

Introduction to Botany. Lecture 9

Alexey Shipunov

Minot State University

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Outline

- 1 Morphology of shoot
 - Phyllotaxis
 - Life forms
 - Modifications of shoot

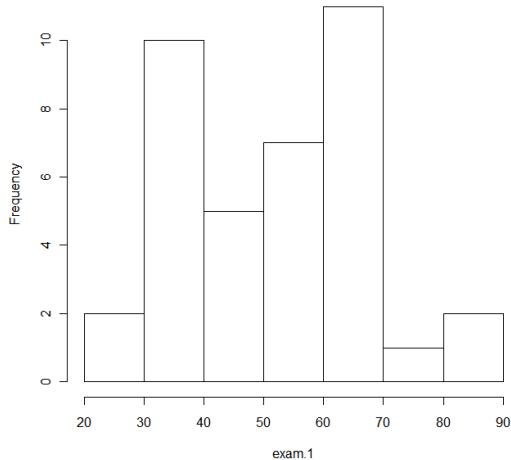
- 2 Leaf
 - Leaf morphology

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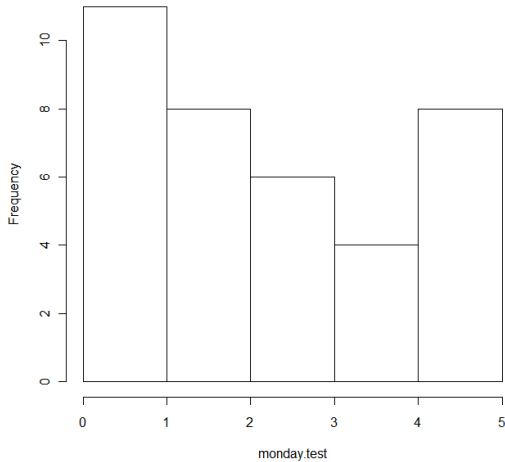
Exam 1

Histogram of exam.1



Monday test

Histogram of monday.test



Arrangement of leaves: phyllotaxis

- One leaf per node: **spiral** arrangement
- Two leaves per node: **opposite** arrangement, they may be:
 - All in same plane
 - Each pair will rotate on 90°
- > 2 leaves per node: **whorled** arrangement (each whorle can also rotates)
- Each type of phyllotaxis has its own angle of divergence

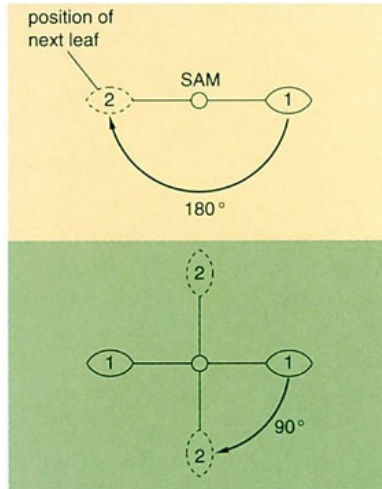
Angles of divergence



alternate



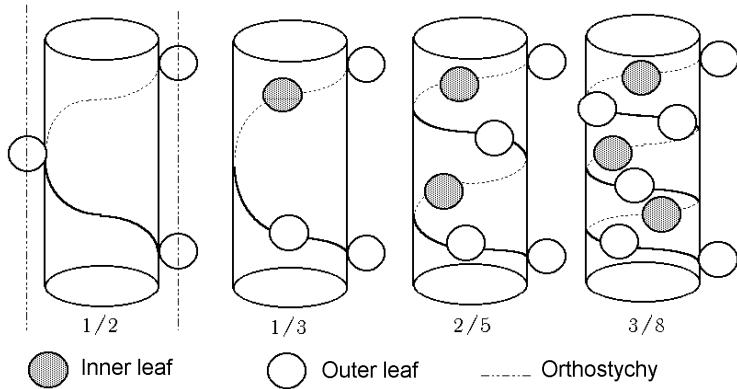
opposite



Spiral phyllotaxis 1

- Multiple types of leaf spiral leaf arrangement mostly follow **Fibonacci rule**
- Formulas of leaf arrangements is very similar to Fibonacci fractions: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, *et cetera**
- Numerator is number of spiral circulations, denominator is number of leaves

