

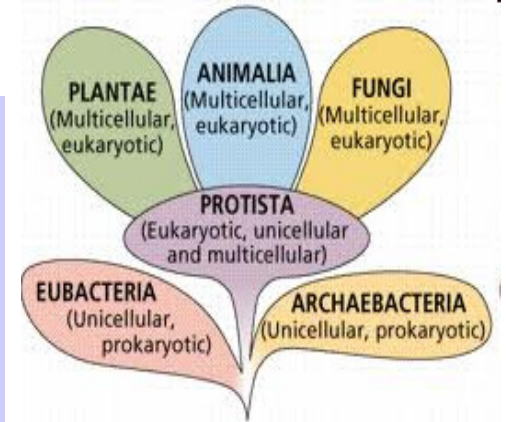
Botany

Botany, or **plant science(s)**, or **plant biology** is a part of the biological sciences (like zoology, mycology, microbiology, biochemistry, ecology etc. that involves the study of plants, algae and fungi.

Historically all living things were grouped as animals or plants. Botany covered all organisms not considered animals.

Organisms that were once included in the field of botany but no longer belong to the plant kingdom include

fungi (studied in mycology), **lichens** (lichenology),
bacteria (microbiology), **viruses** (virology) and
algae, which are now a major part of the Protista.



However, botanists still pay attention to these groups & cover them in introductory botany course

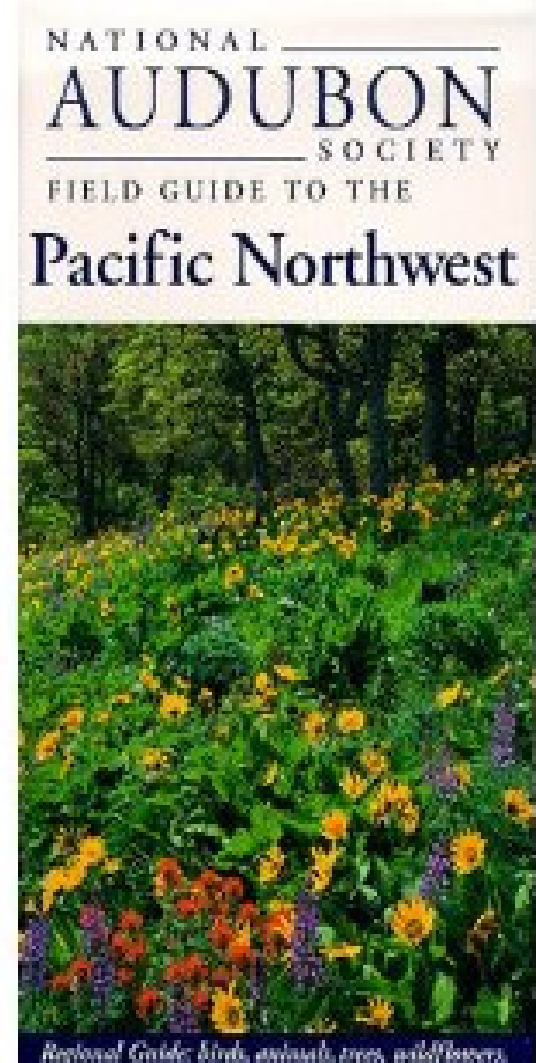
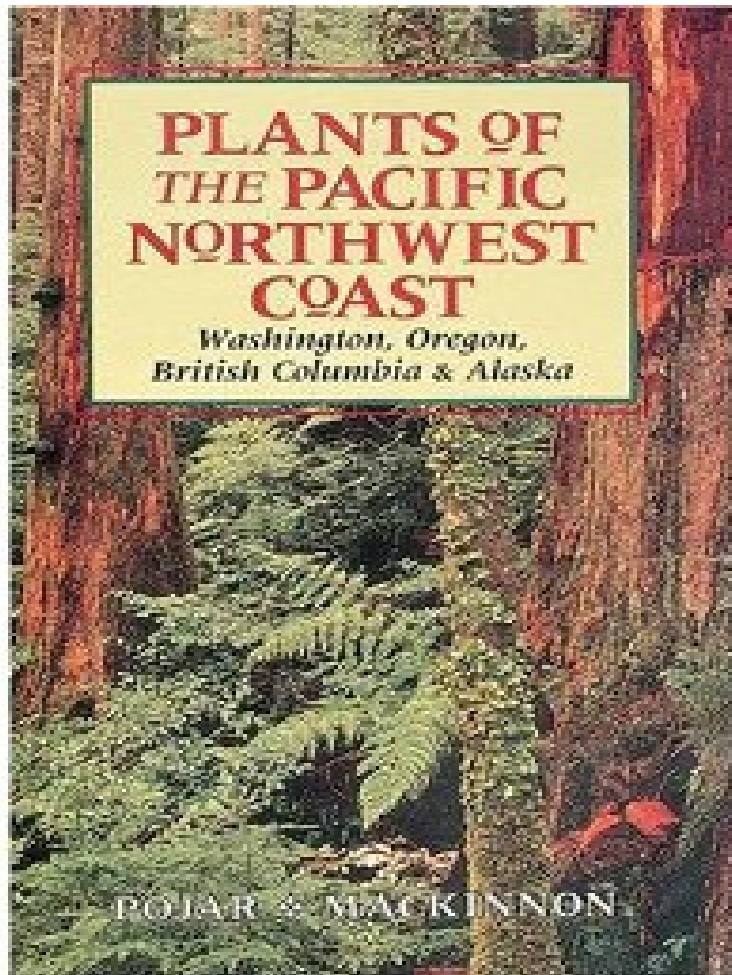
In Roman mythology, **Flora** is the goddess of flowers and spring.

A **flora** is the plant life in a particular region, flora of the Pacific West coast covered by **Pojar & McKinnon**. **Flora and Fauna** are plants & animals of ...

Floras of the Pacific Northwest Coast

**Plants of the Pacific Northwest Coast:
Washington, Oregon, British Columbia, and
Alaska [Paperback]**

Jim Pojar (Author), Andy MacKinnon (Author) .



The subdivisions of Botany

Genetics, systematics, cytology, anatomy, morphology, plant physiology, pathology, and ecology are the established broad sub fields of botany.

Economic botany= relationships between people and plants = ethnobotany

Phytosociology study of plant communities & relationships between species

Ethnobotany = how indigenous populations make use of plants

Biometerology subfield that relates plants with environment & weather

Plant ecology (ecology of vascular plants on land and in wetland ecosystems)

established sub fields are:

Plant pathology (diseases and the changes they cause in structure & function)

Phycology (algae) **Horticulture** (the science of cultivating plants)

Agronomy (soil management and crop management) **Paleobotany** (fossils)

Plant taxonomy (categorizing plant species, these days using DNA analysis)

Paleoclimatology how plants contributed to the atmosphere through history!

Palynology (spores and pollen, both fossilized and current, where a body has

been laying in a particular spot, see **forensic botany**)

Bryology (mosses and liverworts) **Dendrology** (woody plants)

Lichenology (lichens) **Phycology** (algae)

Pteridology (ferns) **Xylology** (study of the structure of wood)

Dendrochronology - tree rings reveal the past

Dr. A. Douglas studied the climates of the past. Found that **varying thickness/width of annual rings corresponds to climate**

dry year → narrow ring

wet year → wide ring

Principle: Trees from the same area & same time show identical sequence of narrow vs wide rings.

Trees of different periods show **sufficient overlap to allow to trace the climate over several lifetimes of trees.**

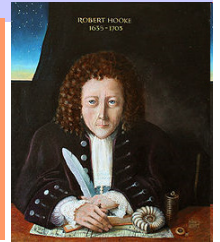
Douglas matched rings from trees used in the construction of Indian pueblos with his data library and determined the age of the construction as 53 BC.



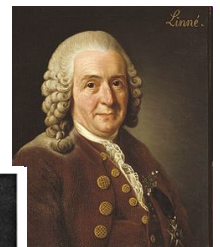
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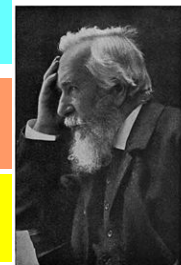
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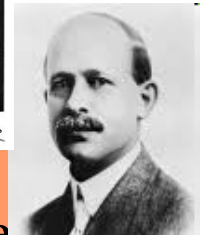
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Plant Physiology Van Helmont and Joseph Priestley



Ecology interaction of plants & animals, named by Ernst Haeckel,



Ethnobotany plant use (e.g. as foods; as medicines; in divination; in cosmetics; dyeing, tools, currency; ,clothing;; in rituals; and in social life "ethnobotany" coined 1895 by US botanist John **William Harshberger**.



Plant Geopgraphy = plant distribution on earth according to habitats started by A Von Humboldt climbing the Chimborazzo in 1796.

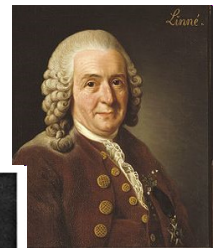
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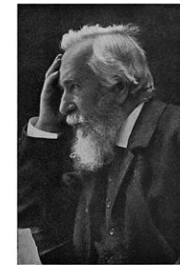


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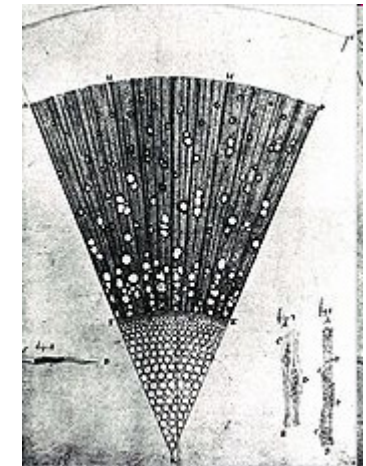
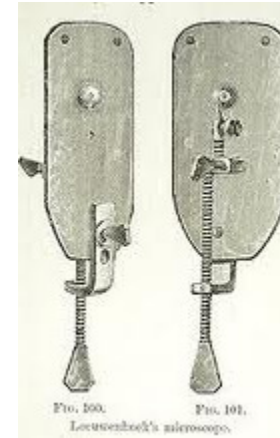


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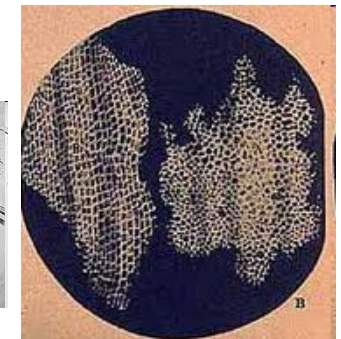
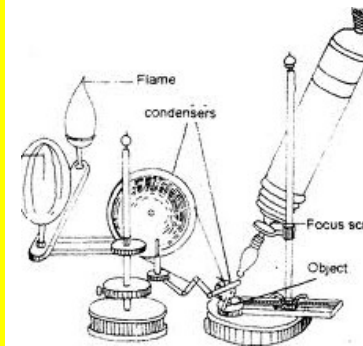


New tools allow new insights - microscopy

Antony van Leeuwenhoek 1632-1727, received no higher education & knew only his Dutch. Leeuwenhoek made *important discoveries*: It was he who discovered **bacteria, microscopic protists, sperm cells, blood cells**, pointed to potential of microscopy



Robert Hook, 1635-1703 is known for his **law of elasticity** (Hooke's law), his book, *Micrographia* and there for first applying the word "**cell**" to describe the basic unit of life. This was based on the observation of cork cells.



Marcello Malpighi (1628 –1694) was an Italian doctor, who gave his name to features, like the Malpighian tubule system. In 1671, **Malpighi's Anatomy of Plants** was published in London by the Royal Society,



Glass making (the forgotten history)

The first true glass was made in Sumer, Mesopotamia or Old Egypt. 2500 BC the **earliest glass objects were beads**, perhaps created as accidental by-products. The earliest vessels were 'core-wound', produced by winding a ductile rope of glass round a shaped core of clay over a metal rod, then fusing it with repeated reheatings.

The alkali of Syrian and Egyptian glass was **soda ash = sodium carbonate, which can be extracted from the ashes of many plants, notably halophile seashore plants:**



Much early glass production, however, relied on grinding techniques borrowed from stone working. The glass was ground in a cold state. Grinding is a prerequisite of lens making. **The Egyptians had the potential to make & grind clear glass beads to lenses. Egypt lost the art of glass making until 100 AD.**

Alexandria 100 AD: **discovery of clear glass through the introduction of manganese oxide**), in Alexandria ca. AD 100. **Cast glass windows, with poor optical qualities appear in the important buildings in Rome and Pompeii.**

Telescope making (the forgotten history)

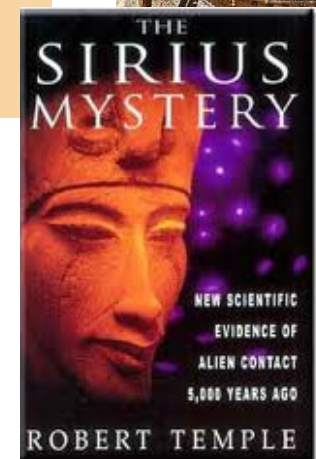
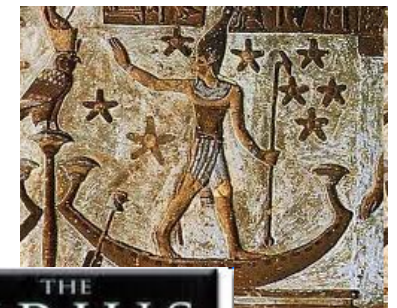
The first true glass was made in Sumer, Mesopotamia or Old Egypt.
7000 BC glass beads found in tombs, but perhaps imports from Syria

Adding cobalt, copper or manganese or manganese oxide they could make blue, green, purple or clear transparent glass.

1200 BC Egyptians discovered how to press glass into molds. They were also good in **grinding and faceting glass**. Do you **think they made lenses? You bet they did.**

Much early glass production, however, relied on grinding techniques borrowed from stone working. The glass was ground in a cold state. Grinding is a prerequisite of lens making. **The Egyptians had the potential to turn clear glass beads to lenses, to make telescopes and microscopes.**

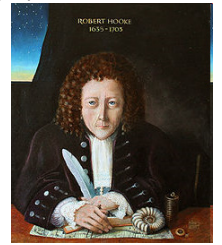
Robert Temple in his book, 'The Sirius Mystery' claimed that an African tribe of Egyptian descent, **the Dogon**, had advanced astronomical knowledge about a moon of the Sirius system that can only be seen with good telescopes.



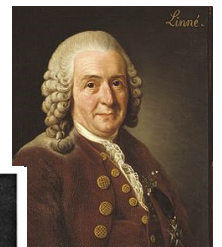
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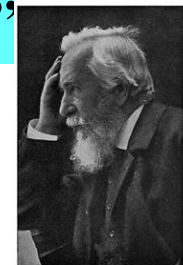


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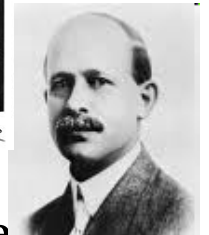


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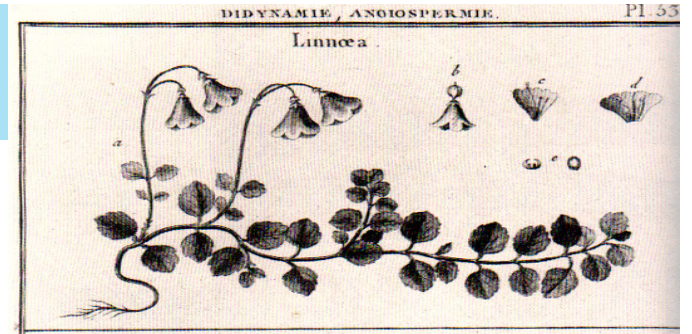


Carl Lineaus in Lapland holding a drum of the aborigines from his book " Flora Laplandica 1737

