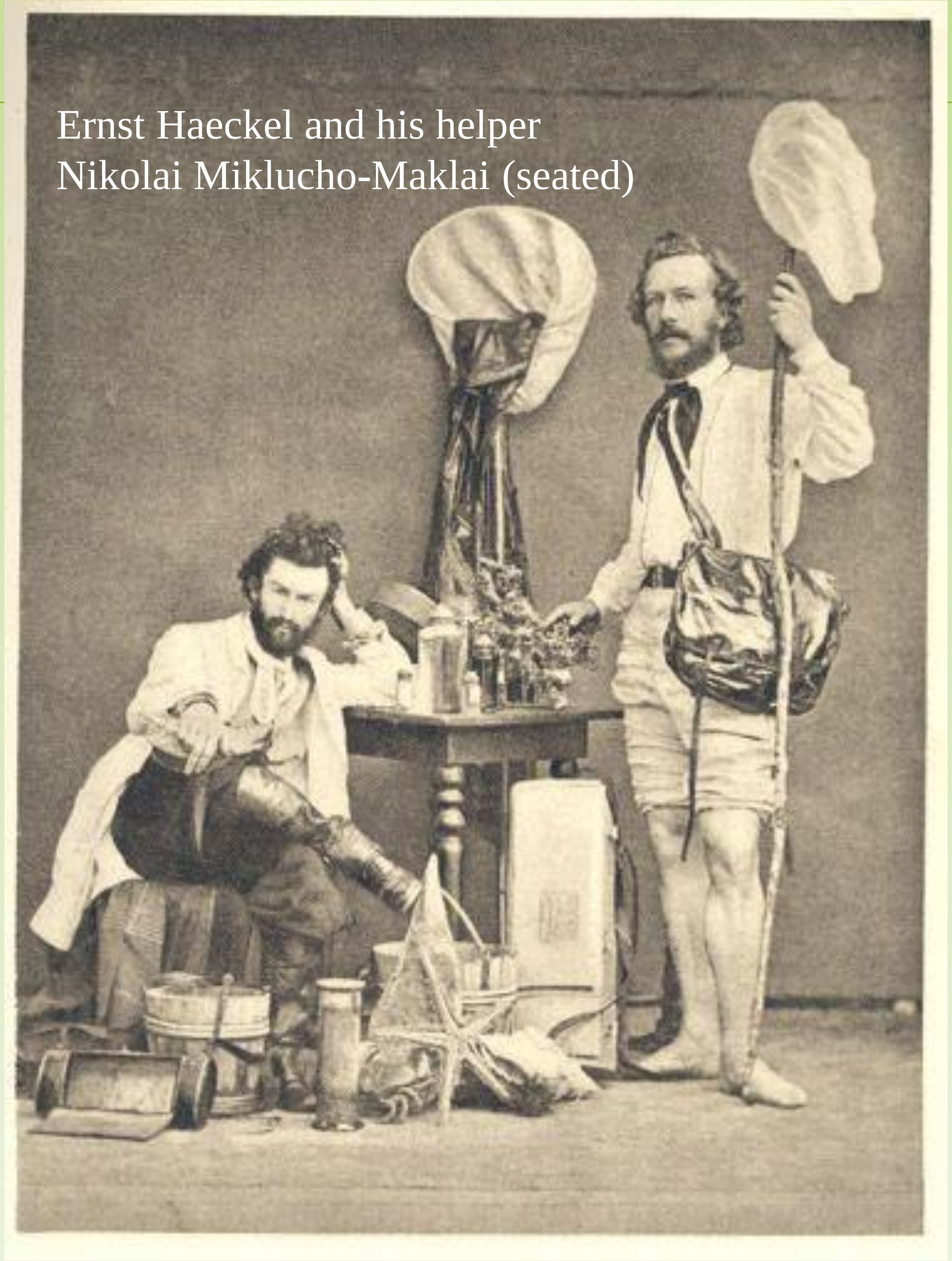

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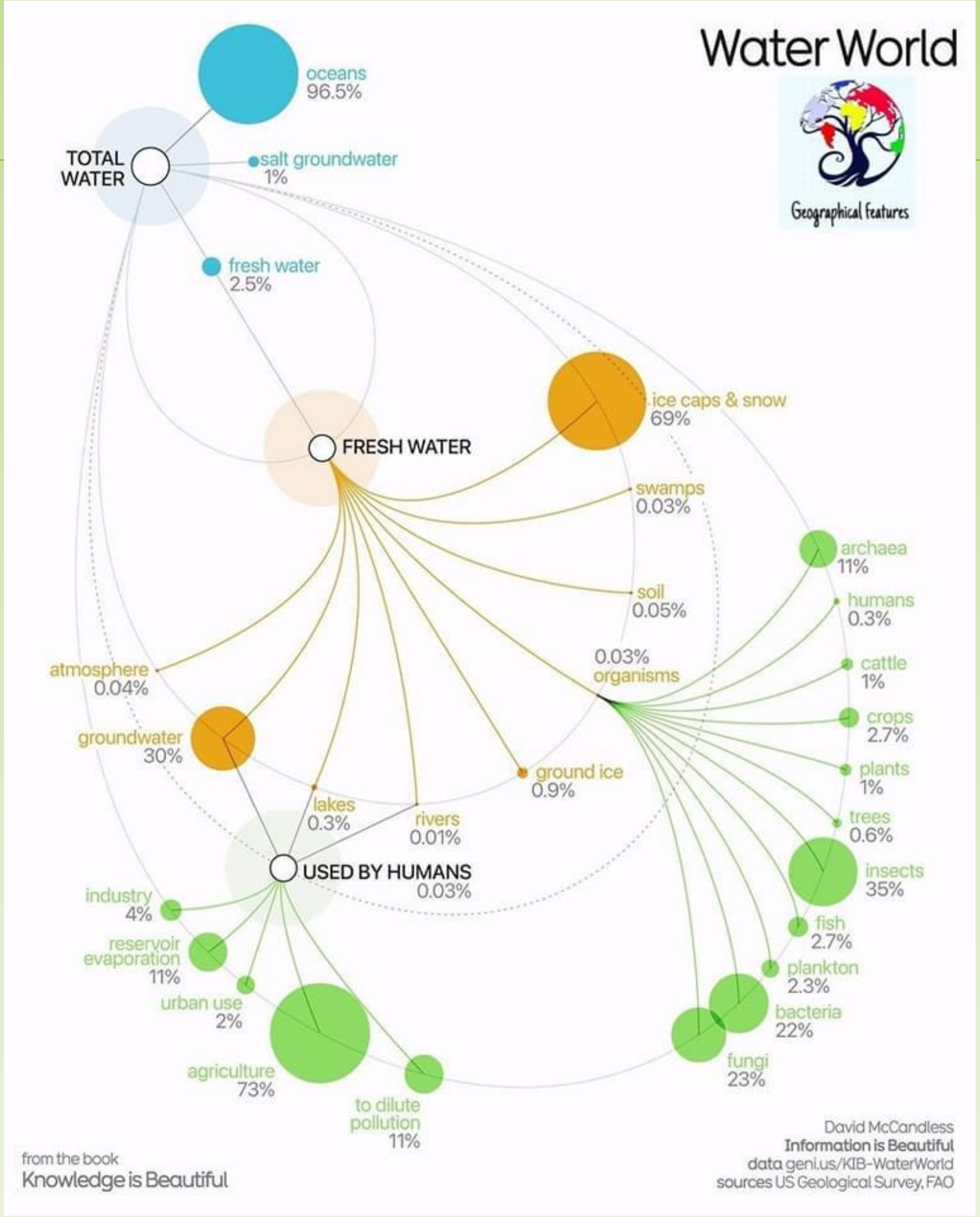
Script 2
Ecology

The physical environment:

Abiotic factors:	Complex interactions of factors:
1. Radiation / light	„Climate“
2. Temperature	
3. Water	
4. Chemical factors gases nutrients food	„Soil, Air“
5. Mechanical factors wind water fire	„Structure“

Water is essential for life on earth, e.g.:
- as habitat for species
- as solvent for nutrients
- as „liquid tissue“ (blood)
- as solvent for waste products (urea etc.)
- as medium for all biochemical reactions


Water World
oceans
96.5%
TOTAL WATER
salt groundwater
1%
fresh water
2.5%
FRESH WATER
ice caps & snow
69%
swamps
0.03%
soil
0.05%
atmosphere
0.04%
groundwater
30%
lakes
0.3%
rivers
0.01%
ground ice
0.9%
0.03%
organisms
archaea
11%
humans
0.3%
cattle
1%
crops
2.7%
plants
1%
trees
0.6%
insects
35%
fish
2.7%
plankton
2.3%
bacteria
22%
fungi
23%
USED BY HUMANS
0.03%
industry
4%
reservoir evaporation
11%
urban use
2%
agriculture
73%
to dilute pollution
11%
from the book
Knowledge is Beautiful
David McCandless
Information is Beautiful
data geni.us/KIB-WaterWorld
sources US Geological Survey, FAO

Factor WATER

Global water cycle:

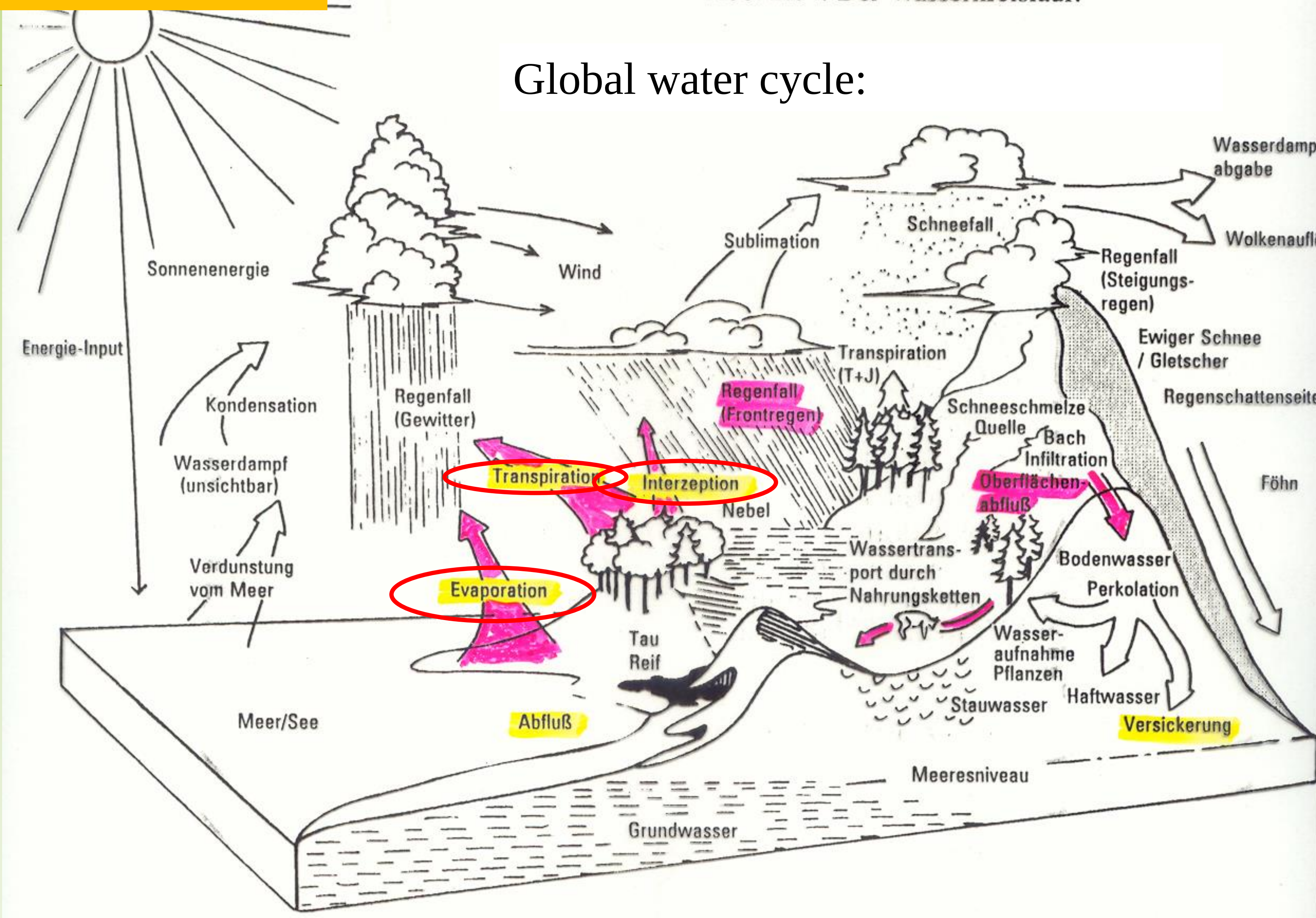


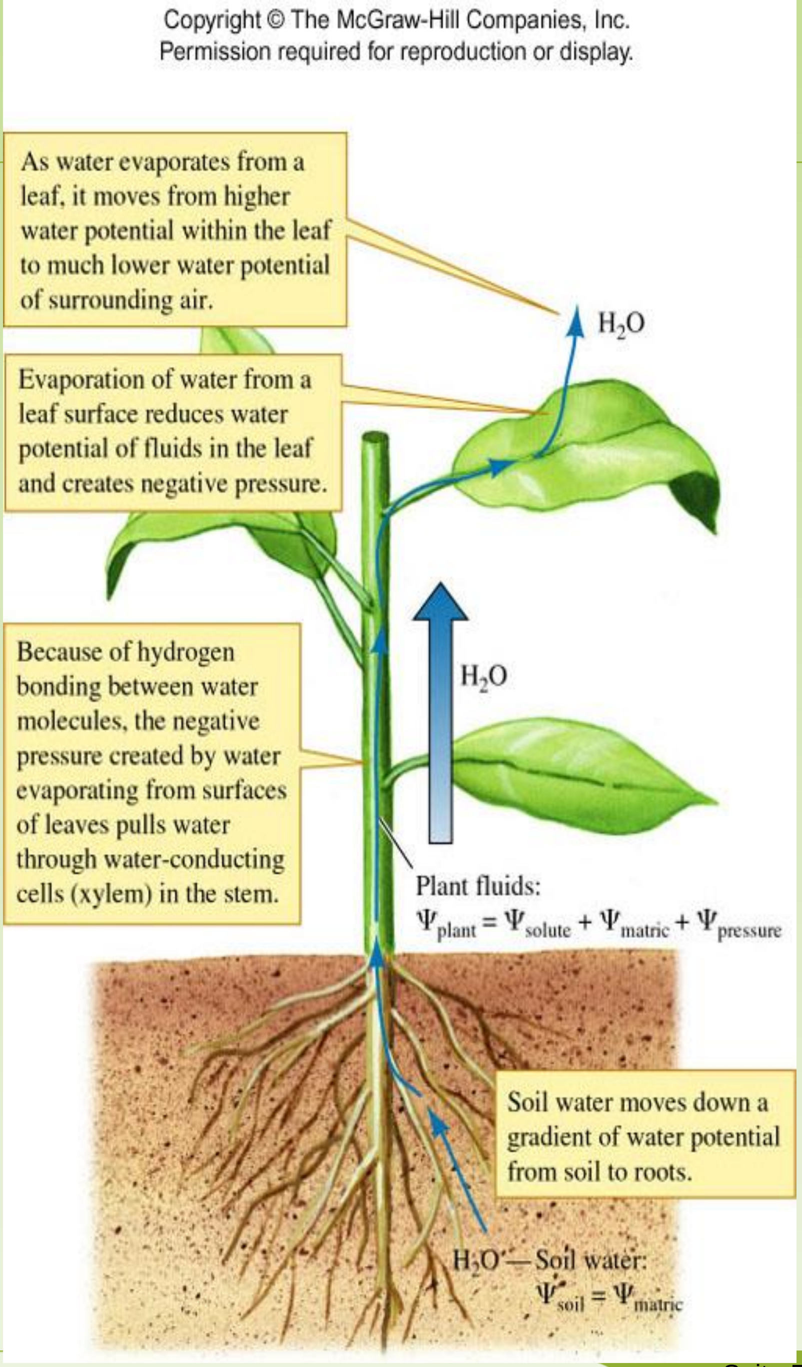
Abb. 2.04. Der Wasserkreislauf.

