

# Introduction to Botany (Syllabus)

COURSE NUMBER	BO 2101		
COURSE TITLE	Introduction to Botany		
INSTRUCTOR	Rainer Stahlberg, PhD		
CLASS TIME	Mondays 2:00 to 4:50 PM Lecture in Room 55 Wednesdays Lab A 9:30-11:50; Lab B 2:00 to 4:20 PM Room 82		
CREDITS	3.0		
STUDENT ADVISING HOURS	By appointment or Wednesdays 1:00 – 2:00 PM room 82		
CONTACT INFO	(Work Phone) 206-897-1790	(Home Phone) 206-546-2395	(E-mail) raista@u.washington.edu

Class includes lectures, labs, a poster session and plant walks. The course consists of 3-hour lectures (not my choice!) and 3 hour-labs each week. No textbook has yet been written that would give you all the information contained in the lectures. **Attendance of the labs is required since there is no possibility to repeat the lab outside the planned hours. Lack of attendance without previous agreement may result in the repetition of the course.** In case you miss **one** lab for a good reason you may have the option organize a 15 min talk about a medically important herb, which should be present in the herb garden. When you have to take this alternative, please, consider that the presentation is open to the entire class and that handouts to all participants are welcome.

# Introduction to Botany (syllabus)

. The lectures introduce **selected topics in such a way that problems in your later career can be recognized and categorized into a familiar scheme and solved in an equivalent manner.**

The lab is intended to encourage curiosity and initiative in the exploration of plant characteristics, ingredients, organs, structures and responses that may be familiar on a superficial basis. In addition it will improve the students' ability to plan experiments as well as to function as part of a team. To support the acquisition of the topics I will supply study questions that allo

# Introduction to Botany (syllabus)

Experiments are the only means of knowledge at our disposal; the rest is just poetry and imagination...  
Max Planck 1910

*Experiments are the only and hard way to test the truthfulness of assumptions, opinions, ideas and hypotheses. However, where applied, this method turns a bucket of untested and countless times regurgitated opinions, rules, judicial laws and fanciful reports (as you have to suffer through in meetings, politics, elections, court sessions, history, art, newspapers, TV, philosophy, religions, myths, legends) into a reliable, proven and repeatable account of events (= science) that allows for a sober assessment of a situation. **It is therefore that experiments and lab sessions are included in scientific courses. It is your opportunity to test some of the statements made in the lectures and textbooks.** It is also a small attempt to improve your way of judgment and make you more critical towards unacceptably low standards in the public discussion and media.*

**Experiments are an attempt to find a common language with nature, a language that allows a direct dialogue. And yes, “experiment” has the same root as experimental, i.e. it may not work the way you thought it should.**

# How to use the Labs

**To be successful means to follow a few simple recommendations.**

1. **Be prepared.** *A lot of effort is wasted if you do not know exactly what you are going to do in the exercise and why you would want to do this. When in the first group it is your task to set up microscope and dissecting scope.*
2. **You are the one to carry the initiative.** *If lab exercises are less conceived as entertainment performed by the instructors but more as a chance to check the truth of ideas and concepts (own and indoctrinated ones) they have a much better chance to be a learning and a fun experience.*
3. *You will work with flames, heaters, acids, solvents, chemicals, and instruments. It is standard for any lab to wear protecting shoes (no sandals), and clothes that cover your legs. A lab coat is recommended.*
4. *Please work calm and with caution, exercise responsibility and respect for your neighbors and team members. When in doubt how to proceed ask the instructor before making a mistake. Take your time. Less can be more.*

# How to use the labs

**5. Clean your place after you finish the experiments.** *If you are in the second group it is your duty to completely clean your work place and remove the microscope & dissecting scope back to their drawers, return all the slides and rinse lab ware.*

**6. You are expected to keep a current lab report** *with your observations and thoughts. For this purpose bring white paper (sheets can be added to this manual), a transparent ruler (mm is the unit of science), pencil #2 and eraser for drawings. During the quarter the instructor collects reports 1-2 times for feedback and evaluation.*

# Lab report

**7. How do write my lab reports?** *The lab report reflects your attitude towards experimentation and the scientific method as a proven path to separate facts from illusions and lore. Some people try to apply this sober approach to as many spheres of their life as possible, in most cases to their advantage. Others, starting with the classic Greeks and some newer ones as well, arrogantly dismiss this “manual” approach as not intellectual enough and overestimate the limited use & power of logic deductions and intuitions.*

**In the labs I want a minimum of formalism, conformism and a maximum of training and experience.** *Therefore, the lab report is a personal, individual account of what you found, observed and concluded. Here we follow Edison’s famous dictum, “every apparent failure is a result” or in other words an experimental correction of the experiment by nature herself.*

*This conversation with nature should be reflected in terms like hypothesis and expectation, experimental formulation of the question, received answer, and most importantly the conclusions drawn from the experiment (the “what did I learn here”). You should include sketches and drawings to illustrate and remember your exchange. I will discuss & collect the reports 1-2 times during the course.*

# Labs

**8. How to make sketches!** You can draw with pencil, color, pen or camera. Entire courses are taught on scientific sketches. The task here is to draw in order to illustrate the point you are trying to make. Microscopic sketches should not be scaled 1:1, i. e. I should not need a microscope to see your drawing. **The idea is to draw the details as large as fit. So if you draw pollen make your sketch of it at least 3-4 cm wide.** Also, add explanations as much as needed (not in the moment but 50 years from now when you show these pictures to your grandchildren).



**9. Most importantly; find fun in exploring nature.** In spite of our shortcomings in UV and IR vision & infrasound hearing, we Neanderthals are among the few species that enjoy both stereotypic & color vision to appreciate the beauty of the natural world.

# How do I succeed in this class?

To support the acquisition of the topics I will supply study questions that allow you to test whether they got the important “take home” points of each lecture. The questions for the tests will be chosen from the study questions. The questions will be posted and updated after the lectures at the web at <http://staff.washington.edu/raista/> under Introductory Botany.

Go to <http://staff.washington.edu/raista/> and **click IntroBot icon**. Pull down the window to get a larger view of the “study question site”. Read also other categories like “upcoming events” etc.

**If you ask me in 3 weeks how to do this** you are likely one of the bad students in this class. **But this really happens in these classes!**

The study questions are the basis for the tests. I.e. I choose the test questions are a smaller selection of the same study questions. **Do you understand this?**

If you do, you know what to do to succeed!



# Introduction to Botany (syllabus)

- **Instructional Materials and Resources** (Recommended Texts or Study Aids)

1. Levetin E, McMahon K : *Plants and Society*, McGraw Hill 2004 to 2011 is ok

2. Pojar/McKinnon “ *Plants of the Pacific Northwest Coast*”

2. “Laboratory exercises in Introductory Botany” by R. Stahlberg (2011) will be handed out in the first class for \$ 15.00 (cash please!).

4. Recommended literature

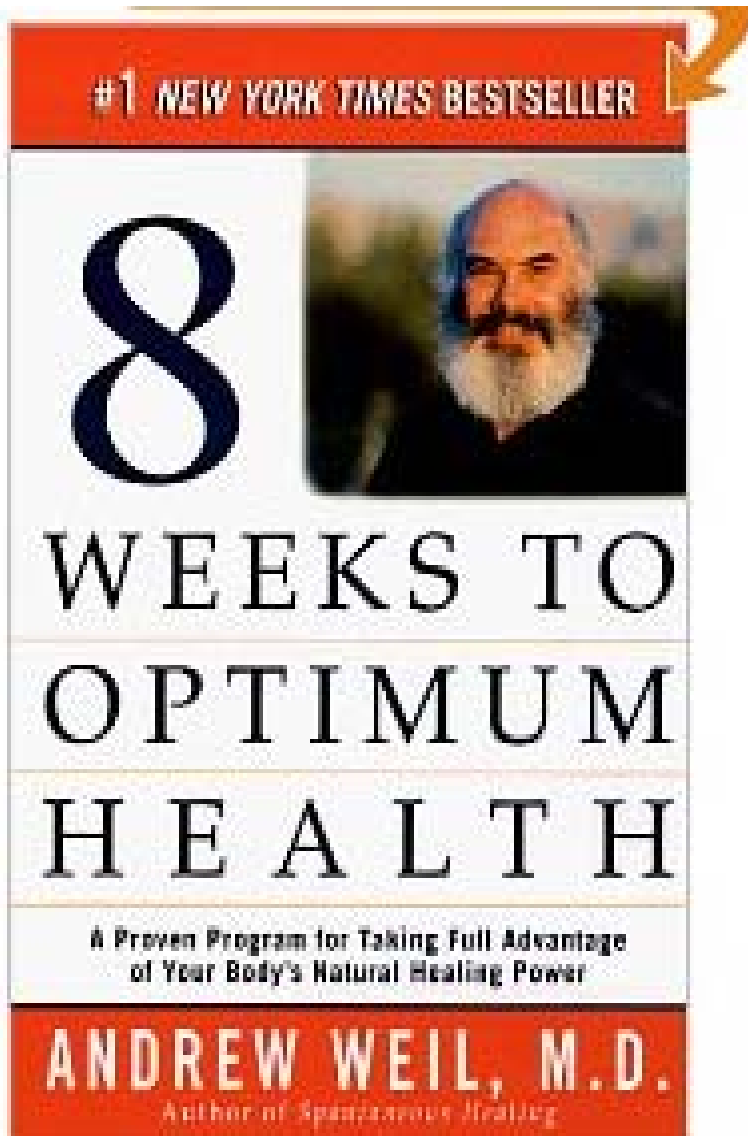
Agosta W C: *Chemical communication. The language of pheromones*. Scientific American Library, New York 1992

Agosta, William: *Thieves, deceivers and killers. Tales of chemistry in nature*. Princeton University press 2001

Anathakrishnan T.N., Sen, Alok (editors): *Biocommunication in insects*, Science publishers Inc. Enfield 1998

# Introduction to Botany (syllabus)

WEEK	DATE	Class TOPIC	Lab topic	Reading	BRIEF OUTLINE OF CONTENT
1	7/11	What is a plant? What are the sub disciplines of Botany	Lab # 1 The algal ancestry of plants	Relevant parts in Ch 3-6, Ch 8	Life strategies of plants: When do plants move, when do plants rest, exceptional or strange plants
2	7/18	The 6 kingdoms of life Plant families and plant ID	Lab # 2 Plant diversity and . identification : Campus walk	Relevant parts in ch 8,9, 22, 23	The role of cyanobacteria for making the oxygen atmosphere + modern life on the planet, the role of algae
3	7/25	Plant IDing by anatomy and characteristic phytochemicals	Lab # 3 Primary metabolism and the making of paper	<b>first written test</b> relevant parts in ch 4. ch. 16-20	What are lower plants and what are higher plants? Mosses, Ferns and conifers
4	8/01	Plant Primary metabolism Fats Proteins, mucilage, starch	Lab # 4 Plant diversity and identification : Visit to the UW	relevant parts from ch. 19.20	The most important families of higher plants and their characteristic features
5	8/08	Secondary metabolism from organic acids to essential oils	Lab # 5: Secondary metabolism and the making of ink	<b>2nd written test</b>	How come that plants can make compounds that we cannot: Vitamins, essential amino acids, essential fatty acids
6	8/15	Toxic plants, spices, aphrodisiacs, plant scents, perfumes	Lab # 6: Poster session you prepare your experiment and then present it in context	Relevant parts in ch. 10,11, 15. 26	the fascination of plant compounds in their interaction with other life forms including bacteria, fungi, insects & humans
7	8/22	From arrow poison to painkillers and anesthesia	Lab # 7: Plant colors and Stains	Relevant parts in ch. 26	Plant are not only the basis of all food pyramids but the basis of all life on the planet
8	8/29	3 <sup>rd</sup> of final test	Finals week: no lab! time for lab make-ups (see Syllabus) !!	<b>3<sup>rd</sup> of final test</b>	



**It takes 3 weeks to change good into bad habits**

**It takes 8 weeks to change bad into better habits**

**Let us use the 8 weeks we have together to make us into more observant people when it comes to Botany.**



**We are what we repeatedly do.  
Excellence and courage, then, are not  
acts of a moment, but trained habits.**

**Aristotle**



**Feel what is beautiful, think what is  
true and do what is right.**

**J. W. von Goethe**

**The three columns of your life**

**From “Wilhelm Meister’s years of apprenticeship”**

**What is a  
plant?**



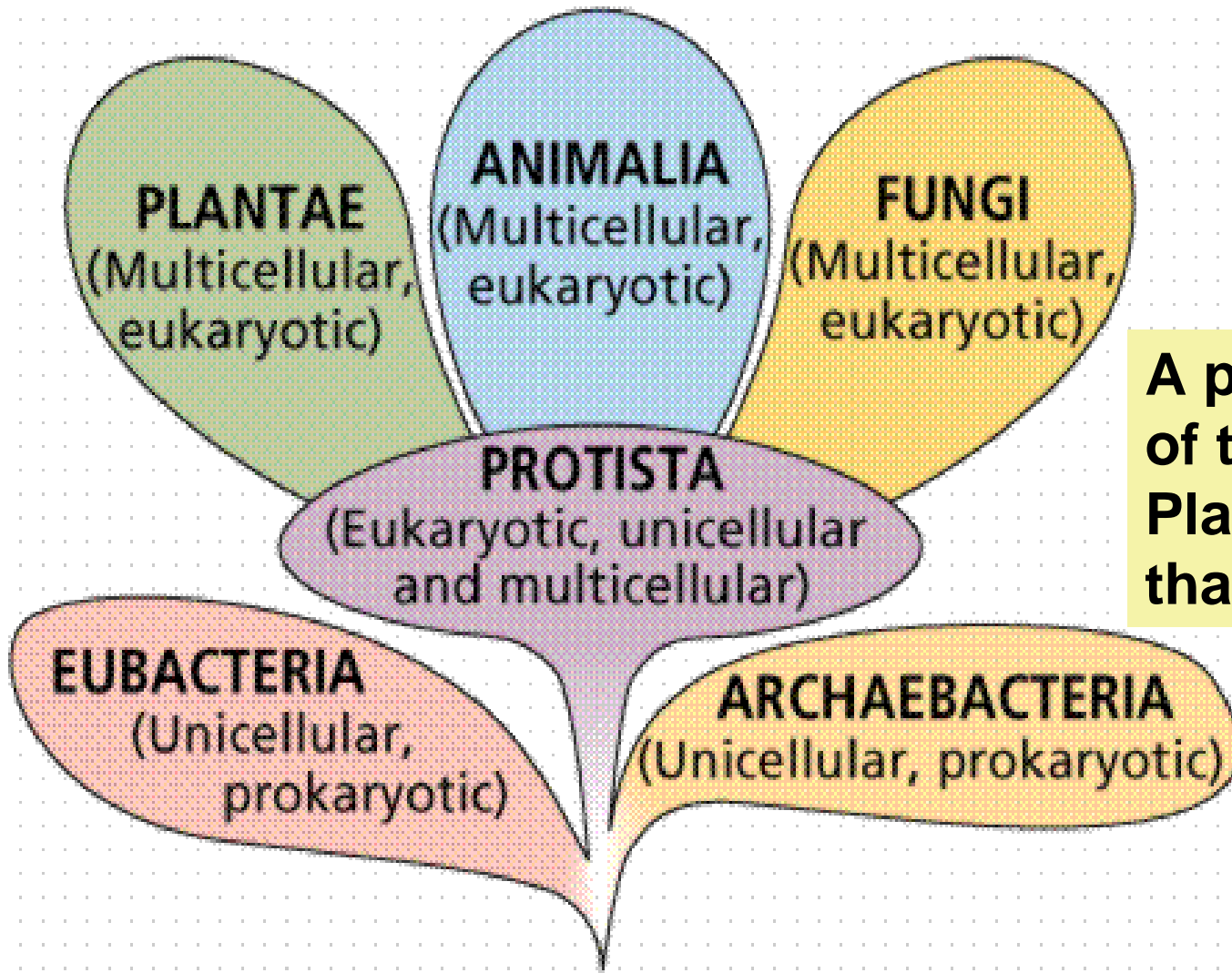
**What is it?  
Plant, fungus,  
protist?**



**Is it really a  
plant?**



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



A plant is a member of the kingdom of Plantae and that is that.



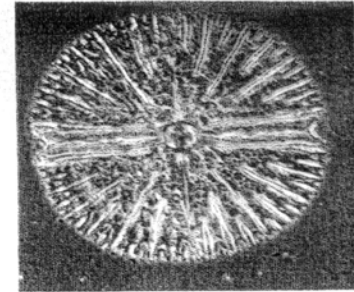
# What the .. Is a plant??

## What the ... is a plant?

→ any member of the kingdom  
Plantae

*typically characterized by:*

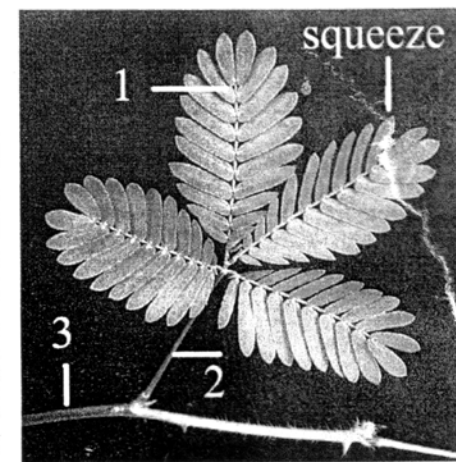
- (1) Lack of locomotion (rooted)*
- (2) absence of sensory organs  
& a nervous system*
- (3) synthesizes polymers by  
photosynthesis*
- (4) alternation of sexual vs.  
asexual generations*



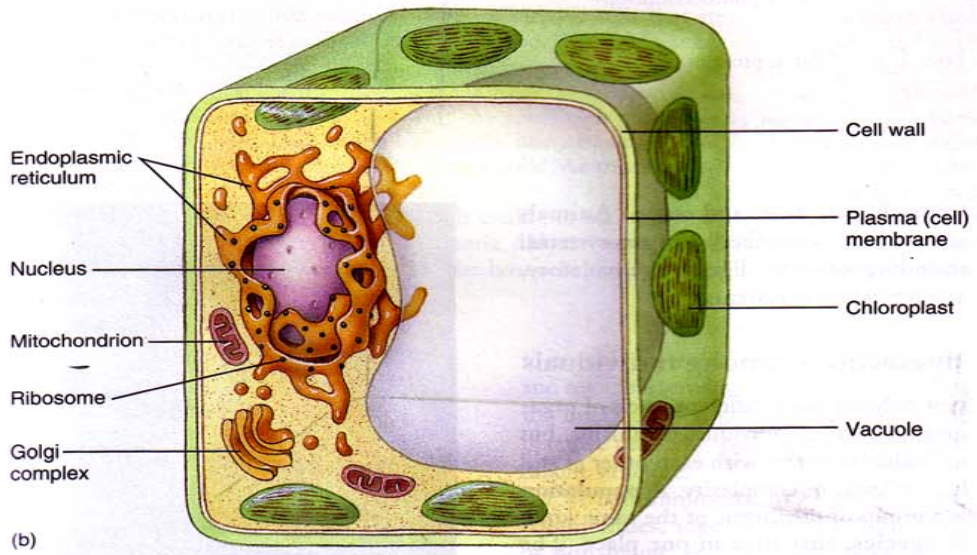
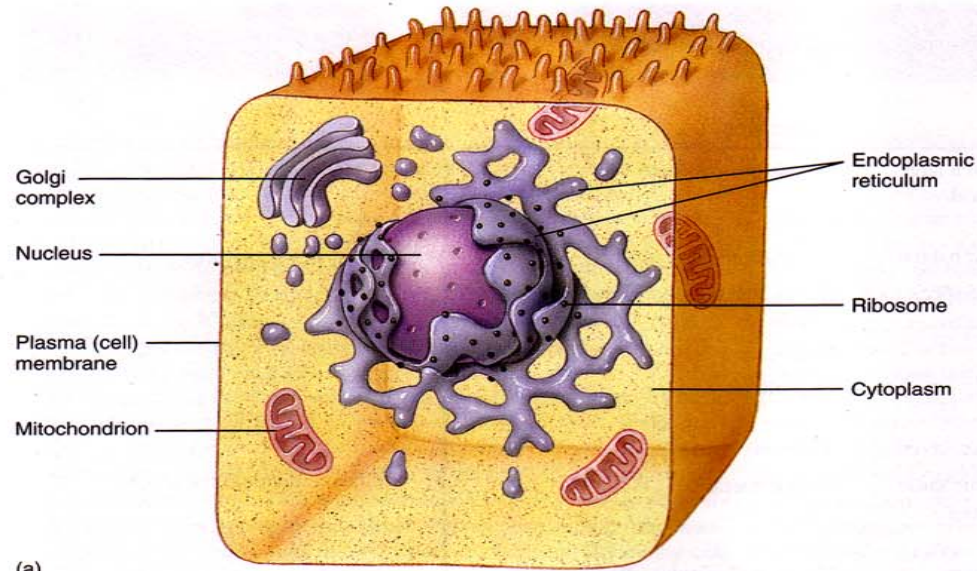
Microcrasterias



Ulva lactuca



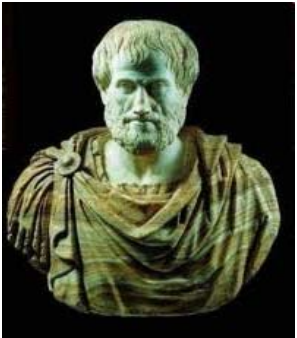
# animal versus plant cell ?



name differences !



# Aristotle and the beginning of Science



Aristotle was born in in 384 BC, near modern-day Thessaloniki. His father was the personal physician to King Amyntas of Macedon. At 18, he went to Athens to continue his education for 20 years at **Plato's Academy**.



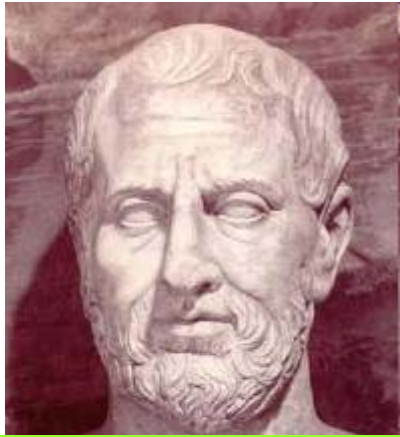
Aristotle traveled with **Theophrastos** to the island of Lesbos, where they researched the **botany and zoology of the island**.

Aristotle was invited by Philip II of Macedon to become the tutor to his son **Alexander the Great** & also to two other future kings: **Ptolemy and Cassander**. Aristotle states that the only thing that could justify monarchy, was if the virtue of the king and his family were greater than the virtue of the rest of the citizens Aristotle encouraged Alexander toward eastern conquest.

Plato with Aristotle in the academy



# Theophrastos and the beginning of Botany



371 – c. 287 BC . At a young age, he studied in Plato's school. After Plato's death he attached himself to Aristotle. Aristotle designated him as his successor at the Lyceum.



Attached a botanical garden to the Lyceum. His student Alexander send many animal & plant species. His surviving botanical works are: remnants of a book on essential oils **1. *Enquiry into Plants***; **2. *On the Causes of Plants***,

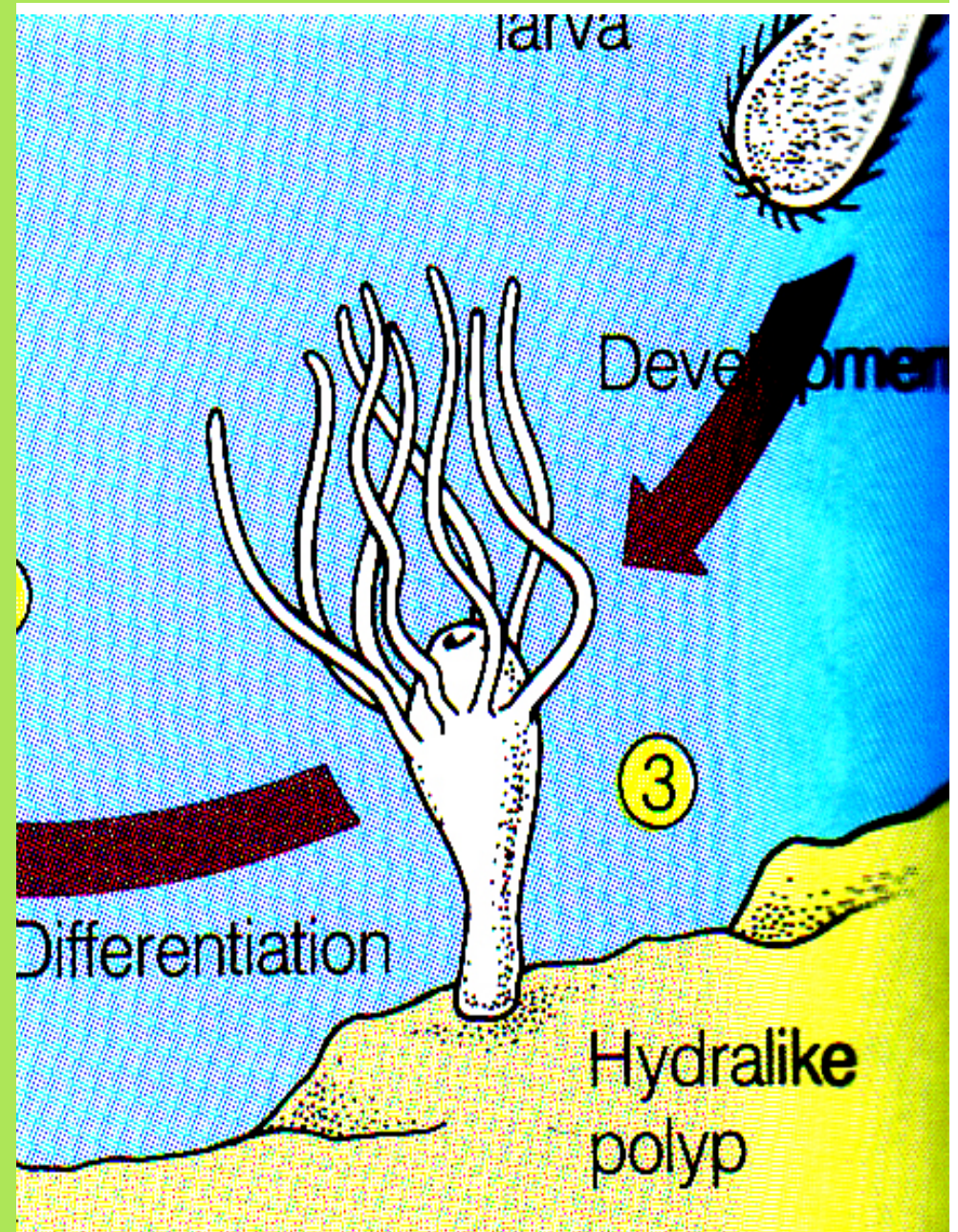
The 1<sup>st</sup> book deals with the parts of plants; the 2<sup>nd</sup> book with reproduction and sowing; the 3<sup>rd</sup> , 4<sup>th</sup> & 5<sup>th</sup> books are devoted to trees; the 6<sup>th</sup> book deals with shrubs; the **seventh book deals with herbs**; the 8<sup>th</sup> book deals with plants with edible seeds; and the **9th book deals with useful juices, gums, resins, oils**. Much of the information on the Greek plants come from his own observations, plus from the reports on plants of Asia brought back from those who followed Alexander



# What is a plant?

**Aristotle** thought of plants as inverted hydras – primitive water animals which move in inverted position using their tentacles as legs as well as mouth.