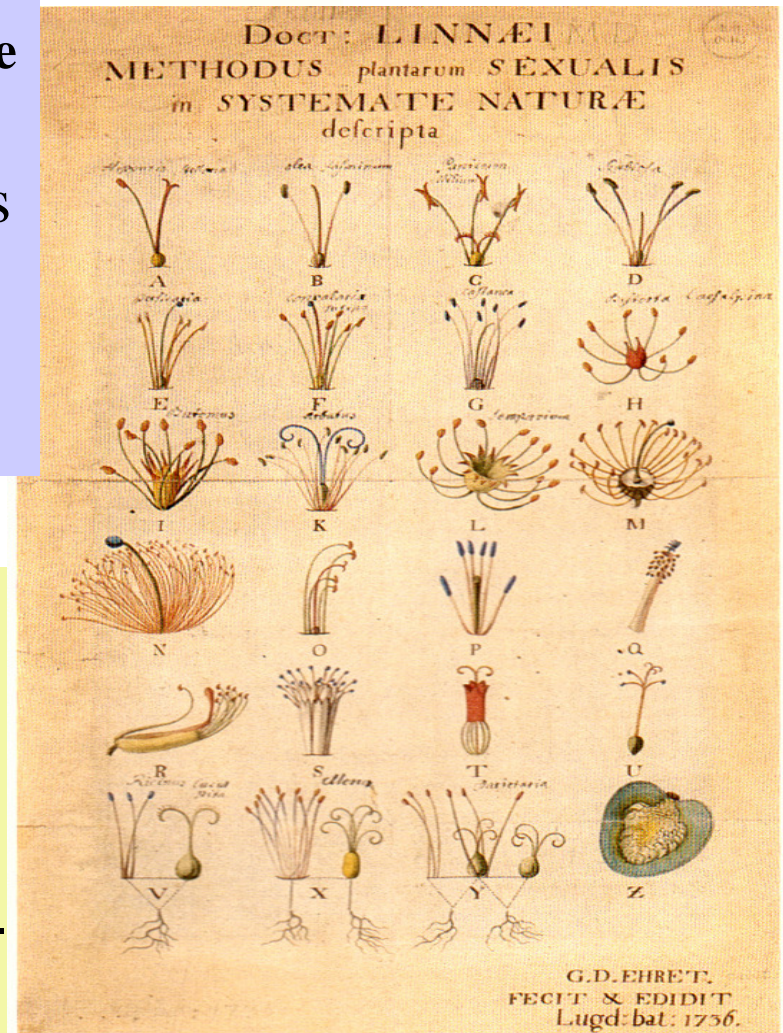
Carl Linnaeus

Most influential book was his **Systema Naturae** – foundation for systematics based on a binomial nomenclature

Linnaeus – a Swedish gynecologist – studied Medicine in Leyden (Holland) made not his money but fame in botany. Was an ethnobotanical pioneer in that he **studied plants & their uses by the Laps – a nomadic nation in northern Europe.**



Linnaeus favorite plant *L. borealis* from his book *Flora Lapponica, of 1737*





Carl von Linne– Prince of Botanists

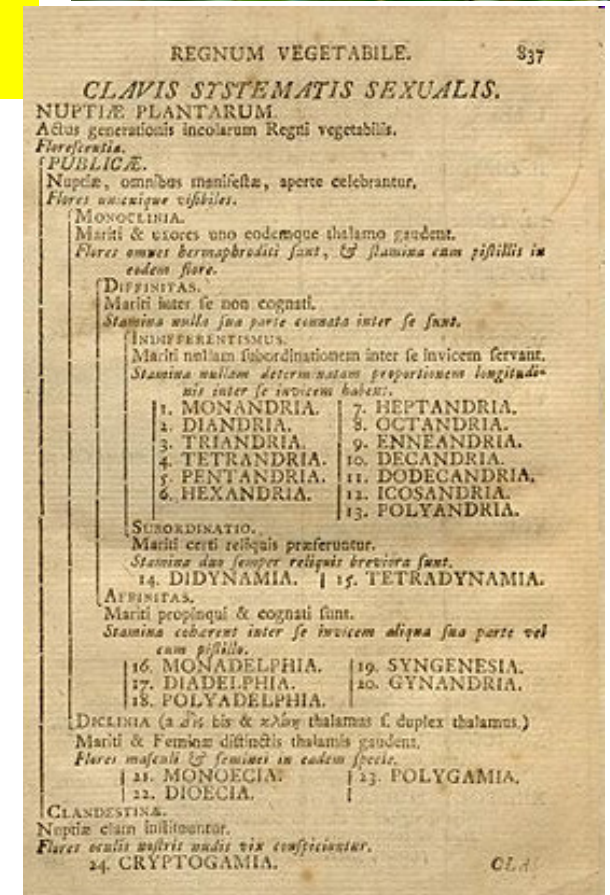
The Twinflower *Linnea borealis* was named after himself. It is a **circumboreal species** occurring both in N Europe & N. America



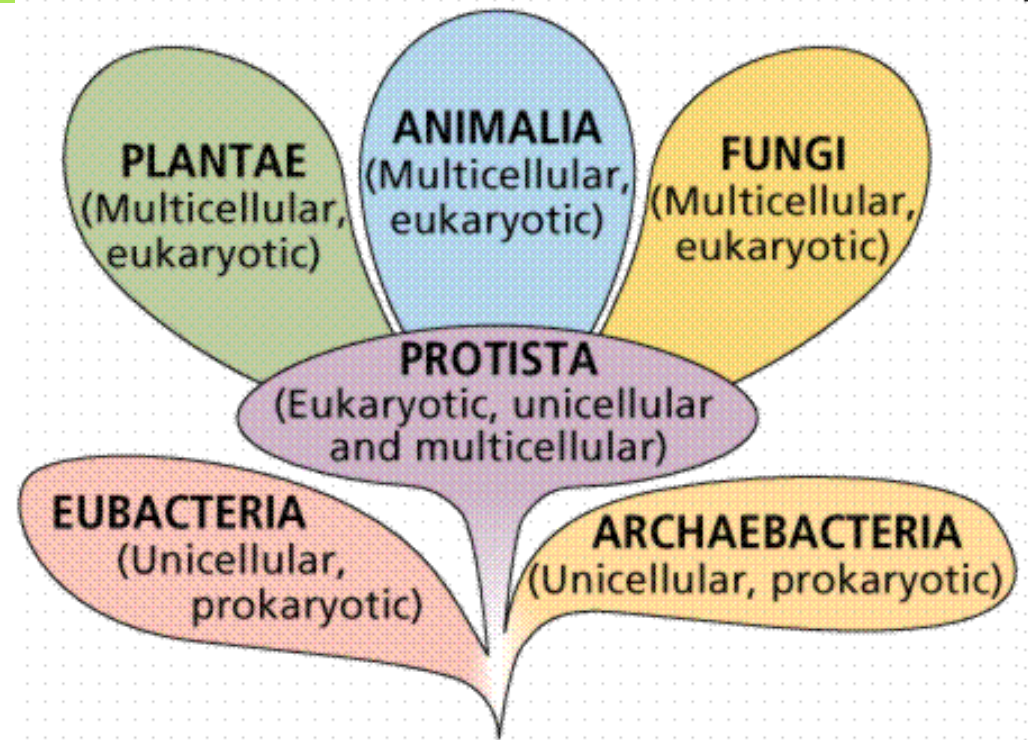
In 1729 Linnaeus wrote a thesis, *Praeludia Sponsaliorum Plantarum* on plant sexuality.

In his *Imperium Naturae*, there are 3 kingdoms: *Regnum Animale*, *R. Vegetabile* & *R. Lapideum*. = the **Animal, Vegetable and Mineral Kingdoms**, survives today in the popular question: "Is it animal, vegetable or mineral?"

In his *Systema Naturae* (1735) there are three **kingdoms**, divided into **phyla or divisions**, then into **classes**, and they, in turn, into **orders, genera** (singular: *genus*), and **species** with an additional rank lower than species.



What is a plant? 5 kingdoms or 6, Sir?



Life

THREE DOMAINS
Many kingdoms

2. BACTERIA:
NO NUCLEUS
NO 'JUNK DNA'
AUTO/HETEROTROPHS

1. ARCHAEA:
NO NUCLEUS,
'JUNK DNA'
AUTO/HETEROTROPHS

3. EUKARYA:
NUCLEUS
'JUNK DNA':
1. PROTISTA
2. ANIMALIA
3. FUNGI
4. PLANTAE

PLANT KINGDOM

Non-Vascular Plants

Bryophyta



Characteristics: Non-vascular, lack true roots and stems, reproduce asexually and sexually.

Rhynophyta

(Lichens)



Lycopodiophyta

(Clubmosses)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Vascular plants - Tracheophytes

Zosterophyllophyta



Trimerophytophyta



Psilotophyta / Filicophyta



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Pteridospermatophyta

(Seed ferns)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Seed plants - Spermatophytes

Pinophyta / Coniferas

(Conifers)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Pallotophyta

(Mosses)



Cycadophyta

(Cycads)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Gnetophyta

(Gnetophytes)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Equisetophyta

(Horseshoe ferns)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Magnoliophyta / Angiospermophyta

(Flowering plants)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Ginkgophyta

(Ginkgo)



Characteristics: Vascular, have true roots and stems, reproduce asexually and sexually.

Divisions

Fern Allies

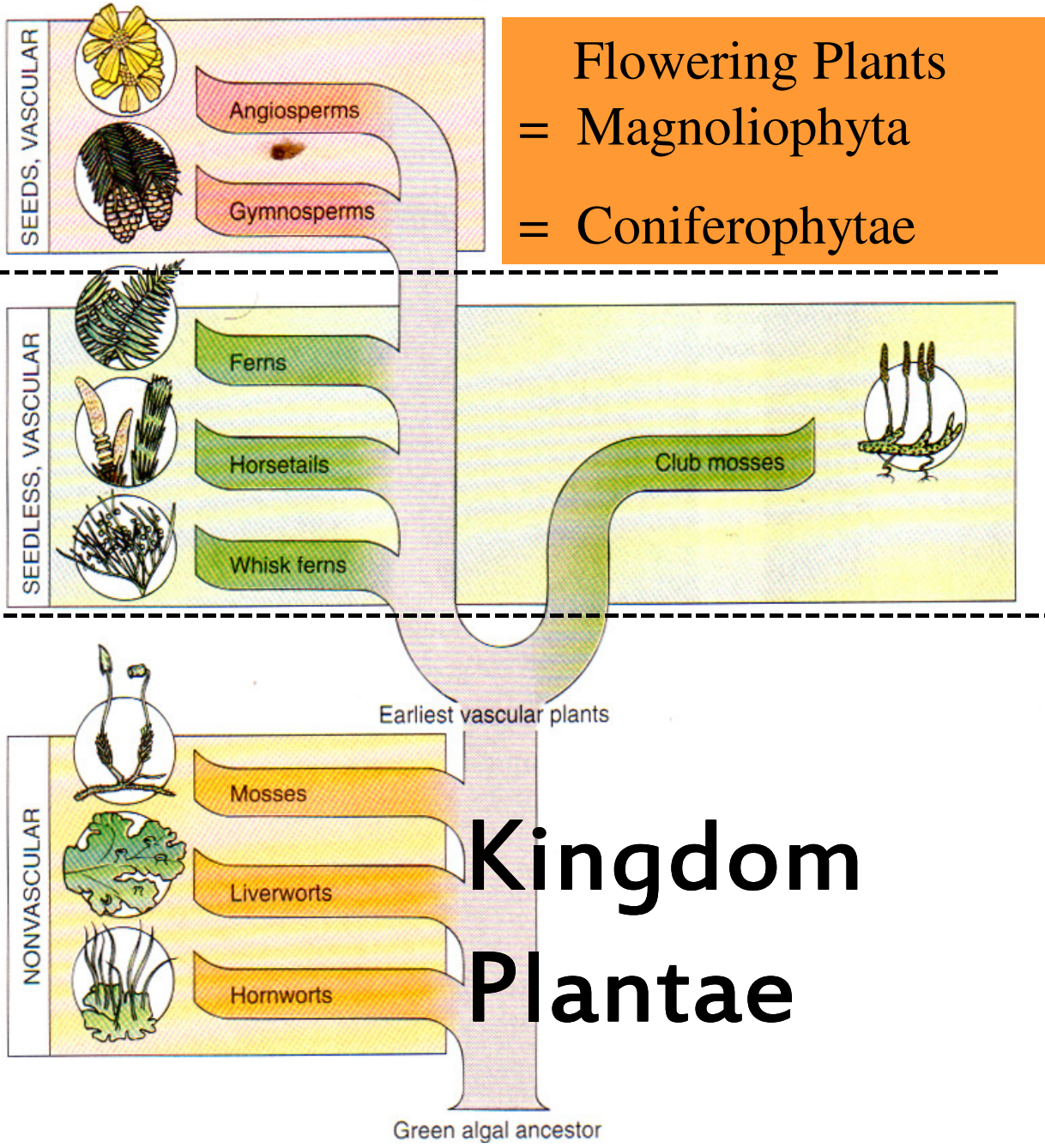
Seed Plants

Pteridophyta

Embryophyta

Subdivisions

Coniferophyta and
Magnoliophyta



**Subkingdom Bryophytes
or Lower Plants**

**Subkingdom Tracheophytes
or Vascular plants**

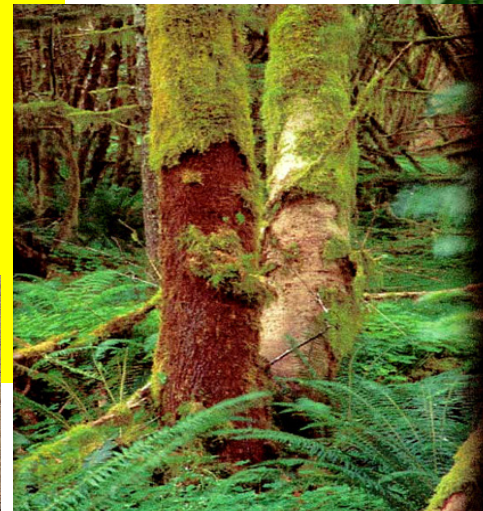
Non-taxonomic classification: Evergreens are everywhere

are plants **that do not shed their leaves during their annual dormancy period** as this is done by non-evergreen = **deciduous plants** which lose their foliage for the dormant part of the year.

Leaf persistence in evergreen plants may vary from a few months to several decades; e.g. **over thirty years** in Great Basin's **Bristlecone Pine *Pinus longaeva*** or about **50 years' persistence of leaf tissue** in ***Welwitschia***, an African which has only two leaves, which grow continuously throughout the plant's life.

There are different types of evergreens:

- 1. conifers (scots pine, red cedar, spruce, hemlock),**
- 2. ancient gymnosperms like cycads**
- 3. plants from frost-free climates such as the rain forests and deserts**
- 4. many grasses**
- 5. Holly, Rhododendrons, Eucalypts,**
- 6. ancient plants like mosses & some ferns that are facultative evergreens**
- 7. "live" oaks from the Mediterranean**



Other classifications of plants:

Forbs and Graminoids

Forbs are **herbaceous flowering plants that are not graminoids** (grasses, sedges and rushes). The term is frequently used in vegetation ecology, especially in relation to grassland ecology. Forbs represent a guild of plant species with broadly similar growth form, which in ecology is often more important than taxonomic relationship.

Examples of forbs are clover, sunflower and milkweed.

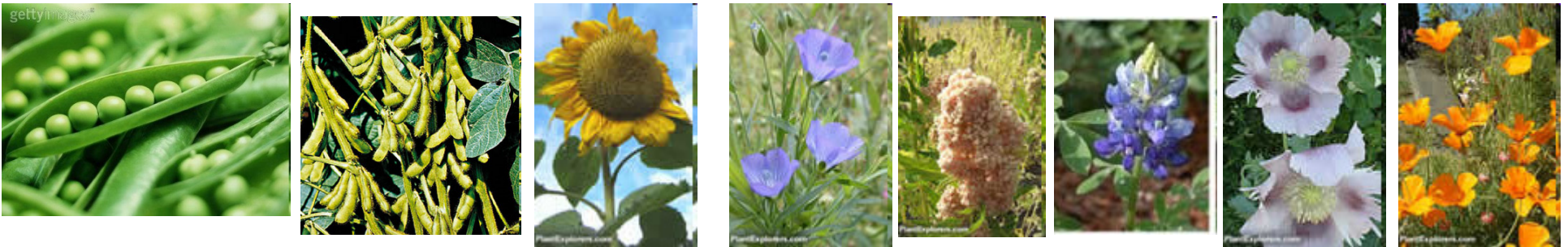
Grasses (technically **graminoids**) are monocotyledonous, herbaceous plants with narrow leaves growing from the base. They include the "true grasses", of the Poaceae (or Gramineae) family, as well as the sedges (Cyperaceae) and the rushes (Juncaceae). Known to form **pasture for livestock**. **Examples** : the papyrus sedge (Cyperus papyrus).

In addition to its use in ecological studies, the term forb may also be used for subdividing popular guides to the wildflowers of a region, together with other categories such as ferns, grasses, shrubs and trees. This approach is not followed in formal regional floras, which are usually organized taxonomically.

Classification by life style: Annuals

Annuals are short-lived plants which has germinate, grow, flower and seed in one season. They produce many but small seeds for survival of winter etc.

