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About the Institute
The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

Cowslip Wine

Mix together: 1 gallon of cold spring water, 1 gallon of picked cowslips, four pounds of white moist sugar, two lemons, 1 Seville orange peeled very thin & sliced, removing the white previously. Put all these ingredients with a cup of yeast to about 9 gallons, stirring it well twice a day for 8 days. Stop it down very close if the fermentation has subsided, & after 2 months it may be bottled, but many prefer drawing it from the cask. If there should be 10 gallons it should stand in the barrel 3 months, & so on in proportion

North London

Collegiate School for Girls.

BOTANY

Agnes Robertson

TERM
TO
CHRISTMAS
1893
(Wks 14)

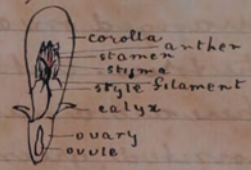
T

Botany

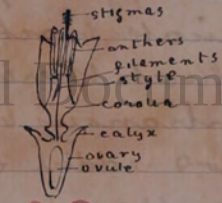
Form IV a — Agnes Robertson

Lesson I — Ord: Compositæ

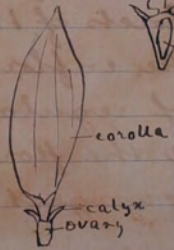
Tubular florets — Stage I Bud



Stage II Dusty flower



Ligulate floret — Stage III Old flower



Note :- The sunflower is not a single flower, but a large, flat, racemose, inflorescence called a capitulum because there are sessile flowers arranged on a fleshy disc, the torus. Outside the inflorescence there are a number of large, pointed, green, roughly-hairy, imbricate, bracts, & amongst the florets there are pointed membranous bracts, white below, & reddish above. Outside the inflorescence there are one or two rows of large, bright yellow, irregular, ligulate, florets, called the florets of the ray. The rest of the inflorescence is made up of regular tubular florets, called the florets of the disk. The youngest flowers are in the middle, & those of the same age in circles round. On examining the disk we find at a certain distance from the centre a circle of flowers which are dusty & have something sticking out of them. Outside these the florets are flatter, & have two tongues curling over.

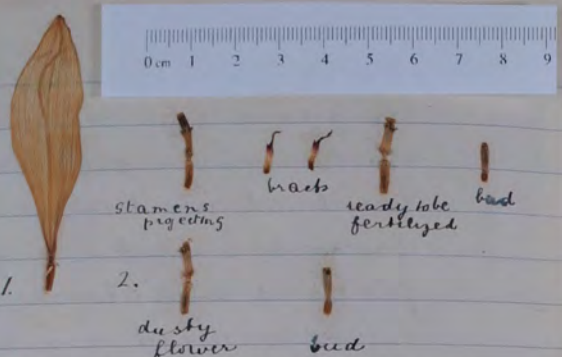
Sept: 19th
1893

Specimens
P. T. O.

Lesson II

Fertilization of sunflower

The sunflower is very conspicuous, made much more so by the ray florets, & the tubular florets hold honey; they are infested by earwigs & beetles especially. The two stigmas at first have their sticky surfaces folded together, & their outsides hairy, so that they resemble a miniature bottle-brush. The pollen is shed into the anther-tube, up the middle of which this bottle-brush passes. As the style lengthens the pollen is all brushed out, giving us the dusty circle. The florets are not self-fertilized because the stigmas are folded together. The style lengthens until all the pollen is brushed out, & the stigmas project. They then curl over, & are ready to be fertilized. The flowers shedding pollen are younger than those with their stigmas uncurled. Insects crawling across the disk, carry the pollen with them from younger to older flowers.



1 Ligulate floret 2. Tubular florets

Lesson II

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If the outside circle of all were shedding pollen there would be no older flowers outside it to be fertilized, & so the pollen would be wasted. Consequently in the outside circle, ray florets, there are no stamens. In daisy there is a pistil & seed is formed, but in sunflower, & cornflower the outside florets are neuter.

Sept 22nd
1893

Lesson III
Desc: of Protococcus

Histology of Plants.

Plants & animals are built up of cells as a house is of bricks. To know what a cell is we must examine a plant such as Protococcus, which consists of only one cell. Rain water which has stood becomes green in colour. On examining a drop of it under the microscope, we find that the green colour is due to small oval green bodies, some swimming about, some at rest. On crushing them we find them to consist of a soft jelly-like material called Protoplasm. In the resting forms this is contained in a tough bag called the cell-wall, which

is composed of a substance allied to starch & called cellulose. The plotoplasm is stained green, but the colouring matter can be dissolved out by spirit. It is called Clorophyll. In every cell there is a kind of knot composed of threads of protoplasm, called the nucleus, which is the vital centre of the cell.

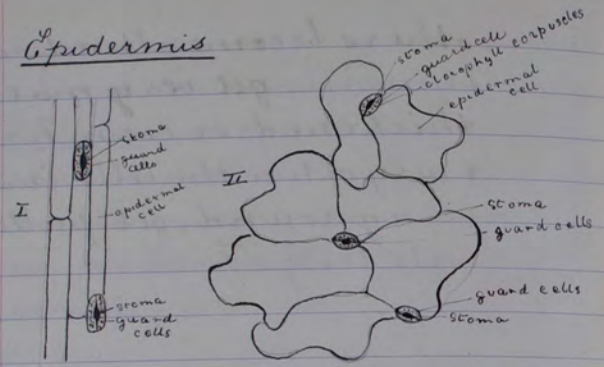
Defn: of cell. An individual mass of protoplasm is called a cell. Plant cells almost always have their protoplasm surrounded by a cell wall. The higher plants are built up of thousands of cells, some of which are very like the cells of protococcus, while others become altered. Sometimes the walls get very much thickened, or even hardened & very often the cells, instead of being round, get pulled out into long threads.

Sept 29.