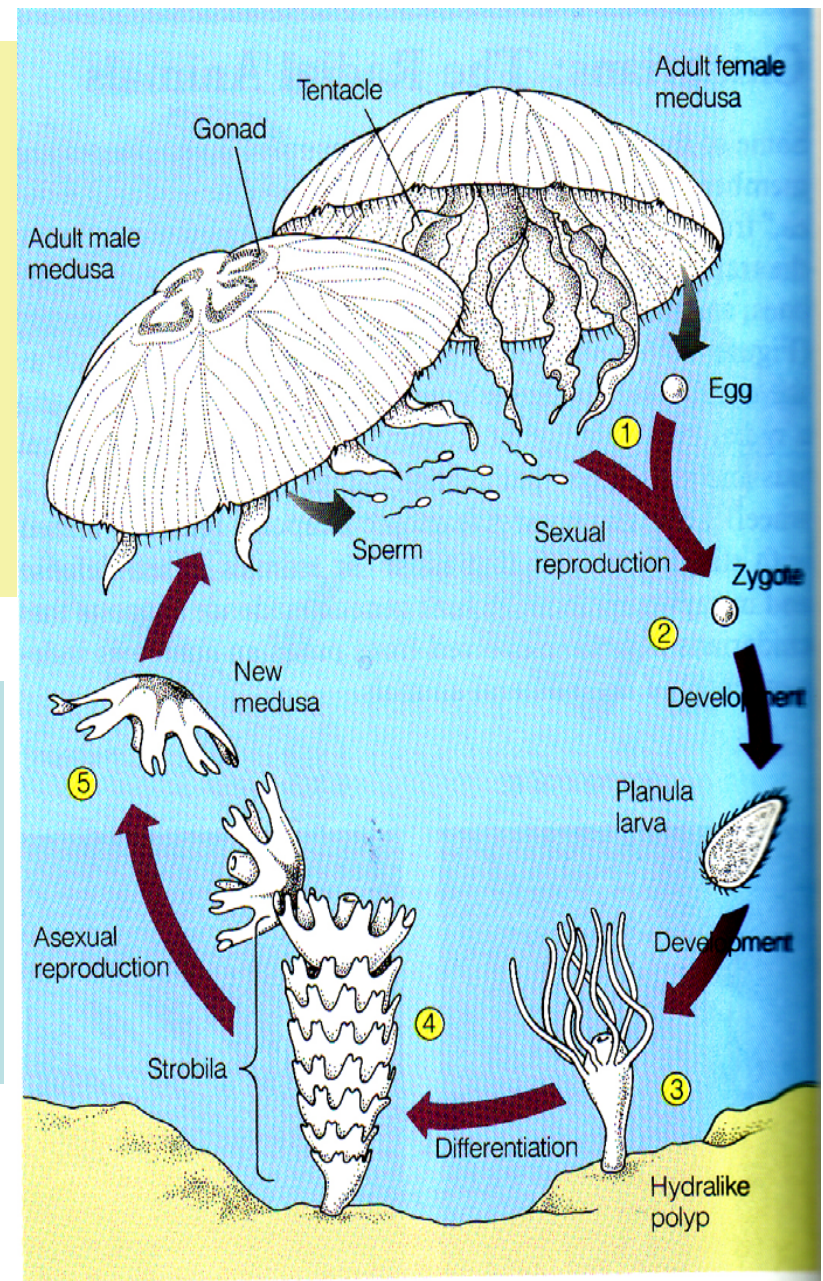
Aristotle thought that plants derive from hydra-like animals that got stuck with their mouth (roots) in the ground in an inverted position = **the first attempt to define the essential differences between the two kingdoms.**



# What is a plant?

Eggs of jellyfishes do not hatch into new jellyfishes but attach to bottom structures, from where they sprout like plants. After some growth period the **sessile plant-like hydroids** blossom or release small jellyfishes. They have colorful protuberances that look like flowers.

**The plant-like hydroids** are water animals having slender stalk-like structures sprouting from rocks and coral reefs and with slow movements & **can be easily mistaken for plants.**





# What is a plant?

## Plant-like features in hydra: Aristotle revisited

1740 A Trembley, Swiss in Holland found green hydras:

### animal or plant? →

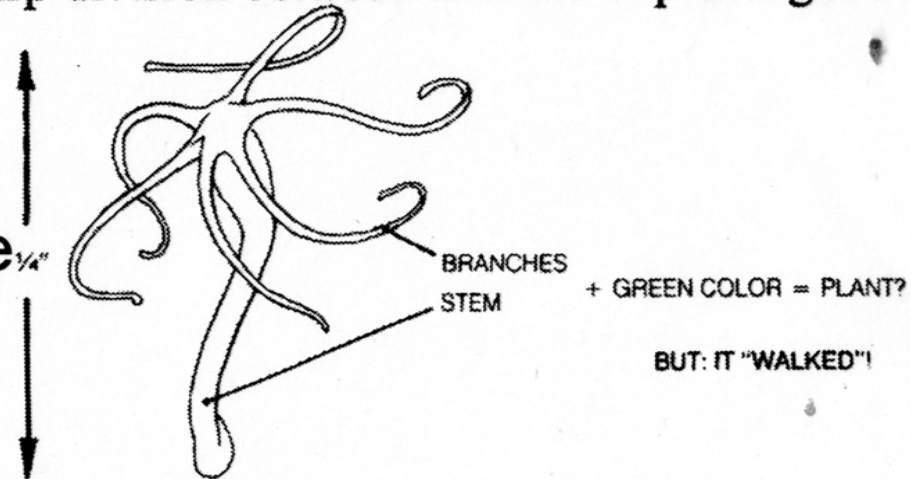
1. green color = plant  
(today: algal endosymbionts);

2. creature walked somersaulting, oh had he read Aristotle

3. Cut them in half regeneration → plant

4. Captured little water fleas and stuffed them into a mouth → animal

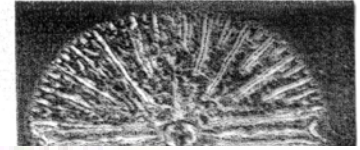
A. Trembley: is this green hydra plant or animal?  
sharp division between animals & plants got blurred



TREMBLEY'S DISCOVERY: ANIMAL OR PLANT?  
Rene de Reaumur: discovered animal regeneration  
in 1712

# What the .. Is a plant??

## What the ... is a plant?



→ any member of the kingdom  
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*typically characterized by:*

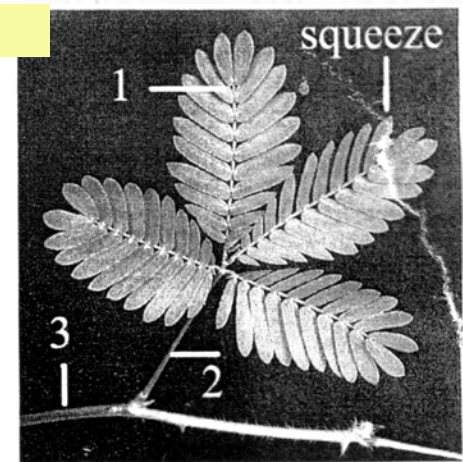
**(1) Lack of locomotion =  
a sessile life style**



ClipartOf.com/6336

**(3) synthesizes polymers by  
photosynthesis**

**(4) alternation of sexual vs.  
asexual generations**



# Sessile? But plants spread faster than animals

Plants travel faster and more effectively than animals with their clumsy devices like fins, wings and stick-legs. 1. Evidence plants are first to appear on sterile islands



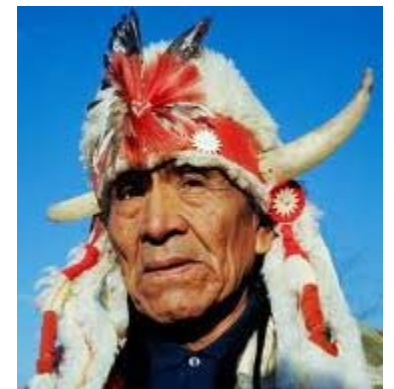
Tree ferns are among the first to settle on the lava of new islands like this one called “Son of Krakatau”. This is easy to understand since fern spores can fly from continent to continent.



Coconut landing on the shore of a new island. When it is not shaded (photoscopic seed) it will germinate and make a new colony of palms without help of humans



The plantain *Plantago major* seed contains mucilage like the linseed. When wet it attaches to any surface and is transported along even by barefoot people. North American Indians took appearance of this plant as a sign that white trappers had invaded their territory.



**Plants travel as seeds (embryos), animals as adults.**



# Plants do not know that they are supposed to be sessile

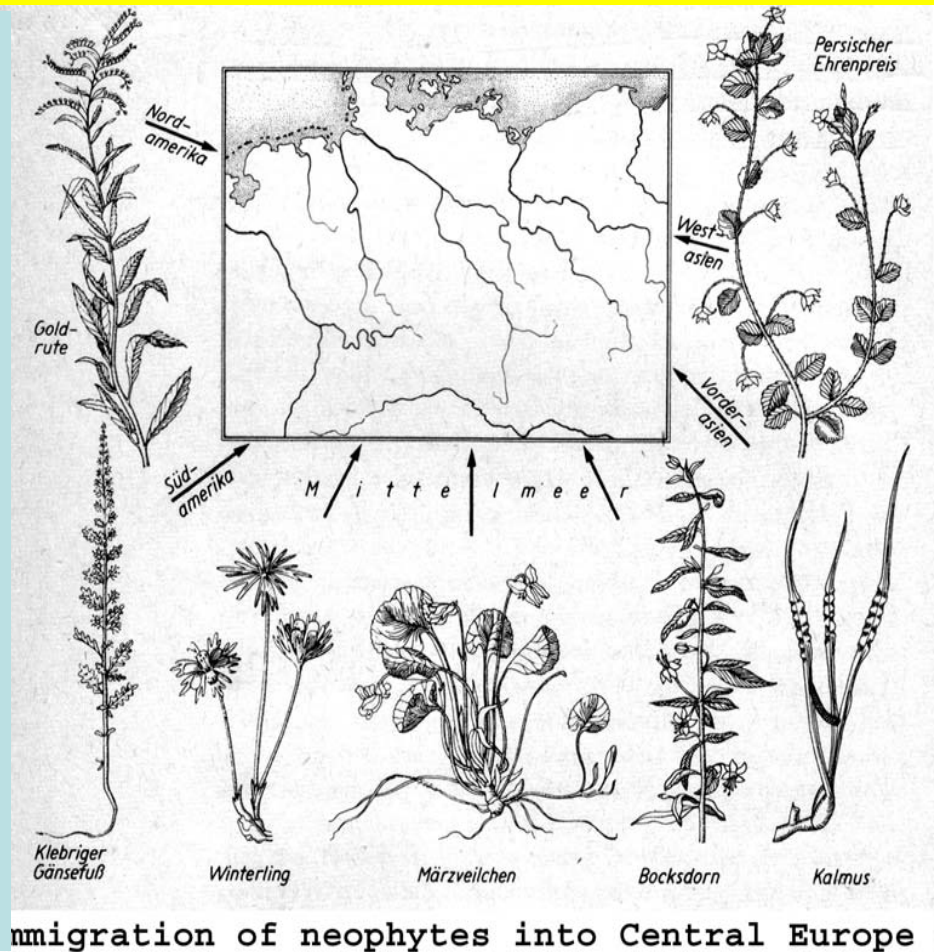
Weedy plants are those who travel & settle beyond their place of origin. They are called “**foreign invaders**” in America & “**neophytes**” in Europe. Many escaped from Botanical gardens. Same is true for every continent!

**Europe** is open to Asia & through humans to Mediterranean + America

**From NAM:** *Elodea canadensis*, *Solidago canadensis*, *mimulus guttatus*, *Amaranthus retroflexus*, *Oenothera biennis*, *Erigeron canad.*

**From Asia:** *Acorus calamus* = sweetflag, *Impatiens parviflora*, *Datura stramonium*, *Viola odorata*

**From S Europe:** *Brassica nigra*, *Amoracia lapathifolia*, *Tulipa sylvestris* (wild tulip)



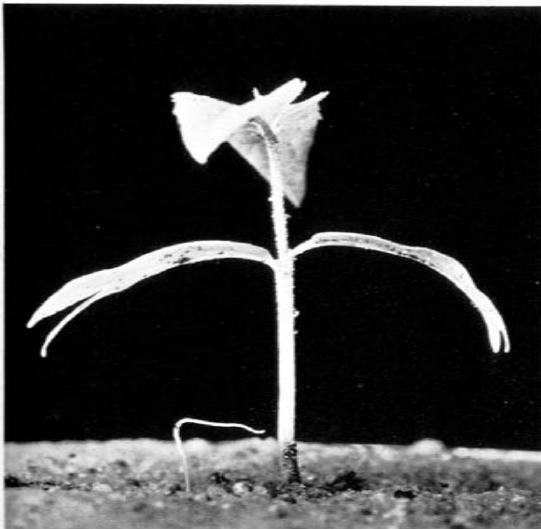
**Neophytes** have superior adaptability, flexibility & ecological tolerance

# The only plants that does the locomotion ....

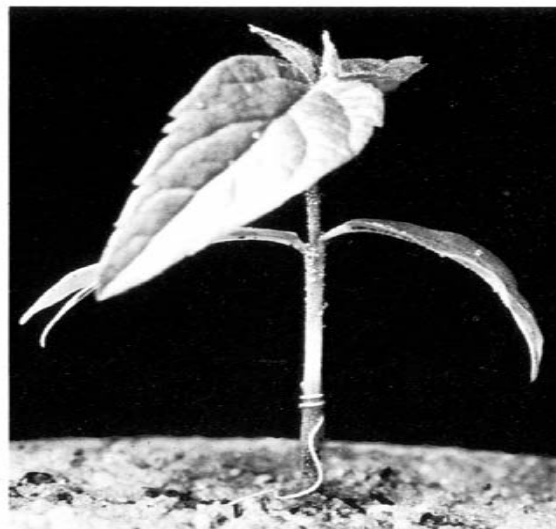


*Cuscuta* (Dodder) about 100 species of yellow, orange or red (rarely green) parasitic leafless (minute scales) plants placed in the morning glory family, **Convolvulaceae**.

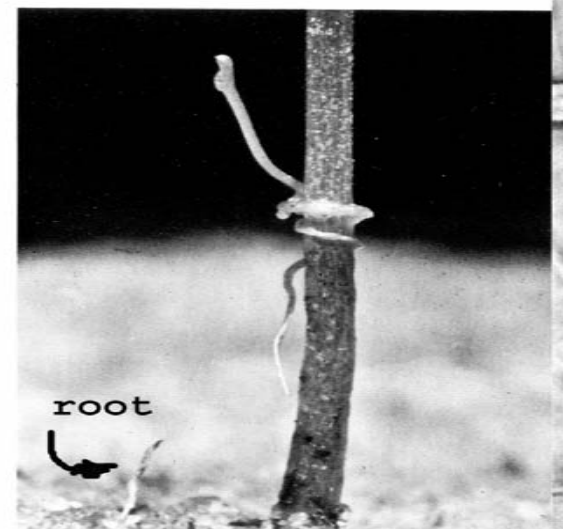
The seeds are minute and produced in large quantities. They have a hard coating, & survive in soil for 5–10 years. **Germination** can occur without a host, it zooms in on the **smell** of nearby plants



1. germination with flexible stem smells the host plant



2. after 12 h it is already solidly attached to the host



3. One week later it has haustoria in the host & abandons root

# What makes a plant different from an animal like us?

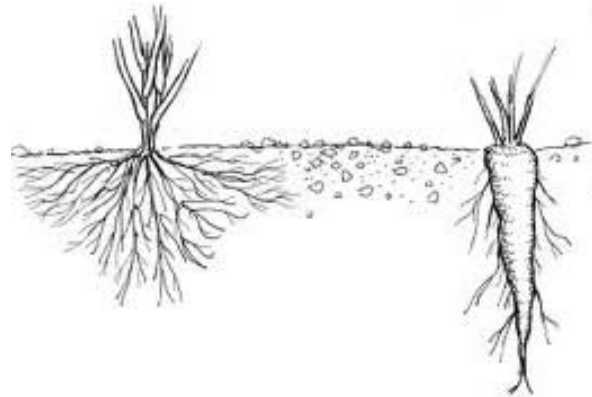


“ Has no head, no ears, it is green but so is the frog .. comes always in pots, & really loves dirt”

# Plants have a hidden part called **Root (1)**

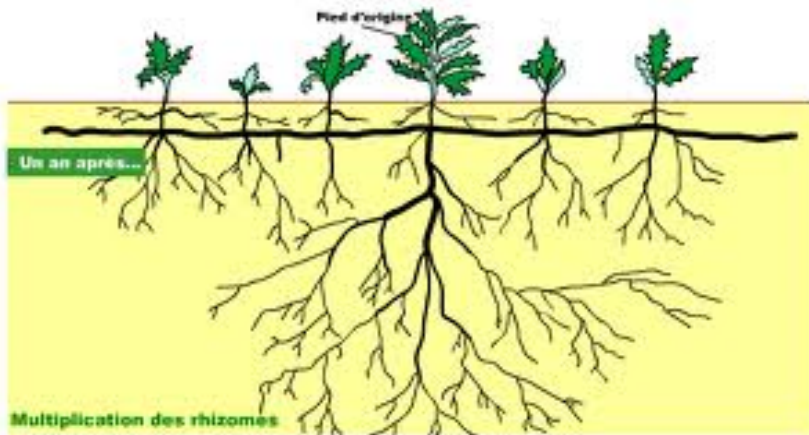


It is not obvious from the look of a plant to guess what kind of root it has: tap root, fibrous, rhizome, bulb etc.

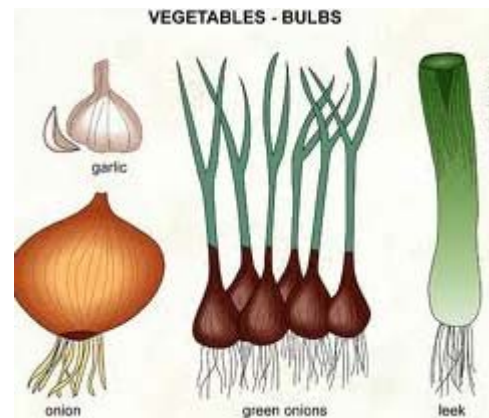


fibrous root system

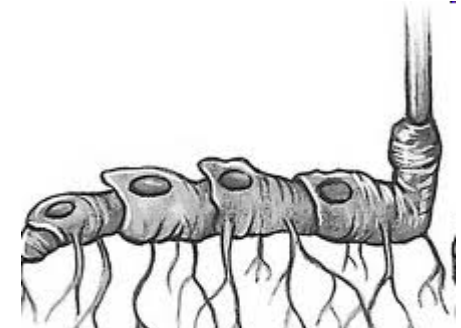
tap root system



Hops grows from rhizomes



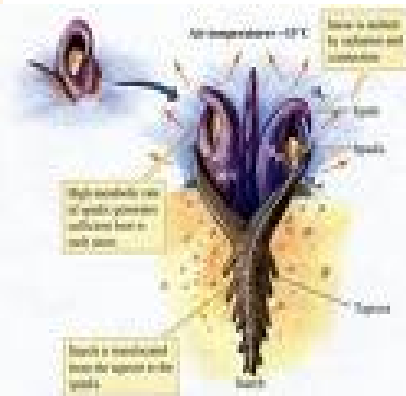
Conifer root with mycorrhiza



Ginger rhizome

# What is a Plant; the hidden part is important

What we see of a plant is not necessary all, plants differ often more by what is beneath the earth than what you can see above it. The subterranean part is also often more important, since all geophytes/cryptophytes survive the winter with the perennial parts that are below the earth. These parts may reflect the fact that the first higher plants on the dry continents were more inside the earth than above it!



Bloodroot  
Sanguinaria

Skunk cabbage  
Symplocarpus

Pasque flower  
Anemone patens

While many macroscopic algae have chlorophyll + leaf-like & stem-like structures (folds & stipes), they & the fungi surely miss out on **roots, an organ that seems to be specific for higher plants.**

# What is a Plant; the hidden part is important

All geophytes/cryptophytes survive the winter with the perennial parts that are below the earth. These parts may reflect the fact that the first higher plants on the dry continents were more inside the earth than above it!

In the winter the only living (or surviving) part of herbal plants is the root, bulb, rhizome below the surface.

Contrary to perennials, **in annual plants the roots do not survive the winter.**

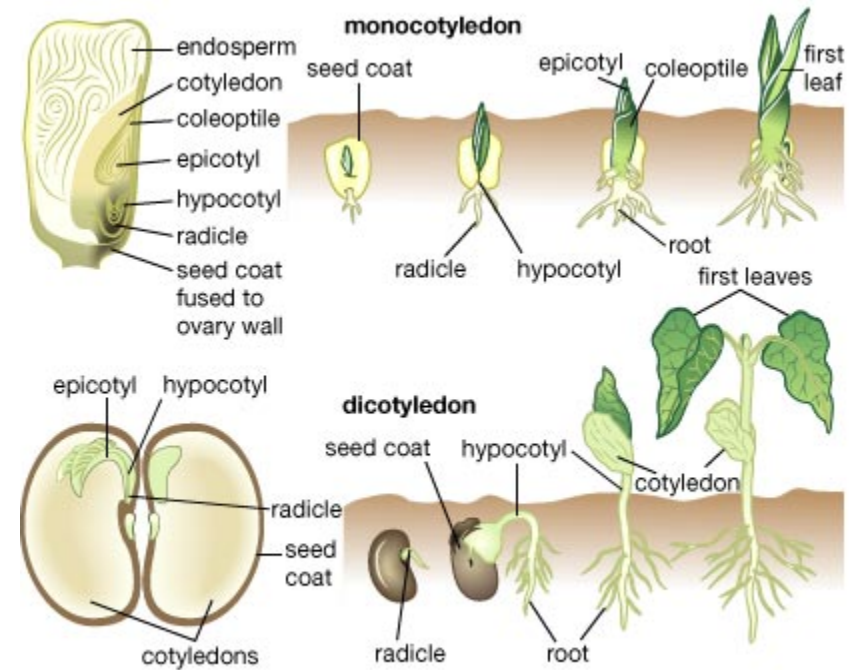


## 2. Higher plants invented survival + prop. units called Seeds

A **seed** is a small, but complete embryonic plant enclosed in a **seed coat**, usually with some **stored food** (exception the smallest orchid seeds). It is the product of the ripened female ovule and the fertilizing male pollen and hence a product of sexual propagation with its genes-mixing effect increasing the genetic diversity of the offspring.

