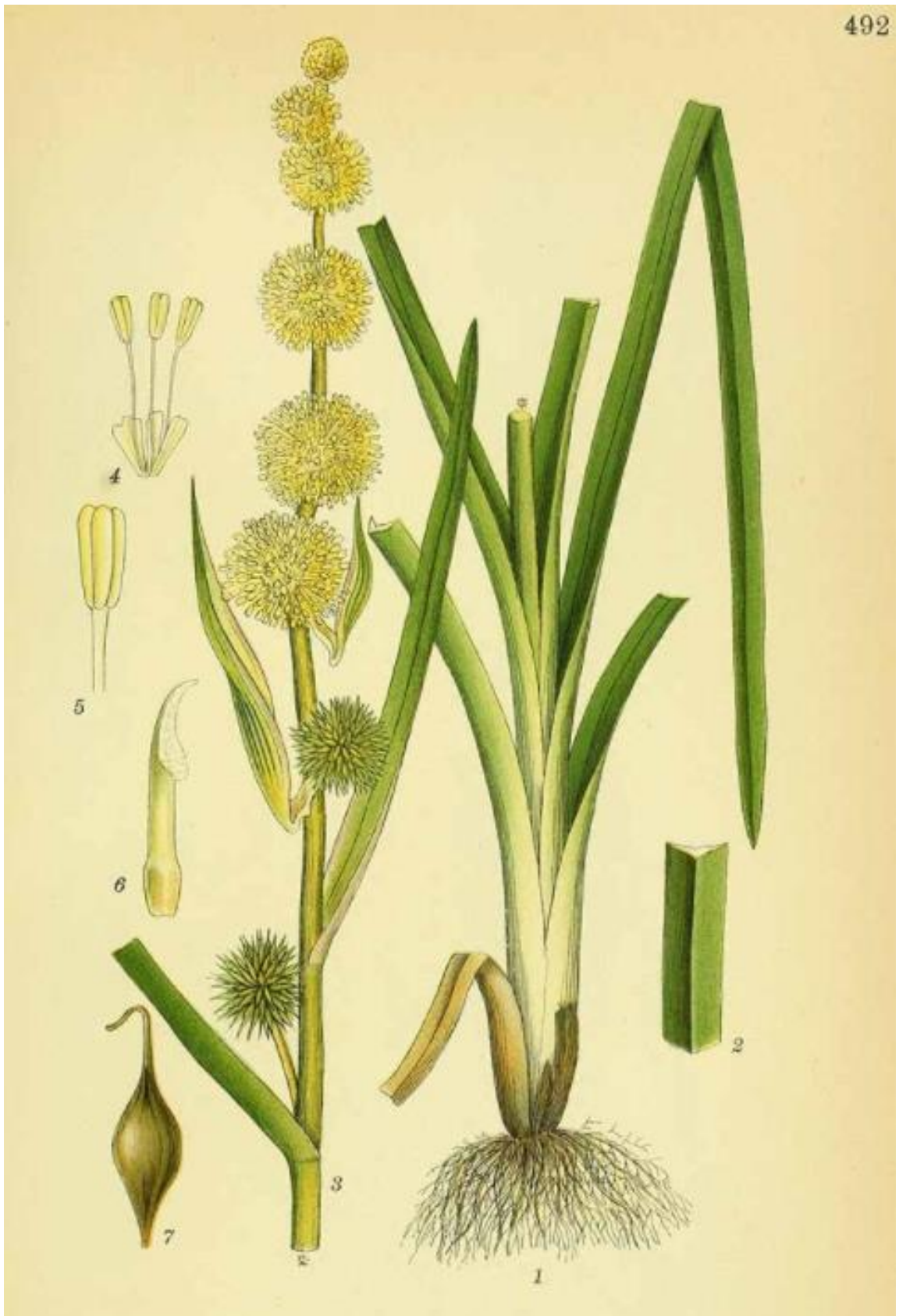


Fig. 4.28. *Sparganium emersum* Rehmann – European bur-reed, unbranched bur-reed [Lindman, 1922]



Fig. 4.29. *Typha angustifolia* L. – Narrow-leaved cattail [Masclef, 1893]

Questions for self-control

MONOCOTS

1. How many and what families has the order Asparagales?
2. What is the common name of the family Orchidaceae?
3. How many genera are there in the family Orchidaceae?
4. In what regions of the Earth occur the species of the family Orchidaceae?
5. How many genera and species are there in the family Cyperaceae?
6. How many sepals and petals has the flower of the species of the family Juncaceae?
7. How many ovules contains the ovary of the species of the family Poaceae?
8. What type of fruit have the species of the family Typhaceae?
9. How many genera and species of the family Typhaceae in the flora of Ukraine?
10. What type of fruit have the species of the family Typhaceae?

CHAPTER 5. PROBABLE SISTER OF EUDICOTS

ORDER 3 CERATOPHYLLALES LINK

Taxonomical composition: 1 family (*Ceratophyllaceae* Gray), 1 genus and 5 species.

FAMILY 6 CERATOPHYLLACEAE GRAY

Common name: Hornwort family.

Taxonomical composition: 1 genus and 5 species.

Features and representatives

The species of the Ceratophyllaceae family are submerged, brittle, rootless aquatic herbs. The plants are free floating and hydrophytic. The leaves are small to medium sized. Pollination is possible by water. The flowers of the plants are functionally male and female and solitary or aggregated in inflorescences. The extant species of this aquatic family are obviously highly specialized; recent research indicates that Ceratophyllaceae are an ancient lineage. From comparative morphologic data, D.H. Les (1988) hypothesized that Ceratophyllaceae are vestiges of ancient angiosperms that diverged early from the line leading to most other modern taxa. The stems are long and branching. The very thin, unstalked branches which are whorled on the stem are leaf-like. The small flowers are with 7–15 tiny sepals that are fused at the base. Pollen-bearing or ovule-bearing flowers are without petals. The ovule-bearing flowers are with a single pistil. On the pollen-bearing flowers there are numerous stamens. The fruit is an achene. The floral formula is $*P_{12}A_{\infty}V*P_{8-12}G_{\underline{1}}$.

Ceratophyllum demersum is aquatic obligate cosmopolitan plant. The places on which can be found the plant are stagnant and slow moving water. The plant can be used as part of the aquarium background. It is rootless perennial plant. *Ceratophyllum demersum* has the 1.5–4 cm long leaves which are forked into 2 (sometimes 4) flattened or linear segments. The segments are with small teeth along one margin. The leaves are arranged in whorls. The whorls have 5 to 12 leaves. The stem of the plant is freely branched, 3–4 m long and easily broken. The flowers are tiny and can be found at the leaf bases. The plant has male and female flowers located separately on the same plant. The female flowers are solitary while the male flowers are located in pairs on opposite sides of the stem. The petals of the flowers are tiny green scales. The flowering duration is from June through September. The fruit of the plant is small (4–7 mm), hard and one-seeded.

Ceratophyllum submersum completely submerges just below the surface of shallow, still or slow-moving waters. It is rootless with underwater flowers plants. *C. submersum*, commonly known as the soft hornwort, is a species of Ceratophyllum. It is a submerged, free-floating aquatic plant. It has been reported

from Europe, Central Asia, northern Africa, scattered places in tropical Africa, Turkey, Oman, Florida, and the Dominican Republic (Fig. 5.1–5.3).

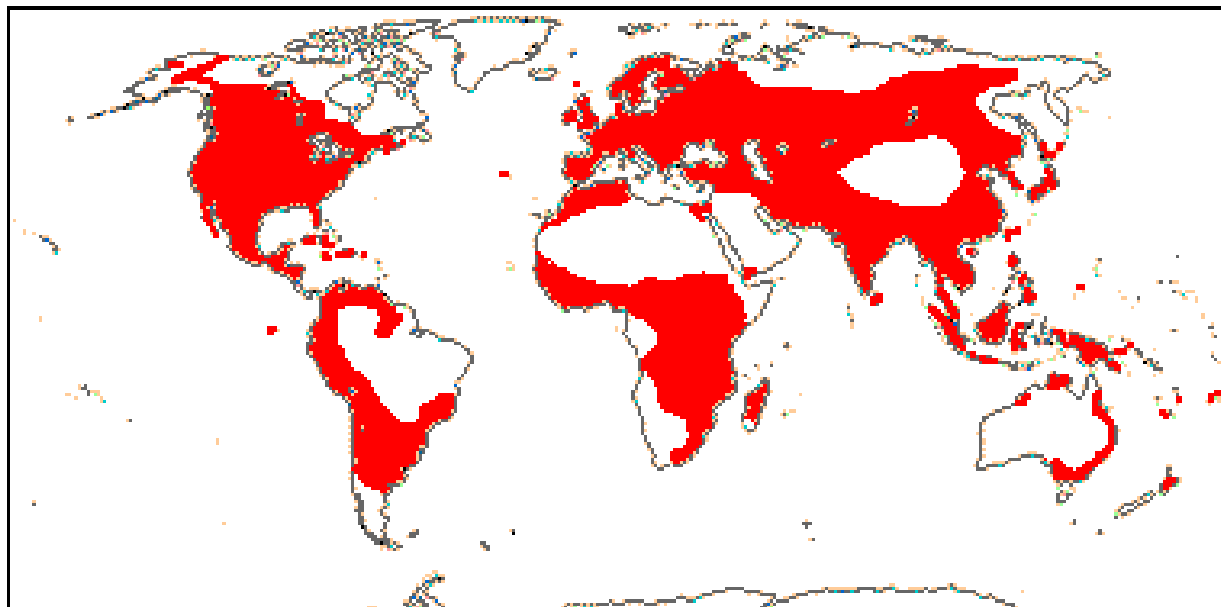


Fig. 5.1. The distribution of the species of the family Ceratophyllaceae [Stevens, 2001]