1893

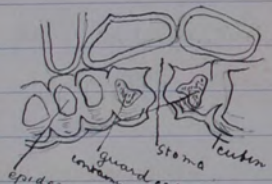
Chlorophyll chlorophyll
Clorophyll chlorophyll
Clorophyll chlorophyll

Lesson 4 Epidermis



Epidermal cells of :-

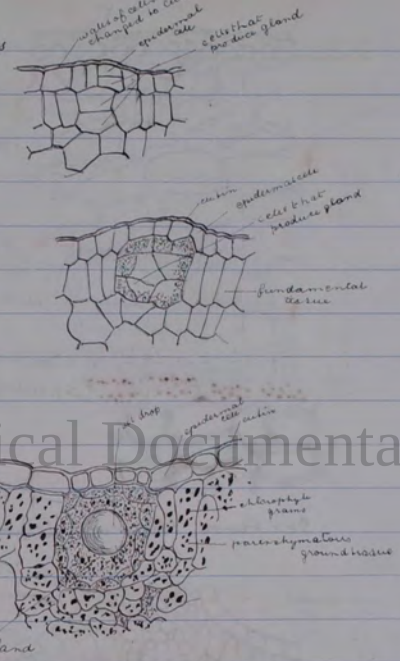
I ~~Hyacinth~~ II violet



Section through stoma & epidermis of leaf of pinus

October 2nd 1893

Lesson 5 Glands



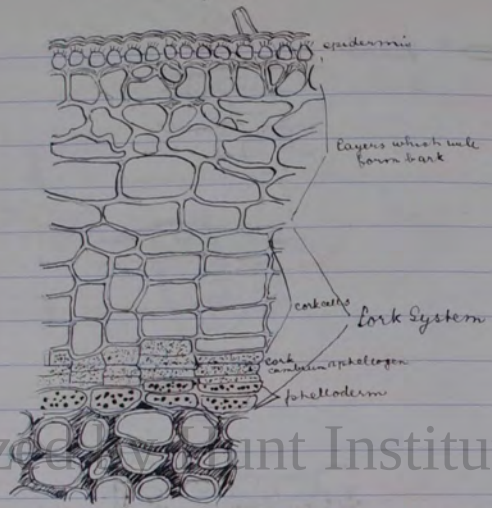
Stages in formation of an oil-gland in the skin of an orange.

October 6th 1893

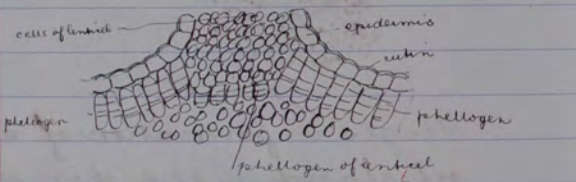
Lesson 6

Cork

Section of Cork



Section through lenticel of elder



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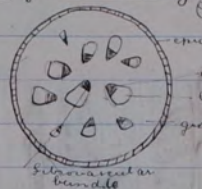
Oct: 10.93

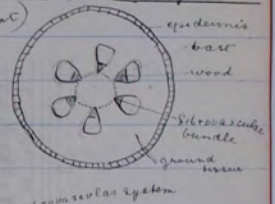
Lesson 7

Fibrovascular system

Stem of a monocotyledon (collateral arrangement)

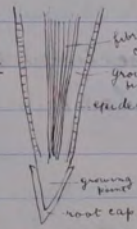


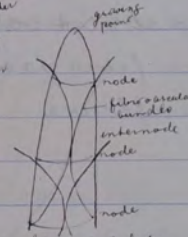
Stem of a dicotyledon



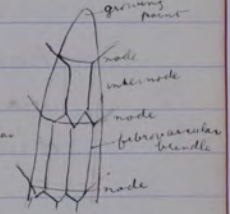
Root section (radial arrangement)

root section





Stem of monocotyledon



Stem of dicotyledon

6/5

Oct: 13 1893

Lesson 8 Cells of fibrovascular bundles

Radial vertical section through an open fibro-vascular bundle in stem of sunflower

October 17
1893

Lesson 9 Cells of fibrovascular bundles

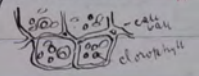
Fibrovascular bundles are made up of:-

(1) Wood
(2) bast

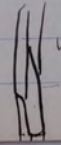
The wood is made up of:-

(1) wood parenchyma which are cells little altered from the original type of protococcus except in being elongated. They contain protoplasm & ~~Chlorophyll~~ Starch grains

Cross section

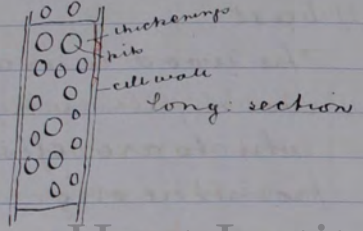


2 Wood fibres which are long lignified cells fitting closely into one another & with no protoplasm or chlorophyll

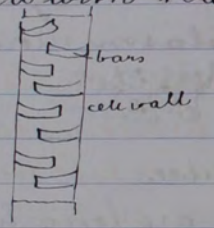


(3) wood vessels
which are formed by the fusion
of several cells
These may be :-

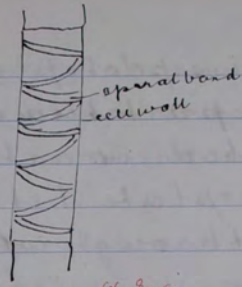
(a) pitted



(b) marked with transverse bars



(c) marked with spiral band

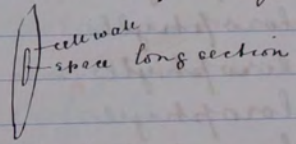


or Rings

The bast may be :-

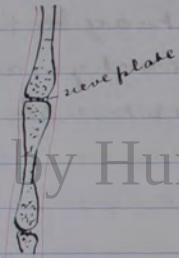
(1) bast parenchyma
which are much like protococcus

(2) bast fibres :-
which are long cells with
very thick soft toughish walls



(3) Sieve tubes :-
which are long cells, particularly

rich in protoplasm with their partition walls partially absorbed, so as to leave a "sieve-plate" between each cell, through which protoplasm passes



8

Oct 20.93

chlorophyll
chlorophyll
chlorophyll
chlorophyll
chlorophyll
chlorophyll

Lesson 10

Notes

Food of plants

Plants contain about 6% water
Water " " " 95% "
Living cells are kept turgid by water in them
Elements found in plants:-

1. Carbon
2. Oxygen
3. Nitrogen
4. Hydrogen
5. Sulphur
6. Phosphorus

necessary to plant life:
- Phosphorus
- potassium
- Magnesium
- Calcium
- iron

sometimes:
- Chlorine

Lesson 11 Plant Food

Plants cannot take in free nitrogen.