**Lower plants have a propagation unit called spore. A spore is a reproductive unit for dispersal and surviving unfavorable conditions.** Spores form part of the life cycles of many bacteria, algae, fungi and **lower plants like mosses and ferns.**

**The difference between spores and seeds is that spores have very little stored food resources compared with seeds.**



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©2002, Gary Fewless

Fern sporangia called sori are packages containing many spores

# How long can seeds live? Germination rate drops to 50 % after how many years .....

**RSI = time after which germination rate drops to 50 % of initial.**

Relative storability index<sup>a</sup>

<i>Crop</i>	<i>Category 1 (1 to 2 yr.)</i>	<i>Category 2 (3 to 5 yr.)</i>	<i>Category 3 (&gt;5 yr.)</i>
<b>Agronomic</b>	Bermuda grass Cotton Field corn Millet Peanut Soybean Sunflower	Barley Ky. Bluegrass Fescue Oats Rape seed Rice Wheat	Alfalfa Sugar beet Clover Vetch
<b>Vegetable</b>	Green bean Lettuce Onion Pepper	Broccoli, cabbage, cauliflower Sweet corn Cucumber Melon Pea Spinach	Beet Tomato
<b>Flower</b>	Begonia Coreopsis Pansy Primrose Statice Vinca	Alyssum Carnation Coleus Cyclamen Marigold Petunia	Hollyhock Morning glory Salpiglossis Shasta daisy Stocks Zinnia

<sup>a</sup>The relative storability index is the expected 50 percent germination in a seed lot stored under favorable ambient conditions. Storage life would be longer under controlled low temperature conditions.

Adapted from Justice and Bass 1979

Hartmann HT et al. "Plant Propagation - principles and practises. Prentice Hall N Y 1997



# Plants can fly !

**Seeds come in dispersal units: embryo , food supply, coat, plus**

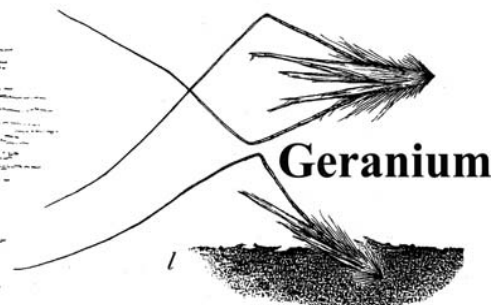
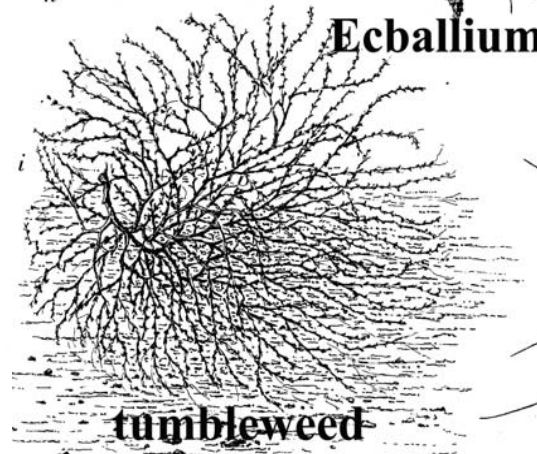
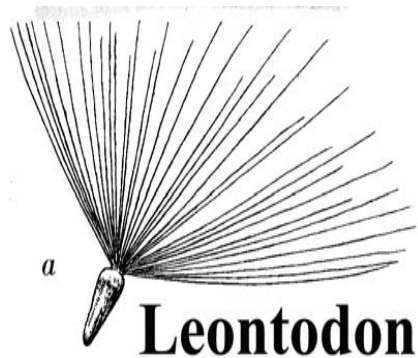
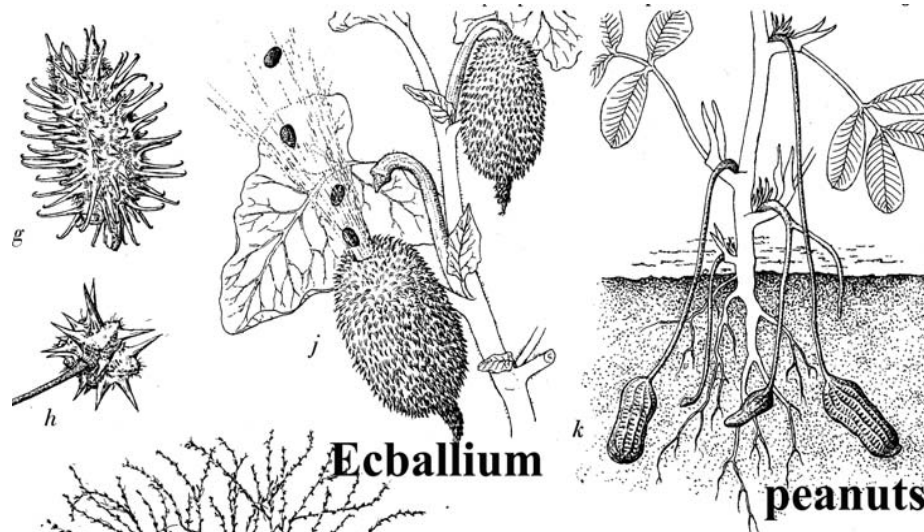
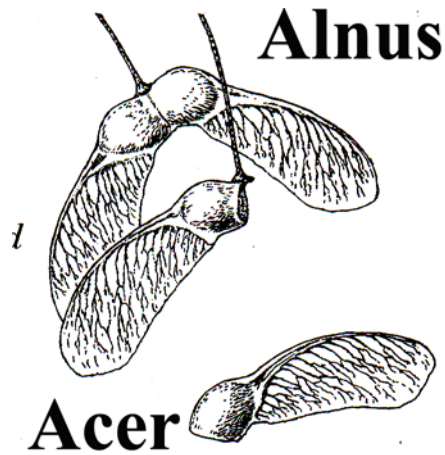
parachutes: lettuce (*Lactuca*) dandelion (*Taraxacum*), thistle (*Cirsium*)

wings: maple *Acer*, alder *Alnus*, tumbleweeds

floats: coconut

bribes: beans, bloodroot etc carry elaiosomes or oil bodies for ant-dispersal

glues: mistletoes, squirting cucumber



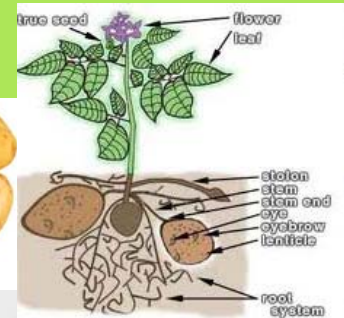
Elaiosomes from *Sanguinaria c.*  
release oleic acid (dead ant sign.)  
linoleic acid (food or brood sign.)



# Vegetative Propagation – animals don't do this at home (3)

Plants consider vegetative propagation the safer method. When they have to choose between asexual and sexual propagation, the clearly vote for the first one. There are many plants that rarely produce flowers: One reason for this behavior is that the assimilated organic substances are drawn to the geophytic organs rather than the flower.

**Potatoes** *Solanum (Lycopersicum) tuberosum*. In large potato fields you find very few plants that are flowering.



**Horseradish** *Cochlearia armoracia* flowers but hardly ever produces seeds since the growth of storage roots has absolute priority.



**Buttercups of** *Ranunculus ficaria* flower in early spring but hardly produce any fruits. They propagate by small visible bulblets that form near leaf nodes at the stem.



**Jerusalem artichoke, Topinambur** *Helianthus tuberosum*. Flowers in late summer but never succeed making seeds store inulin in tubers



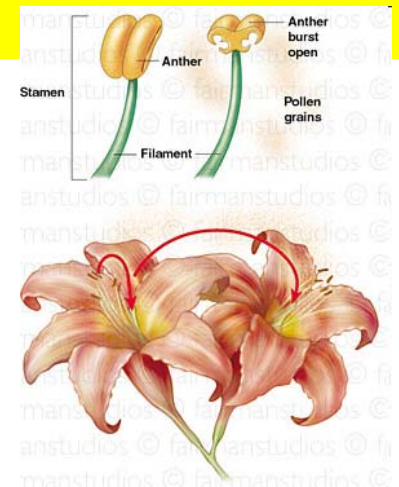
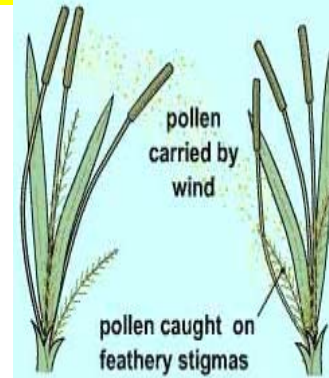
# Higher plants invented a new kind of condemnable Sex

Before artificial insemination, **fertilization in animals always required the intimate presence of both partners at the same location.** Since plants have roots and cannot move even for sex, they found new ways to bring the male gametes (pollen) to the female gametes (ovules). One nice collateral of this is the invention of flowers, color, smell = a better, more beautiful world.

**Plants use either wind or animals (insects, spiders, birds, bats, humans you name it) to get the pollen with the male gametes to the female organs (=stigmas).**

The new mechanism allows one plant to fertilize another that is miles or in some cases (jet stream) even continents away. **A major breakthrough in remote sex allowing a high degree in diversity over large areas and populations.**

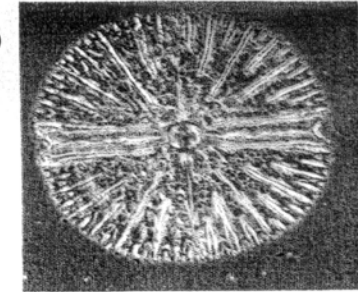
Before mail order of animal sperm was invented the fertilization of ovules depended on the slow **swimming speed of male spermatozoa – a severe handicap.**



# What the .. Is a plant??

## What the ... is a plant?

→ any member of the kingdom  
Plantae



Microcrasterias

*typically characterized by:*

**(1) Lack of locomotion**

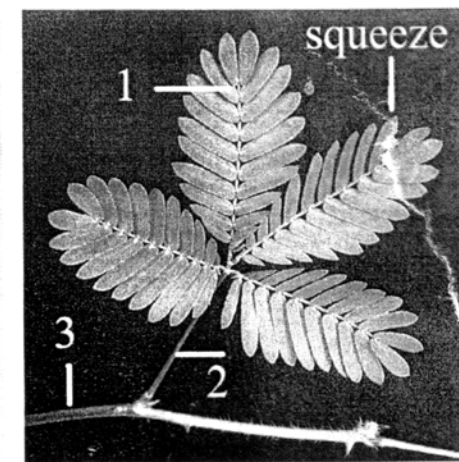
*(2) absence of sensory organs  
& a nervous system*

*(3) synthesizes polymers by  
photosynthesis*

*(4) alternation of sexual vs.  
asexual generations*



Ulva lactuca



# Plants propagate by strange zombie-like bodies: seeds (2)

**Seeds come in dispersal units: embryo , food supply, coat, plus**

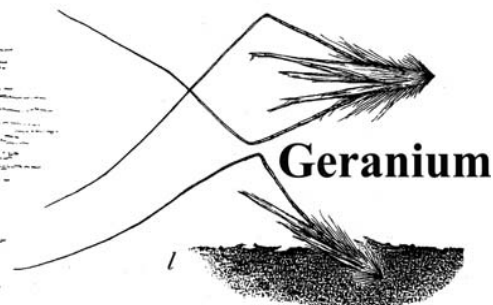
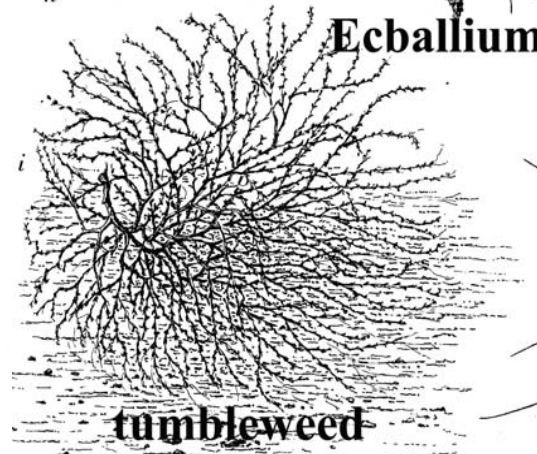
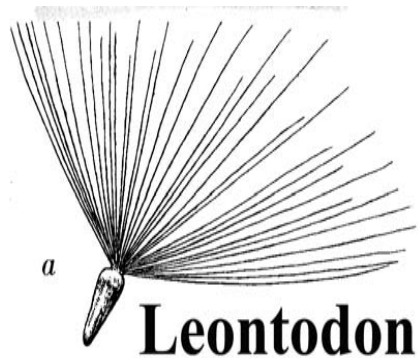
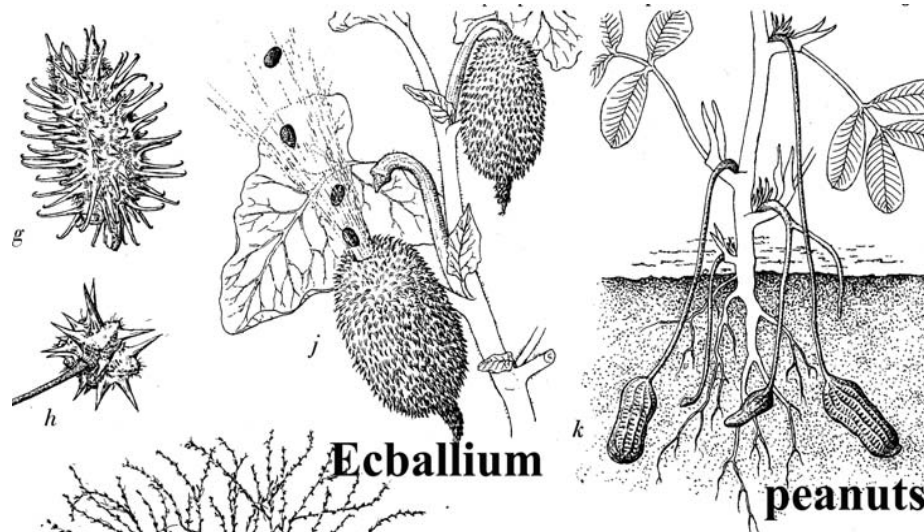
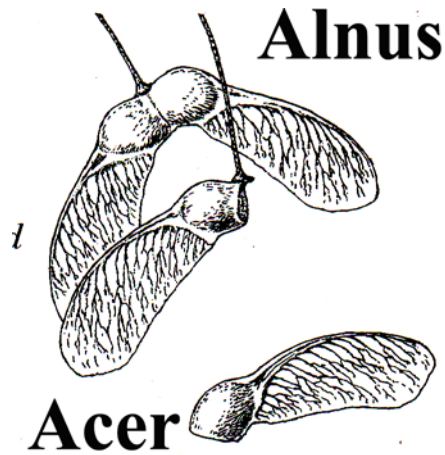
parachutes: lettuce (*Lactuca*) dandelion (*Taraxacum*), thistle (*Cirsium*)

wings: maple *Acer*, alder *Alnus*, tumbleweeds

floats: coconut

bribes: beans, bloodroot etc carry elaiosomes or oil bodies for ant-dispersal

glues: mistletoes, squirting cucumber



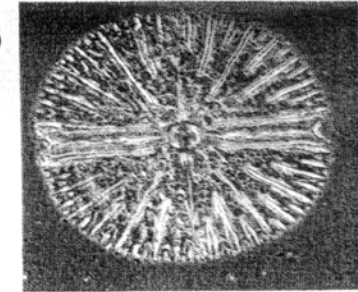
Elaiosomes from *Sanguinaria c.*  
release oleic acid (dead ant sign.)  
linoleic acid (food or brood sign.)



# What the .. Is a plant??

## What the ... is a plant?

→ any member of the kingdom  
Plantae



Microcrasterias

*typically characterized by:*

*(1) Lack of locomotion (rooted)*

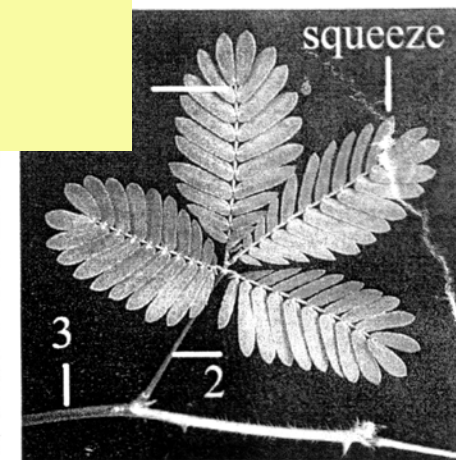
**(2) No sensory organs &  
nervous system**

*photosynthesis*

*(4) alternation of sexual vs.  
asexual generations*



Ulva lactuca



## Plants that can smell! *discovered in 2006*

Cuscuta or dodder is a genus of at least 100 yellow to red species of parasitic plants. Recent genetic research places this genus in the morning glory family Convolvulaceae. Dodder appears as a leafless, chlorophyll-deprived shoot (leaves are reduced to small scales) without a root. After dodder germinates and finds a plant to climb it abandons its earthly root for haustoria.



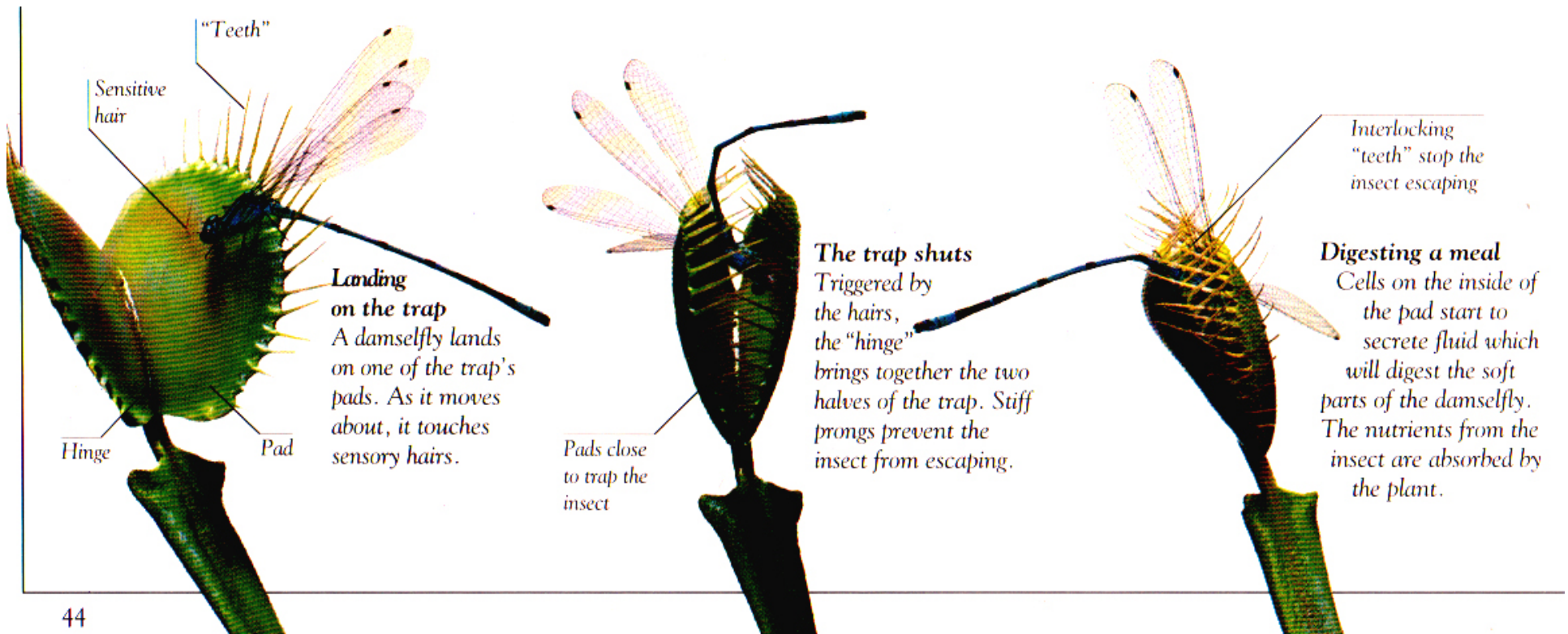
The dodder's stem elongates quickly & waves slowly (circumnutation) in the air checking for odors from potential victims.

.Runyon, Mescher & De Moraes (Science Vol. 313: 2006) at Penn State demonstrated that **dodder uses volatile chemical cues to locate host plants.** *Cuscuta pentagona* showed positive tropistic growth towards a volatiles from tomato plants.



When confronted with a **choice between tomato and wheat**, the dodder made a quick move towards the poor tomato plant. Ah, c'est la vie!

# Plants can feel and respond faster than insects



The Venus flytrap *Dionaea muscipula*, is a living fossil of a carnivorous plant that catches and digests animal prey. When an insect or spider crawling along the leaves contacts a hair, the trap closes if there is a second contact within twenty seconds of the first strike. Counting "two" strikes in sequence makes it likely that the cause is a moving object that is alive. Plants can count!

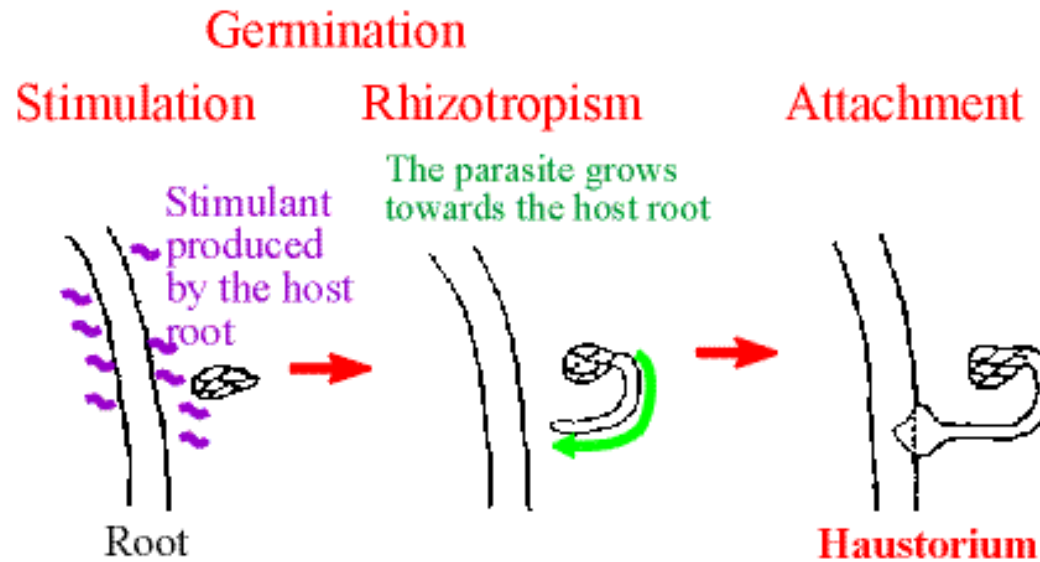




**Leaflet folding in  
*Mimosa pudica*  
photographed at 2 s-  
intervals after touching  
the leaf tip closest to the  
observer with a wooden  
stick of  $r = 0.5$  mm.**

# Plants that can taste!

## Underground development and early development stages of the parasite



Seeds of *Orobanche*, *Striga* and *Alectra* are dormant and require a period of afterripening in warm, dry storage, followed by conditioning in a warm, moist environment. Then they will **respond to germination stimulants in the soil**. Chemical signal ; non-volatile → taste

# Features usually not associated with plants



Plants can adapt to be **predators** of animals (carnivorous plants, Dionea, Nepenthes) or plants (dodder Cuscuta, strangler figs Ficus)



Plants can form lenses to **focus light** not for a sharper vision but for more efficient light use in photosynthesis.



Plants can adapt to very **fast movements** based on their ability to contract tissues through rapid turgor loss. Animal cell contraction is based on protein interaction (e.g. actin/myosin) which plants use only for intracellular streaming etc.



Plants **move quickly over large distances** (Indians could tell of encroachment of their territory by whites by appearance of plantain



Plants can use **mimicry in phenotype & odor** to force animals (insects most but also YOU) to participate in their reproduction

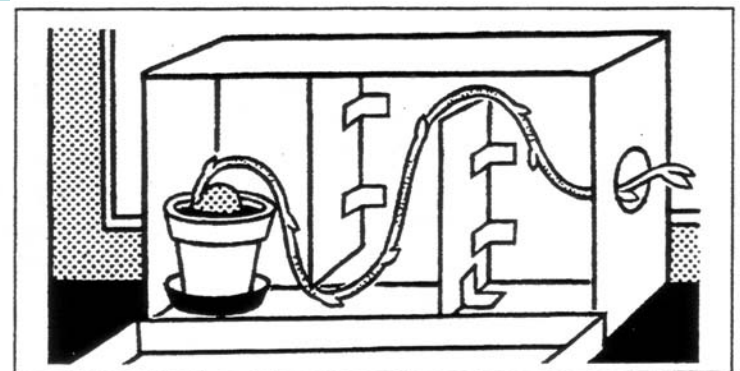
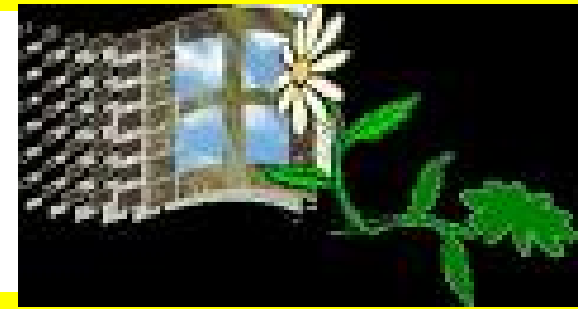
## Plant behavior ?

Many books deal with animal behavior (Ethology). Although plants can move in certain directions they are rooted; i.e. unable to translocate (1). Although plants respond to stimuli, this response does not involve a brain or nervous transmission (2). *Do these two facts exclude behavior?*

The science of “**Plant behavior**” has not been established. It needs the implementation of rigorous tests of features like

**recognition of “self”**: asexually propagating plants like strawberries will not intrude into each other’s root space. What happens if you disconnect the runners and create individual plants?

