Systematic Botany: BIOL 448
Study guide

Alexey Shipunov

Lectures

Contents

Outline

1 Course in general

1.1 Description

Course

- Strictly practical, field-oriented class
- Based on herbarium collection
- Involves determination of families, genera and species most common in North Dakota

Instructor

- Dr. Alexey Shipunov
- Office: Moore 229
- Office Hours: Mondays, Wednesdays and Fridays, 11 am to 12 am
- Phone: 858-3116
- E-mail: alexey.shipunov@minotstateu.edu

Lectures (seminars) : Mondays, Wednesdays and Fridays, 1:00 p.m. to 1:50 p.m., Moore 213. From the middle of October, these hours will be shifted to the "lab" time (Tuesdays). In addition, Monday seminar hours will be mostly used on Fridays in the second half of semester; therefore, most of the time we will not meet on Monday.

Plant determination mostly, from time to tome I will give a theoretical lecture and present identification keys. All determined plants must be signed with me.

Laboratories : Tuesdays from 1:00 p.m as a field trip involving transportation within and/or out of town (approximately 6 hours every week from August to the beginning of October), 6 trips in total. Each trip is counted as double lab.

Apart from the field trip, there will be **a weekday duty** of collection management. On Sundays, I will be on duty myself.

1.2 Tools

Web site

http://ashipunov.info/shipunov/school/biol_448/

North Dakota plant checklist

http://ashipunov.info/shipunov/fnddb2/

References

- Van Bruggen, Th. 1996. **The vascular plants of South Dakota**. 3rd ed. University of South Dakota, Vermillion, SD.
- Larson, G.E. 1993. **Aquatic and wetland vascular plants of Northern Great Plains**. USDA Forest Service, Fort Collins, CO. http://www.fs.fed.us/rm/pubs_rm/rm_gtr238.pdf
- **Flora of North America** [ongoing]. http://efloras.org
- **Flora of Great Plains**. 1986. Kansas State University, Lawrence, KS.
- Johnson, J.R. & Larson, G.E. 2007. **Grassland plants of South Dakota and Northern Great Plains**. South Dakota State University, Brookings, SD.
- Hickey, M. and King, C. 2000. **The Cambridge illustrated glossary of botanical terms**. Cambridge University Press, Cambridge.

1.3 Grading

Exams

- Four exams are given during the semester
- Exams will be based on plant identification and herbarium presentation
- Two failed exams mean the failed class

Labs

- This is a **laboratory course**, meaning that receiving zero points for more than one laboratory results in a failed course.
- Grading of laboratories is based on collection performance, reports and/or drawings. Field trips might be graded with a delay because you will need to finalize your herbarium first.

Absence

There are five legitimate reasons for absence on labs and exams:

1. emergency situations,
2. attested medical conditions,
3. military duty,
4. participation in MSU sports events,
5. dependent sick leave.

Absence from exams or laboratories must be announced to the instructor in advance.

Points

A total of 640 points can be earned and are distributed as follows:

Exams : 400 points

Laboratories : 240 points (20 points per singular lab, 40 points per field trip)

Grading points may vary between exams and labs.

Letter grades

- $A \geq 90\%$
- $B \geq 80\%$
- $C \geq 70\%$
- $D \geq 60\%$
- $F < 60\%$

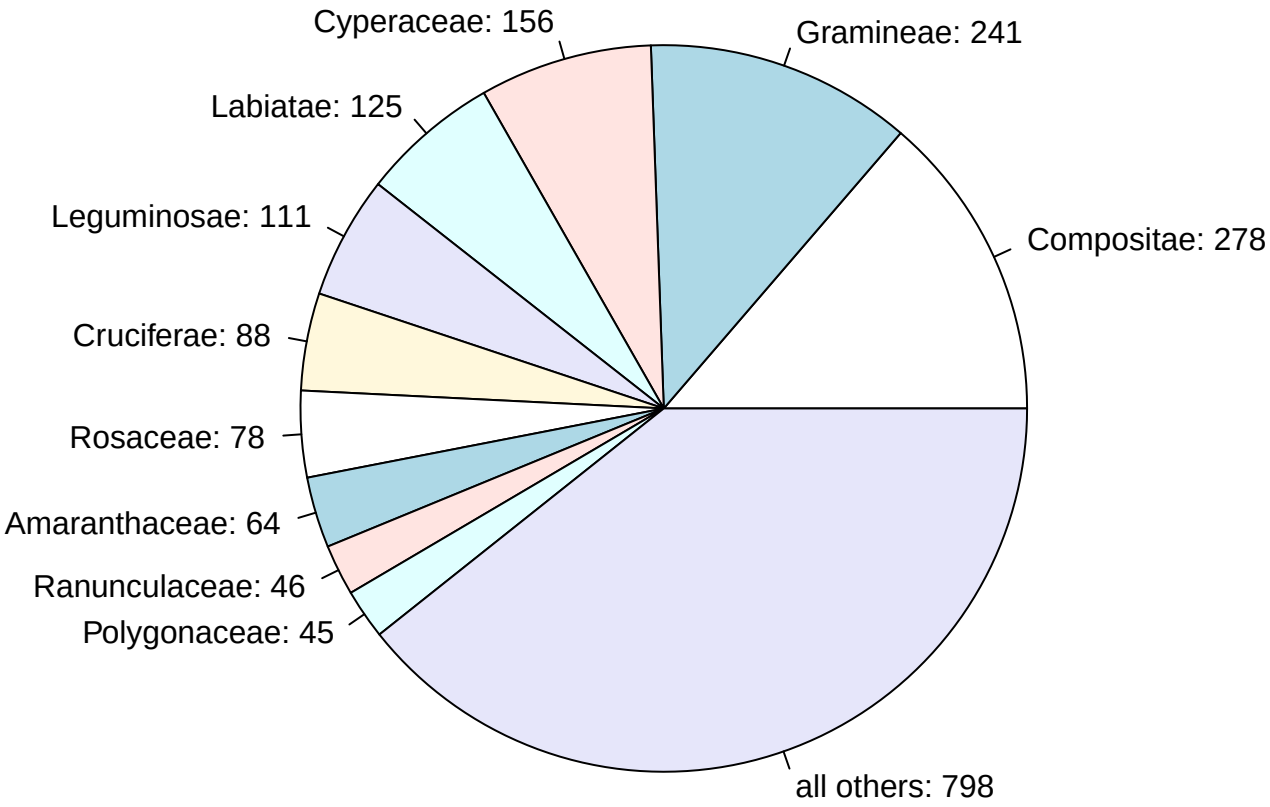
A minimum of one letter grade will be deducted from the grade for academic dishonesty / plagiarism.

1.4 Course schedule

Three piers

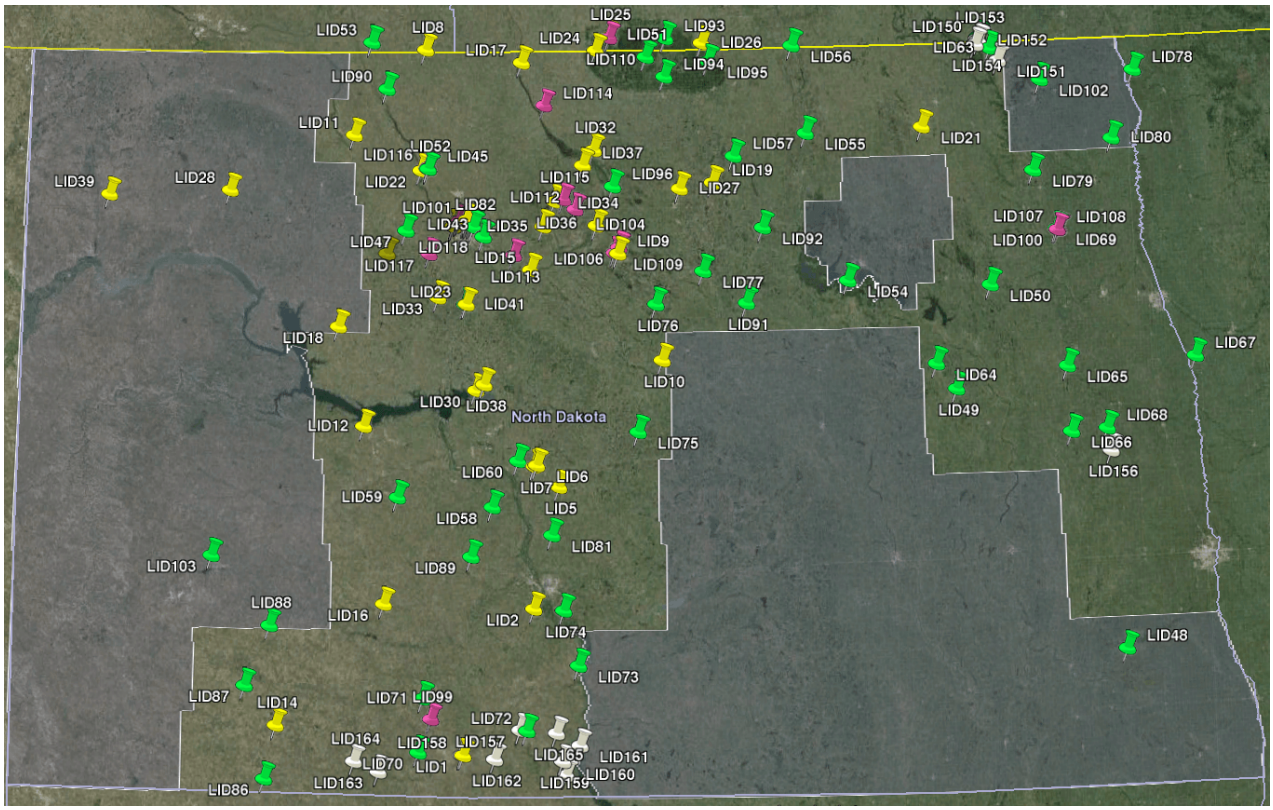
1. Determination of families
2. Determination of genera and species
3. Preparation of herbarium

Family sequence taken from frequencies

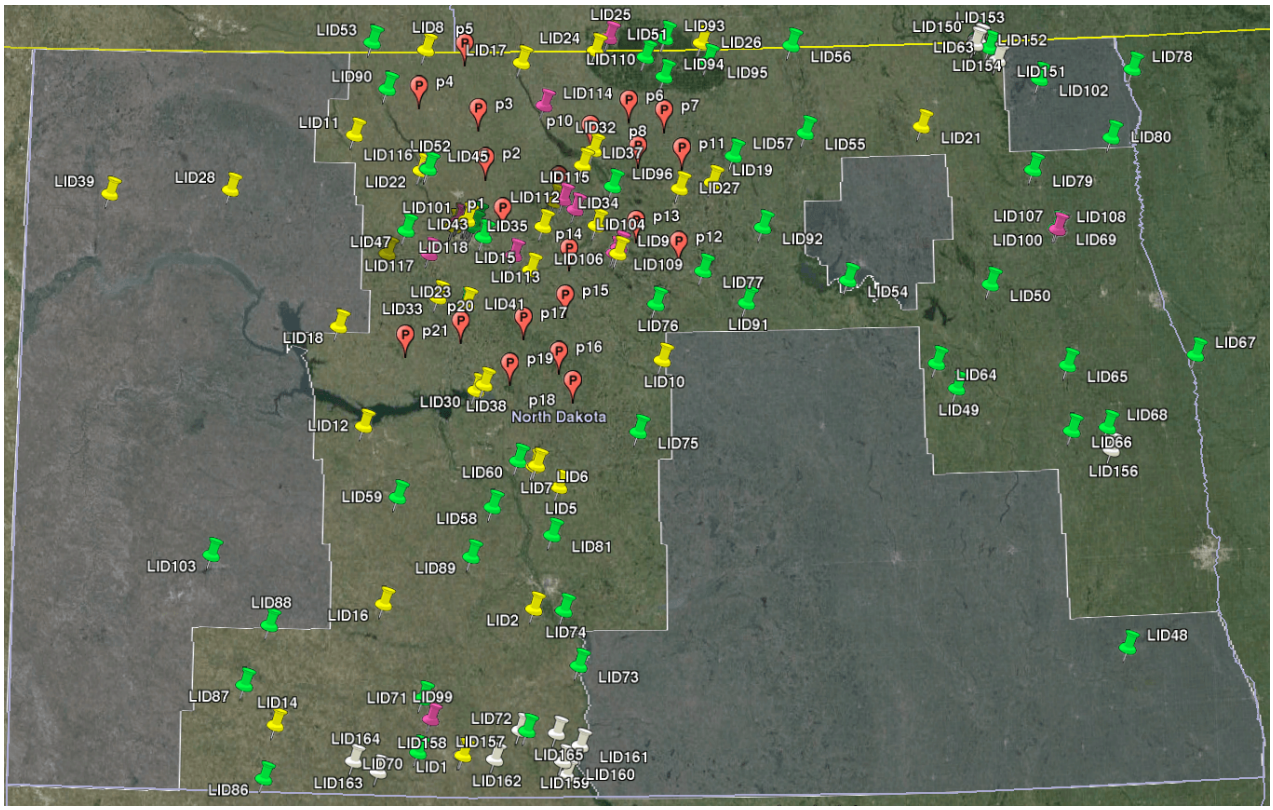


1.5 Field trips

North Dakota coverage 2011–2015



North Dakota: plans for Systematic Botany 2015–2017



2 Plants and plant families

Why do we need to know plant families

- If you know the family, you know characters of hundreds and thousand of genera and species, you may even predict them
- There are 250,000 species of flowering plants and only 350 families; knowing family will significantly reduce efforts
- In science, everything is constantly changing, but plant families are exception—they are stable for more than 300 years

History of plant families

- Famous **Carolus Linnaeus** made the classification of all organic word but he did not use "natural groups", his classification of plants was artificial
- French scientist **Michael Adanson** first in the world apply "bioinformatic" methods to the plant diversity and identify plant families
- **Antoine de Jussieu** adapted this approach to the natural gardening and make these families "alive" as garden beds in Paris.
- In 90% of cases, molecular methods confirmed Adanson's findings

Beware!

- Only Latin names are valid; as to common names, I recommend to ignore them
- Plant systematics is a science so names and concepts are changing over time
- I use recent, typically broad concepts which might be different from books you use, and you are advised to follow my understanding
- I use traditional family names so no Asteraceae but **Compositae**, no Poaceae but **Gramineae**, and so on

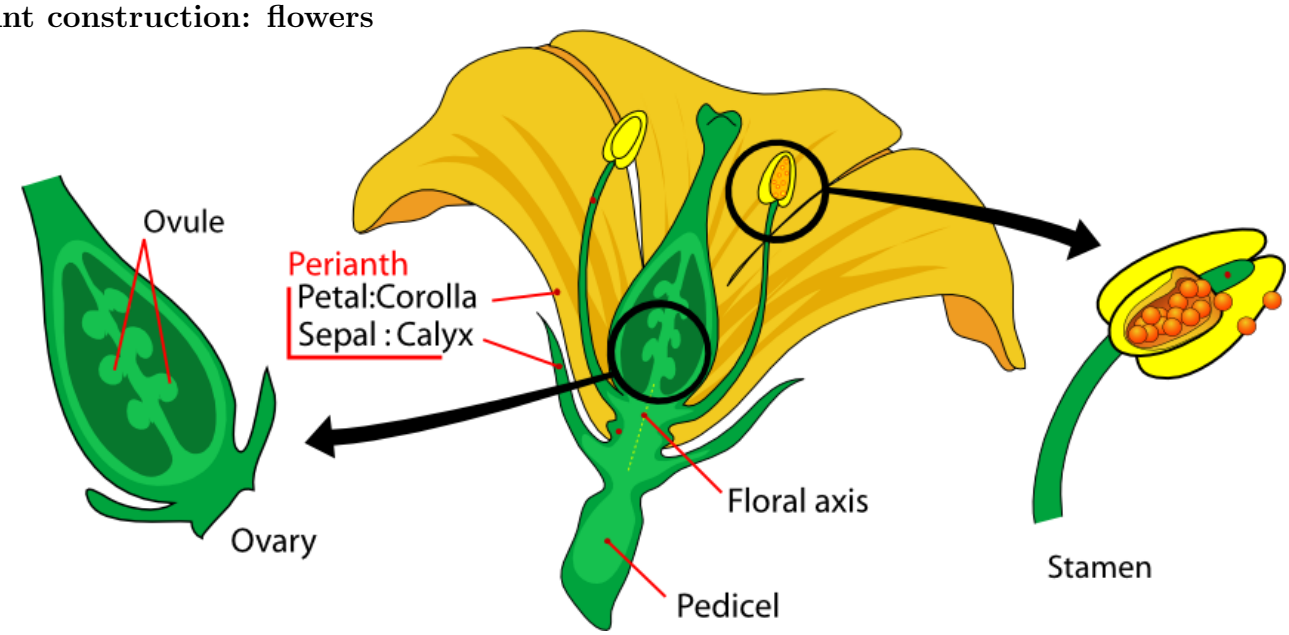
3 Important details of plant construction

3.1 Flowers and leaves

Plant construction: flowers

- Solitary or in inflorescences of multiple kinds
- Symmetry: actinomorphic (radial, star-like) and zygomorphic (bilateral, human-like, with left and right sides)
- Number, size, position, fusing of: tepals, sepals, petals, stamens, pistils and carpels
- Position of ovary: above (superior) or below (inferior) the other parts of flower

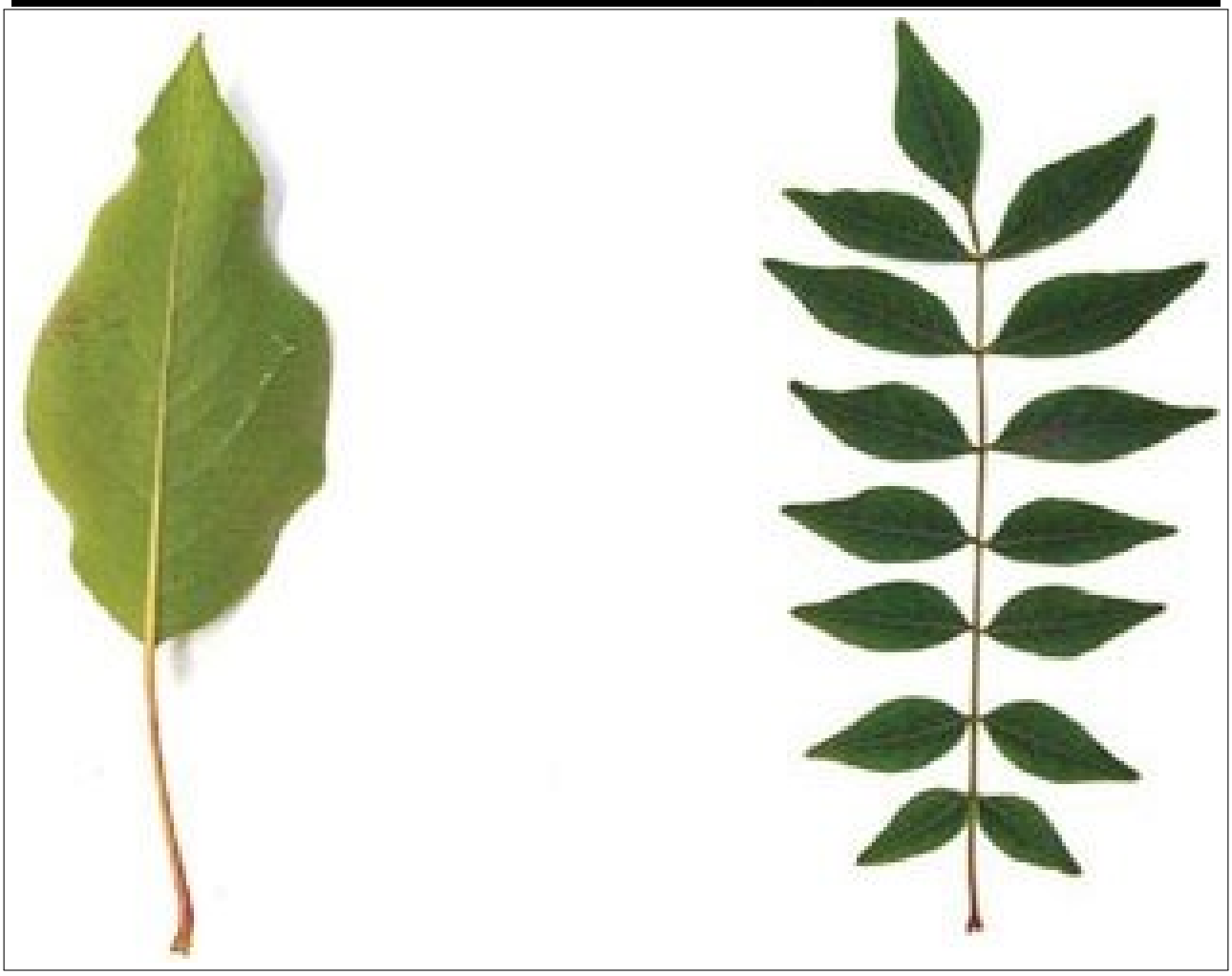
Plant construction: flowers



Plant construction: leaves

- Alternate and opposite leaves
- Simple (whole or dissected) and compound leaves

Plant construction: leaves



Class ID

Please provide a class ID: piece of paper with your name and any four digits, from 1000 to 9999 in any combination.

Summary

- Download syllabus!

  To know plant family, we should check:

- Position and structure of leaves
- Symmetry and number of flower parts

Family key

Presented as a separate resource

For Further Reading

References

[1] A. Shipunov. *Systematic Botany* [Electronic resource]. 2011—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448`

[2] A. Shipunov. Flora of North Dakota: Checklist 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

Outline

4 Compositae, Aster family

4.1 Description

General features of Compositae

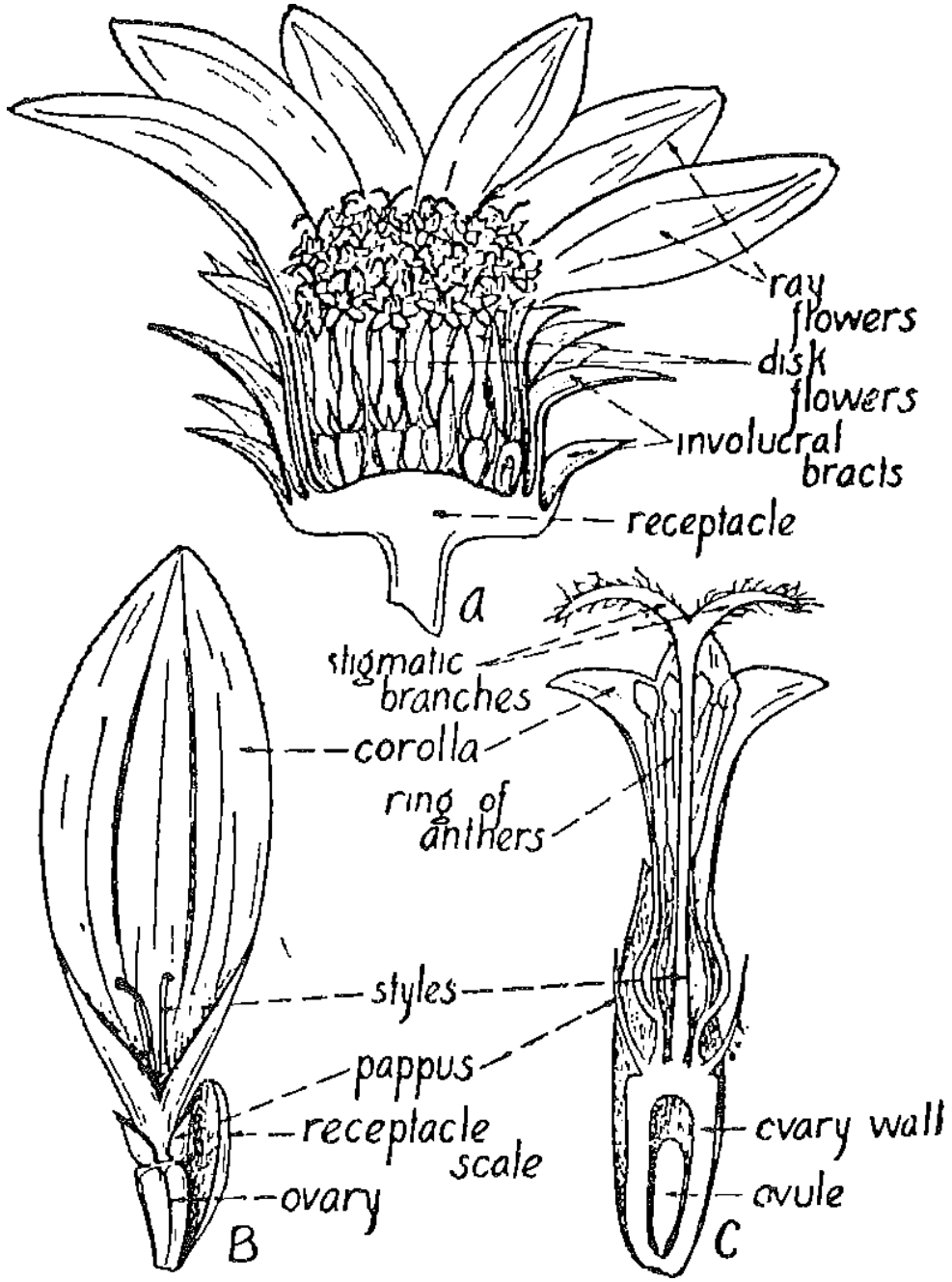
Compositae, or Asteraceae—aster family

- More than 20,000 species
- Cosmopolitan, but better represented in temperate and subtropical regions
- Prefer open spaces

Flowering head, pseudanthium

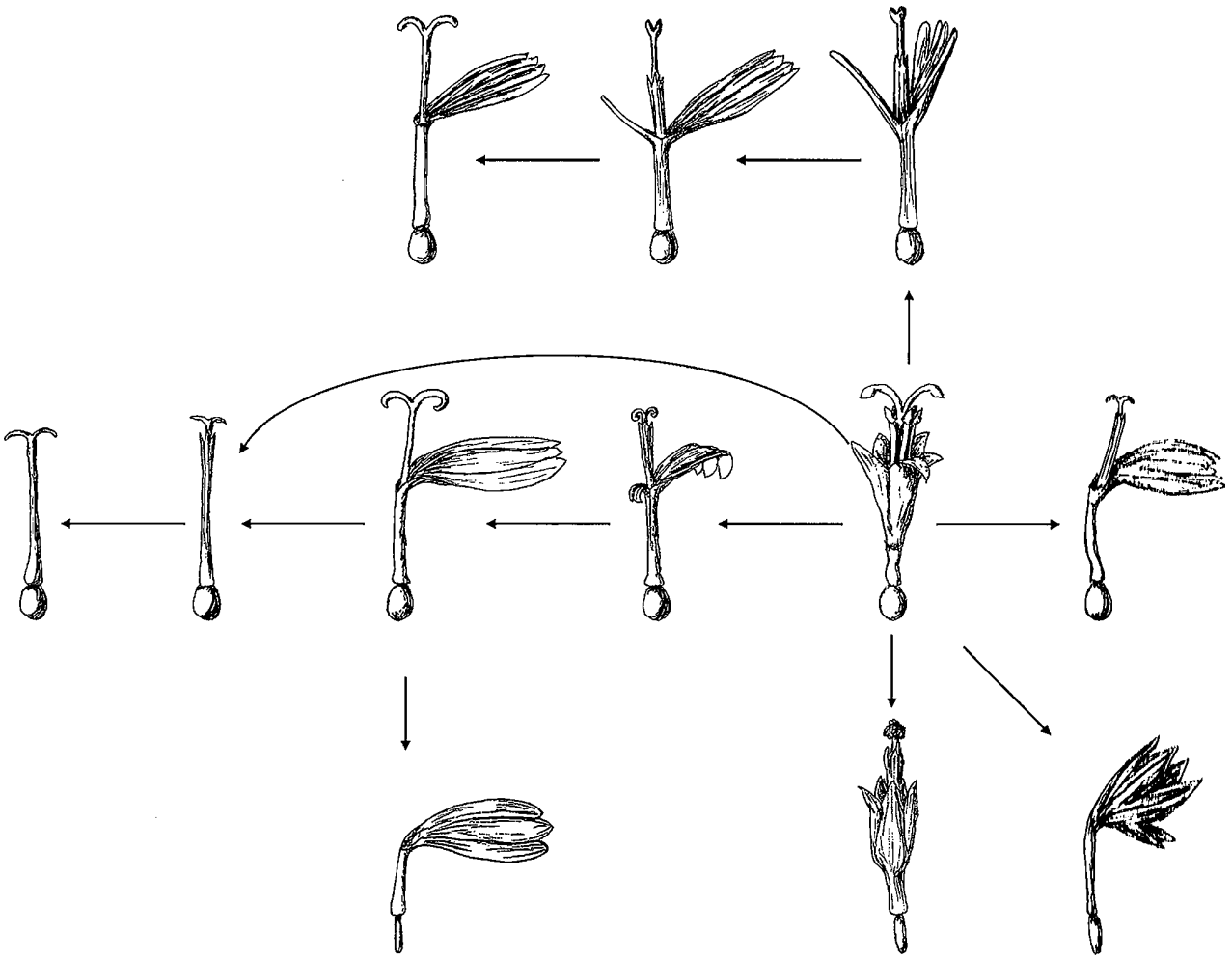
Tubular (disk) and ligulate (ray) flowers in *Matricaria* sp. (chamomile)

Sunflower (*Helianthus*) head

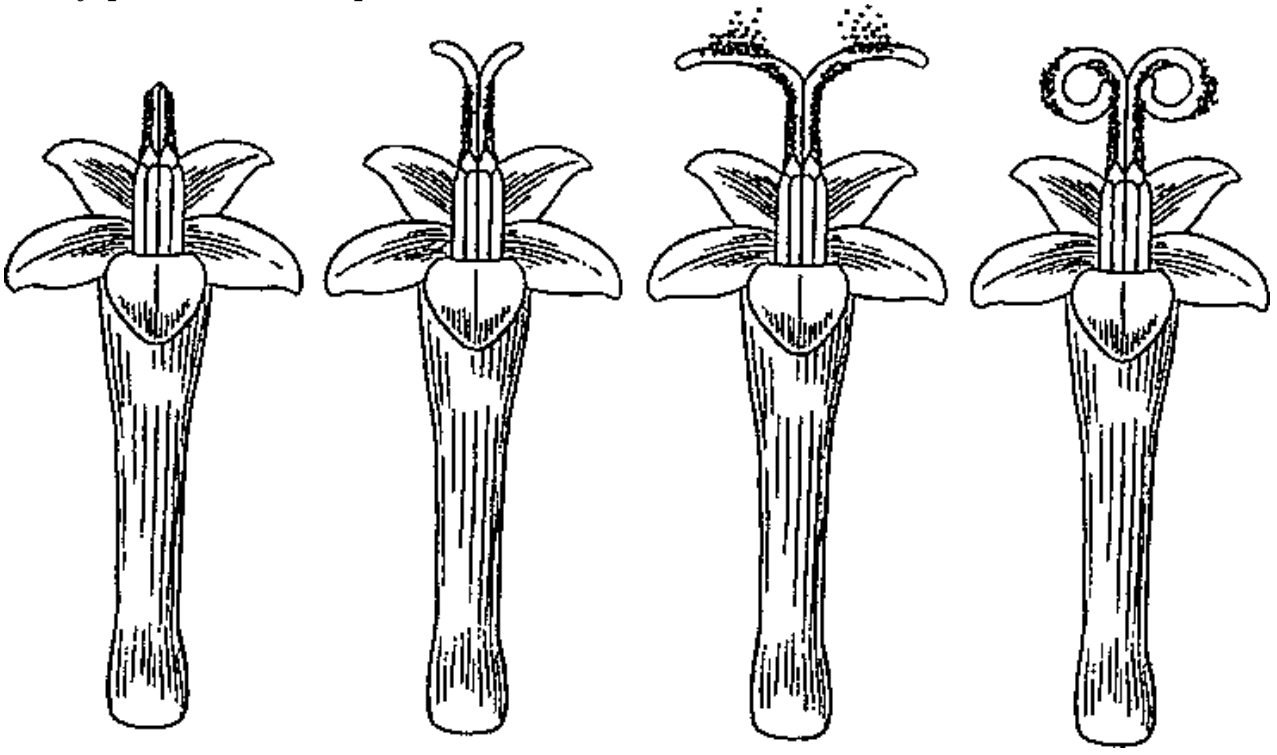


Disk vs. ray heads

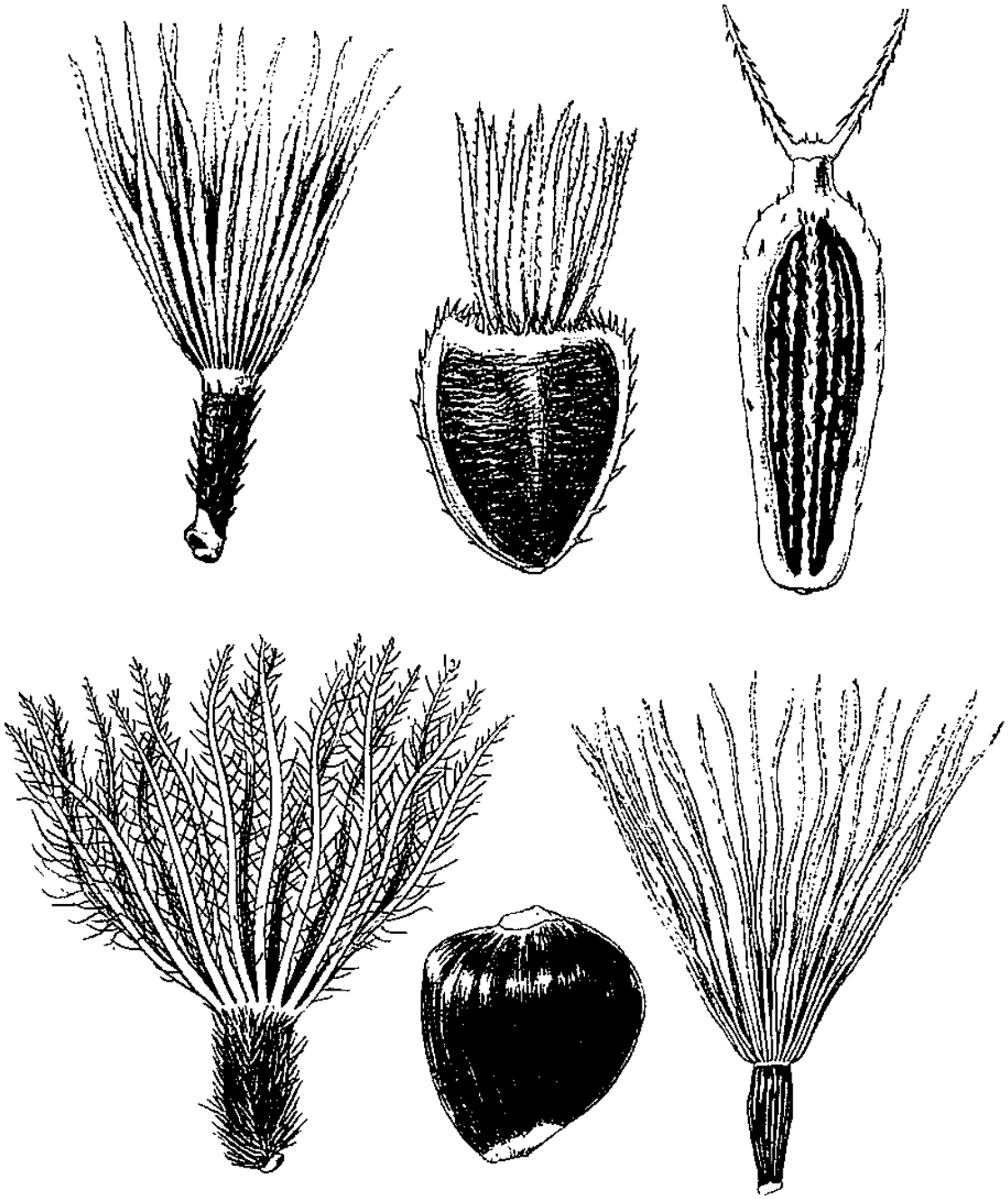
Evolution of flower types



Secondary presentation of pollen



Pappus

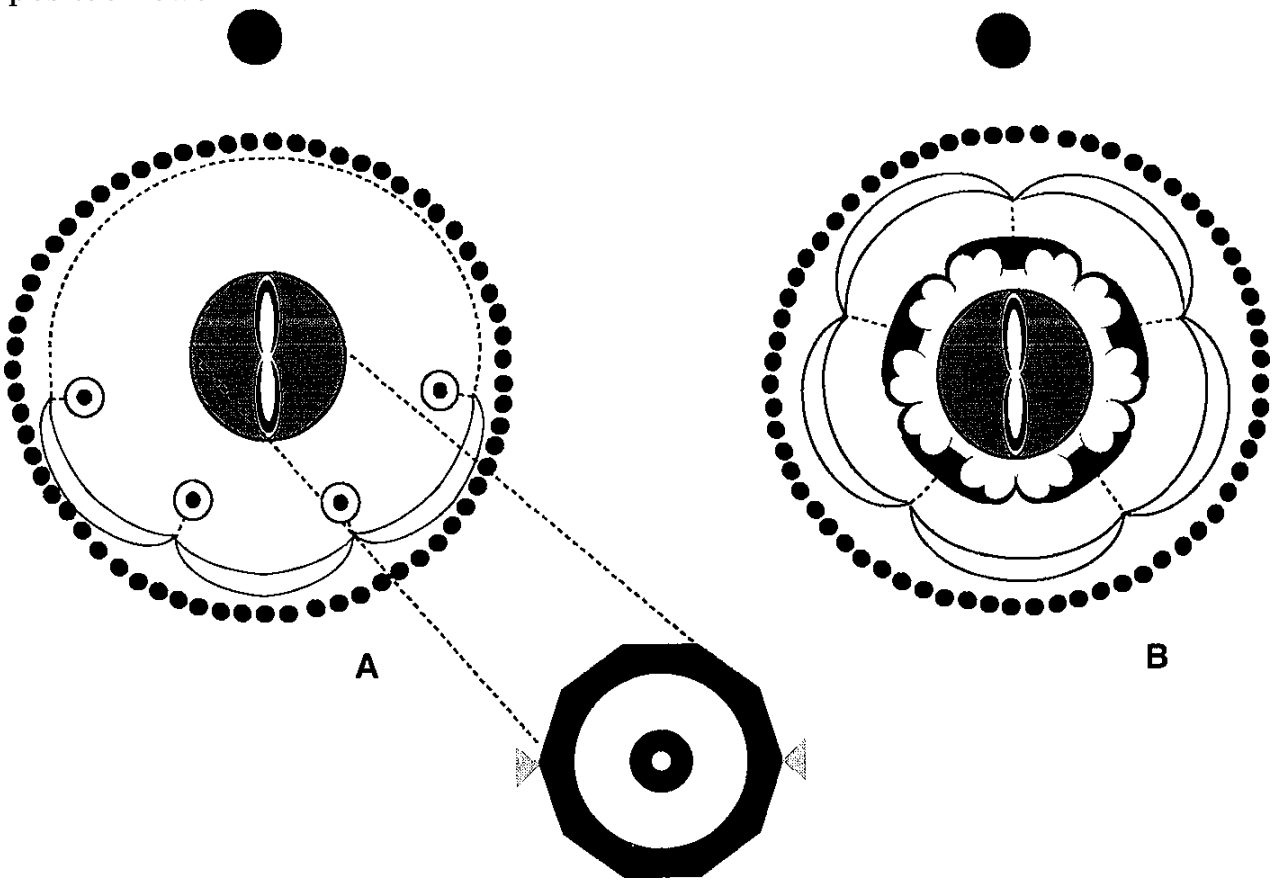


Morphology of Compositae

- Herbs, rarely woody plants; store carbohydrates as **inulin** (not starch), sometimes have resin or laticifers (subfamily Cichorioideae)
- Leaves **alternate or opposite**, without stipules, with pterodromous (net) venation
- Flowers (disk and ray) are in involucrate heads which mimic one flower
- Calyx reduced to hairs or bristles (**pappus**), petals fused in tube or ligula (with 5 or 3 teeth)
- Stamens 5, fused by anthers
- Pistil has 2 carpels, ovary **inferior**