Spiral phyllotaxis 2



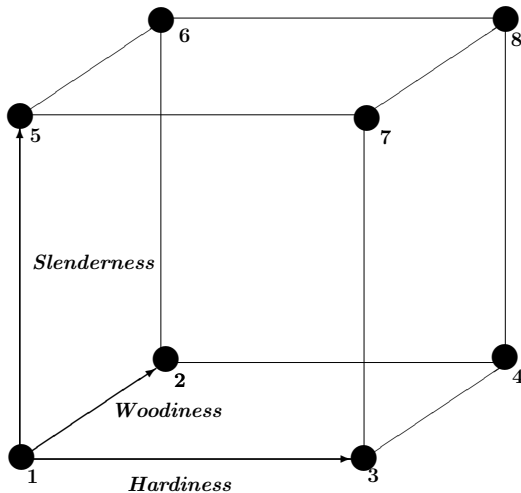
Life forms: ancient approach

- **Herbs:** soft stems
- **Shrubs:** multiple short-lived trunks
- **Trees:** one trunk

Life forms: dynamic approach

- **Hardiness:** sensitivity to all negative influence
- **Woodiness:** % of cells with secondary walls
- **Slenderness:** amount of vertical parts

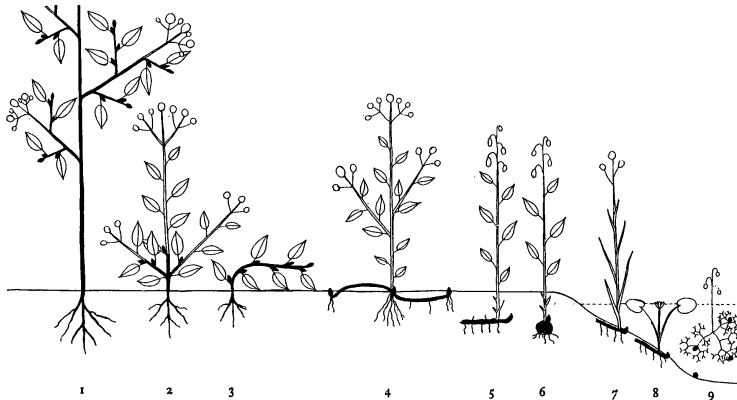
Life cube



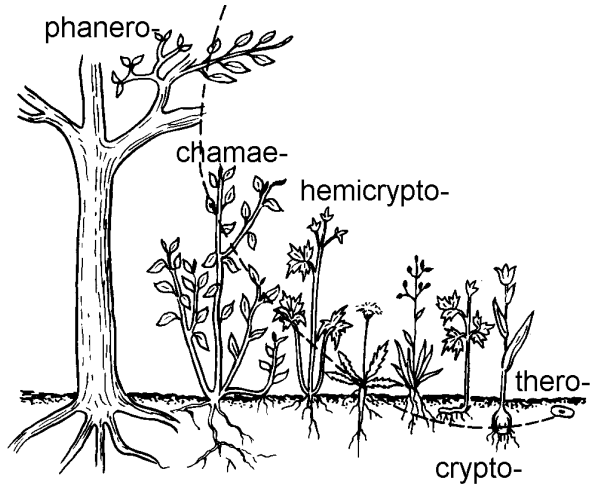
Life forms: Raunkiaer's approach

- **Phanerophytes:** winter buds openly exposed
- **Chamaephytes:** winter buds under snow
- **Hemicryptophytes:** winter buds on soil surface
- **Cryptophytes:** winter buds in the soil
- **Therophytes:** no winter buds, only seeds

Raunkiaer classification (after Raunkiaer, 1937)