“**Plant intelligence**”: It needs more than just to show that plant will find a hole from where the light penetrates into a dark box. It needs offering of real choices equivalent to the maze of rat testing.



# Plant Electricity: The Shocking Truth!

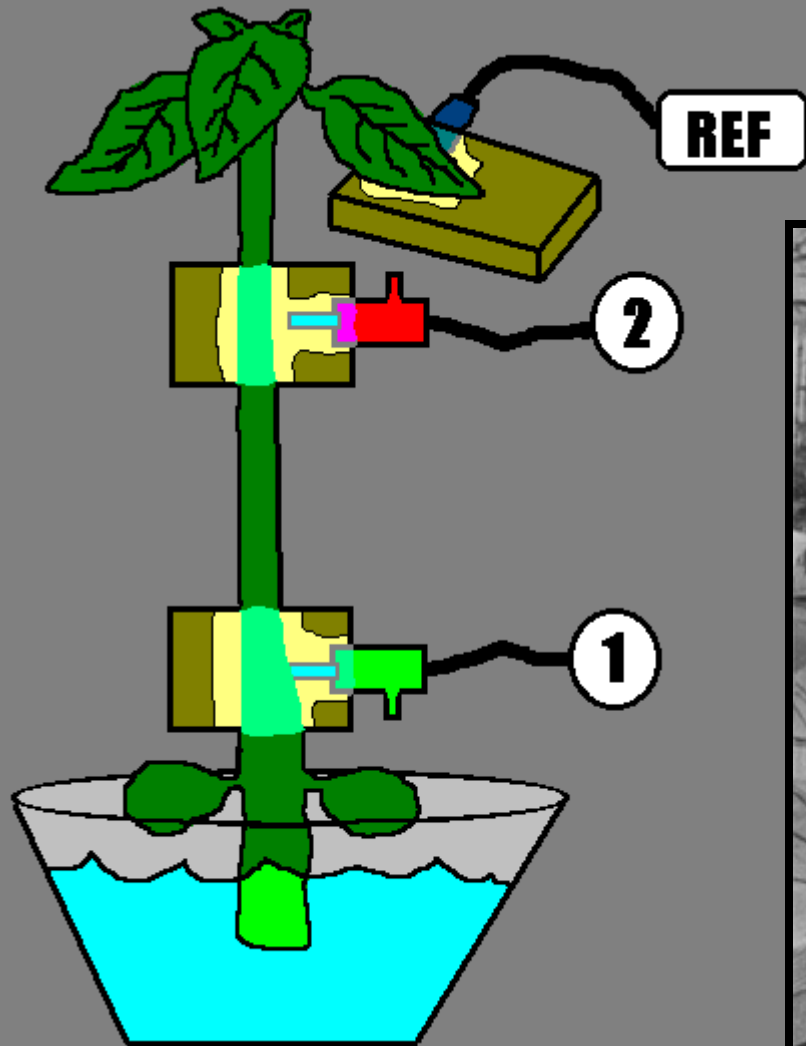


*Mimosa pudica*,  
the “Sensitive Plant”

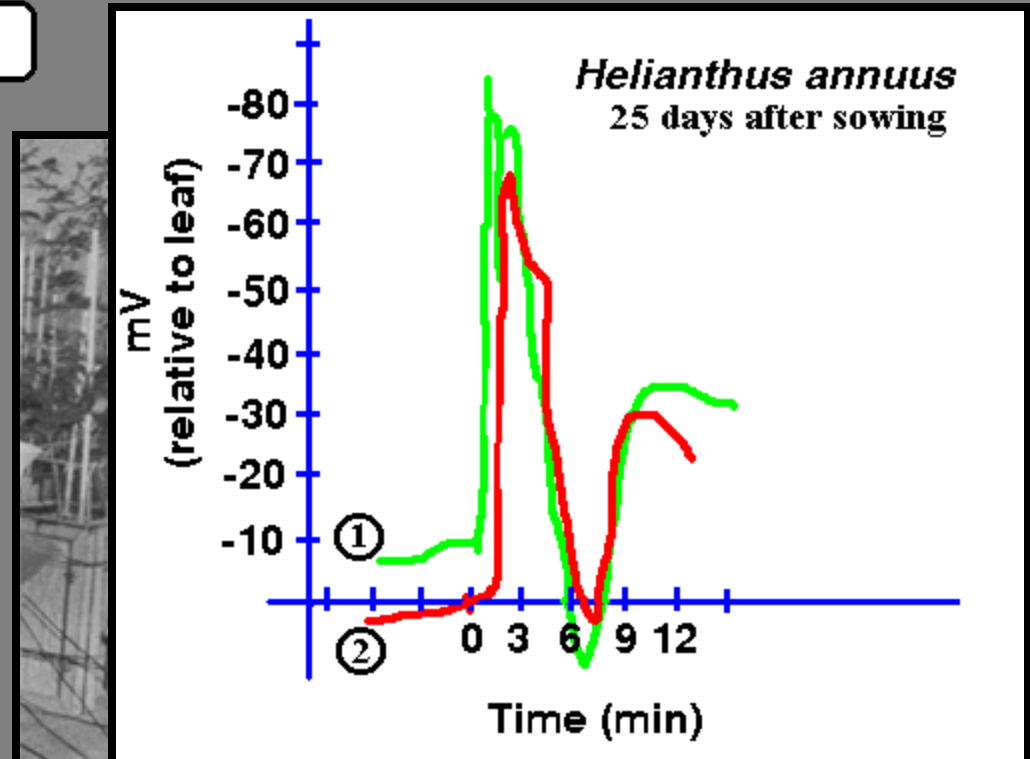
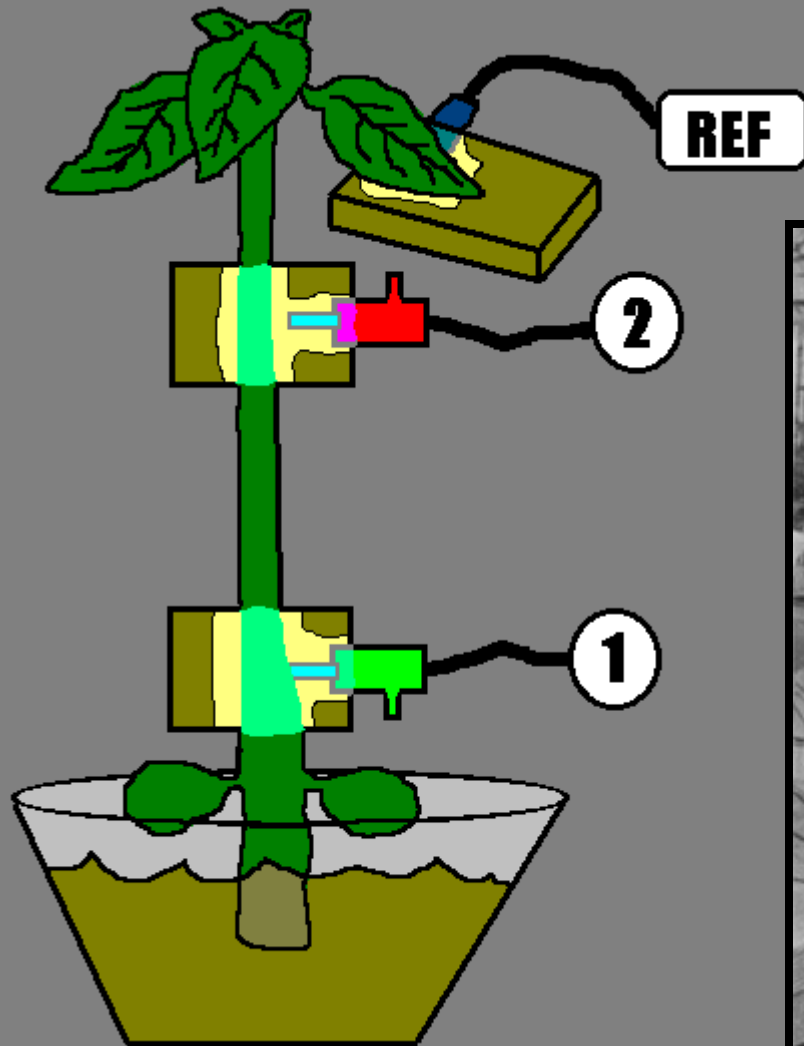


*Dionaea muscipula*  
“Venus Flytrap”

# Measuring Electrical Responses



# Measuring Electrical Responses



# Plant Ethology? - Do plants have behavior?

Behavior of animals is defined as either *inherited sequence of actions triggered by defined clues & situations & directed to a certain purpose (instincts, fixed-action patterns; I)* + *changeable actions qualifying as learned behavior (II)*

*reflexes*: touch of certain spots, nerves (**clue**) involuntary muscle contraction

*instincts*: red color (**clue**) triggers attack of stickling fish, pecking of seagull chick

**learned behavior:**

*habituation* (animal learns to ignore repeated stimuli that are w/o consequence  
*trial-&-error learning = conditioning* Pavlov's dogs connecting bell with food  
all training systems that rely on punishment or reward ( child care)

**time orientation:** how to read the time of the day / year; **social behavior:** rang

**feeding behavior:** how to find food while avoiding predators

*Which examples fit plant behavior?*

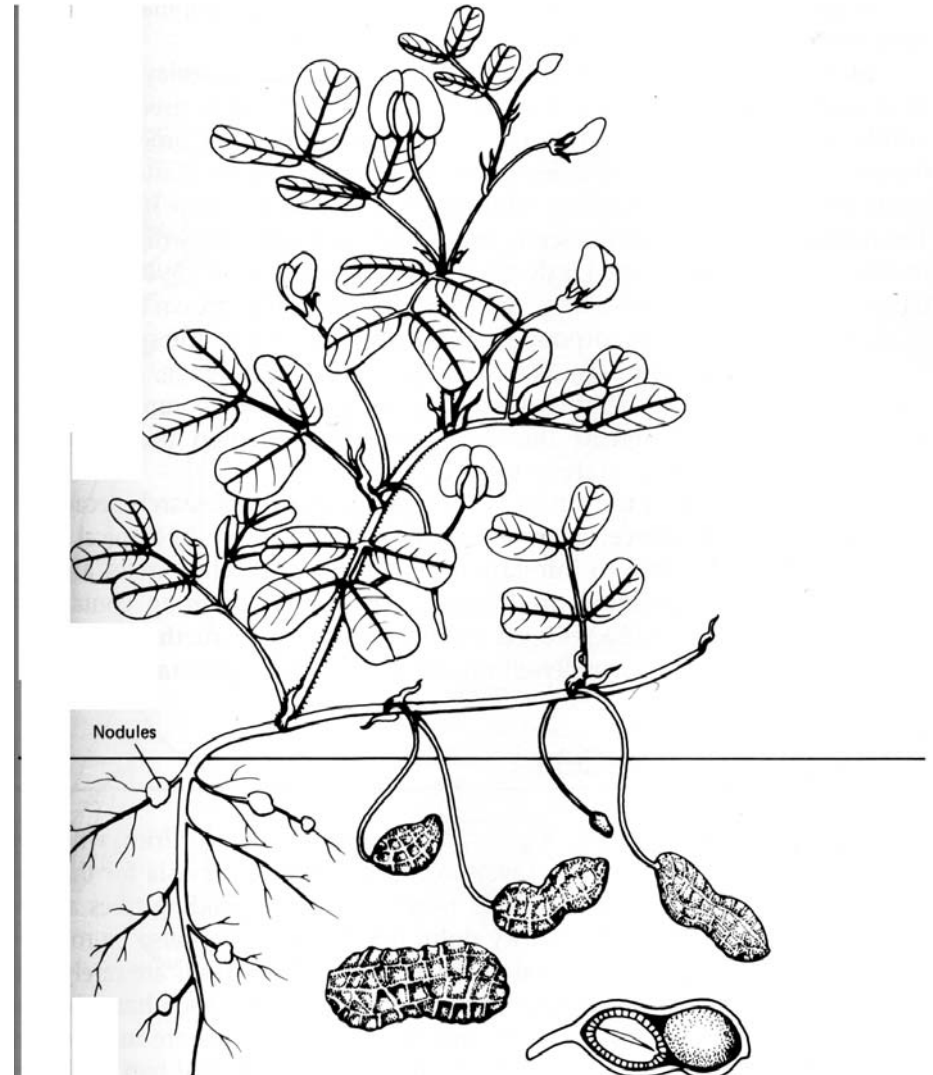
**Establish criteria qualifying behavior! Test these criteria** for sleep movements of leaves, fall burial of buds in Rubus, leaf abscission in autumn, heliotropism, phototropism, gravitropsim, timing of flower opening & closure, of scent release, color change of petals, sensing of support in vines, tendrils, climbing epiphytes, parasites, hemiparasites



# Principles & concepts of plant ethology?

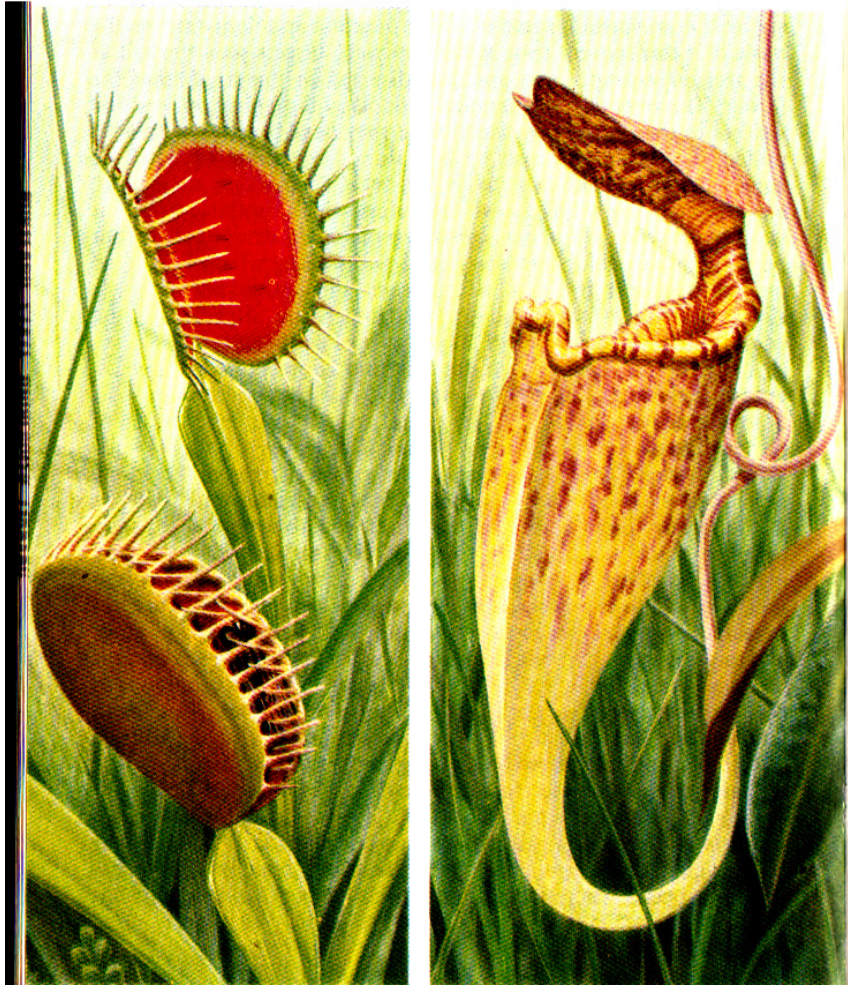
Ethology was useful in establishing common lines of animal behavior but was always polluted by the idea that humans are something special, that human thinking applies to animals (anthropology). It never attempted to define general principles & its presence in other kingdoms. **This still has to be done by anybody to explore this area!**

After fertilization, the flower pedicels of peanuts curve down grow deeper into the safe soil



# Insects as N-rich particles from the air

## Dionaea & Nepenthes mimic flowers to attract insects



Insectivorous plants are an example of how far evolution can drive plants towards animal-like behavior

(Darwin: Dionaea - most animal-like plant!”

1. Simulate flowers in color, smell
2. Increase movement speed to . . .  
. . . insect standards
3. Digest animal matter in cavities .  
. . that resemble stomachs in shape,  
. . low pH + proteinases that are . .  
. . . . identical to those of animals.

# Principles & concepts of plant ethology!

**Reflexes:** Although plants do not have muscles & nerves they show reflexes like the Venus fly trap, mimosa, Oxalis & many others.

Plants change their lifestyle switching from annual to biennial life style, from sexual propagation to asexual propagation, to vivipary, from insect pollination to cryptogamy (violets)



**Recognition of Self:** it was found that fungal hyphae can manage to find food in a maze, that they recognize other hyphae as self or non-self (serious stuff), that similar rules apply to roots that were first part of the same plant and later part of a separated individual. Plants gave readings on a lie detector (GSR = galvanic skin resistance, not generally accepted)

**Mimicry:** Plants show many kinds of purposeful mimicry: seeds of rye (wheat mimicry), Commelina vulgaris (flax mimicry), bee orchid (insect mimicry), window plants (stone mimicry) to iraise their odds in selection

## Irritability in Plants - behavior

Some plants show fast movements, others show the same but slower + therefore draw less attention. Some still wait to be discovered, e.g. think of the nice undulating wave in wheat fields or grass prairies.

**“Hydroscopic movements”** occur both in living & dead pl parts (TG): Teeth in moss spore capsules, spores of mosses & horsetails, *Erodium* seeds, bean & pea pods, “Rose of Jericho”, dried composite heads like Carline thistle, show that the plant is master of this construction.

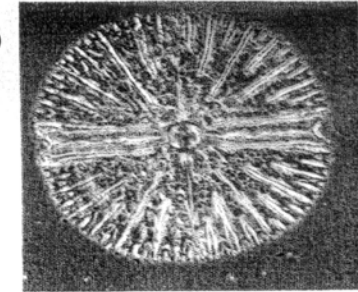
**“Turgor movements”** are rapid leaf movements in *Dionea muscipula* Venus flytrap, *Mimosa pudica*, the compass plant *Desmodium gyrens*, but also rapid movements of the style of *Centaurea cyanus* Bachelor button, stamens of *Berberis* bend inward to dust the bees. Compare this to the slow sleep movements of leaves in *Phaseolus*, *Oxalis*

**“Contraction movements”** are known to be the basis of animal muscle cells and their movements but are considered rare in plant cells that have a stiff cell wall around them. In *Spirogyra* – a green alga – the protoplasm contracts but it has no consequences for the cell length.

# What the .. Is a plant??

## What the ... is a plant?

→ any member of the kingdom  
Plantae



Microcrasterias

*typically characterized by:*

(1) *Lack of locomotion (rooted)*

(2) *absence of sensory organ*

**(3) Lives through  
Photosynthesis**

(4) *alternation of sexual vs.  
asexual generations*



# Parasitic Plants

A **parasitic plant** derives some or all of its sustenance from another plants or fungi (4,100 species in approximately 19 families). **Parasitic plants have a modified root, the haustorium** that penetrates the host plant and connects to the xylem, phloem.

**1 Facultative parasite** – a parasite that can complete its life cycle independent of a host & has a huge range of hosts (*e.g. Pedicularis*)

**2. Holoparasite** – a plant that has no chlorophyll & is completely parasitic on other plants (*Rafflesia, Cuscuta, mistletoe*)

**3. Hemiparasite** – a plant that is parasitic under natural conditions and is also photosynthetic to some degree. Hemiparasites may just obtain water and mineral nutrients from the host plant. Obtain at least part of their organic nutrients from the host as well (*Castilleja, Mycelis muralis, snow plant Sarcodes*)

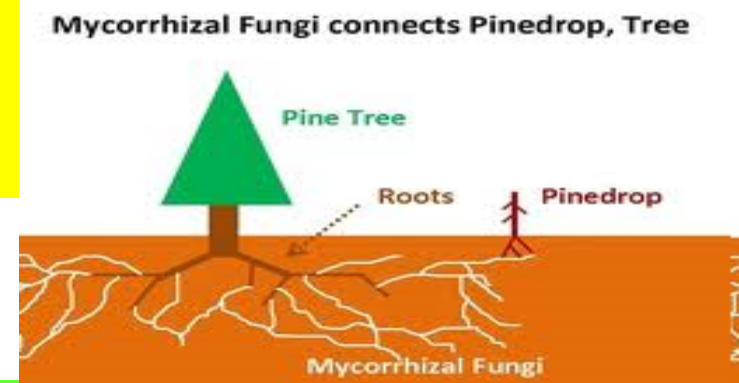


# Beware of chlorophyll-free plants → they are like animals



**Pinedrop** = *Pterospora andromedea* grows in coniferous forests native to North America. It is in the family **Ericaceae**. The upper portion of the red stalk has a series of yellowish, bell-shaped flowers face downward.

They exist for most of their lifecycle as a mass of fleshy roots in relationship with mycorrhizal fungi that is described as either parasitic by different experts. They are thus described as mycorrhizal heterotrophs.



**Coralroot orchids, *Corallorhiza***, are leafless, relying entirely upon symbiotic fungi within their coral-shaped roots for sustenance. Because of this dependence they cannot be successfully cultivated. Most species do not produce chlorophyll, and do not depend on photosynthesis for energy.

Holoparasites have virtually no chlorophyll & are completely parasitic & include 4,100 species in 19 families of flowering plants

## Beware of chlorophyll-free plants → they are like animals



**Indian Pipe or *Monotropa uniflora***, also known as the **Ghost Plant**, is a herbaceous perennial, classified within the **Ericaceae**. It is native to temperate regions of Asia & North America. Unlike most plants, it is white and does not contain chlorophyll. Instead of generating energy from sunlight, it is parasitic, more specifically a myco-heterotroph. Its hosts are certain fungi that are mycorrhizal with trees, meaning it ultimately gets its energy from photosynthetic trees. It can grow in very dark environments as in the understory of dense forest. The complex relationship that allows this plant to grow also makes propagation difficult.



**The Snow Plant or *Sarcodes sanguinea*** is a flowering plant in the heath family. It is a parasitic plant that derives sustenance and nutrients from mycorrhizal fungi that attach to roots of trees. Mycorrhizal fungi are themselves symbiotic parasites that help plants fix nitrogen from the atmosphere in exchange for nutrients from plant roots.



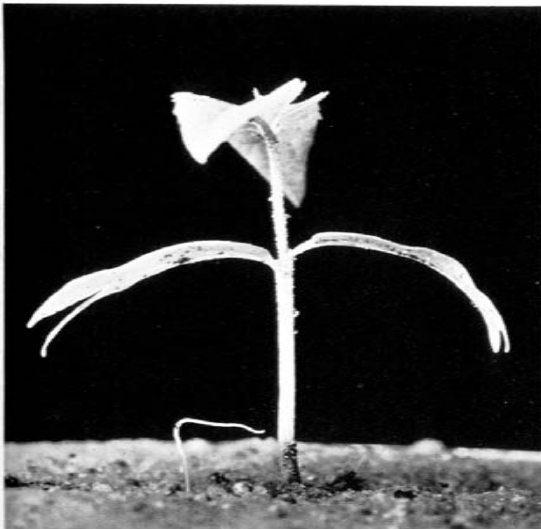


# The only plants that does the locomotion ....

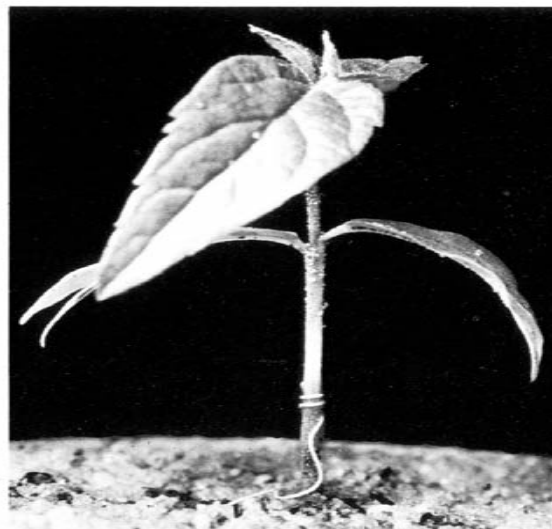


*Cuscuta* (Dodder) about 100 species of yellow, orange or red (rarely green) parasitic leafless (minute scales) plants placed in the morning glory family, **Convolvulaceae**.