Among annual plants are the cereal grains of the world, the peas, beans, soybeans, the sunflower *Helianthus annuus*, buckwheat, flax, jute, tobacco, *Chenopodium quinoa*, *Lupinus*,



but also many flowers like *Althaea*, *Amaranthus*, *Borage*, *Calendula*, *Centaurea cyanus*, *Cosmos*, *Dahlia*, *Datura*, *Eschscholzia*, *Lathyrus*, *Papaver somniferum*



Annuals

Annuals are planted every year



gladiolus

red salvia

marigold

zinnias

snapdragon

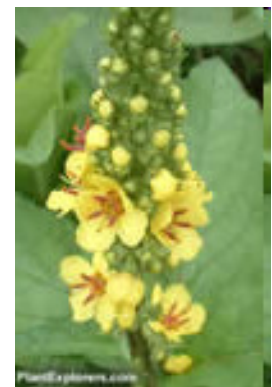
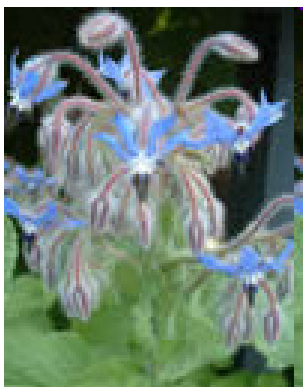
Biennials

Biennials normally do not bloom until the second year but just form a rosette of leaves feeding a subterranean organ like bulb, rhizome, storage root

Many garden plants like beet, celery, cabbage, carrot, turnip, spinach, lettuce,



but also many flowers like *Borago officinalis*, *Chelidonium majus*, *Digitalis purpurea*, *Isatis tinctoria* (woad), *Lunaria annua*, *Myosotis sylvatica* (forget-me-not), *Verbascum thapsus*

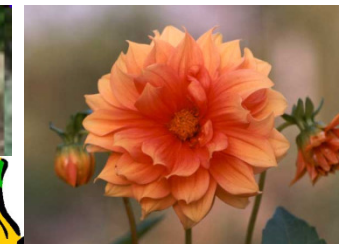


Perennials

Perennials are plants that live longer than biennials, i.e. > 2 years. They are either woody (trees shrubs vines) or herbaceous perennials. The herbaceous perennials survive winter as subterranean organs like roots or stems (rhizomes, colons, bulbs, etc.). Many perennials produce large seeds and with it larger seedlings that quickly develop leaves for photosynthesis. Annuals produce many more seeds but smaller seeds per plant.

Many garden plants like asparagus, banana, rhubarb, lupines but also many ferns, liverworts and grasses

but also many flowers like Epilobium (fireweed), rue Ruta graveolens, peonies, delphinium, primula, dahlia, orchids, begonia etc.



Perennials

Flowers you plant only once!



delphinium



tulips

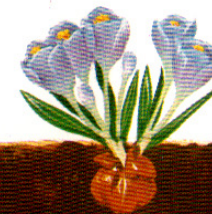


iris

Garden or flower perennials



chrysanthemum



crocus

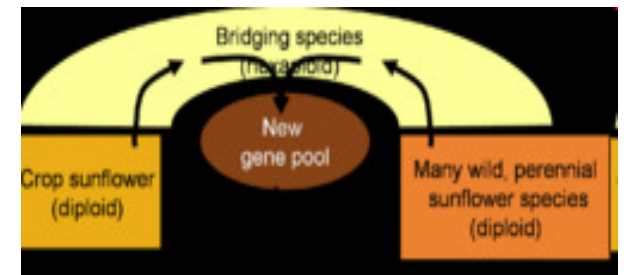


lily

Perennial Crops

Perennials crops are capable of regrowing season after season without reseeded. This limits the enormous opportunities for weeds to settle on the unoccupied fields that annual fields present every spring season.

Perennial crop plants like **perennial rice**, **perennial wheat**, **perennial sunflower** & **perennial sorghum** have a huge lifespan that is so different from other kinds of crops. They propagate by reseeded & vegetative propagation



Advantages Perennial plants have time to develop deep, extensive root systems which increase the efficiency of nitrogen fertilizer use (less pollution), increases access to soil & water makes them drought resistant.



Thinopyrum intermedium is a perennial called wheatgrass because of the similarity of their seed heads to common wheat. However, wheat is annual.

Perennial rice— an *Oryza* ssp.—can spread by horizontal stems below or just above the surface of the soil but also reproduce sexually by producing flowers



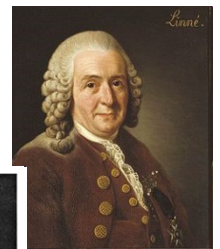
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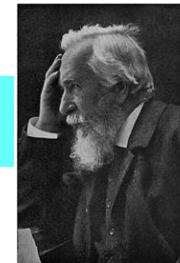


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Van Helmont's test or the first scientific experiment

Aristoteles proposed that plants are inverted animals that eat soil. **This hypothesis was tested by Jan van Helmont in 1668.**

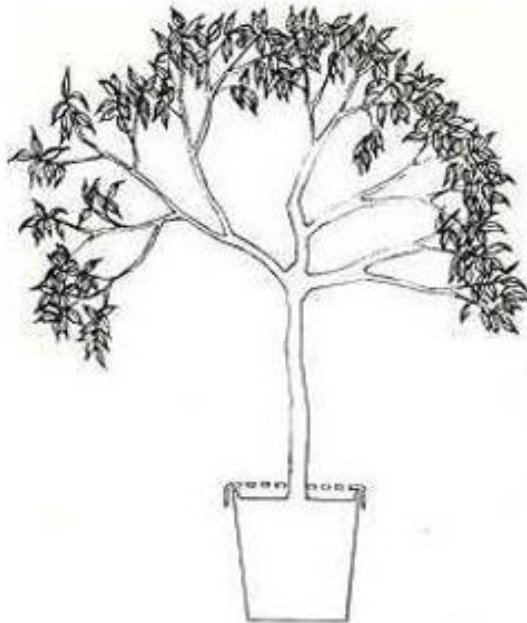
Jan Van Helmont took a small willow tree and planted it in a large pot of soil. Before he measured the mass of the dry soil and the mass of the tree.

Plant	2.27 kg	76.74 kg	Growth:	74.47 kg
Soil	90.72 kg	90.66 kg	Loss:	0.06 kg

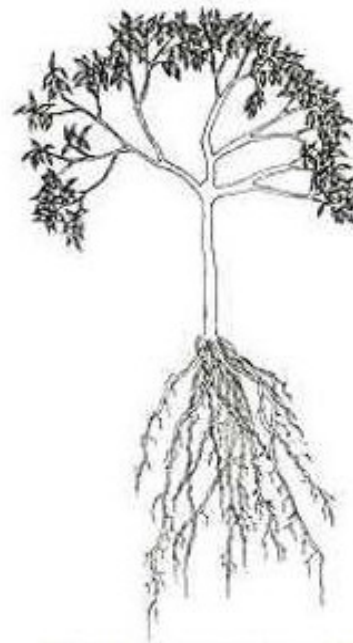
In 5 years the tree had grown by over 74kg. The soil, however, had only lost a 60 g.. Van Helmont concluded that the tree must have grown from the rain water alone.



Van Helmont's tree when he planted it



Van Helmont's tree after five years

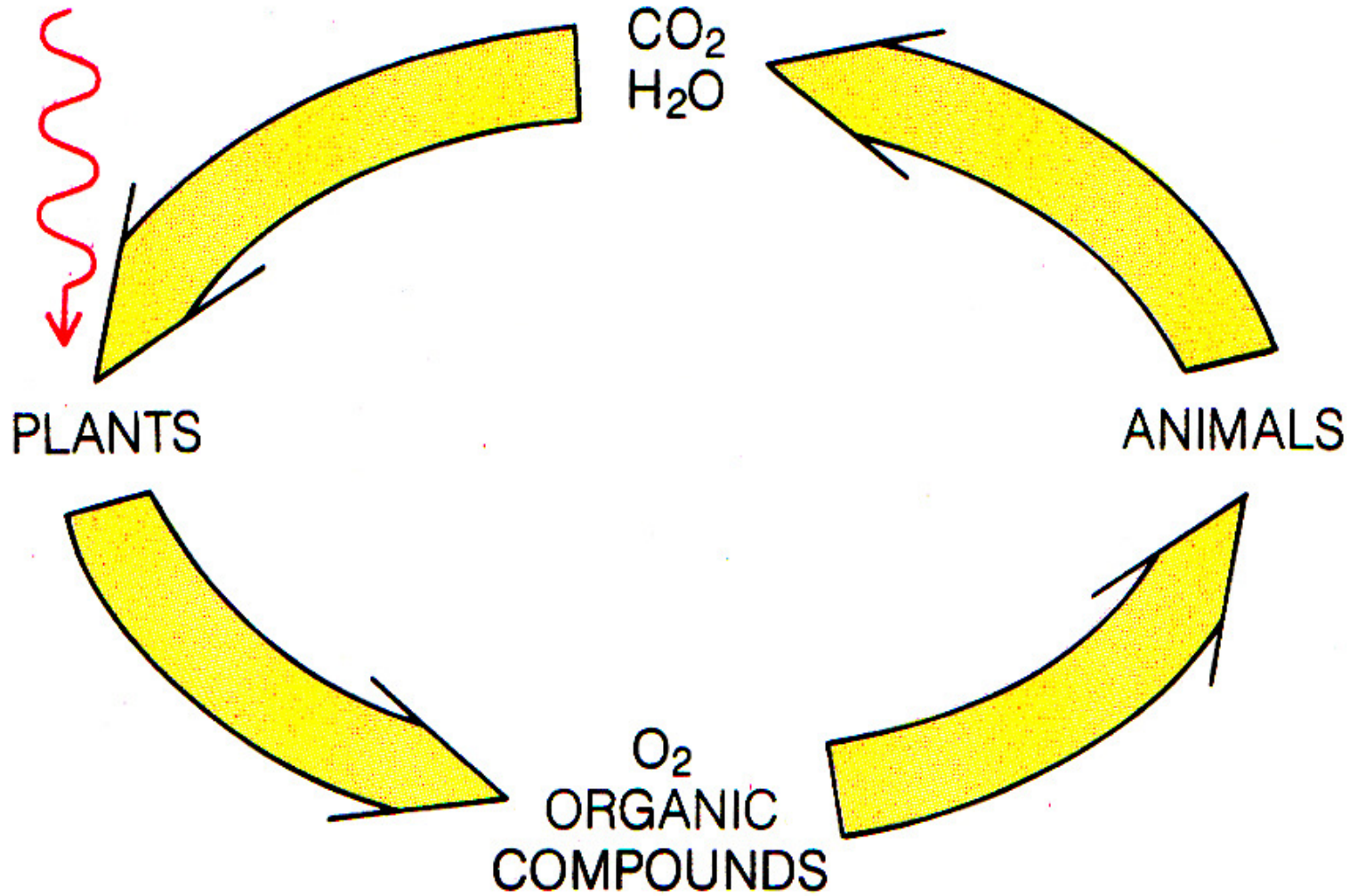


Van Helmont's tree after five years, out of its pot to show the roots

What do **you** think what happened ?

Producers and consumers

SUNLIGHT

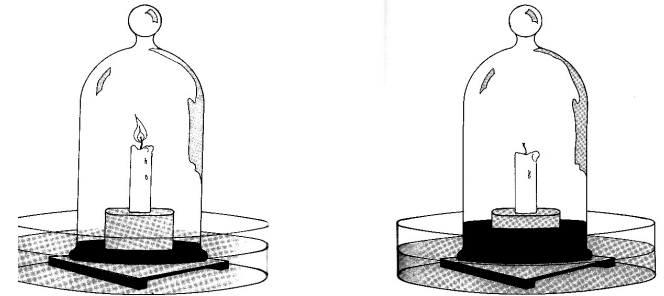


A Planet without Plants is a dead Planet

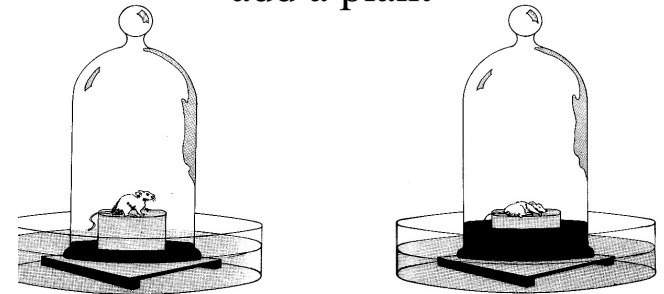
John Mavow 1640-79
Joseph Priestley 1733-1804 showed that there is something in the air that keeps candles & animals going

Fire and animals spoil air → oxidation

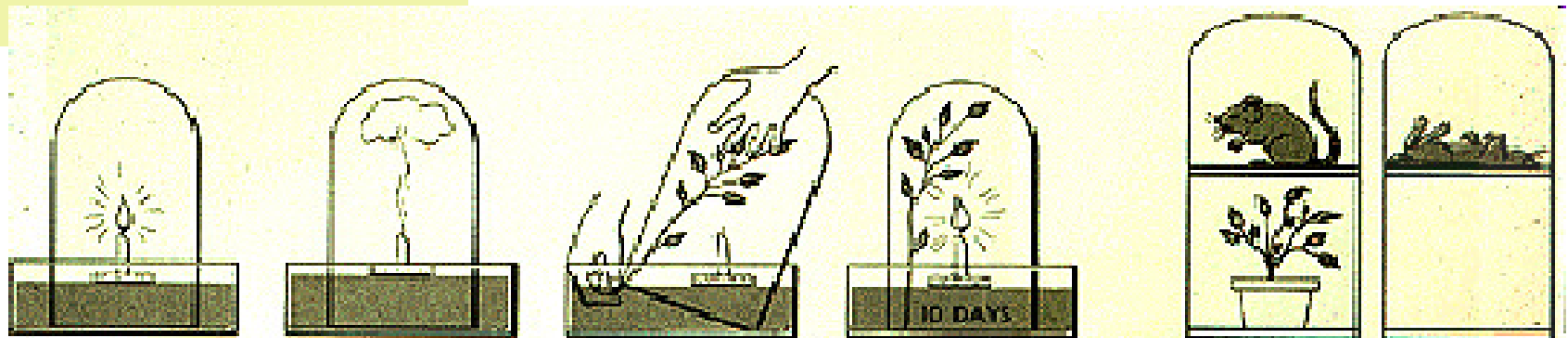
**Plants improve the air.
Oxygen was unknown then.**



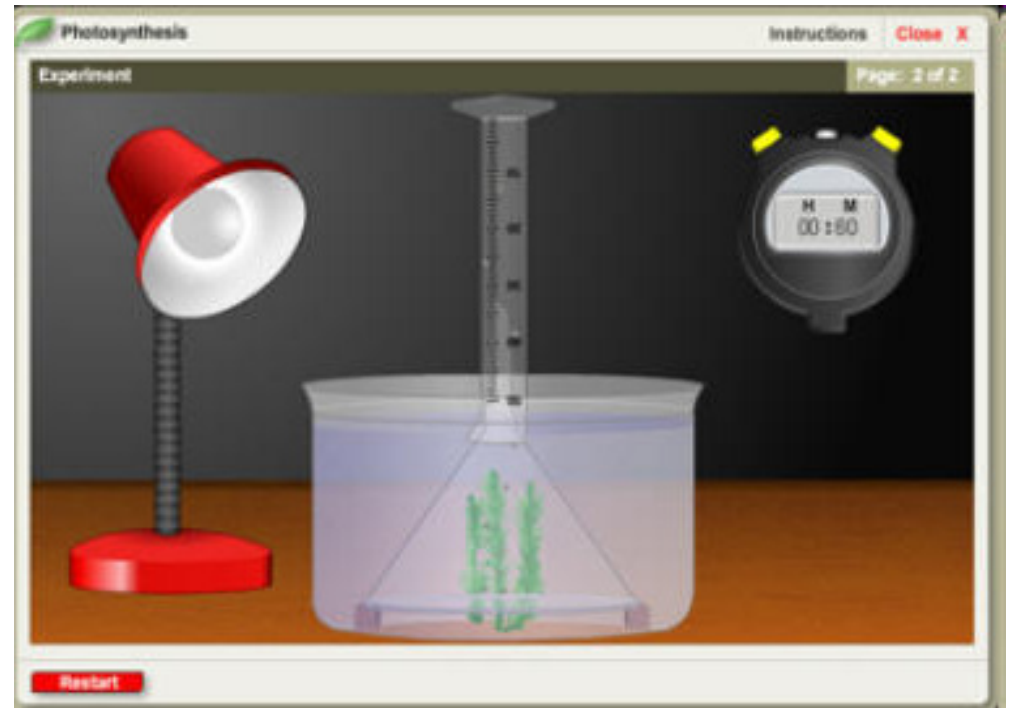
add a plant



& Joseph Priestley used candles & mice to show that both need X
John Mavow (1640-79)



Oxygen from Elodea – an updated Priestley Experiment



9.3.41

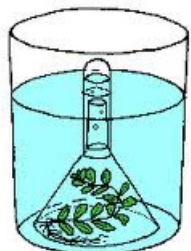
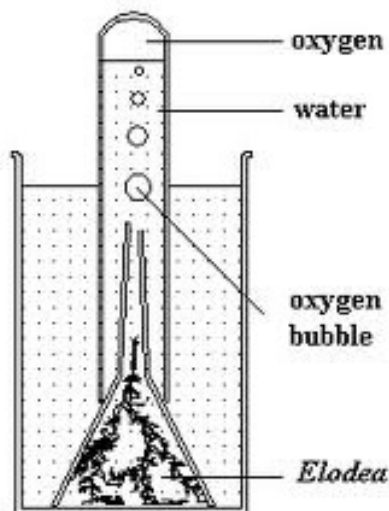


Figure 15 - How to show the production of oxygen by plants.