The lower plants (eg Protococcus) take in nitrogen in form of ammonia nitrates, which consists of nitrogen & hydrogen

Higher plants take it in in the form of nitrates.

Nitrates consist of oxygen, nitrogen & some metal

They are produced from decaying vegetable or animal matter

Iron forms starch & chlorophyll

Potassium stimulates chemical processes in plant

Transpiration is loss of water through the stomata of the leaves

Oct 31st 1893

Lesson 12 Plant Food.

Substances to build up the plant are taken in

(1) From soil by root hairs as water
(2) " air " leaves " gases.

(1) Water containing various substances in solution:-

(a) Nitrates (consisting of oxygen, nitrogen & some metal)
(b) Water (consisting of oxygen & hydrogen)
(c) Salts (such as calcium phosphorus potassium) etc

Is taken in by the root hairs by a process known as osmosis.

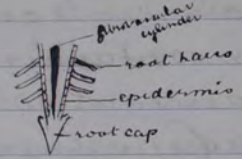
osmosis

Hairs

Water is attracted into the hairs (which are unicellular outgrowths of the epidermis) by the water in the soil being attracted by a vegetable acid in those hairs when the hairs are full of water

the acid solution in the hairs is weaker than that in the next row of cells, so the water passes into them, & so on through the plant

root hairs



Passage of water by wood

The water also gets squeezed into the walls of the wood vessels & pushed up them by root pressure. When this water laden with food material reaches the leaves, contact with the chlorophyll corpuscles reveals the following transformations:

(i) { Carbon dioxide, Water } → protoplasm → { Carbohydrates (i), Amides (ii), Salts (iii) }
(ii) { nitrates
(iii) { salts

(2) The carbon dioxide is obtained from the air

When these elements reach the leaves they are formed into protoplasm

protoplasm

, & then again broken down into carbohydrates amides & salts. The carbohydrates may either be in the form of soluble sugar or insoluble starch. If they are in form of sugar, they dissolve & pass, by osmotic attraction, into the growing buds of the plant. If they are in the form of starch, the starch grains combine with the chlorophyll corpuscles, until a process of fermentation changes the starch to sugar which then passes away. The

starch

sugar

amides (which are little changed from nitrates) are already soluble & so are the salts, so they pass away by osmosis.

Oxygen set free

It is important to notice that a plant gives out as much oxygen as it takes in carbon dioxide. This is shown by the fact that

$6CO_2 + 5H_2O = C_6H_{10}O_5 + 6O_2$

Nov. 7. 93

$(192 \text{ carbon} + 192 \text{ oxygen}) + (10 \text{ hydrogen} + 80 \text{ oxygen}) \Rightarrow (192 \text{ carb} + 10 \text{ hyd} + 80 \text{ oxy}) + (192 \text{ oxygen})$

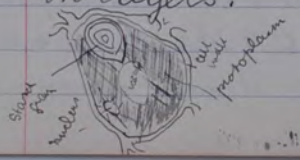
Lesson XIII

Etiolation is caused in plants by the absence of sunlight, or iron. No chlorophyll is formed in the leaves, which are consequently yellowish white in colour, & do not expand properly. No assimilation can goon, & the internodes of the stems are long & spindly. The plant cannot live long in this condition.

Respiration is the breathing of plants. The air is taken in, which is changed into CO_2, water, & ammonia & oxygen is given out. The ammonia is kept in the plant, & the CO_2 & water are given out. Respiration is very

feeble in plants, so that it only shows at night, i.e. when the opposite process of feeding is not going on.

Starch grains are formed in the roots in the leucoplasts. These are masses of protoplasm in the cells of the tubers, roots etc. They are colourless, but otherwise correspond with the chlorophyll corpuscles in the leaves. They take the carbohydrates which are sent down from the leaves, & form starch grains from them in combination with their own substance. The grains are in layers.



Nov. 17. 93

Lesson 14 Examples of irritability

1 Etiolation

2 Heliotropism

Examination of etiolated plants shows us that increase in length takes place faster in the dark than in the light

A plant growing with one side lighted more strongly than the other Ex plant growing in window bends over towards the light.

This is called positive heliotropism.

It can be explained because on measuring the length of the lighted & unlighted sides of the stem it is found, that, though both are growing the unlighted side grows faster.

3 Geotropism

P. T. O.

It is a remarkable fact that all the world over roots grow to, & stems grow from, the centre of the earth. Knight's experiment proves that this is due to gravitation. [See P228.] Roots which obey gravitation are called positively geotropic, stems are negatively geotropic.

4 ~~Bending of roots in direction of moisture~~ supposed to be due to the sensitiveness of the tip of the root. [p. P229] If seeds of mustard & cress are sown on a wad of damp blotting-paper covered with a bell-jar; they germinate. At first the roots grow down; after a time moisture evaporates from the blotting-paper & condenses on the sides of the bell-jar. The roots then curve over & grow straight up into the moist air

5 Movements of mature organs in response to stimulus.

(a) Tendrils on touching a support bend round it

(b) Petioles of sensitive plant drop down & leaves fold up when light changes to darkness & the leaf is touched

(c) Hairs on leaf of sundew close over any insect touching the leaf.

(d) Stamens of nettle & barberry jump & scatter pollen.