- Fruit is **achene**, mature seed has almost no endosperm

Compositae flower



$*\mathrm{K}_{\infty}\mathrm{C}_{(5)}\mathrm{A}_{(5)}\mathrm{G}_{\overline{(2)}}$ (tubular flower) or $\uparrow\mathrm{K}_{\infty}\mathrm{C}_{(3\vee5)}\mathrm{A}_{(5)}\mathrm{G}_{\overline{(2)}}$ (ligulate flower)

4.2 Classification and representatives

Classification and representatives of Compositae

Oil plants, vegetables, ornamentals and medicinal plants distributed in 12 (!) subfamilies, most important are three subfamilies:

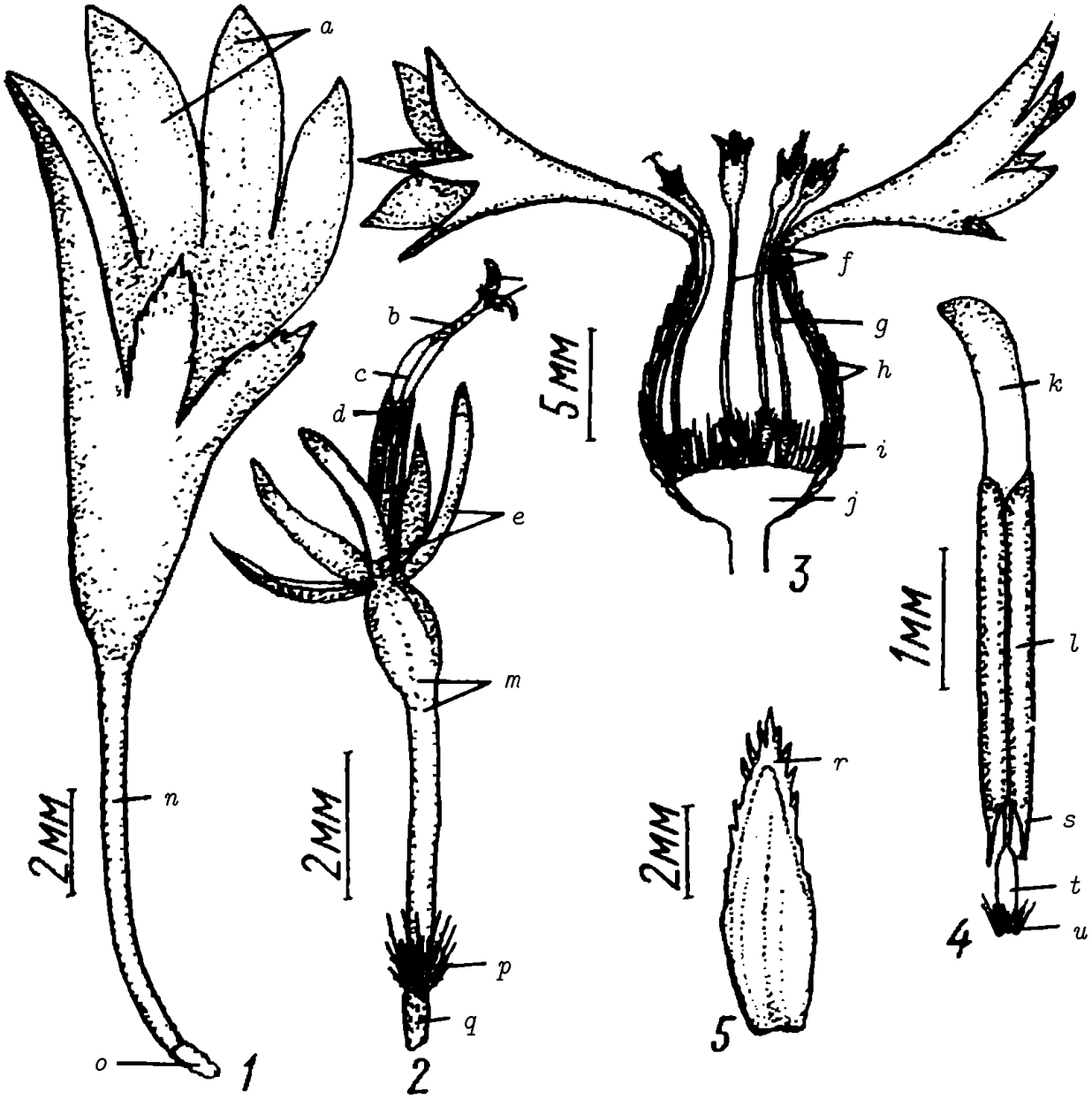
- Mutisioideae: bilabiate + ray flowers
  - *Gerbera*—gerbera, South Africa

***Gerbera* with bilabiate disk flowers**

Carduoideae

- Carduoideae: deeply lobed disk flowers; stems spiny; leaves dissected
  - *Centaurea*—knapweed
  - *Cynara*—artichoke
  - *Carthamus*–safflower
  - *Carduus*–thistle; pappus without branches
  - *Cirsium*–thistle; pappus hairs branched

Knapweed



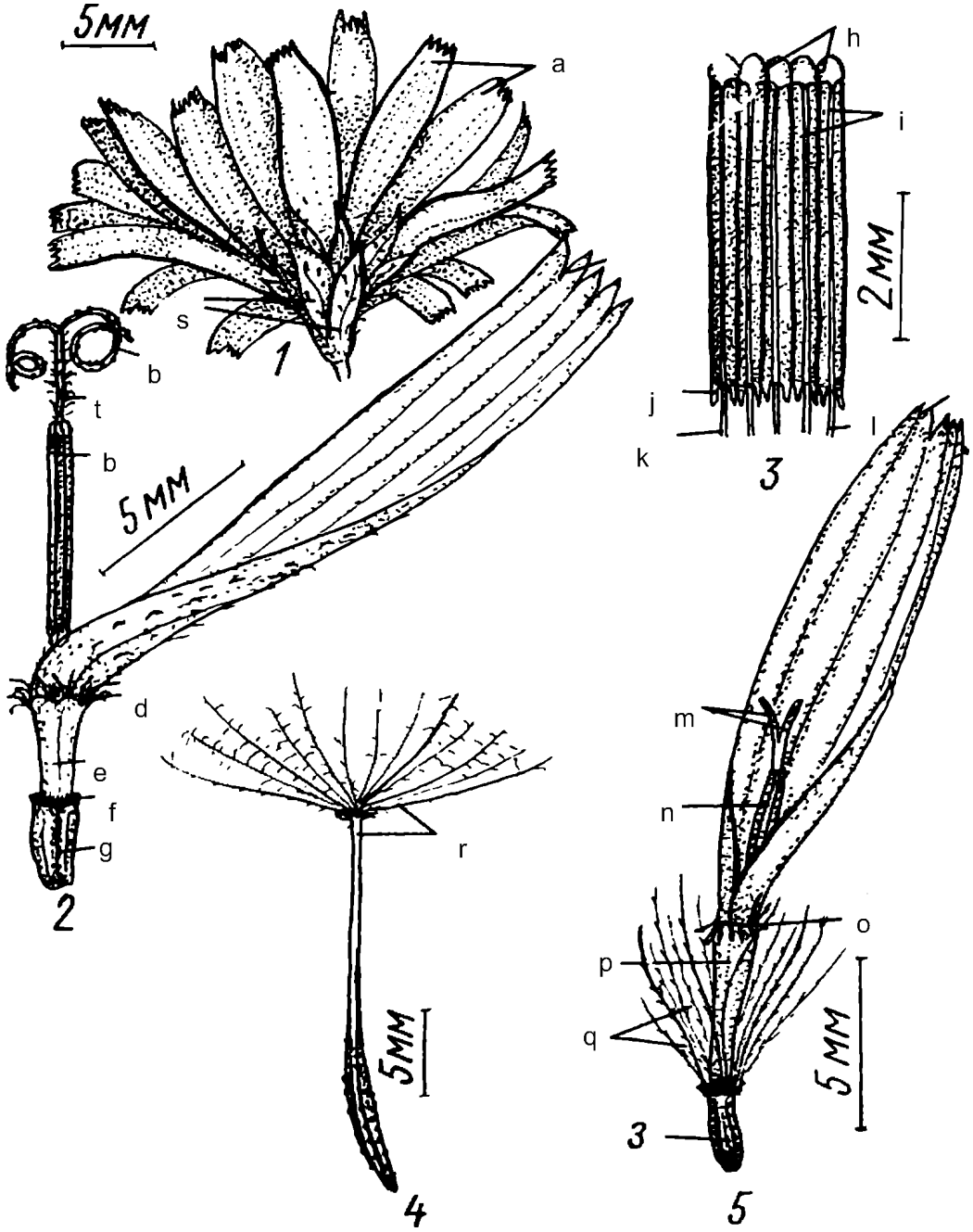
Cynara cardunculus **(artichoke)**

Carthamus tinctorius **(safflower)**

Cichorioideae

- Cichorioideae: mostly ligulate heads: 5-toothed ligulate flowers only. Have lacticifers with latex (milky sap).
  - *Taraxacum*—dandelion
  - *Lactuca*—lettuce
  - *Crepis*—hawskbeard
  - *Lygodesmia*—skeleton weed
  - *Sonchus*—sow thistle
  - *Hieracium*—hawkweed
  - *Cichorium*—chicory

Chicory



Asteroideae

- Asteroideae: tubular + 3-toothed ligulate flowers
  - Astereae: pappus consists of bristles; leaves entire
    - *Aster*—aster, divided now into *Eurybia*, *Oreostemma*, *Symphyotrichum*, etc.
    - *Erigeron*—fleabane
    - *Solidago*—goldenrod

Asteroideae

- Asteroideae

  - Anthemidae: alternate, pinnate leaves; membranaceous involucre bracts; disk + ray; pappus often absent
    * *Artemisia*—sagebrush
    * *Achillea*—yarrow
    * *Chrysanthemum*—chrysanthemum

Asteroideae

- Asteroideae
  - Eupatorieae: mostly opposite leaves; disk flowers with short lobes; pappus elements are bristles
    * *Eupatorium*—thoroughwort
    * *Liatris*—blazing star

Asteroideae

- Asteroideae
  - Heliantheae (2.5k species!): mostly opposite leaves; disk + ray flowers; pappus from scales, sometimes absent
    * *Helianthus*—sunflower
    * *Tagetes*—marigold and lots of other ornamentals
    * *Ambrosia*—ragweed
    * *Bidens*—bur-marigold
      and many, many others

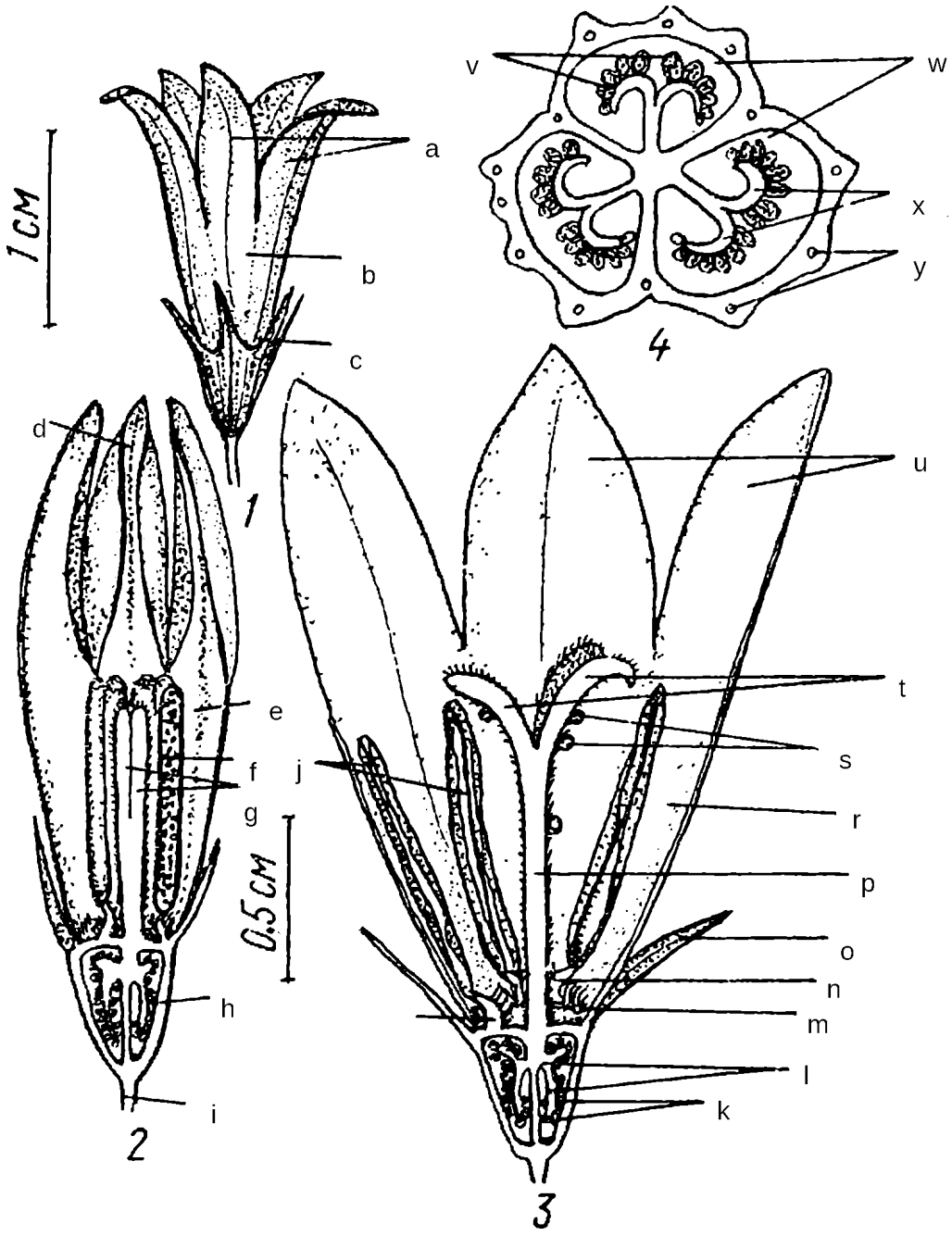
Ragweed

Tagetes patula **(marigold)**

Families close to Compositae

- Campanulaceae—bellflower family (includes Lobeliaceae)
- Differs by solitary flowers of flowers in sparse inflorescences

Bellflower



Summary

- Compositae and Campanulaceae are two close families; both have secondary pollen presentation, fused petals and inferior ovary

For Further Reading (1)

References

[1] A. Shipunov. *Systematic Botany* [Electronic resource]. 2011—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448`

[2] A. Shipunov. Flora of North Dakota: Checklist 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

[3] Minot State University Herbarium (MISU)

(continued)

For Further Reading (2)

References

[1] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.

[2] Flora Van Bruggen, Th. *The vascular plants of South Dakota*. 1996. 3rd ed. University of South Dakota, Vermillion, SD. P. 226–231.

[3] Barkley T.M., Brouillet L., Strother J.L. 187. Asteraceae Martinov. Composite Family. Flora of North America. Volumes 19, 20, 21. Mode of access: `http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=10074`

Outline

5 Gramineae or Poaceae—Grass family

5.1 Description

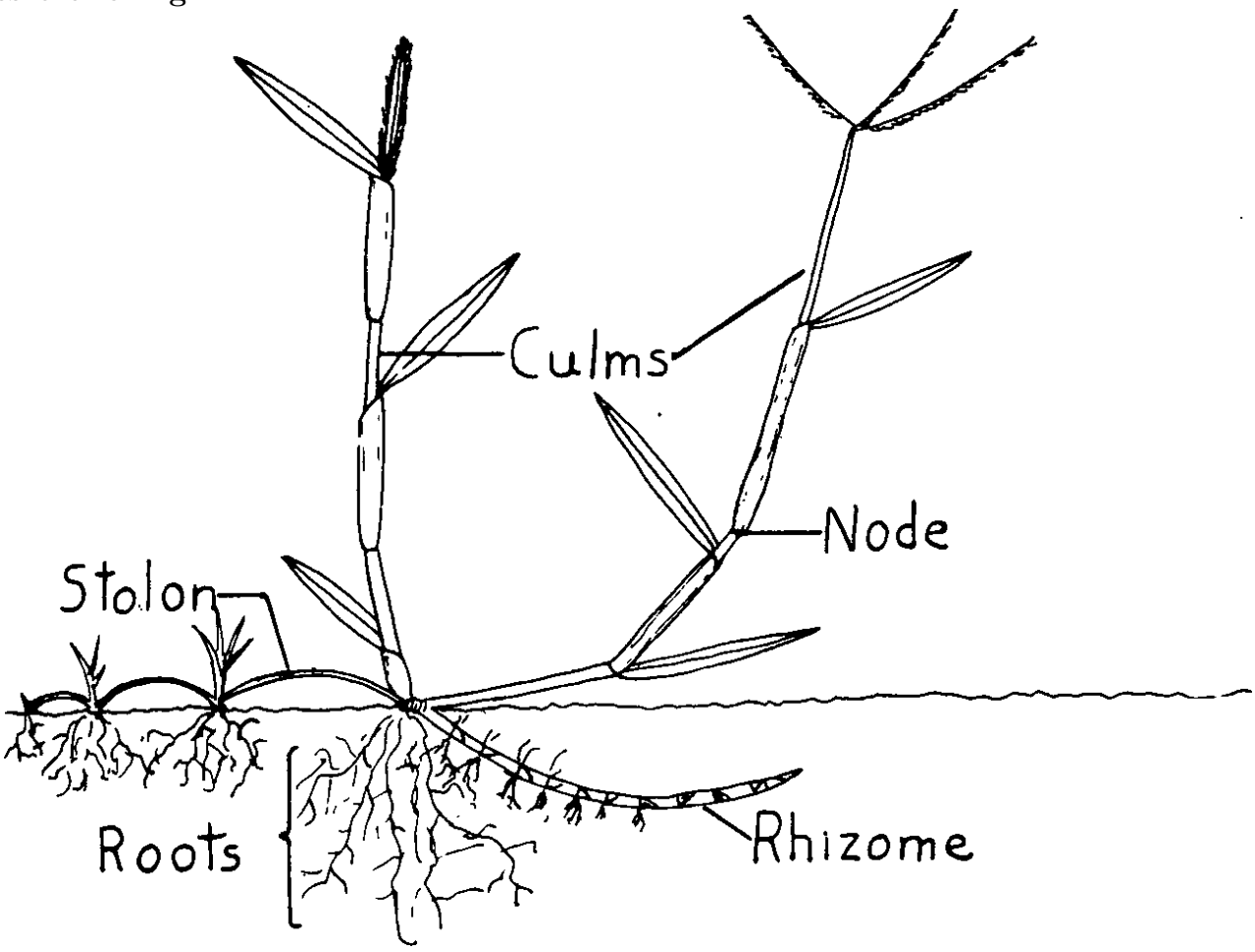
Gramineae, or Poaceae—grass family

- $\approx 8,000$ species distributed thorough all the world, but most genera concentrate in tropics
- Prefer dry, sunny places
- Often form tussocks—compact structures where old grass stems, rhizomes and roots are intermixed
- Grasses form grasslands—specific ecological communities widely represented on Earth. North Dakota prairies are grasslands.

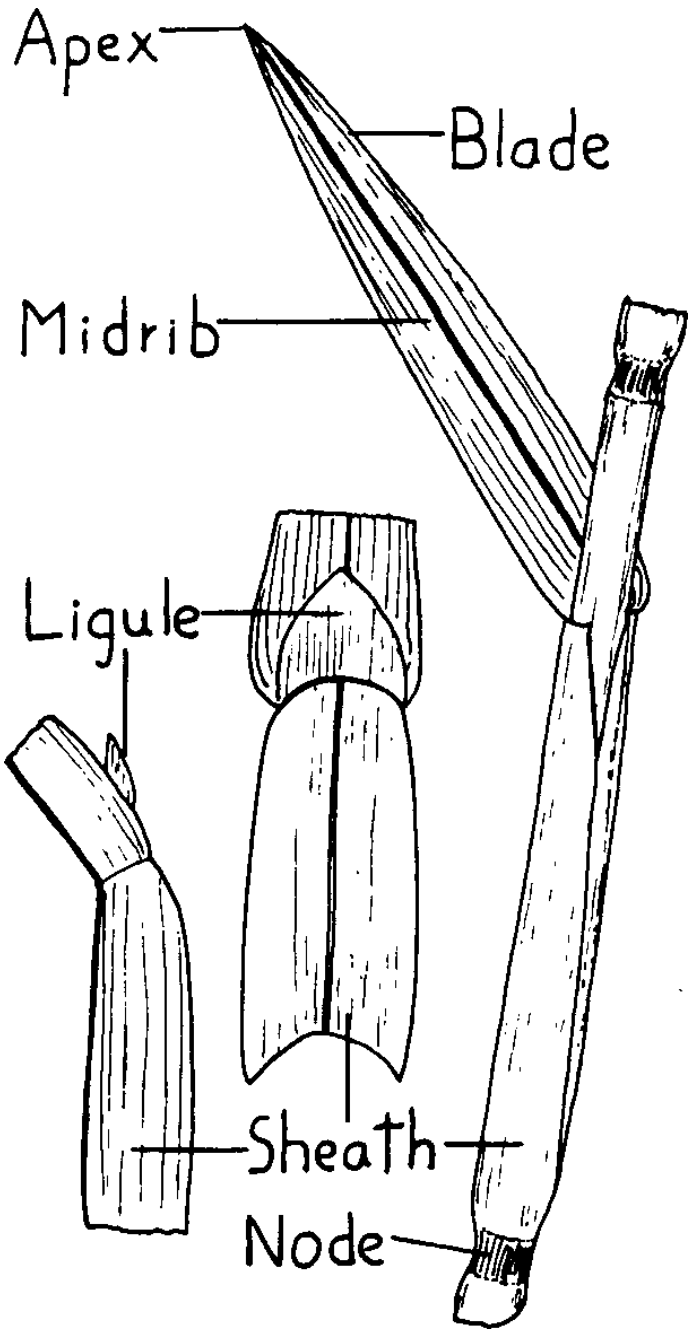
Morphology of grasses

- Stems usually hollow and round
- Leaves flat, in two ranks
- Flowers reduced, wind-pollinated, usually bisexual, form complicated spikelets
- Each spikelet bear two glumes; each flower has lemma and palea scales
- Perianth is reduced to lodicules
- Stamens from 6 to 1 (most often 3), with large anthers
- Fruit is a caryopsis, it includes flower scales
- Seed has a specific embryo with coleoptile, coleorhiza and scutellum

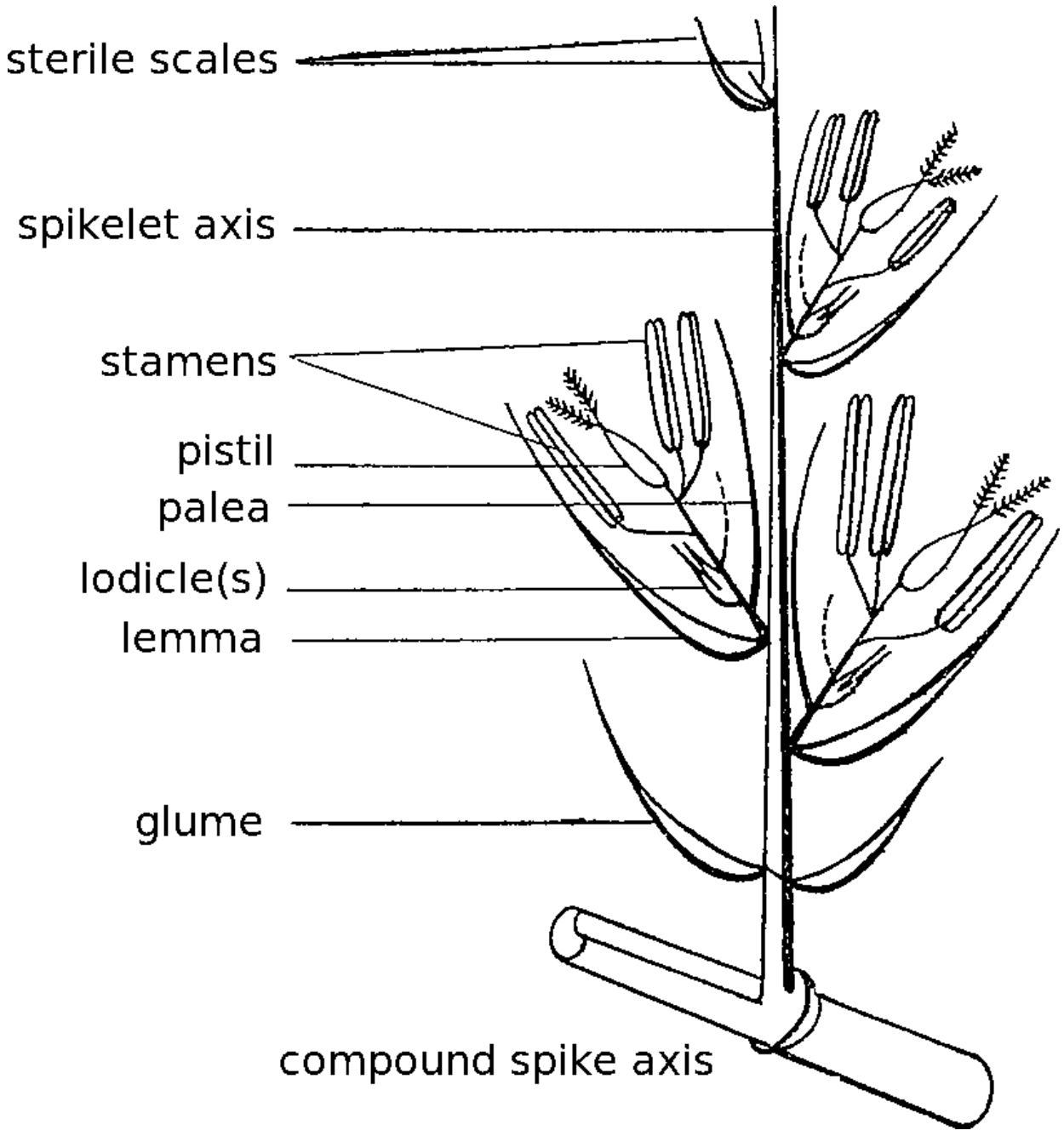
Grass branching



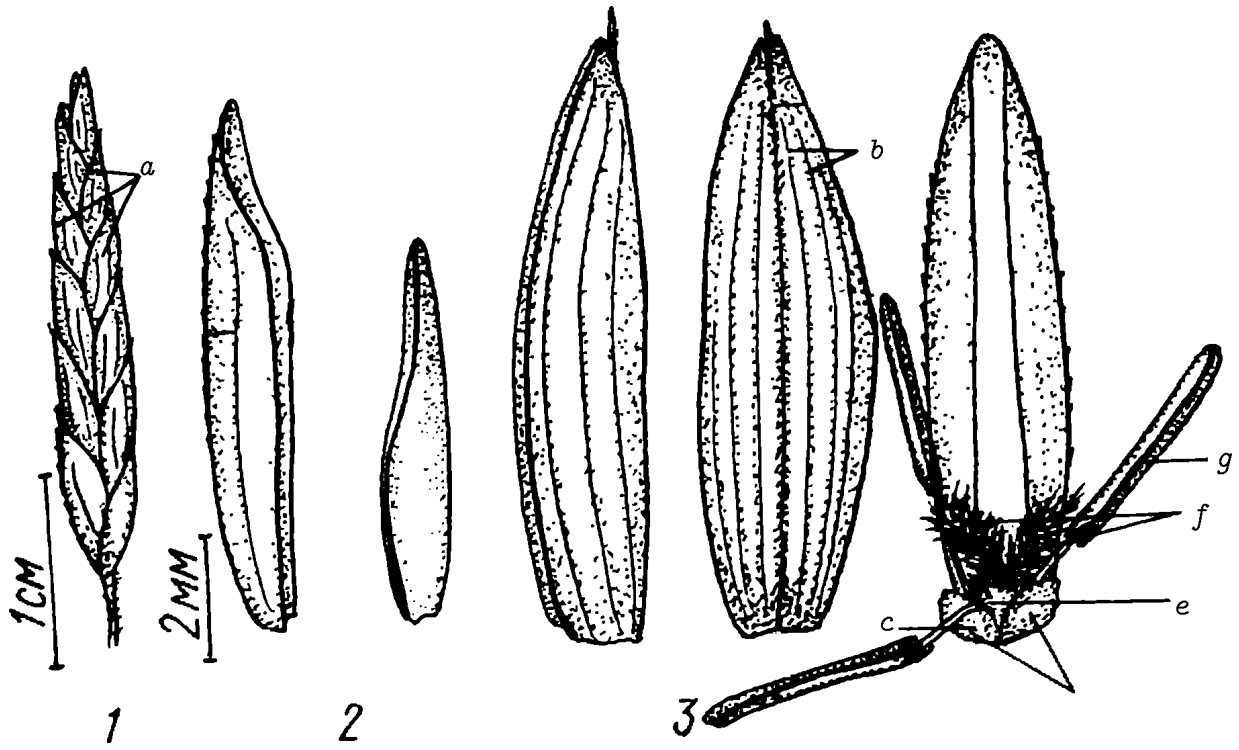
Grass leaves



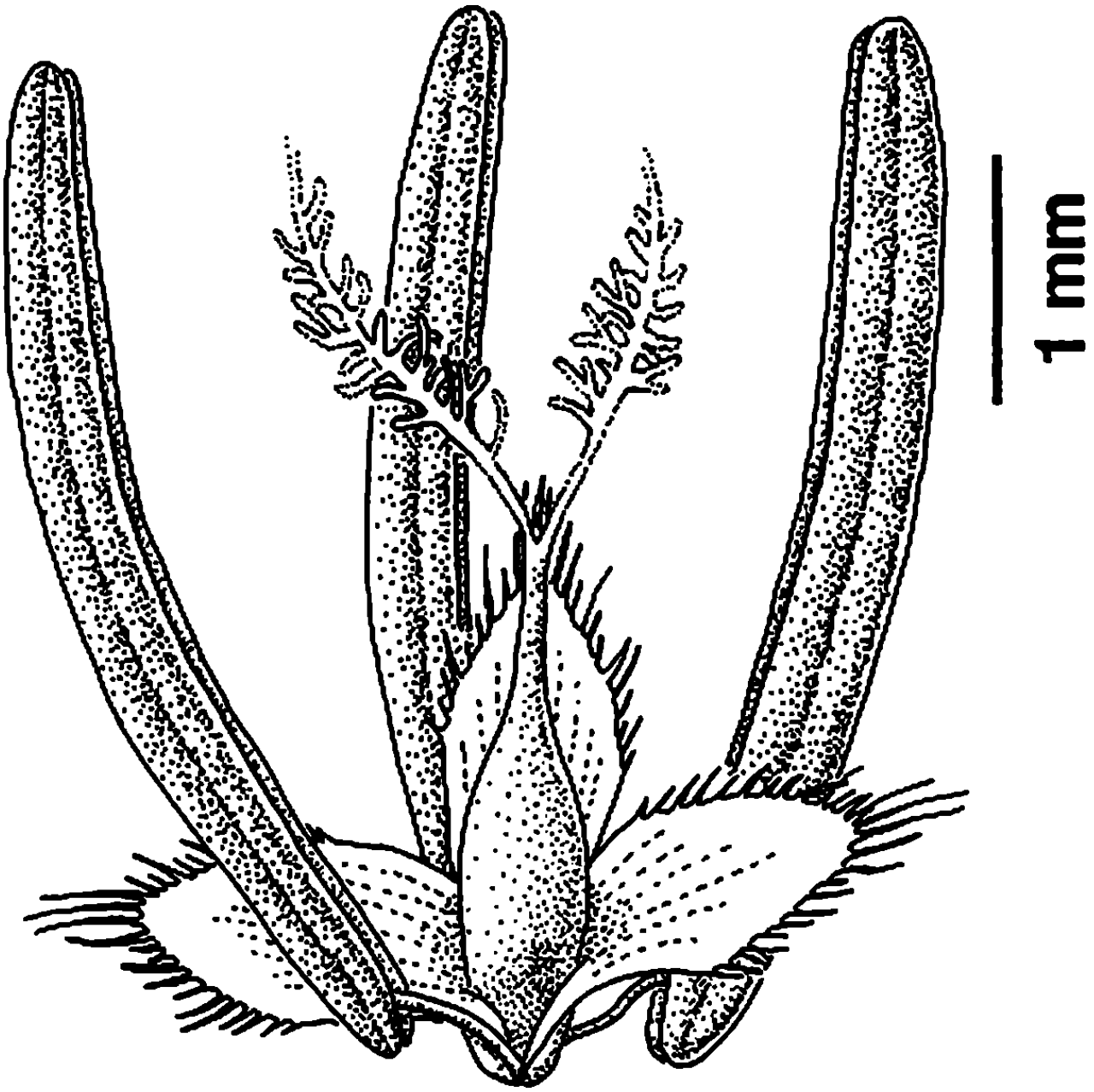
Scheme of grass spikelet



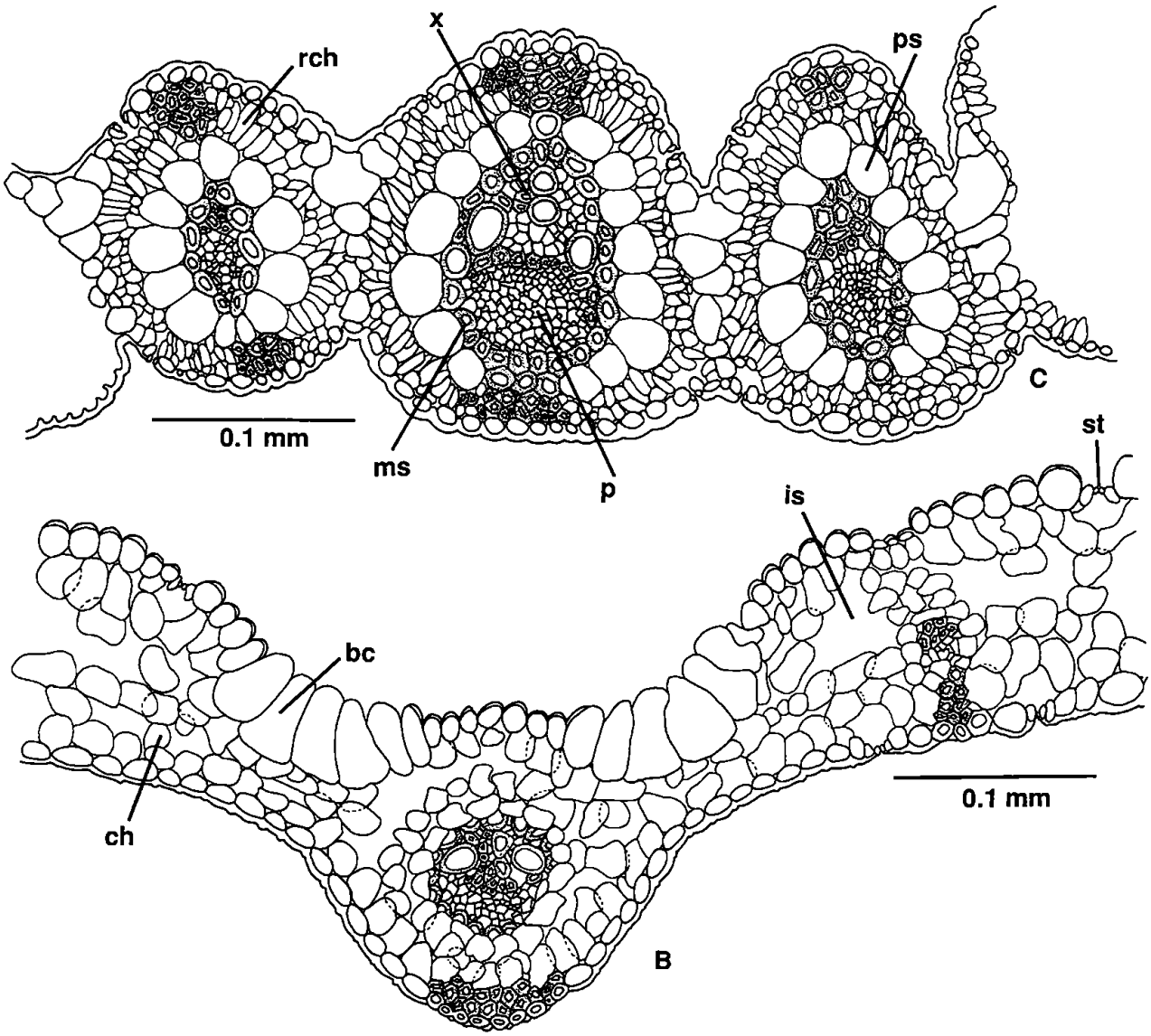
Bromegrass (*Bromus inermis*) spikelet and flower



Grass flower: bamboo

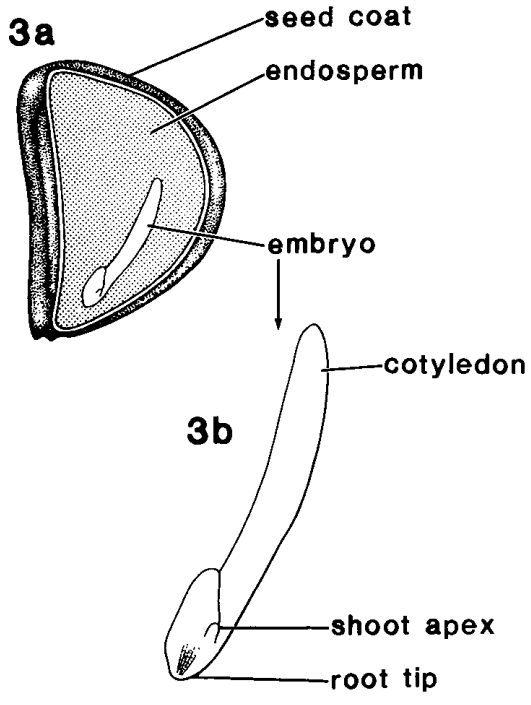


Kranz anatomy of leaves in C_4 grasses (above)