Fig. 5.2. *Ceratophyllum demersum* L. – Hornwort, rigid hornwort, coontail, or coon's tail [Lindman, 1922]

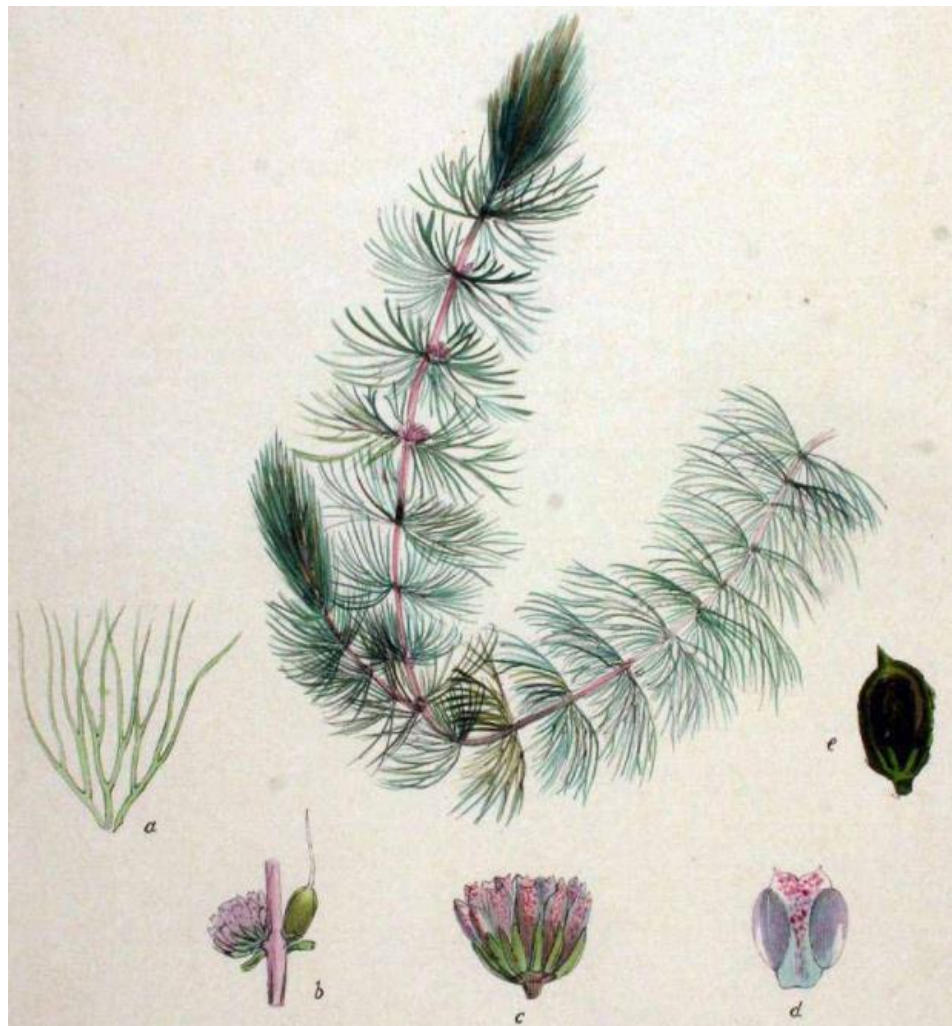


Fig. 5.3. *Ceratophyllum submersum* L. – Soft hornwort or tropical hornwort [Kops, 1895]

Questions for self-control

PROBABLE SISTER OF EUDICOTS

1. How many and what families has the order Ceratophyllales?
2. What is the common name of the family Ceratophyllaceae?
3. How many genera and species are there in the family Ceratophyllaceae?
4. How many pistils contains the flower of the species of the family Ceratophyllaceae?
5. How many sepals contains the flower of the species of the family Ceratophyllaceae?
6. What type of fruit have the species of the family Ceratophyllaceae?
7. In what regions of the Earth occurs *Ceratophyllum demersum*?
8. What is the common name of *Ceratophyllum demersum*?
9. What is the common name of *Ceratophyllum submersum*?
10. What peculiarities of the fruit *Ceratophyllum demersum*

CHAPTER 6. EUDICOTS CLADE

ORDER 4

RANUNCULALES JUSS. EX BERCHT. & J.PRESL

Synonyms: Berberidales Bercht. & J. Presl, Circaeasterales Takht., Fumariales Link, Glaucidiales Takht. ex Reveal, Helleborales Nakai, Hydrastidales Takht., Lardizabalales Leconte in D.W. Taylor & L.J. Hickey, Menispermales Juss. ex Bercht. & J. Presl, Nandinales Doweld, Papaverales Juss. ex Bercht. & J. Presl, Podophyllales Dumort.

Taxonomical composition: 8 families (Berberidaceae Juss., Circaeasteraceae Hutch., Eupteleaceae K. Wilh., Lardizabalaceae R.Br., Menispermaceae Juss., Papaveraceae Juss., Ranunculaceae Juss.), 206 genera and 6212 species.

FAMILY 7

BERBERIDACEAE JUSS.

Common name: Barberry family

Synonyms: Diphyllieaceae Schultz Sch., Epimediaceae Menge, Leonticaceae Airy Shaw, Nandinaceae Horan., Podophyllaceae DC., Ranzaniaceae Takht.

Taxonomical composition: 19 genera and 718 species, including *Berberis* (525 species), *Epimedium* (65 species), *Mahonia* (73 species).

Features and representatives

The Barberry family globally consists of 19 genera and 718 species, but there are only a few native to Ukraine. Some species of the Barberry family are cultivated. The scattered vascular bundles can be found on the stems. The wood of the stem is generally very yellow because of the presence of berberine, an isoquinoline alkaloid. The leaves are usually alternate, and may be simple or compound. They are often spiny, and sometimes completely reduced to spines. The species has usually no stipules. The flowers are usually radially bisexual, symmetric, and have a perianth that is often 3-merous. Both the calyx and the corolla are made up of separate parts. There are 4 or 6 outer petals, 4 or 6 sepals and often 6 showy, nectar-producing inner petals. There are 4 stamens with anther sacs that open by flaps that are hinged at the top. The ovary is superior. There are usually many ovules. The fruit is a berry. The floral formula is $*K_{3+3} C_{3+3} A_{3+3} \underline{G}_1$. In Ukraine *Berberis vulgaris* occurs. It is a strigose shrub with eatable fruits. The bark of *B. vulgaris* contains berberine, which is tourniquet (Fig. 6.1, 6.2).