Transport of water in plants:

TRANSPIRATION!

→**Driving force** in plant´s water transport is the *difference in water vapor pressure in the plant and the surrounding air*

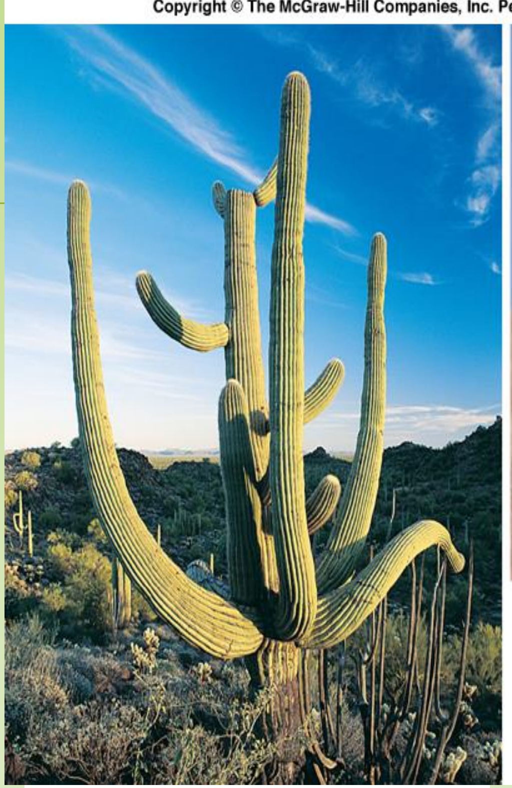
→This depends on temperature, humidity, wind…

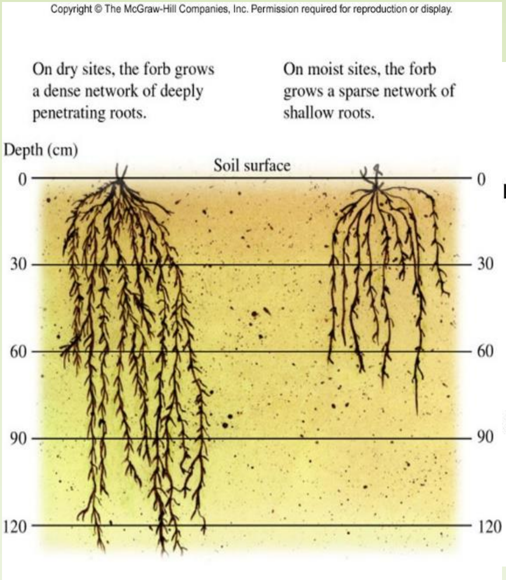


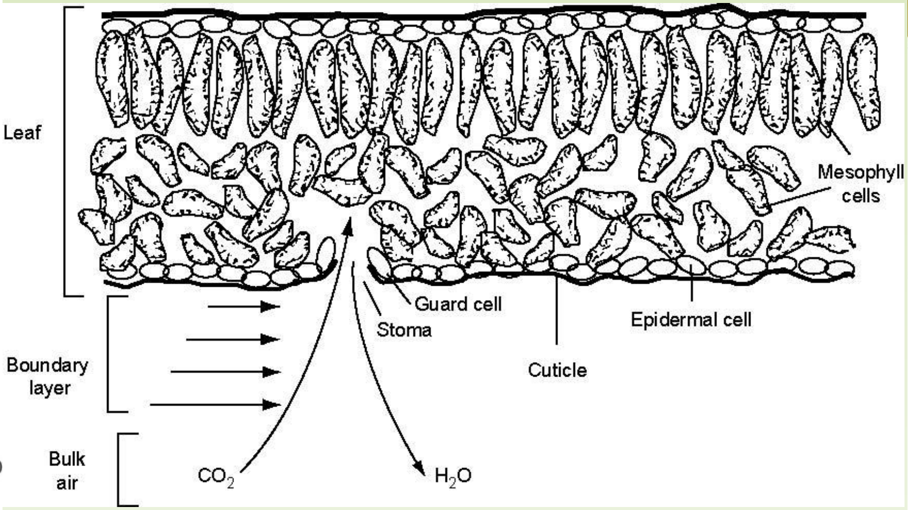
Factor WATER

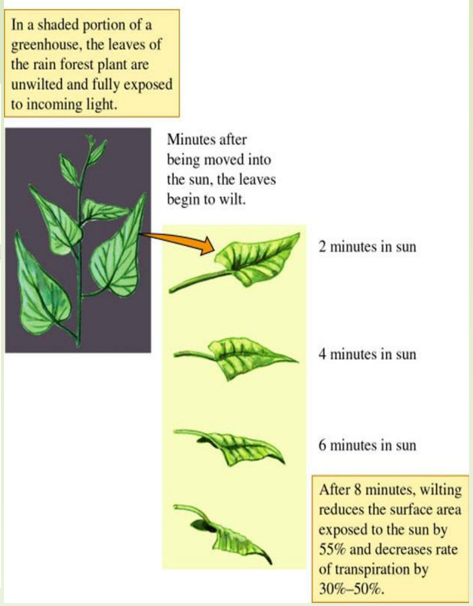
Plants control the water loss and transport:

- Surface reduction
- Adaptation of the root system
- Control of the stomata opening
- Water storage in tissues









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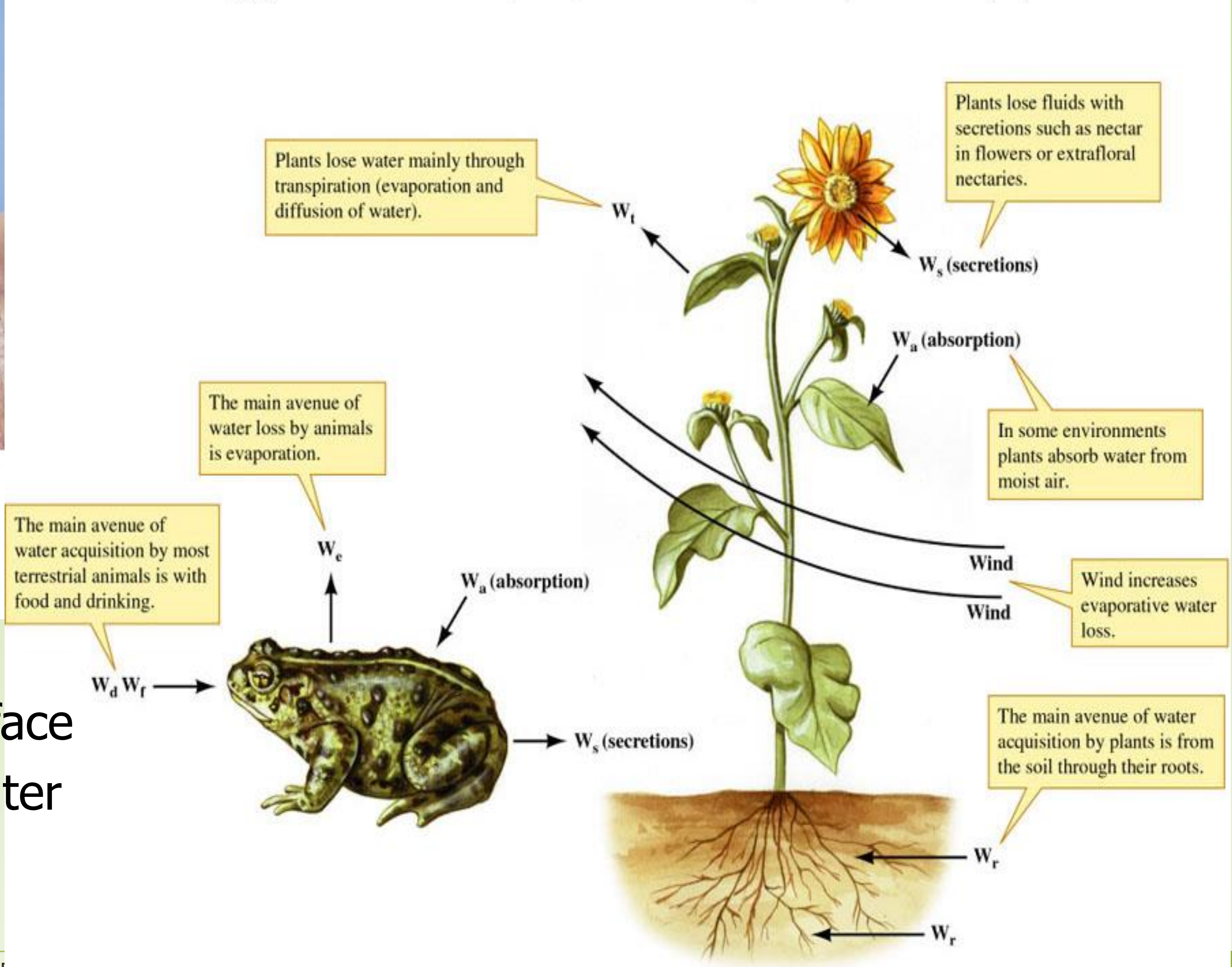
Water in plant and animal:



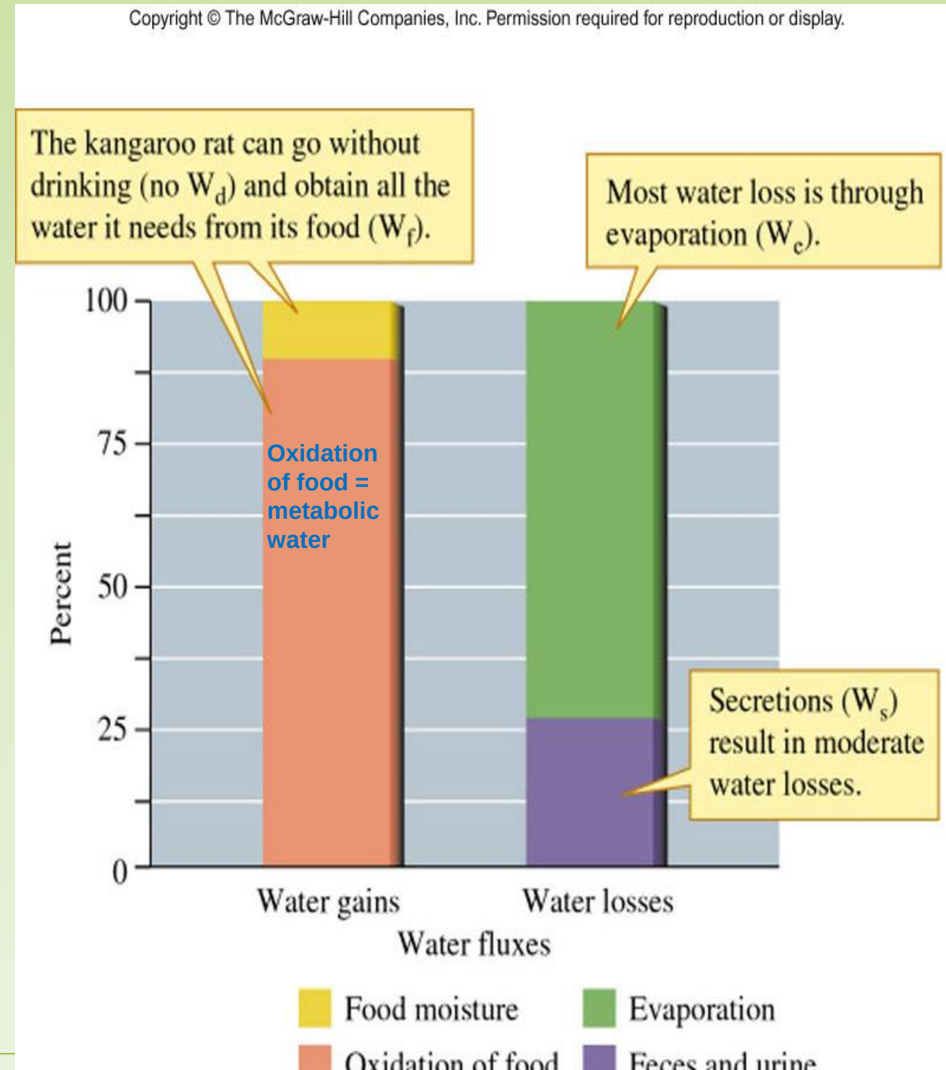
Animal:

- Drinking
- via body surface
- Metabolic water
- (no storage)