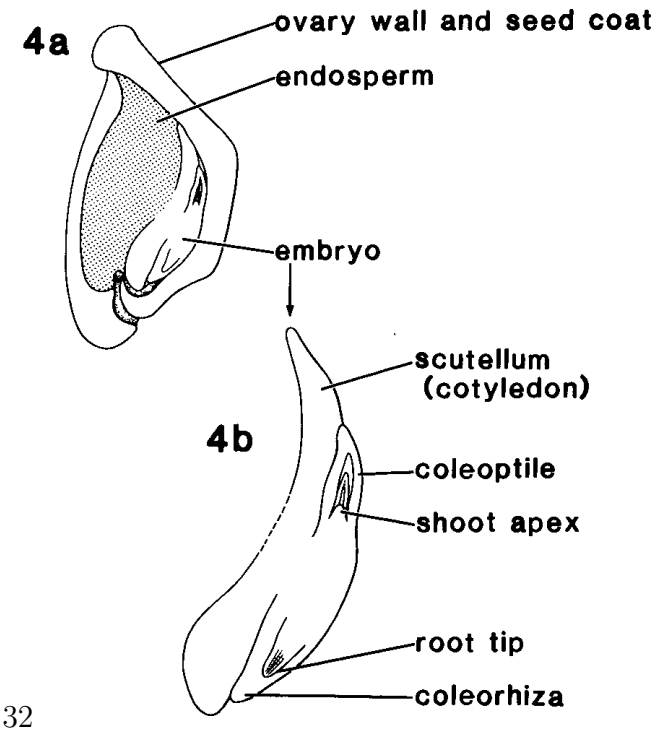
Typical Monocot Embryo

(*Zephyranthes treatiae*, Amaryllidaceae)

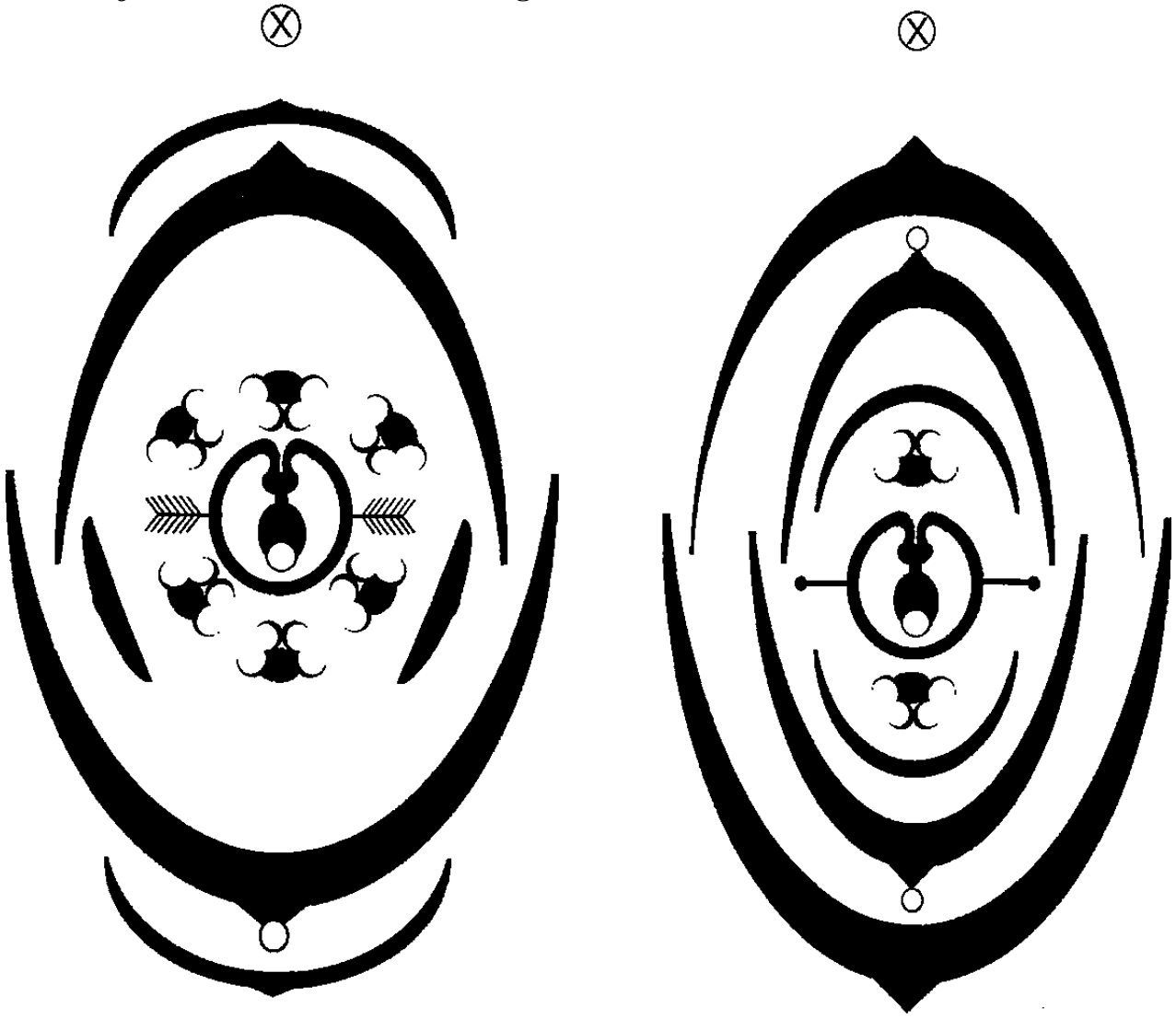


Grass Embryo

(*Zea diploperennis*)



Grasses: *Oryza* and *Anthoxanthum* diagrams



$\uparrow \mathrm{P}_{0-3}\mathrm{A}_{0-3+2-3}\mathrm{G}_{\underline{(2)}}$

Grass inflorescences

- Compound spikes
- Panicles

Rare event: bamboo (*Schizostachyum* sp.) is flowering!

***Festuca* sp.**

Rice (*Oryza sativa*), the most important world crop

Corn (*Zea mays*), the most productive world crop (up to 10 MT/ha)

5.2 Diversity of Gramineae

Subfamily Anomochlooideae

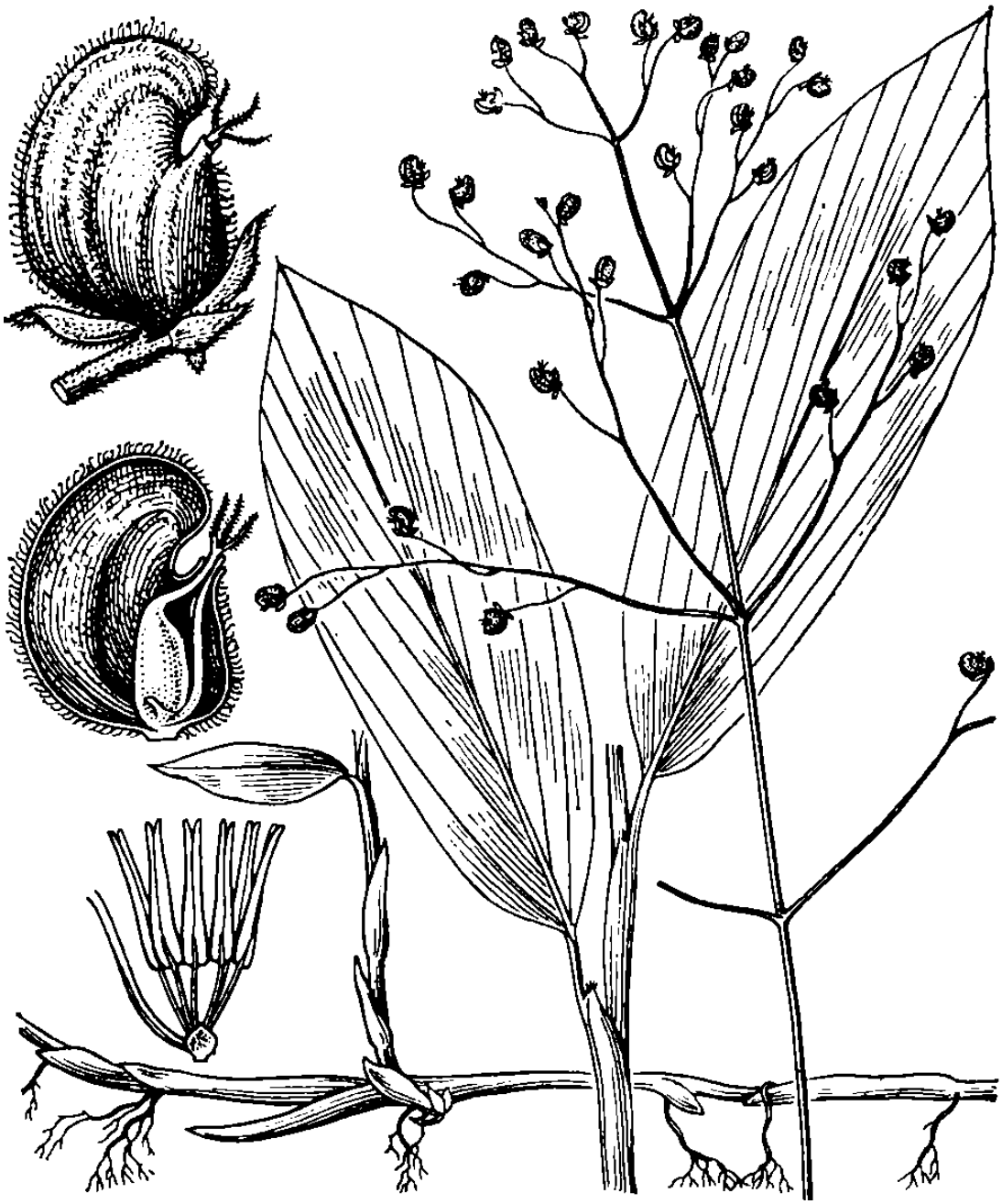
- Broad leaves, no spikelets, no lodicules, 4–6 stamens. Tropical South America.
  - *Anomochloa*—anomochloa
  - *Streptochaeta*—streptochaeta

Anomochloa

Subfamily Pharoideae

- Broad leaves with pinnate venation, spikelets one-flowered, unisexual, in panicles, 6 stamens, 3 stigmas.
  - *Pharus*—pharus, South America
  - *Leptaspis*—leptaspis, tropics of Old World

Leptaspis



Subfamily Puelioideae

- Broad leaves with parallelodromous venation, spikelets with multiple unisexual florets, 3 lodicules, 6 stamens, 3 stigmas

  – *Puelia*—puelia (Tropical Africa, poorly studied)

Puelia

Subfamily Bambusoideae

"BEP clade" starts here.

- Mostly woody plants, leaves broad or narrow, spikelets bisexual or unisexual, number of flower parts vary. $\approx 1,200$ species.
  - *Phyllostachys*—golden bamboo, often cultivated in southern U.S.
  - *Arundinaria*—hill cane, native to eastern U.S.
  - *Bambusa*—bamboo, reaches 35 m in height
  - *Melocanna*—has large berry-like caryopses

Arundinaria appalachiana

Melocanna

Subfamily Ehrhartioideae

- Herbaceous plants, ligules mostly not fringed, sometimes annuals, inflorescences are mostly panicles, 2 lodicules, 2 styles, stamens 3–6. ≈ 120 species.
  - *Oryza*—rice
  - *Zizania*—wild rice
  - *Leersia*—cut grass

Leersia oryzoides

Subfamily Pooideae

Annuals or perennials, inflorescences are compound spikes, racemes or panicles, spikelets bisexual, lodicules 2, stamens 3, styles 2, embryo small (like in previous subfamilies). $\approx 3,300$ species.

Tribes:

Bromeae *Bromus*—bromegrass

Meliceae *Melica*—melic, *Glyceria*—mannagrass

Poeae *Poa*—bluegrass, *Festuca*—fescue, *Avena*—oats, *Phleum*—timothy grass and many others

Stipeae *Stipa*—needle-and-thread, *Oryzopsis*—ricegrass

Triticeae *Triticum*—wheat, *Secale*—rye, *Hordeum*—barley, *Agropyron*—wheatgrass and many others

Bromus commutatus

Subfamily Aristidoideae

"PACCAD clade" starts here.

- Xerophytic grasses, mostly tropical and subtropical, ligules fringed, panicles, lemma with three awns, palea short, stamens 1–3, embryo small or large, C_4 (*Aristida*). $\approx$ 350 species.
  - *Aristida*—threeawn

Aristida purpurea

Subfamily Arundinoideae

- Large perennials, sometimes almost woody, have panicles, palea not reduced, stamens 1–3, embryo mostly large, C_3-plants. ≈ 35 species.
  - *Arundo*—giant reed
  - *Phragmites*—reed

Arundo

Subfamily Danthonioideae

- Large xerophytic grasses with narrow leaves, ligule hairy, lemma with single awn, C_3-plants. ≈ 250 species.
  - *Danthonia*—oatgrass from outside of prairies
  - *Cortaderia*—pampas grass

Cortaderia

Subfamily Panicoideae

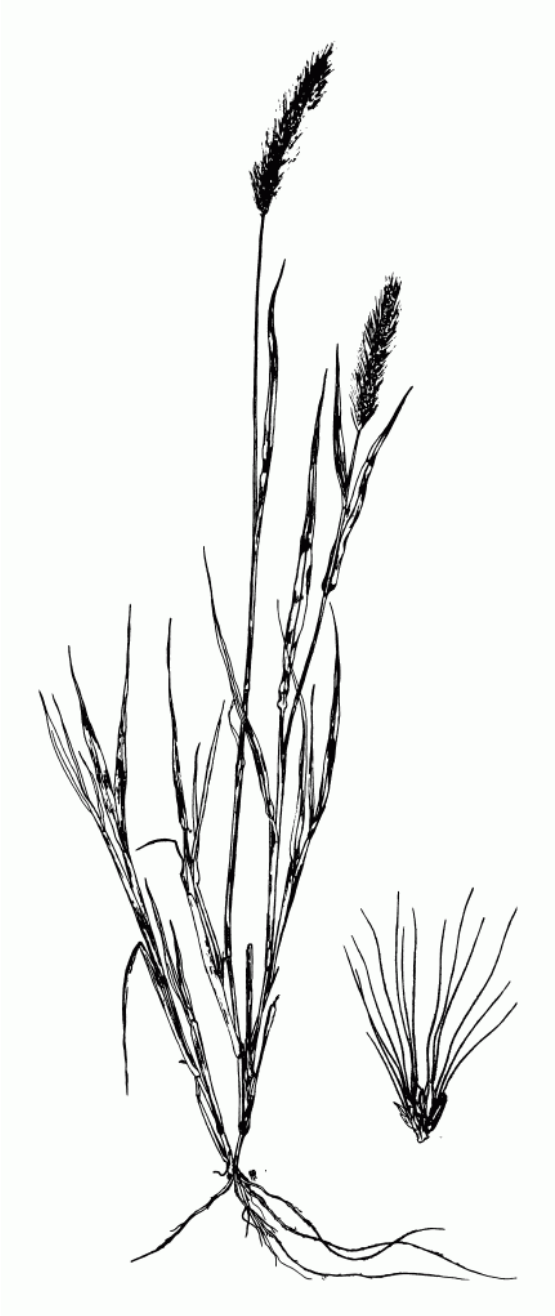
Primarily tropical grasses, ligule often consists of hairs or absent, spikelets frequently paired, embryo large, leaves with Kranz anatomy, mostly C_4-plants. $\approx 3,270$ species.

Tribes:

Paniceae *Panicum*—millet, *Setaria*—pigeongrass, *Cenchrus*—sandbur

Andropogoneae *Saccharum*—sugarcane, *Sorghum*—sorghum, *Zea*—corn, *Coix*—Job's tears, *Andropogon* (*Schizachyrium*)—bluestem

Setaria



Cenchrus

Coix

Subfamily Chloridoideae

Grasses of dry climates, ligule fringed, leaves have specific bicellular microhairs, spikelets compressed, sometimes one-sided, embryo large, C_4-plants, Kranz anatomy. $\approx 1,400$ species

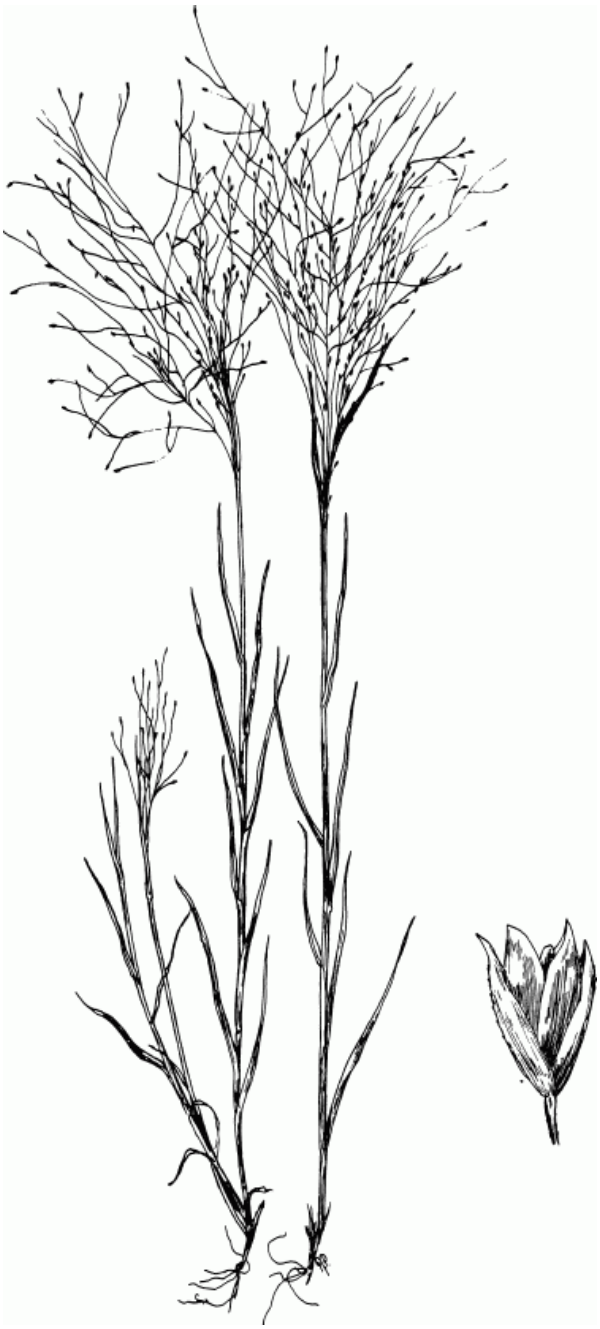
Tribes:

Eragrostideae *Eragrostis*—lovegrass

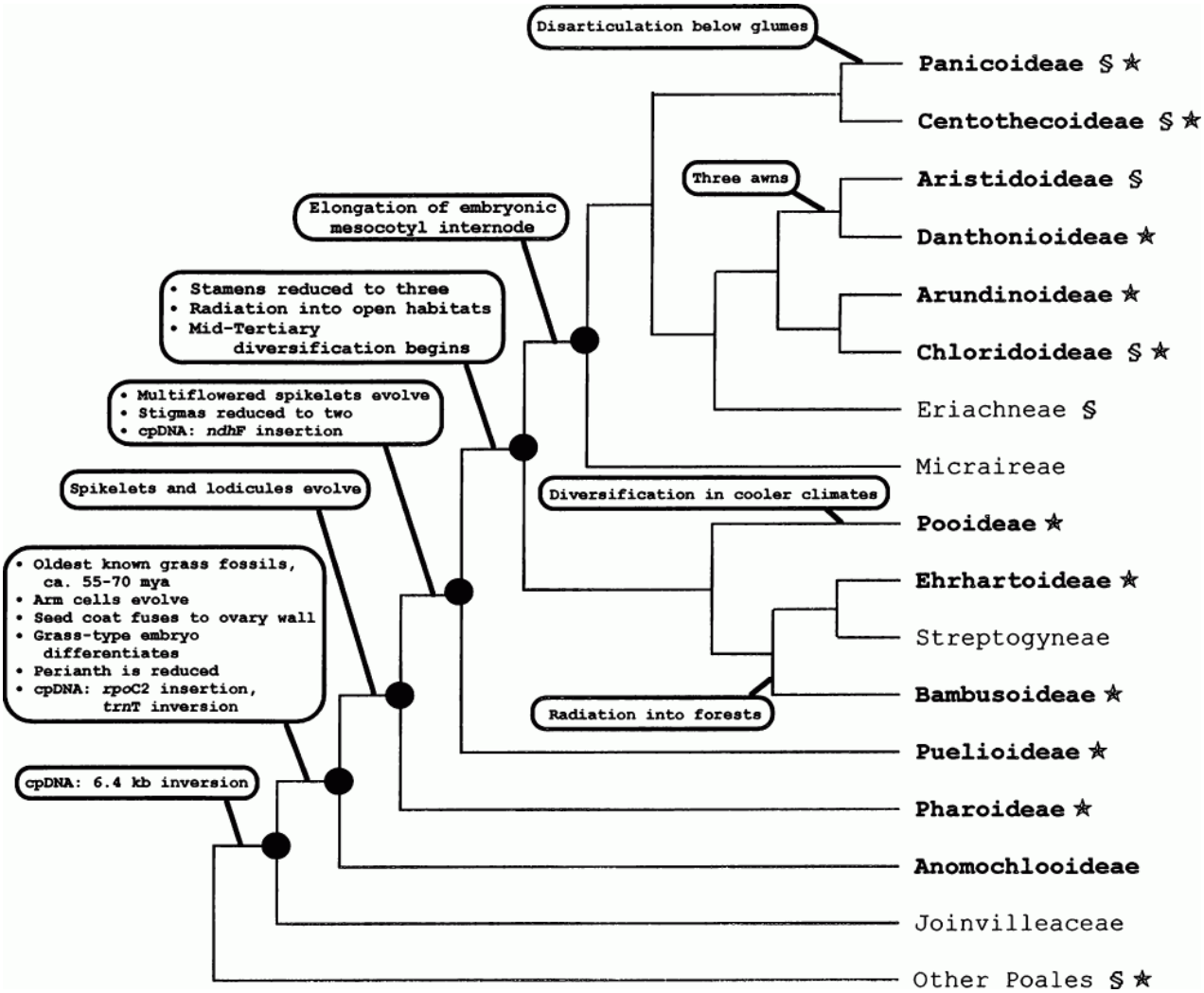
Zoysieae *Sporobolus*—dropseed, *Spartina*—cordgrass, *Calamovilfa*—sandseed

Cynodonteae *Muhlenbergia*—muhly, *Bouteloua*—grama

Muhlenbergia



Phylogeny of grasses



6 Poales: grass-like plants and some others

Graminioid families

- Gramineae
- Cyperaceae
- Juncaceae
- Typhaceae

  And also Restionaceae, Xyridaceae, Mapaniaceae and others

6.1 Cyperaceae—sedge family

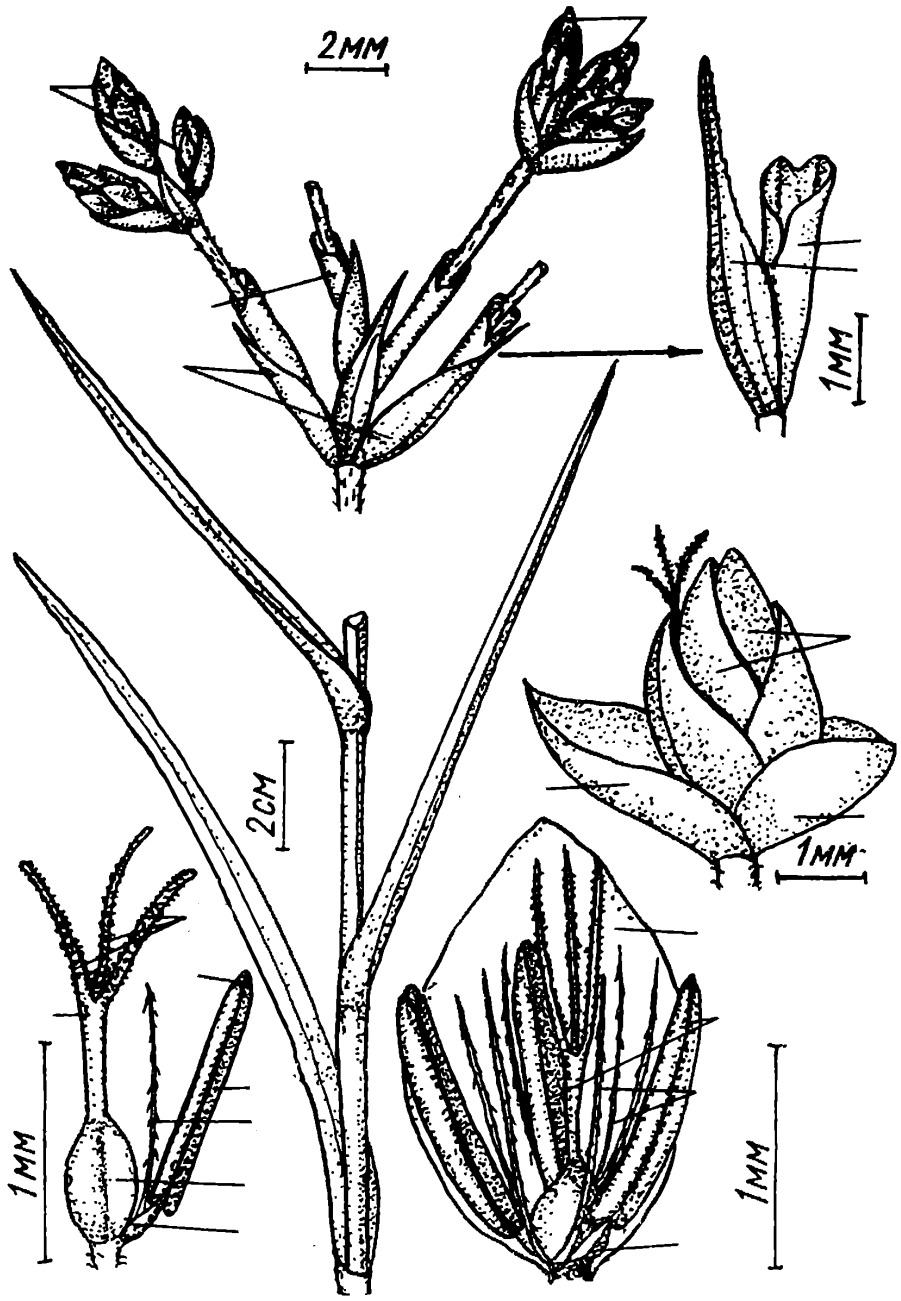
Main features of Cyperaceae

- $4,000$ species, $\approx 1,000$ belongs to sedges, *Carex*
- Grasslike plants, distributed mostly in temperate and Arctic regions
- Prefer wet places

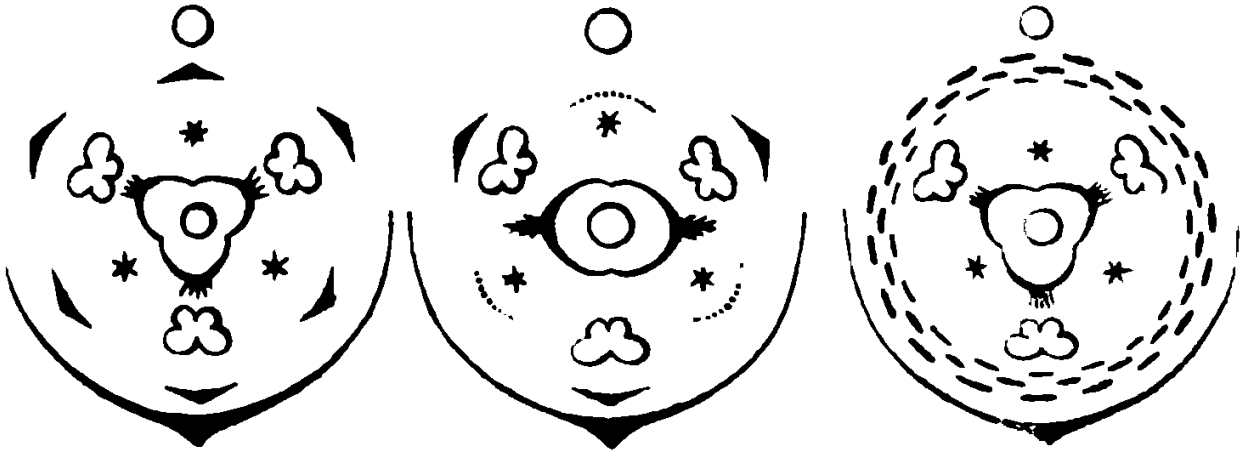
Morphology of Cyperaceae

- Accumilate silica
- Leaves often in 3 ranks, stem is also a triangle on the cross-section
- Flowers small, wind-pollinated, unattractive, often unisexual, form spikes or spikelets and more complicated inflorescences
- Pollen grains in monads (from four microspores, only one survives)
- Perianth often reduced, stamens three, one pistil with one ovule but three carpels
- *Carex* flowers have specific bag-like perigynium
- Fruit is an achene

***Scirpus sylvaticus* floral parts**



Cyperaceae flower diagram



$$*P_{3+3\vee0}A_3\underline{G_{(2-3)}}$$

Diversity of Cyperaceae

Importance: Sometimes food, weaving materials, ornamentals

- *Eleocharis*—spikerush: base of style enlarged. *E. dulcis* is a Chinese water-chestnut. 13 species in ND.
- *Scirpus* s.l.—bulrush: scales are spirally arranged. Genus is fequently split into, e.g., *Scirpus* s.str., *Schoenoplectus*, and *Bolboschoenus* which is sometimes separated from *Schoenoplectus*. If not sure, go to *Scirpus* to ID. 11 species in ND.
- *Eriophorum*, cottongrass was used as fiber source. 4 species in ND.
- *Cyperus*—cyperus: spikelets with two rows of scales. *C. papyrus* was used for famous Egyptian papyrus, *C. esculentus* (chufa) has edible corms (occurred in Fargo region). 9 species in ND.
- ... and of course, *Carex*. 91 species in ND!

***Eriophorum* sp.**

Cyperus papyrus

***Carex* flowers**

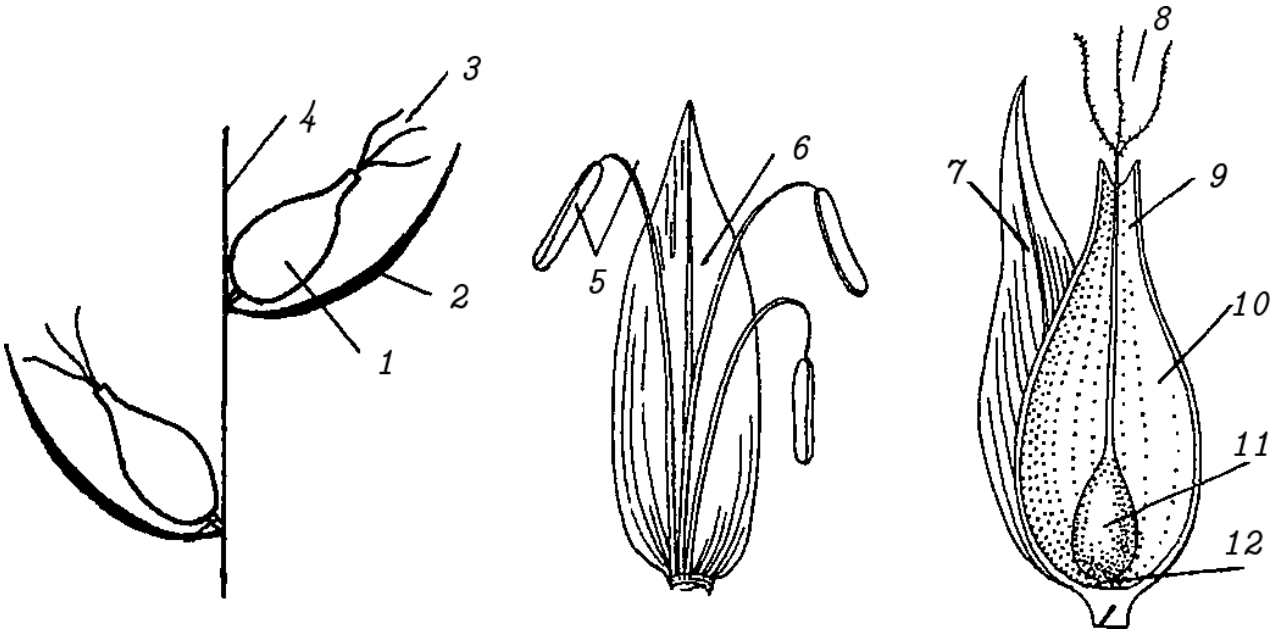
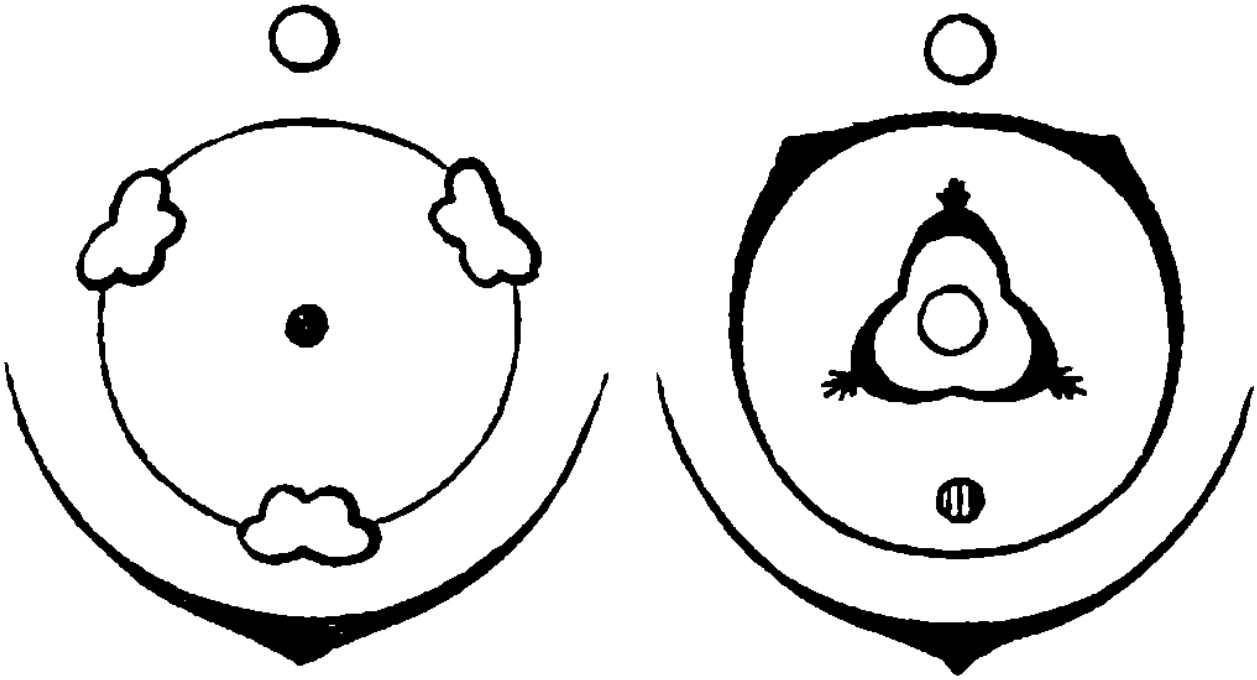


Diagram of *Carex* flower



$\ast \mathrm{P_0A_3}$ or $\uparrow \mathrm{P_0G_{\underline{(2-3)}}}$

Diversity of sedges (*Carex*)

Carex covers almost half of wet places in Arctic and northern temperate region. 3-ranked leaves, female flowers enclosed in perigynium.