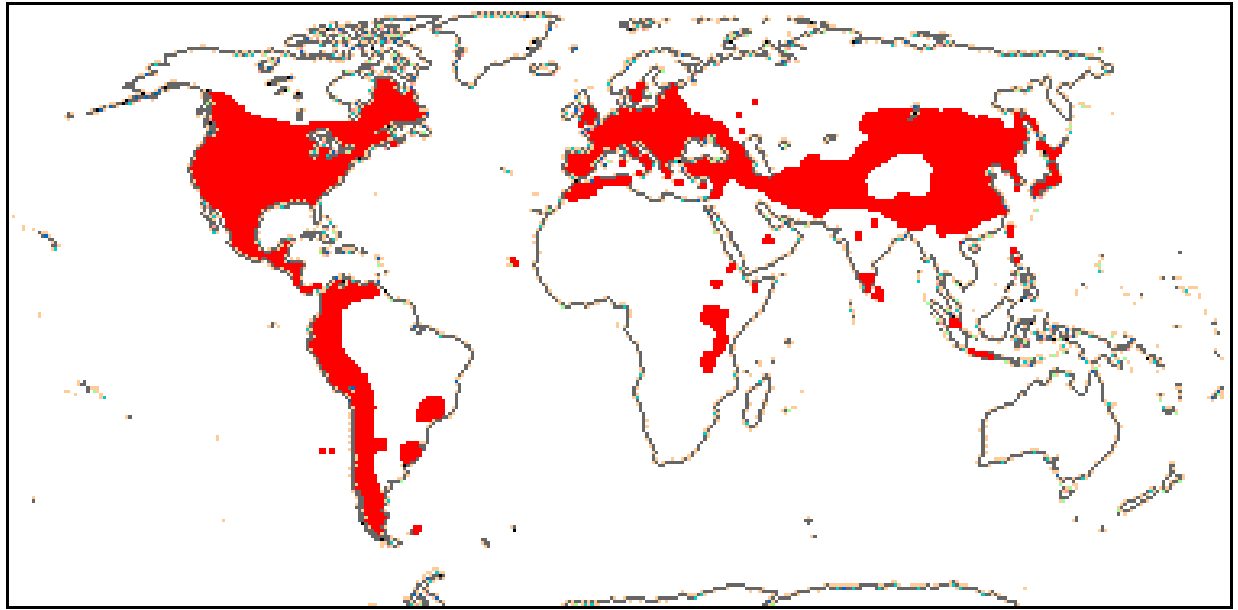


Fig. 6.1. The distribution of the species of the family Berberidaceae [Stevens, 2001]



Fig. 6.2. *Berberis vulgaris* L. – European barberry, common barberry [Thomé, 1886]

FAMILY 8 PAPAVERACEAE JUSS.

Common name: Poppy family.

Synonyms: Chelidoniaceae Martinov, Eschscholziaceae Ser., Fumariaceae Marquis, Hypseochoaceae Willk. & Lange, Platystemonaceae Lilja).

Taxonomical composition: 44 genera and 1023 species, including *Corydalis* (530 species), *Fumaria* (57 species), *Glaucium* (25 species), *Meconopsis* (97 species), *Papaver* (128 species).

Features and representatives

The species of the family are mostly herbs, trees and shrubs. The leaves are alternate, sometimes opposite or whorled. The family consists of the 42 genera and 775 species. The species of the family are mostly spread in the temperate and subtropical regions of the Northern Hemisphere, especially the Mediterranean, western, central, and eastern Asia and southwestern parts of the USA; extending to northern South America; one species of *Papaver* in South Africa and one species in Cape Verde Islands. Species in the Papaveraceae in our region are annual or perennial herbs with leaves that usually grow alternately along the stem. The floral formula is $*K_2C_4A_\infty G_{(2)}$. The species of the family Papaveraceae are annual or perennial herbs.

The leaf blades are usually lobed, or divided into leaflets. The stems and leaves contain latex, a milky or colored sap. The flowers are showy and may be solitary or arranged in branching arrays. The flowers are actinomorphic (radially symmetrical) or zygomorphic (bilaterally symmetrical) and have both pollen-bearing and ovule-bearing parts. There are 2 or 3 sepals that fall off early in the season, and 4 or more petals that may be separate or fused into distinctive shapes. There are 6 to many stamens and 1 style (or none) with a lobed stigma. The fruit is a dry capsule that releases its many small seeds by splitting open lengthwise or opening through apical pores. Species formerly placed in the Fumariaceae are included in the Papaveraceae. The family consists of medicine, oil and ornamental plants. The central place in the family depends on the genus *Papaver*. The species of the genus *Papaver* contains important alkaloids (morphine, codeine, papaverine) which are used in medicine. These alkaloids are peculiarly in the milk sap of *Papaver somniferum*. Its seeds contain oil. Alkaloids are also in the milk sap of *Papaver rhoeas*. The medicinal plants are also *Papaver orientale*, *Chelidonium majus* with yellow flowers and yellow milk sap, *Glaucium corniculatum*.

The members of the subfamily Fumarioideae Eaton are annual or perennial herbs with a basal aggregation of leaves, or without conspicuous aggregations of leaves. The species are rhizomatous, or tuberous. The subfamily are formed by 20 genera and 663 species. The members of the family are located mostly in northern temperate regions; only a few are found south of the equator (a few species of *Corydalis* on mountains in East Africa, genera *Cysticapnos*, *Trigonocapnos*, and *Discocapnos* in southern Africa). In Ukraine there are 8 genera and 30 species of the family Papaveraceae.

The members of the family are with laticifers. It is hairs present or absent. The young stems are commonly with hollow internodes. The flowers of the plants are rarely solitary or usually aggregated in inflorescences. The perianth is with distinct calyx and corolla. It is six or three whorled and isomerous. The calyx is two or one whorled and polysepalous. The corolla is four or two whorled and polypetalous to gamopetalous. The androecium is apparently six. The androecial members are branched. The gynoecium is two carpelled. Carpels are isomerous with the perianth. The pistil is one celled. The gynoecium is syncarpous; eusyncarpous; superior. The ovary is one locular. The fruit is non-fleshy; usually dehiscent, or rarely indehiscent, or lomentaceous. It is a capsule, or a silicula, or a siliqua, or rarely a nut. In Ukraine it is cultivated as ornamental plant *Dicentra spectabilis*.

Fumaria officinalis contains alkaloids, other species of the genus *Fumaria* are weeds. The floral formula of *F. officinalis* is $\uparrow K_2 C_{2+2} A_2 G_{(2)}$. Different species of the genus *Fumaria* occurs in forests. It is *Corydalis capnoides*, *C. intermedia*, *C. cava* (synonym: *C. marschalliana*), *C. solida*. The plants are toxic, contain alkaloids, ornamental (Fig. 6.3–6.6).

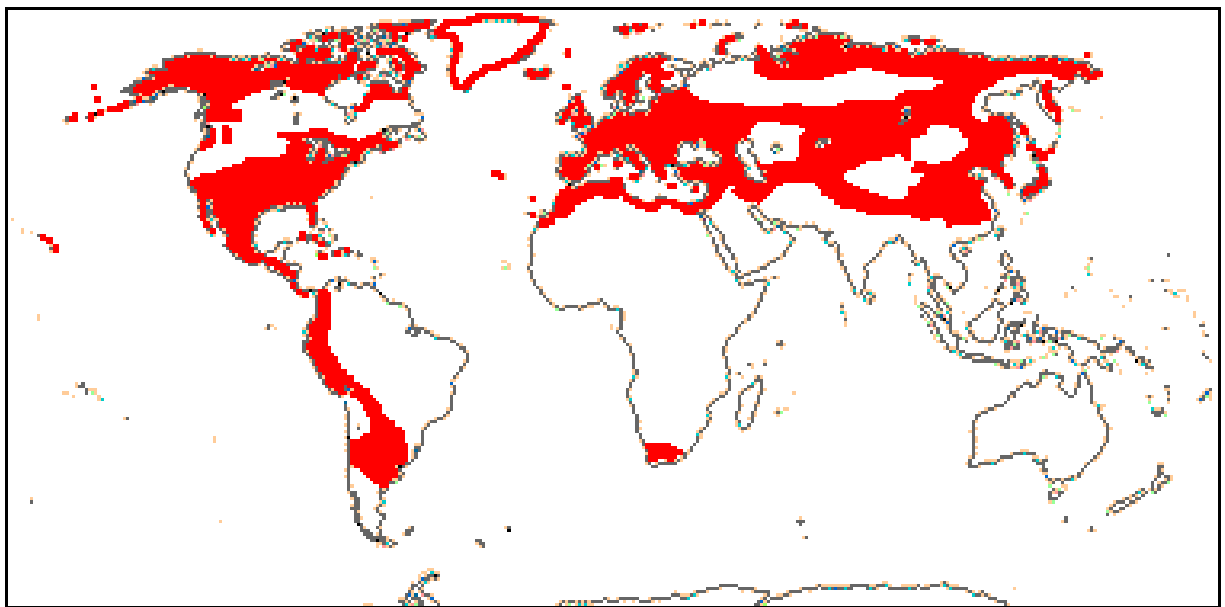


Fig. 6.3. The distribution of the species of the subfamily Papaveroideae Eaton [Stevens, 2001]



Fig. 6.4. *Chelidonium majus* L. – Greater celandine or tetterwort, nipplewort, swallowwort [Kops, 1814]