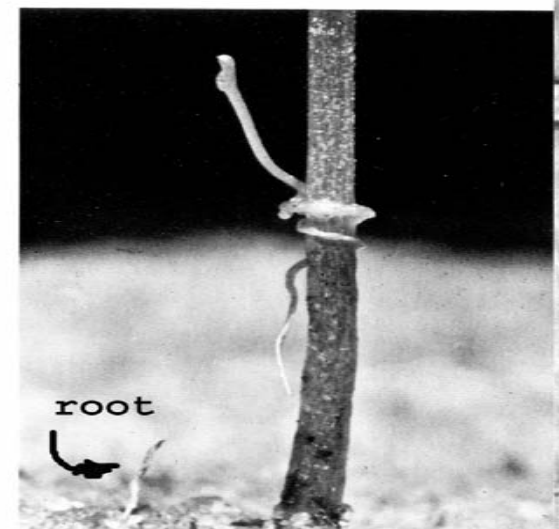
The seeds are minute and produced in large quantities. They have a hard coating, & survive in soil for 5–10 years. **Germination** can occur without a host, it zooms in on the **smell** of nearby plants



1. germination with flexible stem smells the host plant

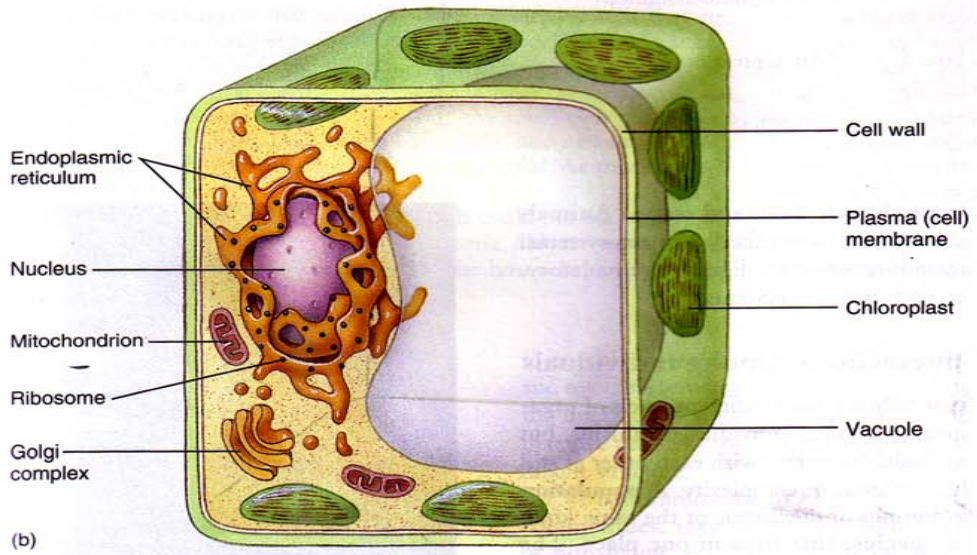
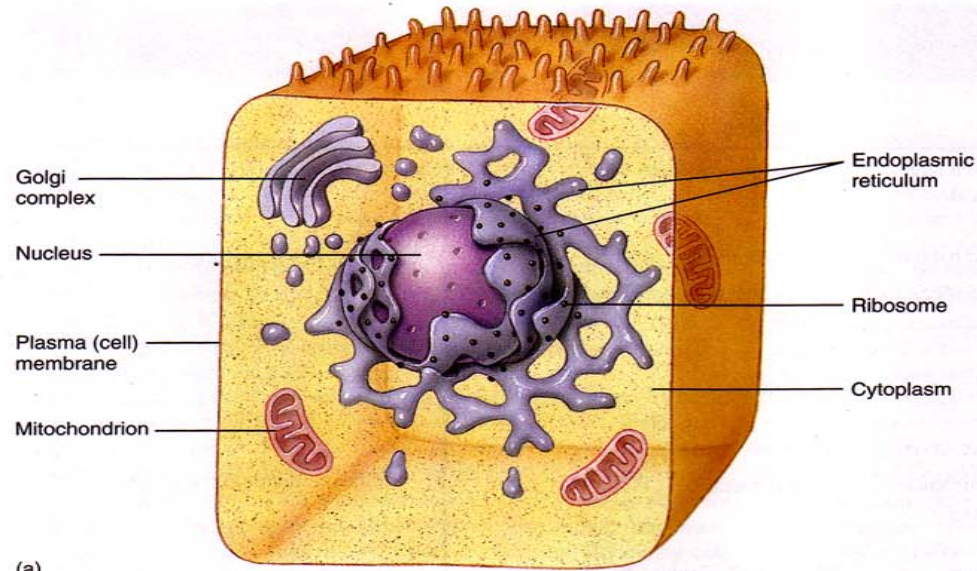


2. after 12 h it is already solidly attached to the host



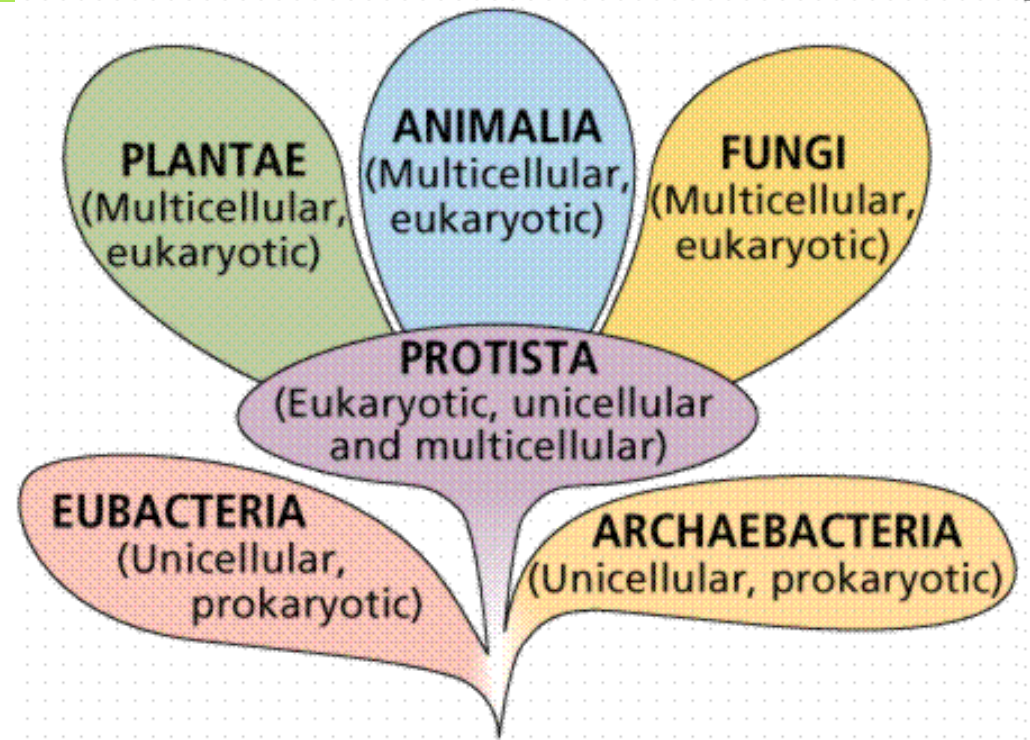
3. One week later it has haustoria in the host & abandons root

# animal versus plant cell ?



name differences !

# 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

**A plant is a member of the kingdom of Plantae and that is that.**

# What is that?

Is that a plant? Is that a fungus? Is that a lichen? What the ...halloh!



Star stinkhorn *Aseroë rubra*, an Australian/Pacific **species of fungi** which spread to Europe & North America



The ghost plant *Monotropa uniflora*, also Indian pipe is chlorophyll-free **parasitic herbaceous perennial plant**, in the Ericaceae like heather & huckleberr



*Frog Pelt* or *Peltigera neopolydactyla* - A large, loosely appressed leaf lichen; lobes broad, 10-25 mm wide; upper surface hairless, olive-green to pale or dark

visit

<http://waynesword.palomar.edu/ww0504.htm>

# What is that?

Is that a plant? Is that a fungus? Is that a lichen? What the ...halloh!



**Spanish moss** (*Tillandsia usneoides*) closely resembles its namesake (*Usnea*, or beard lichen), but in fact it is not biologically related to either mosses or lichens. Instead, it is **an angiosperm plant in the family Bromeliaceae** that grows hanging from tree branches in full sun or partial shade



**Usnea is a lichen** (a composite organism made from algae and fungi) and is referred to as **Old Man's Beard**. It looks very similar to Spanish moss, so much so that the latter plant's Latin name is derived from it (*Tillandsia usneoides*, the 'Usnea-like Tillandsia').

# Personal Botany

## *What is a plant to you?*

*This question addresses your way of relating to plants.*



Did I forget something that you consider important?



Do you need the mystery of plants, forests, jungle, meadows or fields?

Do you need woods or Parks to wind down? Can you live in the prairies?

Do you consider plants as mystic beings that are your direct teachers? Ayahuasca?



Do you need the medicine that grew in the earth within the root of a special plant?



**the plants**



**they tell me fings**

## Botany of Desire Mike's View

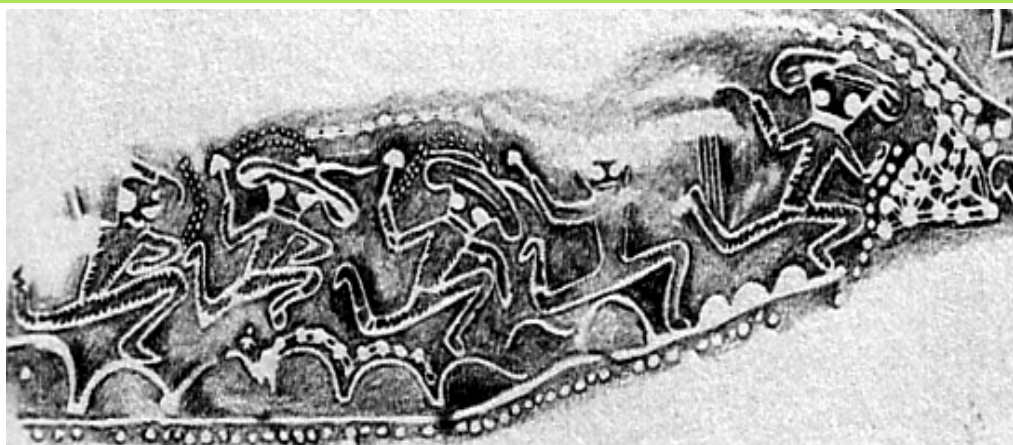
*Botany of Desire: A Plant's-Eye View of the World* is a 2001 nonfiction book by journalist **Michael Pollan**. This work explores the nature of domesticated plants from the dual perspective of humans and the plants. **Four types of human desires** are reflected in the way that we grow, breed, and genetically engineer our plants. The **apple** reflects the desire of sweetness, the **tulip** beauty, **marijuana** pleasure and the **potato** sustenance.





# Plants as origin of medical & psychological experimentation in humans

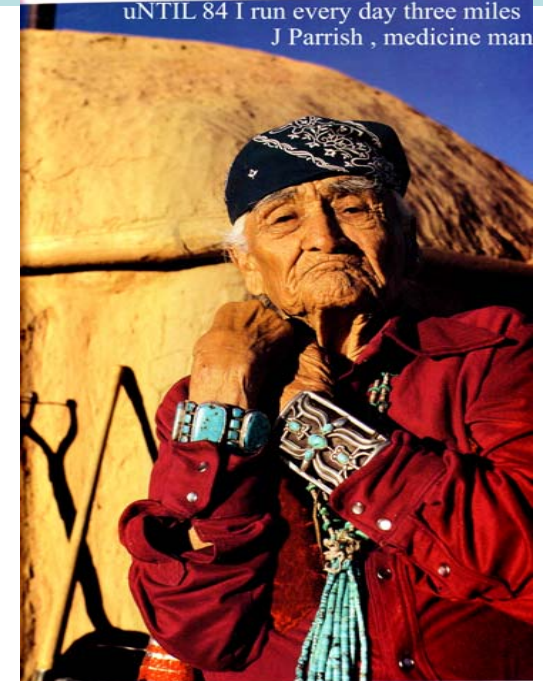
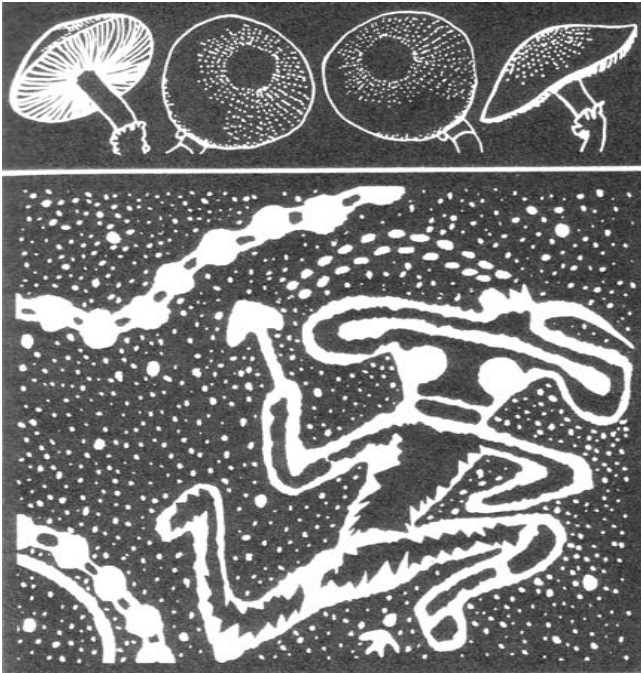
The first hallucinogens humans encountered in the African savannah: were psilocybin-containing **magic mushrooms** (*Stropharia cubensis*) settling dung of hoofed beasts (zebus) and hemp (*Cannabis sativus*) – a multi-use plant luxuriating on human dung piles. The alkaloid **psilocybin excites acuity, self-reflection, cultural activities and vocalization that might have stimulated language** – w/o doubt more important for plant gatherers than stealthy hunters.



Tassili plains in the Sahara 30 ka ago – was possibly the “Eden” (McKenna)



# Medical & psychological habits



***Use of hallucinogenic plants may have stimulated cognitive activities of pre-humans and stimulated strikingly new rituals and habits (dancing, singing, extended vocalizations, painting, symbols, meditation, induced dreaming), some evidence from rock paintings in the Sahara's Tassili plains  
→ culture and spirituality***

**REF: Terence McKenna (1992). Food of the Gods. The search for the original tree of knowledge. Bantam Books, New York.**

"Indians" cultivated two species of tobacco



Mayan Priest  
blowing smoke



Nicotiana rusticum & Nicotiana tabacum



"Indians" using both pipe & rolled leaves  
as well as "fire" to produce smoke!



Despite James I's characterizing tobacco smoking as "A custome lothsome to the eye, hatefull to the nose, harmefull to the braine, dangerous to the lungs, and in the blacke stinking fume thereof, nearest resembling the horrible Stigian smoke of the pit that is bottomless" (*Counterblaste to Tobacco*), the British continued to smoke and went on to develop the genteel art of blowing smoke rings.

# What is a plant spirit? ask this old shaman

In all cultures plants have been seen as having an invisible inner essence or spirit. Plant spirit medicines are mood changing & can evoke joy & tranquility. They may effect body & mind, they may be essential oils, homeopathic dilutions, smells ..



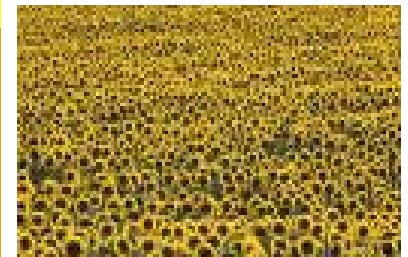
Before we reap the benefits we need to cultivate respect for the plants. Plant are living beings with unique personalities that we have to explore.



**One founding principle of shamanism is that plants & humans can communicate.**

**What does such a claim mean?**

That plants are natural does not mean safe & gentle. On the contrary they are the biochemical master kingdom & we profit from the fact that we share common threats!



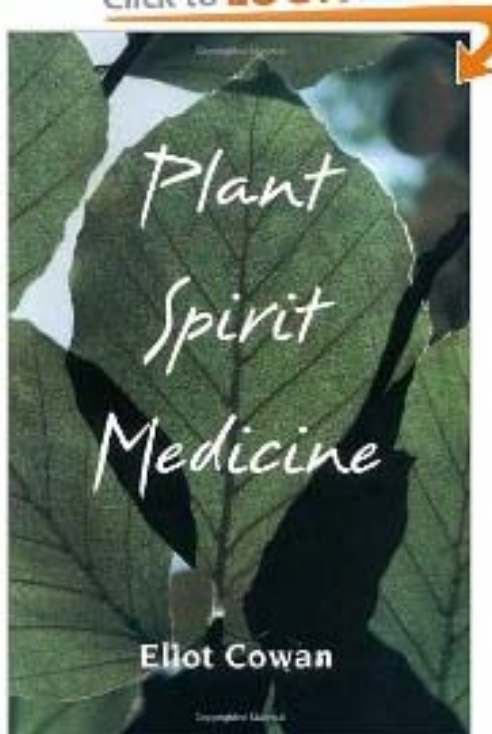
**C G Harvey & A Cochrane (1999) The healing spirit of plants. An illustrated guide to plant spirit medicine. Sterling Publ., Hongkong**

# Plant Perceptions & Emotions



**Elliott Cowan** and before him many Amazonian healers claim that you do **not need to study herbalism** since the herb will only help you if you asked her to and establish communication.

The plant's spirit will tell you how to proceed.



## Chinese Fleece Flower *Fallopia ssp.*



The Chinese Fleece flower is in the genus *Fallopia* in the family Polygoniaceae, a relative of the infamous Japanese Knotweed *Fallopia japonica*. The Chinese use this plant in their traditional medicine for kidney health, strong bones and hair restoration, and as a mild laxative, and it's.. Hey, wait a second...

“ I tell you, ...  
it is a sign, yeah, ah ...  
it's an omen!” The end of  
the world is close, oh Rose

Okay, weird. It's a root that looks like a little dude. But that's a rare, onetime fluke, right? It's not like that's what this species *typically looks like* or anything?? Roots making a perfect couple made headlines in 2006 .... →





aura or unseen entities  
identities seen in totem poles

## Aura-reading exercise:



Spring wolf's spiritual education network

<http://www.paganspath.com/meta/auraex.htm> offers

**Aura reading exercise:** Practice is the key to developing any new skill. Spend at least 15 to 20 minutes on each exercise. Don't lose patience with yourself, just keep trying.

**Trust your instincts.** Sit in front of a potted plant. Choose a spot near the top or at the base of the plant. Let your eyes go out of focus. Look beyond the plant, as if you're focusing on an object hanging from a branch or leaf. *You should begin to see the white inner-aura of the plant.* Keep your focus on the white aura and try moving your perception around to the opposite side of the plant. You might try placing a small lamp behind the plant, to illuminate it's leaves and branches. Avoid to see the bulb. This illumination can help trick your physical sight to focus on the slight reflection of the light that may grow wider and soon you'll realize that what you're looking at is a colorful aura. You should see if the plant is healthy or it's beginning to develop physical problems.

# What is a plant teacher? ask this old sha

Tree spirits guided the deliberations of Nordic & Germanic peoples held council under oaks (*Quercus r*)

Osha (*Ligisticum porteri*) was the major bear medicine of the Sioux, bear itself was teacher about healing plants

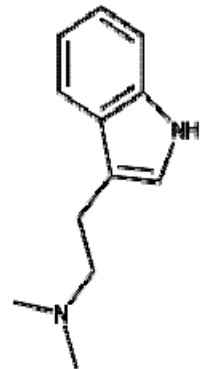
The ancient Greeks believed that their herbal knowledge was handed to them by the centaur Chiron!

Tribes of the Amazonian jungle regard a plant called ayahuasca *Banisteriopsis coapi* their professor of medicine. A tea from this plant gives them visions of the healing power of other plants. Active ingr. is dimethyltryptamine - a hallucinogenic indole

Also Australian aborigines discovered through their dream time how to capture the healing power of plants



...the centaur Chiron reveals secrets of plants to ignorant humans ...





# Plant Magic? ask this old shaman



**Christian Friedrich Samuel Hahnemann (1755-1843)** found 1. that an extract from cinchona bark taken by a healthy person (or animal) causes the *same symptoms* as *in disease malaria* against which it is used as a *remedy*.

H. postulated **healing principle**: "that which can produce a set of symptoms in a healthy individual, can treat a sick individual who is manifesting a similar set of symptoms." This principle, short version is *like cures like*, became basis for an approach which he gave the name homeopathy.

**2. Principle:** If miniscule, *diluted amounts of the same cinchona* extract are taken a day or two after the inhalation of initial full-bodied extract, this miniscule dosage was found to *turn the symptoms off*.

*Will a declining presence of the causative substance be sufficient to switch disease off? Is it true that less is better than a constant amount of remedy?*

Homeopathy uses similar remedies as herbalists. The defining signature, however, is for a herb to cause similar symptoms? This could be called a new, more practical formulation of a **doctrine of signatures**.

# Plant indicators reflect soil they grow on

**Submersed plants:** Elodea, Potamogeton, Ranunculus aquatilis, Alisma, Sagittaria, Myriophyllum, Callitriche

**Floating plants:** Lemna, Nuphar, Pondweeds

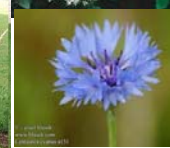
**Near-water plants:** Equisetum limosum (swamp horsetail), Typha, scirpus, Iris, Nasturtium, Juncus, Spiraea, Acorus calamus, Caltha palustris :

**Acid soil (low pH):** Campanula (bellflowers), Calamagrostis lanceolata, Centaurea cyanus, Lycopodium, Matricaria, Veronica

**Alkaline soil (high pH):** Geum (also wet), Lithospermum, Potentilla, Sedum, Thlaspi, Trifolium repens

**Calcium (high pH):** Anemone, Aster alpinus, Convallaria majalis, Carex, Gentiana, Sorbus, Trifolium, Lactuca, Viburnum

**Sand:** Antennaria, Calluna, Equisetum arvense, Erigeron canadensis





**Some plants have been around since the beginning of recorded time (3000 BC): they saw the building of the pyramids, the rise and the fall of Rome, the Mongols, the USA and USE, they saw it all ....**

**Plants are phylogenetically (i.e. as a life form) & ontogenetically (i.e. as individuals) much older than we are, some older than our entire civilization. What does longevity mean for a species?**



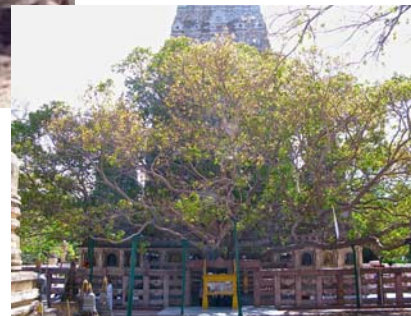
**The Hunza** – a tribe in the mountains of Pakistan – reach often 100 to 120



Adwaita, a Aldabra Giant Tortoise died at the age of **255** in March 2006.



***Pinus aristata*** – the **Bristle cone pine** lives high in the mountains of Colorado & is proven to reach 5000 years



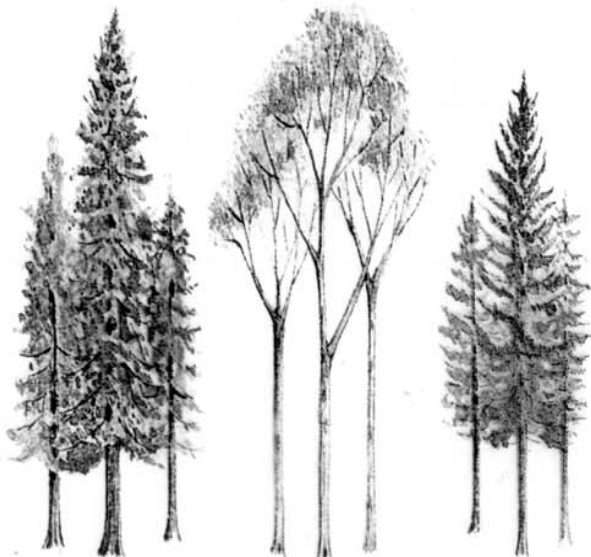
A Sacred Fig (*Ficus religiosa*) specimen, the Sri Maha Bodhi, was planted in 288 BC & is 2,293 years old, oldest flowering plant.

**Pando The Trembling Giant**) is a clonal colony of a single male **Quaking Aspen** (*Populus tremuloides*) in Utah with one massive root system, The plant is estimated to weigh collectively 6,000 tonnes making it **the heaviest known organism and the oldest known living organisms in existence at 80,000 years of age.**<sup>[5]</sup>

# Trees bare witness to bygone times

Trees reach back many ages, the mammoth tree “General Sherman” is older than Jesus. They bare witness to local disasters like fire, drought, earthquakes, and the arrival of the second & third peoples

Sylvan skyscrapers

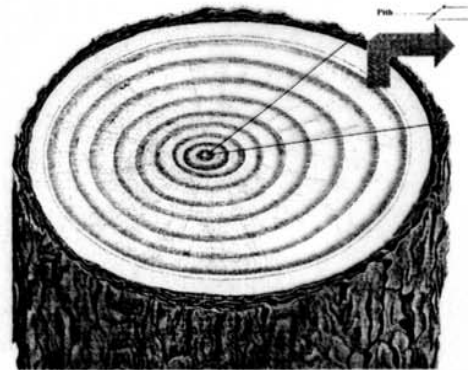


Redwood sequoia  
*Sequoia gigantea*

Giant eucalyptus  
*Eucalyptus ssp.*

Douglas fir  
*Pseudotsuga m*

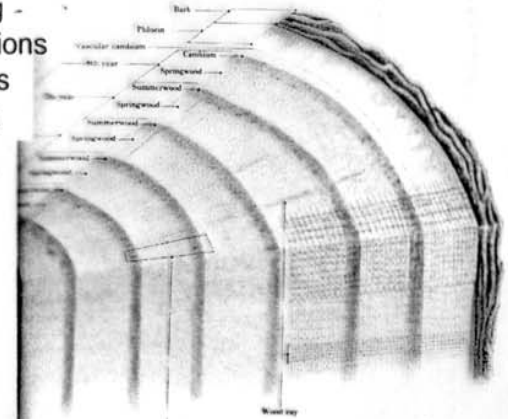
Growth rings in trees provide a living - climate record for the temperate regions of the planet that goes back as far as the age of the tree ... thousands of a



A living climate record

Growth rings not only reveal a tree's age but also record what the weather was like in each year of its life. A wide growth ring indicates that rainfall was plentiful, allowing the tree to grow rapidly. A thin ring indicates drought, when there was little water to spur

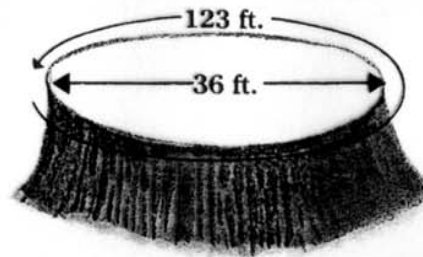
growth. Sometimes growth rings are irregular, growing faster and wider on the south side, where there is plenty of sunlight (right). Fossil tree stumps give evidence that the Earth's climate has changed many times over the last several hundred million years.