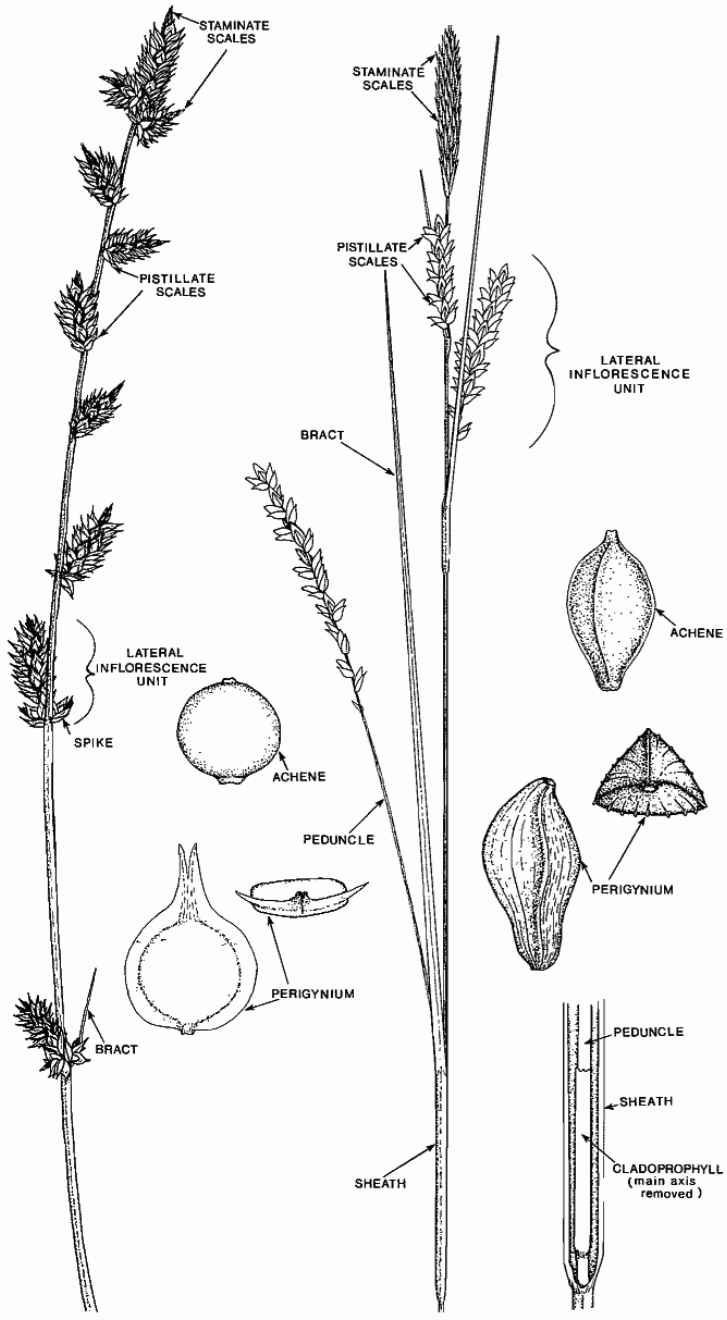
Main groups:

1 spike Subgenus Psyllophora, e.g. *Carex filifolia*

Bisexual spikes Subgenus Vignea (and also tropical subg. Indocarex), e.g. *Carex brevior*

Unisexual spikes Subgenus Carex, e.g. *Carex retrorsa*

Subg. Vignea vs. subg. Carex



Carex filifolia

Carex brevior

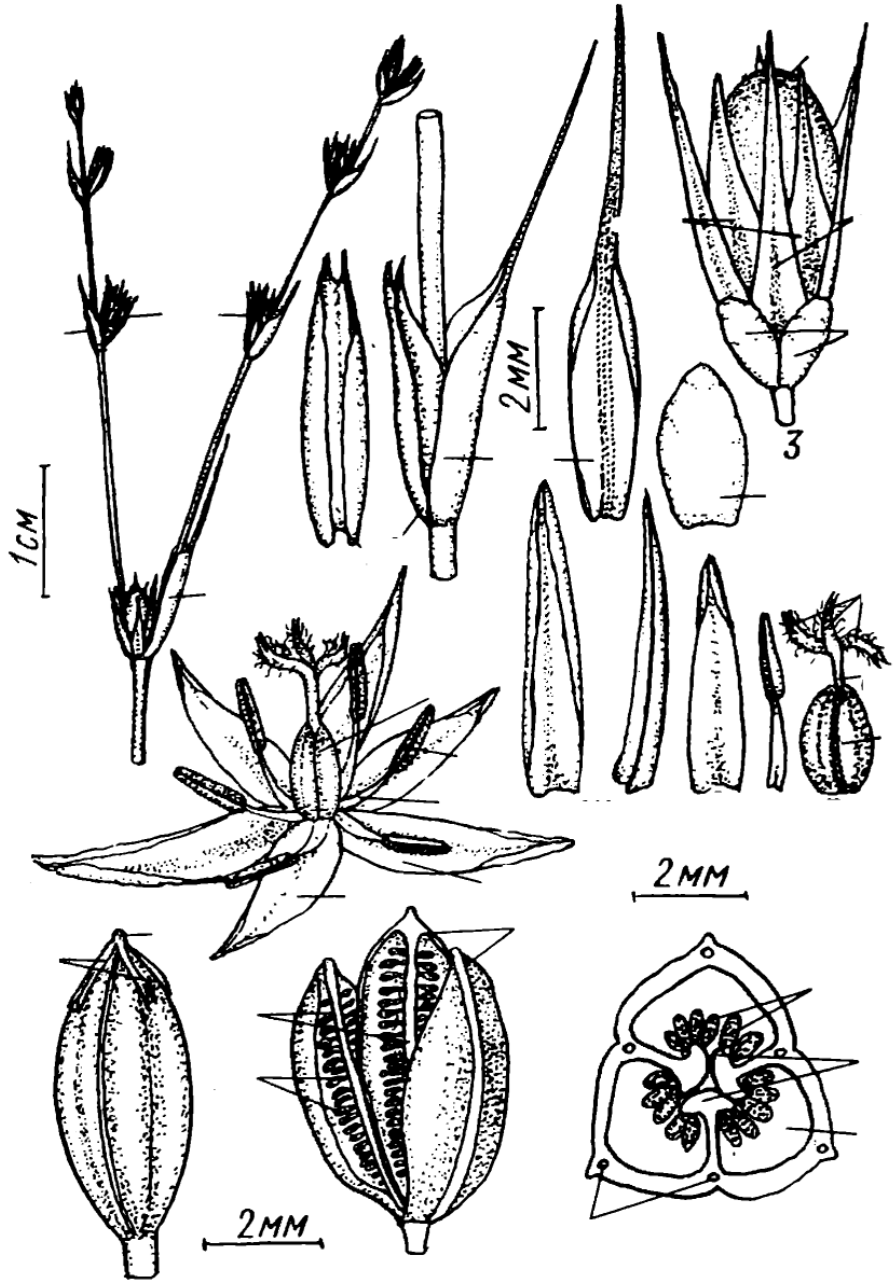
Carex retrorsa

6.2 Juncaceae—rush family

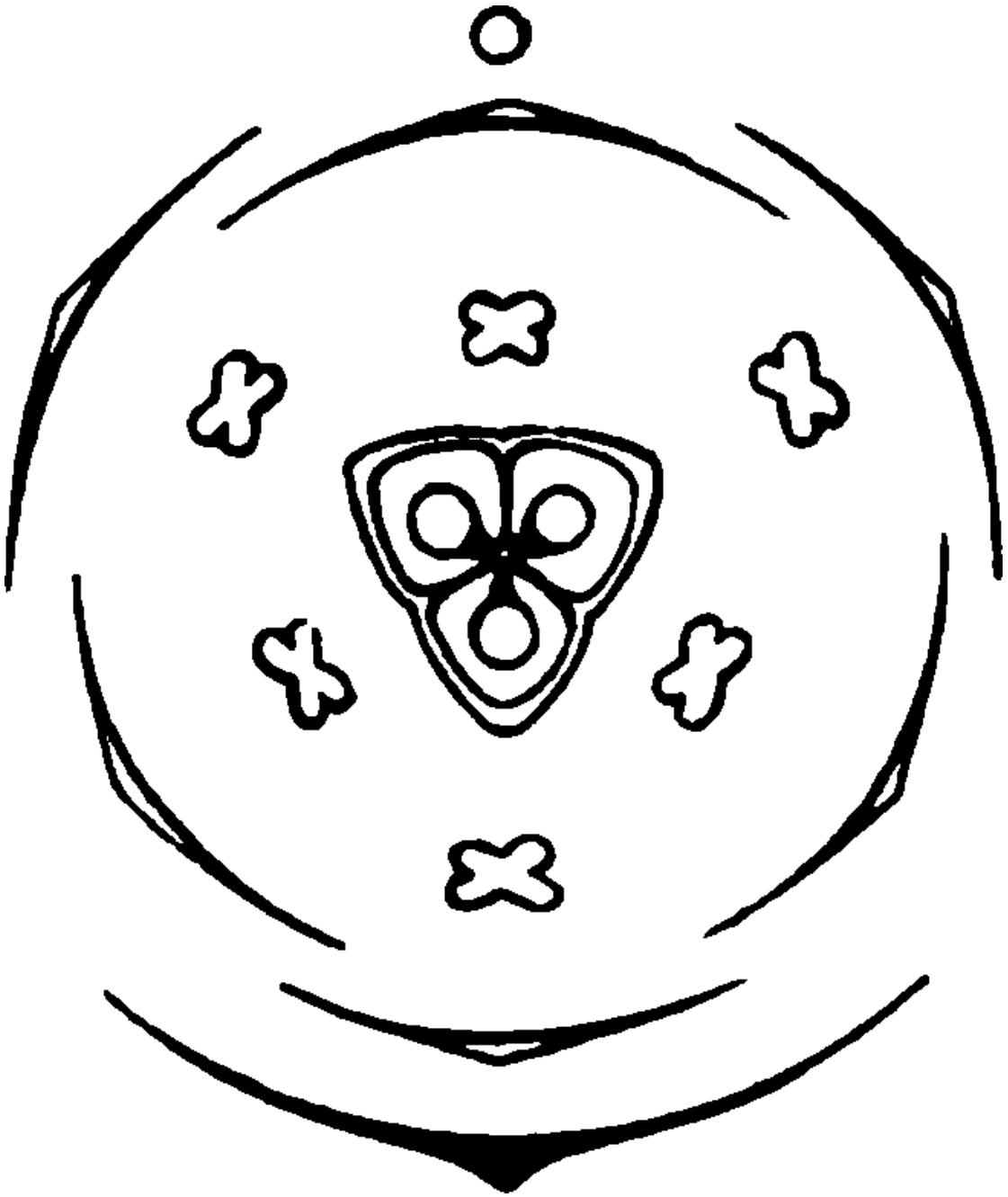
Juncaceae—rush family

- ≈ 300 species
- Distributed in temperate and montane regions, growing in dump places
- Life forms: grass-like herbs
- Leaves flat to cylindric, with open sheath, sometimes reduced
- Flowers actinomorphic, 3-merous, perianth of 6 tepals, 6 stamens
- Pistil has 3 carpels
- Fruit is a capsule

***Juncus bufonius* flower parts**



Juncaceae flower



$\ast \mathrm{P}_{3+3}\mathrm{A}_{3+3}\mathrm{G}_{\underline{(3)}}$

Representatives of Juncaceae

Importance: weaving materials

- *Juncus*—rush: cylindric leaves
- *Luzula*—wood-rush: "normal" grass-like flat leaves

Juncus effusus

Luzula parviflora

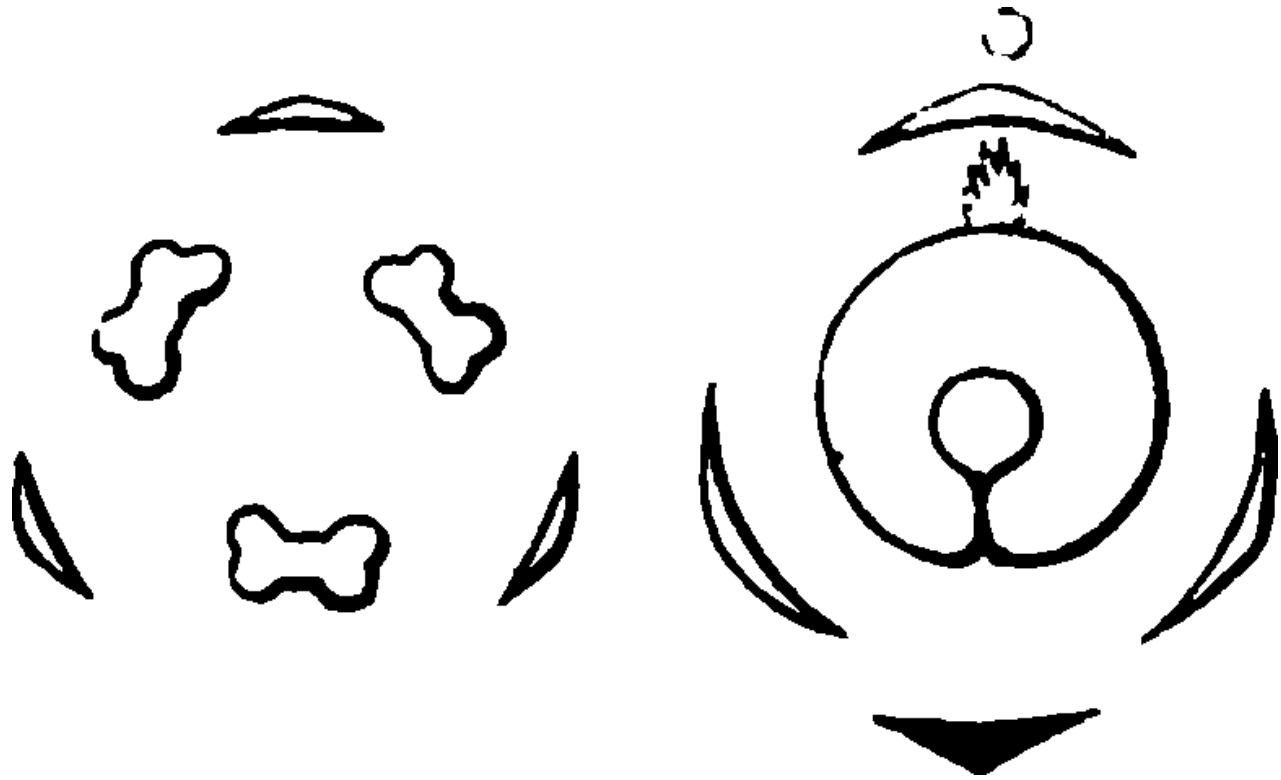
6.3 Typhaceae—cattail family

Typhaceae—cattail family

- ≈ 40 species
- Distribution: widespread
- Life forms: grass-like coastal or water plants
- Leaves distichous, linear, mostly basal
- Dense inflorescences
- Flowers very reduced, male with one or 3 stamens

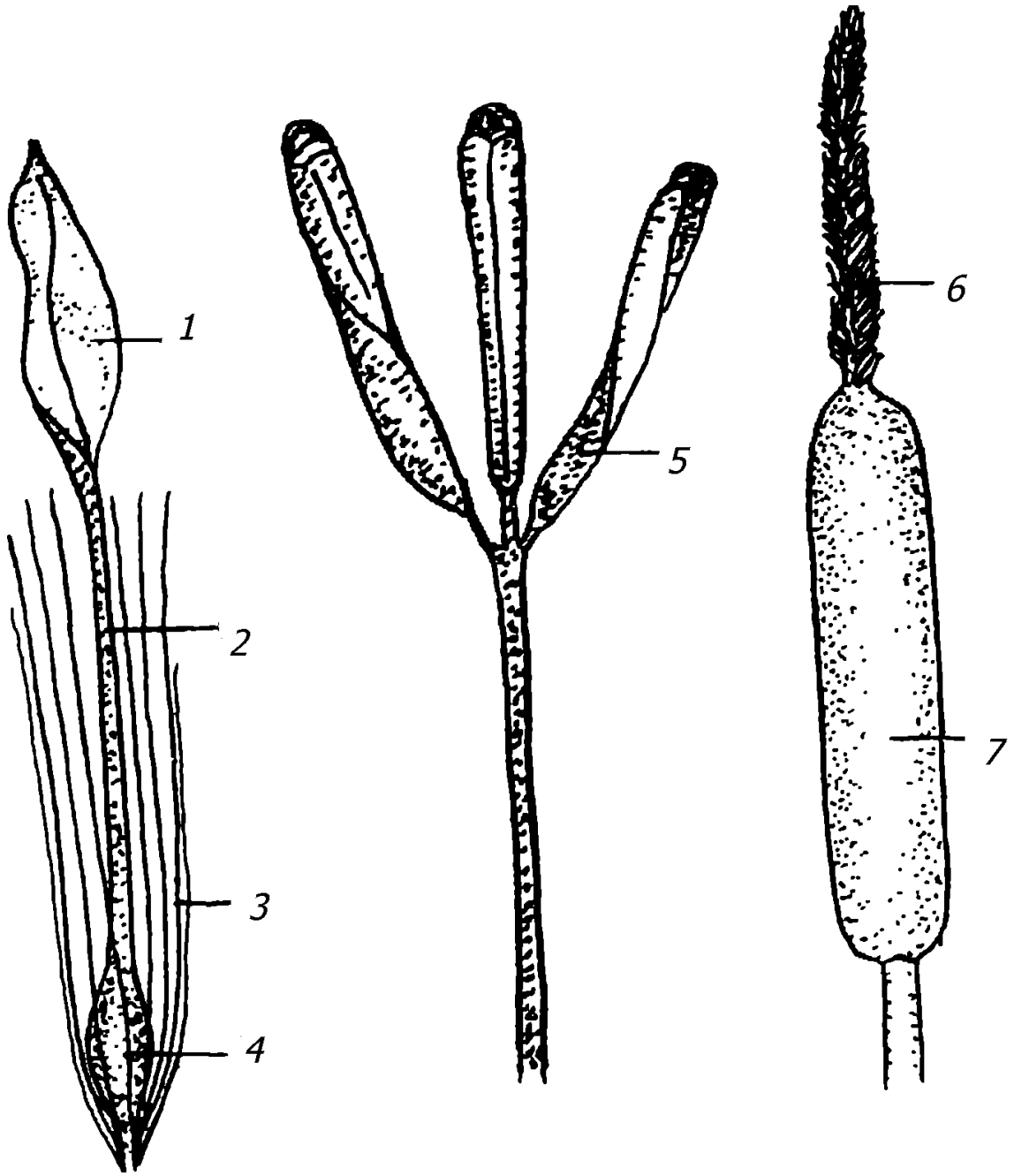
- Pistil unicarpellate, with one ovule
- Fruit an achene or drupe

Typhaceae flowers



♂$*$ P_3A_3; ♀$*$ $P_3\underline{G_1}$

***Typha latifolia* flower parts**



Representatives of Typhaceae

Importance: mating and weaving material, edible pollen and rhizomes, sometimes ornamental.

- *Sparganium*—bur-reed (sometimes separated to its own family)
- *Typha*—cattail

Sparganium eurycarpum

Summary

Character	Juncaceae (rushes)	Cyperaceae (sedges)	Poaceae (grasses)
Genera/species	8/300	146/5,315	650–785/10,000
Habitat	wet areas	wet areas or sterile soils	dry to moist areas
Stem cross section	terete	triangular	terete or ellipsoid
Internodes	solid, with large pith	usually solid	usually hollow, or less commonly solid
Nodes	not jointed	not jointed	jointed
Leaf ranks	3	3	2
Leaf blade	flat to terete	flat	flat
Leaf sheath	open	closed	open and with ligule
Inflorescence	basically cymose, and often congested	arranged in spikelets	arranged in spikelets
Number of bracts subtending each flower	2 or more	1 (glume, scale)	usually 2 (palea and lemma)
Perianth	usually 6 chaffy tepals	absent, or reduced to a varying number of bristles or scales	reduced to 2 (or sometimes 3) lodicules
Anther attachment	basifixed	basifixed	basifixed, but deeply sagittate and appearing versatile
Pollen	in tetrads	single, but each grain ("pseudomonad") representing a degraded tetrad	single
Fruit type	loculicidal capsule	achene	caryopsis (grain)
Embryo	surrounded by endosperm	embedded in base of endosperm	outside of endosperm

For Further Reading

References

[1] A. Shipunov. Shipunov, A. Plants of North Dakota. Manual. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448/nd_manual/nd_manual.pdf`

[2] A. Shipunov. Shipunov, A. Flora of North Dakota: Checklist. Version 2. Ed.: Kartesz, J., and Nishino, M. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

[3] Minot State University Herbarium (MISU)

[4] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.

Other useful books and Web sites

- Pohl (several editions) "How to know grasses"
- Hitchcock (1935) "Manual of Grasses of the United States"
- Flora of North America, two "grass" volumes (not available from `efloras.org`)
- "Manual of Grasses for North America" (2007)
- Looman (1982) "Prairie Grasses Identified and Described by Vegetative Characters"

Outline

7 Pink order: Caryophyllales

7.1 Amaranthaceae—amaranth family

General features of Amaranthaceae

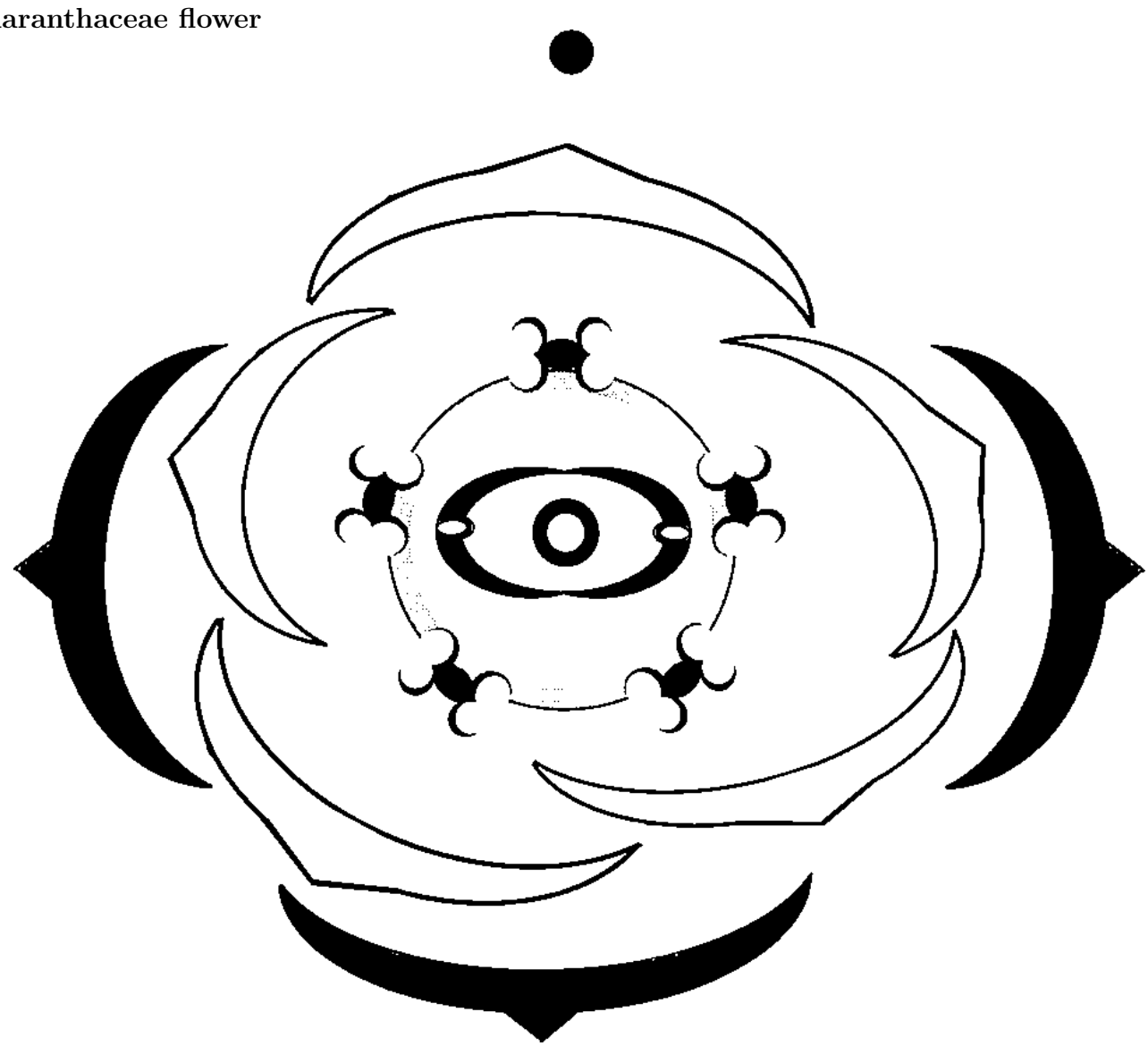
Amaranthaceae—amaranth family

- $\approx 2,500$ species
- Worldwide distribution
- Desert, semi-desert and dryland plants
- Often split in Amaranthaceae s.str. and Chenopodiaceae (beet family)

Morphology of Amaranthaceae

- Herbs and shrubs, contain red pigments **betalains**
- Stems with unusual tissue structure ("abnormal secondary growth"), leaves often succulent, sometimes with salt glands
- Flowers reduced, mono- or bisexual, in dense glomerules
- Pistil has 2 (or 3) carpels and one ovule
- Fruit is a nutlet
- Embryo curved around **perisperm**

Amaranthaceae flower



$$\ast \mathrm{K}_{0-5}\mathrm{C}_0\mathrm{A}_5\mathrm{G}_{\underline{(2-3)}}$$

***Nitrophila occidentalis* frower**

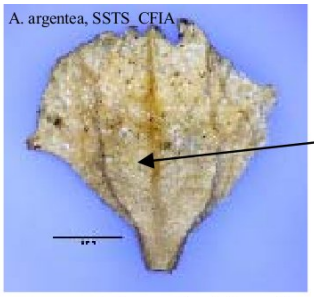
Economically important representatives of Amaranthaceae

Vegetables and so-called "pseudocereals"

- *Beta*—beet
- *Chenopodium quinoa*—quinoa
- *Amaranth*—amaranth, both ornamental and pseudocereal
- *Spinacia oleracea*—spinach

Chenopodium* vs. *Atriplex

- Five fruiting bracts, meeting in the middle of the flat side.
- * Meets on the thin edge in *C. bonus-henricus, C. capitatum* and *C. rubrum.*



- Two fruiting bracts, meeting along the thin edge.
- Note that the pericarp (seed covering) follows the alignment of the bracts.

7.2 Caryophyllaceae—pink family

General features of Caryophyllaceae

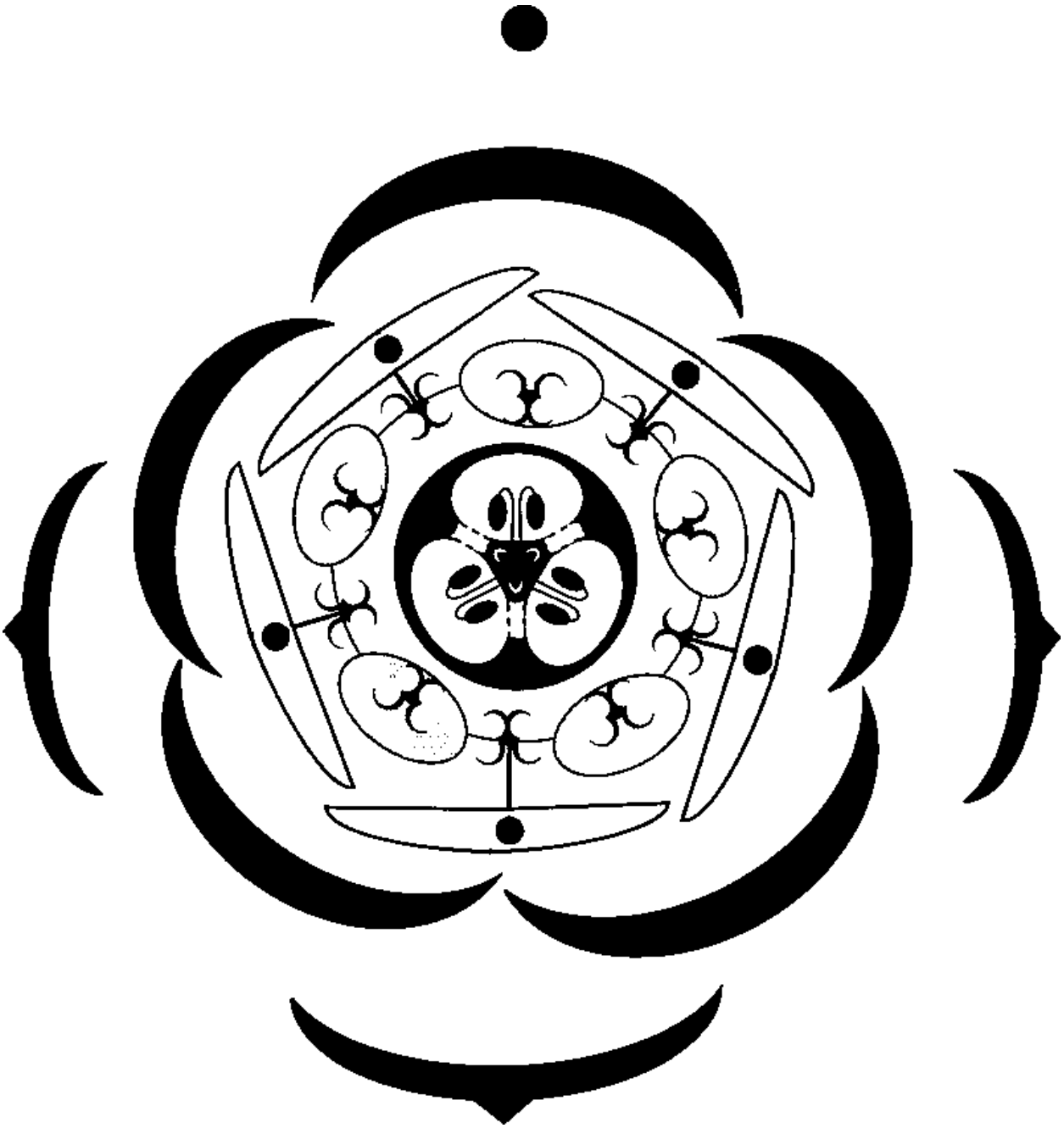
Caryophyllaceae—pink family

- $\approx 2,000$ species
- Distributed in temperate and warm temperate regions of Northern Hemisphere
- Forest, meadow and prairie plants

Morphology of Caryophyllaceae

- Mostly herbs
- Stems are usually swollen at nodes, leaves narrow, opposite, with hyphodromous venation, usually without stipules
- Flower bisexual, pentamerous, in cymes; with free petals and sepals (sometimes sepals fuse), stamens 5 or 5+5,
- Pistil has 3 or 5 carpels, ovules in one camera, attached to the central placenta
- Fruit dehiscent, dry capsule
- Embryo curved around perisperm

Caryophyllaceae flower



$\ast \mathrm{K}_5\mathrm{C}_5\mathrm{A}_{5+5}\mathrm{G}_{\underline{(3-5)}}$

Representatives of Caryophyllaceae
Mostly ornamental and weed plants

- *Dianthus*—pink
- *Stellaria*—chickweed
- *Cerastium*—mouse-ear chickweed

Garden cultivar of *Dianthus*

Cerastium

***Stellaria* sp.**

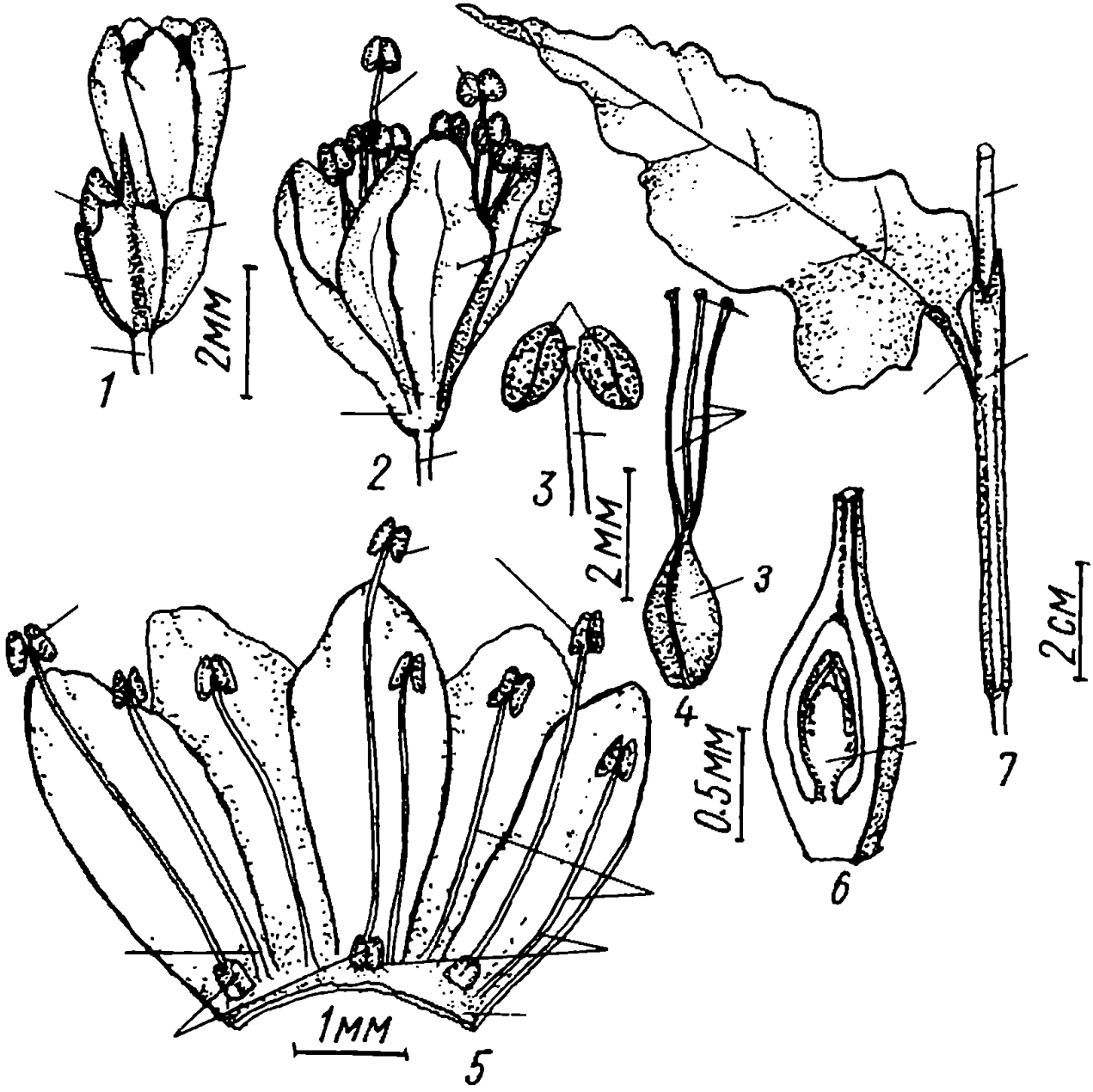
7.3 Polygonaceae—smartweed family

Polygonaceae—smartweed family

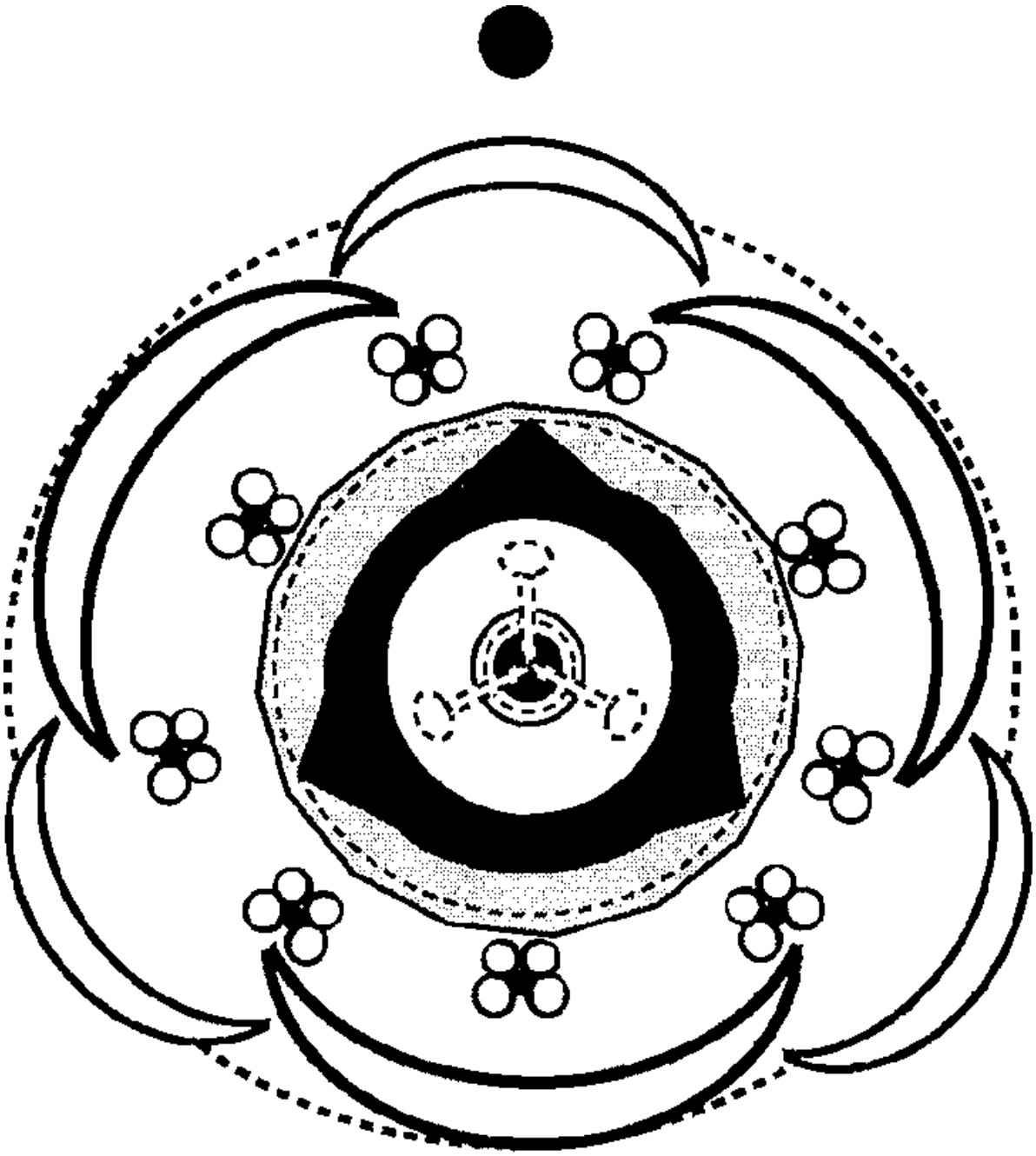
- $\approx 1,100$ species
- Distributed mostly in Northern hemisphere, prefer wetlands
- Life forms: herbs, sometimes shrubs and even trees (sea-grape, *Coccoloba*)
- Leaves alternate, simple, with ocrea—sheating membranous stipule
- Flowers actinomorphic, often 3-merous, without sepals/petals, perianth calyx-like or corolla-like, androecium of 6–9 stamens
- Pistil with three carpels, one camera and one terminal ovule
- Fruit is a nut (1-seeded dry fruit), seed with perisperm

Ocrea

***Persicaria*, smartweed**



Polygonaceae flower



$\ast \mathrm{P}_{\{3+3\}\vee 5}\mathrm{A}_{3-9}\mathrm{G}_{\underline{(3)}}$

Representatives of Polygonaceae

Importance: food and ornamental plants

- *Polygonum*, *Bistorta*, *Persicaria*, *Fallopia*—smartweeds

  Understood differently in "Flora of North America" and USDA PLANTS database

- *Rumex*—sorrel

  Many inconstent keys in the past

- *Rheum*—rubarb

- *Fagopyrum*—buckwheat

- *Coccoloba*—sea-grape
- *Eriogonum*—wild buckwheat

  No ocrea!

Other Caryophyllales

- Nyctaginaceae (3 genera): small flowers with monomerous pistil and big showy bracts, like *Mirabilis* (four-o-clock)
- Cactaceae (cacti and leafy *Portulaca*)

  ***
- Aizoaceae (mostly South African 1 genus in ND)
- Droseraceae (sundew)
- Molluginaceae (*Mollugo*)
- Montiaceae (*Phemeranthus*)
- Nepenthaceae (Asian pitcher plants)
- Phytolaccaceae (*Sarcobatus* in ND)
- Tamaricaceae (*Tamarix*)

For Further Reading

References

[1] A. Shipunov. Shipunov, A. Plants of North Dakota. Manual. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448/nd_manual/nd_manual.pdf`

[2] A. Shipunov. Shipunov, A. Flora of North Dakota: Checklist. Version 2. Ed.: Kartesz, J., and Nishino, M. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

[3] Minot State University Herbarium (MISU)

[4] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.