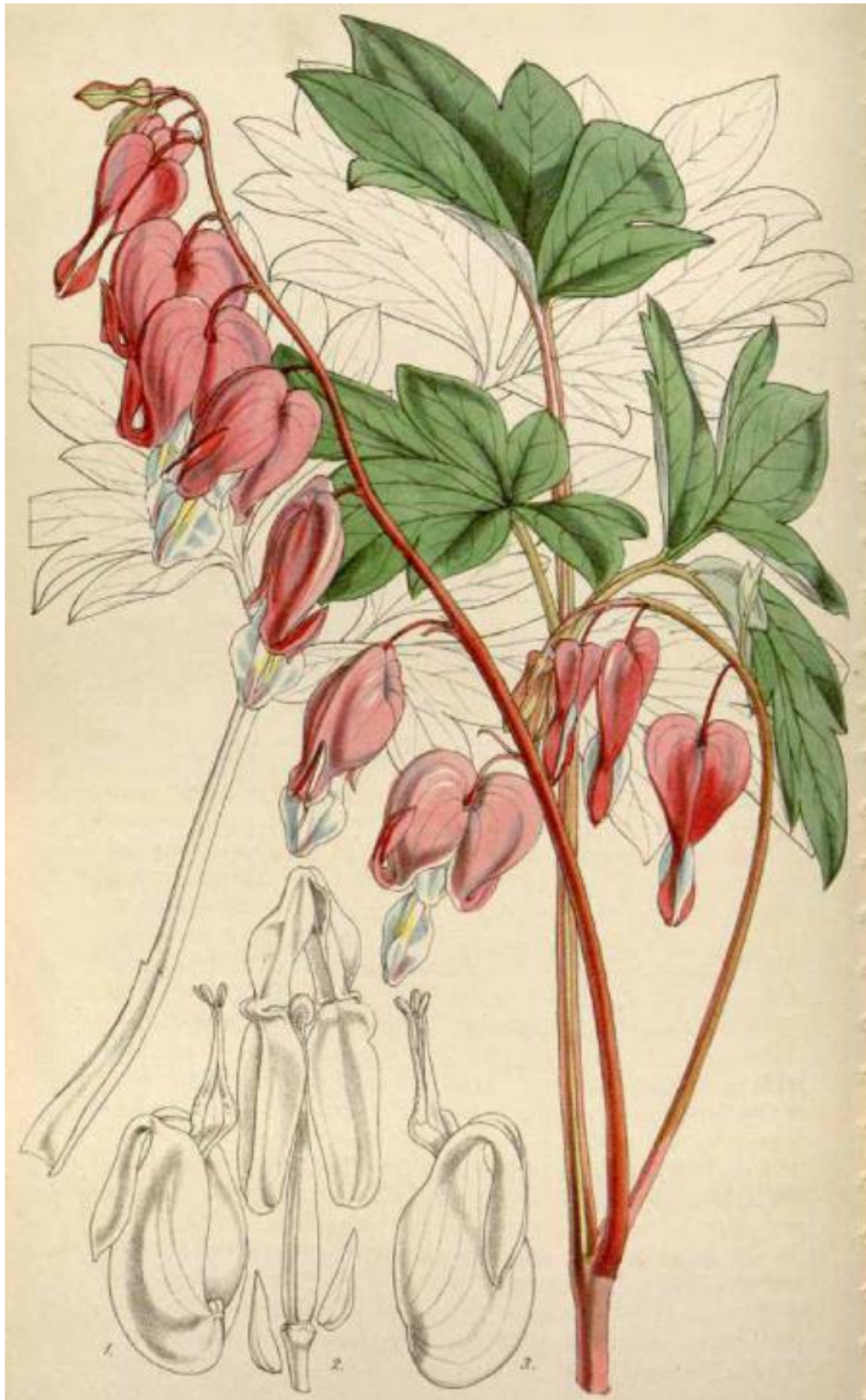


Fig. 6.5. *Lamprocapnos spectabilis* (L.) Fukuhara (synonym: *Dielytra spectabilis* (L.) DC.) – Bleeding heart or asian bleeding-heart [Curtis, 1849]



Fig. 6.6. *Papaver rhoeas* L. – Common poppy, corn poppy, corn rose, field poppy, flanders poppy, red poppy, red weed, coquelicot [Kops, 1822]

FAMILY 9 RANUNCULACEAE JUSS.

Common name: Crowfoot family.

Synonyms: Aconitaceae Bercht. & J. Presl, Actaeaceae Bercht. & J. Presl, Anemonaceae Vest, Aquilegiaceae Lilja, Calthaceae Martinov, Cimicifugaceae Bromhead, Clematidaceae Martinov, Delphiniaceae Brenner, Glaucidiaceae Tamura, Helleboraceae Vest, Hydrastidaceae Martinov, Nigellaceae J. Agardh, Thalictraceae Raf., Xanthorhizaceae Bercht. & J. Presl.

Taxonomical composition: 57 genera and 3877 species, including *Aconitum* (345 species), *Actaea* (29 species), *Adonis* (37 species), *Anemone* (109 species), *Aquilegia* (115 species), *Clematis* (379 species), *Coptis* (15 species), *Delphinium* (524 species), *Pulsatilla* (58 species), *Ranunculus* (1723 species), *Thalictrum* (210 species), *Trollius* (40 species).

Features and representatives

The species of the family are distributed throughout the world but centered in temperate and cold regions of the Northern and Southern Hemispheres. There are 25 genera and 138 species in Ukraine.

The leaves of the family species are typically estipulate, alternate, and compound. The flowers are actinomorphic or less commonly zygomorphic and are usually bisexual. The floral formula is $*K_4C_4A_\infty G_{\underline{\infty}}$.

The perianth of the flowers is usually in two, often 5-merous cycles that may or may not be differentiated into calyx and corolla. The petals are usually nectariferous near the base, and in *Ranunculus* there is a flap of tissue in this position. Typical flowers have many helically disposed stamens and simple pistils on an elongated receptacle. All of the floral parts are distinct. Each pistil has a superior ovary with one locule and 1-several parietal ovules. A single flower commonly produces a cluster of achenes or follicles. The fruit is usually non-fleshy, or rarely fleshy. It is usually an aggregate, or not an aggregate. *Ranunculus repens* occurs on the moist areas, overall Ukraine. *Ficaria verna* is ornamental and noxious plant. It occurs in the forests. The family Ranunculaceae contains many ornamental flowering plants: *Helleborus viridis*, *Aquilegia vulgaris*, and species of the genera *Delphinium*. The species needed the preservation on the territory of Ukraine are *Trollius europaeus*, *Adonis vernalis*, *Pulsatilla alpina* (synonym: *P. alba*) (Fig. 6.7–6.9).

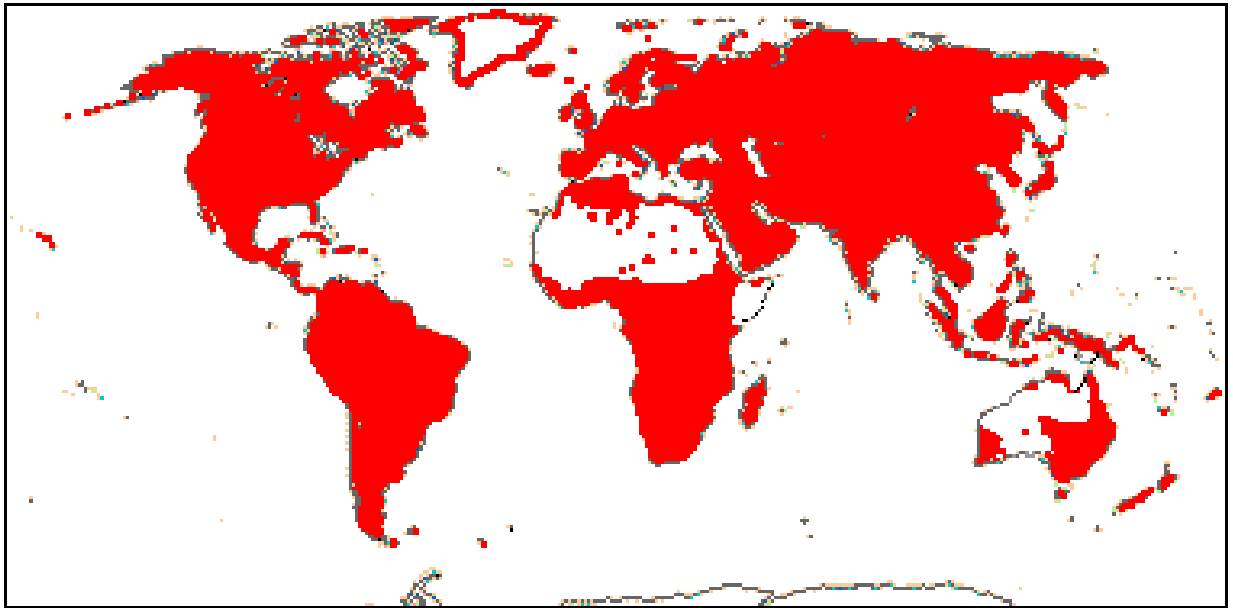


Fig. 6.7. The distribution of the species of the family Ranunculaceae [Stevens, 2001]



Fig. 6.8. *Ficaria verna* Huds. – Lesser celandine [Palmstruch, 1807]



Fig. 6.9. *Ranunculus repens* L. – Creeping buttercup, creeping crowfoot [Sturm, 1826]

ORDER 5
PROTEALES JUSS. EX BERCHT. & J.PRESL

Synonyms: Nelumbonales Mart., Platanales Mart.