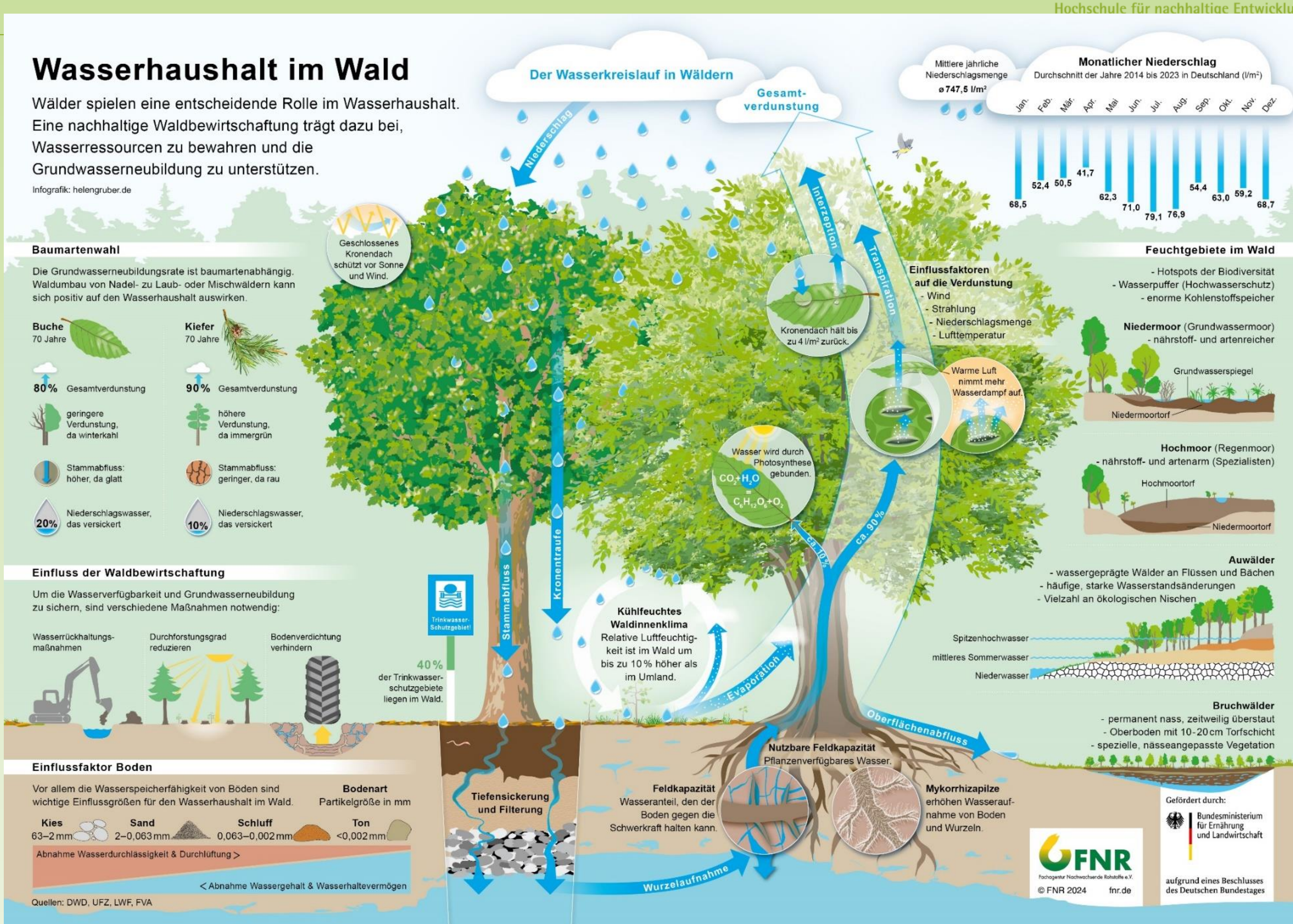
Regulation and adaptation:

Terrestrial animals in dry habitats: high risk of water loss

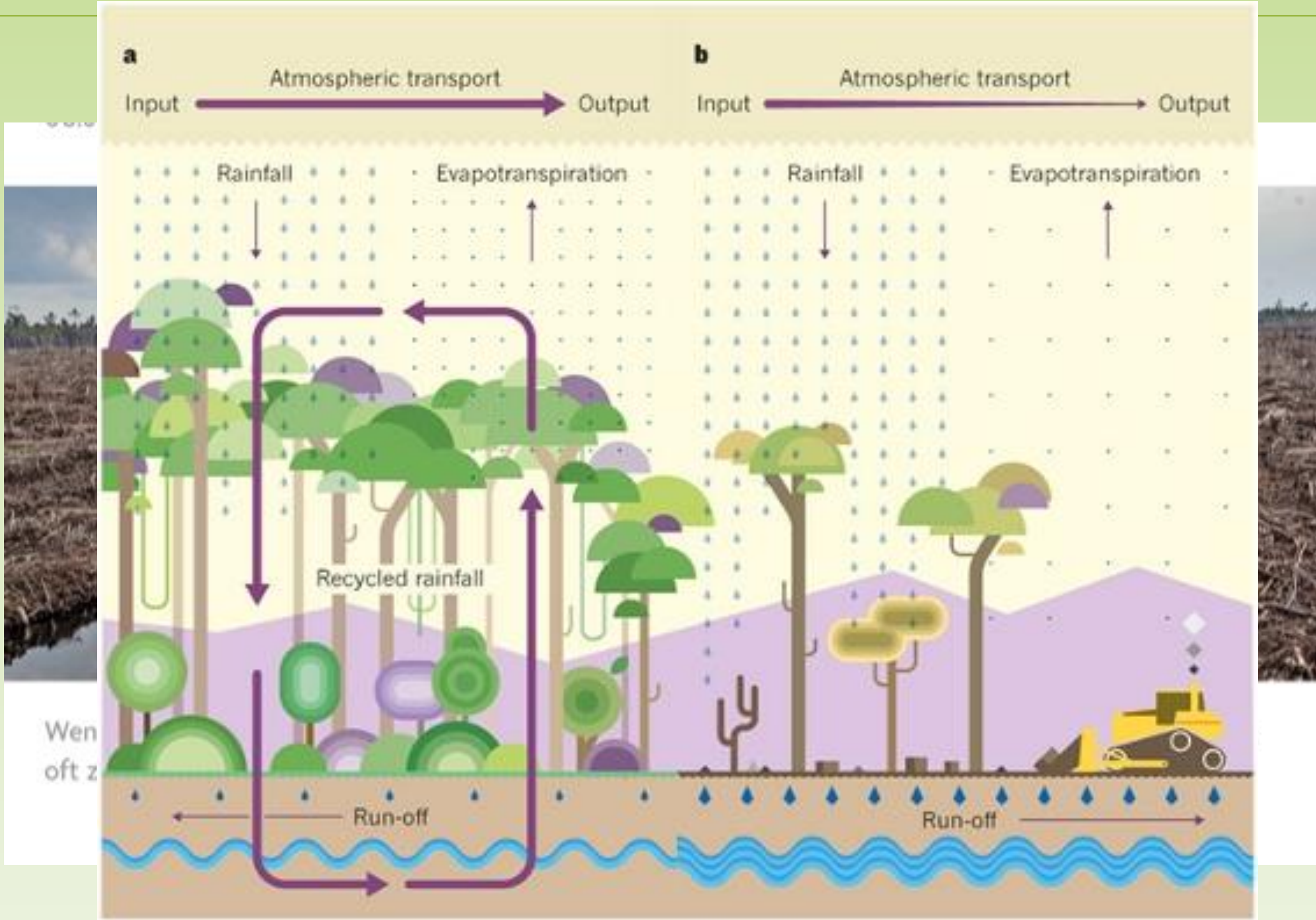
The importance of
"metabolic" water
for small desert animals:

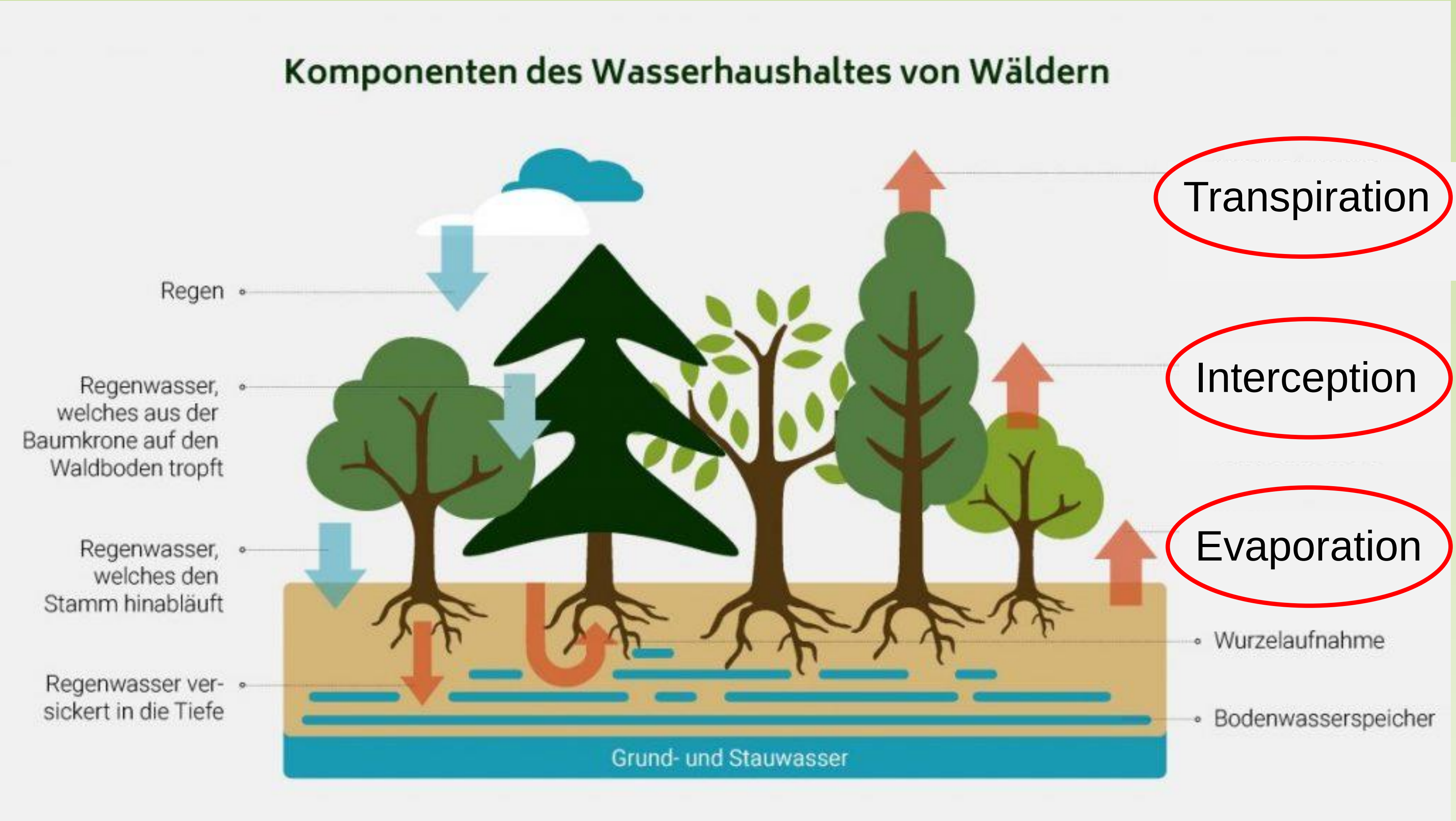


Water balance of a forested area



Water balance of a forested area compared to open range




Komponenten des Wasserhaushaltes von Wäldern
Regen
Regenwasser, welches aus der Baumkrone auf den Waldboden tropft
Regenwasser, welches den Stamm hinabläuft
Regenwasser versickert in die Tiefe
Transpiration
Interception
Evaporation
Wurzelaufnahme
Bodenwasserspeicher
Grund- und Stauwasser

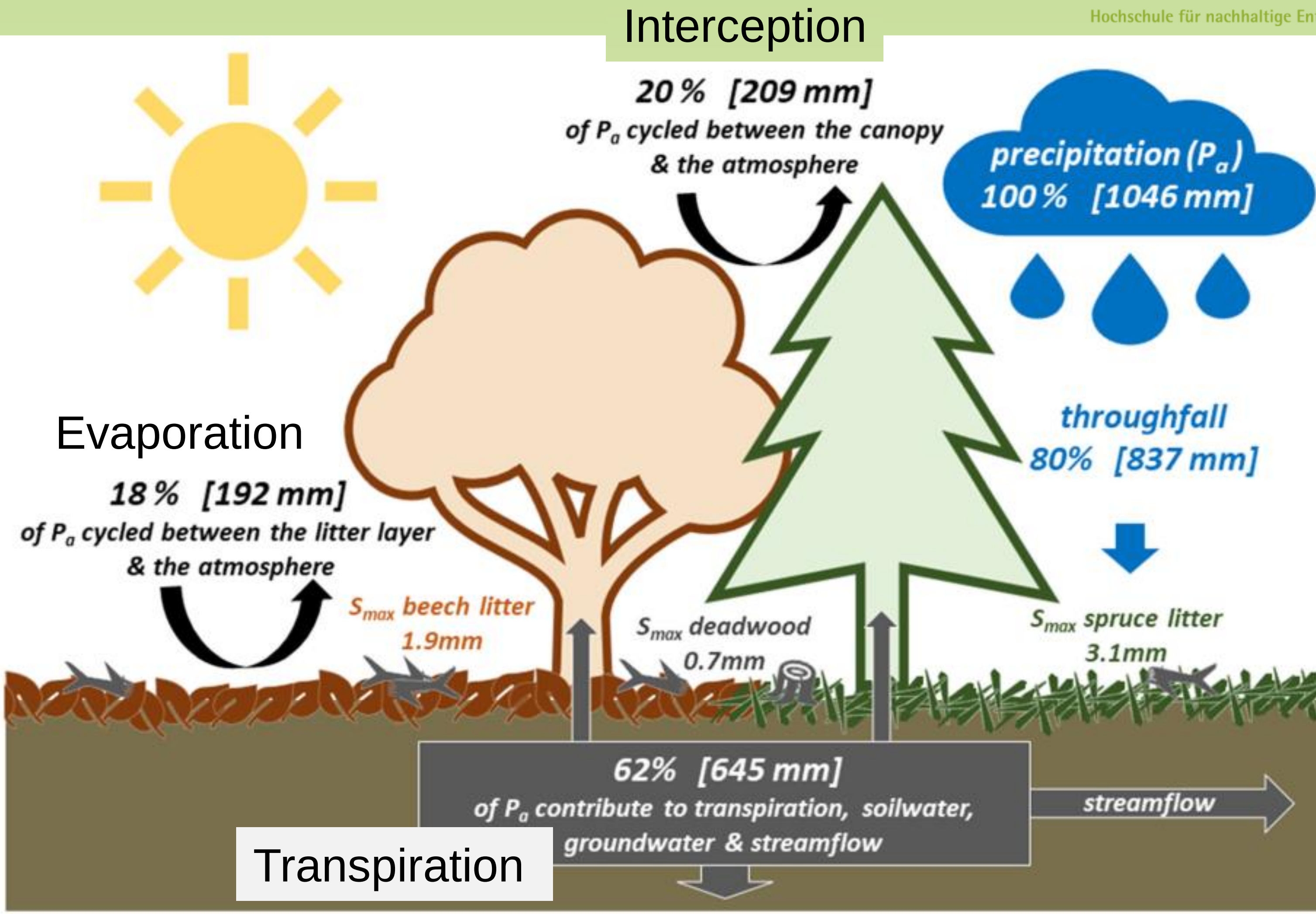


FIGURE 10 Conceptual scheme of the 'Waldlabor' forest water cycle, accounting for the storage in the forest litter layer estimated from field and laboratory experiments and their implications for the larger forest water cycle. Roughly 38% of annual precipitation are intercepted in the forest-floor litter layer and canopies; therefore, only 62% of annual precipitation reaches the subsurface soil and groundwater storages and is available for plant transpiration, groundwater recharge and streamflow.

Ecohydrology. 2023;16:e2493 Floriancic, M., et al. https://doi.org/10.1002/eco.2493

Factor WATER

Water loss due to **transpiration** (*controlled, through stomata*): comparison of plant species:

Birke		4 –4,7 mm/Tag
Buche		2 –3,8 mm/Tag
Lärche		4,5–6,1 mm/Tag
Fichte		4,3–4,4 mm/Tag
Kiefer		2,3–2,5 mm/Tag
Douglasie	etwa	5,3 mm/Tag
Sandrohr (*Calamagrostis epigejos*)		6,8–8,8 mm/Tag
Heidelbeere (*Vaccinium myrtillus*)		0,5–0,9 mm/Tag
Artenreiche Krautschicht eines Waldes	etwa	0,7 mm/Tag

Factor WATER

Loss of water due to interception (*uncontrolled*) dependant on the annual precipitation:

Annual Precip. (mm/yr)	Interception (%) *Pinus*	*Fagus*	*Picea*	*Abies*
500	35	40	60	80
700	25	39	43	57
1000	17	20	30	40
1500	12	13	20	27

(Nach LANG, 1970)

Thinning	no.	%			Canopy-throughflow	Trunk-water	Loss due to interception
mäßig	1388	79	54	78	63	1,7	35
schwach	1747	100	69	100	58	2,4	40

Spruce stand in Germany

→ Influence of thinning on water balance in a spruce stand:

More thinning means: more water reaches the ground and less is lost to interception.