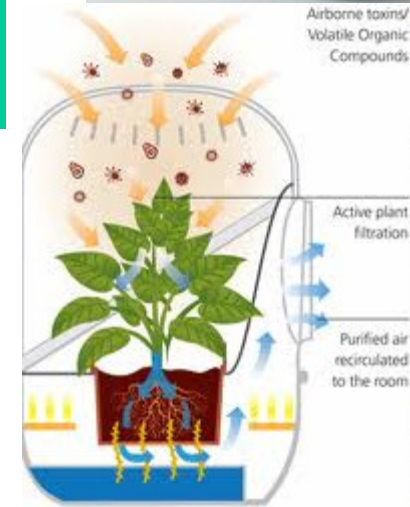
GAS BUBBLE PRODUCTION BY ELODEA	
Distance of Plant From Light (cm)	Production of Gas Bubbles/Minute
10	40
20	20
30	10
40	5

The mystic feature of plants to improve the air we breath

***Sansevieria trifasciata* or Snake Plant or Mother-In-Law's Tongue:** The best Bedroom plant since it converts a lot of CO₂ (carbon dioxide) to O₂ (oxygen) at night, you could live in a completely air sealed room if you had 6-8 waist high plants The snake plant also removes formaldehyde from the air. Areca palm removes xylene and other organic volatiles from glues.



Sansevieria
&
Areca palm
Dyopsis I.



A tropical vine called "the coughing bean" is sensitive to dust. When the leaves are coated with dust the leaf produces gas pressure and expels the dust with an audible paroxysm similar to coughing or sneezing
Readers Digest:Secrets of the Natural world 1993

Bel-Air indoor air filtration systems sucks in dirty air and runs it through a plant's leaves, roots, and a "humid bath" before releasing it back into your room, purified.

A plant hermetically sealed in a bottle since 1972 – a modern Priestley or van Helmont

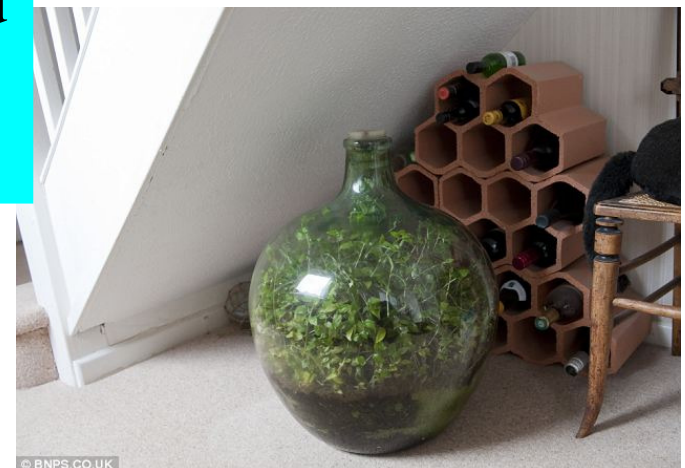
-- David Latimer first planted his bottle garden in 1960 and last watered it in 1972 before tightly sealing it shut 'as an experiment'

--The hardy spiderworts plant inside has grown to fill the 10-gallon container by surviving entirely on recycled air, nutrients and water

For the last 40 years The Tradescantia plant has been completely sealed from the outside world. The spiderplant has not only survived but has also grown. Unfortunately Latimer did not not take Intro Botany and hence forgot to weigh the plant before & after.

Read more:

<http://www.dailymail.co.uk/sciencetech/article-2267504/The-sealed-bottle-garden-thriving-40-years-fresh-air-water.html#ixzz36AdNcoil>



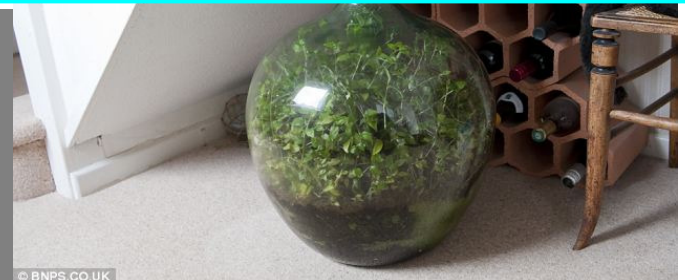
Make your own Greenhouse cheap & small

Prospects for a bottle garden for the busy student

1. A plant sealed in a bottle needs soil which contains bacteria, fungi. You plant can be overgrown by fungus
2. The website claims that the only input needed is light but in order to grow the plants also need CO₂. Some will be produced by fungi & bacteria in soil. I would predict the plants become CO₂-starved.
3. The water will be completely recycled. The normal situation is that plants evaporate multiple amounts of their own mass. → Not all plants can be bottled.
4. Bottle gardens are nice stations to experiment with ecological problems like will this or that plant species be able to grow in a bottle? After all, Tradescantia might be a lucky exception.

Read more:

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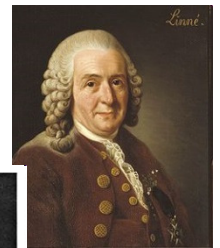
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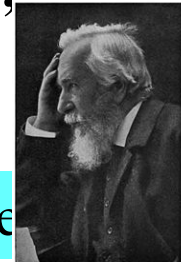
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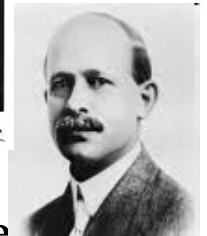
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Plant Physiology Van Helmont and Joseph Priestley



(4) Ecology interaction of plants & animals, named by Ernst Haeckel



Ethnobotany plant use (e.g. as foods; as medicines; in divination; in cosmetics; dyeing, tools, currency; ,clothing;; in rituals; and in social life "ethnobotany" coined 1895 by US botanist John **William Harshberger**.

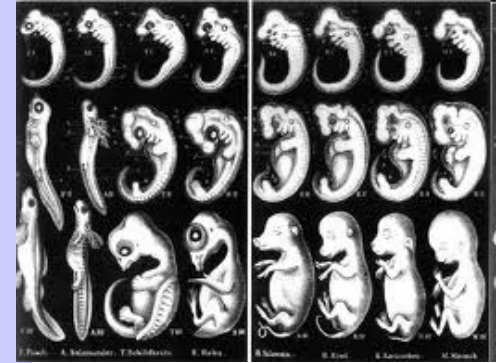


Plant Geopgraphy = plant distribution on earth according to habitats started by A Von Humboldt climbing the Chimborazzo in 1796.

Ecology



Ecology is a sub-discipline of biology, the study of life. The word "ecology" ("Ökologie") was coined in 1866 by the German scientist Ernst Haeckel. Haeckel was extreme anti-clerical Darwinist at the Univ of Jena. "The World Riddles" 1880.



famous dictum
"ontogeny recapitulates
phylogeny"

Ecology studies (1) adaptation of organisms to their environment.
(2) temporal & spatial patterns of organisms (3) interaction of organisms
Ecology is unusual in that it treats Homo sapiens like any other species

A v Humboldt first to describe "plant associations"
1898 Anton Kerner von Marilaun "Plants of the Danube Basin" translated into English "The fundamentals of ecology"
Ch Raunkiaer (Dane) life form classification
J. Braun-Blanquet coined "plant Sociology" for communities
Aldo Leopold best known book *A Sand County Almanac* (1949), and Rachel Carson for "the silent spring"

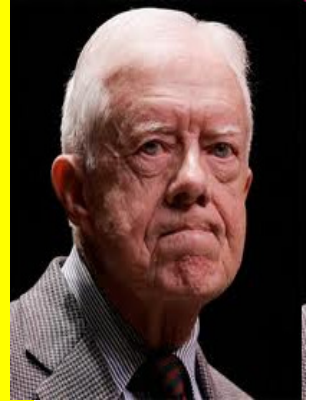


Environmental Sciences

Environmental sciences are composite of natural & social sciences, technology, business, law, ethics, aesthetics with ecology as the major basis.

Global 2000 report was projection of 1980s for president Carter

1. Continued rapid human population growth 4/5 in poor countries
2. 90 % rise in food production worldwide but not in poor countries
3. Stress on all natural resources by rising population needs
4. Fuel sources diminish, fuel wood depleted, coal & oil depleted
5. Forests will shrink , esp tropical ones with irrev loss of species
6. Water quality & supply will become a liability with conflict pot.
7. Greenhouse gases will enhance global warming & deplete ozone l



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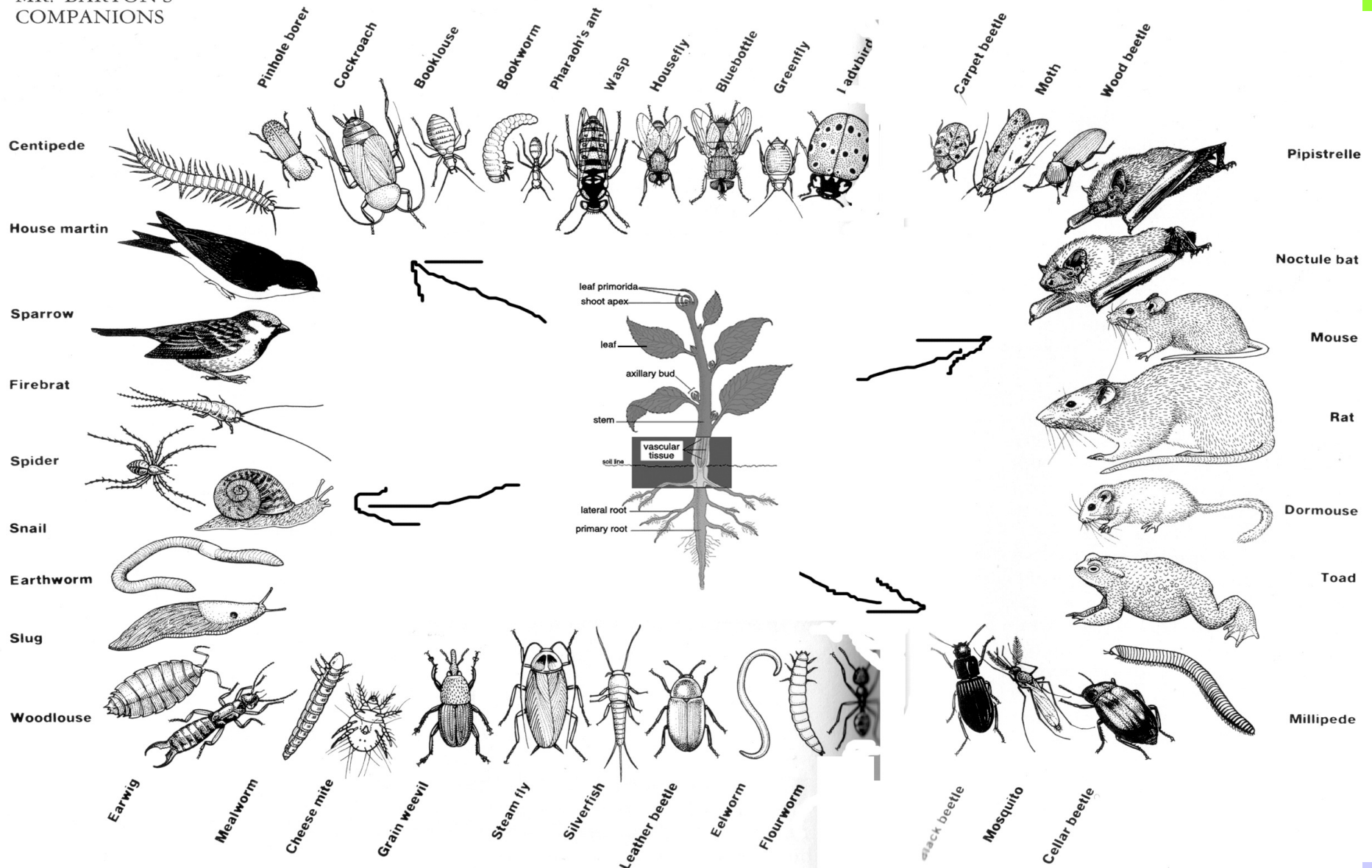
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www.BlackCommentator.com
Click to view larger printer friendly version of cartoon

How much for the defense budget, General?

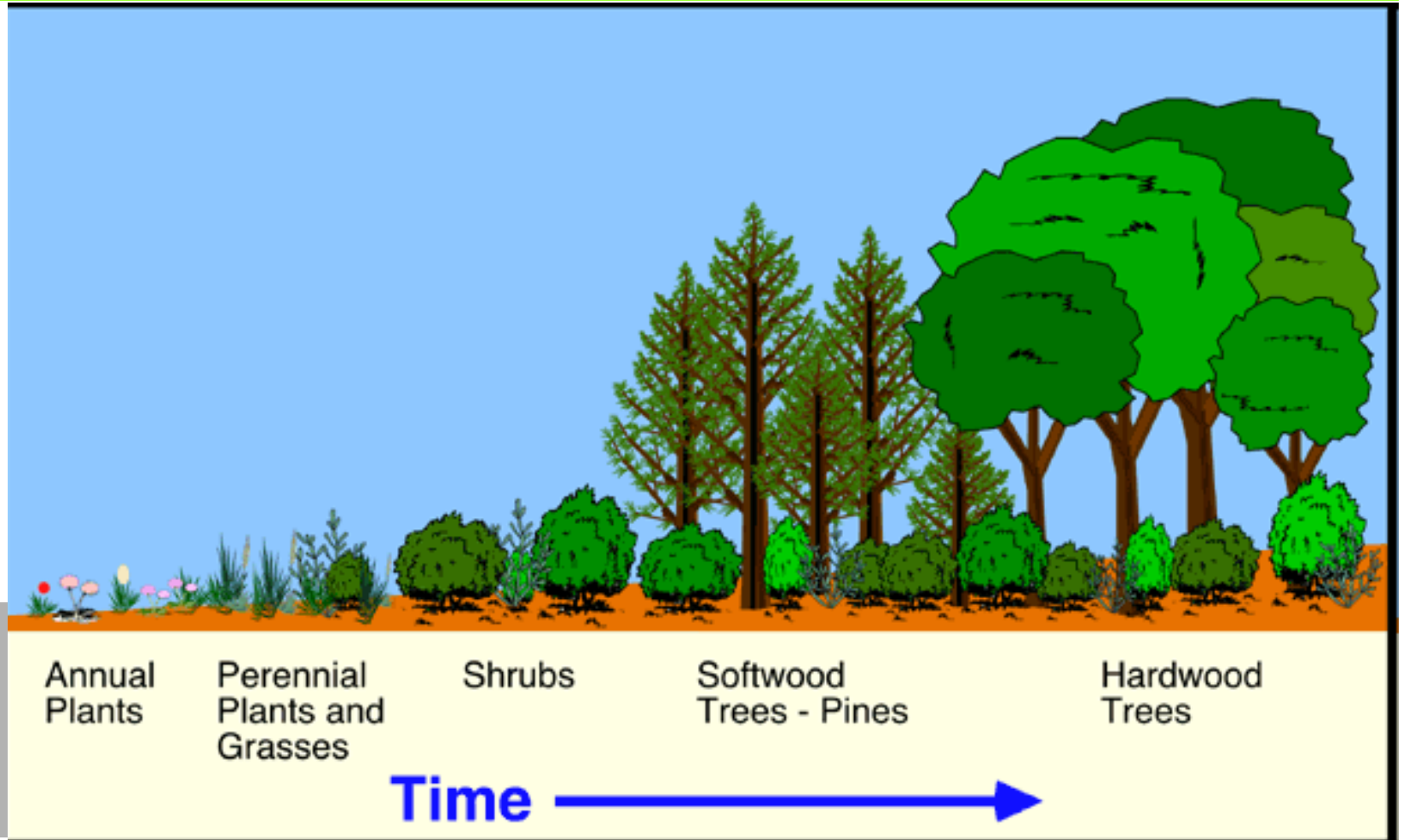
MR. BARTON'S
COMPANIONS



These are only the zoological antagonists of plants. You add to this representatives of the **bacteria, fungi & other plants.**