Nov. 17, 93

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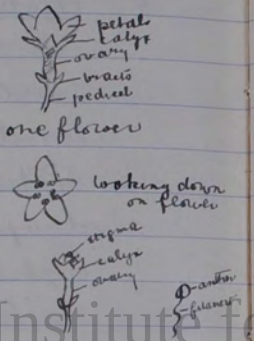
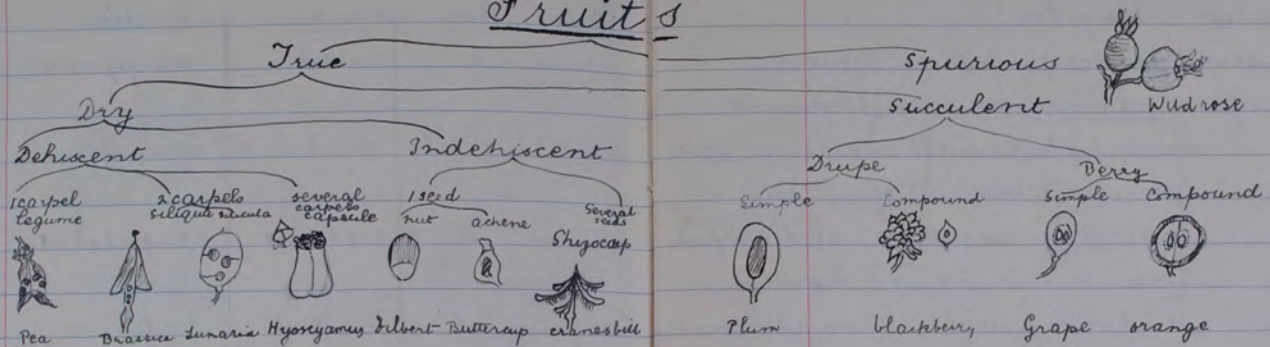
Lesson 16 *Laurustinus* (Viburnum Tinus)



Parts	No	Union	Position
Sepals	5	united	epigynous or Superia
Petals	5	united	epigynous
Stamens	5	distinct	epipetalous
Carpels		united	Inferia

Nov. 21. 93

Fruits



Description of Lemon

Name Lemon

Order

Class: True, because it consists of nothing but ovary. Succulent because it is juicy Berry because it has a soft endocarp Compound berry because it consists of more than 1 carpel

No of carpels about 10

Union United

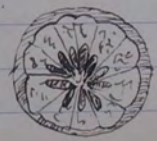
Position Superior

No: of cells Same as no: of carpels

Placenta axile

No of seeds 1 to each carpel

App: of pericarp A thick white layer with yellow outside for epicarp. a juicy sweet acid flesh for mesocarp a softer layer of jelly for endocarp



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Nov 29. 93

6429

Lesson 15 Name Apple

Order Rosaceae Sub:ord: Pomeæ

Classification Spurious, consists of calyx & receptacle as well as ovary; Pome because it consists of a fleshy receptacle with the hard carpels seed inserted in a hard horny endocarp with a small amount of succulent pulp round it formed from the ovary & round that more fleshy fruit formed from receptacle

No. of carpels 5

Position Inferia

No of cells 5

No of seeds about 7

App: of Pericarp The boundaries of the pericarp are marked by a ring of green points. Those are the epicarp. Inside that is the fleshy

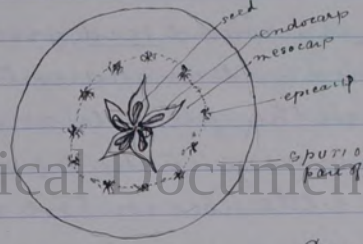
6429

pulp or mesocarp, & inside that the horny endocarp

Seeds The seeds are dark brown & pear-shaped 1 or 2 - end cells

Placent: Axile Sutural

5



Dec: 5: 93

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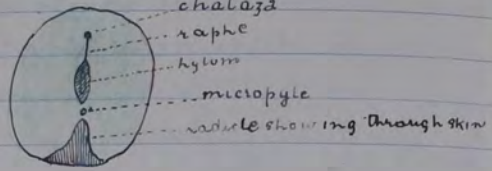
Lesson 16 — Germination of pea

Diagram of pea-seed

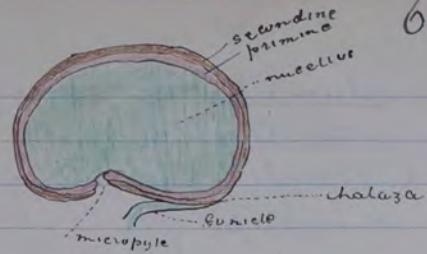


External appearance — Pea is a round seed, green in colour, covered by a transparent skin, through which the yellow triangular radicle can be seen. At the tip of the radicle is a little hole in the skin, the micropyle. Just beyond the micropyle there is an oval white mark where the funicle joined on, called the hylum. From this we can trace a very short raphe to a kind of lumpy spot, the chalaza.

Kind of ovule — Since the micropyle & chalaza are near together the seed is derived from the third kind of ovule

6429

Diagram of ovule



Embryo — The whole interior is occupied by the embryo & is therefore exalbuminous. The embryo consists of a large radicle & plumule, & two thick cotyledons rich in starchy food.

Stages in Germination

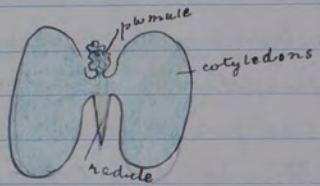
1. The triangular shoot is composed of the root & the upper part is part of the stem. The first thing that happens is for this to straighten itself, in obedience to gravitation, & to grow down.
2. The petioles of the cotyledons lengthen & push the radicle &

plumule each free from the cotyledons

3. The plumule straightens itself & grows up.
4. There is a fourth stage in many plants, though not in pea, where the stem below the cotyledons lengthens & pushes the cotyledons above ground, where they form the first pair of aërial leaves.