Outline

8 Rosanae and Celastranae superorders of Rosidae

8.1 Leguminosae, or Fabaceae—legume family

General features of Leguminosae

Leguminosae, or Fabaceae—legume family

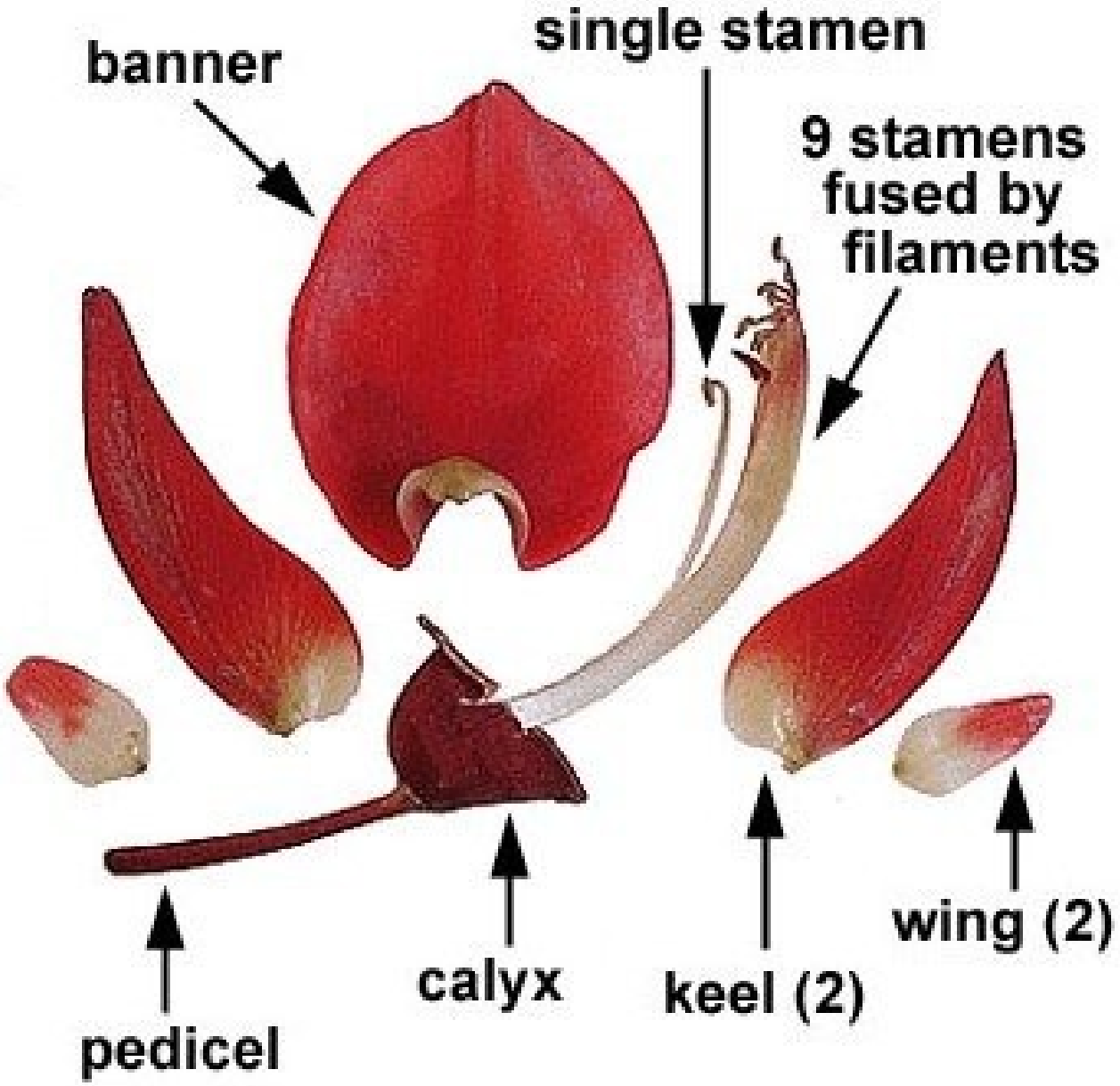
- Up to 17,000 species, third largest angiosperm family after Compositae (aster family) and Orchidaceae

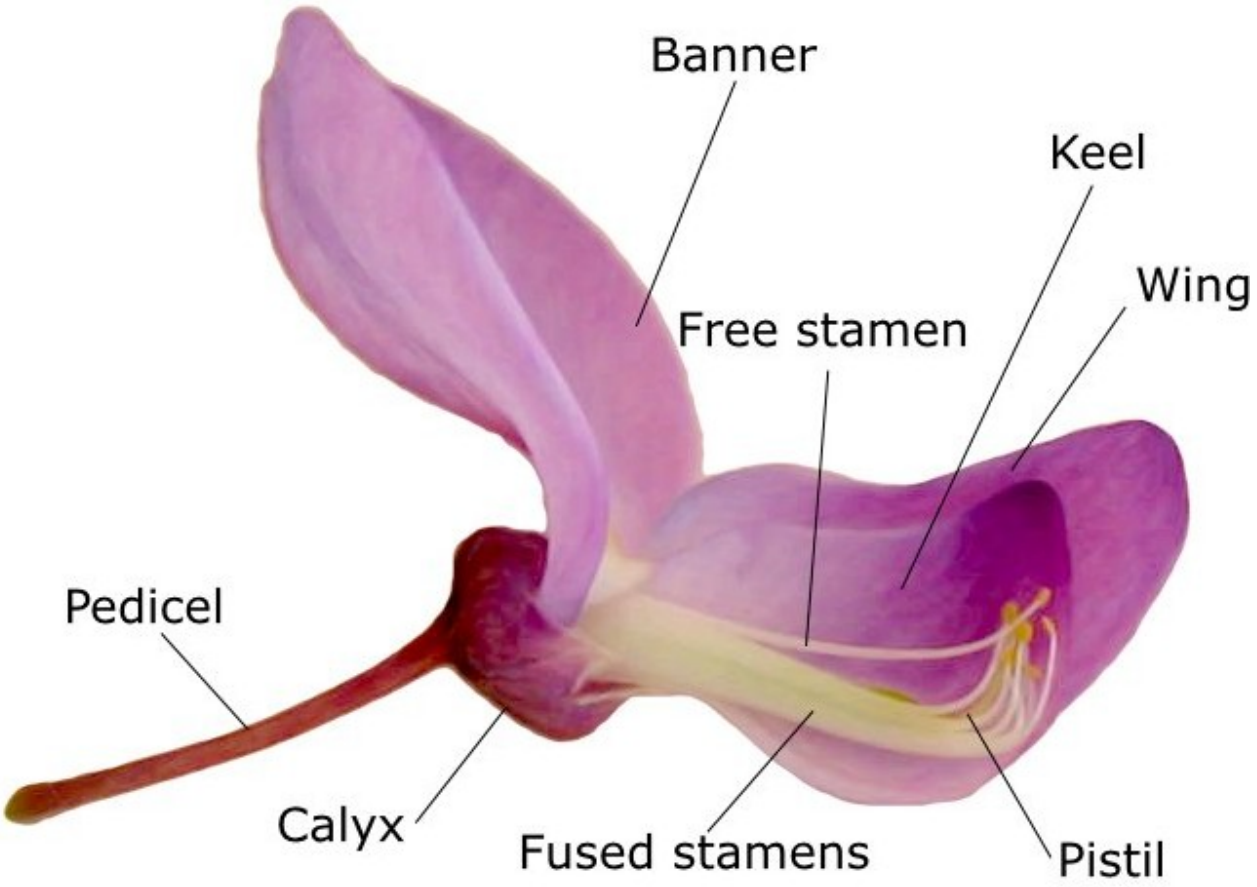
- Widely distributed throughout the world but preferably in tropics
- Three subfamilies (Caesalpinioideae, Mimosoideae, Papilionoideae) often treated as separate families

Morphology of Leguminosae

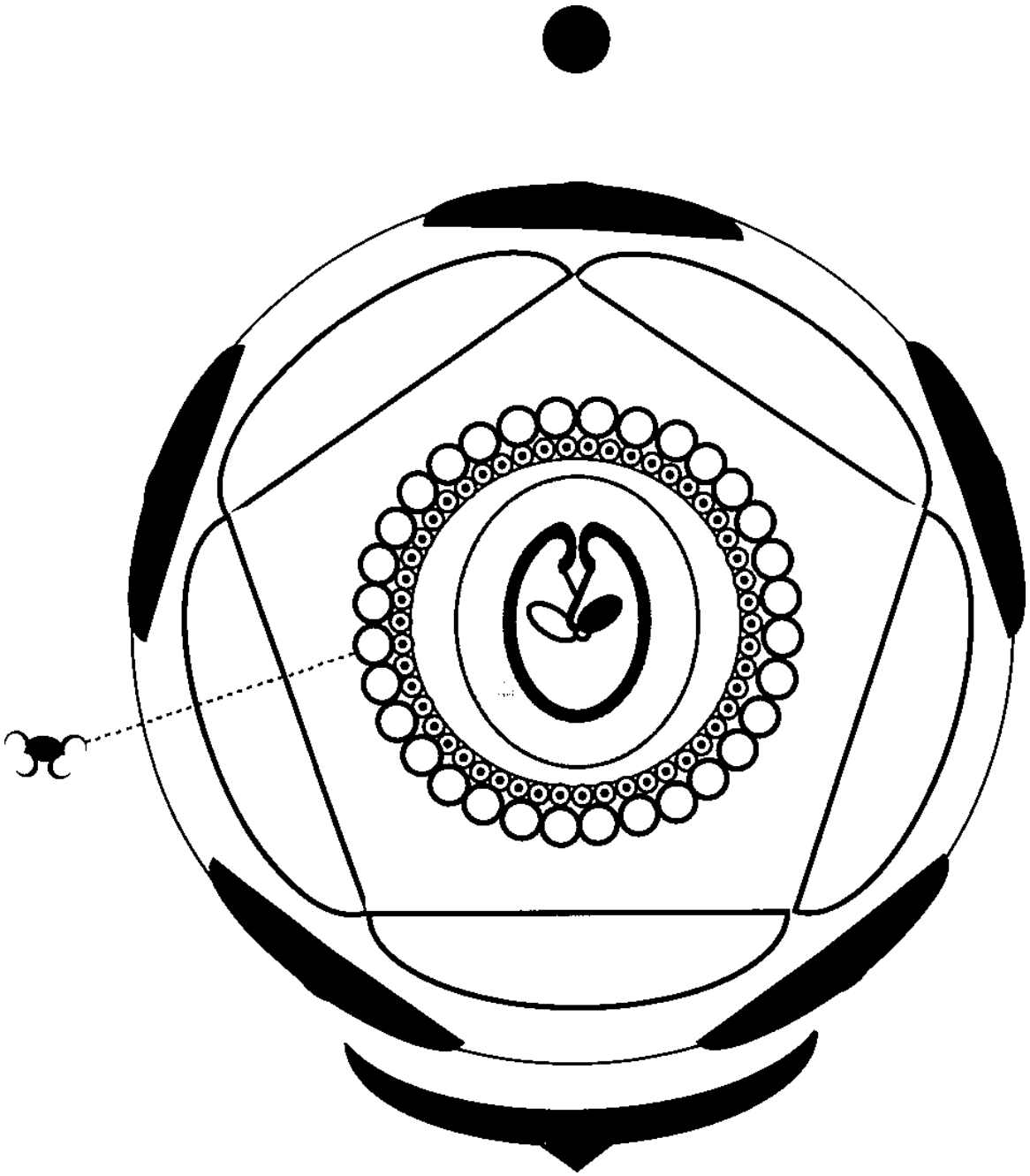
- Have root nodules with nitrogen-fixing bacteria
- Leaves alternate, pinnately compound (once or twice), with stipules
- Sepals 5, united; petals 5, in Papilionoideae they are free, unequal and have special names (banner, keel and wing), in Mimosoideae they fuse and form tube
- Stamens often 10 with 9 fused and one free stamen; in Mimosoideae, stamens are numerous
- Singe pistil with single carpel
- Fruit is a legume: dehiscent with one camera
- Mature seeds without endosperm

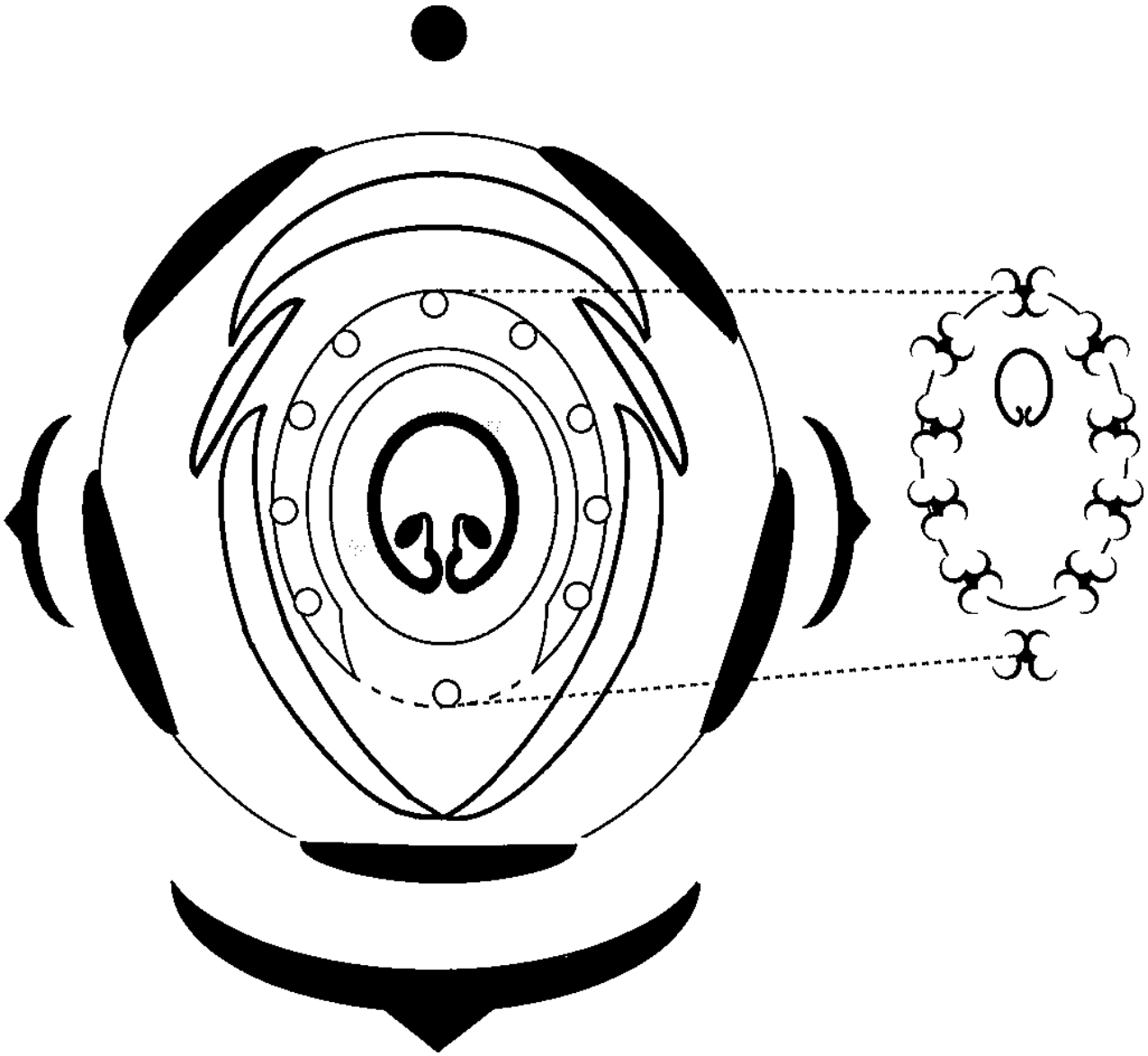
Flower of Papilionoideae


banner
single stamen
9 stamens
fused by
filaments
wing (2)
keel (2)
calyx
pedicel

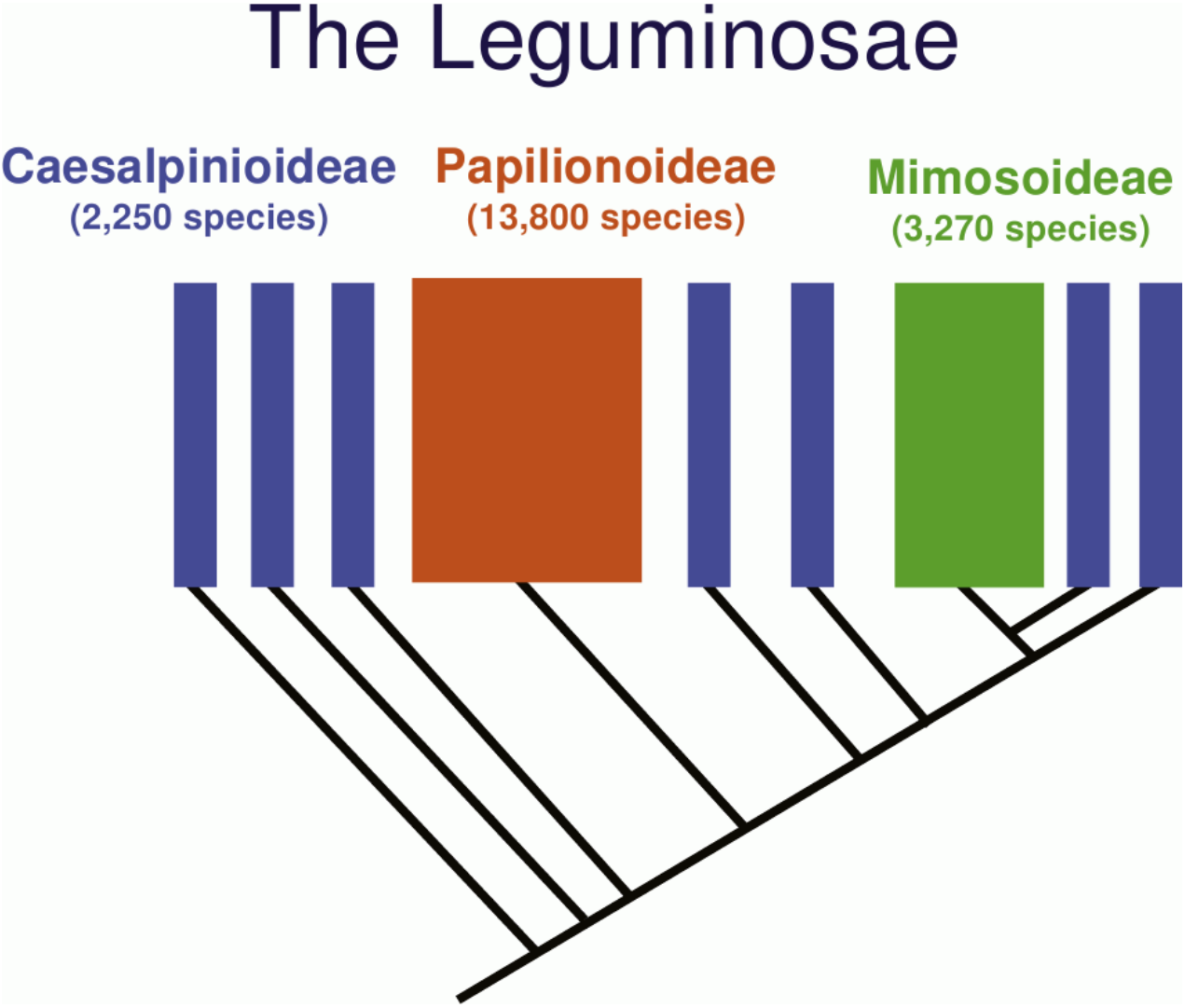


Leguminosae flower: Mimosoideae and Papilionoideae





$*\mathrm{K}_{(5)}\mathrm{C}_{(5)}\mathrm{A}_{5-\infty}\mathrm{G}_{\underline{1}}$ or $\uparrow\mathrm{K}_{(5)}\mathrm{C}_{1,2,2}\mathrm{A}_{1,[4+5]}\mathrm{G}_{\underline{1}}$



Leguminosae classification

- Three subfamilies: Caesalpinioideae, Mimosoideae and the biggest is Papilionoideae (Faboideae)
- Caesalpinioideae:
  - *Gleditsia*—gleditsia
  - *Bauhinia*—orchid tree
  - *Cercis*—redbud
  - *Delonix*—royal poinciana
- Mimosoideae:
  - *Desmanthus*—prairie mimosa
  - *Prosopis*—mesquite
  - *Acacia*—acacia
  - *Mimosa*—sensitive plant, mimosa

***Delonix regia* in flower**

Unusual legume—*Harleyodendron unifoliatum*

Phyllodes of Australian *Acacia glaucoptera*

Desmanthus illinoensis

Mimosa pudica **before touch**

***Mimosa pudica* after touch**

Representatives of Papilionoideae (Faboideae)

- Swartzioids (*Swartzia*: highly unusual, but only in tropics)
- Genistioids
  - *Lupinus*—lupinus
- Dalbergioids
  - *Amorpha*—false indigo
  - *Petalostemon*, or *Dalea*—prairie-clover
  - *Arachis*—peanut

  - *Desmodium*—tick-trefoil

- Millettioids
  - *Apios*—ground nut
  - *Phaseolus*—beans
  - *Glycine*—soybeans
  - *Psoralea*—breadroot

***Swarzia* sp.**

Representatives of Papilionoideae (Faboideae) (contd.)

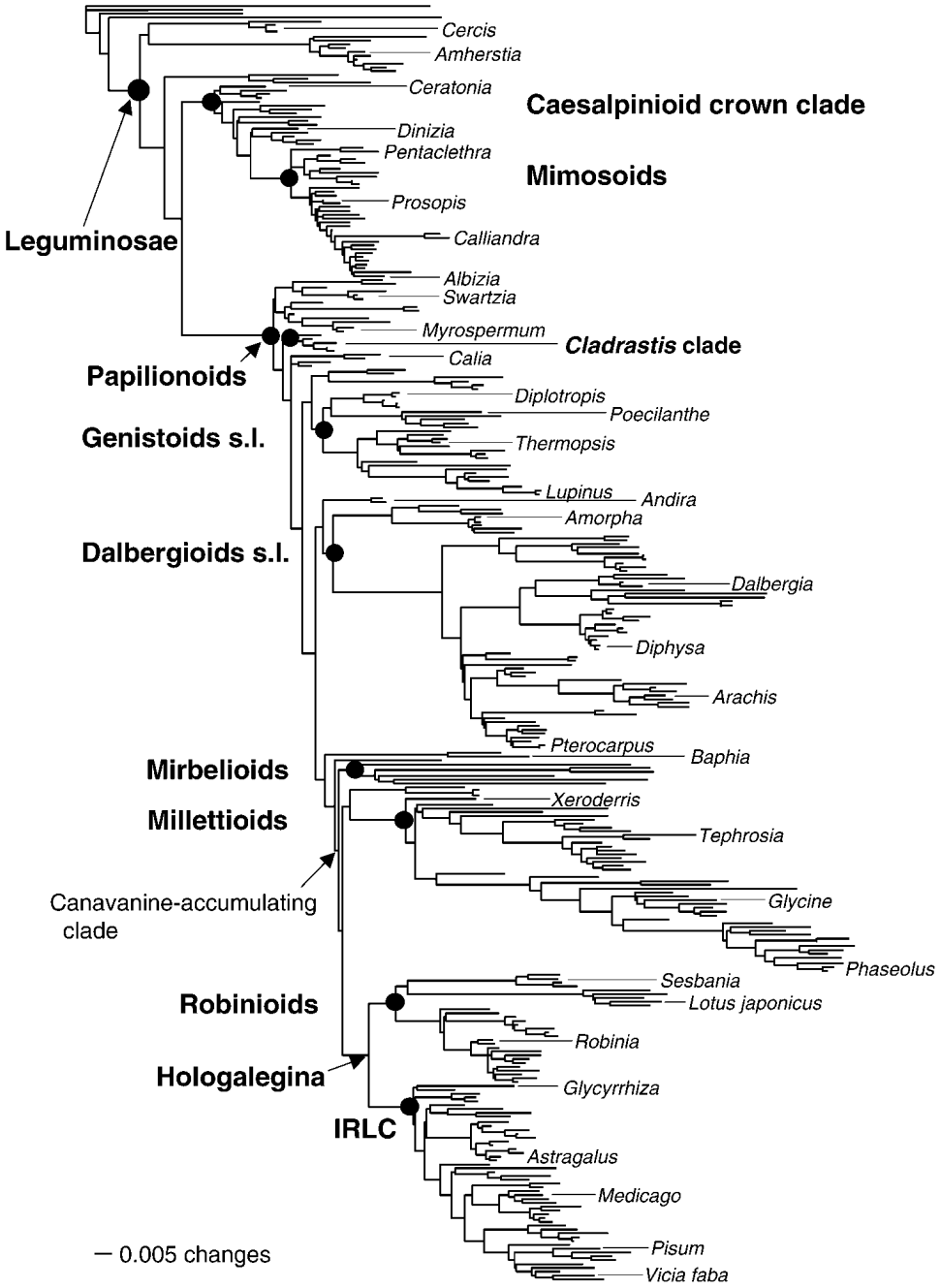
- Robinioids

  - *Lotus*—trefoil
  - *Robinia*—locust
- IRLC ("inverted repeat-lacking") group
  - *Caragana*—Siberian peashrub
  - *Astragalus*—milkvetch
  - *Oxytropis*—loco-weed
  - *Trifolium*—clover
  - *Vicia*, *Lathyrus*—vetch
  - *Medicago*—alfalfa
  - *Melilotus*—sweet clover
  - *Pisum*—pea

***Glycine max*, soybean**

***Arachis hypogaea*, peanut**

Phylogeny of legumes



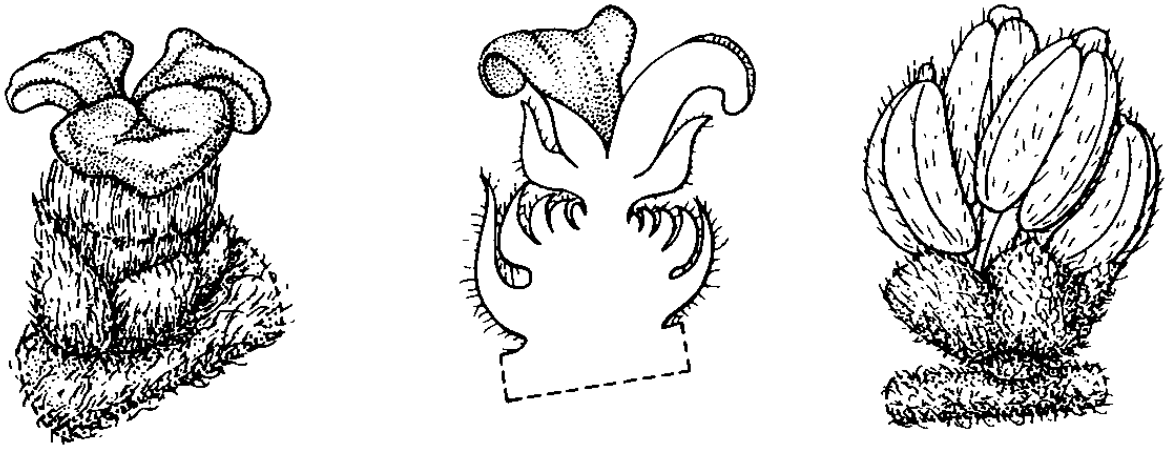
8.2 Fagaceae—beech family

Fagaceae—beech family

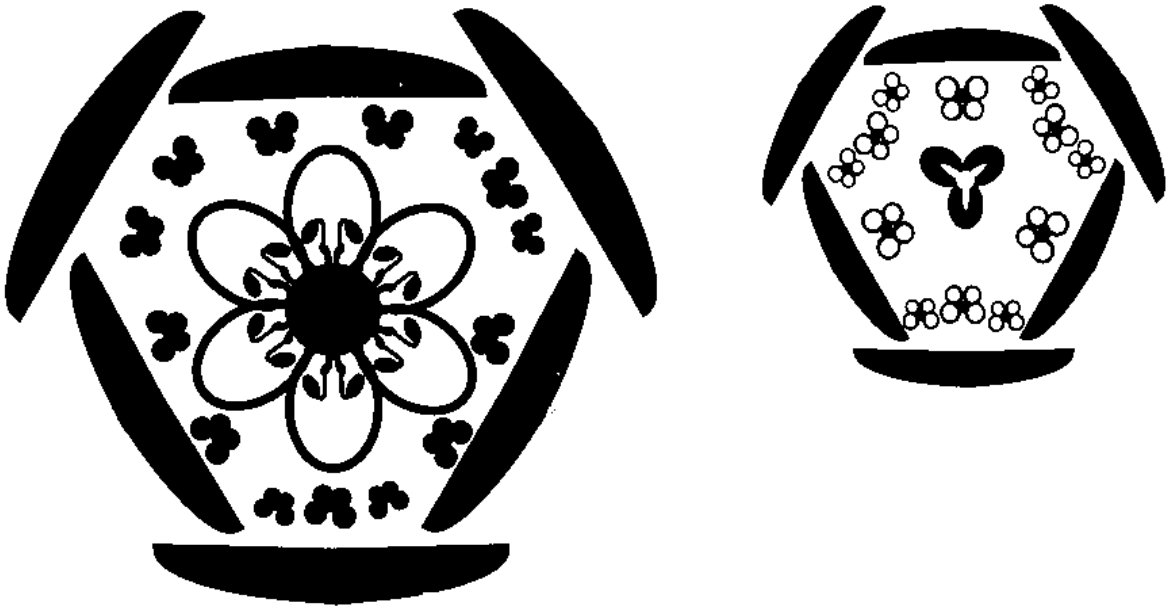
- ≈ 800 species
- Distributed mostly in broad-leaved forests of North hemisphere
- Life forms: trees, rarely shrubs with mycorrhizal roots
- Leaves simple, entire or lobed, alternate, with minute stipules
- Flowers in catkins, very reduced due to wind pollination, unisexual; carpellate flowers with involucre of multiple fused bracts; perianth scale-like, stamens from 4 to numerous

- Pistil of 3–6 carpels, ovary inferior, 5 of 6 ovules are aborting
- Fruit a nut (acorn is a nut + involucre) with one seed with large embryo and no endosperm

***Quercus* flowers and inflorescences**



Fagaceae flowers



$$♀{*}\,\mathrm{P}_{6-9}\mathrm{G}_{\overline{(6)}}\ ♂{*}\,\mathrm{P}_{6-9}\mathrm{A}_{6-12}$$

Representatives of Fagaceae

Importance: wood producers, sometimes (chestnut) also food plants

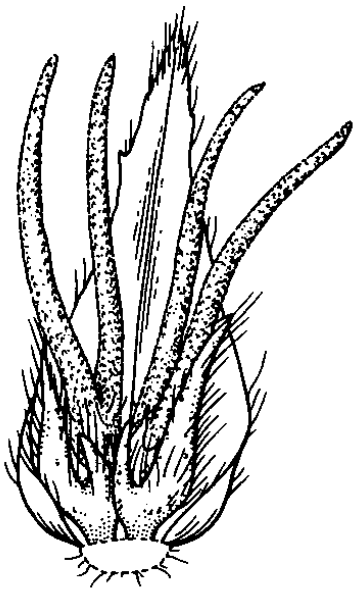
- *Quercus*—oak
- *Fagus*—beech
- *Castanea*—chestnut

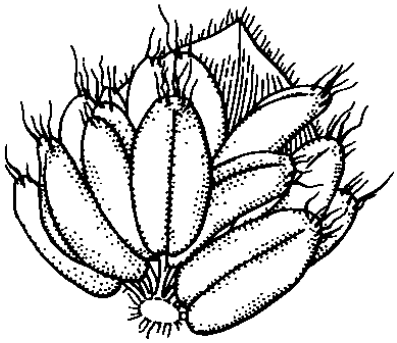
8.3 Betulaceae—birch family

Betulaceae—birch family

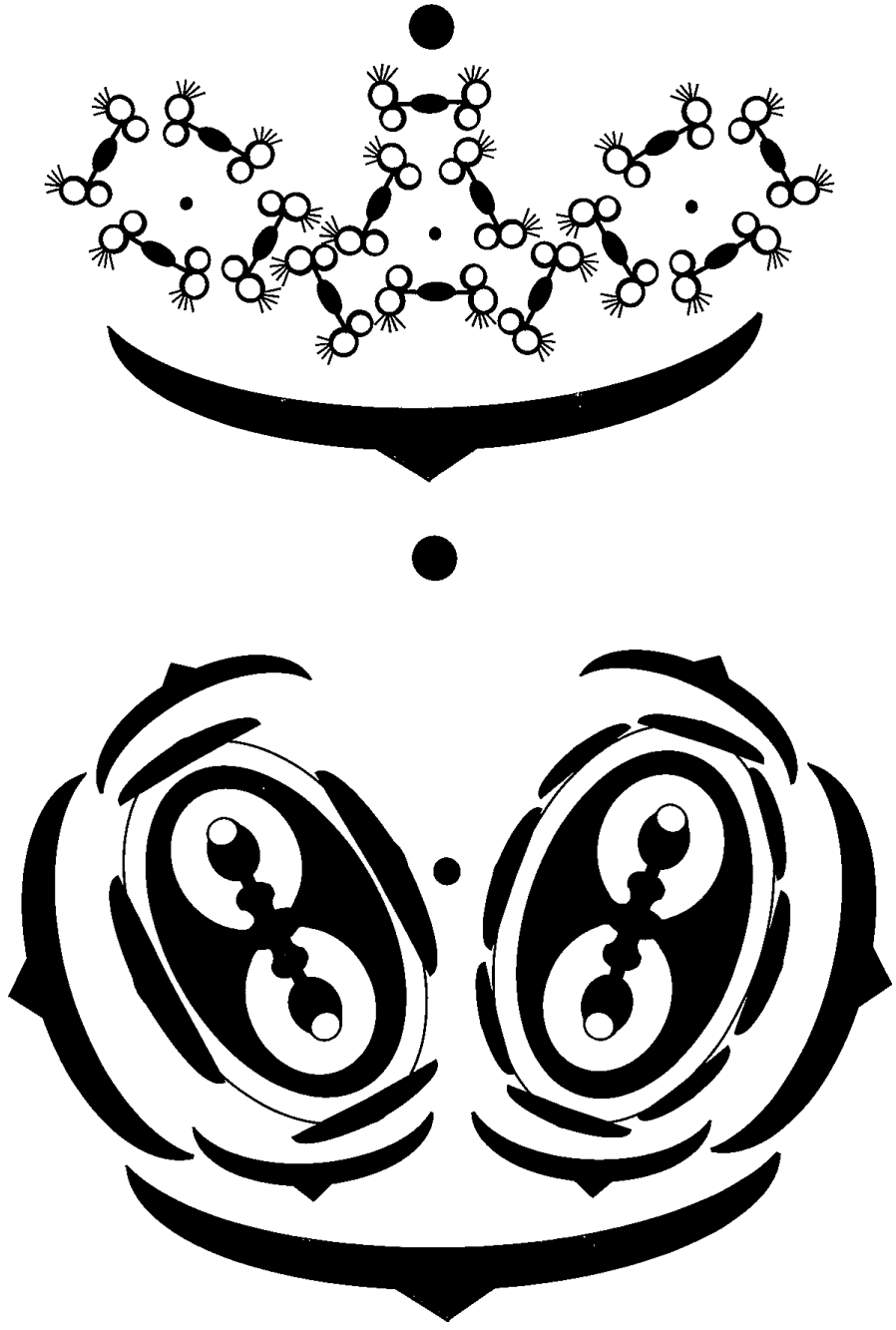
- ≈ 150 species
- Distributed in Northern hemisphere, frequent from temperate to arctic regions
- Life forms: trees and shrubs with mycorrhizal roots
- Leaves alternate, simple, serrate, deciduous, with stipules
- Flowers in catkins or compact inflorescences, very reduced, unisexual, associated with bracts; perianth minute or absent, stamens 1–4
- Pistil bicarpellate, ovary inferior, ovules 2, one aborting
- Fruit a nut or nutlet, with subtended bracts, seeds with large embryo and almost no endosperm

***Carpinus* flowers and inflorescences**





Betulaceae flowers and inflorescences



$\male * \mathrm{K}_{0-6}\mathrm{C}_0\mathrm{A}_{1-4}$ $\female * \mathrm{K}_{0-6}\mathrm{C}_0\mathrm{G}_{\overline{(2)}}$

Representatives of Betulaceae

Importance: ornamental, wood, edible nuts (*Corylus*)

- *Corylus*—hazelnut (in subfamily Coryloideae: naked male flowers and female flowers with perianth)
- *Betula*—birch
- *Alnus*—alder

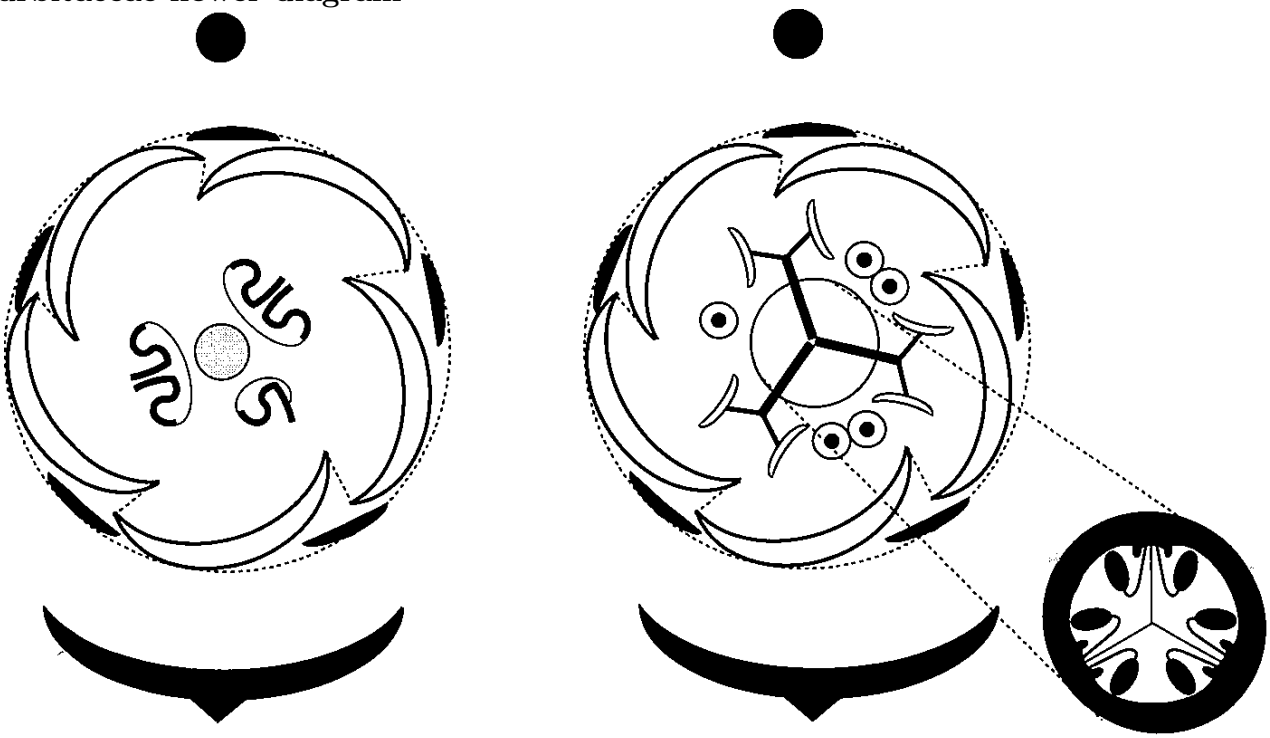
Cucurbitaceae, melon family

- $\approx$ 900 species, mostly tropical and subtropical plants
- Prefer dry regions, important component of different deserts