Factor WATER

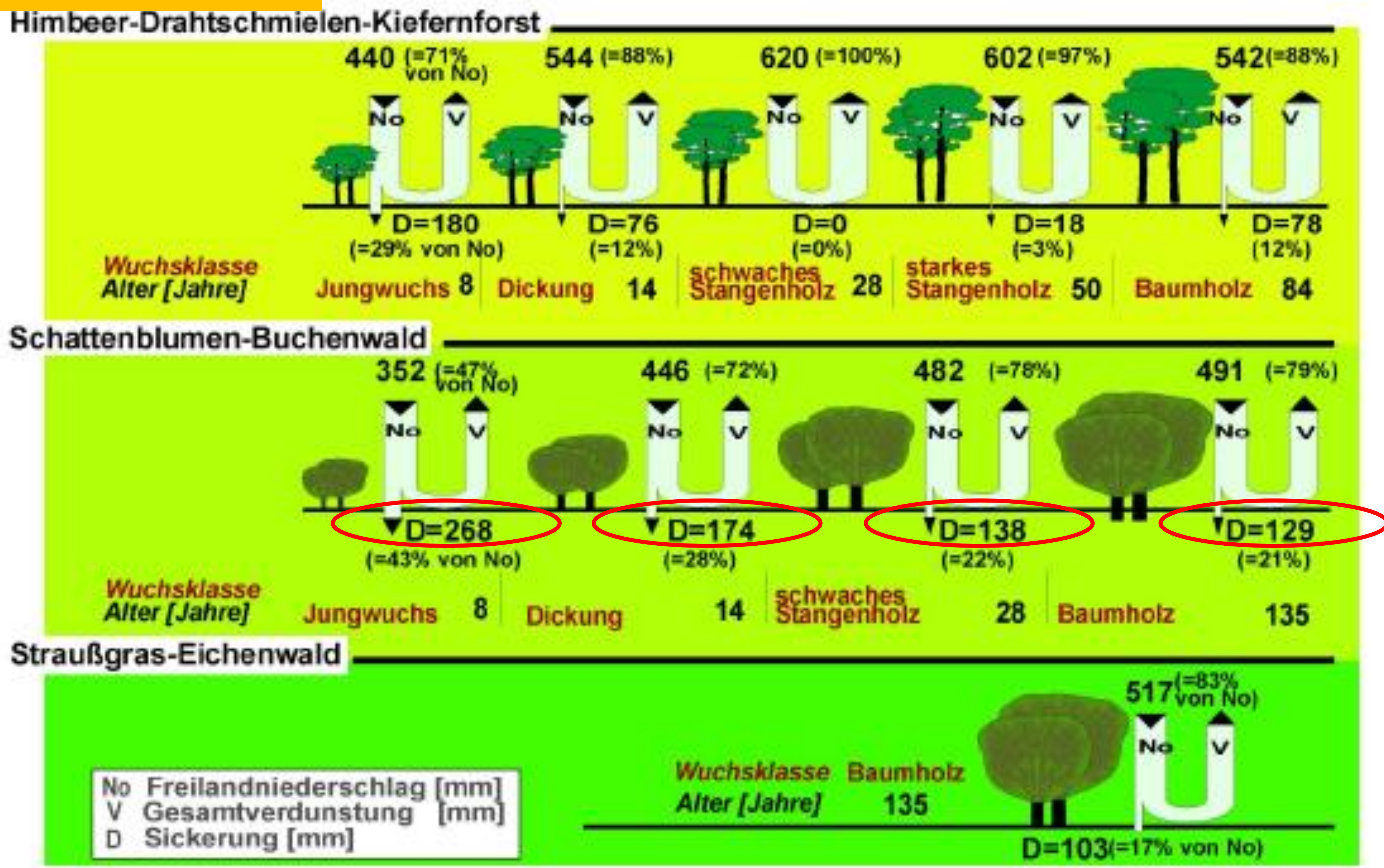


Abbildung 5: Wasserhaushalt von Kiefern- und Buchenbeständen in unterschiedlichen Wuchsstadien und für einen Eichenbestand im Baumholzstadium (Quelle: MÜLLER 2002b)

The physical environment:

Abiotic factors: | Complex interactions of factors:

1. Radiation / light — „Climate“

2. Temperature

3. Water

4. **Chemical factors** — „Soil, Air“
   - gases
   - nutrients
   - food

(5. Mechanical factors) — („Structure“)
   - wind
   - water
   - fire

Chemical factors: *Food / nutrients*

Plants (Producers, autotrophic):

- **O_2 - and CO_2 supply** (→ from air, always available, no limit)
- **Anorganic nutrients** (→from the soil, limited, often bound)

(→*only **0.2 %** of the soil nutrients are readily available to plant roots*)

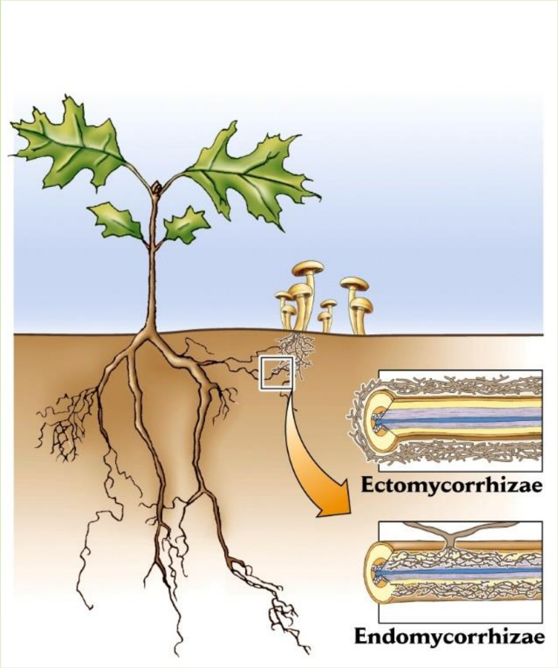
Animals (Consumers / decomposers; heterotrophic):

- **O_2 supply**
- **„food“ (organic matter)**

(*quantitative and qualitative problems*)

*Do **plants** influence the availability of nutrients?*

- **Root systems, root hairs**
- **Mycorrhiza**



- **Symbiotic bacteria/nitrogen fixation**

*Does a **FOREST** influence the availability of nutrients?*

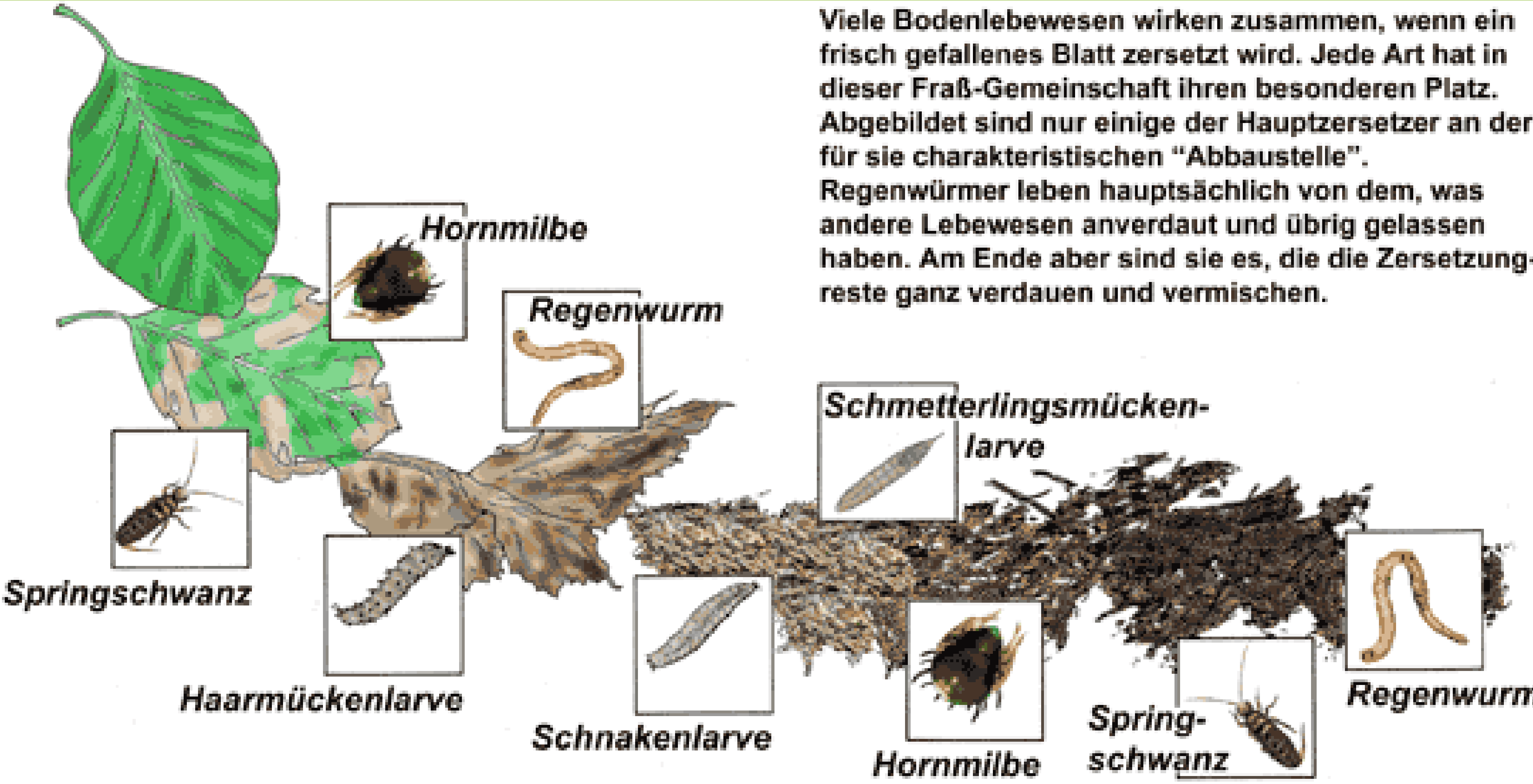
- **Regulation of temperature and humidity**
- **Root system** (living / dead roots: water, O_2, nutrients, structure..)
- **Delivery of leaves (organic matter) for humus production**

→ habitat for humus-organisms (decomposers)
→ release of nutrients from decaying plant matter

→ The forest installs it´s own „animal farm“ for recycling...!

The forest and the factor NUTRIENTS

Viele Bodenlebewesen wirken zusammen, wenn ein frisch gefallenes Blatt zersetzt wird. Jede Art hat in dieser Fraß-Gemeinschaft ihren besonderen Platz. Abgebildet sind nur einige der Hauptzersetzer an der für sie charakteristischen "Abbaustelle". Regenwürmer leben hauptsächlich von dem, was andere Lebewesen anverdaut und übrig gelassen haben. Am Ende aber sind sie es, die die Zersetzung-reste ganz verdauen und vermischen.



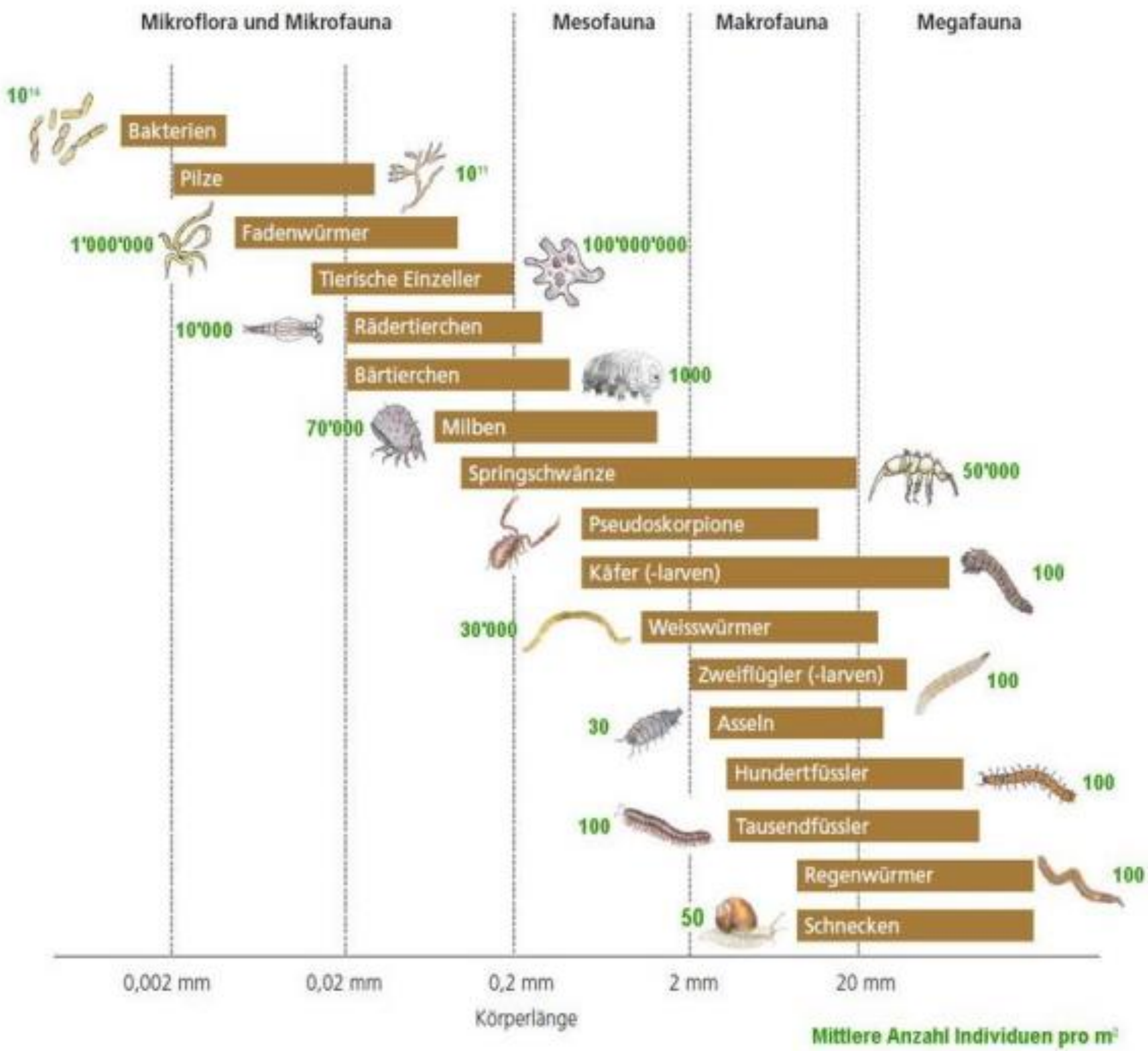


Abbildung 23: Körperlängen der Bodenorganismen, respektive Durchmesser der Pilzfäden (nach Briones 2014) und mittlere Anzahl Individuen der wichtigsten Bodenorganismen in einem Quadratmeter Boden (nach Dunger 1983). (Walser et.al. 2021)