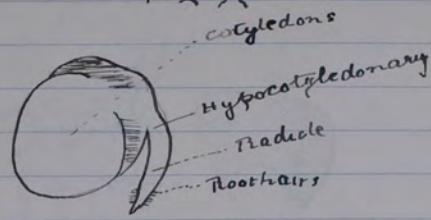
Dec: 893

Diagram of embryo

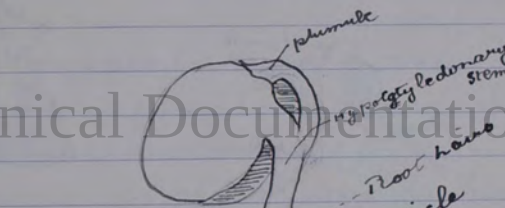


PEA

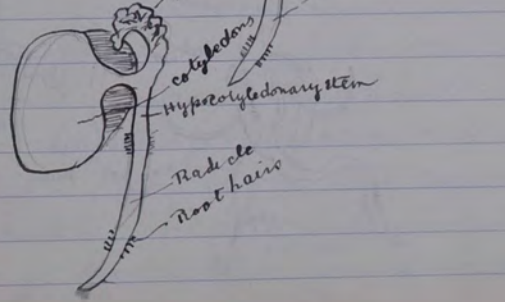
Stage 1.



Stage 2

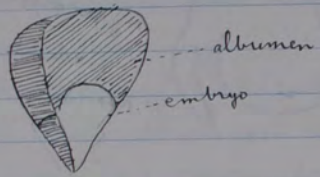


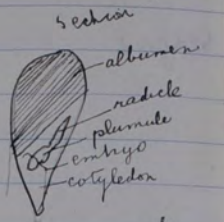
Stage 3



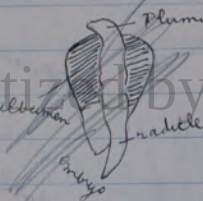
MAIZE

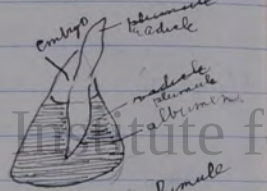
Stage 1



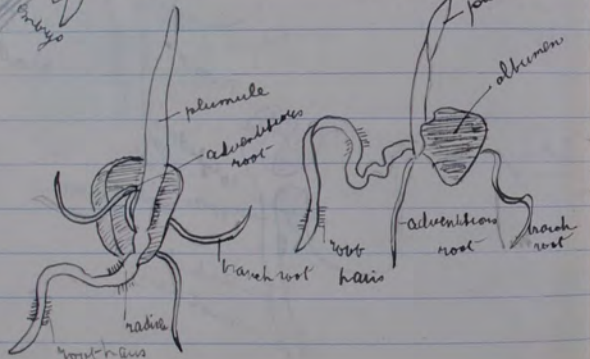


Stage 2

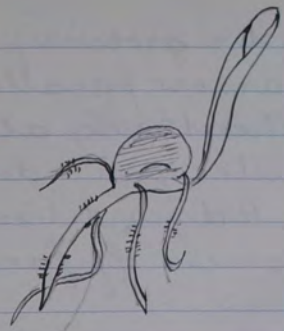




Stage 3



Stage 4



Maize seed is albuminous. The embryo is embedded in endosperm, which is starchy. The embryo consists of 1 cotyledon which sheathes completely round the radicle & plumule, & is sometimes called the scutellum. This remains in connection with the endosperm & absorbs food from it for the young shoots. The plumule grows out from the broad end &

of the seed & grows up & unfolds long narrow parallel veined leaves, sheathing at the base. The radicle grows down & soon branches. Adventitious roots are also given off from the base of the stem.

In some monocotyledons the cotyledon is after a time drawn out of the seed, & becomes aërial like an ordinary leaf.

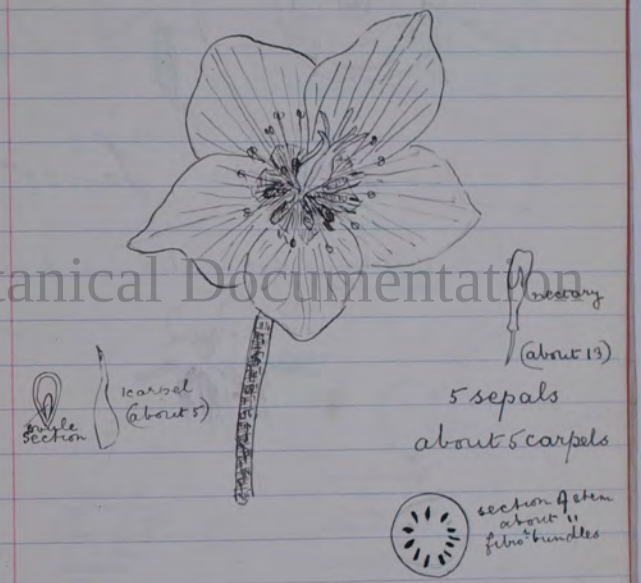
In some, E.G. Hyacinth, the plumule after growing for a little while, becomes swollen, also the leaves, & forms a bulb.