Taxonomical composition: 4 families (Nelumbonaceae A. Rich., Platanaceae T. Lestib., Proteaceae Juss., Sabiaceae Blume), 85 genera and 2012 species.

FAMILY 8
PLATANACEAE T. LESTIB.

Common name: Plane-tree family.

Taxonomical composition: 1 genus and 9 species.

Features and representatives

The family contains one genus *Platanus* and eight species, which are spread from the Balkan Peninsula to western Himalayas, Indochina, and America from Canada to Mexico. In Ukraine there is one species *Platanus occidentalis* which is used as ornamental plant. Its light and strong wood is used for making of furniture. The floral formula is ♂ $K_{3-5}C_{3-5}A_{4-7}$, ♀ $K_{3-5}C_{0-4-5}G_{(\underline{5-9})}$.

The monoecious family consists of species, which are trees with scaling bark. The flowers are arranged in the globose, unisexual capitula. The perianth is four- or six-merous, it is arranged in two whorls. The number of stamens is four-six. They are opposite the outer perianth-segments. The ovary is superior. The numbers of free carpels are three – six. Each carpel is with one (two) pendulous. The ovules are orthotropous. The fruit is achene (Fig. 6.10, 6.11).



Fig. 6.10. The distribution of the species of the family Platanaceae [Stevens, 2001]



Fig. 6.11. *Platanus occidentalis* L. – American plane, American sycamore, buttonwood [Duhamel du Monceau, 1804]

Questions for self-control

EUDICOTS CLADE

1. What is the common name of the family Berberidaceae?
2. How many and what families has the order Ranunculales?
3. How many genera and species are there in the family Berberidaceae?
4. How many petals has the flower of the species of the family Berberidaceae?
5. How many sepals has the flower of the species of the family Berberidaceae?
6. How many stamens has the flower of the species of the family Berberidaceae?
7. What is the common name of the family Papaveraceae?
8. In what regions of the Earth occurs the species of the family Papaveraceae?
9. What type of symmetry have the flowers of the species of the family Papaveraceae?
10. What is the common name of the family Ranunculaceae?
11. In what regions of the Earth occurs *Berberis vulgaris*?
12. What is the common name of *Lamprocapnos spectabilis*?
13. What is the common name of *Chelidonium majus*?
14. What peculiarities of the fruit *Ranunculus repens*

CHAPTER 7. SUPERROSIDS

ORDER 6

SAXIFRAGALES BERCHT. & J. PRESL

Synonyms: Crassulales Link, Grossulariales DC. ex Bercht. & J. Presl, Haloragales Link, Iteales Doweld, Sedales Rchb., Sempervivales Juss. ex Bercht. & J. Presl

Taxonomical composition: 15 families (Altingiaceae Lindl., Aphanopetalaceae Doweld, Cercidiphyllaceae Engl., Crassulaceae J.St.-Hil., Cynomoriaceae Endl. ex Lindl., Daphniphyllaceae Müll.Arg., Grossulariaceae DC., Haloragaceae R.Br., Hamamelidaceae R.Br., Iteaceae J. Agardh, Paeoniaceae Raf., Penthoraceae Rydb. ex Britton, Peridiscaceae Kuhlman, Saxifragaceae Juss., Tetracarpaeaceae Nakai), 123 genera and 3246 species.

FAMILY 9

ALTINGIACEAE LINDL.

Common name: Sweetgum family.

Taxonomical composition: 1 genus and 15 species.

Features and representatives

The species of the family Altingiaceae occur in East Mediterranean, from East Asia to Malesia, in Central America. The plants of the family Altingiaceae are monoecious, deciduous trees and often produce resins. The leaves are spirally-arranged, usually palmately-lobed with petiolar stipules. The inflorescences are capitate. The buds are protected by scales.

Liquidambar styraciflua is also called as sweetgum. This plant is a deciduous tree 24–32 m tall found in moist low forests. Bloom time of is from April to May. Leaves of *L. styraciflua* are deep green with long petiole. Yellow-green flowers are monoecious and appear in spring. Staminate flowers with hairy bracts form terminal racemes. The pistillate flowers are in solitary head. The fruit of *L. styraciflua* is compound and consist of numerous capsules. *L. styraciflua* is a source of hardwoods and used for furniture. Sweetgum is a popular ornamental plant. *L. orientalis* are the source of storax (styrax) balm. *L. excelsa* spread in mountain forests from East Himalayas to Java and Sumatra is 60 meters tall and gives valuable wood.

Altingiaceae are monoecious, deciduous trees that may be recognised by their spirally-arranged, usually palmately-lobed leaves with petiolar stipules and by their capitate inflorescences. The buds have scales, and the plants often produce resins (Fig. 7.1, 7.2).

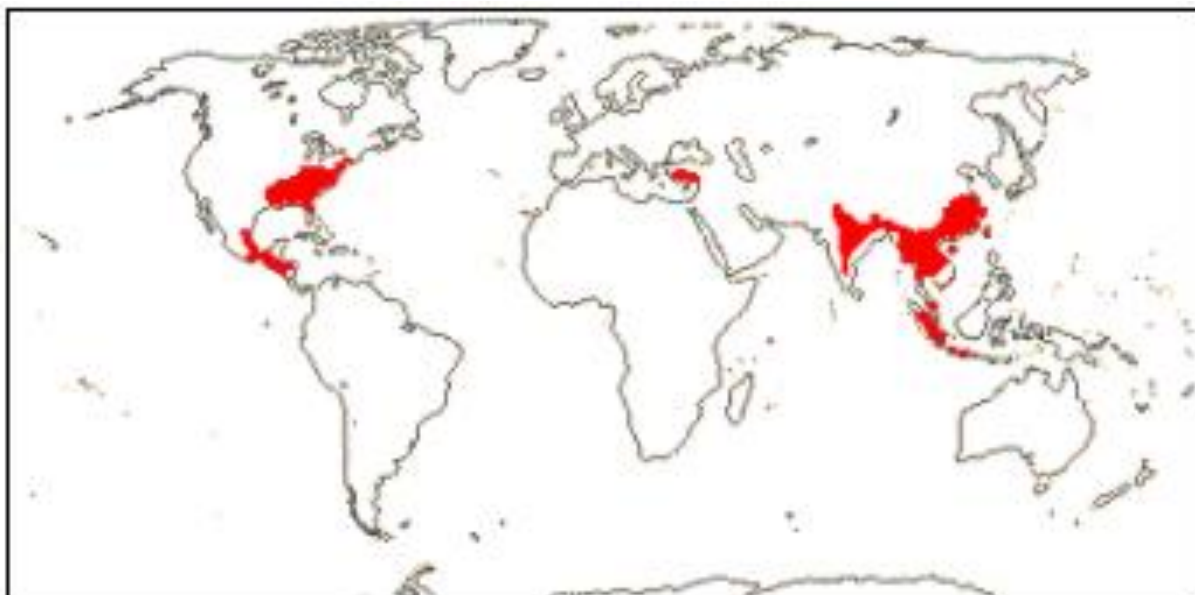


Fig. 7.1. The distribution of the species of the family Altingiaceae [Stevens, 2001]



Fig. 7.2. *Liquidambar styraciflua* L. – Sweetgum [Hayne, 1830]

FAMILY 10 CRASSULACEAE J.ST.-HIL.

Common name: Stonecrop family.

Synonyms: Cotyledonaceae Martinov, Rhodiolaceae Martinov, Sedaceae Roussel, Sempervivaceae Juss., Tillaeaceae Martinov

Taxonomical composition: 34 genera and 1757 species, including *Crassula* (217 species), *Kalanchoe* (186 species), *Tylecodon* (51 species), *Sedum* (463 species), *Sempervivum* (64 species).

Features and representatives

The species of the family Crassulaceae widely occur, mainly in dry and warm regions, but centered in tropical and especially South Africa. In Ukraine there are five genera and 24 species. The species of the family Crassulaceae are annual, biennial or perennial herbs. They can be rarely small shrubs. The leaves are undivided. They are exstipulate, more or less succulent. The flowers are regular. They form usually cymes, less often spikes or racemes. They can be solitary in leaf-axils. The number of free or united sepals is four to circa twenty. Such number of elements has petals. The stamens are hypogynous or epipetalous.