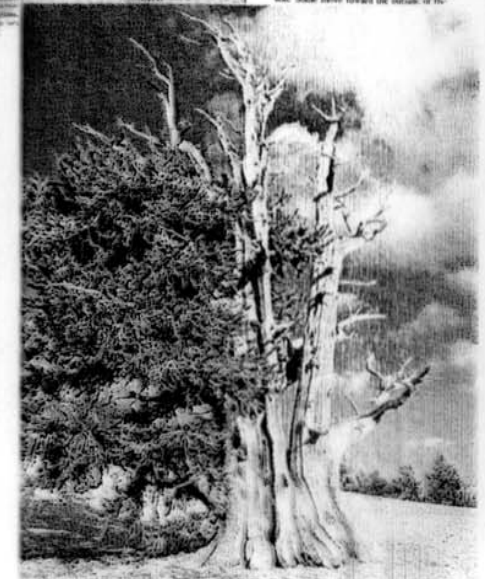
Forming growth rings

The main parts of a tree trunk are not used above and document its growth. Bark forms the protective outer layer. Just inside the bark is a thin layer from which new bark forms. This layer contains the vascular bundles with a thin layer of phloem (yellow) and xylem (white). The thin phloem layer is often mistaken for part of the bark. Between the phloem and the xylem lies the cork cambium (green). Another cambium layer, one cell thick (like brown line), is virtually invisible, yet this is where the tree trunk is growing. Cambium cells divide constantly during the growth season. Some move toward the outside of the

## General Sherman's vital statistics



Diameter: 36 ft.  
Circumference: 123 ft.  
Height: 272 ft.  
Age: 3,500 years



A bristlecone pine in California

# Annuals, biennials, perennials & really old plants

Species	Age (years)
Bacteria	20 min
Annuals	1
Biennials	2
Alnus	100
Malus silv.	200
Fraxinus ash	300
Juglans walnut	400
Ulmus	500
Larix larch	600
Abies fir	800
Fagus beach	900
Picea spruce	1000
Quercus r oak	1200
Castanea	1500
Taxus yew	> 2000
Sequoia	4000
Pinus aristata	
bristlecone pine	6000
arctic lichens	>20 000

Some bacteria divide after 20 min existence & hence never age or die but grow to 13 Mio Mio cells /d. → in line this means length inc from 1  $\mu\text{m}$  to 13 000 km algal cells (diatoms) live 5 days, yeast cells can live already 3 weeks.

**Single-celled organisms** have short life span & do not end their life as a corpse since they often directly continue life in the form of 2 daughter cells

Long life time is feature of **multicellular organisms**, which cannot continue their life as an individual but end it with the production of a multicellular corpse. This applies to both plants & animals.

In plants they oldest creatures are the largest → trees  
in animals this is not so, turtles can outlive whales

# Perennials

*Most flowers that you plant as seeds in the spring are annuals. You must save the seeds to regenerate the species in the next spring: gladiolus, salvia, marigold, zinnias, snapdragons, sweet peas Lathyrus*

## Annuals

Annuals: gladiolus, red salvia, marigold, zinnia, snapdragon, sweet peas Lathyrus



gladiolus red salvia marigold



zinnias snapdragon Lathyrus

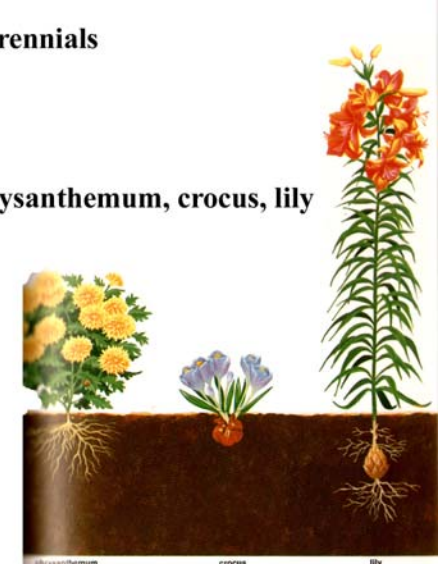
## Perennials

Some Perennials

delphinium, tulips, Iris, chrysanthemum, crocus, lily



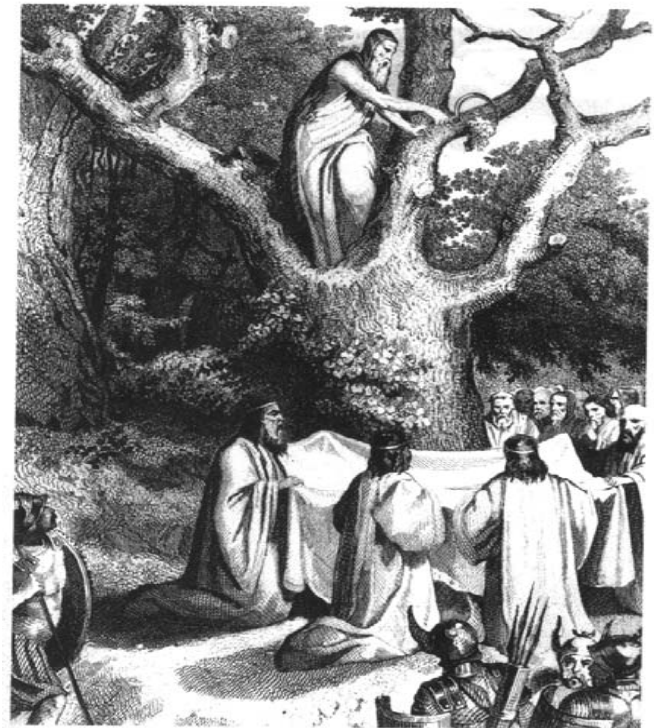
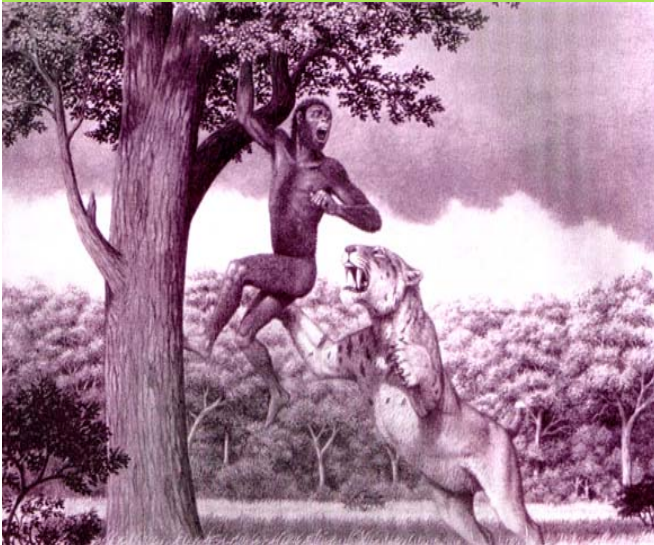
delphinium tulips iris



chrysanthemum crocus lily

*Some flowers do not have to be planted as seeds every year. You plant them just once & they will bloom every year → they are perennials They survive as geophytes (bulbs, corms, rhizomes, tubers, buds) & need some protection during the cold winter weather: lilies, tulips, crocus, iris, chrysanthemum, delphinium (most crowfoots)*

# Trees of life – ethnobotanical archetypes



Humans are unconsciously aware of trees as their original habitat and refuge from predators. Trees are the largest and longest living beings on the face of the planet. According to Carl Jung this might explain the concept of trees as the source of all life (archetypes)

*Arrière de l'Arbre qui porte des feuilles, lesquelles tombées sur terre se tournent en oyseaux volants, & celles qui tombent dans les eaux se muent en poissons.*



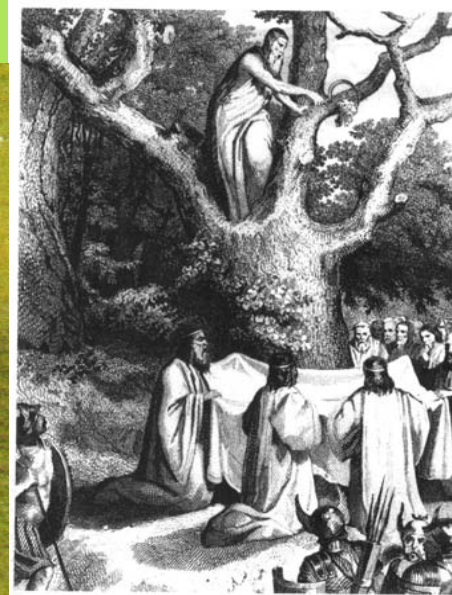
*(Courtesy of Missouri Botanical Garden.)*



# Plants & People - Mystical features of plants

**Tree -a life form different from humans and animals**, from small seeds can arise huge plants, seeds germinate and plants grow only when in contact with the earth (Antheus) trees reach a much older age than humans or any known animals outlasting many of their generations and is able and predestined to record life, events and accumulate wisdom: *Ficus religiosa* in India, *Quercus robur* in Germania

==> **Circle and Tree of life** are most common, universal symbols - “archetypes of the collective unconsciousness of mankind” (Carl Jung 1956). Both symbol in seeds.



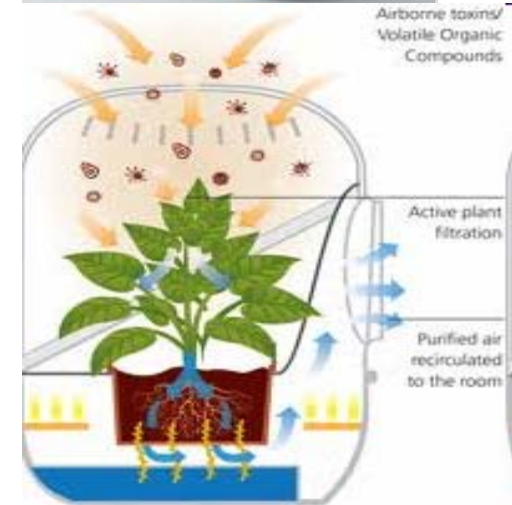
Islamic symbol Ricinus seed Celtic oak/mistletoes Hindu gods + banyan

# The mystic feature of plants to improve the air we breath

## *Sansevieria trifasciata* Mother-In-Law's Tongue:

The best Bedroom plant since it converts a lot of CO<sub>2</sub> (carbon dioxide) to O<sub>2</sub> (oxygen) at night, you could live in a completely air sealed room if you had **6-8 waist high snake plants** The snake plant also removes formaldehyde from the air.

Areca palm removes xylene and other organic volatiles from glues. No need to divorce your hobby-airplane partner.



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

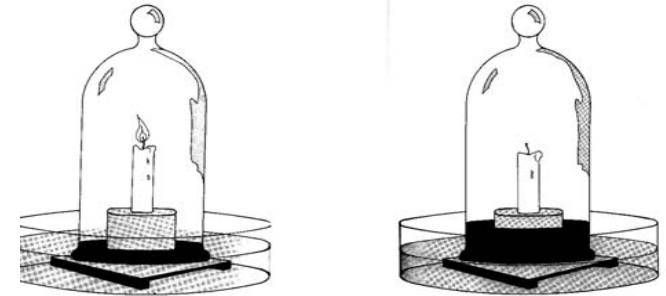
The Bel-Air indoor air filtration systems suck in dirty air and run it through a plant's leaves, roots, and a "humid bath" before releasing it back into your room, purified.

# A Planet without Plants is a dead Planet

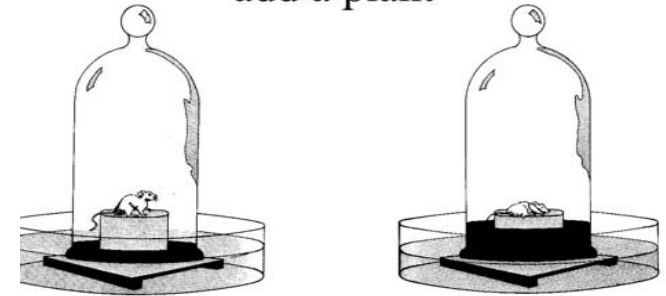
John Mavow 1640-79  
**Joseph Priestley** 1733-1804 showed that there is something in the air that keeps candles & animals going

**Fire and animals spoil air → oxidation**

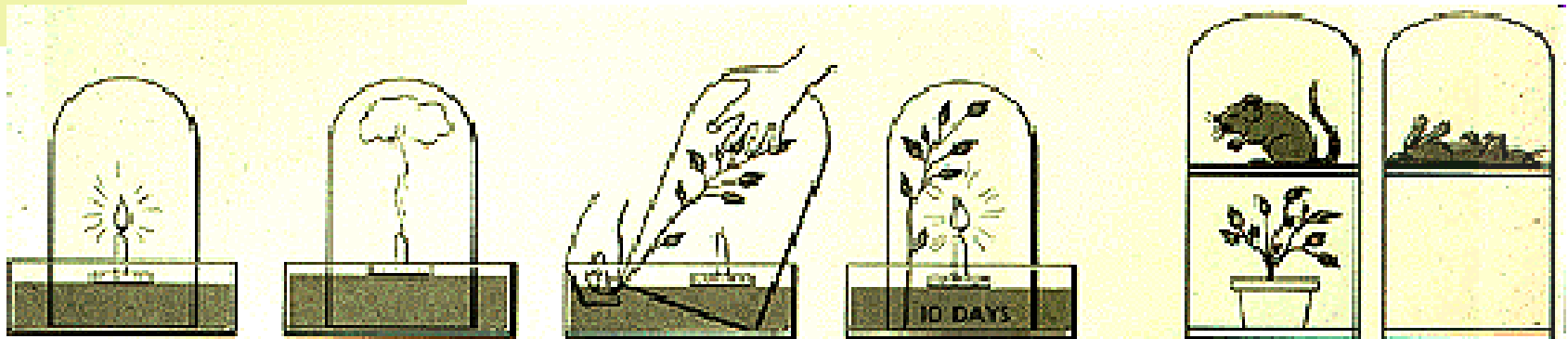
**Plants improve the air.  
Oxygen was unknown then.**



add a plant

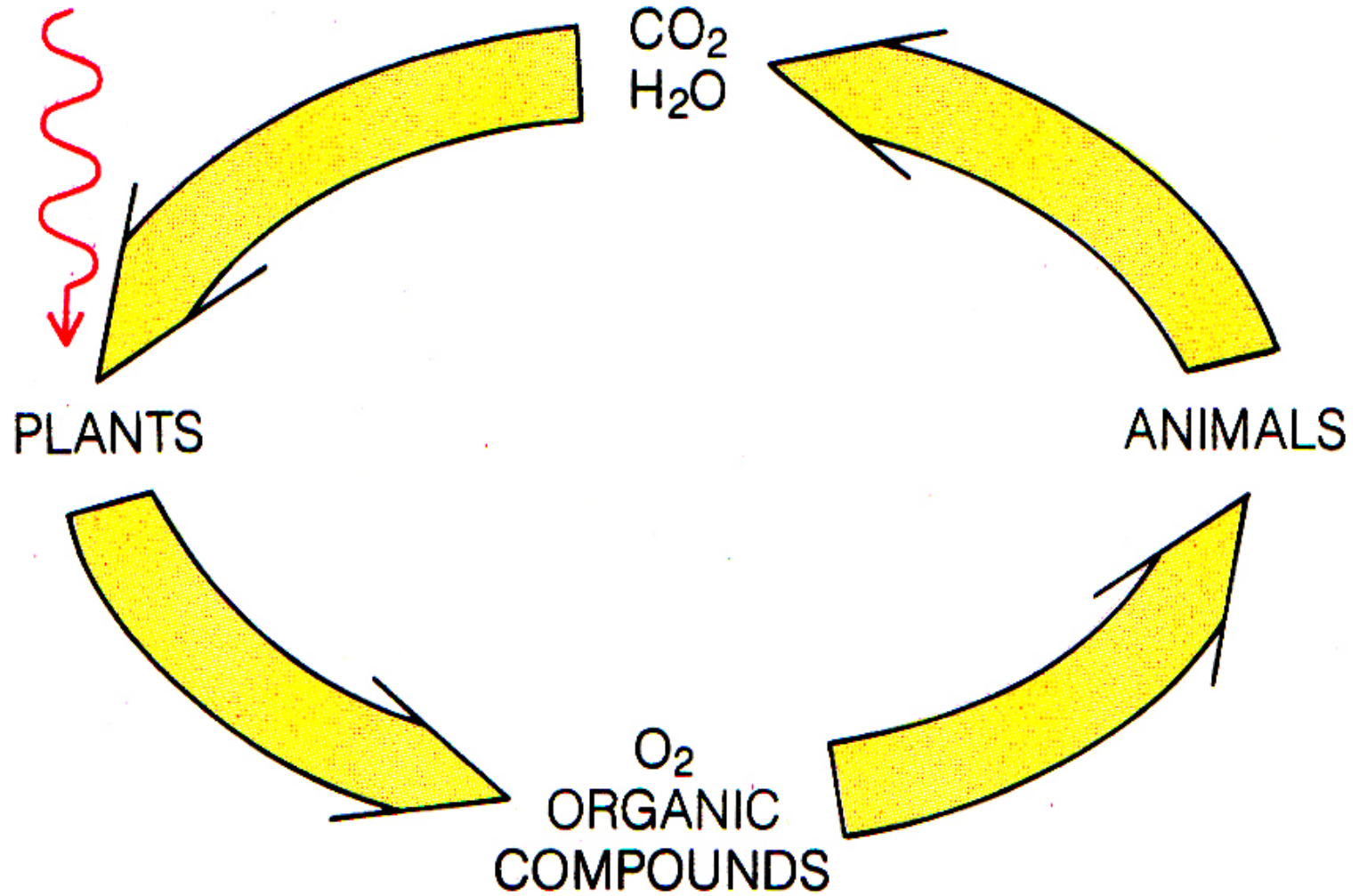


& Joseph Priestley used candles & mice to show that both need X  
John Mavow (1640-79)



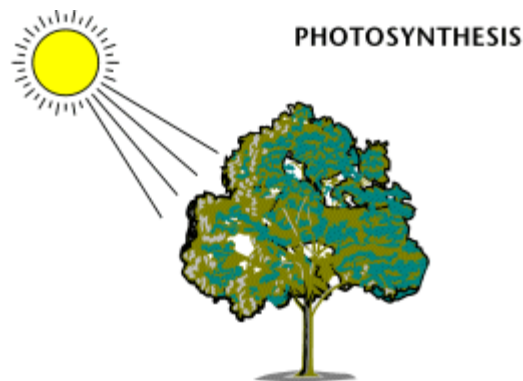
# Producers and consumers

SUNLIGHT

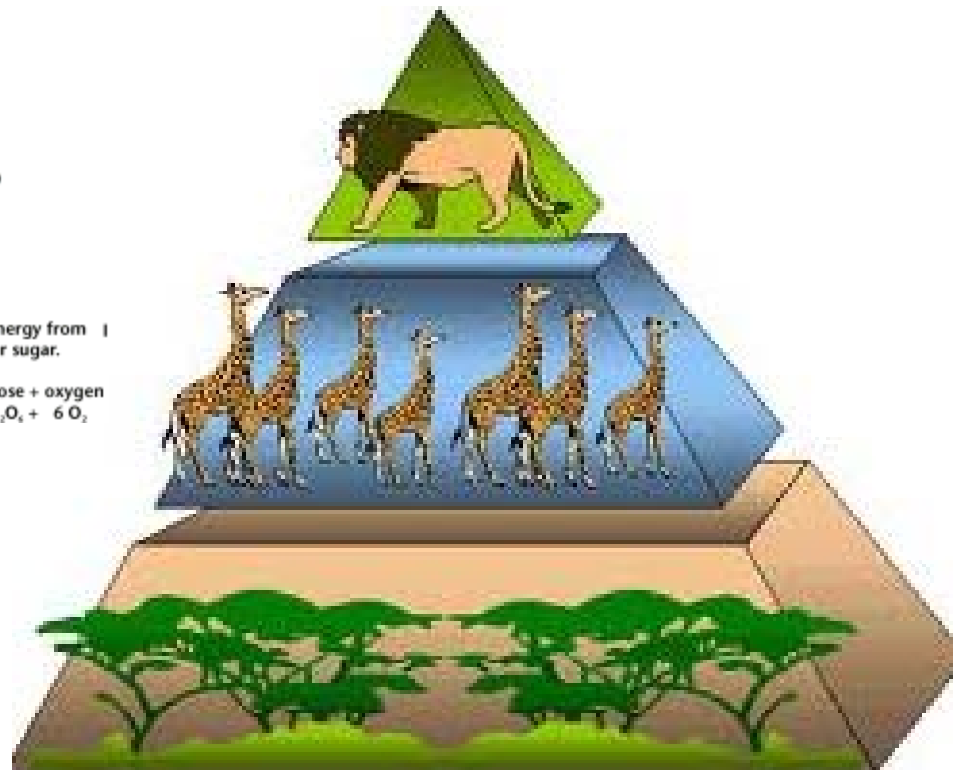


# The second role of Plants on the Planet → biomass

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.