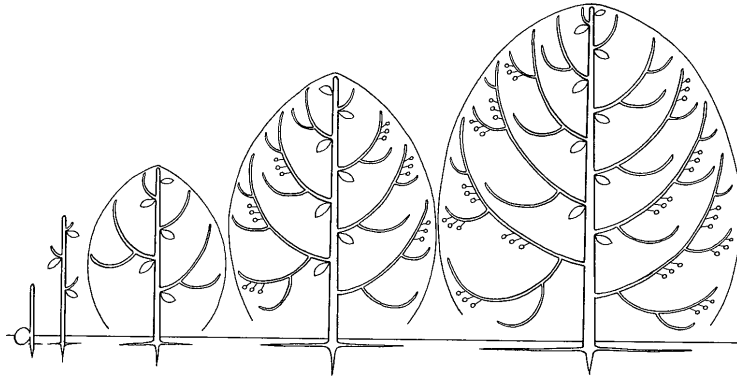
Raunkiaer classification again



Life forms: architectural models

- Developed for tropical trees, but also cover temperate forms which are less diverse
- Each model has a name of famous botanist, e.g. Thomlinson, Cook, Attims

Attimis architectural model



Many temperate trees are growing according to this model

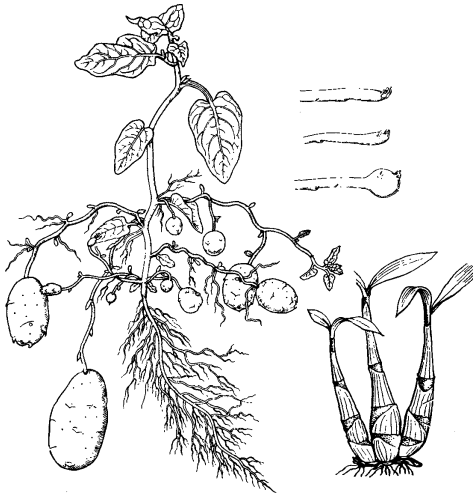
Modifications of shoots and stems

- **Rhizomes**: underground stems
- **Tubers**: enlarged portions of rhizomes
- **Bulbs**: storage shoots, leaves $> 50\%$ of mass
- **Corms**: storage shoots with minute leaves
- **Thorns**: defense shoots
- **Cladophylls**: leaf-like shoots
- **Stolons** (runners): aboveground horizontal shoots

Bulbs and corms



Tubers



Thorns



Cladophylls



Goethe's primary plant



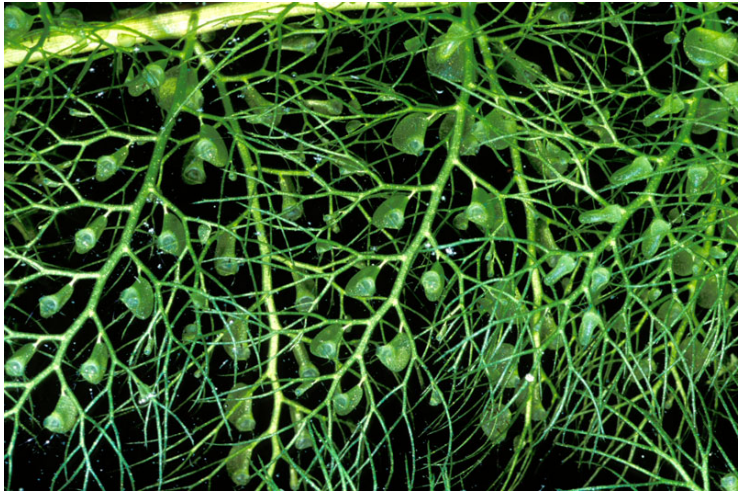
Famous German poet and writer Johann Wolfgang Goethe is also a founder of plant morphology. He invented an idea of “primary plant” where all organs were modifications of **leaf**.

External function and modifications

Each external function requires a specific modification of organ.