.. we will talk about **animal´s adaptations** to **factor „nutrients“** in lectures later this year

Importance of earth worms for nutrient availability:

Significance for the soil and nutrient cycling:

1. Improvement of soil structure:

- **Improved oxygen supply for upper part of soil**
- **Improved water storage in soil (capillary action)**
- **Enhancement of fine root growth**

2. Mixing of organic layer (litter) and mineral soil

3. Generation of „clay-humus-complexes“ to retard nutrient wash-out

The forest and the factor NUTRIENTS

Importance of earth worms for nutrient availability:

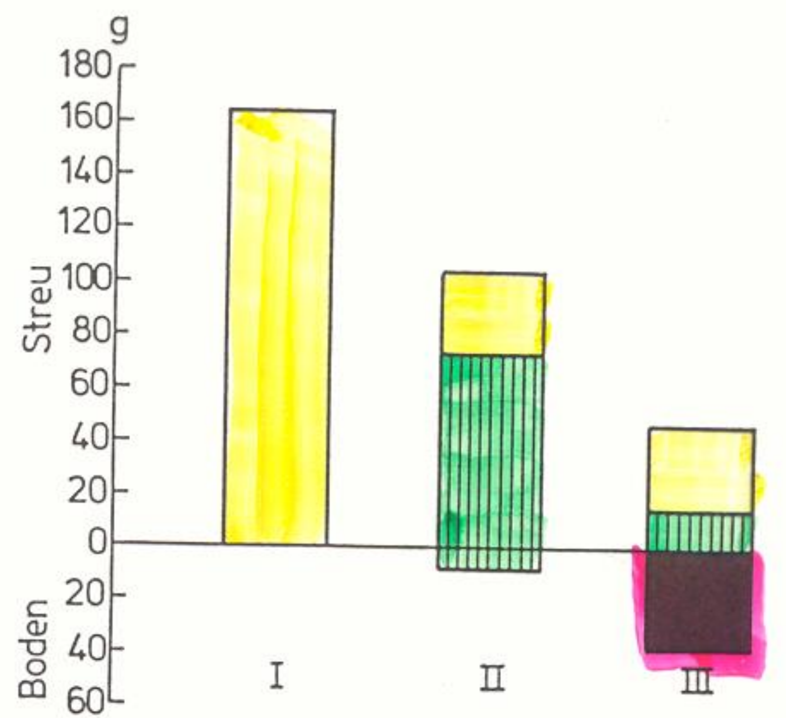


Abb. 55: Qualitative und quantitative Veränderung der organischen Substanz und ihre Verteilung infolge unterschiedlicher Versuchbedingungen. – I – Zustand vor dem Versuch, II – Zustand nach dem Versuch in der Variante ohne Regenwürmer, III – Zustand nach dem Versuch in der Variante mit Regenwürmern. (Nach PEREL, KAROACEVSKIJ, JEGOROVA.)

Chemical factors: *Food / nutrients*

Plants (Producers, autotrophic):

- **O_2 - and CO_2 supply** (→ from air, always available, no limit)
- **Anorganic nutrients** (→from the soil, limited, often bound)

(→*only* ***0.2 %*** *of the soil nutrients are readily available to plant roots*)

Animals (Consumers / decomposers; heterotrophic):

- **O_2 supply** *(see lecture „fundamentals of zoology“ – respiration!)*
- **„food“ (organic matter)**

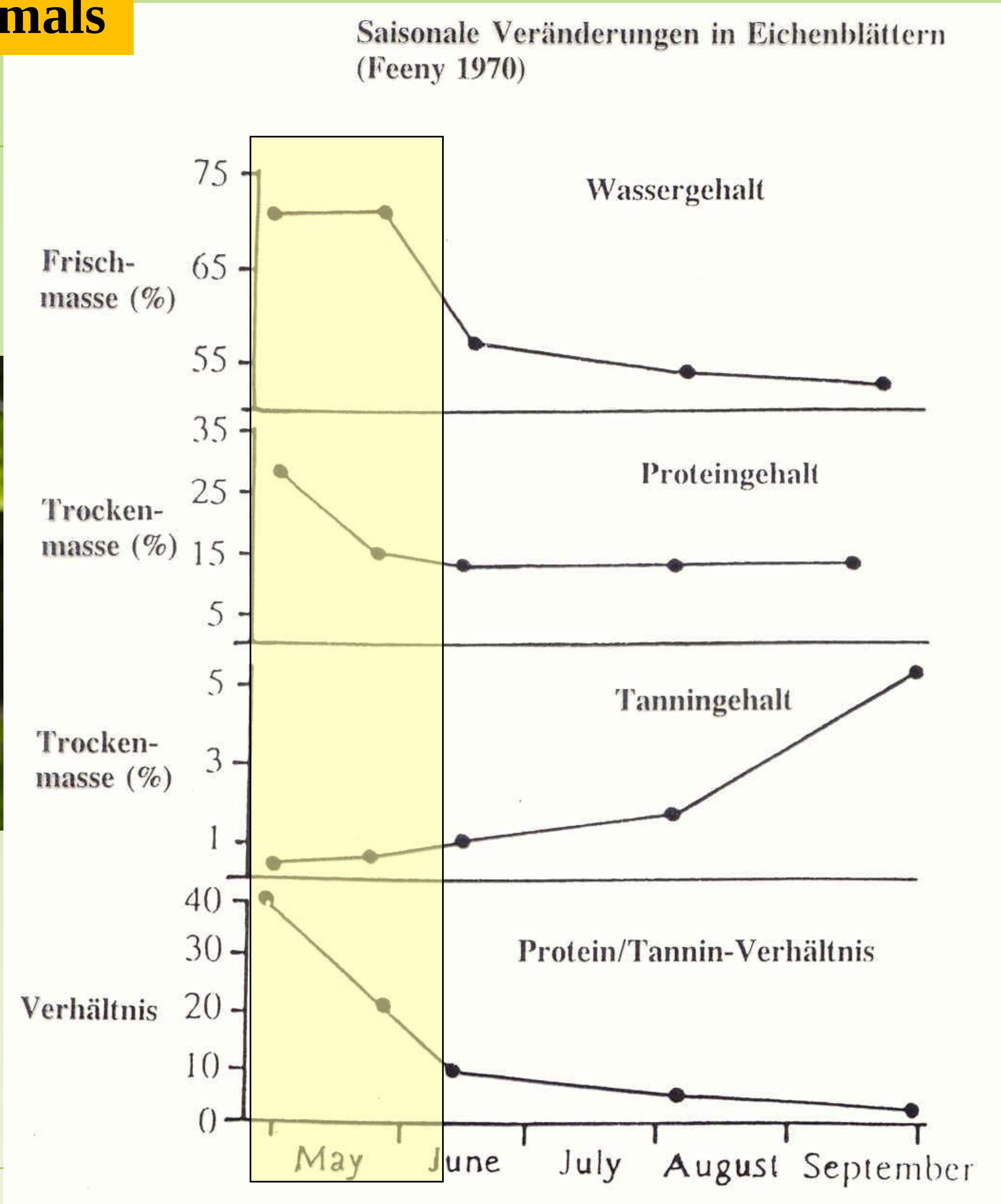
(*quantitative and qualitative problems*)

Chemical factors: *Food / nutrients*

problems:

- often very specialized demands (*specialists*)
- food may be difficult to find or access *(e.g.flowers)*
- food may be available for a short time period only

Factor NUTRIENTS / animals



Chemical factors: *Food / nutrients*

problems:

- often very specialized demands (*specialists*)
- food may be difficult to find or access *(e.g.flowers)*
- food may be available for a short time period only
- **digestion of food may be difficult *(cellulose)***

Example: Herbivores (feeding on plants)

- N/C relation in plant biomass : 1/40
  (animal biomass: 1/10)
- Cellulose and lignins are difficult to digest
- toxins in vacuoles (e.g. alkaloides)
- Resins, tannins make digestion difficult

Chemical factors: *Food / nutrients*

problems:

- often very specialized demands (*specialists*)
- food may be difficult to find or access *(e.g.flowers)*
- food may be available for a short time period only
- digestion of food may be difficult *(cellulose)*

solutions:

- **Sensoric adaptations („Senses“)**
- **Selective feeding**
- **Physiology (e.g. de-toxification mechanisms)**

Chemical factors: *Food / nutrients*

problems:

- often very specialized demands (*specialists*)
- food may be difficult to find or access *(e.g.flowers)*
- food may be available for a short time period only
- digestion of food may be difficult *(cellulose)*

solutions:

- Sensoric adaptations („Senses“)
- Selective feeding
- Physiology (e.g. de-toxification mechanisms)
- **Development (e.g. diapause)**
- **Parental care**

Chemical factors: *Food / nutrients*

problems:

- often very specialized demands (*specialists*)
- food may be difficult to find or access *(e.g.flowers)*
- food may be available for a short time period only
- digestion of food may be difficult *(cellulose)*

solutions:

- Sensoric adaptations („Sinne“)
- Selective feeding
- Physiology (e.g. de-toxification mechanisms)
- Development (e.g. diapause)
- Parental care
- **Anatomy (gut /stomach, mouth parts...)**
- **Symbiosis**
- **Hyperphagy / Coprophagy**

Example: aphids and bacteria

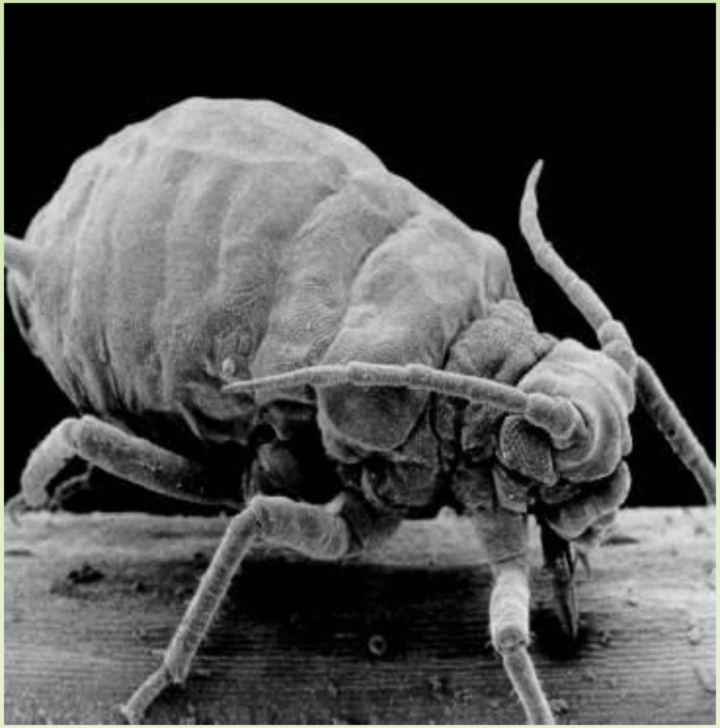
Aphids are phloem feeders

- rich in carbohydrates (16-25%)
- poor in nitrogen (0,02-2%)

- Strategy: ***Hyperphagy*** (ingestion of (too) much food) and ***Symbiosis*** with micro-organisms

Example: aphids and bacteria

Most of the ploem sap simply passes through the aphid´s gut: filtration gut
= the first part of the hind gut is located close to the beginning of the midgut;
in this area, liquids from the midgut can easily transfer to the hindgut (diffusion)
and be expelled from the aphid (= ***hyperphagy****).*
Only concentrated, nitrogen-enriched food reaches the midgut and is digested)



Example: aphids and bacteria

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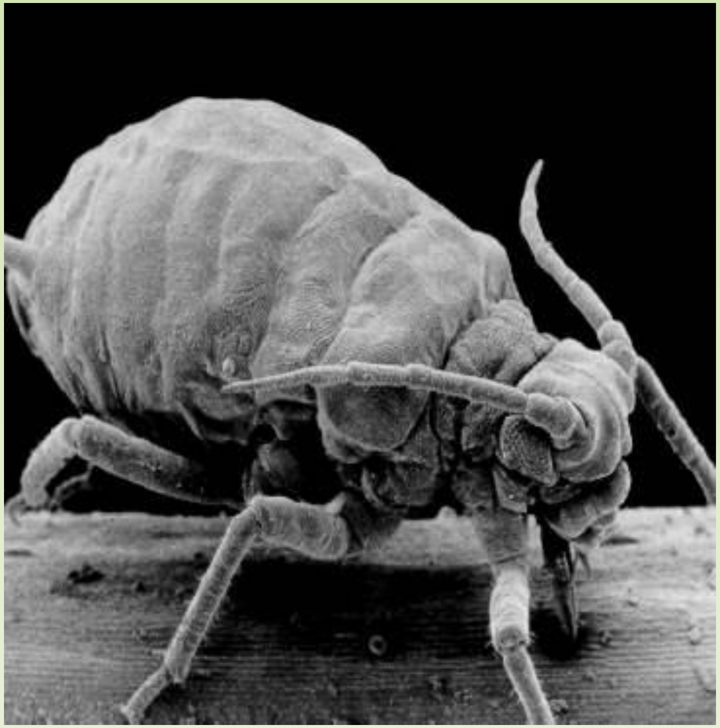
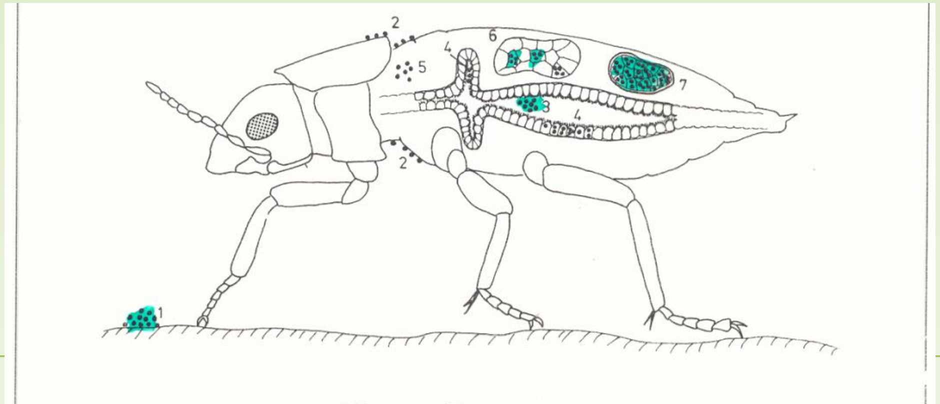
= the first part of the hind gut is located close to the beginning of the midgut;
in this area, liquids from the midgut can easily transfer to the hindgut (diffusion)
and be expelled from the aphid (= ***hyperphagy****).*
Only concentrated, nitrogen-enriched food reaches the midgut and is digested)

Bacteria in *mycetocytes* as symbionts

Bacteria (contribute to 2-5% of aphid biomass) provide the aphids with 10 different amino acids