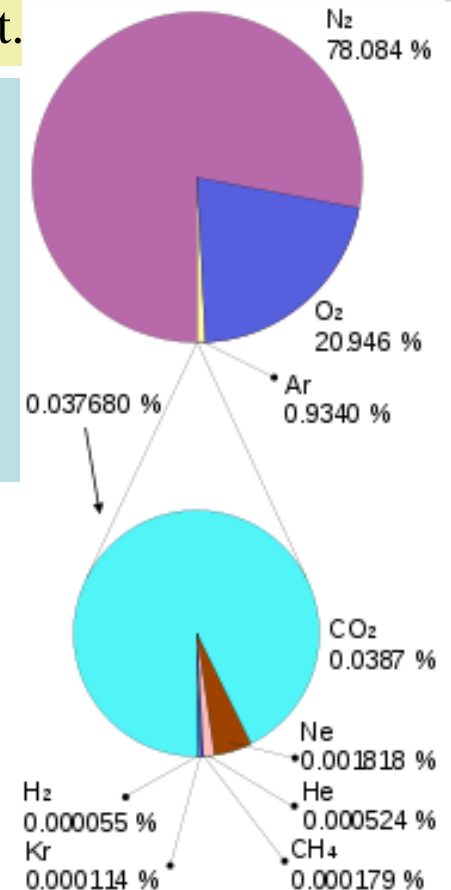
# Other features associated with plants: a warmer planet

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  $\text{CO}_2$  & water vapor absorbed heat or IR. Svante **Arrhenius** saw that human influence on carbon would eventually cause doubling of atmospheric  $\text{CO}_2$ , 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 ( $\text{CO}_2$  & 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.**



## A world without Plants?



**Life in the dark depth** of the oceans: thermal vent communities right here on our home turf

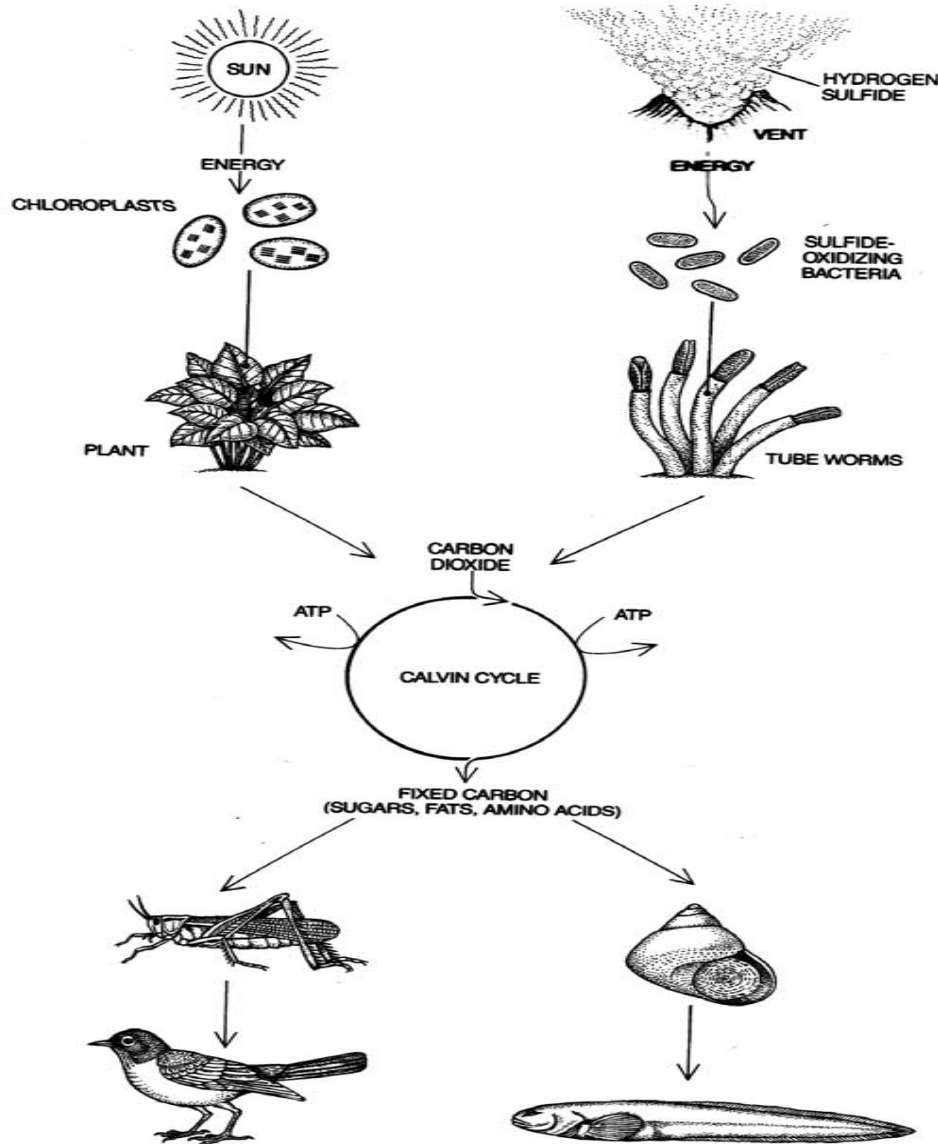


# Two alternatives of life on the planet earth and else?

## Two worlds of organic life

Photosynthesis

Chemosynthesis



**Life in the dark**  
depth of the  
oceans:  
thermal vent  
communities

**Life in the**  
**bright sun:**  
photosynthesis  
based life forms



## What kind of plants do we have on earth? A collection.



*Welwitschia mirabilis* is a plant living in remote areas of the Namib desert. It is in the subdivision of Gnetophyta in the Gymnosperms related to conifers. The plant is a living fossil & was named after the **Austrian botanist Friedrich Welwitsch who discovered it in 1859**. Two ever-growing leaves (**toilet paper plant**)

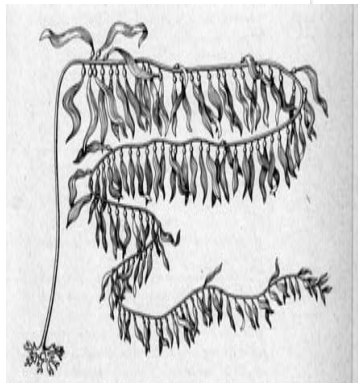


*Hydnora africana* is an achlorophyllous plant native to southern Africa that is parasitic on the roots of members of the Euphorbiaceae family. The plant grows underground, except for a fleshy flower that emerges above ground and emits an odor of feces to attract dung beetles and carrion beetles. The flowers act as traps for a brief period retaining the beetles that enter, then releasing them when the flower is fully opened

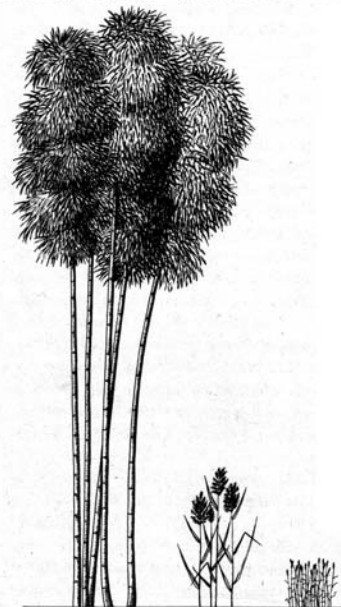
# The largest plants on earth

The smallest algae are single cells, the smallest flowering plant (anthophyte) is Lemna minor or duckweed. The largest marine life form are kelps or brown algae extending the size of a blue whale.

The tallest grasses (monocots incl palms)



The longest "plant relative" on earth is *Macrocystis pyrifera* - a brown alga called "The giant kelp"



20-30m bamboo	4m reed	1.5m wheat
<i>Gigantochloa verticillata</i>	<i>Phragmites australis</i>	<i>Saccharum officinarum</i>
giant bamboo	reed grass	sugar cane
up to 40 m	up to 6 m	up to 9 m

The tallest of the tallest plants = trees



Local news: Doug fir reaches 90 m

Condos	Eucalyptus	Sequoia	Picea alba	Quercus ro	Fagus
30 m	130 m	110 m	75 m	50 m	40 m
100a	400 a	4000a	1000a	1200a	900a

The tallest seed plants are Eucalyptus trees in the Myrtaceae family. The giant redwood *Sequoia giganteum* reaches 135 m & stem thickness of 12 m, coastal or evergreen redwood *Sequoia sempervirens* has same height but lesser stems

# Bizarre Plants

**Monstrous + stinky (amines):** *Amorphophallus titanum*, *Rafflesia arnoldii*, *Aristolochia grandiflora* (Humboldt), *Welwitschia mirabilis*, *Victoria amazonica*, Aztecs' handflower tree *Cheirostemon platanoides* (related to Cocoa tree, Humboldt), Baobab (sausage) trees *Adansonia*, boogam trees *Idria columnaris* (desert in Baja California), elephant or skunk tree *Bursera microphylla* (Baja California; tug on leaf & it burps out a foul smelling, fetid spray over a distance of 50 cm), squirting cucumber *Ecballium elaterum* shoots fruit as a rocket over 3 m distance, slimy mucilage with seeds sticks to the one who touched the fruit



WB Emboden(1974): Bizarre Plants; magical, monstrous, mythical. MacMillan P. NY

# The weirdest plants on earth

The weirdest plants are often also very rare leftovers (living fossils) of bygone times. Their presence is a great treasure – a true “Jurassic Park”.



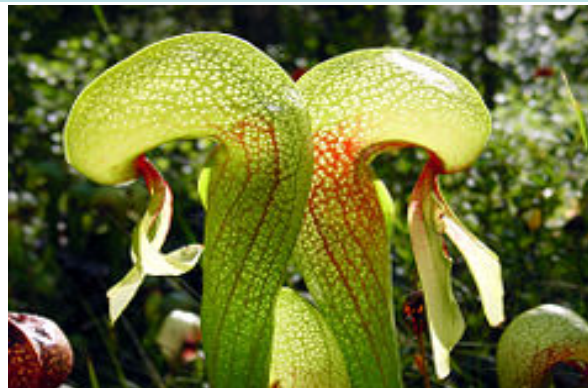
Dionaea musc. trap distribution



Welwitschia endemic to Namib



Rafflesia attracts by cadaverine



Darlingtonia is an insect trapper



Amorphophallus corpse pl

The tallest seed plants are Eucalyptus trees in the Myrtaceae family. The giant redwood *Sequoia giganteum* reaches 135 m & stem thickness of 12 m, coastal or evergreen redwood *Sequoia sempervirens* has same height but lesser stems

# Bizarre Plants :Dictamnus

The burning bush *Dictamnus albus* is a member of the Rutaceae. Many plants of dry locations are known to increase production of terpenes to cool leaf surfaces by terpene transpiration.



Dictam, however, produces so much that it can undergo **self-ignition**  
→ **stories of self-igniting & burning bush stories in Bible & Koran**  
It is thought that droplet formation in the leaf focuses sunlight to a temperature that ignites terpenes which burn like a gas grill using the stomates as valves.

## *The burping skunk tree*

is a member of the Burseraceae, related to frankincense (*Boswellia*) and myrrh (*Commiphora*) but unlike them it stinks (skunk tree).

**The elephant tree *Bursera microphylla*** is native to Northern Mexico, Southern California and Arizona, especially desert regions. It reaches 5 m in height. The foliage is made up of long, legume-like leaves which are composed of paired leaflets. It flowers in rounded yellow buds which open into small, star-shaped white or cream flowers



When you tug on a leaf **it burps and emits a fine spray over 50 cm** distance that is foul fetid smelling *caused by amines*



# Bizarre Plants: Dragon blood plants

## Dragon blood plant *Draceana draco* (Canarian Islands) dragonier

The dragon who guarded the garden of the Hesperides. Draco was venerated plant of the guanches- extinct natives of the Canarian Islands.

The aromatic & red colored resin is obtained from different species : *Croton*, *Dracaea*, *Calamus rotang*. & was used in ancient times as varnish, medicine, incense, and dye. In modern times it is used as varnish for violins, in photoengraving, as an incense resin, and as a body oil.



*Draceana sanderiana*



Resin called Dragon blood



*Draceana draco* (Canaria)

## Buddha's Hand *Citrus medica*



Buddha's hand is a citrus fruit popular in China and Japan for its strong fragrance. It fails as a fruit since it's pretty much all zest and no pulp, but it has other uses,



**Buddha's hand**, *Citrus medica* var. *sarcodactylis* (also known as **fingered citron**), is a fragrant citron variety in the Rutaceae whose fruit is segmented into finger-like sections. The origin of Buddha's hand plant is traced back to Northeastern India.



# Compass plants



**Prickly lettuce *Lactuca seriola*** is a compass plant. If you look at it from the east or west it looks broad but when viewed from the North it looks like flattened by a car.

Another compass plant is *Silphium laciniatum* (**Compass Flower**, or **Rosinweed**)- a sunflower native to the Prairies of Dakota. Like lactuca it aligns leaves in N-to-S direction.



A HORTICULTURAL COMPASS



The rule that moss is growing on the northern side of trees is false for more than one reason. Moss prefers shade and the shade is from all sides in a dense forest. Second, what is growing on the northern side of trees is the *green algae Pleurococcus*. It cannot deal with direct sunlight and prefers N.

## Bizarre Plants: the largest & weirdly shaped seed

**Maldives or Seychelle Islands** : source of unusual seed **coco-de-mer** seeds first mistaken as eggs of griffins (Georg Eberhard Rumpf 1682 named it *Cocus maldivicus*): most important aphrodisiac & antidote like the benzoar (ideal goblet material). Rudolf II German Emperor (1650) payed 4000 florins = 5000 gold thalers (dollars) for a seed



1742 French landed from Mauritius, 1768 that the islands interior was explored & confirmed as the source of coco-de-mer, the Seychelles' nut **Lodoicea palms** (daughter of Troy's Priam



**difficult to germinate**; first Kew Royal Garden plants were pre-germinated in Seychelles & then grown in 1854 , hurrah ==> a yellow horizontal shoot projects parallel to soil surface for 3 m before horizontal shoot develops & root grows. Horizontal shoot rots away & seedling cannot be traced back to seed. Jelly-like endosperm of nuts is a delicacy for the rich.



“Surely, Sir, it is Priam’s daughter”

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1742 French landed from Mauritius, 1768 that the islands interior was explored & confirmed as the source of coco-de-mer, the Seychelles' nut **Lodoicea palms** (daughter of Troy's Priam

**difficult to germinate**; first Kew Royal Garden plants were pre-germinated in Seychelles & then grown in 1854 , hurrah ==> a yellow horizontal shoot projects parallel to soil surface for 3 m before horizontal shoot develops & root grows. Horizontal shoot rots away & seedling cannot be traced back to seed. Jelly-like endosperm of nuts is a delicacy for the rich.

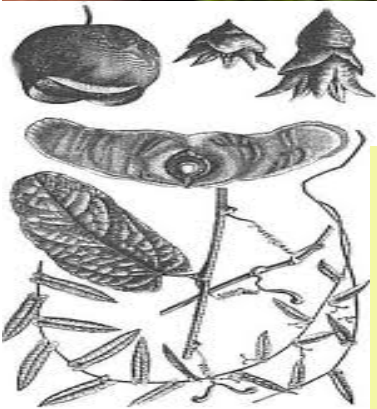


“Surely, Sir, it is Priam’s daughter”

# The flying *Zanonia* fruit served as a template for the first non-stalling airplane trianer (STOL)



*Zanonia macrocarpa* (Syn. *Macrozanonia macrocarpa* (Blume) Cogn., *Alsomitra macrocarpa* M.Roem.) alias Javan cucumber is a vine in the cucurbitaceae. The fruit - a maple-like samara - has thin dry wings with 13 cm wing span and can fly with only a slight turn distances of up to 50 m. The plant was first described under the name *Zanonia macrocarpa* in 1825 by Carl Ludwig Blume



This principle was used to build a monoplane in 1903 in cooperation of botanists with the Austrian airplane pioneer **Ignaz Etrich** (designing strategy called biomimetics) and in 1912 the motorized glider “Taube” which had a stall speed of less than 10 mph (idiots could fly this one). Unfortunately this design was not fit for tight turns – the developing strategy of fighter planes



← The “Taube” of the famous Lieutenant Plüschow was the only plane of the Imperial Navy in Tsingtao, in 1914 a German colony in China. Before Tsingtao was overwhelmed by superior numbers of Japanese & British ships & troops he flew his badly damaged plane for 250 miles into China & continued on foot

## The Devil's Claw



The horrifying seed pods are designed to latch on to the feet of passing animals, which will then transport them to another location before crushing them underfoot and releasing the seeds.

*Harpagophytum procumbens*, also **Devil's Claw**, is in sesame family, native to South Africa. The plant's large tuberous roots contain steroid & are used to reduce pain and fever, and to stimulate digestion. Europeans used it to treat arthritis.



## Chinese Fleece Flower *Fallopia ssp.*



The Chinese Fleece flower is in the genus *Fallopia* in the family Polygoniaceae, a relative of the infamous Japanese Knotweed *Fallopia japonica*. The Chinese use this plant in their traditional medicine for kidney health, strong bones and hair restoration, and as a mild laxative, and it's.. Hey, wait a second...

“ I tell you, ...  
it is a sign, yeah, ah ...  
it's an omen!” The end of  
the world is close, oh Rose

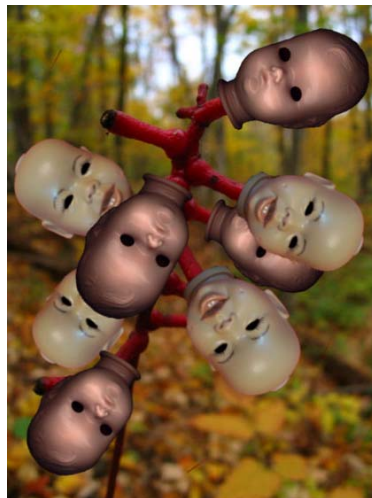
Okay, weird. It's a root that looks like a little dude. But that's a rare, onetime fluke, right? It's not like that's what this species *typically looks like* or anything?? Roots making a perfect couple made headlines in 2006 .... →



## Doll's Eyes *Actaea pachypoda*



*Actaea pachypoda* (Doll's-eyes, White Baneberry) is a herbaceous perennial plant in the family Ranunculaceae, native to eastern North America. The berries contain cardiogenic toxins which can have an immediate sedative effect on human cardiac muscle tissue, and are the most poisonous part of the plant. Ingestion of the berries can lead to cardiac arrest and death.



The Doll's eye plant, also known by the equally unsettling name "white baneberry." Just in case you were actually thinking of eating this thing, those eyeballs are highly poisonous.

# Chinese Black Bat Flower *Tacca chantrieri*



Bats are freakin' scary. For the same reason, nature has decided to use that same mold to make plants that can induce spontaneous bowel movements, with the addition of some tentacles just to be sure, black bat flowers.

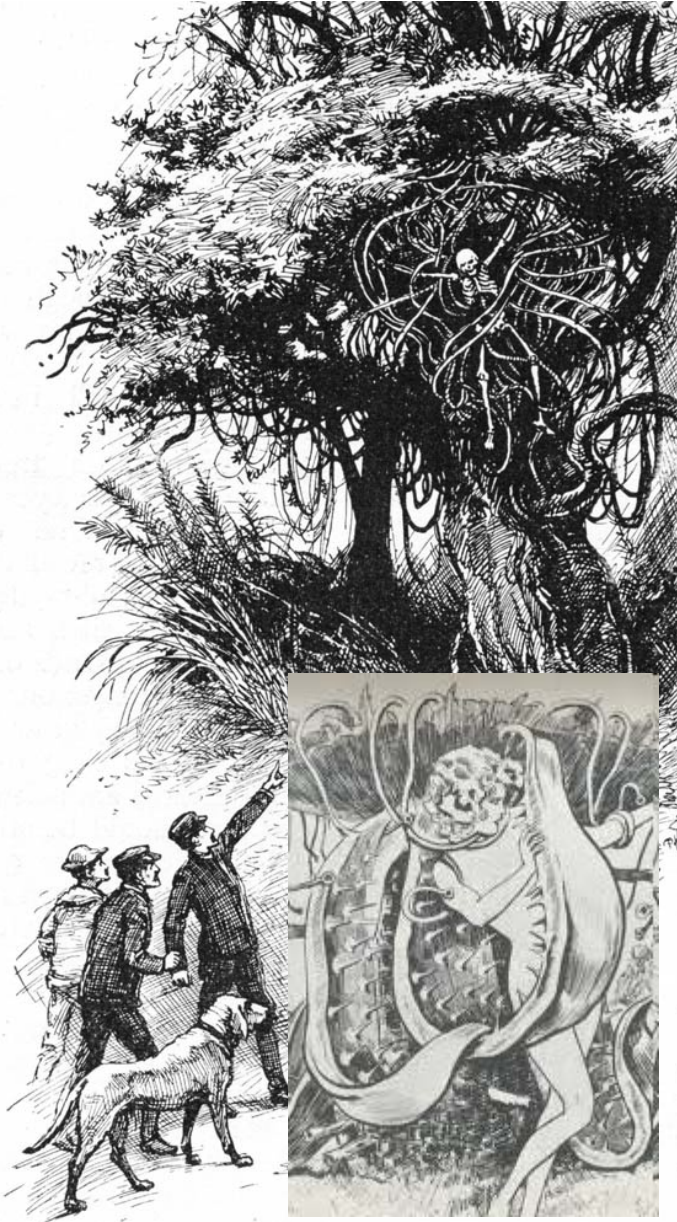


The **Black bat flower**, *Tacca chantrieri*, is in the yam family Dioscoreaceae. & unusual in that it has black flowers. These flowers are bat-shaped, are up to 12 inches across, and have long 'whiskers' that can grow up to 28 inches. *Tacca chantrieri* grow wild in the tropical forest in Yunnan Province, China,



# Terrible or horrible Plants

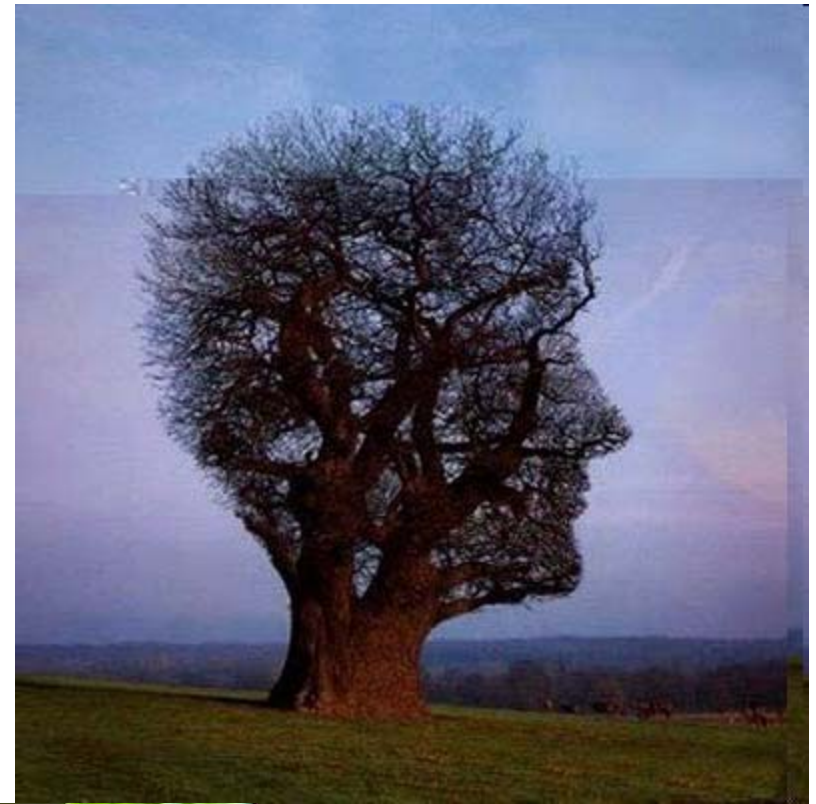
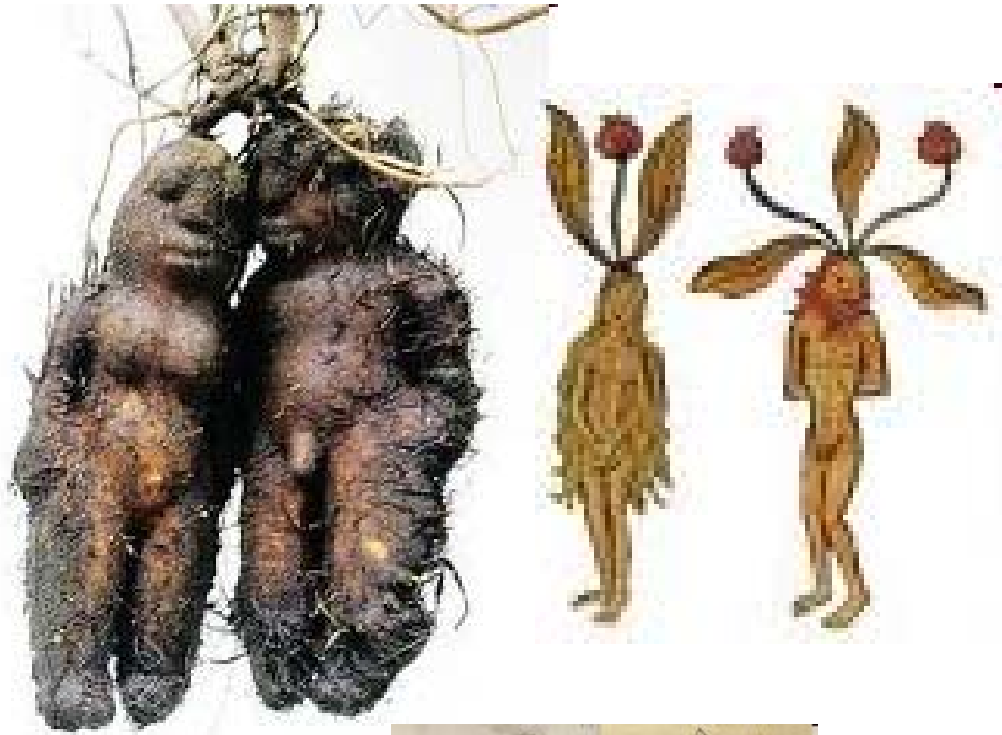
While many stories about man-eating or man-killing plants belong in the realm of **fairy tales and fantasy**, that is **unfortunately not always the case.**



BBC 2006:

A new species of giant carnivorous plant has been discovered in the highlands of the central Philippines. The pitcher plant is among the largest of all pitchers and is so big that it can catch rats as well as insects in its leafy trap.