Morphology of Cucurbitaceae

- Hairy herbs or vines with tendrils (modified shoots)
- Vascular bundles bicollateral: phoem locates from both sides of xylem
- Leaves alternate, without stipules, sometimes palmately dissected, with actinodromous venation
- Flowers unisexual, in raceme-like inflorescences
- Petals fused, form a tube
- Stamens usually fused
- Pistil with 3 carpels, ovary inferior (flower epigynous)
- Fruit is a berry

Cucurbitaceae flower diagram



$$\ast \mathrm{K}_{(5)}\mathrm{C}_{(5)}\mathrm{A}_{(3-5)};\ \ast \mathrm{K}_{(5)}\mathrm{C}_{(5)}\underline{\mathrm{G}_{(3)}}$$

Representatives of Cucurbitaceae

- Many famous crops:
  - Pumpkin, squash—*Cucurbita*
  - Melon—*Melo*
  - Watermelon—*Citrullus*
  - Cucumber—*Cucumis*
  - Gourd—*Lagenaria*

- In North Dakota, invasive wild cucumber (*Echinocystis*) is a common plant now
- Exploding cucumber—*Ecballium* is a famous example of mechanical seed distribution
- *Hodgsonia* is one of the most attractive Cucurbitaceae

Wild watermelon, *Citrullus colocynthis*

Wild cucumber, *Echinocystis lobata* (near Minot)

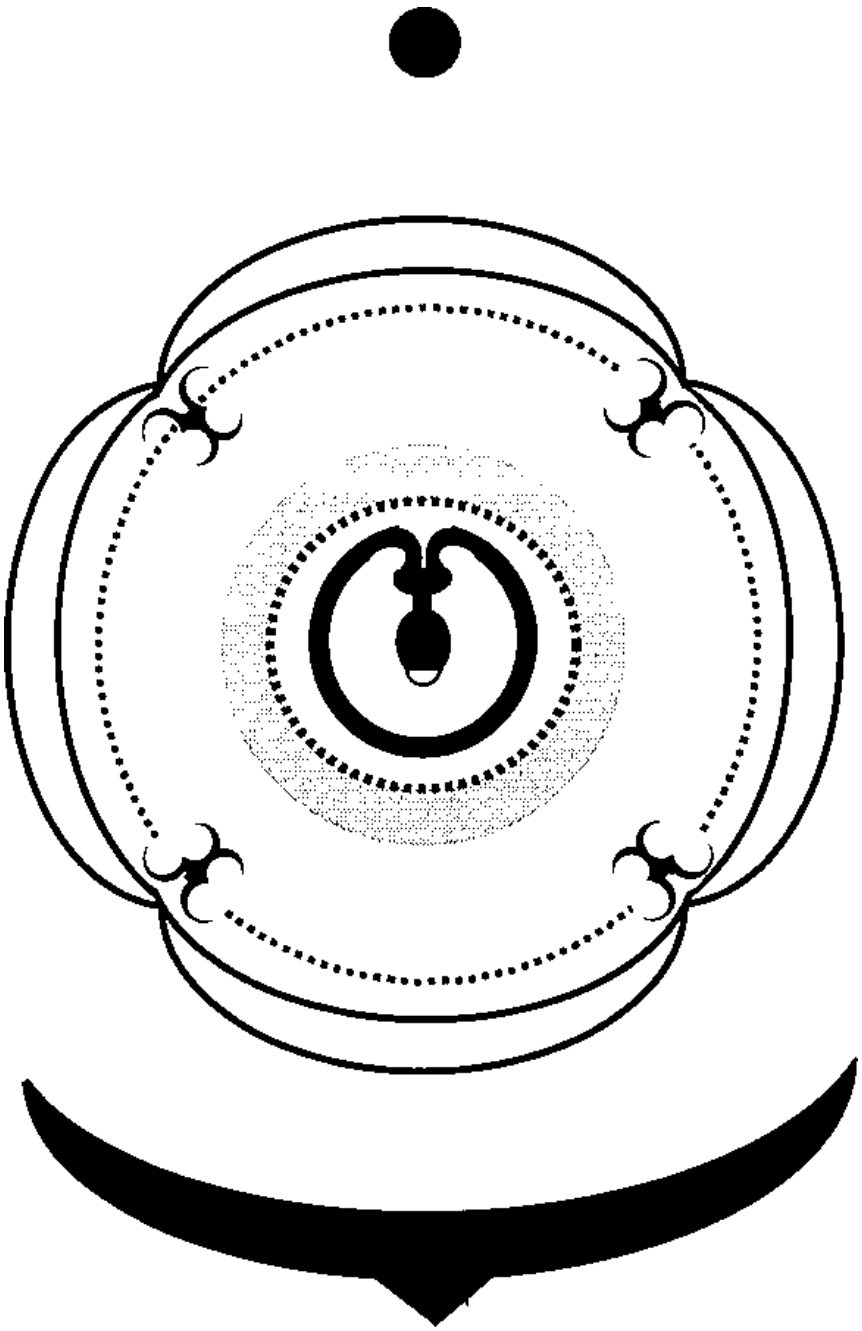
***Hodgsonia heteroclita*, female plant**

8.4 Elaeagnaceae—Russian olive family

Elaeagnaceae—Russian olive family

- ≈ 50 species
- Distributed in temperate and subtropical parts of Northern hemisphere
- Life forms: shrubs or small trees, often thorny, roots nodulated with nitrogen-fixing bacteria
- Leaves alternate or opposite, simple, entire, without stipules, with specific lepidote trichomes
- Flowers solitary or in inflorescences, 4-merous, without petals; 4 sepals attached to the hypanthium, stamens also 4.
- Pistil monomeric, with one basal ovule, ovary superior
- Fruit consists of dry achene inside of fleshy hypanthium

Elaeagnaceae flower



$*\,\mathrm{K}_{4-5}\mathrm{C}_{0}\mathrm{A}_{4-5}\mathrm{G}_{\underline{1}}$

Representatives of Elaeagnaceae

Importance: fruits are edible, *Hippophaë* is cultivated as berry plant

- *Elaeagnus*—Russian olive: we have *E. angustifolia*, Russian olive, and *E. argentea*, silverberry
- *Shepherdia*—buffaloberry, two species in ND: *Sh. argentea* and *Sh. canadensis*
- *Hippophaë*—sea-buckthorn

***Hippophaë*—sea-buckthorn**

8.5 Rosaceae—rose family

General features of Rosaceae

Rosaceae—rose family

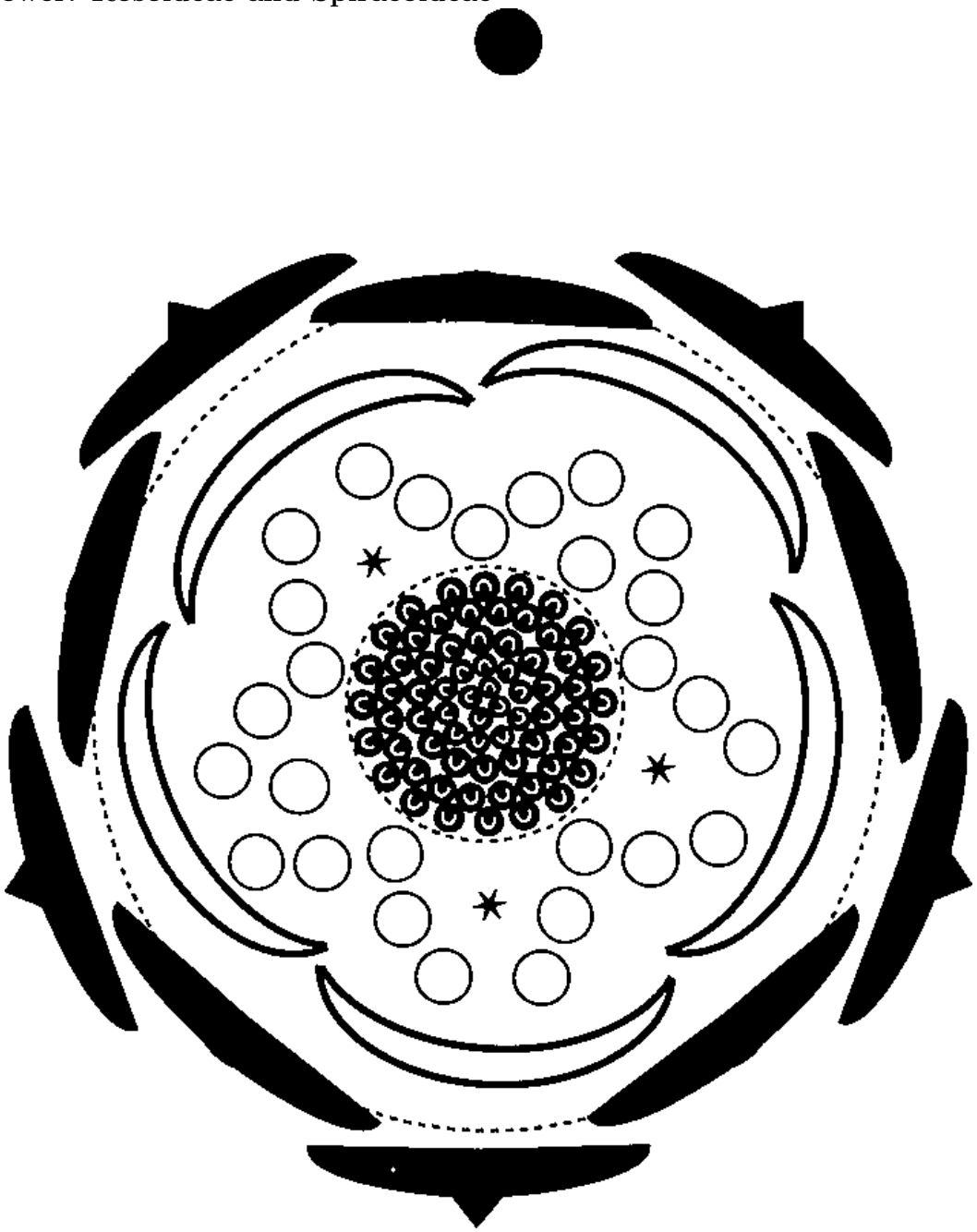
- $\approx 3,000$ species
- Nearly cosmopolitan, but more common to temperate and subtropical regions of Northern Hemisphere
- Forest and meadow plants, do not prefer dry places

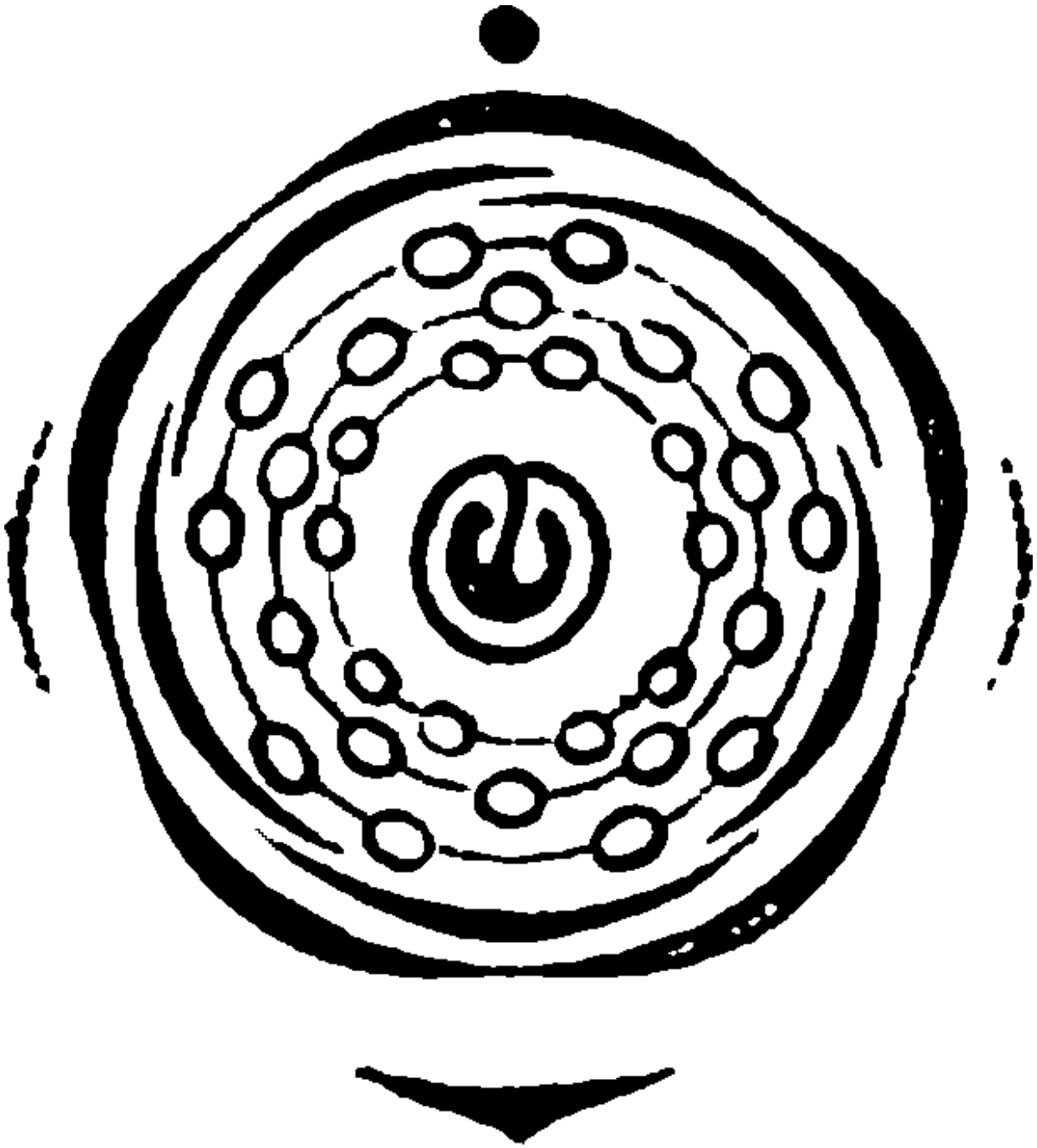
Morphology of Rosaceae

- Trees, shrubs and herbs
- Often accumulate cyanogenic compounds (contains $\boxed{-\mathrm{C} \equiv \mathrm{N}}$ group); some Rosaceae have nitrogen-fixing bacteria as symbionts
- Alternate, simple or dissected leaves with stipules
- Flowers with hypanthium; in Maloideae hypanthium fuses with pistils and produces inferior ovary
- Calyx with connected sepals, corolla with distinct petals
- Stamens numerous, typically in sets of 5 (or 10)

- Fruits diverse: multiple nuts/drupes in Rosoideae, multiple follicles or single drupes in Spiraeoideae, pomes in Maloideae
- Mature seeds without endosperm

Rosaceae flower: Rosoideae and Spiraeoideae





$\ast \mathrm{K}_5\mathrm{C}_5\mathrm{A}_{5-10-\infty}\mathrm{G}_{\underline{1-5-\infty}} \vee \mathrm{G}_{\overline{(3-5)}}$ (Maloideae)

Representatives of Rosaceae

Several subfamilies, each with economically important members:

- Rosoideae (multiple one-seeded fruits)
  - *Rosa*—rose
  - *Fragaria*—strawberry and close genus *Potentilla*—cinquefoil
  - *Rubus*—blackberry, raspberry
- Spiraeoideae (fruits—follicles of solitary drupes)
  - *Prunus*—cherry, peach, apricot, plum

  - *Spiraea*—meadowsweet, important component of prairies

- Maloideae (now often inculded in Spiraeoideae; have inferior ovary, fruits are pomes)
  - *Pyrus*—apple, pear
  - *Crataegus* (hawthorn), *Sorbus* (mountain ash), *Amelanchier* (serviceberry), *Aronia* (chokeberry) and others

***Spiraea tomentosa*, prairie plant**

Aronia* × *mitchurinii

Spontaneous hybrid between American chokeberry and European *Sorbus aria*

***Potentilla fruticosa*, shrubby cinquefoil**

8.6 Salicaceae—willow family

General features of Salicaceae

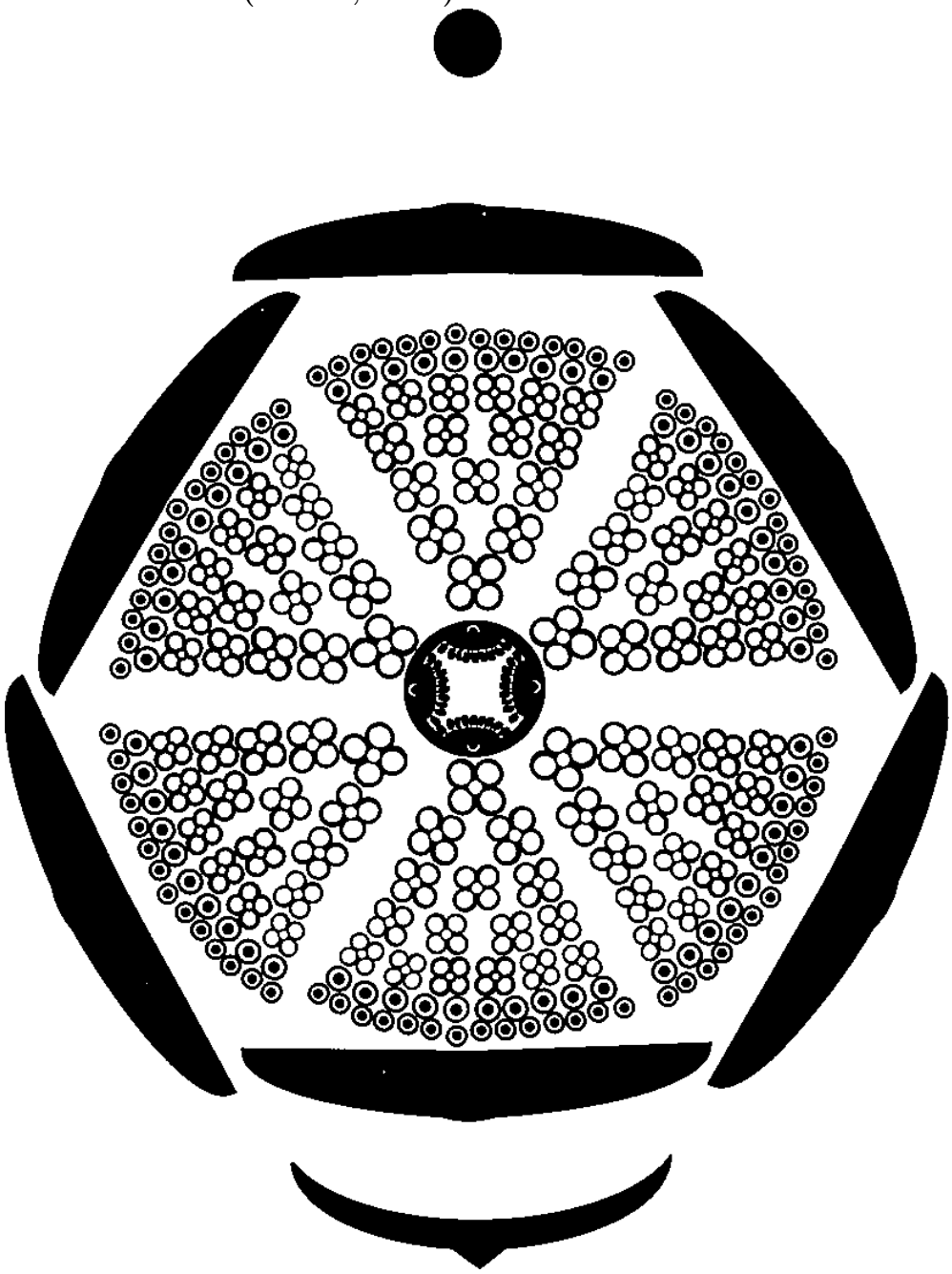
- ≈ 1010 species
- Distributed across all climatic zones, most genera are in tropics, most species in temperate regions
- Poplar (*Populus*) and willow (*Salix*) are important component of temperate riparian forests

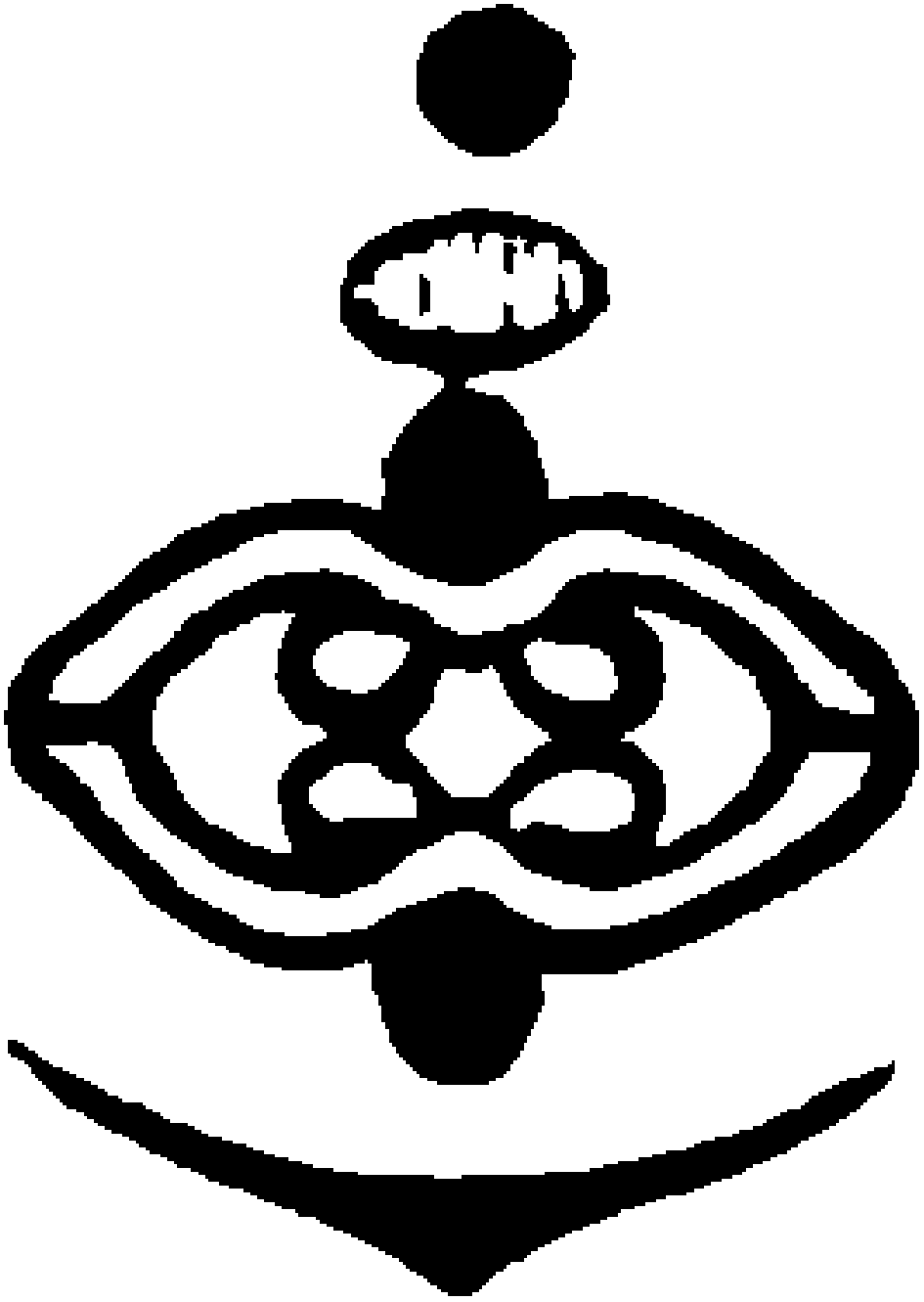
Morphology of Salicaceae

- Trees, usually with alternate simple leaves with stipules and salicoid teeth

- In many genera, flowers are more and more reduced—from flowers with numerous stamens and both sepals and petals to apetalous flowers with several stamens
- Flowers often have disk—flattened nectariferous structure
- Pistil of two carpels
- Fruit is a capsule
- Seeds often with hairs

Salicaceae: *Azara* and *Salix* (female, male)





$$\ast \mathrm{K}_{0-6}\mathrm{C}_{0-8}\mathrm{A}_{2-\infty}\mathrm{G}_{\underline{(2-4)}}$$

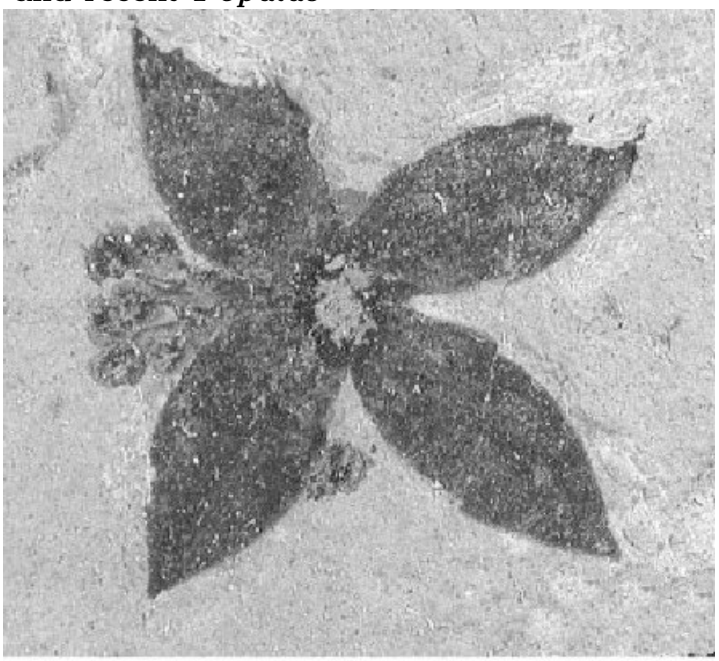
Representatives of Salicaceae

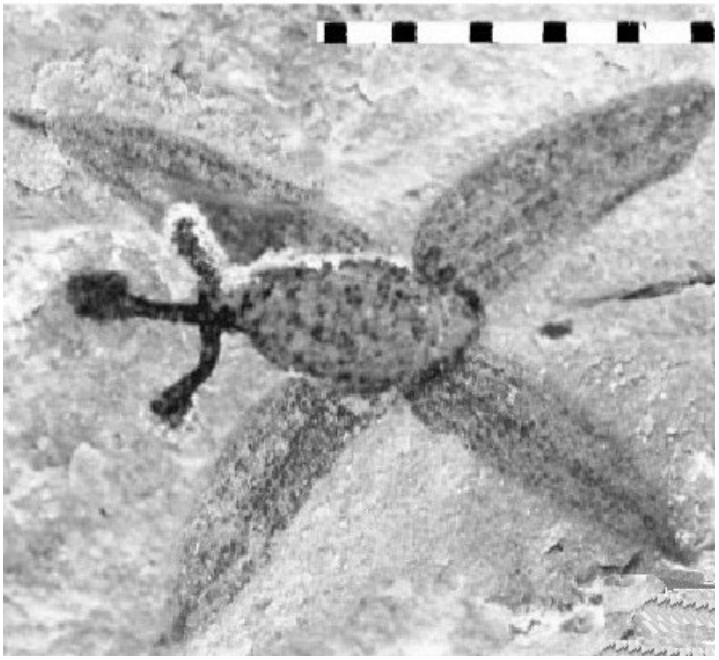
- Willow (*Salix*), almost 300 species of trees and shrubs, important component of Northern flora
  - Subgenus *Salix*
    - *S. amygdaloides*
    - *S. alba**
    - *S. babylonica**
    - *S. fragilis**
    - *S. lucida*
    - *S. serissima*
  - Subgenus *Longifoliae*
    - *S. exigua*
  - Subgenus *Chamaetia*
    - *S. pedicellaris*
  - Subgenus *Vetrix*

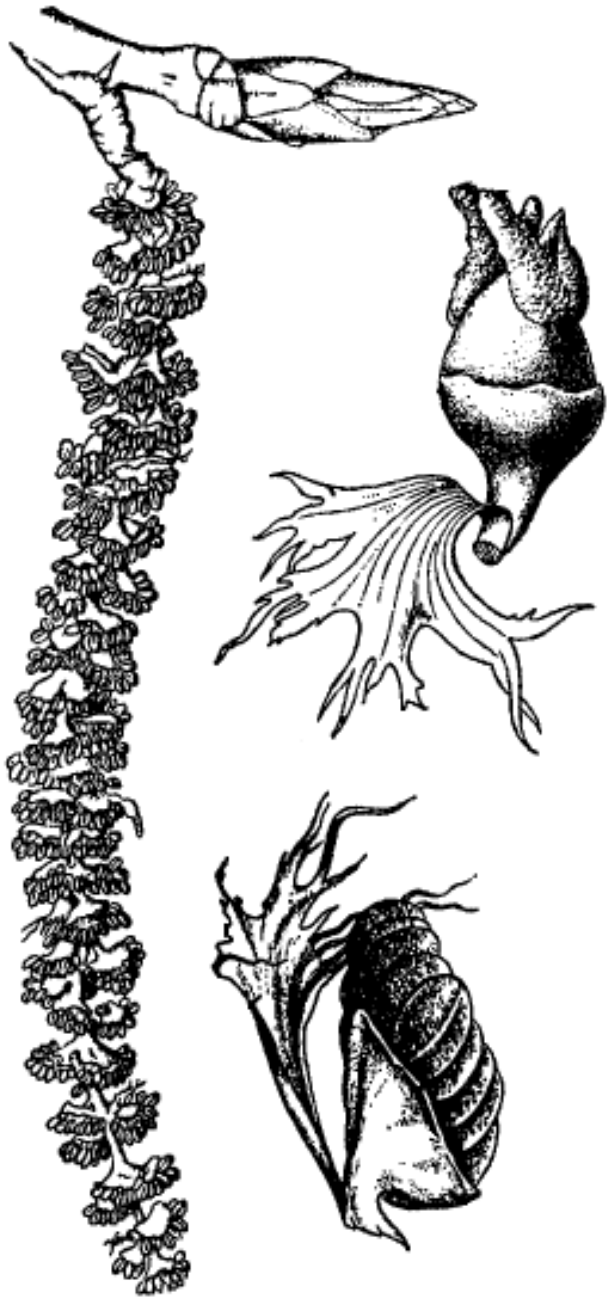
    - *S. cordata*
    - *S. eriocephala*
    - *S. lutea*
    - *S. discolor*
    - *S. humilis*
    - *S. bebbiana*
    - *S. candida*

- Poplar, or cottonwood (*Populus*) has ≈ 40 species. Cultivated as a wood source. Aspen (*Populus tremuloides*) is a main component of North Dakota forests.

Salicaceae: salicoid teeth; fossil *Pseudosalix* and recent *Populus*

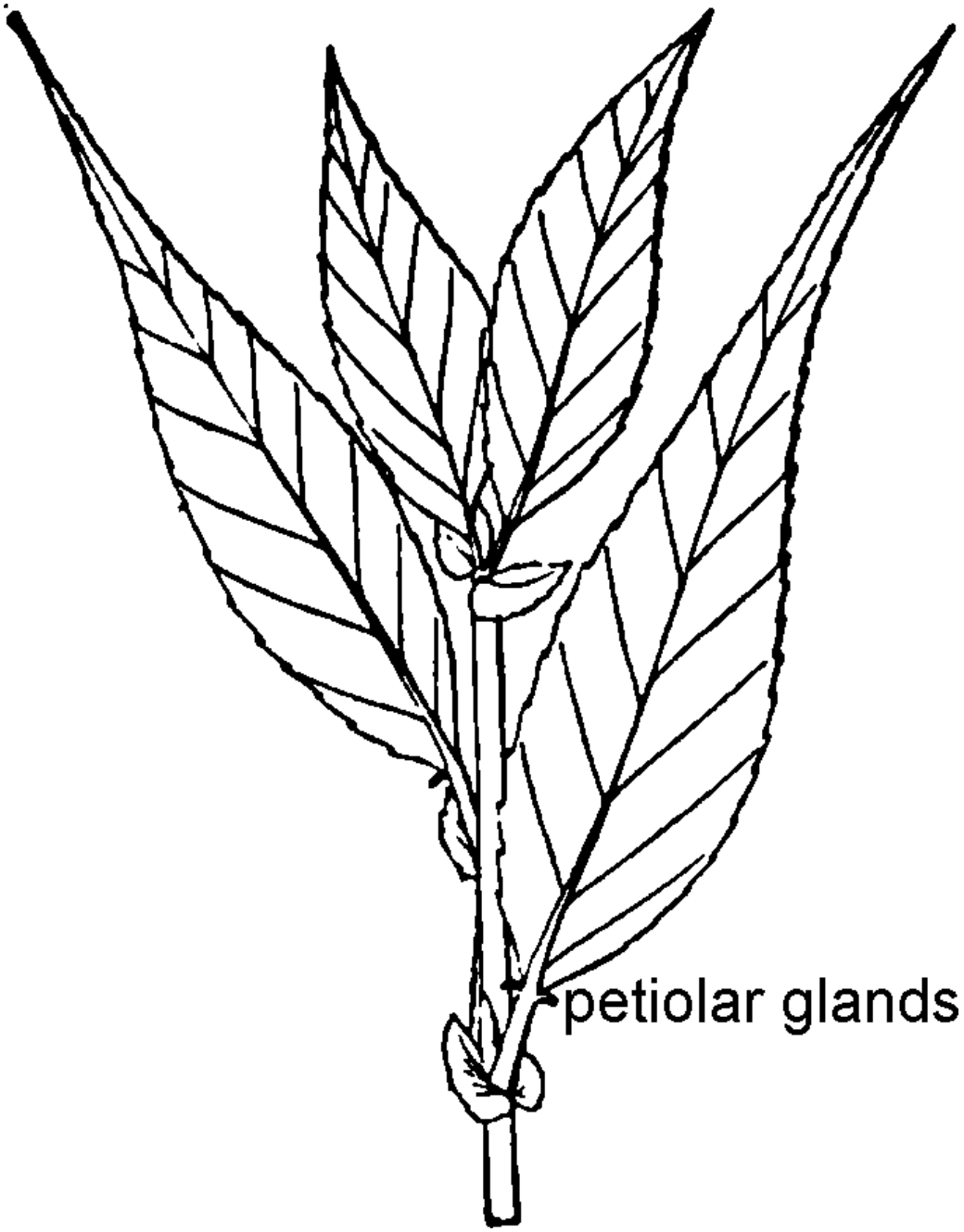






***Salix hastata*, female and male plants**

***Salix* sp., petiolar glands**



Aspen, *Populus tremuloides*

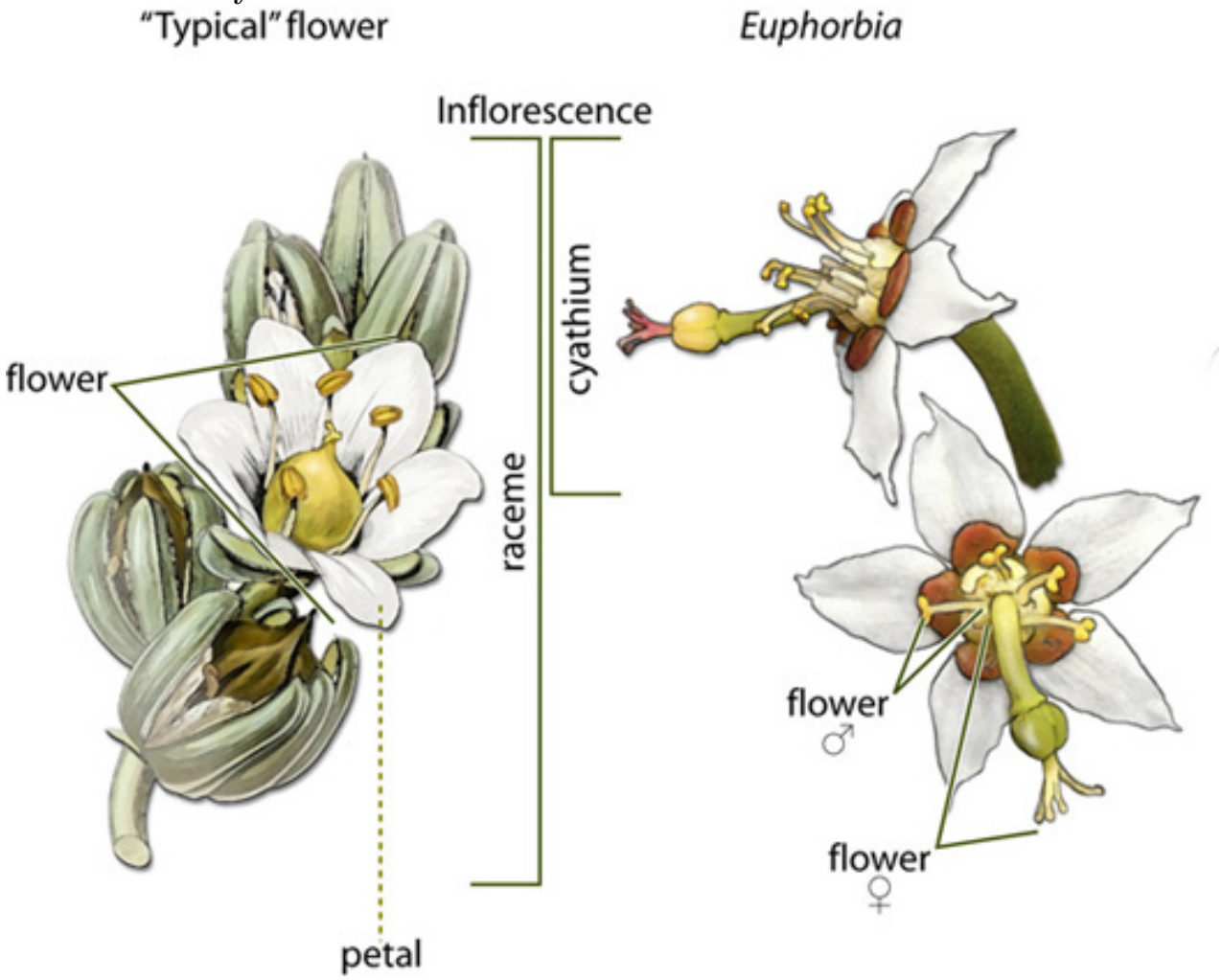
***Azara* flowers**

8.7 Euphorbiaceae—spurge family

General features of *Chamaesyce*

- Sometimes, treated as *Euphorbia*
- Inflorescences are cyathia, small and flower-like

Typical flower vs. cyathium



Other Rosanae/Celastranae

- Rosales
  - Urticaceae: *Urtica* (nettle) *etc.*
  - ... and other smaller families
- ... and several other orders

For Further Reading

References

[1] A. Shipunov. Shipunov, A. Plants of North Dakota. Manual. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448/nd_manual/nd_manual.pdf`

[2] A. Shipunov. Shipunov, A. Flora of North Dakota: Checklist. Version 2. Ed.: Kartesz, J., and Nishino, M. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

[3] Minot State University Herbarium (MISU)

[4] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.

