DIGITAL AGE

Special Topics: Plants

Collected and edited by Prof. Zvi Kam,
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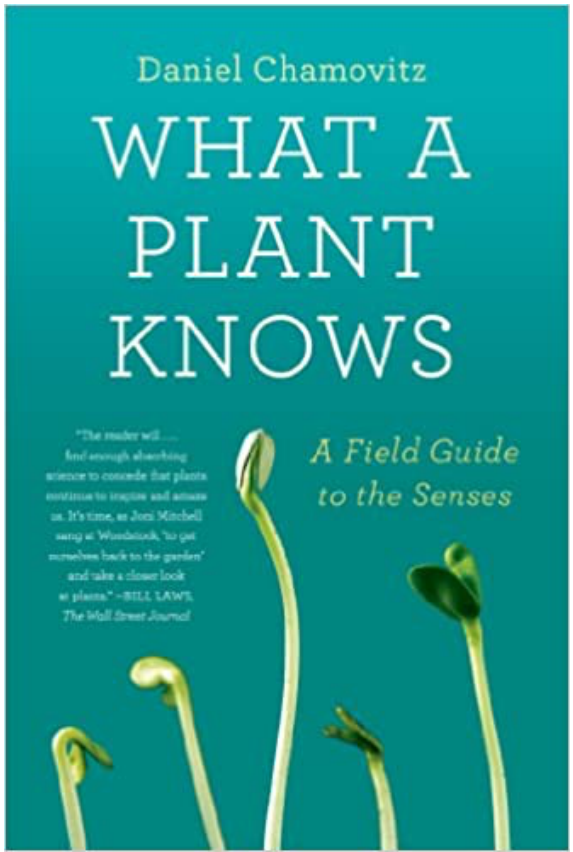
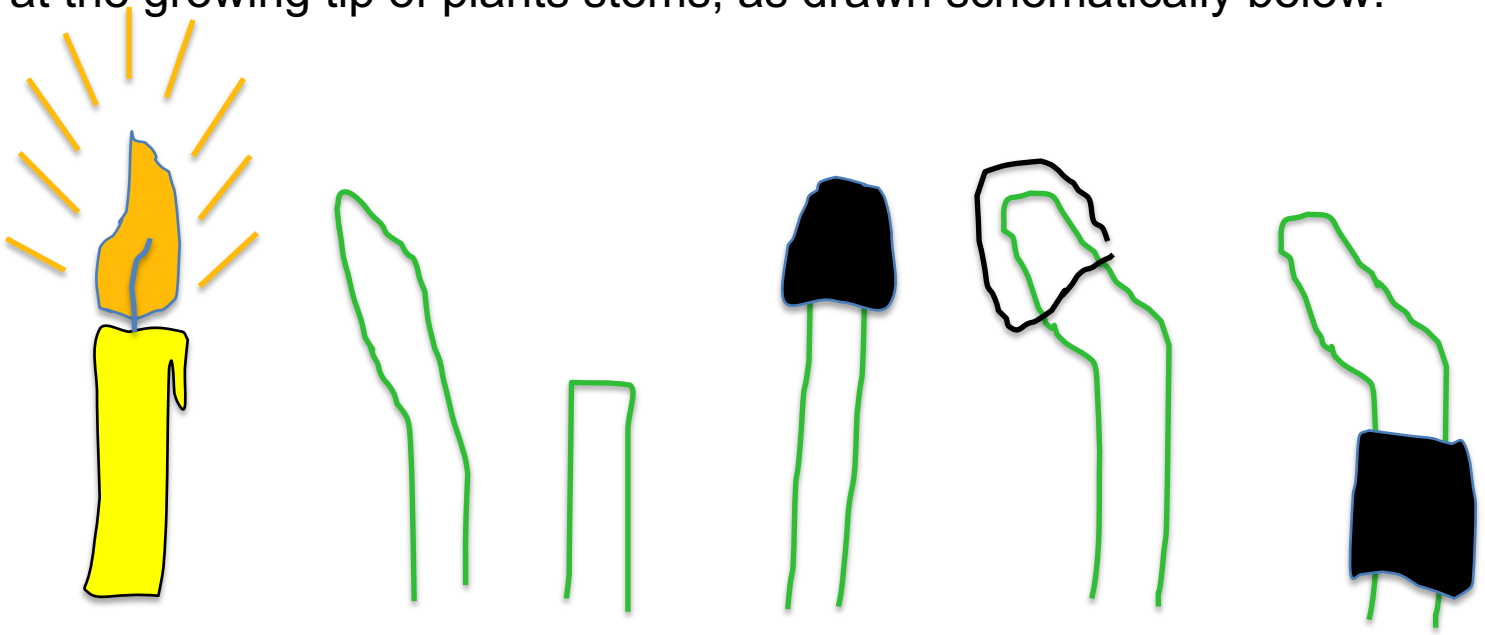
Based on the book:
What a Plant Knows: A Field Guide to the Senses
By: Daniel Chamovitz



SENSING LIGHT

1864 Julius von Sachs phototropism – blue light induce movement in plants.

1880 Charles & Francis Darwin made simple experiments demonstrating light sensation at the growing tip of plants stems, as drawn schematically below:



The protein responsible for phototropism was isolated at the 20th century.