This symbiosis developed approx.150-250 Mill. Years ago





The bacteria (*Buchnera)* are transmitted to the embryos

I. <u>LECTURES</u>

- <u>Principles of *General Ecology*</u>
- components of ecosystems
- energy flow / nutrient cycles
- adaptation of organisms to abiotic conditions
- development of ecosystems

Ecosystems develop / change over time:

SUCCESSION **is a repeated pattern of change over time in species composition of an ecological community**

PRIMARY SUCCESSION

Bare rock, gravel, sand, clay, etc.
NO biological component at start

SECONDARY SUCCESSION /
(usually following DISTURBANCES)

Vegetation removed, soil profile intact
Some biological component at start

Succession

Primary succession - growth on a new mineral substrate

- Volcanic deposition
- End of glaciation
- Landslides
- Tsunami
- Sand dunes
- River bars

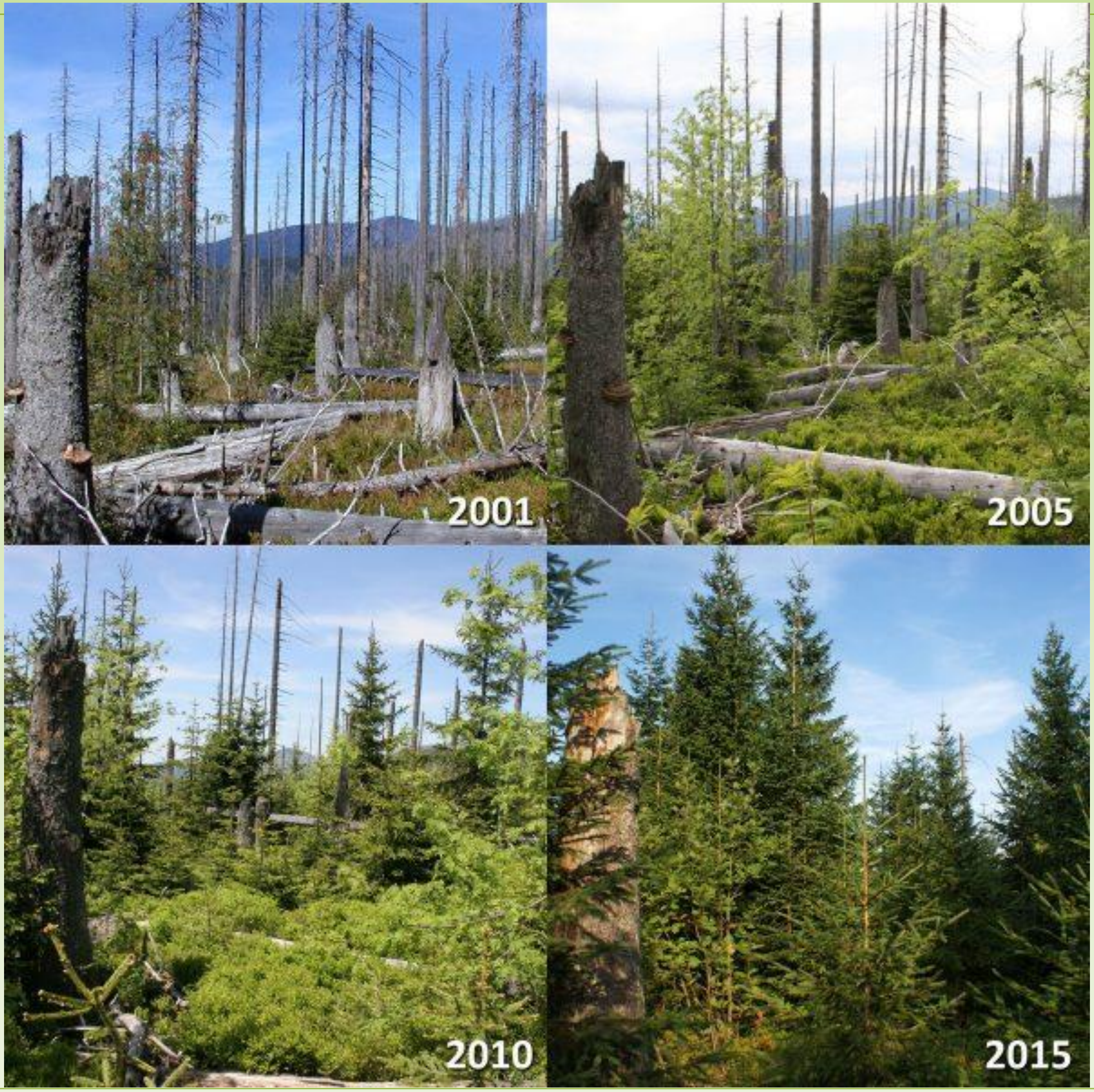
Secondary succession / usually following **Disturbance:**
new organisms but soil remains intact from previous community.

(*Disturbance:*
Any physical force that results in mortality of organisms or loss of biomass. Important are frequency, intensity, and scale of disturbance)

- Fire
- Hurricane/storm damage
- Insect outbreak
- Clearcut
- Agriculture
  (development of unused areas)

Development (“succession”) of Mt. Saint Helens area: Primary and secondary succession

Development ("succession") of NP Bay. Wald (after damage by bark beetle, *Ips typographus*):



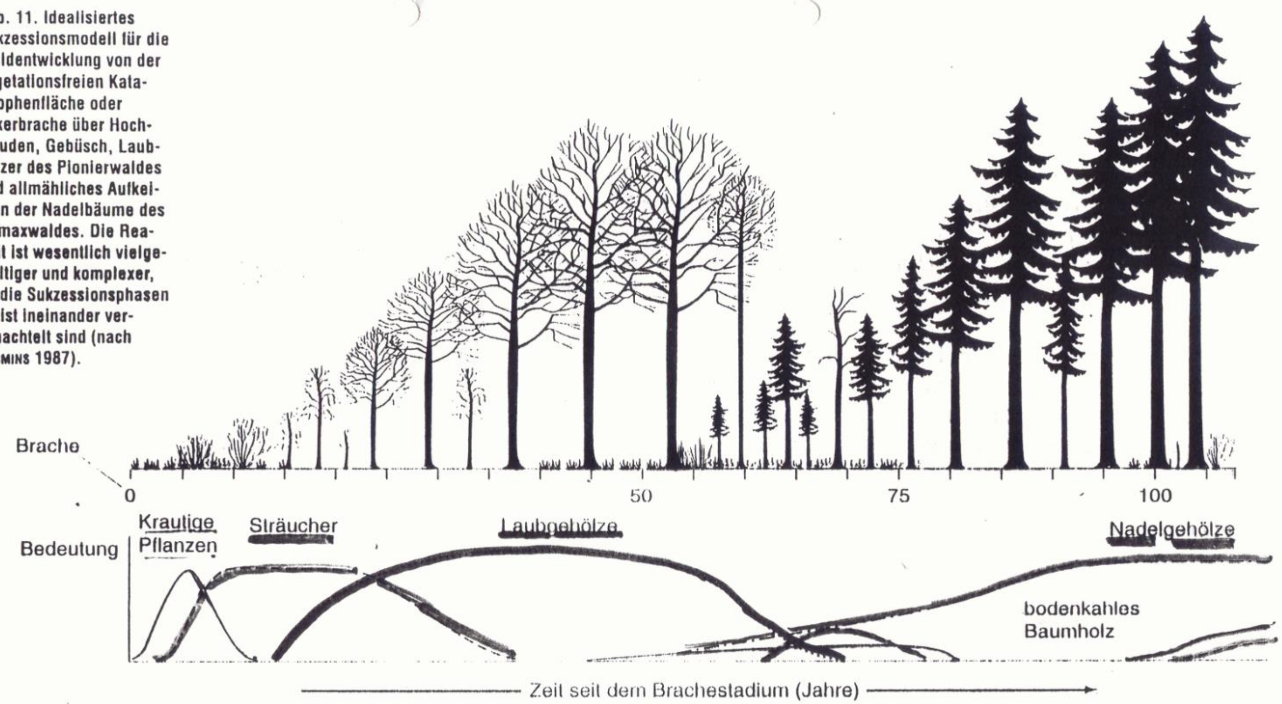
source:
NPV Bay. Wald

→ *(SECONDARY)* SUCCESSION:

- starts on an "open" site created by a disturbance from outside the system

- is directional
- has predictable components (=species)
- ends with a stable "climax" community (?)

Abb. 11. Idealisiertes Sukzessionsmodell für die Waldentwicklung von der vegetationsfreien Katastrophenfläche oder Ackerbrache über Hochstauden, Gebüsch, Laubhölzer des Pionierwaldes und allmähliches Aufkeimen der Nadelbäume des Klimaxwaldes. Die Realität ist wesentlich vielgestaltiger und komplexer, da die Sukzessionsphasen meist ineinander verschachtelt sind (nach KIMMINS 1987).



Changes in species composition - examples

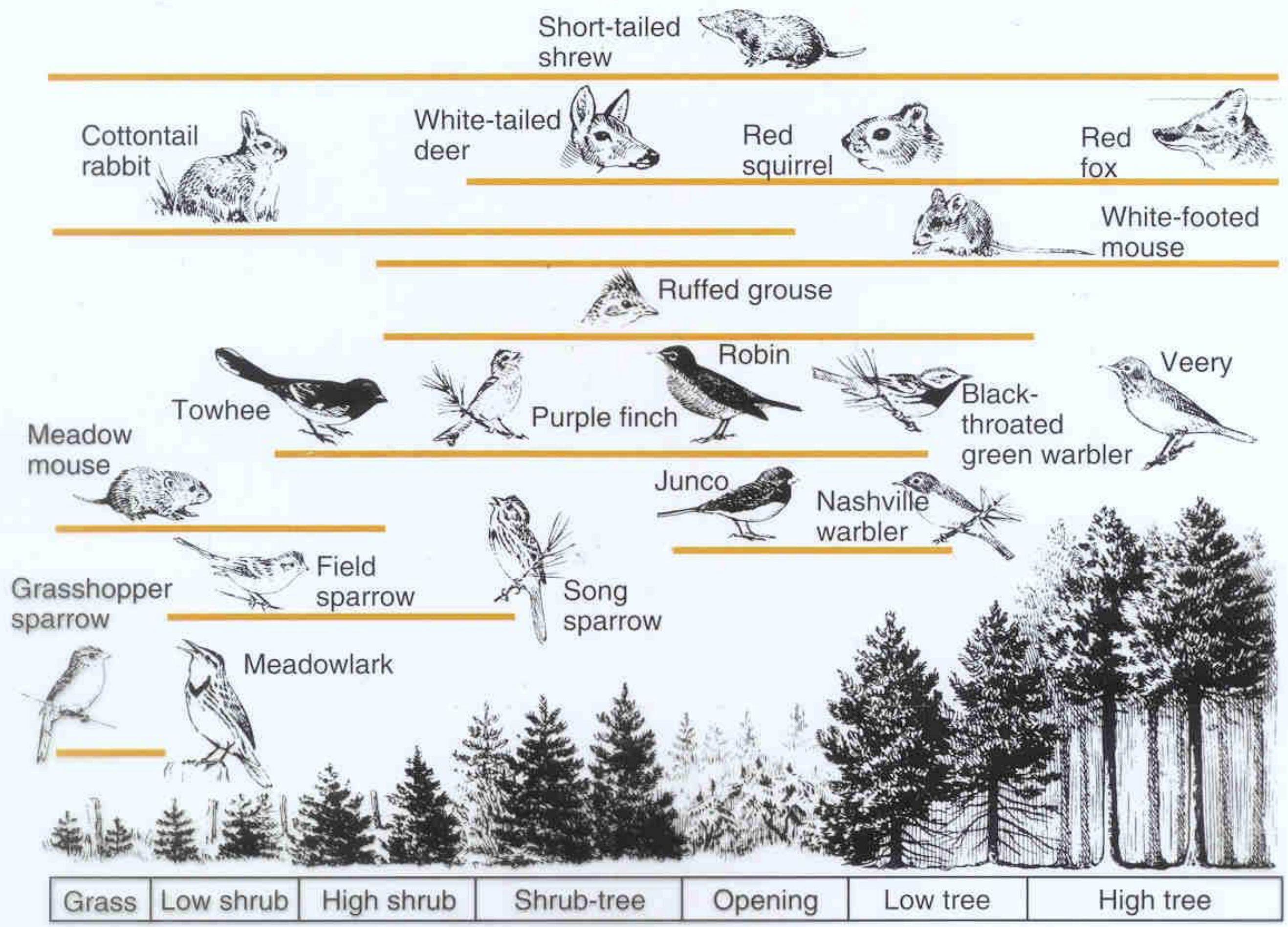


Figure 30.13 Wildlife succession in large conifer plantations in central New York State. (After R.L. Smith 1960.)

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Secondary Succession in Forest Ecosystems:

- ***There are two general development lines:***

1. Forest ecosystems
   with unpredictable, strong disturbances

2. Forest ecosystems
   without unpredictable disturbances
   (i.e. with predictable disturbances; seasons)

1. Forest ecosystems with unpredictable, strong disturbances (*like fire*)

Example: Boreal forests

No disturbance

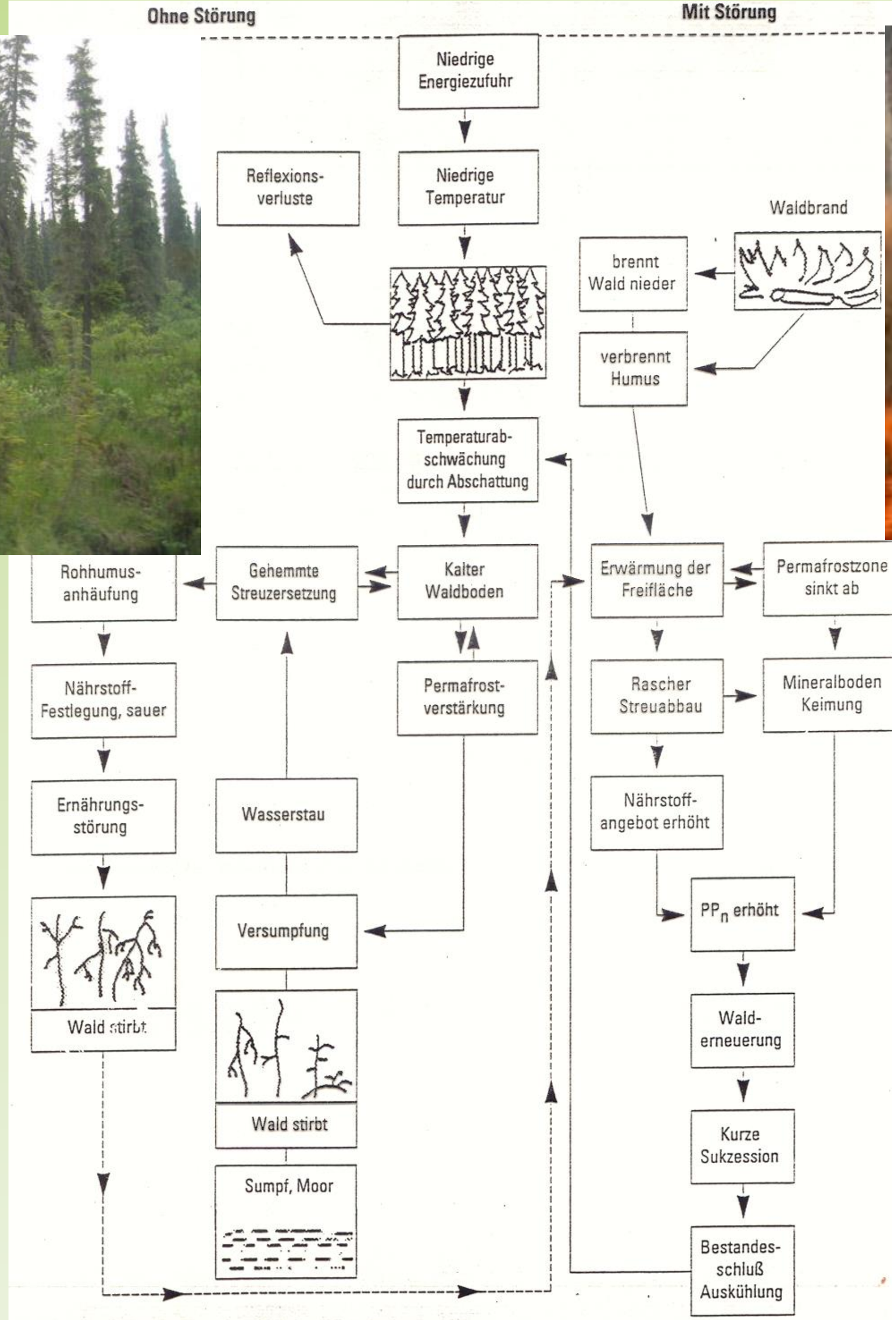

Abb. 2.45. Entwicklungslinien und -zyklen des borealen Nadelwaldes bei störungsfreier Dynamik nach Störungen.