Outline

9 Malvanae superorder of Rosidae

9.1 Cruciferae, or Brassicaceae—cabbage family

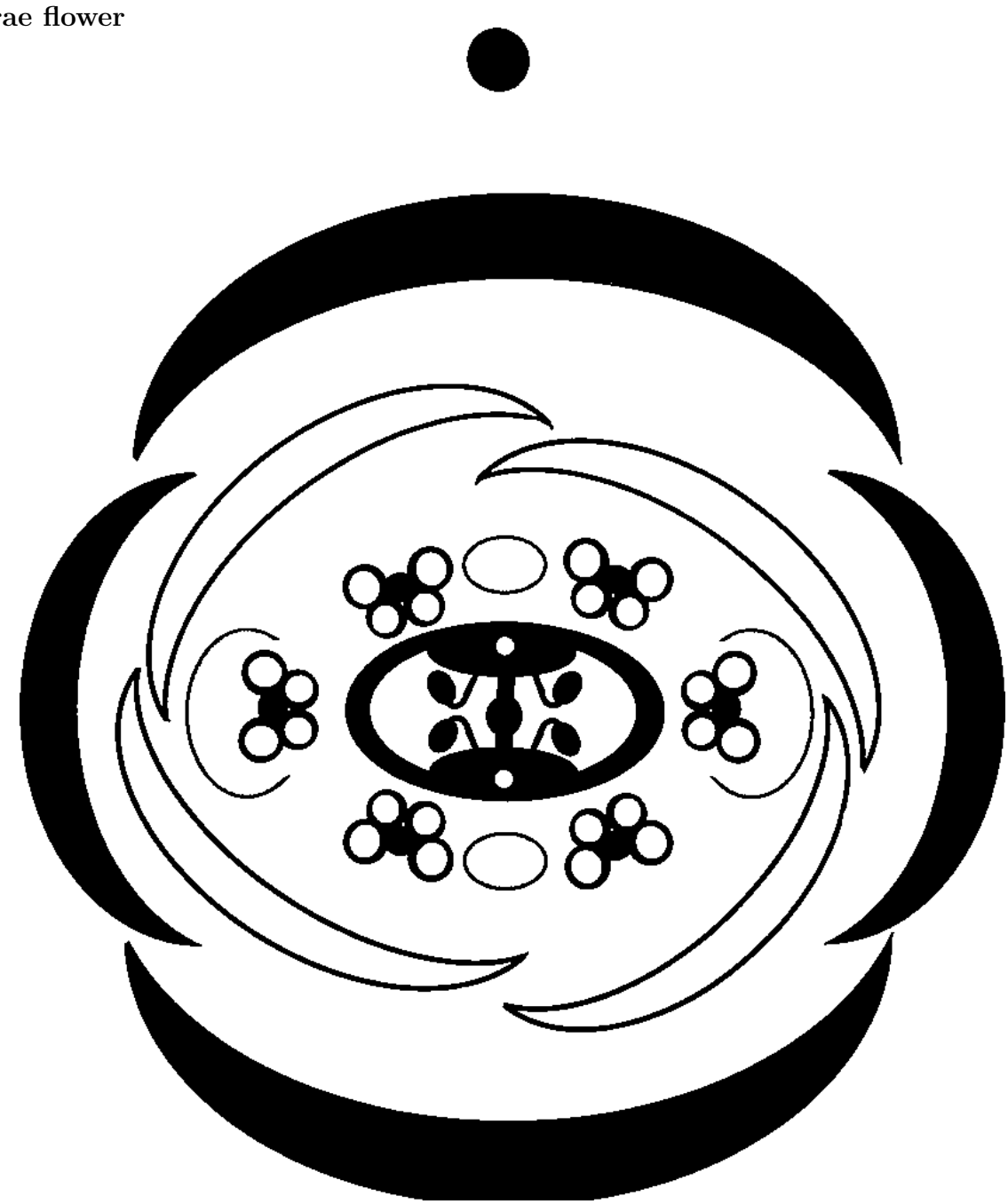
General features of Cruciferae

- $\approx 3,000$ species
- Found mostly in temperate regions, especially in dry climates
- Morphologically and ecologically uniform family

Morphology of Cruciferae

- Herbs, often **hairy**, contain mustard oils
- Leaves simple, often dissected, alternate, without stipules
- Flowers dimerous, in racemes
- 4 sepals, 4 petals, ancestrally also 4 stamens but inner stamens split each in two = 6 stamens in total
- Pistil has two carpels
- **Fruit** is a silique: dehiscent, with two cameras and replum bearing seeds. Identification without fruits is really difficult.
- Mature seeds with small amount of endosperm

Cruciferae flower



$$\ast \mathrm{K}_4\mathrm{C}_4\mathrm{A}_{2+2,2}\mathrm{G}_{\underline{(2)}}$$

Representatives of Cruciferae

Important vegetables and spices, e.g.

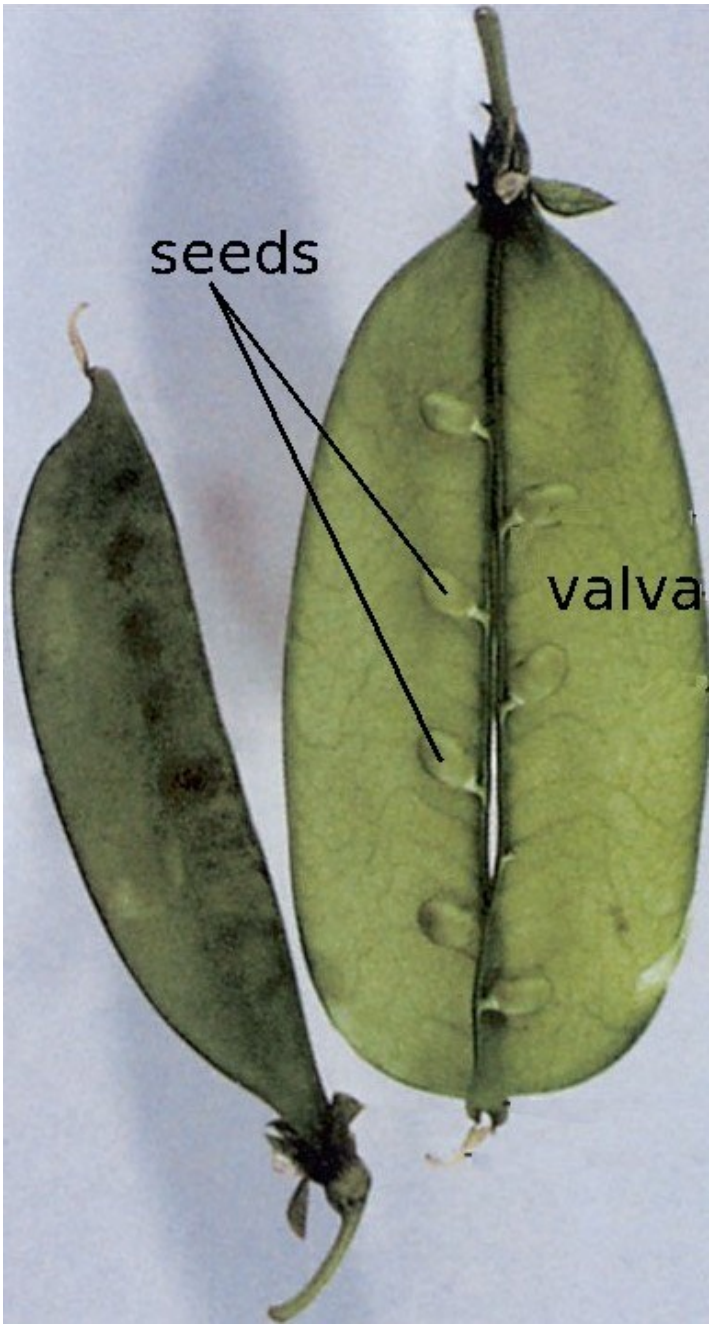
- *Brassica oleracea*—broccoli, cabbage, cauliflowers
- *Brassica nigra*—black mustard
- *Brassica rapa*—turnip
- *Brassica napus*—rapeseed and "canola"
- *Raphanus*—radish

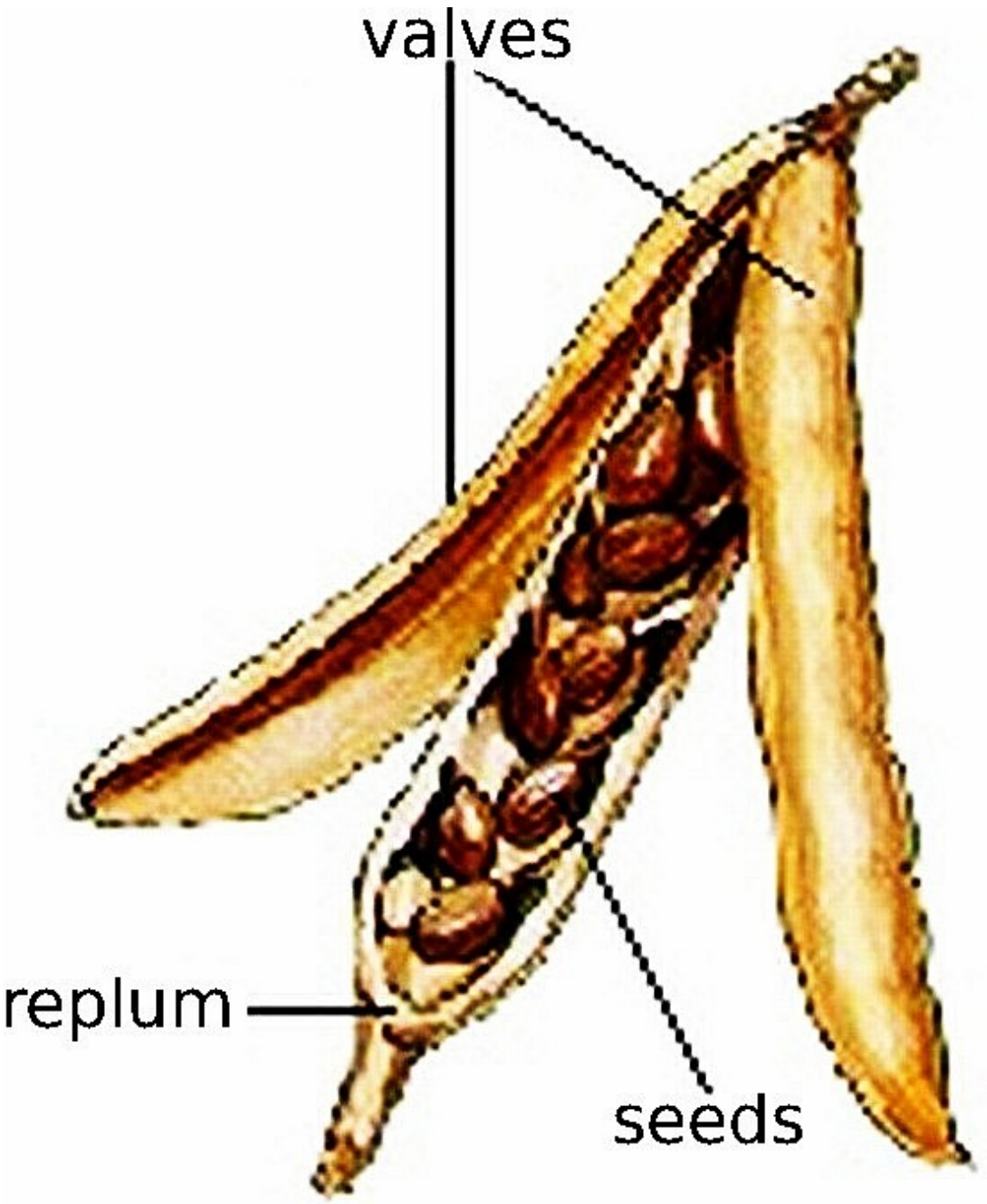
- *Armoracia*—horseradish

  and

- *Arabidopsis thaliana*—famous model plant

Legume and silique





Arabidopsis thaliana

9.2 Malvaceae—cotton family

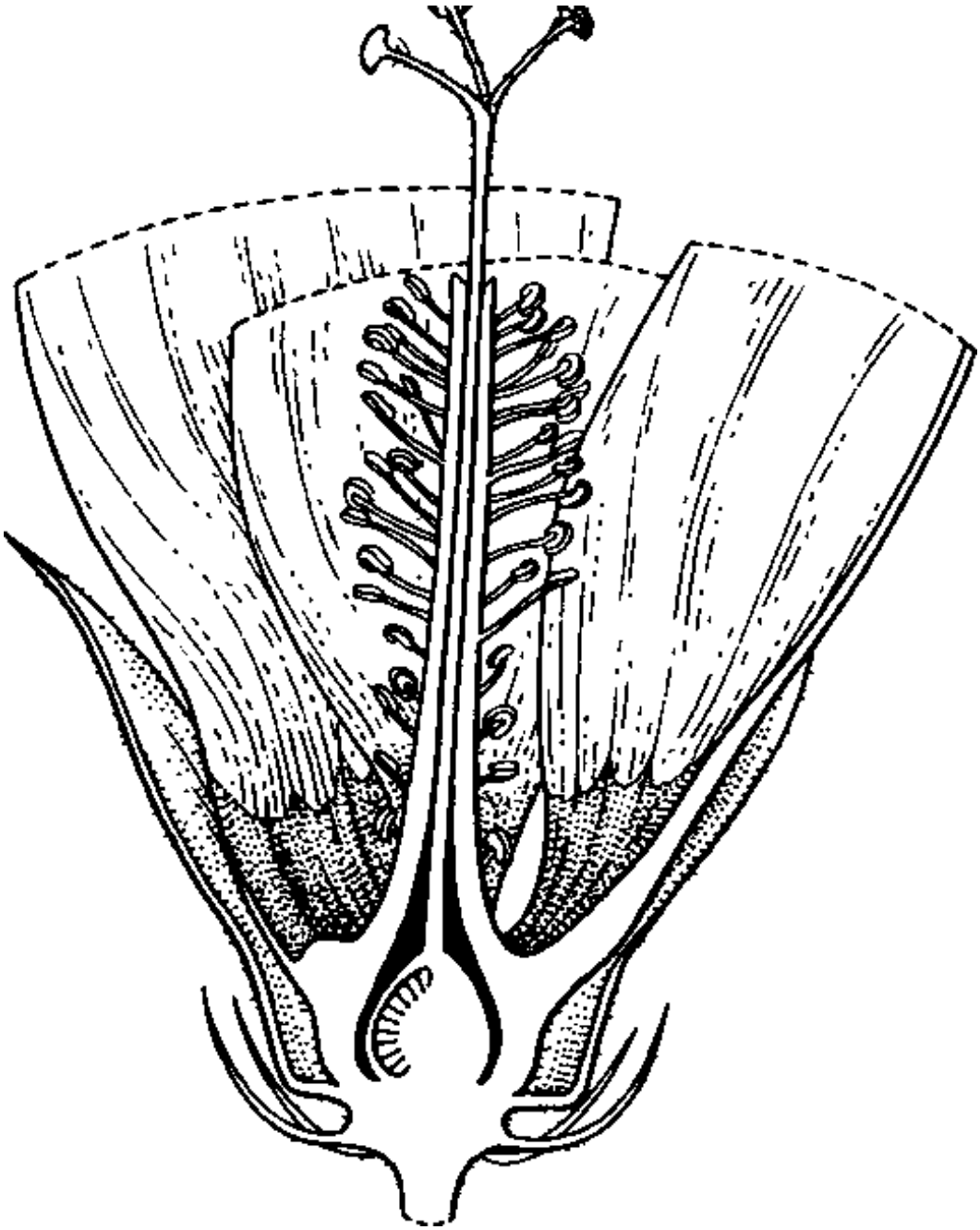
Malvaceae—cotton family

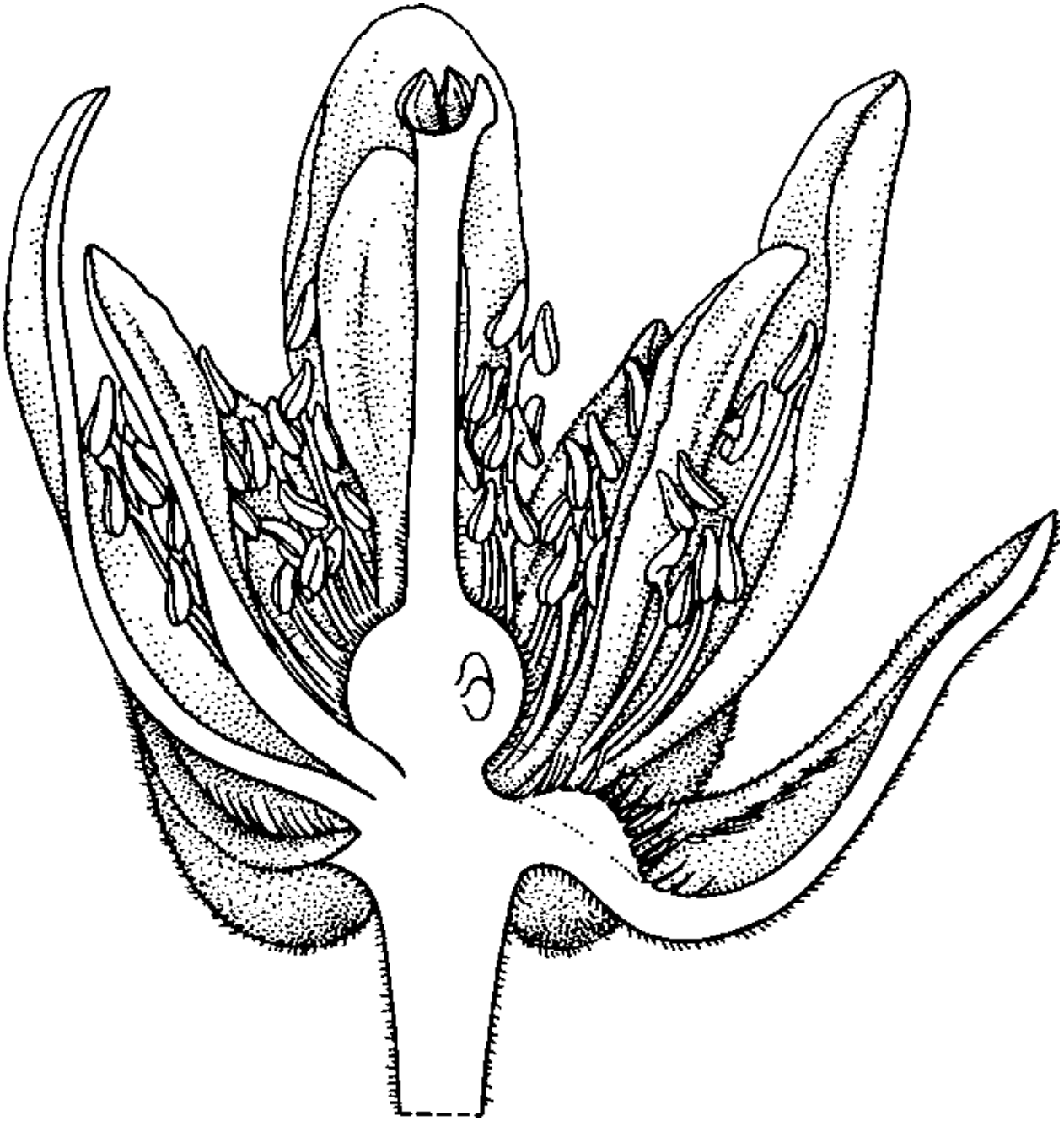
- $\approx 2,300$ species, now united several families (Bombacaceae, Sterculiaceae, Tiliaceae and Malvaceae s.str.)
- Distributed in tropical and temperate regions, equally in forests and grasslands
- Life forms: mostly trees and shrubs, core Malvaceae are herbs
- Leaves simple (or palmately compound), often with actinodromous venation, alternate, with stipules, often with star-like hairs
- Flowers mostly in inflorescences, bisexual, actinomorphic, usually with double perianth and often also with epicalyx, 5-merous; stamens multiplied and often fused in 1, 5 or more groups

- Pistil with superior ovary and 5 carpels
- Fruit is a capsule

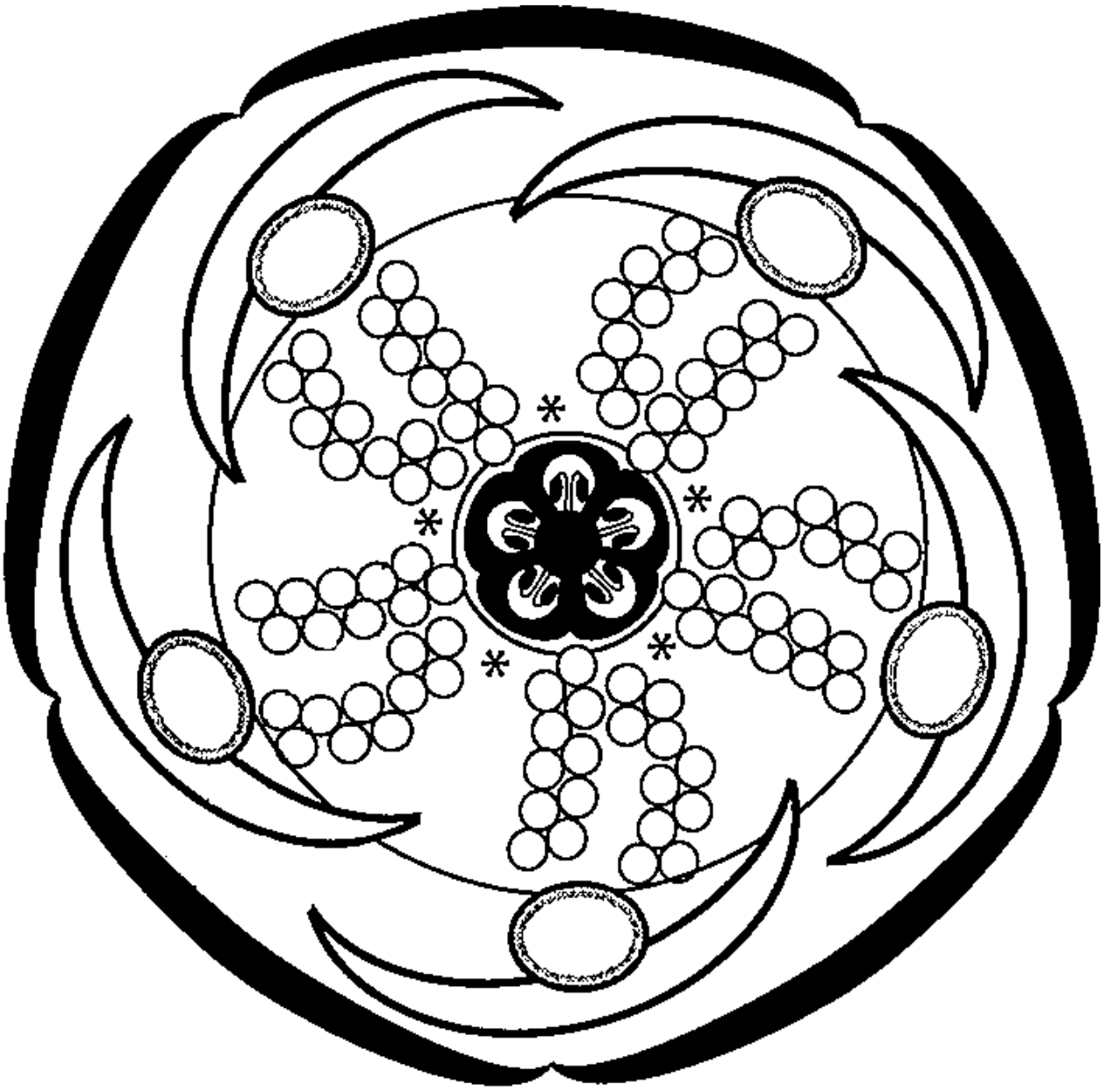
Malvaceae flowers

***Hibiscus* and *Tilia* flowers**





Malvaceae flower



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Representatives of Malvaceae

Importance: textile (cotton), food (cocoa, hibiscus) and ornamental (mallows, basswood)

- *Malva*, *Abutilon*, *Sphaeralcaea*—mallows
- *Theobroma*—cocoa tree
- *Gossypium*—cotton
- *Hibiscus*—hibiscus

Hibiscus tea plant

For Further Reading

References

[1] A. Shipunov. Shipunov, A. Plants of North Dakota. Manual. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/school/biol_448/nd_manual/nd_manual.pdf`

[2] A. Shipunov. Shipunov, A. Flora of North Dakota: Checklist. Version 2. Ed.: Kartesz, J., and Nishino, M. 2017—onwards. Mode of access: `http://ashipunov.info/shipunov/fnddb2`

[3] Minot State University Herbarium (MISU)

[4] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.

Outline

10 Asteridae. Order Lamiales

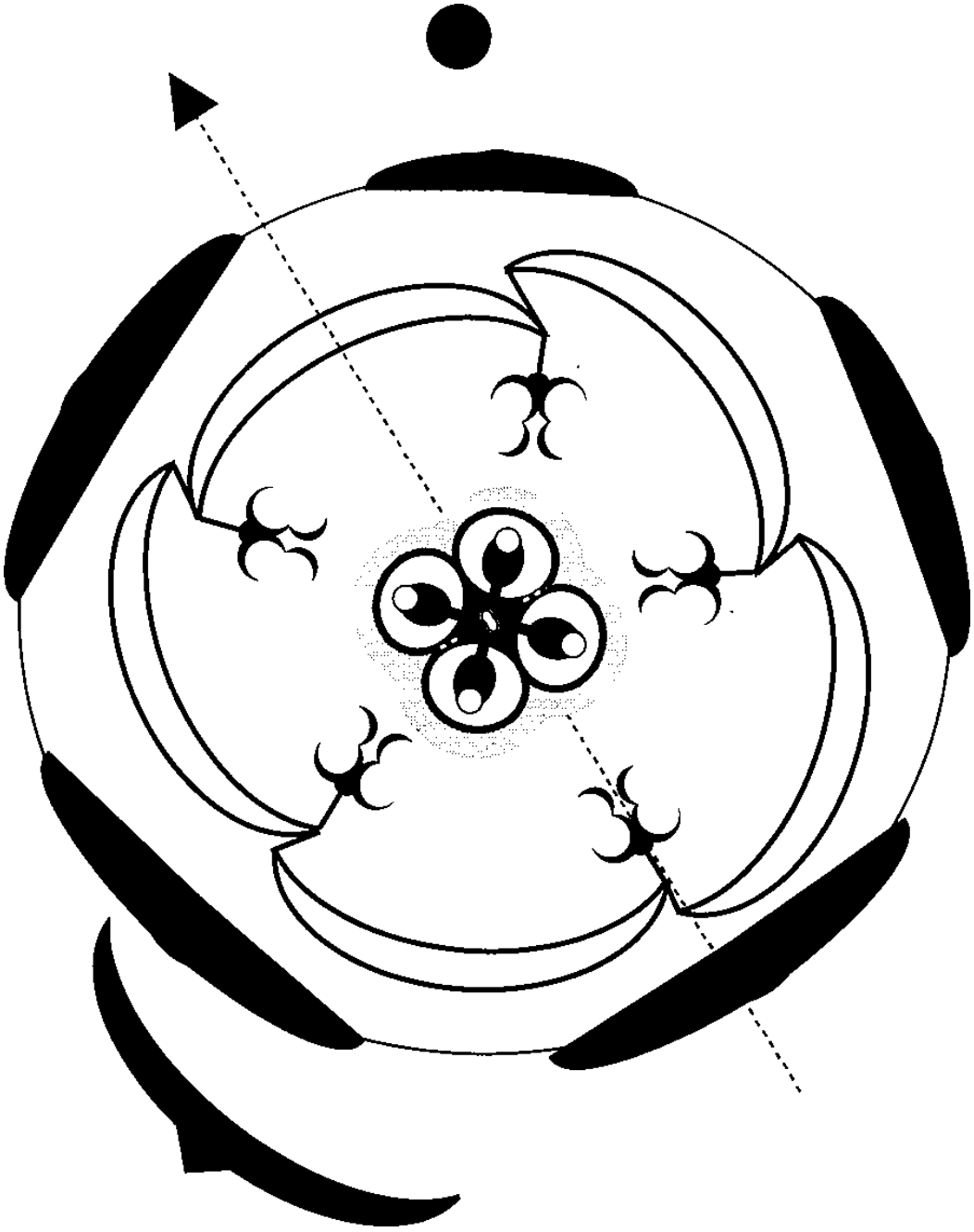
10.1 Boraginaceae—borage family

Description of Boraginaceae

- $\approx 2,000$ species, cosmopolitan
- Usually herbs, with roughly pubescent alternate leaves

- Flowers in cymes (cincinnia); bell or funnel-shaped, symmetric, 5-merous
- Pistil with two carpels which are secondary divided (similarity to Labiatae)
- Fruit schizocarp with 4 nutlets

Boraginaceae flower



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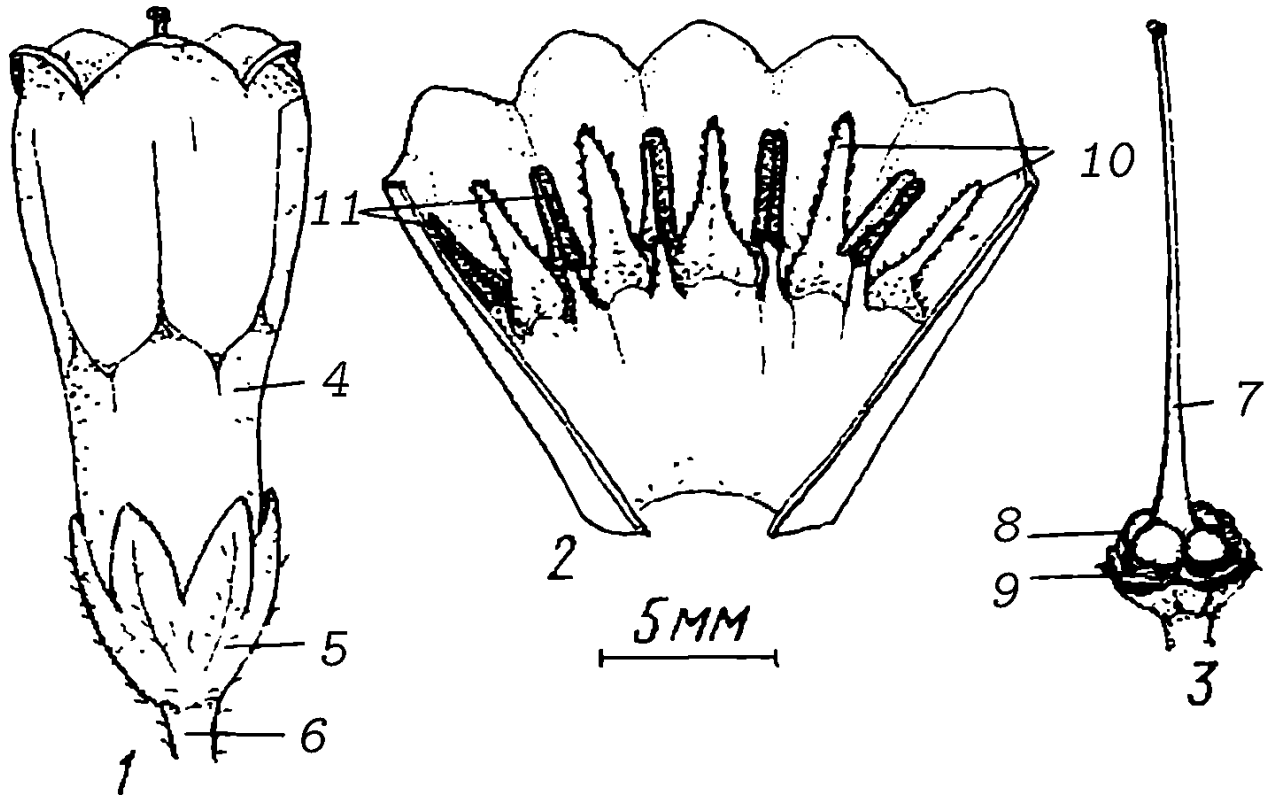
Flower of *Symphytum* (Boraginaceae)



Representatives of Boraginaceae

- *Lithospermum*—puccoon
- *Cynoglossum*—hound's tongue
- *Cryptantha*—cryptantha

Adjacent family Hydrophyllaceae (waterleaf family) also occurs in North Dakota.

10.2 Solanaceae—potato family

General features of Solanaceae

Solanaceae—potato family

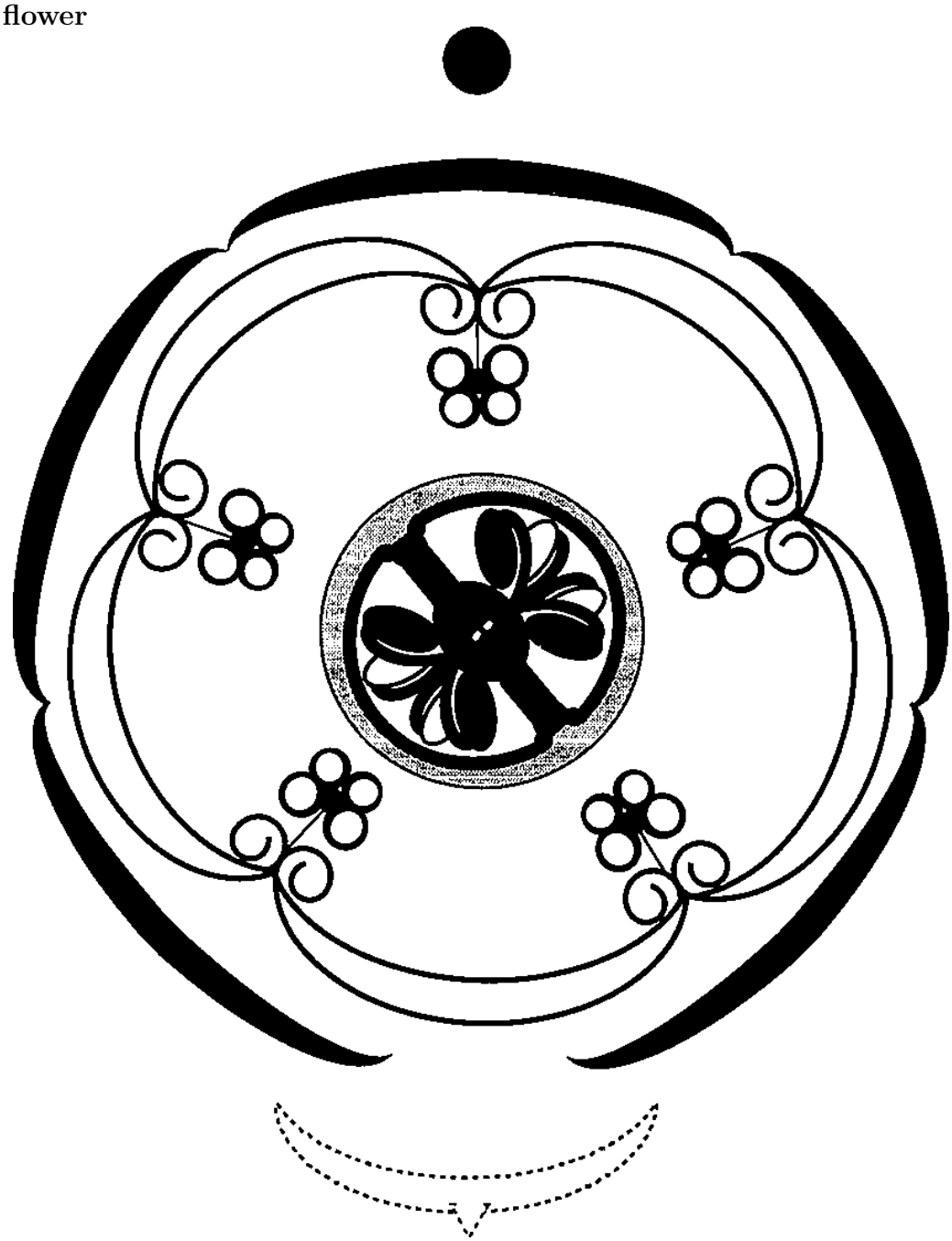
- $\approx 2,300$ species, most of them belong to one genus, *Solanum*
- Cosmopolitan, with center of diversity in South America
- Prefer places with good water supply

Morphology of Solanaceae

- Herbs, shrubs, vines, small trees; produce alkaloids, often poisonous
- Stems with bicollaterate vascular bundles
- Leaves alternate, without stipules, with pterodromous venation, simple or compound

- Flowers in cymes, actinomorphic (polysymmetric)
- Petals fused, stamens are attached to corolla
- Pistil has two carpels oriented obliquely to median plane of flower
- Fruit is mostly berry or capsule; seeds with well-developed endosperm

Solanaceae flower



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Representatives of Solanaceae

Mostly vegetables and spices

- *Solanum*—include potato (Solanum tuberosum), tomato (Solanum lycopersicum) and eggplant (Solanum melongena)

- *Capsicum*—red (Mexican) pepper
- *Nicotiana*—tobacco
- *Petunia*—important ornamental
- *Atropa*—belladonna, important medicine plant, source of atropin

***Solanum tuberosum* (potato) fruits**

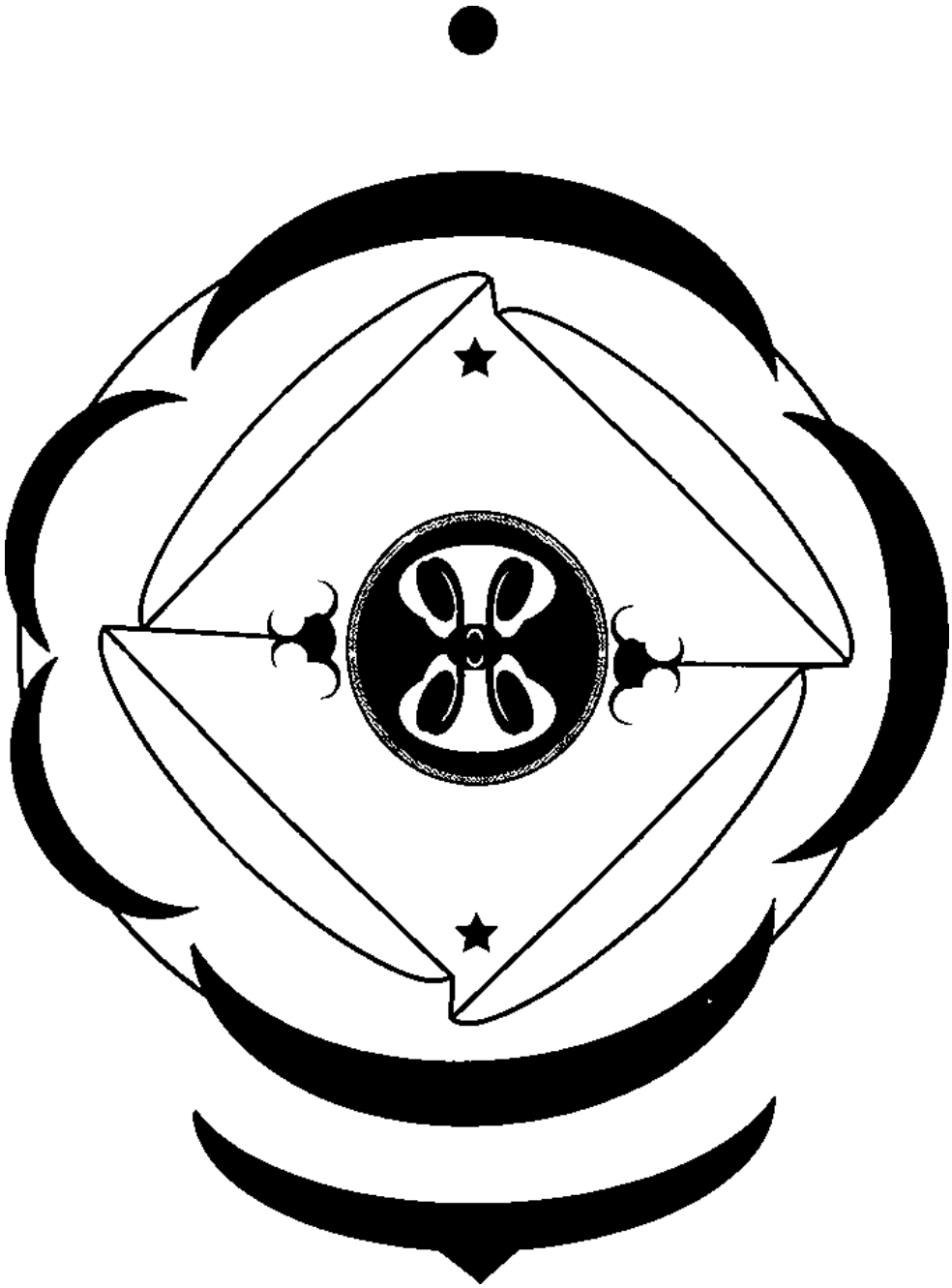
***Solanum melongena* (eggplant) flowers**

10.3 Oleaceae, olive family

Description of Oleaceae

- ≈ 600 species, mostly Eurasian
- Trees or shrubs, with opposite leaves without stipules
- Flowers in raceme-like inflorescences; 2-merous, symmetric; with two stamens; sometimes reduced (ashes)
- Pistil with two carpels
- Fruit capsule

Oleaceae flower



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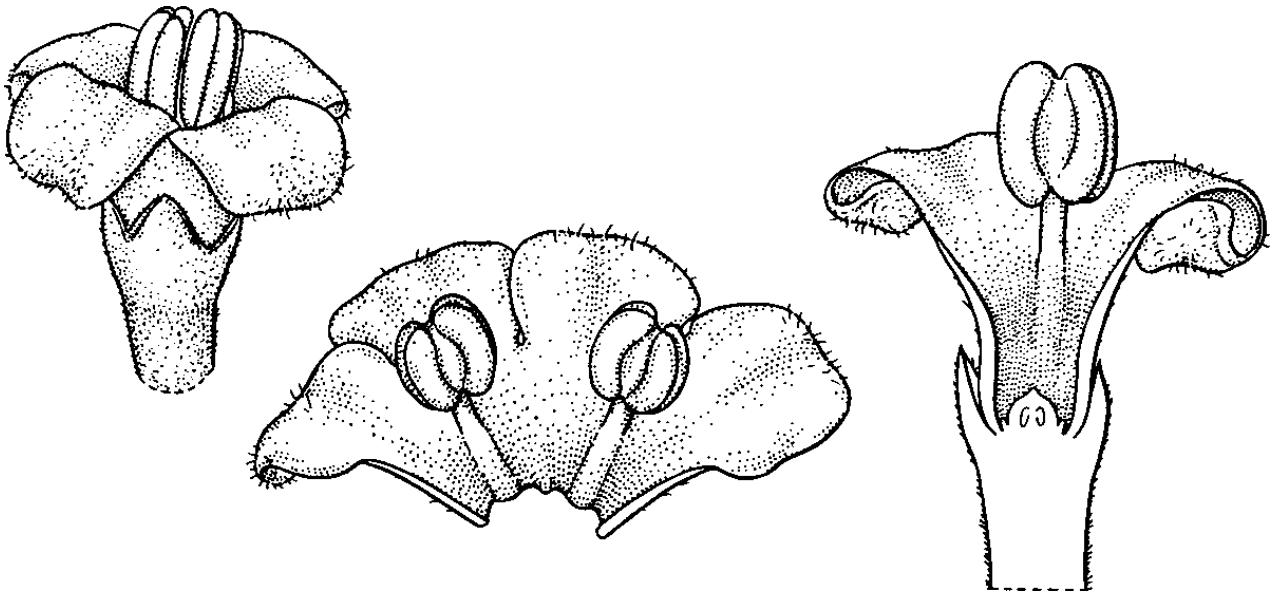
Osmanthus **(Oleaceae) flower**



Ash (Fraxinus) flowers develop anthers with lots of pollen, and prominent stigmas to receive pollen from a wind. All other parts of ash flowers are reduced.