Succession – or how plant communities develop

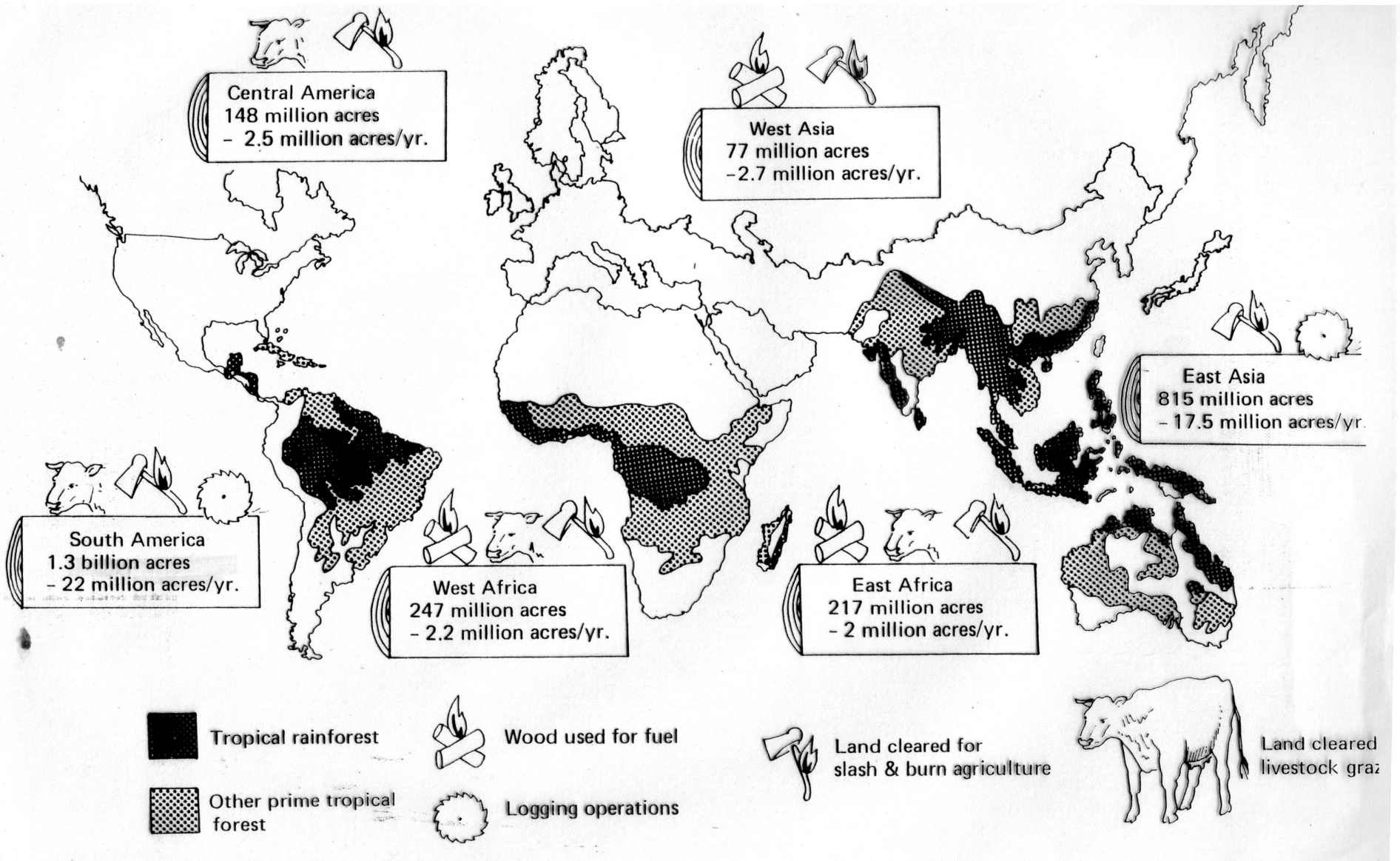
Lichens
and mosses
break the
rocks



Just like a young organism, also ecosystems grow and develop until they reach a climax state. This is a scientifically proven law.

If undisturbed, an ecosystem will become increasingly complex & diversified over time.

The destruction of forests goes on exactly as predicted in the Carter

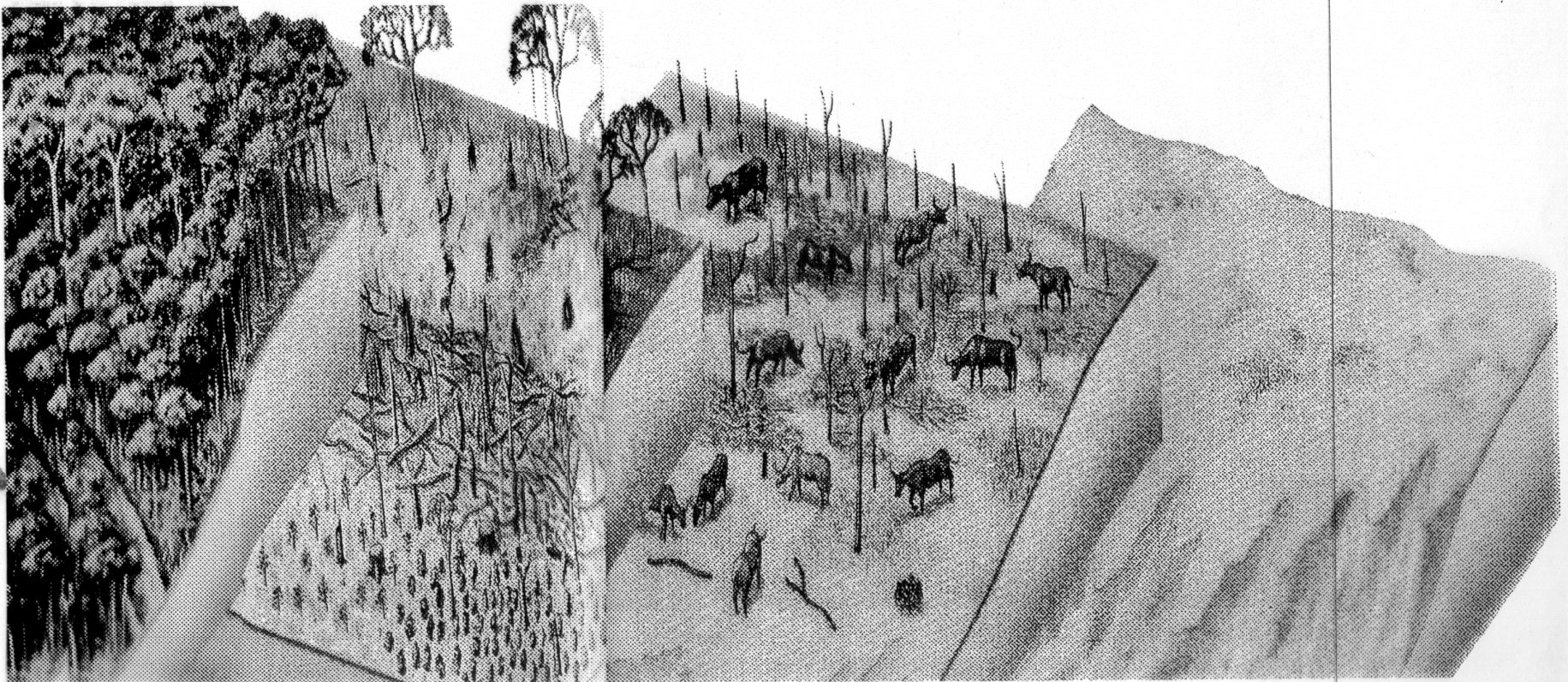


The succession of centuries will be reversed by some of us Homo stupidi

Slash and burn does more damage in tropical rainforests

Self-eviction from paradise

Traditional burn-&-go agriculture leads to desertif. of the tropics plus → global climate change & crisis

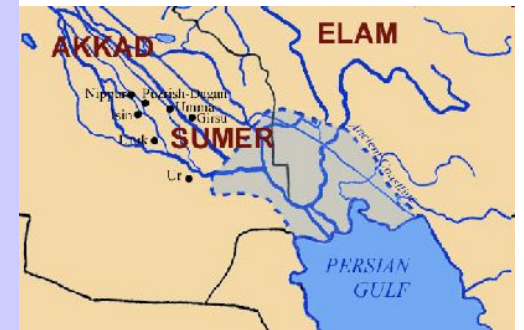


Man-made "succession" in tropical rain forests

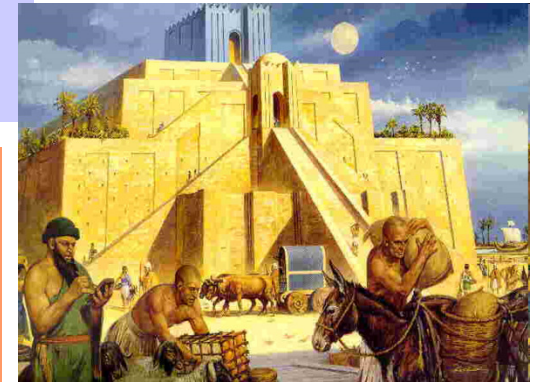
The Fall of the Akkadian Empire in 2100 BC



The Akkadian state was the first empire situated between the Tigris & Euphrates rivers. reached its zenith between the 24th and 22nd centuries BC following the conquests of **king Sargon of Akkad**. It was the **predecessor of Babylonia and Assyria**; Akkad was a huge town with fine walls, art, taxes & burocrats (scribes).



Suddenly (2100 BC) Akkad collapsed after Naram-sim – king & grandson of sargon – supposedly plundered the temple of the windgod.

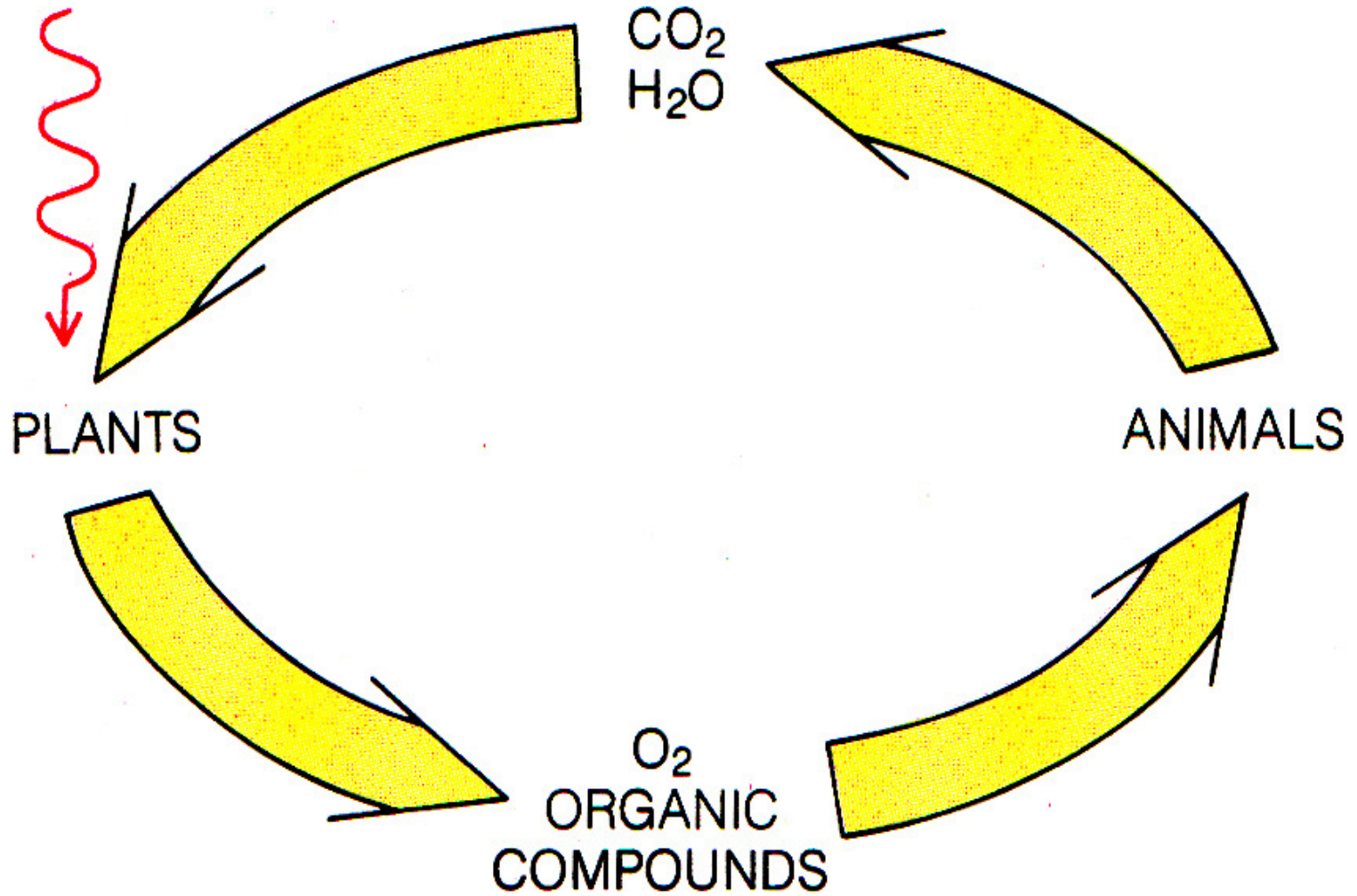


1978 archaeologist Harvey Weiss (Yale) excavated old Akkadian city of **Tell Leihan** at the Syrian-Iranian border. Constructed timeline from **foundation** (5000 BC) to **zenith** with approx. 30 000 inhabitants in 2600 BC. → from 2200 to 1900 BC they found **no signs of human inhabitation**.

Soil samples indicated a **drought so prolonged & severe** that it appeared to the Akkadian people as a **finite climate change**. Egypt collapsed simultaneously.

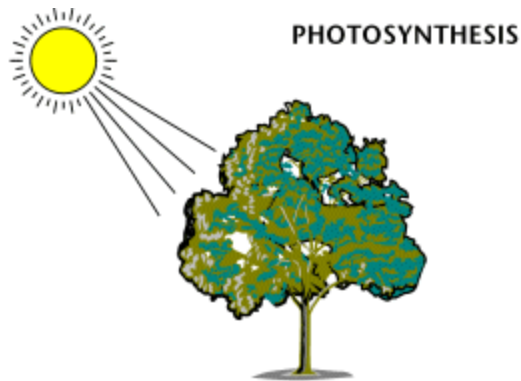
Producers and consumers

SUNLIGHT

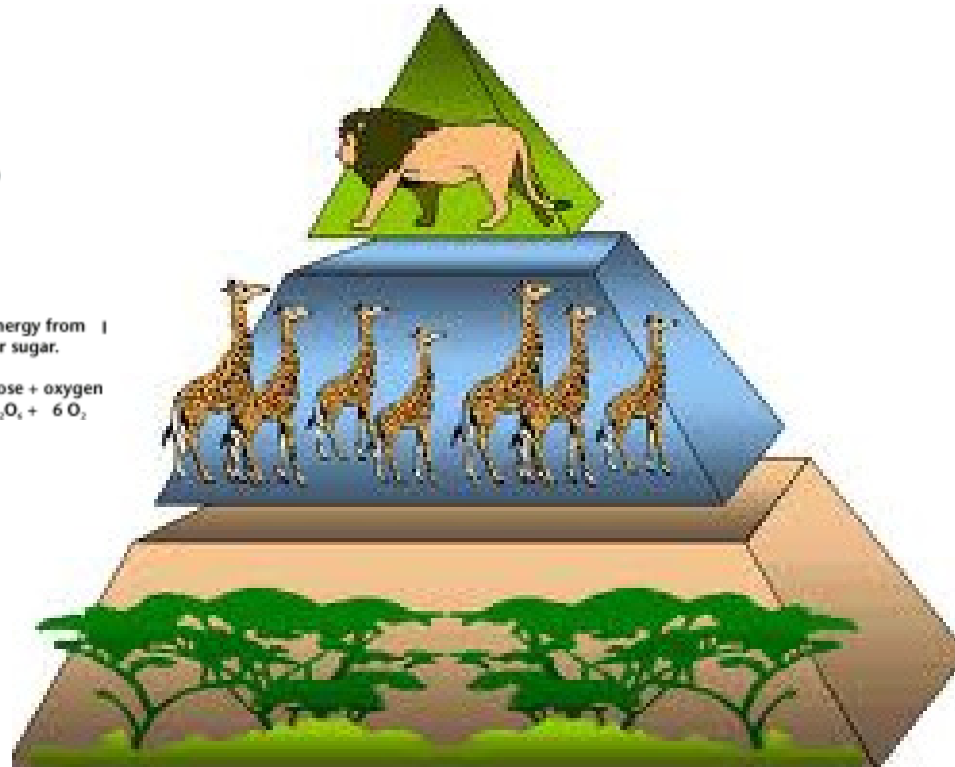
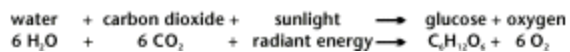


The second role of Plants on the Planet → biomass

While photosynthetic bacteria use the light energy to produce **ATP** (Adenosin Triphosphate – the universal currency of energy in living beings) **algae and plants are the major creators of biomass on the planet.** Biomass stores a certain percentage of the solar energy and most heterotrophic organisms depend on it for their existence.