The number of stamens is the same as petals or more frequently twice as many. The carpels are superior. They have equal number to the petals. They can be free or slightly connate at the base and develop into follicles. The scale-like nectaries are located between the stamens and the carpels. The species of the family, which are located in Ukraine, are mainly the medicine and ornamental ones. In pine and mixed forests it is located the members of the genera *Sempervivum* and *Sedum*. As house plants it is planted *Kalanchoe daigremontiana* and *K. blossfeldiana*, which are medicinal ones. *Sempervivum ruthenicum* is an indicator of poor pine forests. *S. tectorum* is planted as an ornamental and soil-protective species.

Some succulent Crassulaceae are frost-hardy and suitable for use as garden plants and in horticultural displays. A common feature of the *Crassulaceae* is the biochemical adaptation to arid conditions: Crassulacean Acid Metabolism (CAM). Because organic acids are used for temporary sequestration of carbon dioxide, CAM plants often taste bitter. Some Crassulaceae are poisonous, especially in the genera *Cotyledon*, *Kalanchoe* and *Tylecodon* which members contain cardiotoxic and cumulatively neurotoxic Cotyledoside, and should not be consumed or fed to animals. These plants are unpopular with South African farmers as they cause a wasting disease Krimpsiekte or death of livestock (Fig. 7.3, 7.4).

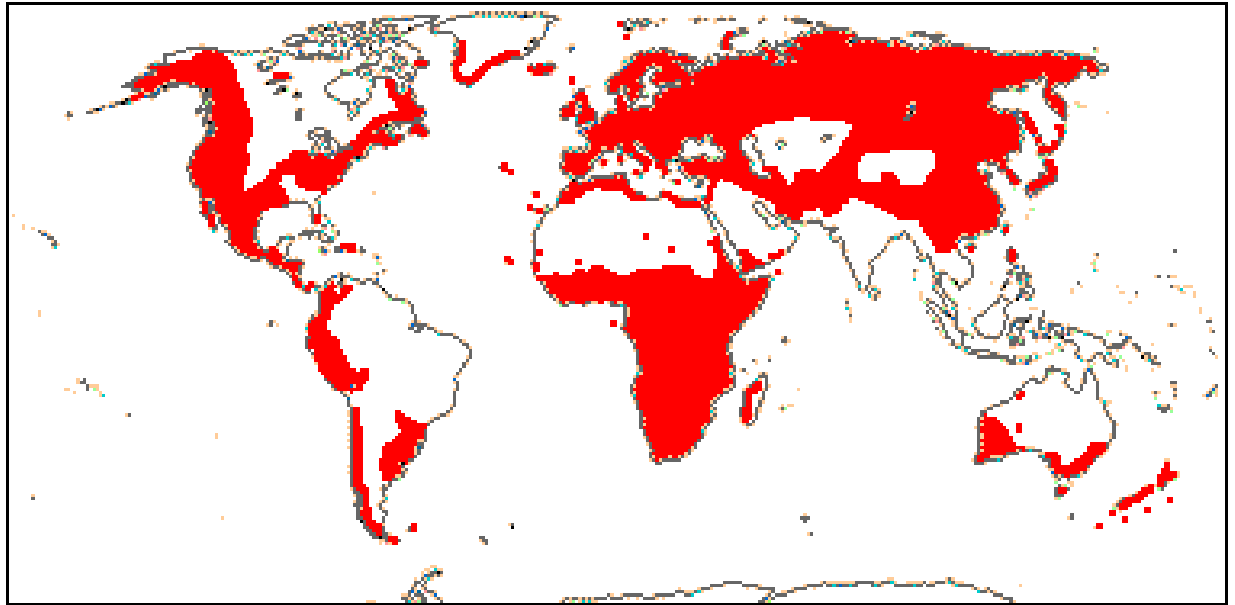


Fig. 7.3. The distribution of the species of the family Crassulaceae [Stevens, 2001]



Fig. 7.4. *Sempervivum ruthenicum* Schnittsp. & C.B. Lehm. – Houseleek, hen-and-chickens, old man and woman, roof house leek [Drapaliuk, 2025]

FAMILY 11 GROSSULARIACEAE DC.

Common name: Gooseberry family.

Synonyms: Ribesiaceae Marquis.

Taxonomical composition: 1 genus and 194 species.

Features and representatives

The species of the family Grossulariaceae occur worldwide. Most of the genera, with the notable exception of *Ribes*, occur chiefly or entirely in the Southern Hemisphere. In Ukraine there are two genera and nine species.

The Grossulariaceae family consists of currants and gooseberries in our area. They are substantial, woody shrubs, with or without prickles, from the genus *Ribes*. They have alternate and usually palmately (hand-like) lobed leaves. The flowers are in clusters of few to several at the ends of the branches. Within each flower, the sepals are generally showier than the petals. The five sepals are usually fused to the ovary and extend beyond it to form a tubular or saucer-shaped free hypanthium to which the five petals are attached.

The flowers have usually five stamens, alternate with the petals and with them inserted near, or at, the top of the hypanthium. The two styles vary from separate to completely fused. The fruits are several-seeded berries, all of which are edible, however in some species they are not very tasty. The main role plays the genus *Ribes* and one of its species *R. nigrum*, which may be found on the moist places along the river banks, in the forests. It is also widely used *R. aureum*, *R. rubrum*, *Ribes uva-crispa* in agriculture (Fig. 7.5–7.7).

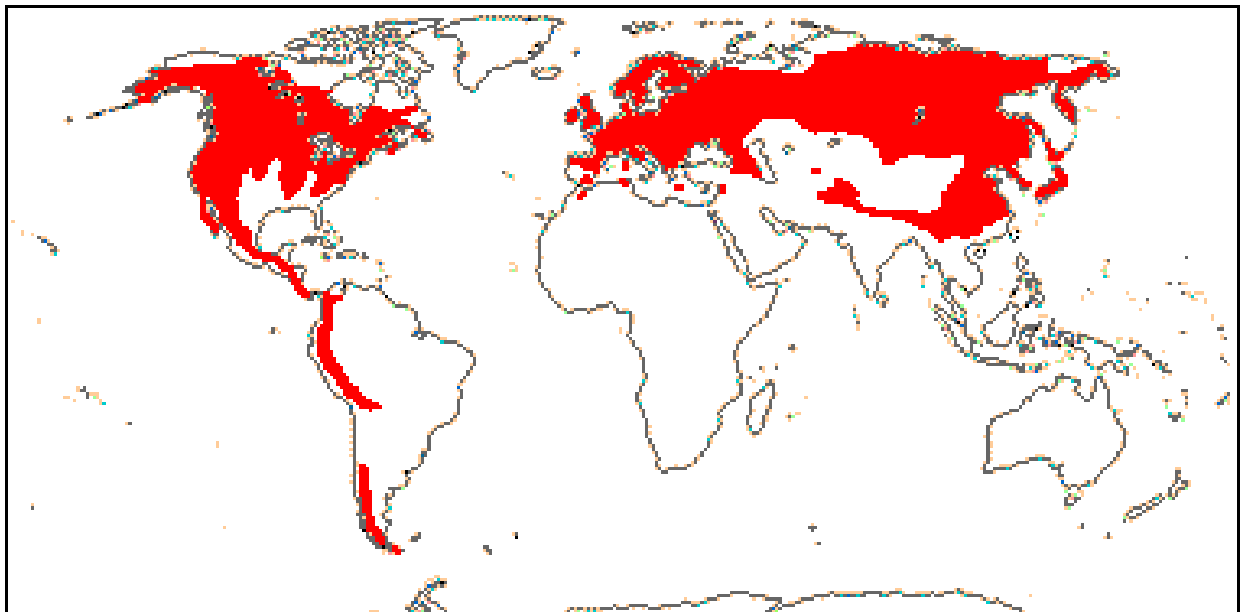


Fig. 7.5. The distribution of the species of the family Grossulariaceae [Stevens, 2001]



Fig. 7.6. *Ribes nigrum* L. – Black currant or European black currant [Hayne, 1813]