Disturbance

Fig. 1. Effects of fire exclusion in a Douglas-fir forest of western Montana 1909, 1928, 1938, and 1948 (from Gruell et al. 1982).

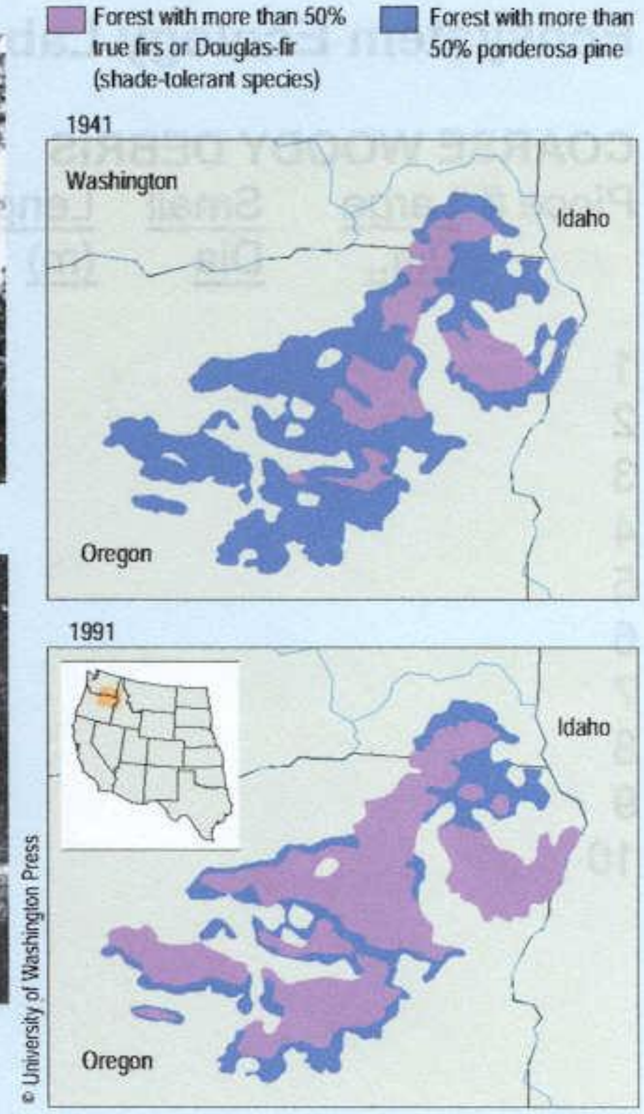

Fig. 2. Forest composition differences between 1941 and 1991 in the Blue Mountains of Oregon and Washington. Douglas-fir and true fir abundance have increased with fire suppression (from Langston 1995).

Effects of fire suppression

change in species composition!

Land management explains major trends in forest structure and composition over the last millennium in California's Klamath Mountains PNAS 2022 Vol. 119 No. 12 e2116264119

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For millennia, forest ecosystems in California have been shaped by fire from both natural processes and Indigenous land management. In California, where **20th-century fire suppression**, coupled with a warming climate, **has caused forest densification and increasingly large wildfires** that threaten forest ecosystem integrity and management of the forests as part of climate mitigation efforts.

We examine climatic versus anthropogenic influence on forest conditions over 3 millennia in the western Klamath Mountains—the ancestral territories of the Karuk and Yurok Tribes—by combining paleoenvironmental data with Western and Indigenous knowledge.

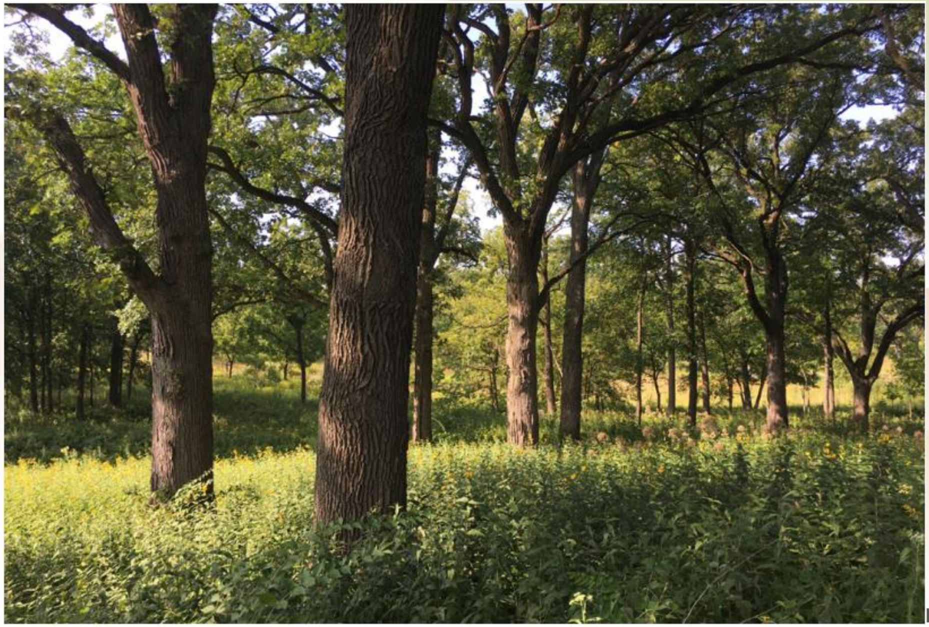
A fire regime consisting of tribal burning practices and lightning were associated with long-term stability of forest biomass. Before Euro-American colonization, the long-term median forest biomass was between 104 and 128 Mg/ha, compared to values over 250 Mg/ha today.

Indigenous depopulation after AD1800, coupled with 20th-century fire suppression, likely allowed biomass to increase, culminating in the current landscape: a closed Douglas fir–dominant forest unlike any seen in the preceding 3,000 y.

These findings are consistent with precontact forest conditions being influenced by Indigenous land management and suggest large-scale interventions could be needed to return to historic forest biomass levels.

Prescribed fire to reduce shade tolerant sugar maple in the understory and reduce tree density in restoration of oak woodland in Kansas, USA. Photo

„**Fire management**“ prevents „hot“ canopy fires → → as no „fuel wood“ is accumulated and leads to ←←regeneration!



Oak woodland restoration Illinois, USA, after tree thinning and repeated prescribed fires. Photo Daniel Dey

2. Forest ecosystems without unpredictable disturbances:

These forests (e.g. deciduous forest in central Europe) show typical secondary succession, but eventually develop a dynamic balance.

In such a (natural) forest, small „mosaic“ patches of forest development phases - different in age, species composition, and structure – constitute a highly diverse spacial and temporal pattern.

Each „mosaic“ patch is a habitat by itself; however, the whole forest (= *sum of all „mosaic“ patches*) constitutes the functional forest ecosystem with a typical nutrient flow, energy exchange & biodiversity.

= MOSAIC-CYCLE CONCEPT

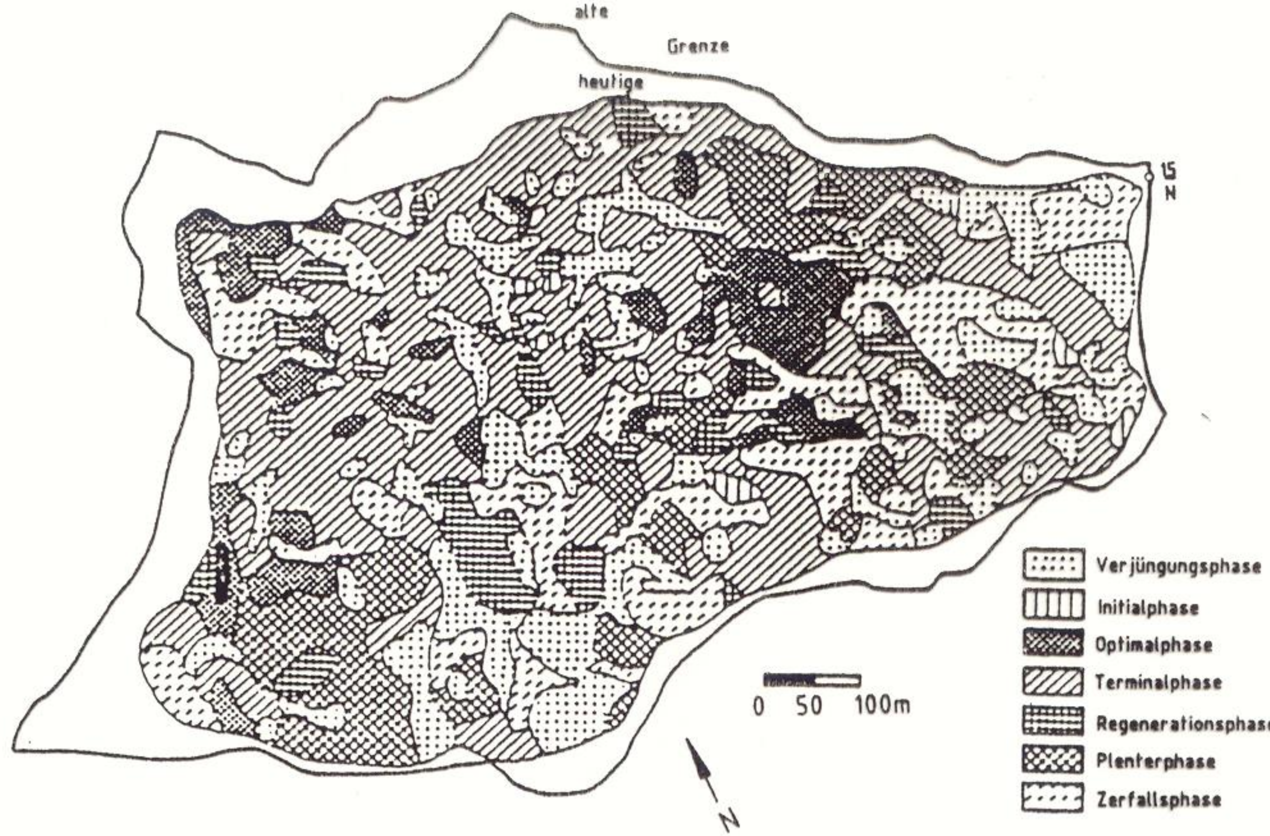


Abb. 2. Im Urwaldgebiet Rotwald lassen sich die verschiedenen Phasen des dortigen Buchen/Tannenurwaldes genau unterscheiden. Die Mosaiksteine sind im allgemeinen um 1 ha oder knapp 1 ha groß. Nach H. Mayer (1987). Diese Bilder sollten nicht dazu verleiten, großflächige Altersklassenwälder als Wirtschaftswälder anzulegen. Die Mosaikgröße von 1 ha sollte nicht überschritten werden.

„Mosaic“-patches differ in size (area), according to the forest ecosystem!

Example: *Rotwald* in Austria; *Bialowieza* forest in Poland

....What about the size of „mosaic“- patches in tropical forests?

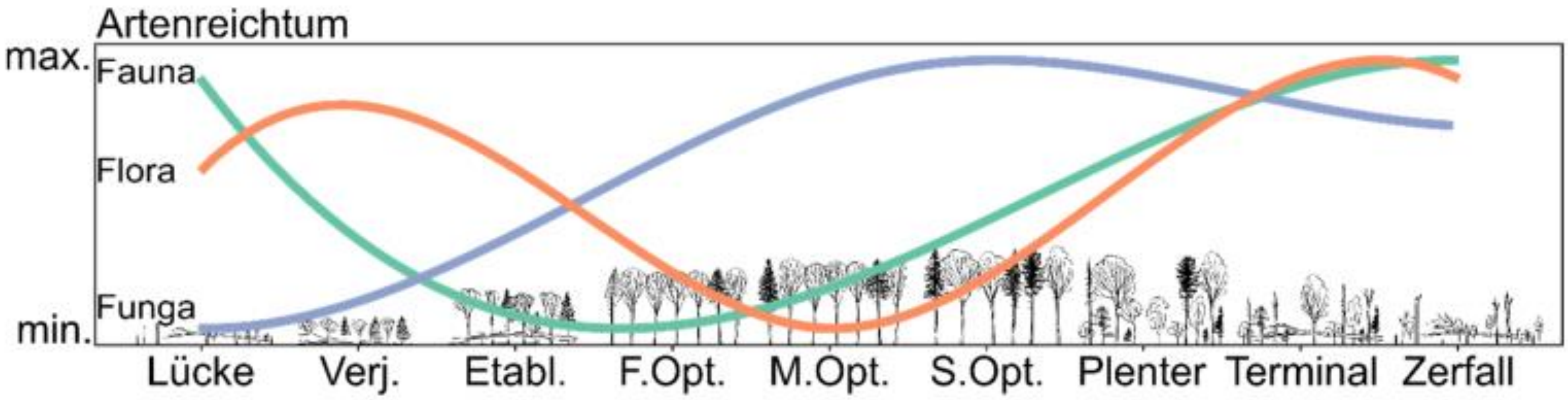


Abb. 1: Artenreichtum entlang von Waldentwicklungsphasen im Bergmischwald aus Buche, Tanne und Fichte (nach Hilmers et al. 2018).

Diversity and species composition changes and varies greatly between the different forest development phases.

If, however, you have all phases in one forest at the same time (= mosaic structure!), you may find all species somewhere in that forest

Conclusion: During the development (succession) of a forest, the (abiotic and biotic) conditions change – and so does the biocoenosis!

HNE Eberswalde
Hochschule für nachhaltige Entwicklung (FH)

What is the influence of forest management on this succession, and what are the consequences?