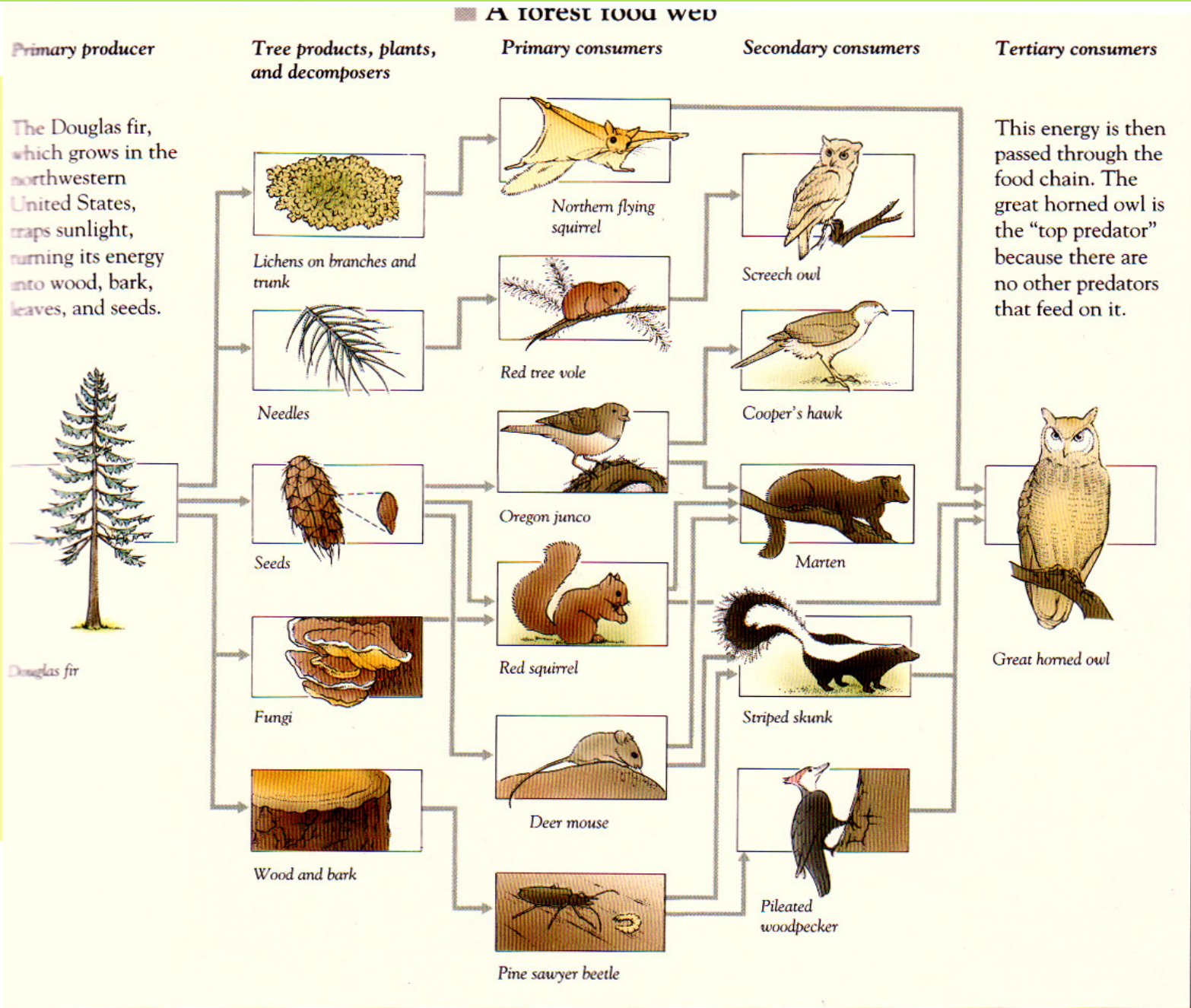


In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose - or sugar.

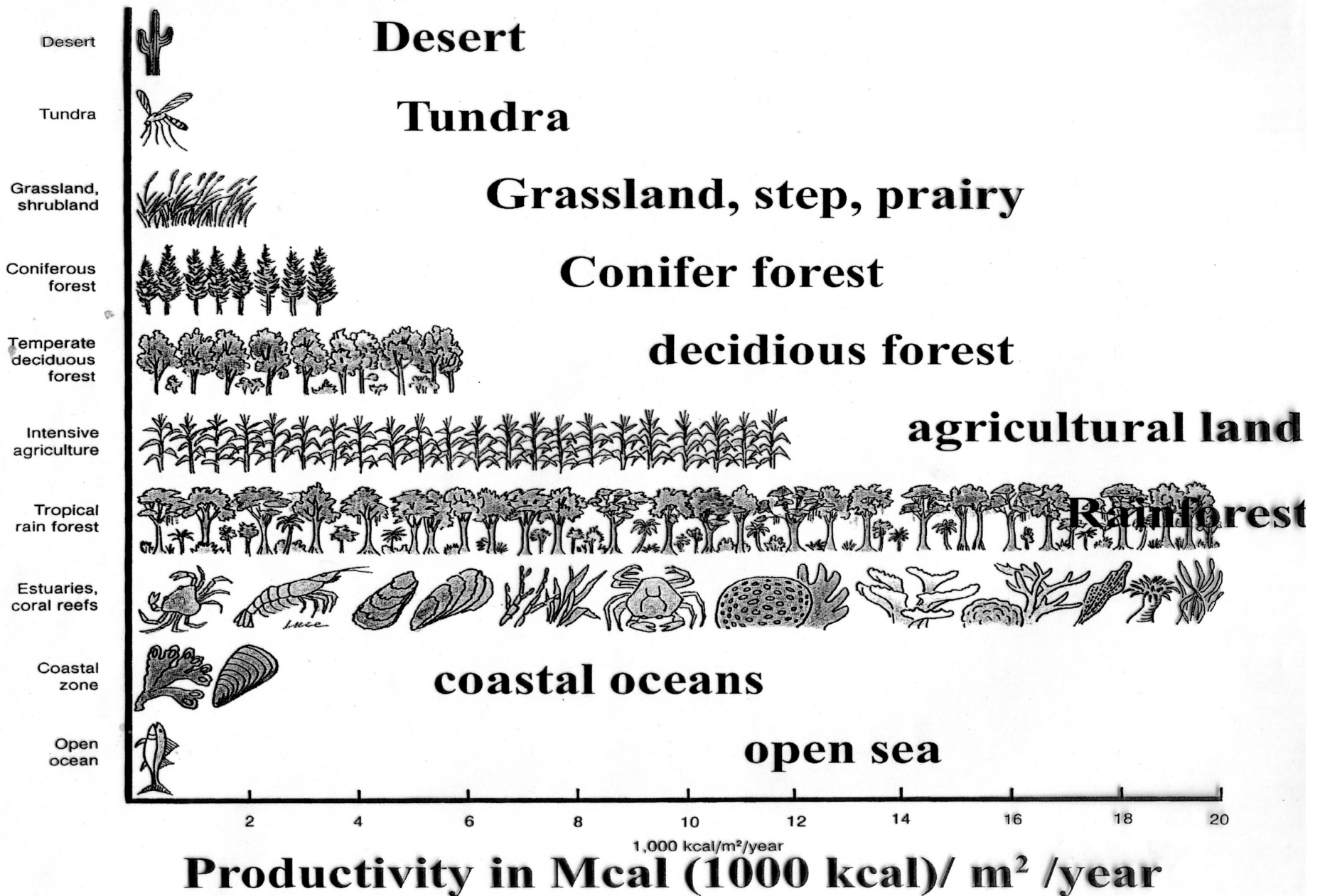


Plants are Primary Producers of Biomass & habitat

Without this biomass there are no other life forms like fungi & animals possible. This is important to realize when you see an ecosystem at work



Which ecosystem has the highest biomass production on earth?



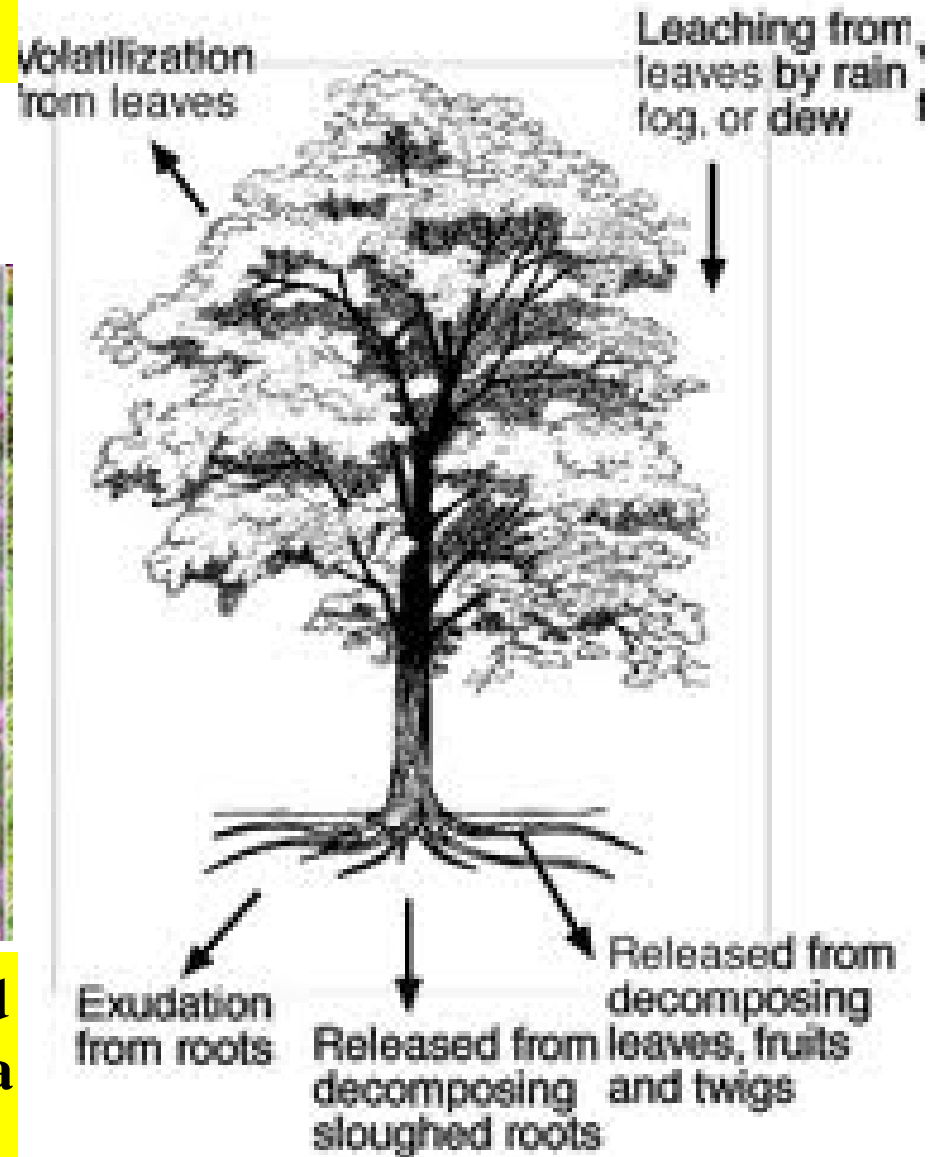
Allelopathy

If a plant is transplanted to an environment with weak competitors



Centaurea maculosa or spotted knapweed **in Europe:** one among many **in America** an invasive outcompeting the natives

While species in the native environment have evolved resistance to the phytotoxins, species in the new environment have had time to evolve resistance. Lack of allelochemical resistance in the new range, allows invasives to displace native species.



Garlic mustard (*Alliaria petiolata*) - an allelopathic plant

Garlic mustard (*Alliaria petiolata*) is a biennial flowering plant in the Mustard family, Brassicaceae native to Europe *but a invasive weed (neophyte) in NAm including Washington.*



Absence of native enemies increases its seed production and allows it to out-compete native plants. It is a p threat to the West Virginia White Butterfly (*Pieris virginiensis*) and Mustard White Butterfly (*Pieris oleracea*); which lay their eggs on native *Dentaria* or Toothwort plants, but confuse them with garlic mustard plants. The eggs & young butterflies cannot live on the garlic mustard, because of toxic chemicals

A study published in 2006 concluded that Garlic Mustard produces **allelochemicals that harm mycorrhizas** that many North American plants, including native forest trees, require for optimum growth.[[]

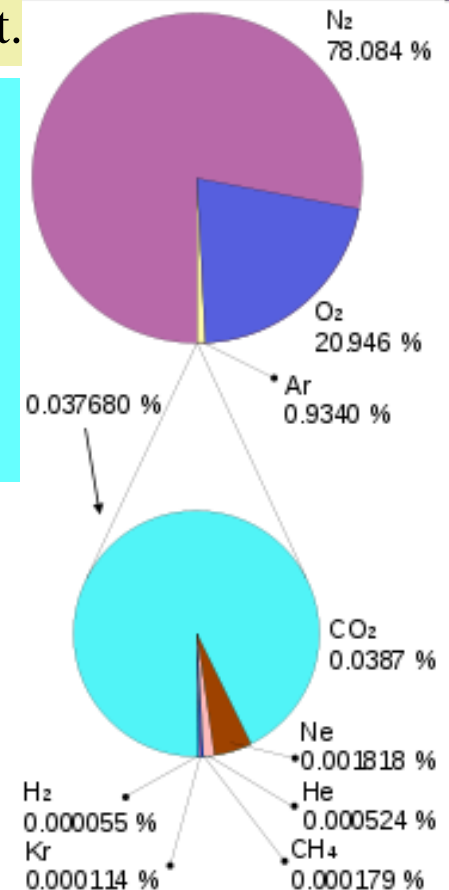
Other features associated with plants: a colder planet

1800: geologists found a succession of geological ages with **changes in climate**. In 1837 **Louis Agassiz** was the first to scientifically propose that the Earth had been subject to **ice ages**. John Tyndall investigated the gases of the atmosphere & found that only CO₂ & water vapor absorbed heat or IR. Svante **Arrhenius** saw that human influence on carbon would eventually cause doubling of atmospheric CO₂, reduce snow & ice cover on earth, & make the planet darker and warmer yet.



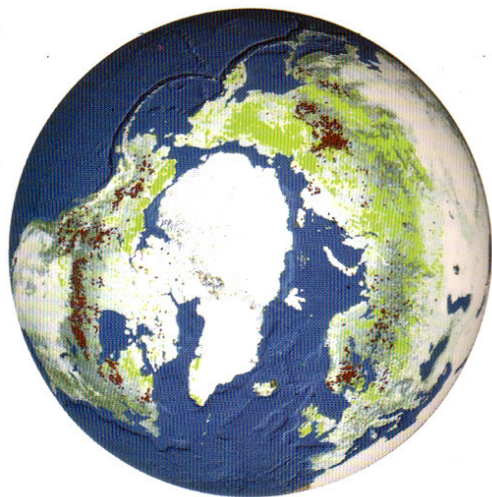
"Earth's surface is 33 degrees warmer than it would be without an atmosphere. A planet the size & distance of earth from the sun, in thermodynamic equilibrium with solar radiation, would have a surface temperature of -18 degrees C. Earth's average surface is 15 degrees C, or 33 degrees C warmer. This increase in temperature is due to **greenhouse gases (CO₂ & Water) in the atmosphere.**"

Average atmospheric pressure at sea level is about 1 atmosphere (atm) = 101.3 kPa (kilopascals) = 14.7 psi (pounds per square inch) = 760 torr = 29.9 inches of mercury. Atmospheric pressure is the total weight of the air above unit area at the point where the pressure is measured. **Thus air pressure varies with location and time, because the amount of air above the Earth's surface varies.**



Rise in Temps by 1 C → Forest invades Tundra

Tree rings show that from the 15th – 19th century **Siberian larches** *Larix sibirica* grew in the arctic Urals **in a stunted, shrubby form** with weak creeping & multiple stems. From 1900 on, they switched to tall, upright trees, since 1950 they became single-stemmed & partially fertile.



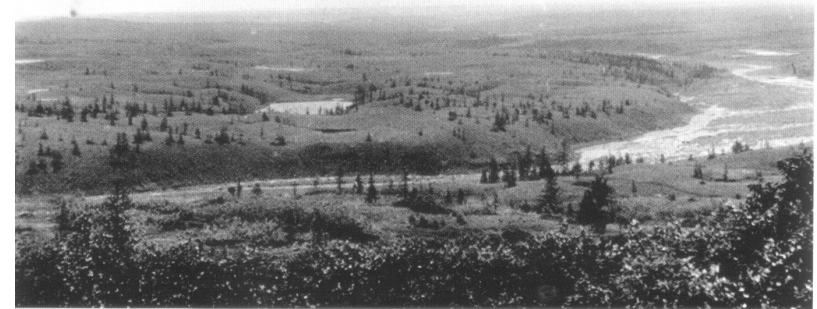
Satellite mapping from 1981-2005:
green shows increasing photosynthesis in tundra belt

This goes along with a temp increase of only 1° C in summer & a doubling of precipitation in winter (increasing snow will protect larger trees).



multi-stemmed Siberian Larch progresses into the treeless Tundra

1962: Siberian Ural with dwarfed infertile trees/shrubs



2004: larches form real forest with erect stems & seeds



The upper photo, taken in 1962, shows mostly low



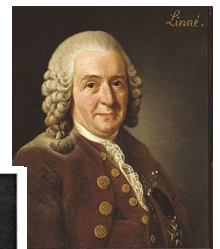
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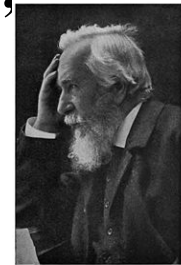


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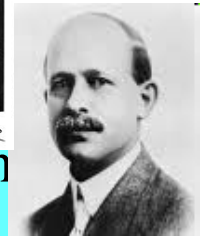


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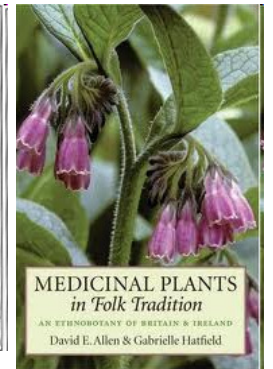
Ethnobotany

Ethnobotany ("*ethnology*" - study of culture & "*botany*" - study of plants) is the study of the **relationships between people and plants**.