1864 Julius von Sachs1906 Maryland Mamoth discovered a tobacco mutant that grow indefinitely, but lacks flowers, therefore could not be spread.

1918 Wightman W. Garner & Harry A. Allard found that limited illumination induce tobacco to flower – photoperiodism. Chrisanthemes flower when days are short (or nights long?). If illuminate at night, but turn light off before daylight, they flower. A short pulse of light is sufficient to “break” the sensation of long nights. He concluded that plants do not measure the day length, but the night length.
Irises flower when day is long. Their sensitivity is to red, not blue light.

1950 Harry Borthwick 1960 Warren Butler found that infra=red light cancelled the red light effect: a switch tturnd on in red, and off by IR. Illumination of one leaf affects all the plant.

1980 Maarten Koornneef plants growing in dark are higher, with yellow leafes. He induce a mutation in Arabidopsis and looked for taller yellow plants, thus isolated color-sensitive mutants. Cryptochrome – sensitive to blue light and control the circadian clock. Isolated in 1993 and found common to plants and animals (jet lag). The name given by Jonathan Gersel: Cryptic for long time – hidden. Today 11 photoreceptors found.

SENSING SMELL

In the USA: fruit ripening by burnt carosine.
1924 Frank E. Denny Ethylene (and not the burning heat) induced ripening.

1930 Richard Gane Ethylene is secretion from ripened apples. Therefore banannas in a bag induce pears, avocados etc. to ripen. The ethylene secretion (kind of a hormone) synchronize ripening of fruits on the same tree.

Consuelo De Moraes a parasite plant "searching" for tomatoes, smelling beta-myrcene and rejected by wheats "smelling" Z-3-Hexenyl acetate

www.sciencemag.org/content/vol313/issue5795/images/data/1964/DC1/1131371_s1.mov

1983 David Rhodades & Gordon Orians discovered warms that attacked one tree but not its neighbors
Ian Baldwin & Jack Schultz cut leaves spreads phenols and tanines that drive larva away

Willow-bark contains aspartic acid (Asperin) as protection agains bacteria. Was known to the Babilonians, and reported by **Hipocrates**

AND OBVIOUSLY: flowers smell attracts insects for pollination.

MOVIE OF DIRECTED MOVEMENT TOWARDS THE PLANT

SENSING CONTACT

1875 Darwin cilia inside carnicorous plants traps cause its closure within tenth of a second. The cilia are not networked to force induction. More than one cilia need to be stimulated to activate the trap. Is it MEMORY?

Burdon Sanderson found that they start an electric wave

Alexander Volkov 100 years after Sanderson he discovered that the electric wave accumulates Ca ions that open K channels. The channels could be blocked by drugs that block nerve pulses in humans.

1901 Sir Jagadish Chandra Bose in Cavendish labs – an electric wave in leaves of Mimosa causing Ca wave reaching pulvinus cells at the leaf basis and induce water secretion and mechanical collapse of the leaf.

1960 Frank Salisbury a grass with rugby-like small thorny sticky fruits stop growing after tauch.

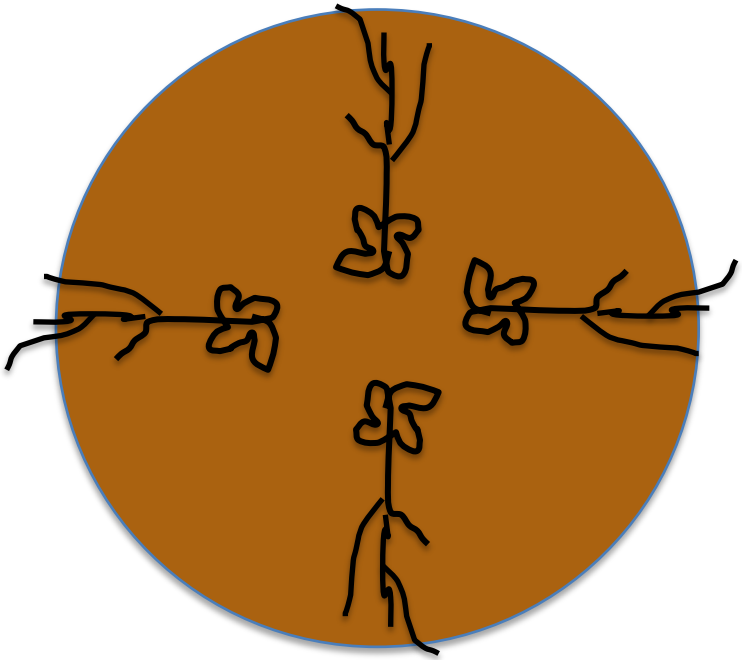
1970 Mark Jaffe found that stop growth after contact is common

Janet Braam sprayed plants to induce gene expression, and discovered increasing expression of genes related to contact sensation, e.g. Calmodulin.