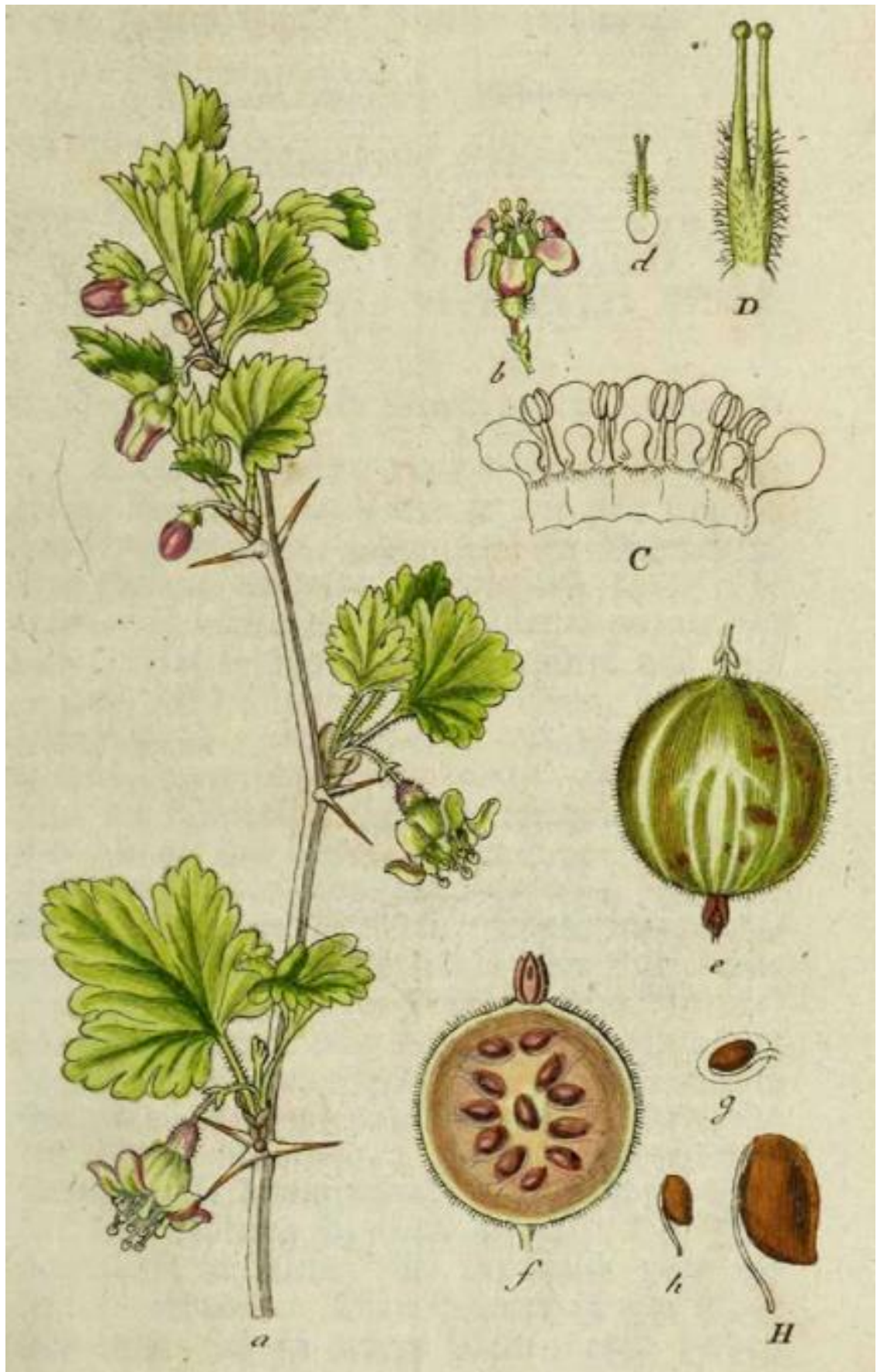


Fig. 7.7. *Ribes uva-crispa* L. – Gooseberry [Sturm, 1796]

Questions for self-control

SUPERROSIDS

1. What is the common name of the family Altingiaceae?
2. How many and what families has the order Saxifragales?
3. How many genera and species are there in the family Crassulaceae?
4. How many petals has the flower of the species of the family Grossulariaceae?
5. How many sepals has the flower of the species of the family Crassulaceae?
6. How many stamens has the flower of the species of the family Grossulariaceae?
7. What is the common name of the family Crassulaceae?
8. In what regions of the Earth occurs the species of the family Altingiaceae?
9. What is the common name of the family Grossulariaceae?
10. In what regions of the Earth occurs *Ribes uva-crispa*?
11. What is the common name of *Sempervivum ruthenicum*?
12. What is the common name of *Chelidonium majus*?

LIST OF LATIN NAMES OF DESCRIBED SPECIES AND SUBSPECIES

<i>Anacamptis coriophora</i>	Orchidaceae	Asparagales	47, 83
<i>Berberis vulgaris</i>	Berberidaceae	Ranunculales	66, 120, 122
<i>Carex rostrata</i>	Cyperaceae	Poales	53, 98, 99
<i>Carex vulpina</i>	Cyperaceae	Poales	53, 100
<i>Cephalanthera damasonium</i>	Orchidaceae	Asparagales	42, 84
<i>Ceratophyllum demersum</i>	Ceratophyllaceae	Ceratophyllales	65, 116, 118
<i>Ceratophyllum submersum</i>	Ceratophyllaceae	Ceratophyllales	65, 116, 119
<i>Chelidonium majus</i>	Papaveraceae	Ranunculales	68, 123, 125
<i>Corallorhiza trifida</i>	Orchidaceae	Asparagales	40, 85
<i>Cypripedium calceolus</i>	Orchidaceae	Asparagales	39, 81, 86
<i>Dactylorhiza majalis</i> subsp. <i>cordigera</i> (<i>Dactylorhiza cordigera</i>)	Orchidaceae	Asparagales	48, 90
<i>Dactylorhiza incarnata</i>	Orchidaceae	Asparagales	47, 87
<i>Dactylorhiza maculata</i>	Orchidaceae	Asparagales	48, 81, 88
<i>Dactylorhiza majalis</i>	Orchidaceae	Asparagales	48, 89
<i>Dactylorhiza viridis</i>	Orchidaceae	Asparagales	49, 91
<i>Epipactis palustris</i>	Orchidaceae	Asparagales	42, 92
<i>Epipactis purpurata</i>	Orchidaceae	Asparagales	42, 93
<i>Epipogium aphyllum</i>	Orchidaceae	Asparagales	43, 94
<i>Ficaria verna</i>	Ranunculaceae	Ranunculales	72, 128, 130
<i>Goodyera repens</i>	Orchidaceae	Asparagales	45, 95
<i>Gymnadenia conopsea</i>	Orchidaceae	Asparagales	49, 96
<i>Juncus compressus</i>	Juncaceae	Poales	54, 103
<i>Lamprocapnos spectabilis</i>	Papaveraceae	Ranunculales	67, 126
<i>Liquidambar styraciflua</i>	Altingiaceae	Saxifragales	73, 135, 137
<i>Luzula pilosa</i>	Juncaceae	Poales	54, 104
<i>Papaver rhoeas</i>	Papaveraceae	Ranunculales	69, 127
<i>Platanus occidentalis</i>	Platanaceae	Proteales	73, 132, 133
<i>Ranunculus repens</i>	Ranunculaceae	Ranunculales	72, 128, 131

<i>Ribes nigrum</i>	Grossulariaceae	Saxifragales	77, 142
<i>Ribes uva-crispa</i>	Grossulariaceae	Saxifragales	76, 141, 143, 144
<i>Secale cereale</i>	Poaceae	Poales	60, 106
<i>Sempervivum ruthenicum</i>	Crassulaceae	Saxifragales	75, 138
<i>Sparganium emersum</i>	Typhaceae	Poales	64, 113
<i>Typha angustifolia</i>	Typhaceae	Poales	64, 114

DISTRIBUTION, ECONOMIC USES AND CONSERVATION STATUS OF DESCRIBED SPECIES AND SUBSPECIES

№	Species	Distribution: World/Ukraine	Economic uses	1. RDBU, 2021; 2. The IUCN Red List of Threatened Species, 2016	Page
1	2	3	4	5	6
ANGIOSPERMS					
Monocots clade /Asparagales Link/ Orchidaceae Juss.					
1	<i>Anacamptis coriophora</i>	Southern and Central Europe, Crimea, Caucasus, Iran, Asia Minor, Syria, Palestine, Algeria / Carpathians, Roztochchia-Opillya, Polissia, Forest Steppe, Steppe (rarely)	Dyeing, medicinal	1. Vulnerable 2. Europe: LC	47, 83
2	<i>Cephalanthera damasonium</i>	Asia-Temperate, Europe / Transcarpathia, Carpathians, Roztochchia-Opillya, Forest Steppe (Right Bank is relatively common, mainly in the western part; Left Bank is very rare), Mountain and Southern Crimea (usually)	Ornamental	1. Rare 2. Europe: LC	42, 84