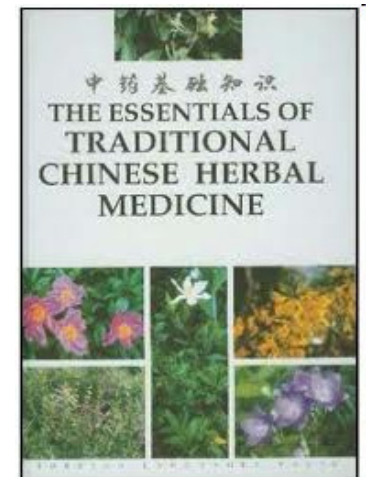
Ethnobotanists document & explain complex relationships between cultures & plants: focusing on **how plants are used**, managed and perceived across human societies (e.g. as **foods**; as **medicines**; in **divination**; in **cosmetics**; in **dyeing**; as **textiles**; in **construction**; as **tools**; as **currency**; in **rituals**; and in other aspects of social life.



Richard Evans Schultes

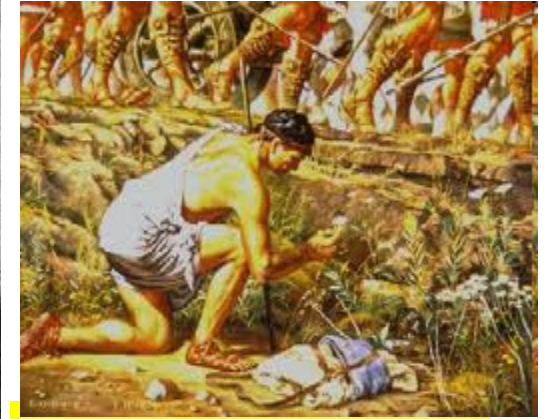


Though the term "**ethnobotany**" was **coined in 1895** by the **US botanist John William Harshberger**, the history of the field begins long before that. In A.D. 77, the Greek surgeon Dioscorides published "*De Materia Medica*", which was a catalog about the medicinal use of 600 plants in the Mediterranean. In 1542 Leonhart Fuchs, botanical artist, led the way back into the field. His "*De Historia Stirpium*" cataloged 400 plants native to Germany & Austria (hahaha 1542!)



European ethnobotany

Pedanius Dioscorides (40—90 AD) was a Greek physician, pharmacologist and botanist, physician of the Roman Army & author of a 5-volume encyclopedia about herbal medicine (a pharmacopeia), that was widely read for more than 1000 years.



Dioscorides

Leonhard Fuchs, was a German physician and one of the three founding fathers of botany, along with Otto Brunfels and Hieronymus Bock he was author of the famous herbals or *Kreuterbucher*. In 1542 Leonhart Fuchs, botanical artist, led the way back into ethnobotany when he in "*De Historia Stirpium*" cataloged 400 plants native to Germany. In 1536 he founded the first non-clerical herbgarden at the University of Tübingen,



Chinese ethnobotany

Shen Nong is reputed to have lived some 5,000 years ago. His name means "*the Divine Farmer*" and he is the father of Chinese agriculture, he taught his people how to cultivate grain as food and to avoid killing animals. Prior to Shennong, people were sickly, wanting, starved and diseased; but he then taught them agriculture, which he himself had researched, eating hundreds of plants — and even consuming seventy poisons in one day. The most well-known work attributed to Shennong is *The Divine Farmer's Herb-Root Classic* .



Huang Di or **The Yellow Emperor** 2697–2597 BCE is regarded as the founder of Chinese civilization.

His Classic of Internal Medicine, written as discussion between the Emperor and his minister does not discuss herbs to a great extent, but is important in understanding the basic ideas of traditional Chinese herbal science, acupuncture and moxibustion Yin and Yang, the Five Phases of Evolutive Change, Meridian theory.



Huang Di

Arrow poison making is one aspect of ethnobotany

*virola sap -
fungicidal*



Yamomam dries virola resin on arrowheads (a tree with a bark that gives red antifungal sap to cure skin inf

Plastic coating keeps arrow heads sharp in wet climate



WIKIPIEDIA

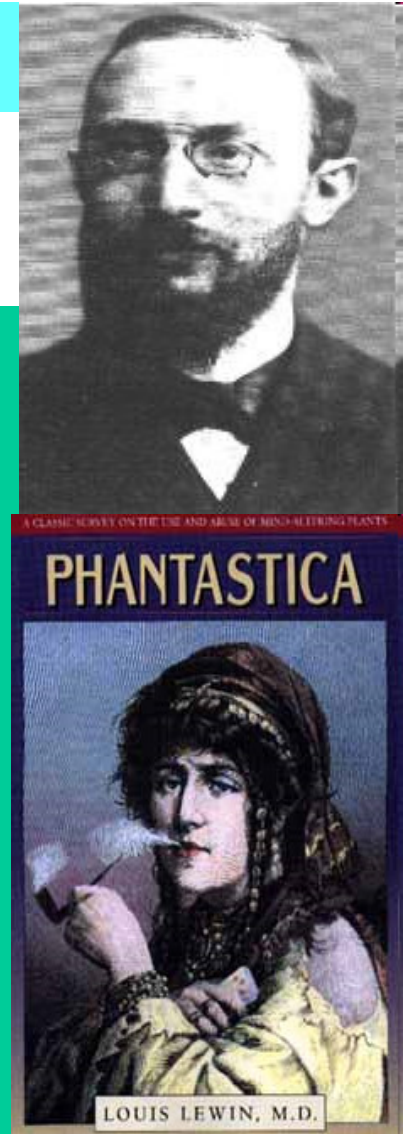
WEARING THE WESTERN
clothes that are being seen more frequently, this Tirió Indian holds the bark of the virola tree. Throughout the Amazon Indian tribes use its blood-red sap as a cure

Phantastic Plants

Louis Lewin German toxicologist first to study psychoactive plants systematically. 1924 appeared his book “Phantastica “

Lewin's most enduring task was to create a system of **classification of psychoactive drugs and plants** based on their action. His original categories were:

- **Inebriantia** (Inebriants such as alcohol)
- **Exitantia** (Stimulants such as Khat or Amphetamine)
- **Euphorica** (Euphorians and Narcotics such as Heroin)
- **Hypnotica** (Tranquilizers such as Kava)
- **Phantastica** (Hallucinogens or Entheogens such as Peyote or Ayahuasca)



Peyote *Lophophora williamsii* was for some time named after Lewin “*On Anhalonium lewinii and other cacti*”, Lewin wrote about leprosy, *On Areca catechu*, *Piper betel* and the chewing of Betel leaves, *Abortion by poisons*, *effects of Aconitine on the heart* and so on.

Midsummer dream SOLSTICE Parties in the past

During midsummer solstice days are so long that it seems the sun stands still. In many areas nine types of wood were collected for the solstice fire. **Dried mugwort** was placed on the fire creating fragrance & violet flames. Ancient goddesses like Diana or Frau Holle were present in the mugwort and one had to jump through the purifying flames. At this time horses could talk, nymphs & fairies appeared, elves disclosed treasures, crabs flew through the air, ...

What caused these visions? Henbane beer drunk in copious amounts, hours of uninterrupted dancing, nights without sleep, bell caps, haymaker's mushroom, liberty caps, fly agarics. Saint Vitus was the patron of these mushrooms

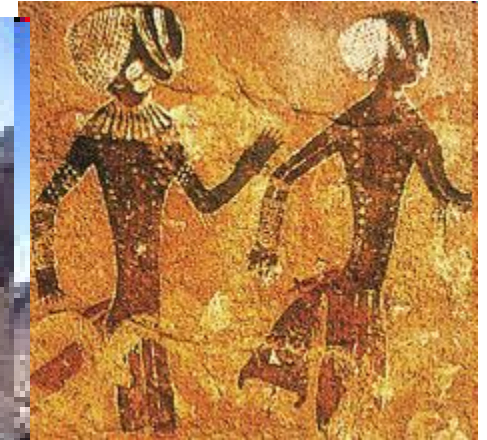


Midsummer herbs were: Hypericum perfor. (lightflower), chamomile (sungod), wild Thyme, wolf's claw Lycopodium with explosive spores, Mugwort Artemisia vulg. (woman herb since a sitzbad bring back missed menses, Arnica (protecting the grain harvest) Calendula (love magic), Elder Sambucus sacred to frau Holle the witch goddess (flowers heated in butter), Oxeye daisy was an oracle (nobleman, beggar, city man, farmer, soldier, king, lawyer), Yarrow Achillea, Vervain (male aphrodisiac), Burdock Arctium was Thor's plant against evil

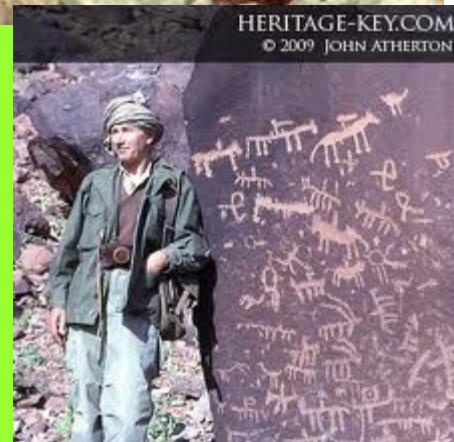
Claudia Muller-Ebeling, Christian Ratsch, Wolf-dieter Storl (2003): Witchcraft medicine. Healing arts, shamanic practices & forbidden plants. Inner Traditions Rochester, VM, USA

When the Sahara was green!

1860 A caravan of Tuareg camels silently moves through stony plateau of the desert. With them is German explorer Heinrich Barth on his way to lake Chad. The sandstone cliffs carried carvings of buffalos ostriches & people.... But no camels....



1930: French Lt. Charles Brenans saw many cave drawings in the Algerian Sahara. French explorer **Henri Lhore** followed the description & brought phototgraphs to the astonished public ...



“Civilization perishes without notice”

Civilization exists by geological consent, subject to change without notice. **Will Durant** *US historian (1885 - 1981)*

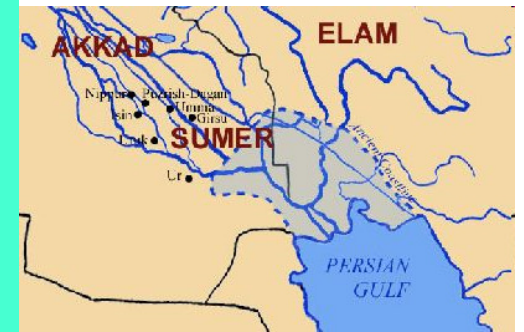
Tsunamis,
earth quakes, apparently
unexplainable drought spells,
floods & global warming
are factors that canceled
civilizations in the past and
will do so in the future



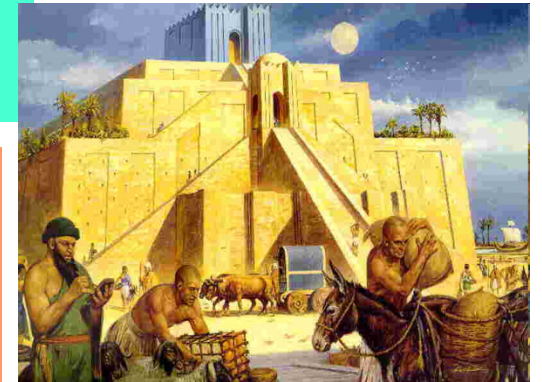
The Fall of the Akkadian Empire in 2100 BC



The Akkadian state was the first empire situated between the Tigris & Euphrates rivers. reached its zenith between the 24th and 22nd centuries BC following the conquests of **king Sargon of Akkad**. It was the **predecessor of Babylonia and Assyria**; Akkad was a huge town with fine walls, art, taxes & burocrats (scribes).



Suddenly (2100 BC) Akkad collapsed after Naram-sim – king & grandson of sargon – supposedly plundered the temple of the windgod.



1978 archaeologist Harvey Weiss (Yale) excavated old Akkadian city of **Tell Leihan** at the Syrian-Iranian border. Constructed timeline from **foundation** (5000 BC) to **zenith** with approx. 30 000 inhabitants in 2600 BC. → from 2200 to 1900 BC they found **no signs of human inhabitation**.

Soil samples indicated a **drought so prolonged & severe** that it appeared to the Akkadian people as a **finite climate change**. Egypt collapsed simultaneously.

Where are all the honeybees gone...?

thriving colonies disappear overnight without leaving a trace, the bodies of the victims are never found. Only in this case, it's not fiction: It's what's happening to fully a third of commercial beehives, over a million colonies every year. Often the queen = mother of the hive is abandoned to starve and die.

“This is the biggest general threat to our food supply,” says Kevin Hackett, the national program leader for the U.S. Department of Agriculture’s bee and pollination program.



the cause of the mysterious CCD “colony collapse disorder” that threatens the future of beekeeping worldwide remained unclear. But three new studies point at a culprit that many have suspected all along, a class of pesticides – neonicotinoids.

Scientists at the Harvard School of Public Health re-created colony collapse simply by administering small doses of a popular neonic, imidacloprid.

n the U.S. alone, these pesticides, produced primarily by the German chemical giant Bayer and known as “neonics” for short, coat a massive 142 million acres of corn, wheat, soy and cotton seeds. They are also a common ingredient in home gardening products.

If you were a shaman or healer?

Which kind of plants would you care about?

(1) **Hallucinogens** like Ahayuaska

“I need to keep talking with the spirits and gods”
this is where my knowledge & power comes from!”

(2) **Pain reducing plants** like opium, marihuana, remove depression (spiritual) & physical discomfort of diseases

(3) **Abortifacients**. An **abortifacient** induces abortion. Abortion a common practice in tribes that have limited resources and territory. bitter melon, wild carrot, ergot, tansy, pomegranate

(4) **Purgative herbs** (laxatives) either stimulate or lubricate the large intestines to promote bowel movement. **They** clean the system of bad matter and bad spirits.

(5) **Aromatics**. Are used to clean the air of evil spirits who stink. Important are (1) those that repel insects, bacteria (of course a shaman does not “know” but guesses this) and those that have a stimulatory effect (coumarins in sweetgrass, pine needles, tobacco smoke)



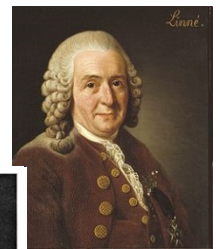
The subdivisions of Botany

Fungi, bacteria and algae no longer belong to the kingdom of Plantae and hence are no longer considered part of Botany in the strict sense. In older textbooks (1800 to 1950) you still find these kingdoms considered as part of the Botanical sciences .

Plant anatomy internal structure English **Robert Hook** (1635-1703) coined the phrase “**Cell**” **Anton van Leeuwenhoek, Malpighi** used **microscope** to explore new phenomena “ a new world before their eyes”

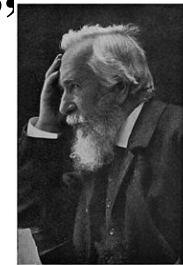


Taxonomy = systematics, **Carl von Linne** “ Systema Naturae” 1738 laid the foundations for the modern scheme of binomial nomenclature. The Swiss philosopher Jean-Jacques Rousseau (father of Democracy) sent him the message: “**Tell him I know no greater man on earth**”

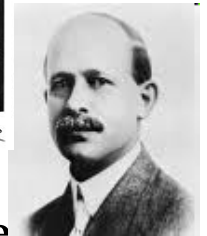


Plant Physiology Van Helmont and Joseph Priestley

Ecology interaction of plants & animals, named by Ernst Haeckel,



Ethnobotany plant use (e.g. as foods; as medicines; in divination; in cosmetics; dyeing, tools, currency; ,clothing;; in rituals; and in social life "ethnobotany" coined 1895 by US botanist John **William Harshberger**.



(6) Plant Geography = plant distribution on earth according to habitats started by A Von Humboldt climbing the Chimborazzo in 1796.