FF	V	Dickungs-phase	Schluß-wald-phase	Optimalphase	Plenterphase	Klimax	Zerfallsphase	Zusam-men-bruch	F/V
(2)	2	10%	5%	20%	33%		22%	8%	=600 J.
	[redacted]				im Forst				
		Haselhuhn Sperber	Bunt-specht (Sper-ber)	Buntspecht Dreizehenspecht Habicht Zwergschnäpper (Schwarzspecht) (Hohltaube)	Buntspecht Dreizehenspecht Weißrückenspecht Schwarzspecht Hohltaube Rauhfußkauz Habicht Trauerschnäpper (Sperlingskauz) (Auerhuhn) (Haselhuhn)		Buntspecht Dreizehenspecht Weißrückenspecht Schwarzspecht Hohltaube Rauhfußkauz Sperlingskauz Waldkauz Habicht Schreiadler Gartenrotschwanz Trauerschnäpper Baumpieper (Grauspecht)	Buntspecht Dreizehenspecht Schwarzspecht Grauspecht Grünspecht Wendehals Waldkauz Habichtskauz Waldohreule Mäusebussard Wespenbussard Haselhuhn Auerhuhn Baumpieper Heidelerche	

Abb. 33. Im Laufe seiner rund 600jährigen Lebensspanne kann ein Urwald sehr unterschiedliche Entwicklungsphasen durchlaufen, wie sie in diesem Sukzessionsschema – am Beispiel des Bergmischwaldes – mit der jeweiligen Vielfalt indikatorisch wichtiger Vogelarten verglichen werden. Die schwarze Markierung kennzeichnet die Spanne forstlicher Umtriebszeit, innerhalb der eine maximale Struktur- und Formenfülle nicht zur Entwicklung kommen kann; Zeitachse nach Angaben aus dem Rothwald (aus SCHERZINGER 1991).

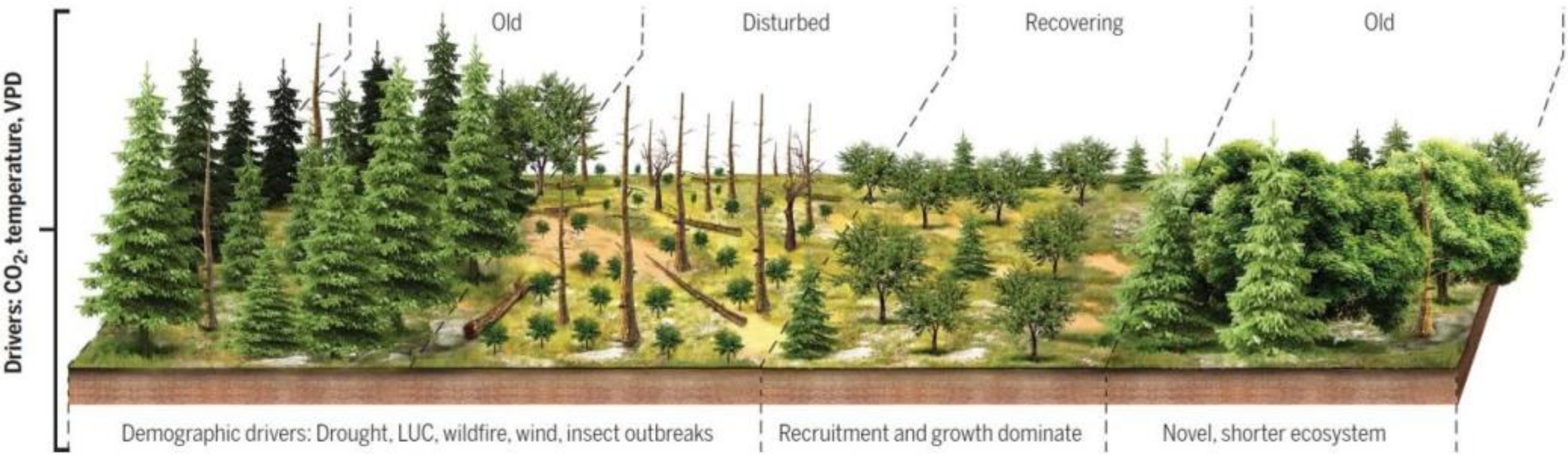


Abb. 1: Modellhafte Vorstellung von der Veränderung der Wälder im Rahmen des Klimawandels (Mc Dowell et al. 2020, Abbildung freundlicherweise vom Autor überlassen)

..no more lecture for now..! From now on: PRACTICAL FIELDWORK!

→ **Lecture will resume in October**

(then: Applied ecology – functions of consumers, biotic interactions, biological control, invasive species..)

Störungen sind natürlicher Teil des Systems, verändern sich aber stark

Bedingt durch den globalen Wandel ist für die Zukunft mit vermehrten Störungen und neuartigen Störungsregimes zu rechnen

Störungen haben vielfältige Auswirkungen auf Waldökosysteme

Sie erhöhen die Diversität von Wäldern, reduzieren aber auch eine Vielzahl von Ökosystemleistungen für die Gesellschaft

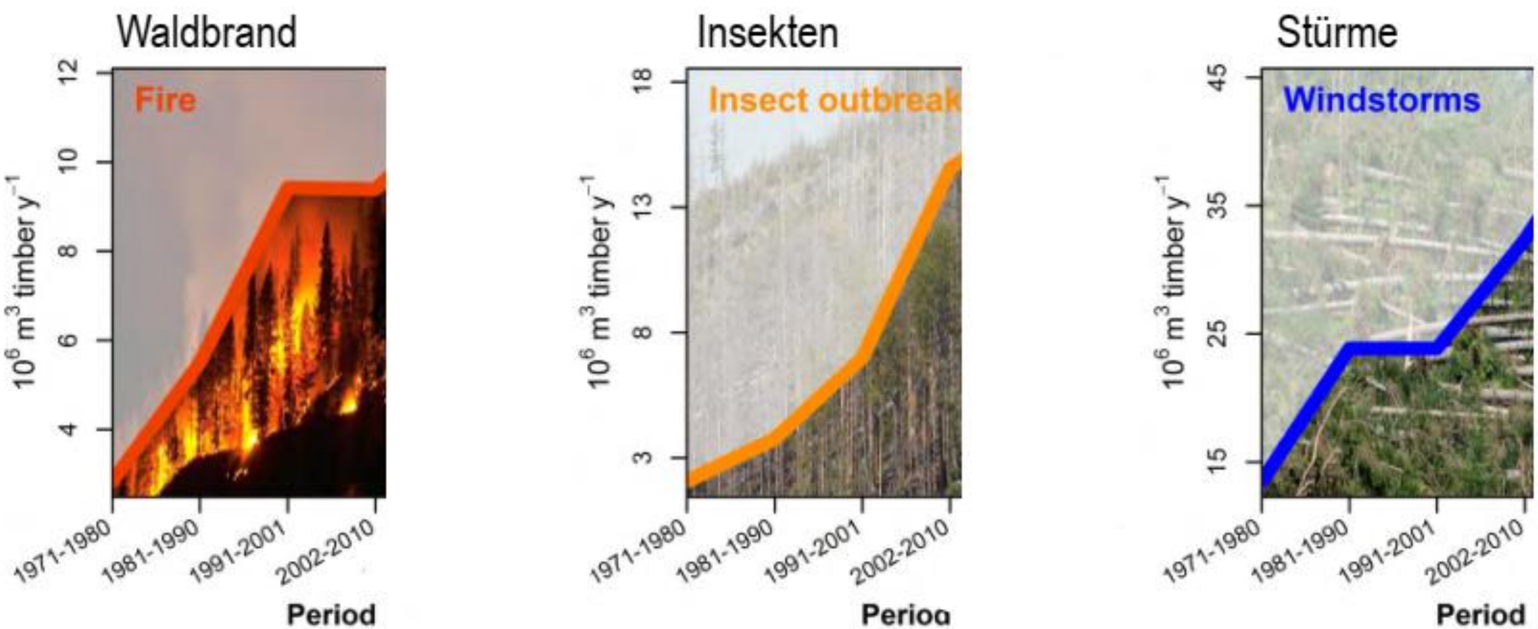
Resilienz ist ein zentrales Element des Waldbaus der Zukunft

Waldbewirtschaftung muss sich an steigende Unsicherheit durch geänderte Störungsregimes anpassen

Störungsentwicklung in Europa

Weiterer Anstieg in den kommenden Jahrzehnten

Steigerungsrate +1 Mill. m³ pro Jahr



Hauptursache des weiteren Anstiegs: Klimawandel

Störungen steigen in allen untersuchten Szenarien (14 Klima- und 4 Landnutzungsszenarien) weiter an

Seidl et al. (2014, Nature Climate Change)

PRACTICAL PART “ecology”:

Aim: **Investigate / analyze a forest ecosystem** and identify the influence of different management strategies

Ecosystem components to investigate:

- forest stand („trees“)
- soil conditions („nutrients“)
- meteorological conditions („heat/drought“)
- vegetation („herb diversity“)
- structural diversity („microsites, special structures“)
- animals („animal diversity“)

→ begin April 22, 10 appointments

→ We need six groups (7 students each) – please send me your list!

II. Practical part "ecology" (April 22nd – July 1st)

Practical part on Tuesday, 10 appointments:

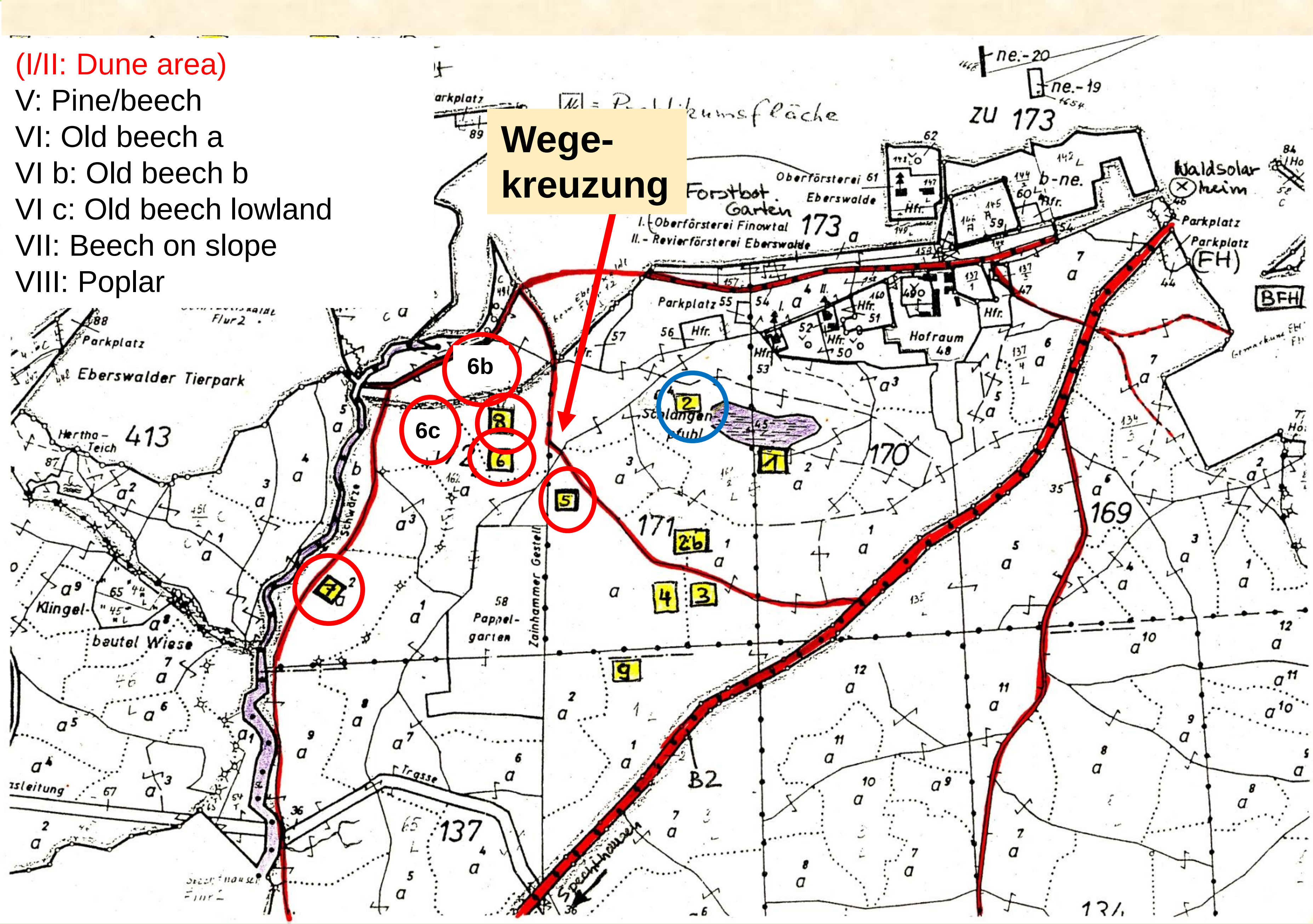
April	22	plot specification, installation of equipment and traps
	29	forest mensuration (Doris Kramm)
May	6	lecture/exercise "vegetation survey" (Dr. Hornschuch)
	13	vegetation survey on your plots
	27	excursion (Dr. Hornschuch)
June	3	monitoring of structural diversity (Linde/Kolling)
	10	interim evaluation of results
	17	sorting of pitfall traps, first determinations of arthropods
	24	evaluation of your results; preparation of exam
July	1	**oral exam** – presentation of results on the plot

→ **You will receive email-instructions** (where you have to be at what time)

→ **Please study all scripts (plant ID etc.) BEFORE coming to the plots!!**

..you have seen the plots on April 15 and decided where you´d like to work

(I/II: Dune area)
V: Pine/beech
VI: Old beech a
VI b: Old beech b
VI c: Old beech lowland
VII: Beech on slope
VIII: Poplar



Schon 47 Fälle von Borreliose

Potsdam. In Brandenburg sind 2019 bereits 47 Fälle von Borreliose gemeldet worden. Das teilte das Gesundheitsministerium Brandenburg mit. Allein im Landkreis Uckermark wurden sieben Fälle bekannt – damit gab es dort die meisten Fälle im Land. Ende Januar waren die Milbentiere besonders aktiv: Zehn Meldungen stammten aus der Woche vom 21. bis 27. Januar. Jeweils fünf Borreliose-Erkrankungen wurden in den Landkreisen Oberhavel, Märkisch-Oderland und der kreisfreien Stadt Brandenburg/Havel gemeldet. 2018 zählte das Ministerium insgesamt 1555 Fälle von Borreliose in Brandenburg. (dpa)

Gefahr durch Zecken 18. März 2022
Ein **Insekt** mit einem gefährlichen Krankheitserreger verbreitet sich weiter nach Norden.
Nachdem bis vor wenigen Jahren Norddeutschland noch außen vor war, ist seit dem 3. März sogar der Landkreis Oder-Spree durch das Robert-Koch-Institut als **FSME-Risikogebiet** eingestuft worden. FSME ist eine Erkrankung der Hirnhäute und des zentralen Nervensystems und mit Medikamenten nicht heilbar.

Und: In Deutschland sind 20 bis 30 % der Zecken mit **Borrelien** infiziert

Please take care!

- Plug your pants into the socks
- Use a repellent
- After the practical excercise:
  → Search your body