# Plants mimicking other life forms

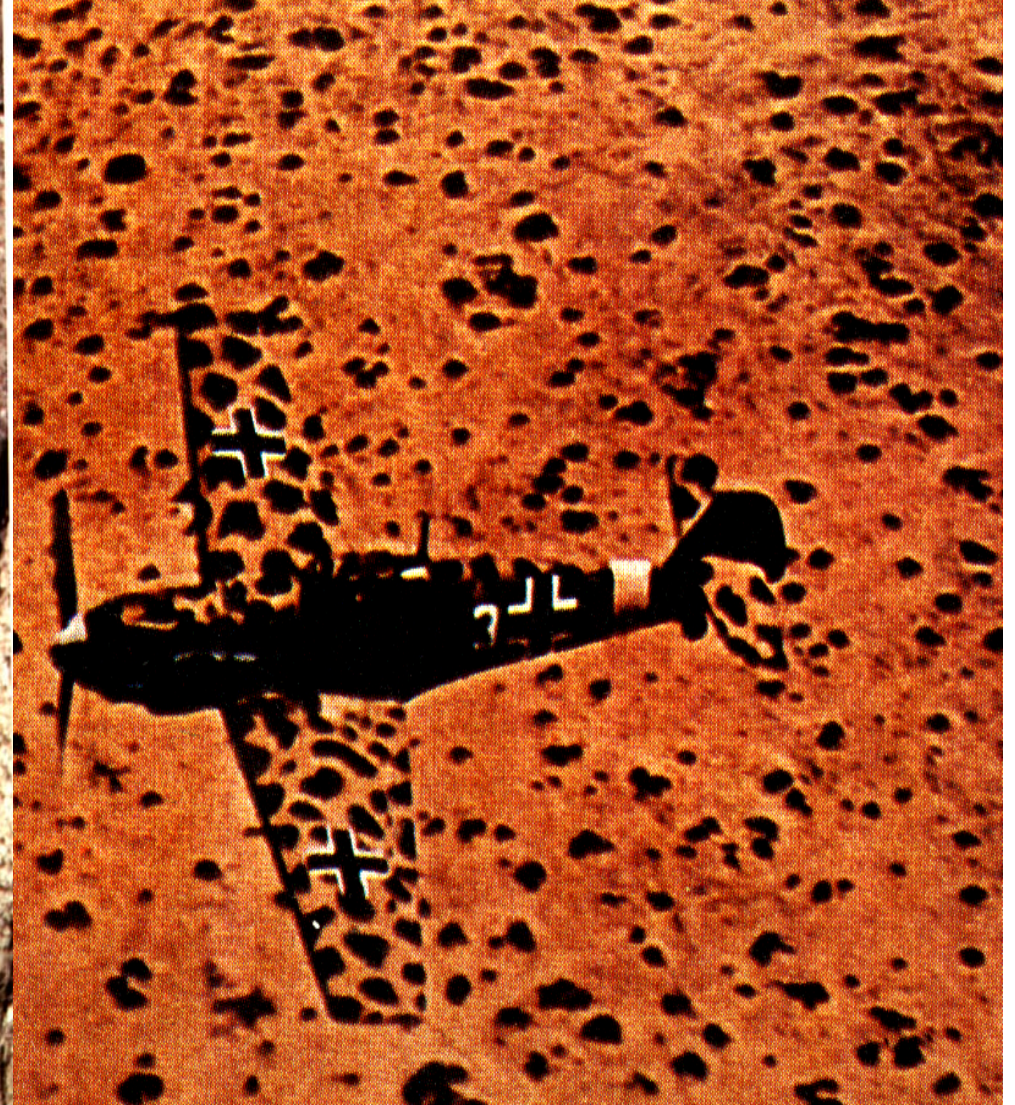


<http://aayuni.tumblr.com/post/4832997867/9-creepy-plants-that-shouldnt-exist>

# Camouflage and Mimicry

nature-made

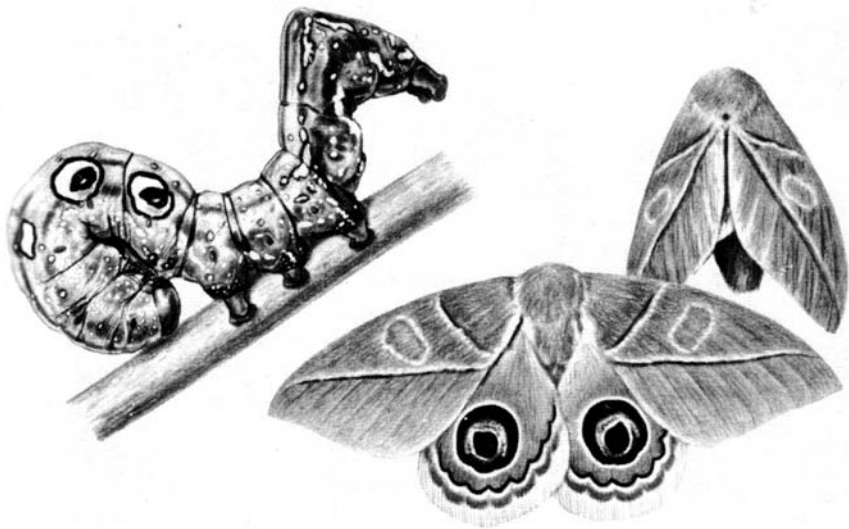
man-made



# Mimicry

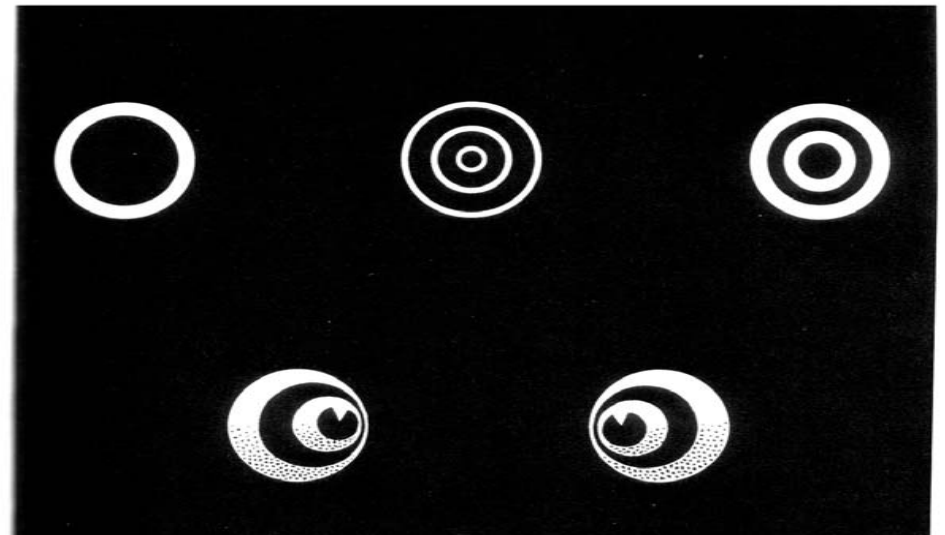
Mimicry provides great examples for similar appearances in genetically different, i.e. **phylogenetically unrelated species, i.e. for convergent evolution.** *Muellerian mimicry* explains the evolutionary advantage to look like a poisonous species or another thing dangerous to the predator.

Sudden display of eyespots is a common feature of both butterflies and caterpillars



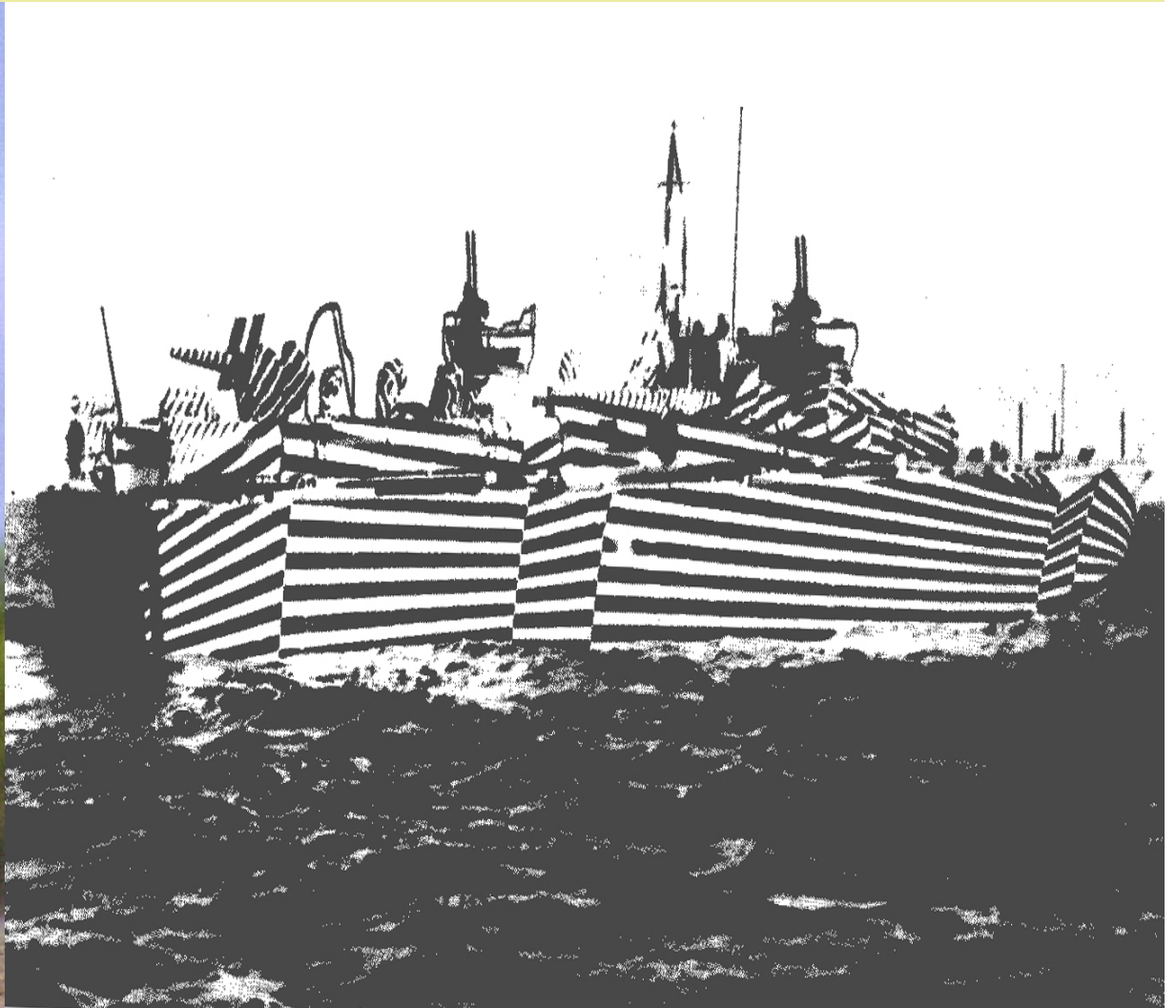
Blest (1957) used yello-hammer birds to test eyespot patterns for the effectiveness by placing them next to mealworms.

Strongest repellent was pair of eccentric rings resembling stare of vertebrate threat



Wolfgang Wickler (1974) *Mimicry in Plants and Animals*. McGraw-Hill, N.Y.

# Camouflage: confusing directionality



**Optical illusions: flaws in image processing mislead about body size, shape & its anticipated direction!**

# Camouflage: faking identities



flipping caterpillar



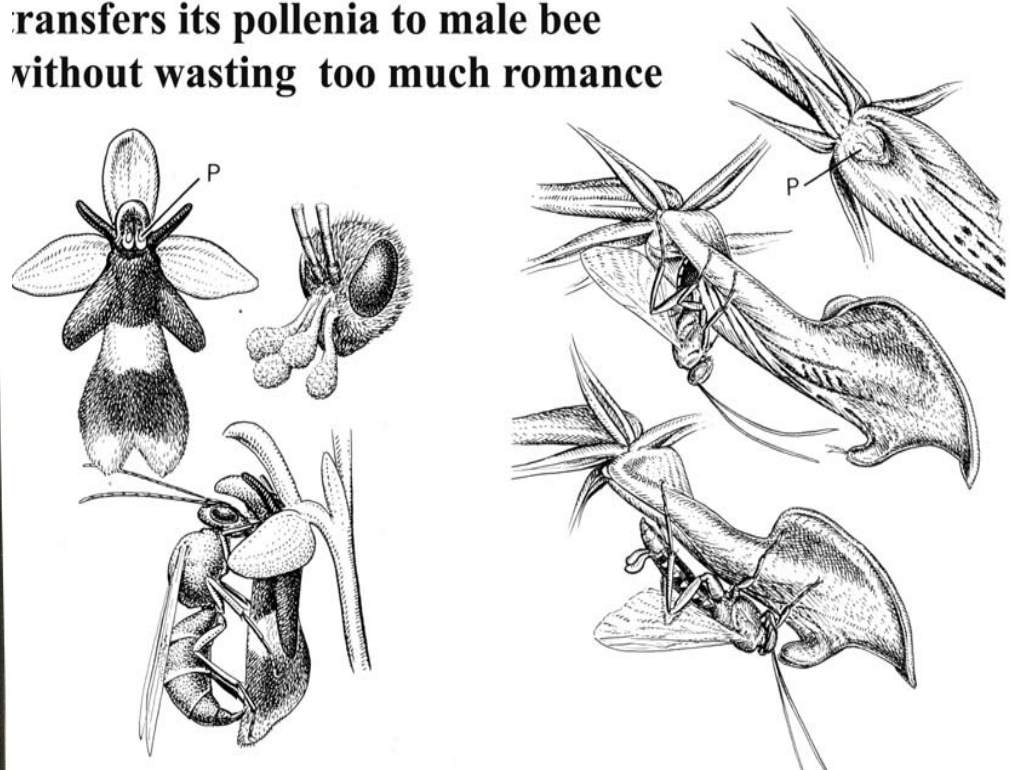
# seeking sex outside your own species

**sex, violence & betrayal**  
**bee orchid *Ophrys apifera***  
**simulates female dummies**



Several orchids specialized in producing female dummies luring young inexperienced males of flies, bees & wasps into a ludicrous game

**fly orchid *Ophrys insectifera* with P- pollinia**  
**transfers its pollinia to male bee**  
**without wasting too much romance**



Wolfgang Wickler (1974) *Mimicry in Plants and Animals*. McGraw-Hill, N.Y.

# Simulation of insect egg deposition

Passion flowers developed two ways to counteract predation by *Heliconius* butterflies:

1. Some passion flowers can change their leaf shape when they detect heavy herbivory. The result is confusion on the part of the herbivores about the species identity.

2. They simulate areas of egg deposition which signal to the female butterfly that her offspring would likely be exposed to cannibalism by the older conspirators. Which mom would take such risks??



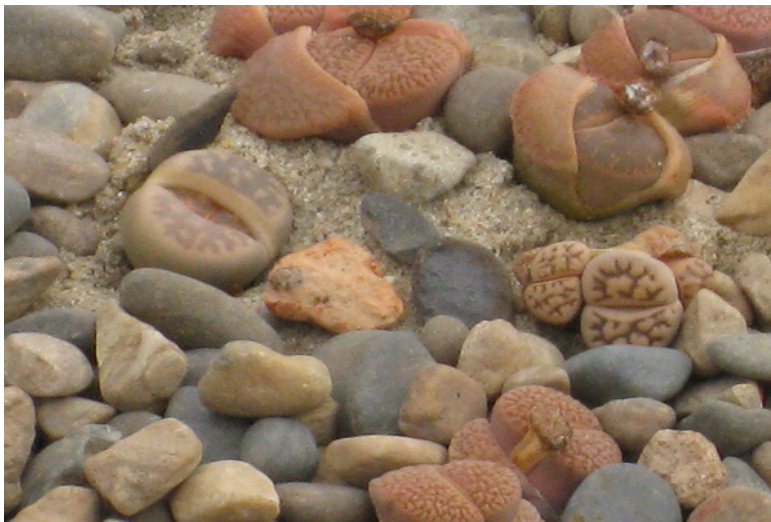
**Wolfgang Wickler (1974) Mimicry in Plants and Animals. McGraw-Hill, N.Y.**



# When growing in the desert, look like a rock!

## Lithops are called mimicry plants:

they have a unusual **deceptive camouflage**: shape, size and color causes them to resemble small split stones in the desert. Animals could otherwise eat them during drought common in Southern Africa.



Aposematic color warnings are the opposite of camouflage. This is new in plant sciences.

They rely upon the fact that herbivores learned to associate these colors with pain.



# Mimicry & Convergence

Mimicry provides great examples for similar appearances in genetically different, i.e. **phylogenetically unrelated species, i.e. for convergent evolution. *Muellerian mimicry*** explains the evolutionary advantage to look like a poisonous species or another thing dangerous to the predator.



Euphorbia obesa



Euphorbia ingens toxic

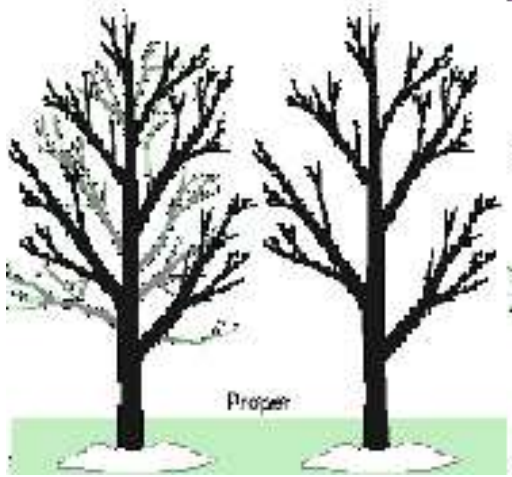


Cactus converges in shape

Wolfgang Wickler (1974) *Mimicry in Plants and Animals*. McGraw-Hill, N.Y.

# Pruning

Pruning is the selective removal of plant parts, typically shoots and branches, to improve health, control growth or enhance fruiting, flowering or appearance.

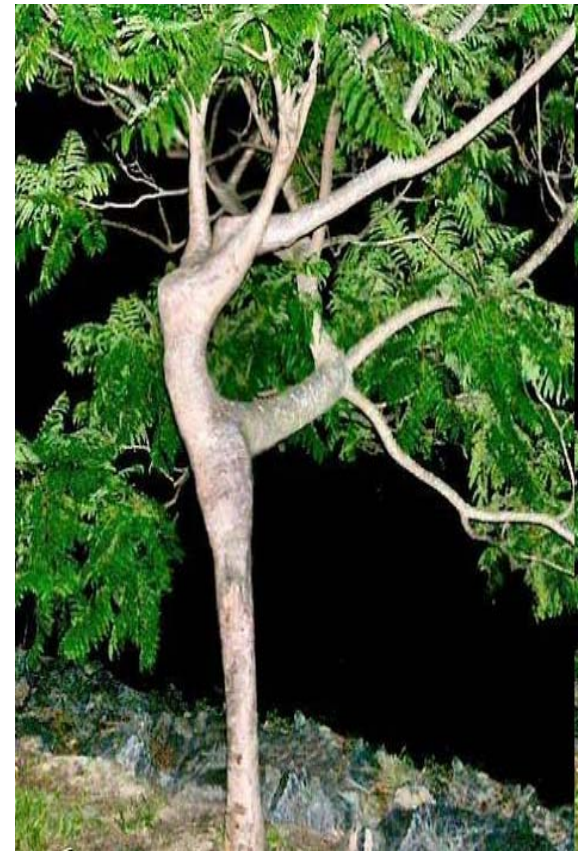
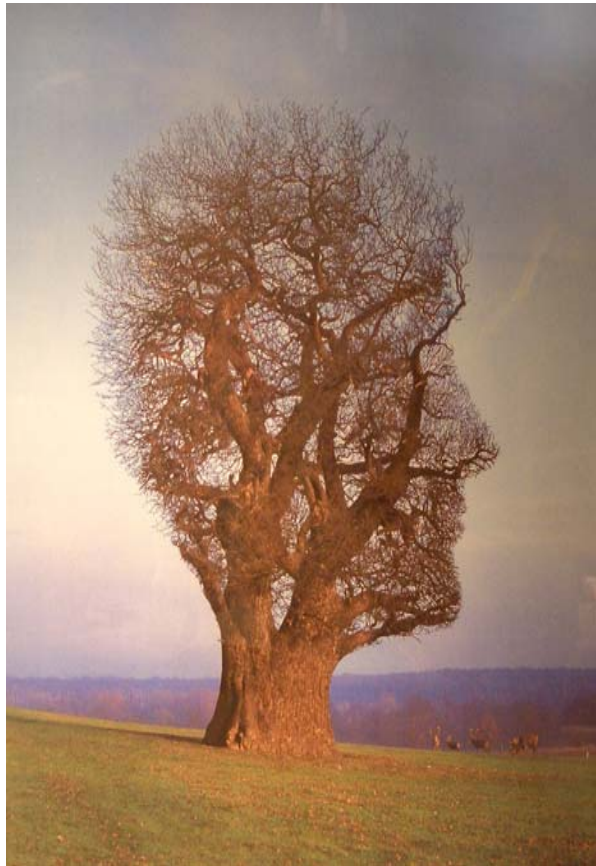


## Plant Mimicry under human influence

Shape your house plants into genuine partners of life that you can enjoy in the privacy of your home and yard!

Unlike your current partners these plants do not

- ask you what you can do for them
- .....
- cook you meals
- tell you to .....



# Camouflage and Mimicry

*Ophrys* orchid

insect



## Camouflage in jungle Plants

Found in the rain forests of Ecuador these sick-looking plants appear to have already been attacked. As a rule of (green) thumb, plants that compromise their ability to transform sunlight into energy via photosynthesis die out. However, in this case the survivors seem to be those that sacrifice a bit of light-harvesting capacity for a camouflaged appearance.



Typically, the top predator of this particular plant lays its eggs on the leaves, which in turn hatch into larvae that leave a trail of white behind as they feast on the leaves. By displaying a white pattern from the beginning, however, these plants look already-inhabited and thus further egg-laying moths are deterred from laying their own offspring.

**Camouflage** is a deceptive method of avoidance of observation that allows an visible organism to remain indiscernible from the surroundings.



Catfish & zebras are using lines or stripes to hide their individuality & body outlines. The SAmerican eyespot frog fakes wrong directionality plus wrong identity



**Mimicry** is faking similarity to another species that is a threat to the predator. This similarity can be in appearance, behaviour, sound, scent and even location.

**The Indian cobra** protects its back by face markings of a monkey or human.

**Emperor moths** show an attacking bird a pair of staring eyes of a dangerously large lurking, bird-eating vertebrate



# Plant Quiz

1. Which plant is the smallest flowering plant?

**1. *Wolffia arrhiza*** – the small relative of duckweed Lemnna being only 0.5 mm across.



2. Which plant has the largest single flower?

**2. *Rafflesia*** , a stinky parasitic plant from the Mediterranean region.



3. Which plant has the largest leaves? ...

**3. The *Raffia palm*** This imposing African palm has the largest leaves of any tree. **IT has leaves that measure up to 20 m in length.** are the source of raffia, a natural fiber



4. Which plant has no leaves?  
.....  
.....

**4. *First*, there are lower plants like *mosses*, which do not have real leaves. *Second*, there are *desert plants and deciduous trees* that drop their leaves part of the year. *Third*, there are parasitic plants like *coralroots and pinedrops* that are pale and have no leaves, just scales. *Fourth*, there are *cacti* that have modified leaves appearing as spines.**



# Plant Quiz

5. Which plants have no roots?

.....

Lower plants ( bryophytes) have no real roots. There are parasitic plants like cuscuta (dodder) or mistletoe that absorb nutrients from their hosts. Third, there are duckweeds like *Wolffia arrhiza*.

5. Which plant makes only tow leaves although living more than 1000 years?

***Welwitschia mirabilis***. This South African desert plant produces only 2 leaves, which it extends during its whole world.

6. Which plant produces the largest seeds? .....

**Coco de Mer, Seychelles nuts**

7. Which plant family has the smallest seeds?

**The orchids.**

8. Which plant has the longest-living seeds?

**Arctic Lupine** were found frozen in the soil of the Canadian Yukon were estimated to be 10-15,000 years old. Nevertheless, they did germinate into new plants.

# Plant Quiz

9. Which plant has the edible fruit with the most calories?

**Avocado** has 750 cal per pound. On the other hand cucumber has only 70 cal /pound.

10. Which plant produces the largest edible fruits?

Of course, the **pumpkin** reaching up to 180 pounds followed by melons with 45 pounds.

11. Which creature is largest living being on earth?

**Sequoia gigantea** specimen “General Sherman” is 83 m tall with a trunk of 24.22 meters circumference.

12. Which creature is longest living being on earth?

**Lichens** in Antarctica were shown to be older than 10,000 years growing 3.4 mm/century. A clone of quaking aspens in Utah is said to be 80 000 a old.

13. Which creature is longest living plant on earth?

***Pinus longaeva*** – the Bristlecone pine form the SW of the USA. A clone of quaking aspens in Utah is said to be 80 000 a old

# Plant Quiz

14. Which plant was the first one in space?

It was *Arabidopsis* aboard the Soviet spaceship Salute 7 in 1982.

15. Which plant is the oldest recent species (old but still around) flower plant?

*Ginkgo biloba* first appeared all over the world 180 Million years ago. 300 years ago, it was extinct except for some monasteries in China.

16. Which plant has the deepest roots and how deep do they go?

The deepest roots were found with a *Ficus* species in South Africa reaching 120 m deep. **The official record is with the 10 m tall tree *Boscia albitrunca* from Kalahari Desert with roots measured 68 m lon**

17. Which plant is the tallest monocot?

**It is giant bamboo *Phyllostachys nigra* reaches up to 18 m tall.**

18. Which plant is the tallest dicot?

*Eucalyptus regnans* at Mt. Baw Baw, Victoria, Australia, is believed to have measured 143 m (470 ft.) in 1885. Formerly, another Australian eucalyptus, at Watts River, Victoria. almost certainly had been over 150 m (492 ft.) tall."

# Plant Quiz

19. Which creature is the largest by volume being on the planet?

**Avocado** has 750 cal per pound. On the other hand **Sequoia gigantea** specimen “General Sherman” is 83 m tall with a trunk of 24.22 meters circumference. **It has a volume of 1,487 m<sup>3</sup> (52,500 cu ft).**

20. Which creature is the largest being by area?

**A giant fungus of the species *Armillaria ostoyae* (honey mushrooms)** in the Malheur National Forest in Oregon was found **to span 8.9 km<sup>2</sup> (2,200 acres)**, which would make it the largest organism by area.

21. Which creatures are the longest beings in the ocean?

These are the **giant kelps *Macrocystis pyrifera***, which may reach a length of over 100 ft (30 m). This majestic giant of the kelp forest grows faster than tropical bamboo—about three to five inches each day.

22. Which stinky plant has the largest inflorescence of all flowers on earth?

**Amorphophallus titanum** – the devils stinking horn is in the skunkcabbage family Araceae from Indonesia

# Plant Quiz

23. Which plant shoots its fruit over distance of 3 m using the same principle as a rocket motor?

**The squirting cucumber  
*Ecballium elaterium***



24. Which plant burps out a foul-smelling spray when you tug on one of its leaves?

**The Bursera or  
elephant tree from  
California**



25. Which plant resembles most the burning bush of Bible and Koran stories?

**The burning bush  
*Dictamnus albus* is a  
Mediterranean member  
of the Rutaceae**

26. There are two huge differences in ..... and in .....that exists between perennial trees and all other life forms on the planet.

**Size and Age (= longevity of individual life)**

27. What is a compass plant?

**Prickly lettuce *Lactuca seriola* is a compass plant as well as *Silphium laciniatum* – the Compass Flower. They align their leaves in the N – S direction**