<i>Function</i>	Stem	Leaf	Root	FU
Expansion	Rhizomes, stolons			
Storage	Bulbs, corms, tubers			
Photosynthesis	Cladophylls			
Defense	Thorns			
Support	—			
Insect catching	Traps (bladderwort)			

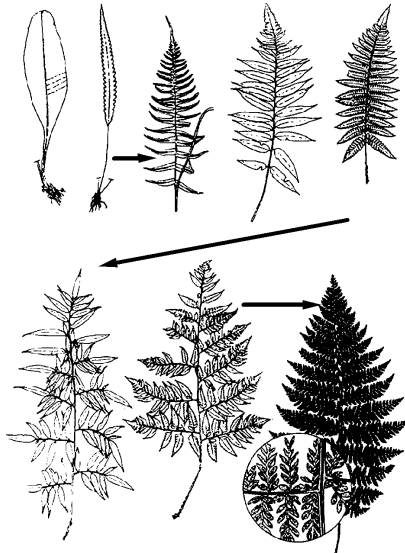
Traps of bladderwort (*Utricularia*)



Definition, functions and features

- Lateral flattened organ of plant with restricted growth
- Functions:
 - Photosynthesis
 - Respiration
 - Transpiration
 - Synthesis of secondary chemicals
- Features:
 - Have bud in the axil
 - Do not grow by apex
 - Do not produce new leaves
 - Have hierarchical morphology

Hierarchical levels in leaf morphology



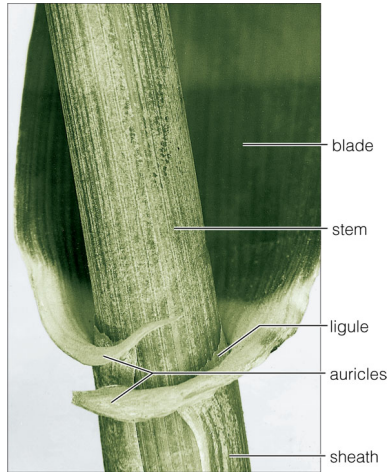
General characters

- General characters apply to the whole leaf
- Stipules (present or not, how many etc.)
- Leaf base (sheath etc.)

Stipules



Leaf base

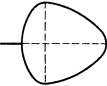
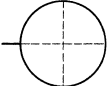
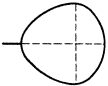
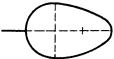
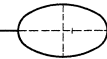
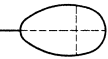
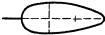
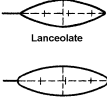

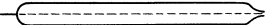


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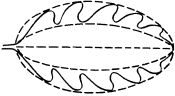

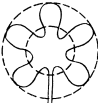
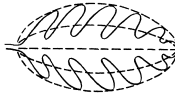


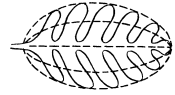

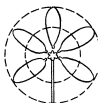
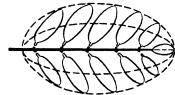
Repetitive characters

- Repetitive characters are the same on each level of leaf hierarchy
- Form
- Dissection
- Petiole (stalked/non-stalked etc.)
- Repetitive characters of same type may combine: single leaf could have several of them*

Form

	Maximum width closer to leaf base	Maximum width in the middle	Maximum width closer to the apex
Length = width or slightly more	 Deltate	 Elliptic	 Cuneate
Length > 1-1.5 x width	 Ovate	 Oblong	 Obovate
Length > 3-4 x width	 Narrowly ovate	 Lanceolate	 Narrowly obovate
Length > 5 x width	 Linear		

Dissection

		Tri-	Palmately	Pinnately
Simple leaves	Lobed (from 1/4 to 3/4)			
				
	Dissected (from 3/4 to midrib)			
Complex leaves (leaflets stalked, with joints)				

Terminal characters

- Terminal (leaflet) characters are applicable only to terminal parts (normally, leaflets) of leaves
- Form of base
- Form of tip
- Type of margin
- Surface
- Venation

Summary

- Spiral arrangement of leaves follows **Fibonacci** rule
- Life forms classifications are based primarily on characteristics of shoot
- Storage, defense and underground growth result in extensive modification of shoot
- Leaves have general, repetitive and terminal characters

For Further Reading



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.
Plant Biology. 2nd edition.
Thomson Brooks/Cole, 2006.
Chapter 5.4 and 6.1.