Plant Geography = Phytogeography = Geobotany

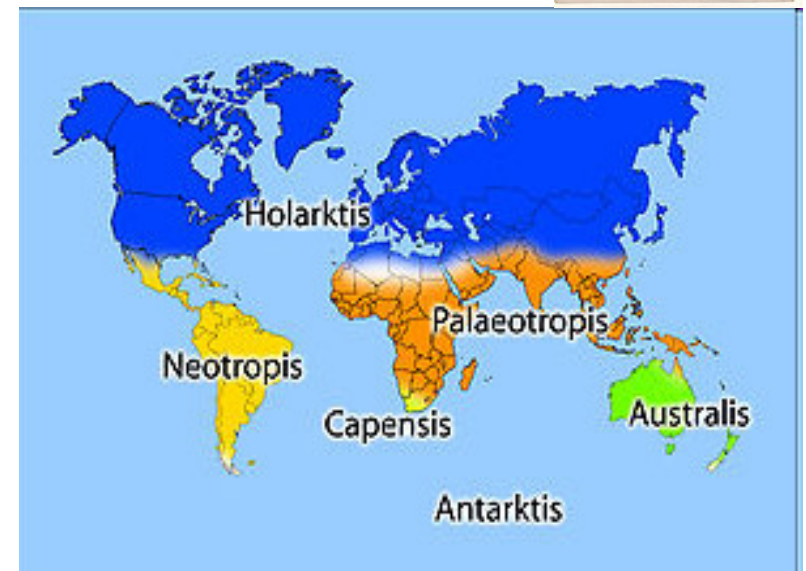
deals with the geographic distribution of plant species, the history and the causes of plant distribution. The basic data element of phytogeography are specimen record of an area or region.

What good does it if you know a plant, know the medicinal effects of the plant, are able to identify it in the wild but do not know where to find it? Dahhh

Alexander Von Humboldt, (1769 –1859) is often referred to as the "father of phytogeography". He advocated a quantitative approach to phytogeography that has characterized modern plant geography.



Botanists suggest six floristic kingdoms (Boreal or Holarctic, Neotropical, Paletropical, South African, Australian, and Antarctic), the largest natural units he determined for flowering plants. kingdoms are subdivided into smaller units = floristic regions and provinces. There are a total of 37 floristic regions.



**“Humboldt is here more popular than Goethe & Beethoven together:
he is called the second discoverer of America”**

1. shipped from the Rio Negro (tributary of the Amazon to the Orinoco ==> river systems are connected.

2. Proposed the isthmus of Panama as best spot to dig a transcontinental canal to the Pacific.

3. Wrote book about the political system in Cuba that **condemned slavery** & told that to Jefferson.

4. was one of the first to bring scientific data about **curare** arrow poison of the Amazon.

5. His geomagnetic measurements showed that magnetic force declines from poles to equator.

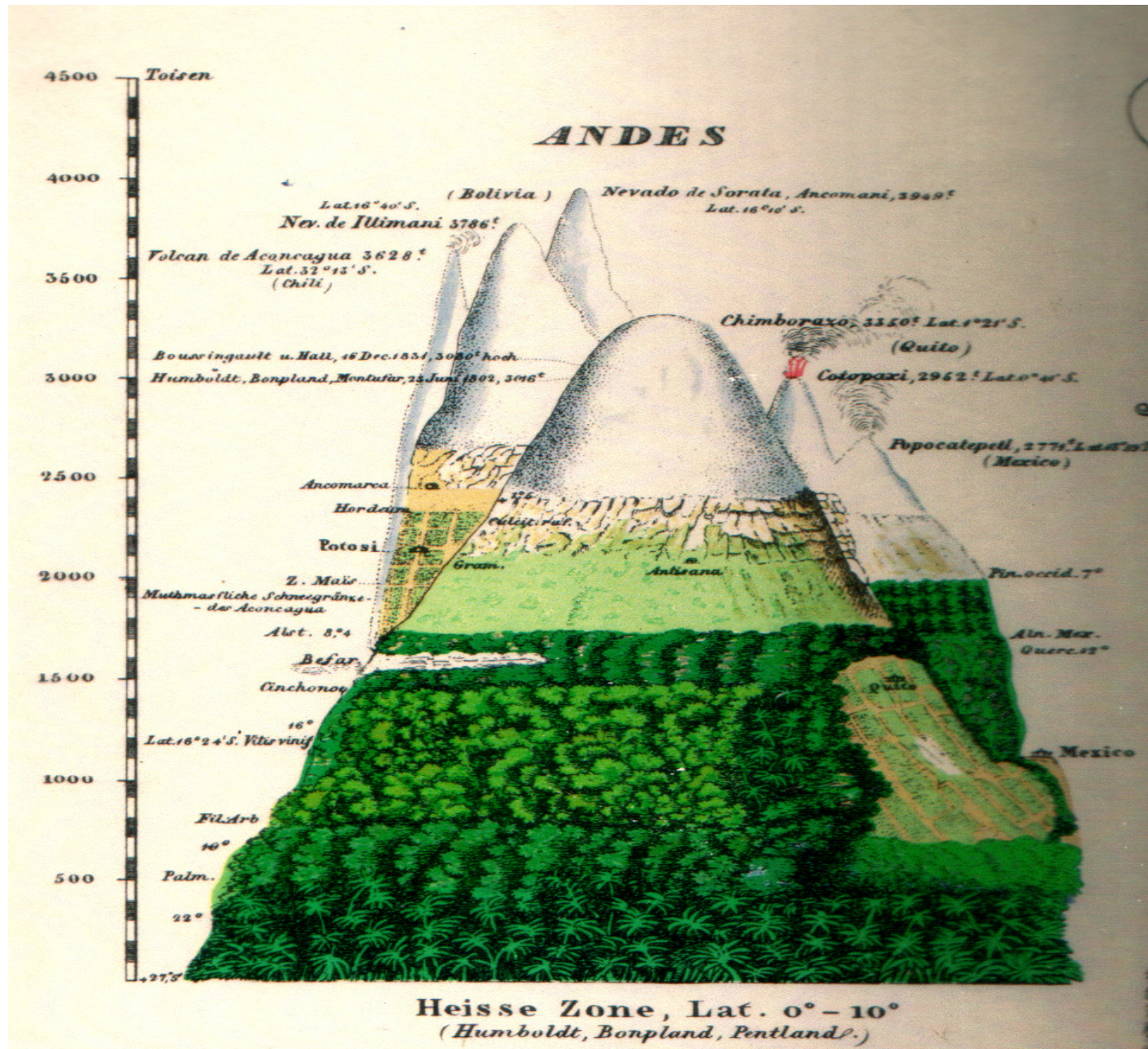
6. Introduced **guano** as fertilizer for exhausted soil

7. Climbed the Chimborazo (**record for the next 40 years**) while noting down the changes in flora with altitude (founding **plant geography**)

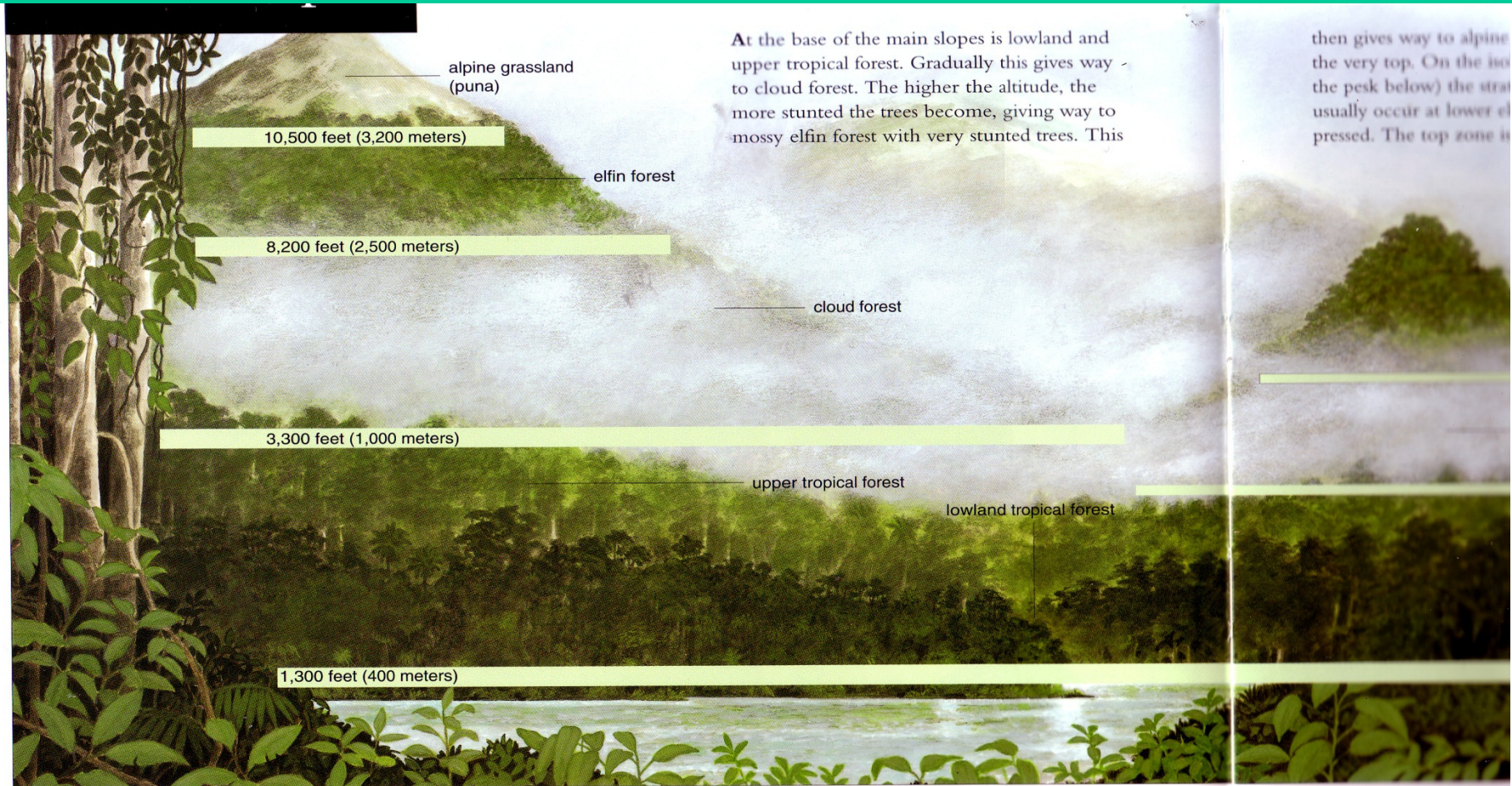
8. collected more than 60 000 plant species, **5600 of them unknown.**



Classic view printed after Humboldt's drawings in "Cosmos"



Modern view of the stratification in rainforest (200 years after Humboldt's drawings)



At the base of the main slopes is lowland and upper tropical forest. Gradually this gives way to cloud forest. The higher the altitude, the more stunted the trees become, giving way to mossy elfin forest with very stunted trees. This

then gives way to alpine the very top. On the iso the peak below) the strat usually occur at lower el pressed. The top zone is

THE VALLEY OF SMOKE

Where the Peruvian Andes come together with the Amazonian forests below, they break into isolated ridges, or foothills, forming some of the wettest places on earth. Indians call one such place Cosnipata (the "Valley of Smoke"). The "smoke" is actually condensing water vapor, swirling almost constantly between the steamy

flowering plants, and almost every other form of tropical life is equally staggering.

John Fitzpatrick and David Willard's interest in the region, and particularly the Cerro de Pantiacolla, began in the 1970s with their many trips into the great Manu National Park, probably the most biologically diverse park in the world. Their interest stemmed partly from

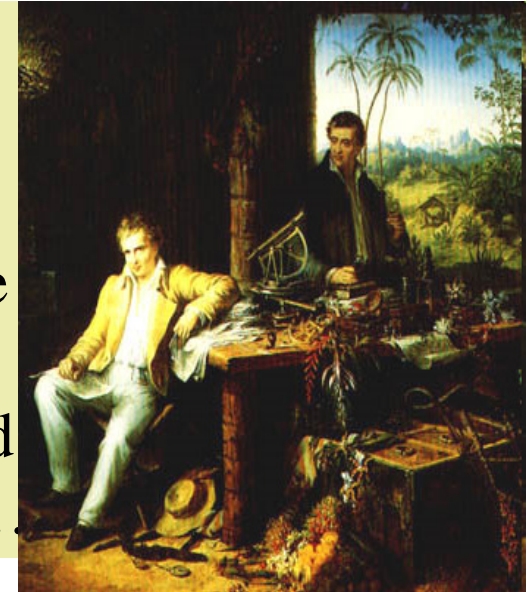
acting as ecological "islands" for species to survive and their ancestors became mountain slopes. If this countless ridges of the might be places where through time. This was explain the unparalleled



Microtype

Havana 1801: Letter to Berlin botanist Carl Ludwig Willdenow:

In a world where the sea is crowded with pirates, where neutrality passes are meaningless, nothing worries me more than the safety of my manuscripts and Herbaria. It is uncertain whether we will survive this trip. Therefore we copied our plant descriptions (**two volumes with currently 1400 species**). & send them to different people. You will edit the plants if .



With tears we daily open our plant boxes & herbaria. The incredible humidity of Amazonia and the *discovery of novel insects that destroy paper and plants defeats all European methods of preservation.*: camphor, turpentine, pitch. Out of eight specimens we can toss away five as total losses.

Because of the mosquitoes we work in a smoke-filled hut, at night we sometimes cover ourselves with sand. Only where the brown-watered rivers Atabato etc. start, suddenly both mosquitoes & crocodiles are gone

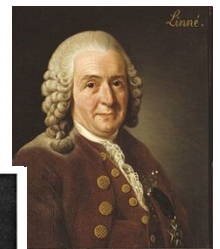
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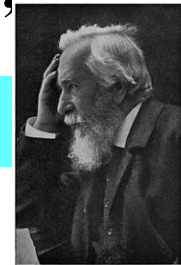
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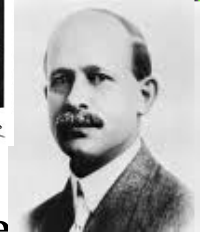
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Plant Genetics Gregor Mendel “give peas a chance! & you..



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Gregor Mendel – a monk called to start a new science



Then there were different Christians, people who did not want to reject science but make it better: The **pastor Christian Sprengel** discovered that plants actually do have sex (a sure way to get fired) and then supermonk **Gregor Mendel** so far ahead and so lucky he must have had help from his Commander in chief.

















Gregor Johann Mendel (1822 – 1884) was an Augustinian monk, who gained posthumous fame as the founder of genetics. Mendel showed that the inheritance of these traits follows laws later named after him. His work was not recognized until the 20th century.

Mendel was extremely lucky in his choice of the plant (give peas a chance!), which bred in clear dominant/recessive traits and showed experimental skill in his thorough inbreeding of the traits before the crossing.

All the traits that he or God chose (petal color, seed color, seed shape, pod color where either recessive or dominant & located on different chromosomes to freely redistribute during crossing.

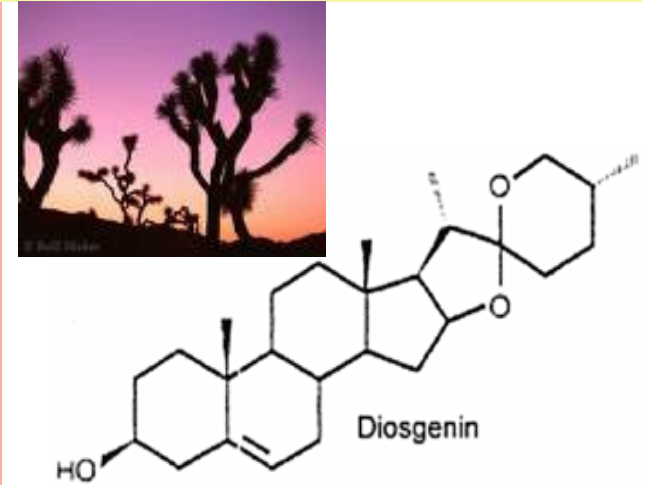
➔ From 1856 to 1863 Mendel tested 29,000 pea plants. Unfortunately, he used mathematical statistics. Tough reading!

Seed shape	Seed color	Flower color	Flower position
 round	 yellow	 purple	 axial (side)
 wrinkled	 green	 white	 terminal (tips)
Pod color	Pod shape	Plant height	
 green	 inflated	 tall	
 yellow	 constricted	 short	

Plants jumpstart the Contraceptive Revolution

Russel **E Marker** (Penn State) worked in steroid chemistry & looked for drug to compensate **lack of progesterone** causing miscarriages in women

Started with *Joshua tree & Sarsaparilla* & then switched to *Dioscorea tokoro* where Japanese had found the saponin diosgenin in 1937. From it he synthesized female hormone progesterone in 5 steps, male hormone testosterone in 8 steps. Wild yams is still today used in India & China. In the West today all contraceptive pills are made synthetically.



Gossypium - famous for growing long fiber cells is that all ?????



Other plants have contraceptive potential, Soybeans, cotton
Gossypium barbadense, Fenugreek, Dieffenbachia seguine, Anthurium kesmannii. Gossypol is tested as a **male contraceptive**, used for centuries in China



Anthony Huxley (1984). Green Inheritance. Gaya Books limited , London



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Henry trained himself in the 'dramatic pause'.