3	<i>Corallorhiza trifida</i>	Northern Europe and the mountains of Central Europe to the Pyrenees, Switzerland, Northern Italy, Croatia, Transylvania, Eastern Europe, the Crimea, the Caucasus, Transcaucasia, all of Northern Asia to the Sea of Okhotsk, Japan, North America, Western Greenland, Iceland / Carpathians, Roztochchia-Opillya, Polissia, Forest Steppe (on the Right Bank), Mountainous Crimea – rarely	Medicinal	1. Rare 2. Europe: LC	40, 85
4	<i>Cypripedium calceolus</i>	Asia-Temperate, Europe / Transcarpathia, Prykarpattia, Roztochchya-Opillya, Western Polissia, Forest Steppe, Mountain and Southern Crimea (very rare)	Ornamental	1. Vulnerable 2. Global: LC, Europe: NT	39, 81, 86
5	<i>Dactylorhiza cordigera</i>	Alps, Carpathians, Hungary, Balkan Peninsula, Norway / Carpathians (rare)	Ornamental	1. Vulnerable	48, 90
6	<i>Dactylorhiza incarnata</i>	Europe, the Balkans, Asia Minor and Central Asia. Caucasus, Western Siberia, Dzungaria, Mongolia /	Medicinal, ornamental	1. Vulnerable 2. Europe: LC	47, 87

		Carpathians, forest zone, forest-steppe, steppe (rarely), mountainous Crimea			
7	<i>Dactylorhiza maculata</i>	Europe, Asia / Carpathians, forest and forest-steppe zones	Medicinal, ornamental	1. Vulnerable 2. Europe: LC	48, 81, 88
8	<i>Dactylorhiza majalis</i>	Scandinavia, Atlantic and Central Europe, Mediterranean / Carpathians, Subcarpathians, forest and steppe (very rare) zones, Southern macroslope of Mountainous Crimea	Medicinal, ornamental	1. Rare 2. Europe: LC	48, 89
9	<i>Dactylorhiza viridis</i>	Temperate belt of Eurasia and North America / Carpathians (from the lowlands to the subalpine belt), Opillia, Roztochchia, Mountain Crimea	Medicinal	1. Rare 2. Europe: LC	49, 91
10	<i>Epipactis palustris</i>	Eurasian-Mediterranean species / Polissia, Carpathians, Roztochchia, Opillia, Forest Steppe, Steppe (along the valleys of large rivers), Mountainous Crimea	Ornamental	1. Vulnerable 2. Global & Europe: LC	42, 92
11	<i>Epipactis purpurata</i>	Central Europe / Carpathians, Prykarpattia, Roztochchia, Podillia	Ornamental	1. Rare 2. Global & Europe: LC	42, 93
12	<i>Epipogium aphyllum</i>	Scandinavia, Atlantic, Central	Ornamental	1. Endangered	43, 94

		and Eastern Europe, Mediterranean, Caucasus, Asia Minor, Western and Eastern Siberia, Far East, Japan, China / Carpathians, Bukovyna Prykarpattia, Prut-Dniester interfluve, Northern Podillia, Middle Dnieper, Mountainous Crimea			
13	<i>Goodyera repens</i>	Eurasia from Fennoscandia to the southern part of the Far East, Sakhalin and Hokkaido, individual fragments are known in the Alps, the Balkans, the Carpathians, the Crimea, Asia and Western China, in the Himalayas, Korea, Central Japan and North America / Carpathians, Roztochchia, Polissia, Podillia (north-eastern part), Mountain Crimea	Ornamental	1. Vulnerable	45, 95
14	<i>Gymnadenia conopsea</i>	Europe, Caucasus, Siberia, Far East, Asia Minor, Iran, Mongolia, China, Japan / Carpathians, Polissia, Roztochchia, Opillia, Forest Steppe, Mountain Crimea	Medicinal, ornamental	1. Vulnerable 2. Europe: LC	49, 96

Poales/Cyperaceae					
15	<i>Carex rostrata</i>	Northern and Central Europe to Spain, Northern Italy, Albania and Bulgaria, Eastern Europe, Caucasus, Asia Minor, Kazakhstan, Northern Mongolia, almost all of Siberia (except Yakutia and the Far East, North America / Polissia (usually), Forest Steppe (occasionally), The northern part of the Left Bank Steppe (very rare)	Environmental	2. Global & Europe: LC	53, 98, 99
16	<i>Carex vulpina</i>	Native to Africa, Asia-Temperate, Europe / All over Ukraine (usually), in the southern regions of the Steppe and Crimea (rarely), wet meadows, sedge eutrophic swamps, banks of reservoirs, roadside ditches	Vertebrate poisons	2. Global: LC	53, 100
Juncaceae					
17	<i>Juncus compressus</i>	Asia-Temperate, Europe / All over Ukraine	Weed	2. Global, Mediterranean: LC	54, 103
18	<i>Luzula pilosa</i>	Asia-Temperate, Europe / In forest areas – usually, in the			54, 104

		northern part of the Forest Steppe			
Poaceae					
19	<i>Secale cereale</i>	Asia-Temperate, Asia-Tropical, Europe / All over Ukraine, but more often in Polissia and Forest Steppe	Medicinal, vertebrate poisons	2. Europe: NA	60, 106
Typhaceae					
20	<i>Sparganium emersum</i>	Asia-Temperate, Asia-Tropical, Eurasia, Europe, Northern America / Prykarpattia, Polissia, Forest Steppe (usually), the northern part of the Steppe (rarely)	Medicinal	2. Global, Europe: LC	64, 113
21	<i>Typha angustifolia</i>	Africa, Asia-Temperate, Europe, Northern America / all over Ukraine (usually)	Food, fodder, ornamental	2. Global, Europe, Mediterranean: LC	64, 114
PROBABLE SISTER OF EUDICOTS/Ceratophyllales/Ceratophyllaceae					
22	<i>Ceratophyllum demersum</i>	Africa, Asia-Temperate, Asia-Tropical, Australasia, Europe, Northern America, Southern America / Throughout Ukraine, Crimea (surroundings of Simferopol), in stagnant and slow-flowing waters (usually)	Ornamental, seed contaminant	2. Global, Europe: LC	65, 116, 118

23	<i>Ceratophyllum submersum</i>	All of Europe (except the Arctic), the Caucasus, Western Siberia, Central Asia / Almost throughout the territory of Ukraine (occasionally), Crimea (only in the mountains)	In aquariums for decreasing nitrogen, medicinal	2. Global, Mediterranean: LC	65, 116, 119
EUDICOTS/Ranunculales/Berberidaceae					
24	<i>Berberis vulgaris</i>	Asia-Temperate, Europe / Throughout Ukraine (of course), Crimea (in the mountains and on the Tarkhankut Peninsula)	Dye, food, medicinal, wooden	2. Europe: LC	66, 120, 122
Papaveraceae					
25	<i>Chelidonium majus</i>	Africa, Asia-Temperate, Europe / All over Ukraine	Medicinal, poisonous, vitamin, weed (euapophyte)	2. Europe: LC	68, 123, 125
26	<i>Lamprocapnos spectabilis</i>	Asia-Temperate / Absent in Ukraine	Ornamental, vertebrate poisons		67, 126
27	<i>Papaver rhoeas</i>	Africa, Asia-Temperate, Asia-Tropical, Europe / All over Ukraine, disappears in the East	Medicinal, ornamental	2. Europe: LC	69, 127
Ranunculaceae					
28	<i>Ficaria verna</i>	Africa, Asia-Temperate, Europe / Carpathians, Polissia, Forest Steppe	Euapophyte (Ukraine), ornamental		72, 128, 130
29	<i>Ranunculus repens</i>	Africa, Asia-Temperate, Europe	Euapophyte (Ukraine),	2. Europe,	72, 128, 131

		/ All over Ukraine (usually)	medicinal, ornamental, seed contaminant, vertebrate poisons	Mediterranean: LC	
Proteales/Platanaceae					
30	<i>Platanus occidentalis</i>	Northern America / Ukraine: in gardens and parks	Ornamental	2. Global: LC	73, 132, 133
SUPERROSIDS/Saxifragales/Altingiaceae					
31	<i>Liquidambar styraciflua</i>	Northern America, Southern America / Ukraine: cultivated	Essential oils, flavor fixative, gum/resin, ornamental, shade/shelter, wood	2. Global: LC	73, 135, 137
Crassulaceae					
32	<i>Sempervivum ruthenicum</i>	Europe / Polissya (occasionally), Forest-steppe, northern part of the Steppe (quite often)	Medicinal, ornamental		75, 138
Grossulariaceae					
33	<i>Ribes nigrum</i>	Asia-Temperate, Europe / Carpathians, Prykarpattia, Polyssia, Forest Steppe	Essential oils, food, medicinal	2. Europe: LC	77, 142
34	<i>Ribes uva-crispa</i>	Africa, Asia-Temperate, Europe / Carpathians, Prykarpattia, Polyssia, the northern part of the Forest Steppe	Food, medicinal		76, 141, 143, 144

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ТЕРТИШНИЙ АНАТОЛІЙ ПЕТРОВИЧ

Botany

Current system of flowering plants

Part III

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