Dec. 9. 93

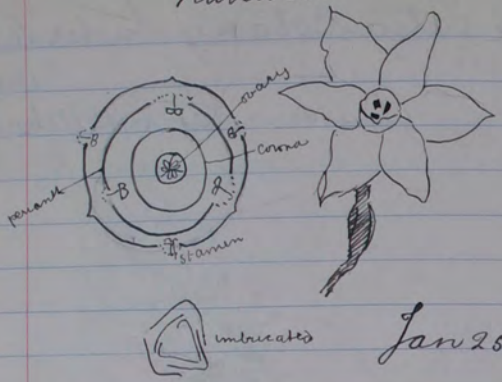
1894 Extra Botany Easter Term

Lesson I

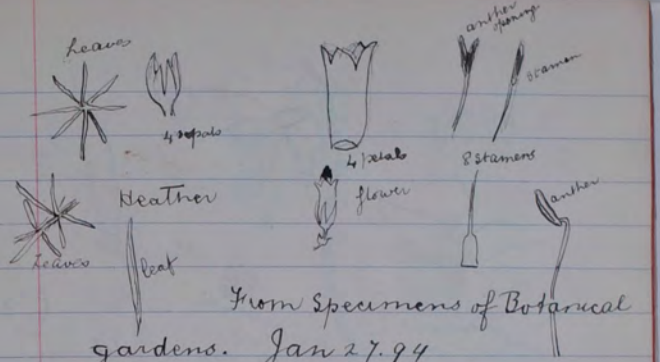
Christmas Rose (Helleborus niger)



Narcissus

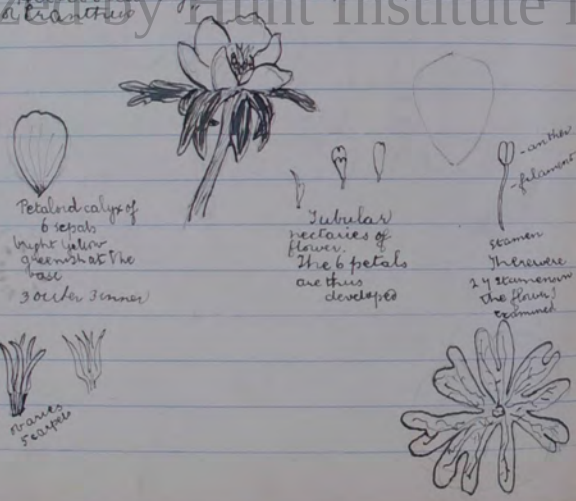


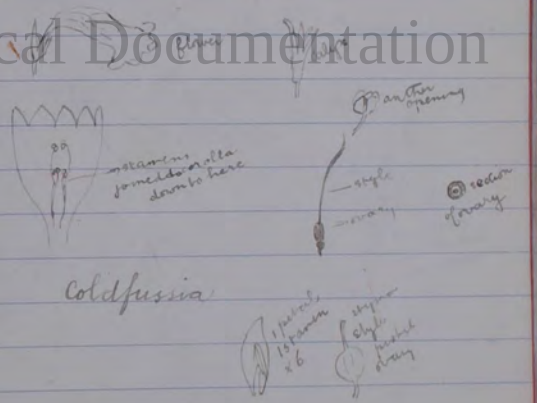
Jan 25th 1894



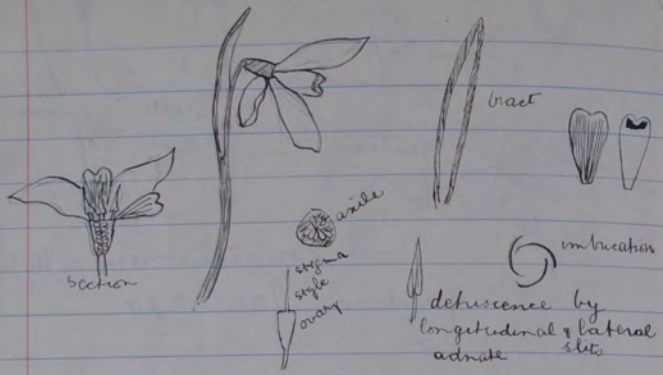
From Specimens of Botanical gardens. Jan 27. 94

Helleborus Hyemalis Winter Aconite
Anthers

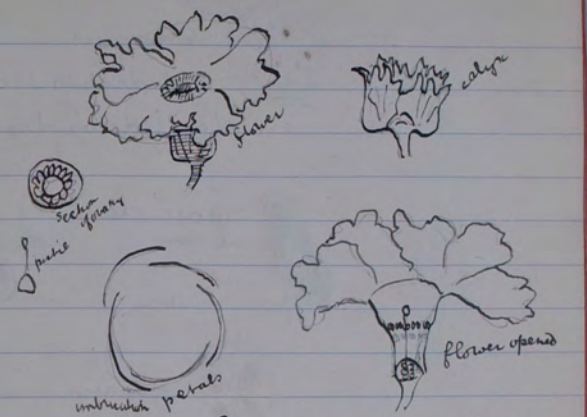




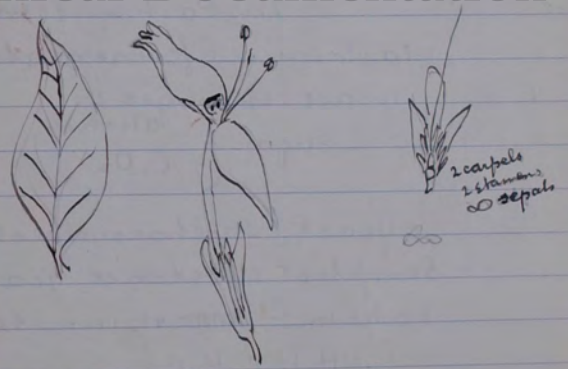
Colchicum



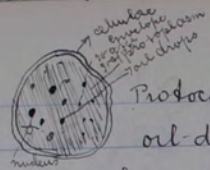
Snowdrop Order:- Amaryllidaceæ



Primula Primulaceæ



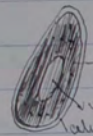
Justicia
ord acantaceæ



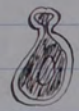
Protococcus

oil drops & starchgrains

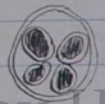
nucleus divides before cell



yeastcell



budding cell



formation of ascospores

M. Pasteur found that yeast causes fermentation

yeast changes :-

Sugar { alcohol / C. O_2.