Representatives of Oleaceae

- *Syringa*—lilac
- *Ligustrum*—privet
- *Fraxinus*—ash, *F. penssylvanica* is the most common tree in prairie coolies

10.4 Labiatae—mint family

General features of Labiatae

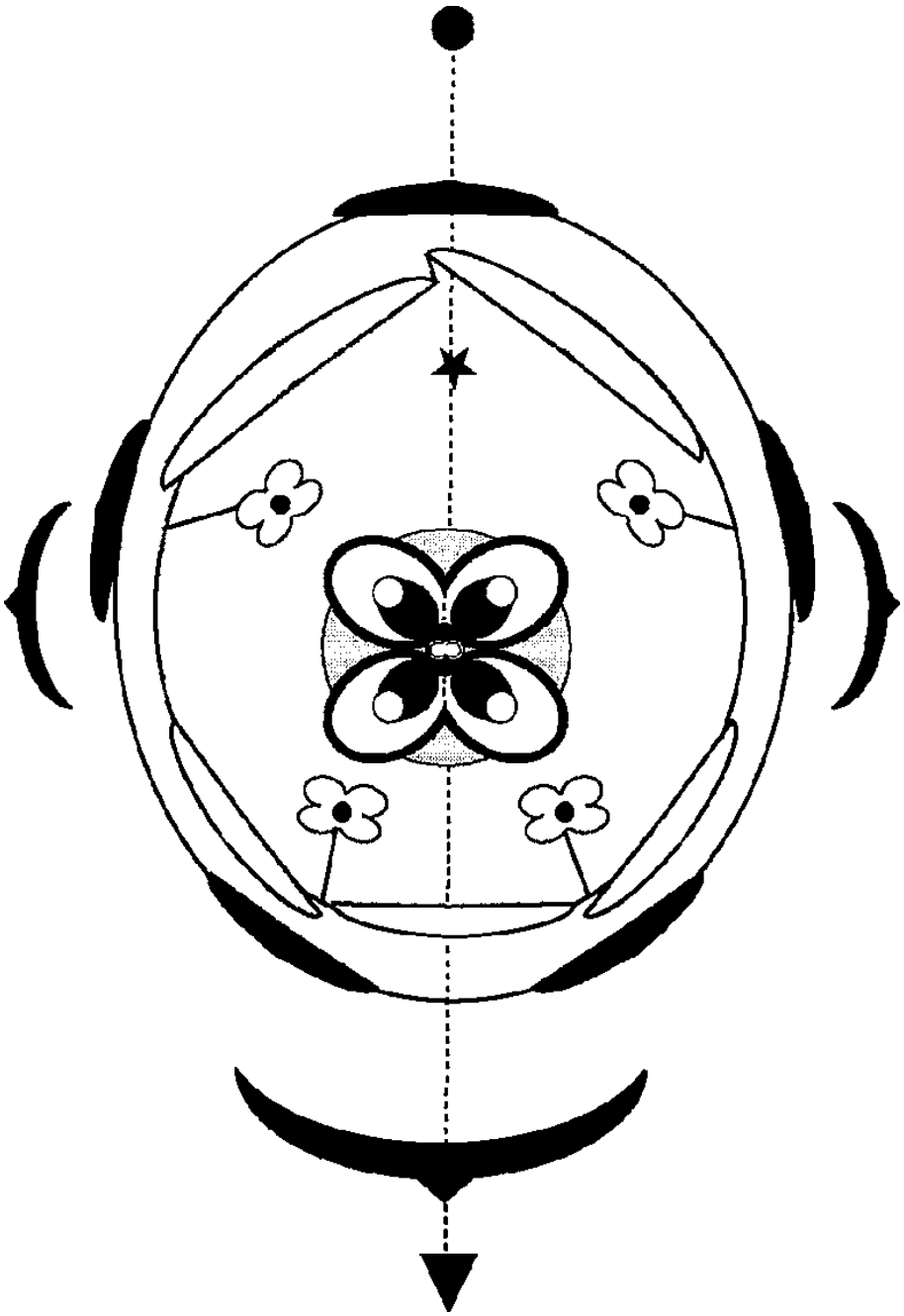
Labiatae—mint family

- $\approx 8,200$ species
- Cosmopolitan, but occur mostly in Northern Hemisphere
- Prefer open spaces

Morphology of Labiatae

- Herbs; contain iridoid compounds
- Often hairy, frequently aromatic, herbs or (rarely) shrubs
- Young stems are typically quadrangular or round; leaves opposite or alternate, without stipules, simple, with pterodromous venation
- Flowers in axillary or terminal inflorescences, zygomorphic (monosymmetric), but plantains (*Plantago*) have almost actinomorphic flower
- Calyx tubular, petals also fused, with two upper and one lower petals bigger than others, stamens frequently in two pairs, attached to corolla
- Pistil with two carpels, but each carpel could be secondary divided (like in Boraginaceae)
- Fruit is a capsule or schizocarp of four half-carpellary nutlets, seeds with little endosperm

Labiatae flower



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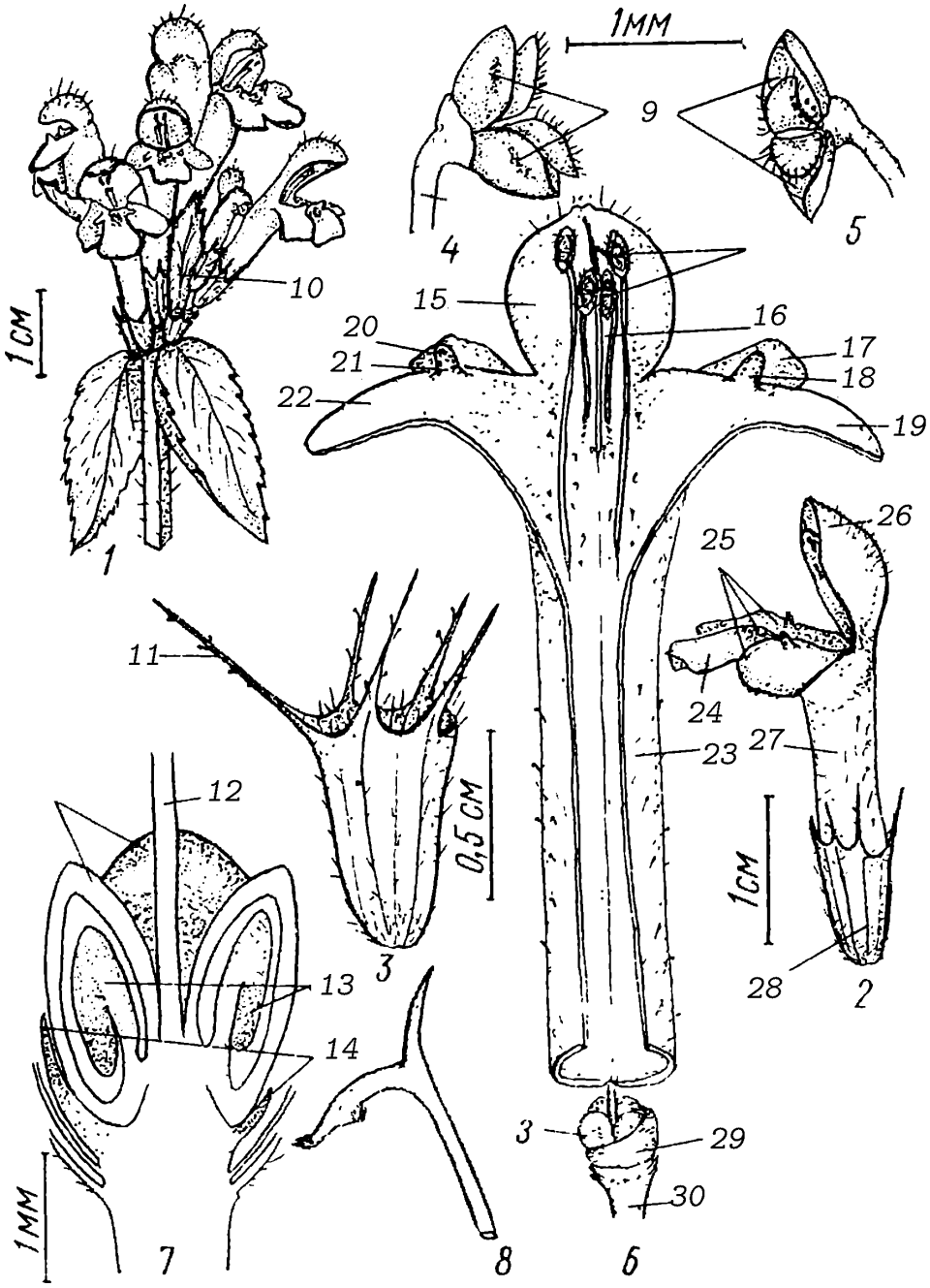
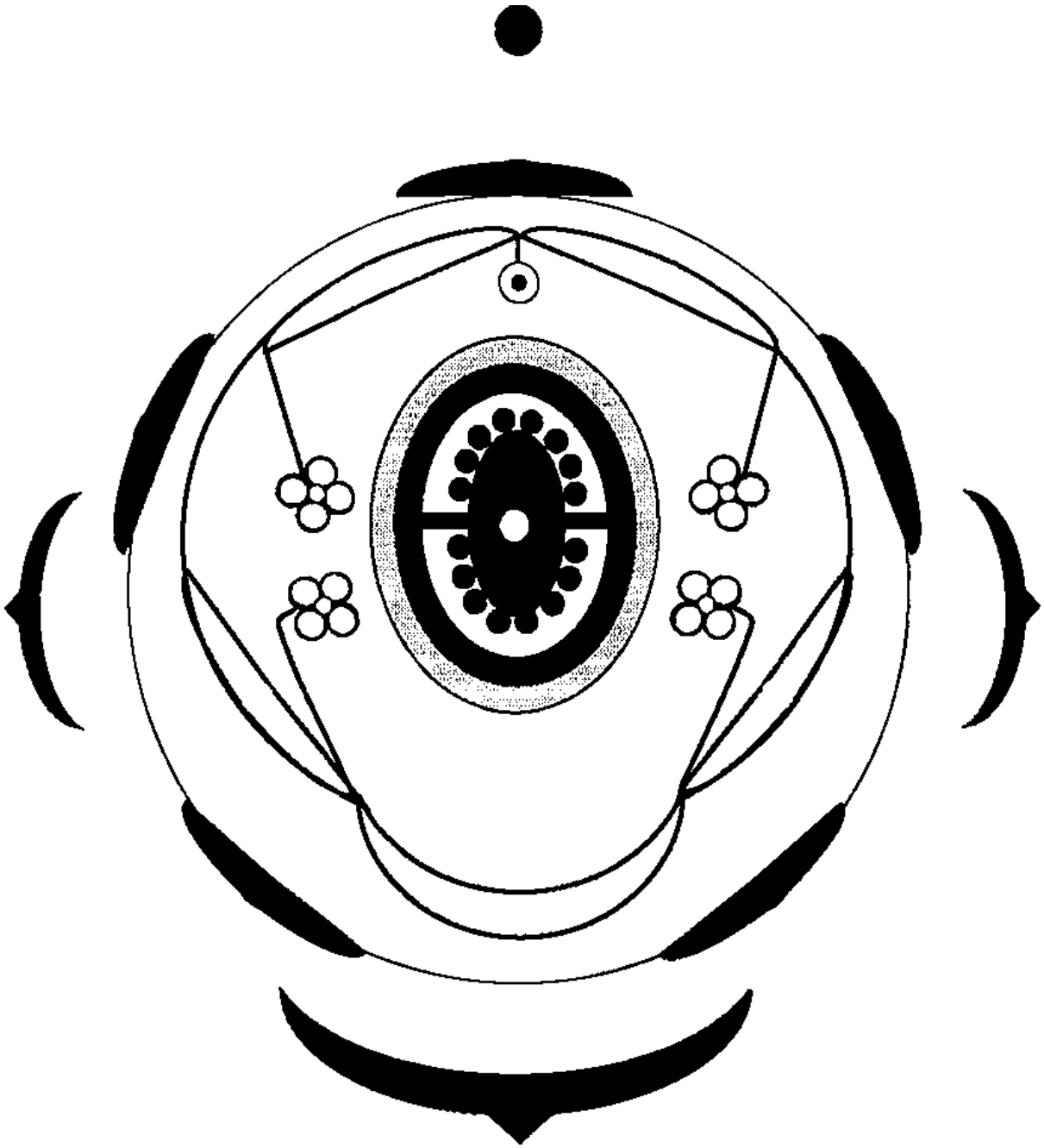
Galeopsis **(hemp nettle) flower**



Mentha spicata **(mint)**

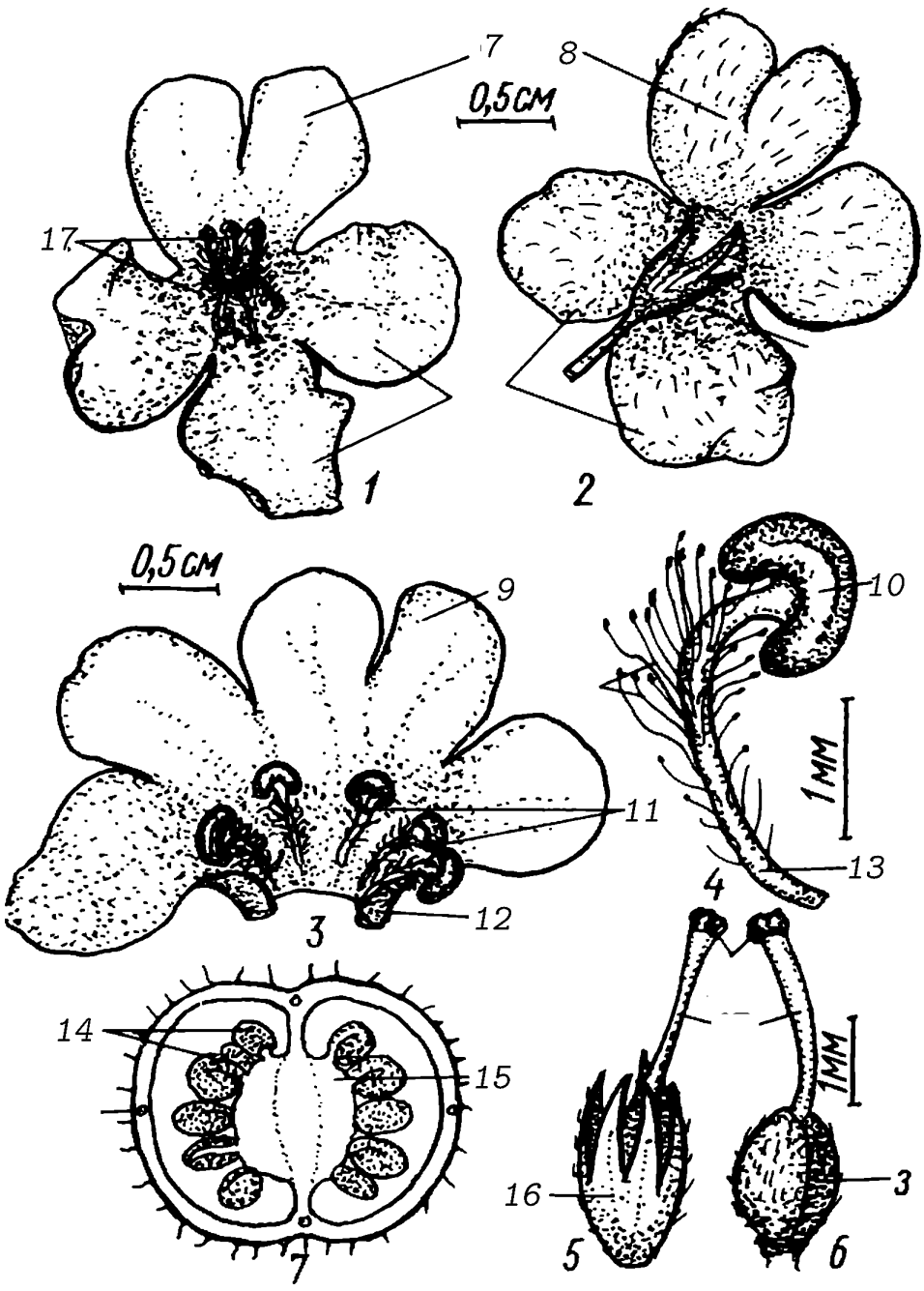
***Thymus* sp. (thyme)**

Flower of *Penstemon*

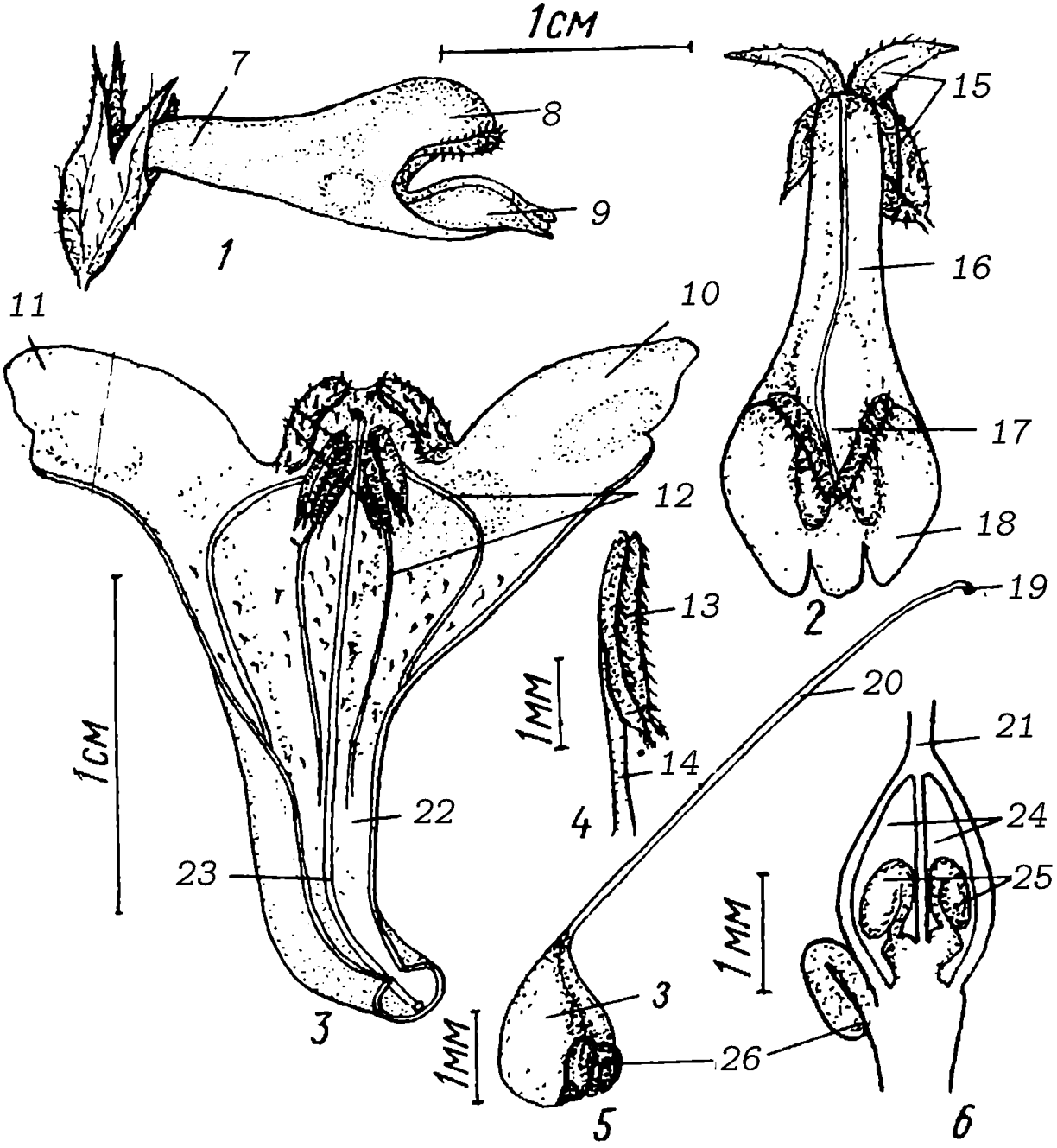


$\uparrow \mathrm{K}_{(5)}[\mathrm{C}_{(2,3)}\mathrm{A}_4]\mathrm{G}_{\underline{(2)}}$

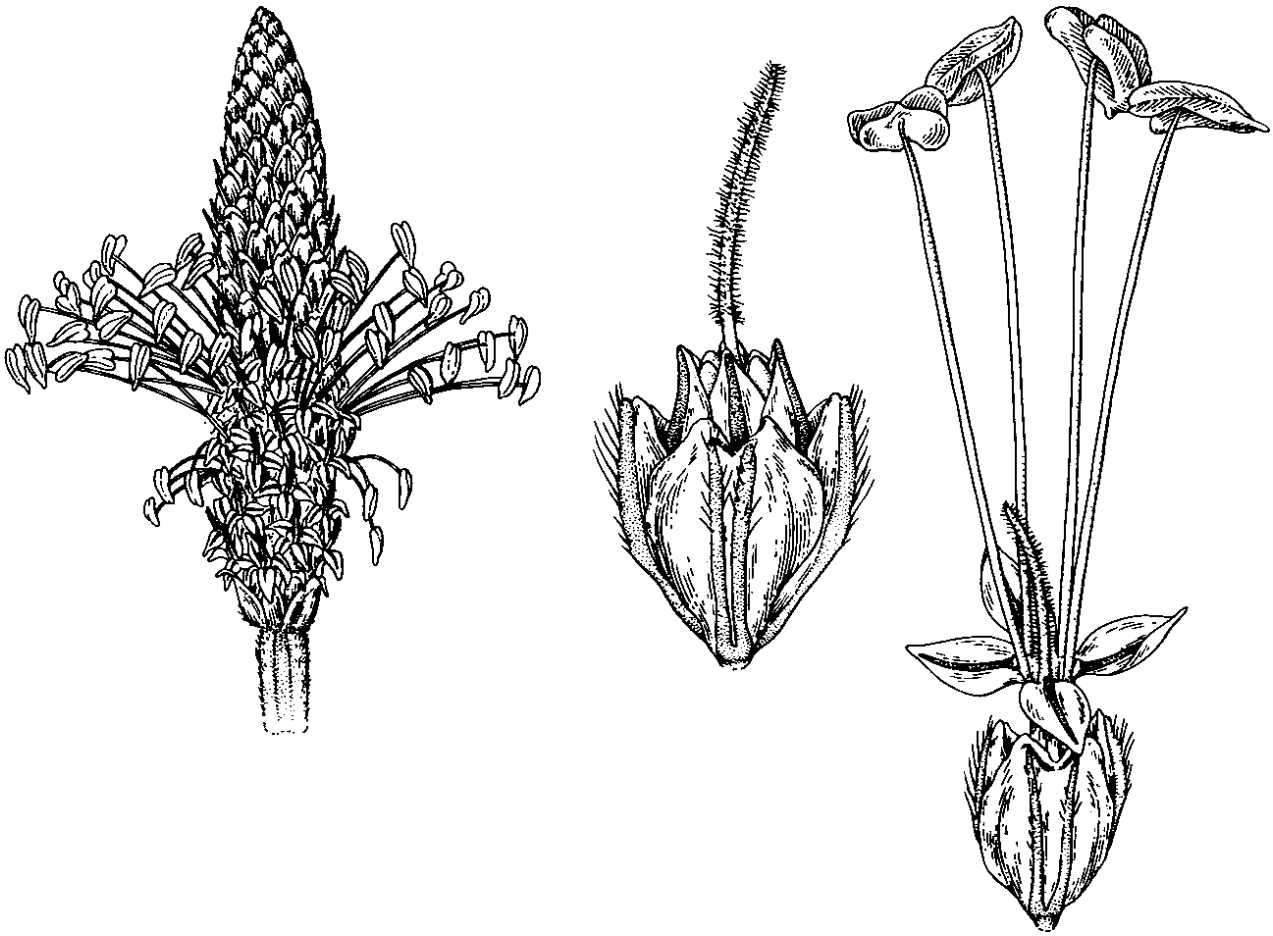
Verbascum **(mullein) flower**



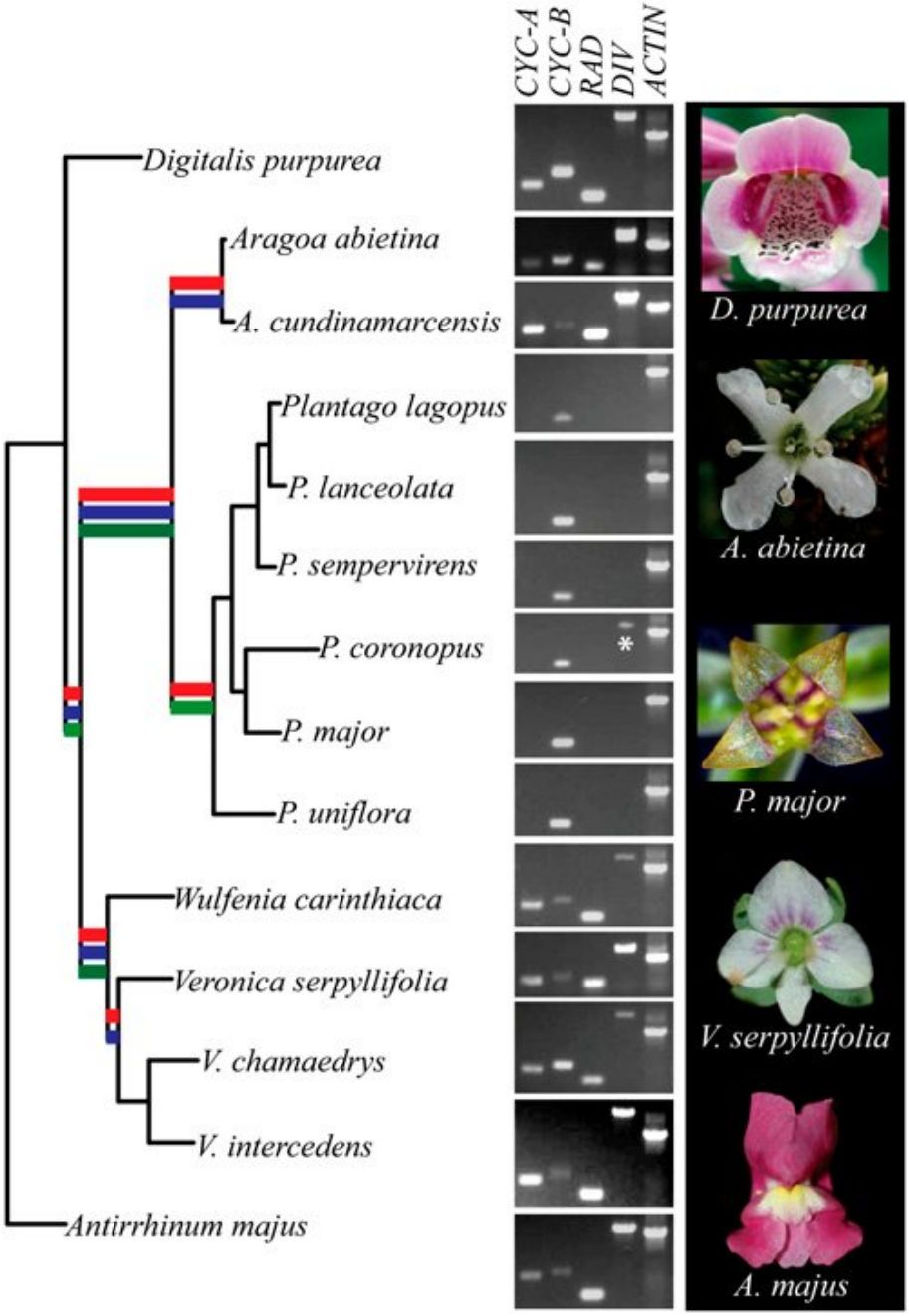
***Melampyrum* flower**



Plantago **(plantain) flowers**



Origin of *Plantago* actinomorphic flowers (Preston, 2011)



Diversity of alliance

- *Scrophularia* group
  - *Verbascum*—mullein
- *Veronica*/*Plantago* group
  - *Veronica*—speedwell
  - *Plantago*—plantain
  - *Penstemon*—beardtongue
  - *Hippuris*—Mare's tail
  - *Callitriche*—water-starwort

- *Orobanche* group
  - *Castilleja*—painted cup
  - *Pedicularis*—lousewort
  - *Agalinis*—false foxglove
  - *Orobanche*—broomrape

Diversity of alliance (contd.)

- *Utricularia* group
- *Phryma* group
  - *Mimulus*—monkeyflower
  - *Phryma*—loopseed
- *Verbena* group
- *Lamium* group
  - *Lycopus*—hoarhound
  - *Physostegia*—obedient plant
  - *Monarda*—wild bergamot
  - *Mentha*—mint
  - *Thymus*—thyme

11 Spore plants, Pteridophyta

11.1 Equisetopsida, horsetails

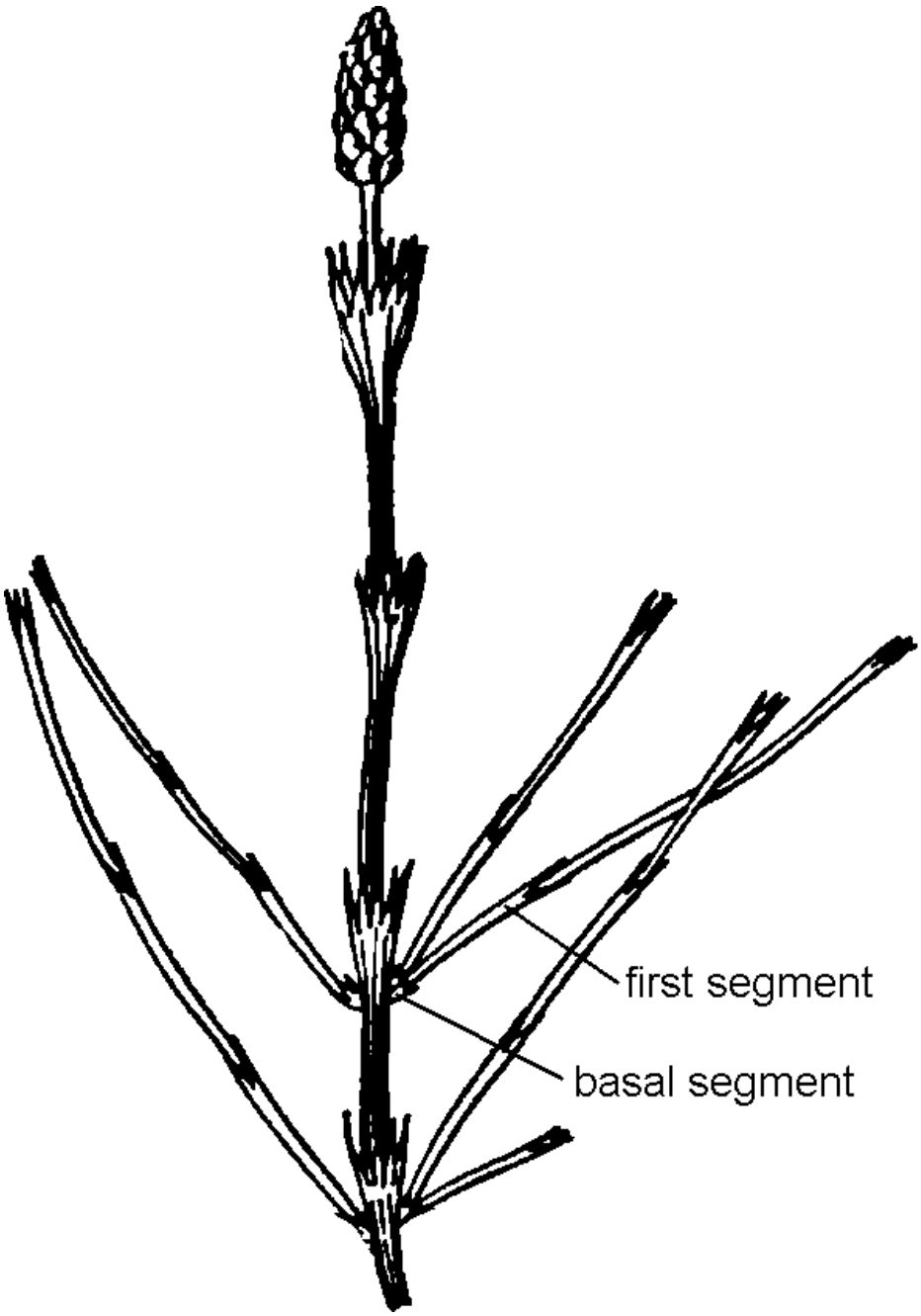
Equisetopsida

- Small group of one genus, *Equisetum* with ≈ 30 species
- Leaves are reduced into scales, stems are segmented, photosynthetic. Have specific anatomy od stem (stele)—**artrostele** with specific central, **valecular** and **carinal** canals (similar to stele of some grasses)
- Sporangia associated with specialized leaves—sporangiophores. Spores have attached **elaters**. Gametophyte minute, usually dioecious but plants are homosporous
- One family, Equisetaceae, and one genus, *Equisetum*, with 6 species in North Dakota

Strobili and sporangiophores of *Equisetum arvense*

Equisetum giganteum

***Equisetum* sp., basal and first segments**



For Further Reading

References

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[3] Minot State University Herbarium (MISU)

[4] Flora of Great Plains. 1986. University Press of Kansas, Lawrence, KS.