SENSING GRAVITY

1758 Henri-Louis Duhamel du Monceau turned upside down seeds and demonstrated that roots always developed downwards.

1808 Andrew Knight seeds planted in a centrifuge (turned by river water) grew with their roots outwards



~1990 Darwin & Son burnt the preifery of root tips of beans at set times after start of its growth downwards – and concluded that the message is sent from the root tip to the two sections of the seed. He discovered that also leaves has gravity sensation. Today we know plants hormone-like “auxin” concentrated at the dark part of the plant and induce inclination towards light of leaves. Jungle plants that grow upside-down miss this gene (or it is mutated).

~1990 John Kiss cell organelles called Statoliths with high density fall to the bottom of the root cells and induce growth. Similar to balance maintenance in our ears. Displacement of the organelle by a magnetic bead change root growth direction. Plants growth in sattelites is not directional.

Plants have cyclic motions, with periods from an hour till a day. It is not caused by sun cycle, since the motion stopped in space. It is therefore gravity induced.

MEMORY

1959 Rudolf Dostál (Prague) dissection of one leaf prevent development of buds at the injured side.

Baptiste Lamark showed that freezing seeds of winter wheats for a short time escapes the need to pass the whole cold winter to germinate in spring.
Cherry blossom is dependent of winter memory.

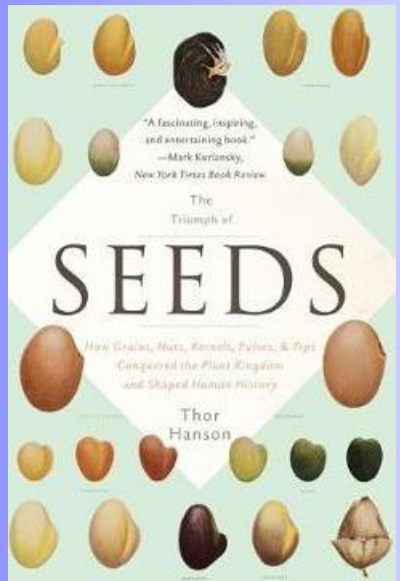
1898-1976 Trofim Denisovich LysenkoJean the biologist who controlled science under Stalin's communism. He got his recognition due to improved wheat crops at the 30th. He rejected Darwinism, and believed that environment affects inherited properties, that fitted well to the communist re-education…

Today we recognize epigenetic phenomena via histone methylation.

Memory mechanisms in plants are based on accumulation of some compounds.

SEEDS

Thor Hanson



Theophratus Aristotle's student, "the father of botany" described germinating plants.

Seed may have one, two or many sections. They span sizes from microscopic till avocado seed (that should supply food to the sprout inside the jungle), seeds may be light to be carried by winds, inside fruits and resistant to the digestive system, to be spread by animals that eat them.

Plants store in their seeds nutrition at different forms of starches and fats: gluten (grasses) lipids (lentils and nuts) saturated fats (coconut) waxes (khokhova) and butter (coacoa).
Grasses store ready energy in their seeds for fast usage of initial growth and sunlight harvesting. Jungle plants with little sun store more fatty energy forms, with high caloric value. But there are exclusions: Canola oil is extracted from grass seeds.

Seed cycle, between grasses (wheat, corn, rice, surgum) and lentils (humus, peas, beans, soy) enrich soil with nitrates and supply complete protein diate.

Guar-gum seeds store complex polymers that adsorb water effectively. Applied to extract oil from oil shales.

Carboniferous/Permian transition – Transition from hot-humid climate with pine trees proliferated by pollination in swamps (the main contributer to coal deposits), to dry climate dominated by plants proliferating by seeds.
The claim is that plants with seeds developed in parallel on hills and side-by-side to swamp plants, and at the climate transition took over the landscape.

Female spores fertilized inside water by male pollens. Some spores grow to sized much bigger than the pollens, and evolved towards seeds. Seeds may evolve from a spore wrapped by leaves.

What cause the seed to be dormant, and germinate at temperature change, humidity, light etc. ? Lack of water inside the seed arrests metabolism. But what are the genetic responses inducing life in seeds?

Why plants have more than two alleles of their genome? Maybe DNA damage due to the dry seed moiety.

Why are seed storing energetic and metabolic “expensive” components such as alkaloids (capaicin pepper and other spices, coffee, coacoa, guarna, cola, tea) and poisons (ricin) ?

The answer is protection from insects and their larvae, but also “addictive” to bees.

SEEDS BANK: a program to save diversity of plants genes.

The Plant Hunters: The Adventures of the World's Greatest Botanical Explorers

by

Carolyn Fry

Plants collection from all around the British empire: in “Cue Gardens” in London

Smuggling of “green” and “black” tea plants from China to India by Robert Fortune

1723 export of the coffee tree donated to Lewis XIV from Jardin Royal des Plantes in Paris by Gabriel-Mathieu de Clieu to Martinique and from there spread all over central and south America.

Use of the Wardian case to protect trees and plants during the long sailing from the far east and south America to Europe, spread exotic plants in the western world.

“The mutiny on the Bounty” a delegation sent to bring the bread tree from far Asia to serve as a cheep food for slaves all around the British empire.
What Asians loved was considered disgusting to Africans…