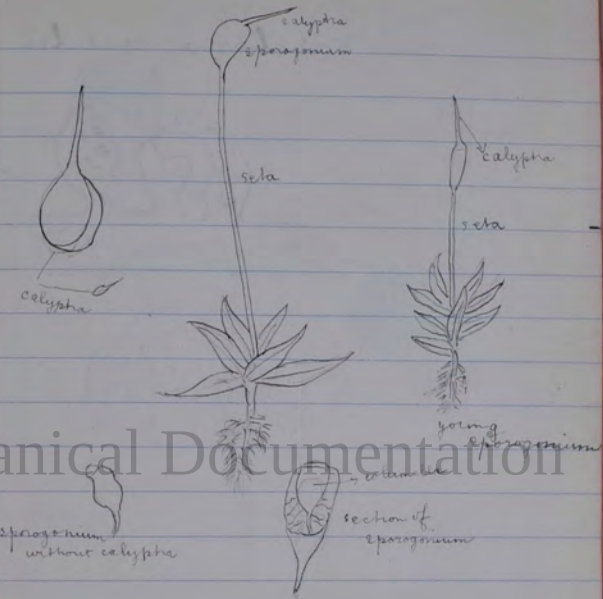
Yeast ; saccharomyces cerevisiae

Simplest substance yeastcan take in :- ammonium tartrate.

$\{(NH_4)_2, C_4H_4O_6\}$

Yeast & protococcus belong to Thallophytes.

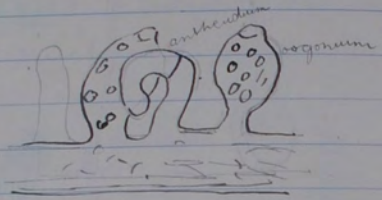
Febry 1844

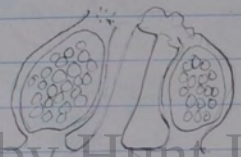


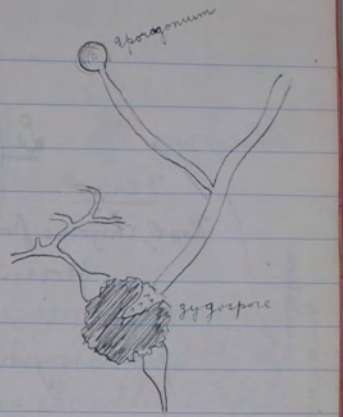
FUNARIA HYGROMETRICA

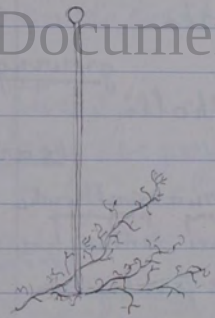
(drawn from life)

Vaucheria sessilis









Mucor mucedo

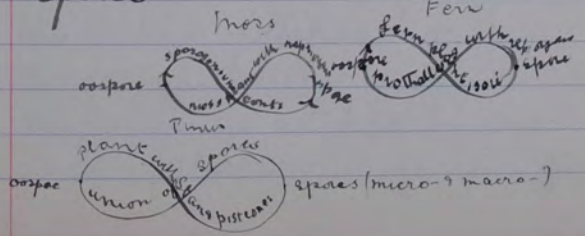
Life Histories

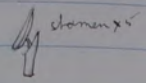
	Fern	Pinus
Sporebearing generation	Root, rhizome fronds bearing	Root, stem, leaves, some modified into
		Stamens — Carpels
	sporangia	Pollensacs — ovules
	containing	
	spores	Pollengrains (microspores) — embryosacs (macrospores)
	growing into	
	prothalli	four celled — endosperm
Egg bearing generation	bearing	
	archegonia containing — antheridia producing	pollentube — several archegonia reduplicate
	oospheres — antherozoids	— oosphere
	oospore fertilization	— oospore
	foot + new plant	
	Fertilization	
Spore bearing generation	oospore	embryo

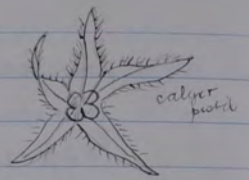
sporogonium

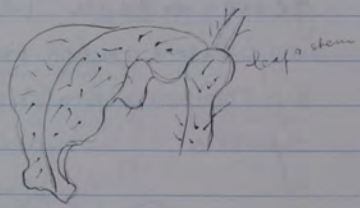
In ferns the sporebearing generation begins with the oospore, includes the whole plant + ends with the spores.

In mosses the spore-bearing generation begins with the oospore + only includes the sporogonium + ends with spores









Bract

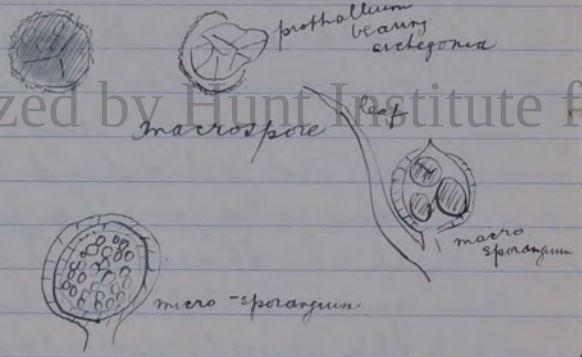
Selaginella

Selaginella is larger than a moss, but very delicate, & it has well-developed fibro-vascular bundles & roots. The stem bears pairs of opposite leaves, always one large, & one little, crossing one another, the big ones spread out towards the light, & the little ones, pressed up against the stem on the less light side. There are a great many branches, all in one plane, certain branches only bearing sporangia. In these special branches, opposite leaves in pairs are alike, with a sporangium at the base of each. The sporangia are of

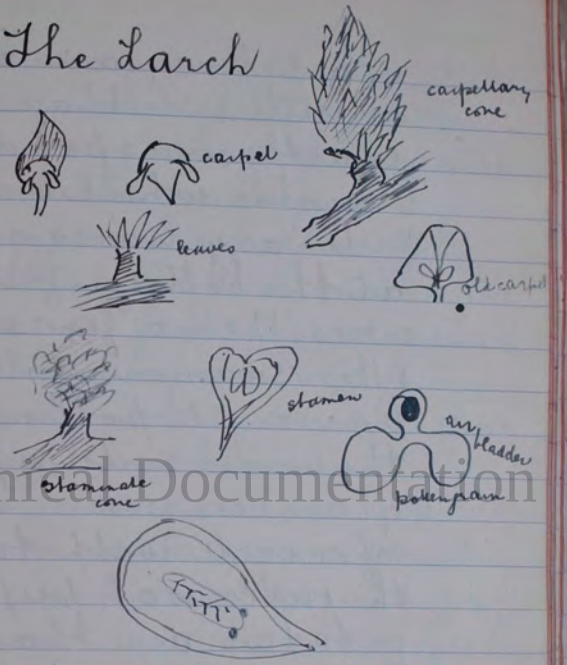
two sorts, some small & very dark brown, & inside a number of tiny little spores, in tetrahedral groups of four, others lighter coloured & bulging out on account of the four large spores which they contain. The spores are all set free from the plant, & that is the end of the sporophore generation. The spores, falling on damp earth germinate & produce the oophore or egg-bearing generation, but this is extremely reduced. Prothallia are formed, but they are so small that they remain within the ruptured exospore. The macrospores divide into several cells, of which all except one are set free as antheridzoids, the one cell which is not set free represents the prothallus.

The macrospore divides into a little mass of cells representing the prothallus, which bursts the exospore & sticks out a little, & on the projecting part, one or two antheridzoids are borne. After fertilisation the oosphere becomes an oospore, & divides to become a new selaginella plant, which therefore appears to grow out of the spore. In the great reduction of the oophore generation selaginella resembles flowering plants, but the great difference is that all the spores are set free in

selaginella, germinate independently, whereas in the flowering plants the macrospore (embryo sac) is embedded in the ovule & stops there, so the oophore takes place embedded in the preceding sporophore.



The Larch



Larches drop their leaves every year, they are the only British firs which do so. The leaves are acicular & born on dwarf shoots.
Two kinds of flowers, staminate

& carpellary are also borne on little side branches, exactly corresponding to branches which bear leaves. Ordinary leaves appear at the bottom of staminate cones, then a few scaly leaves & then stamens, little brate leaves with pollen sacs on the under side, & pollen grains consisting at first of one cell with two coats, the outer coat puffed out into two air bladders. The carpellary cones consist of pink pointed bracts, at the base of each bract a fan shaped green carpel, & at the base of each carpel two ovules. The chunks get filled up with pollen, & the carpels swell up & get very resinous & shut up the pollen. And the ovules curve round & scoop up the pollen. The pollen grain divides into four or five cells, corresponding to the prothallus, & forms a pollen tube corresponding to an antheridium. The ovules contain each an embryo sac, corresponding to a macrospore, which divides into a mass of cells, the prothallus, embedded in which are one or more corpuscula, corresponding to archegonia, the lowest cell being an oosphere. The pollen tube comes down &

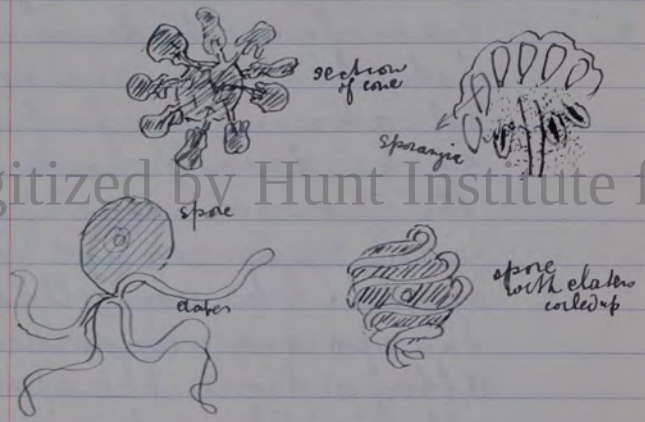
fertilizes the oosphere which becomes an oospore & divides to form a new plant.

Apul 10. 94

Equisetum

The equisetaceæ at the present day are represented by small plants, 1 to 2 feet high. In the coal measures equisetums form the prevailing trees. The stem has a well developed fibro-vascular system, & consists of nodes & internodes, each node bearing an annular dentate leaf sheath (forming a ring round the stem) & numerous whorled branches. These green branches are given off each year from an underground stem, & are ridged. The fertile spikes are quite different, they are generally devoid of chlorophyll, & appear earlier in the year than the sterile spikes, but often the fertile cones form the terminations of sterile spikes, & in equisetum sylvaticum the fertile spikes turn green when the spores are ripe. The fertile spikes consist of peltate shields like umbellas, with the sporangia underneath. after a time the spores are set free. The extine bursts in a curious way into four ribbons called the elaters. A much lobed prothallus is formed, bearing anthredia

at the extremity of the lobes, or archegonia in the angles between them. (So equisetum is isosporous, but selaginella is heterosporous)



Lycopodium

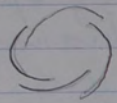
Lycopodium has a much branched stem, with crowded green linear leaves arranged spirally. It has fertile spikes, sometimes much like the sterile spikes. In most species they are yellowish, in contrast to the rest of the plant which is green. All the sporangia are alike. Large subterranean prothallia have been found, but they have never been grown artificially.

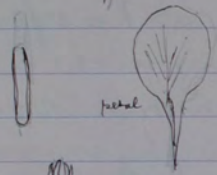
Selaginella & lycopodium are called incorrectly "club mosses"

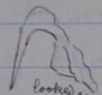
Order

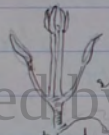
Cruciferae

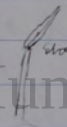

cruciferous flower

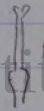

arrangement of petals


petal

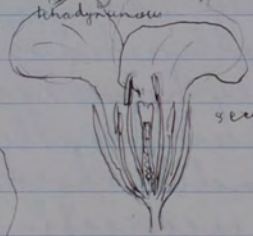

looked at sideways

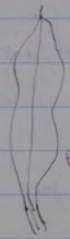

stamen


stamen

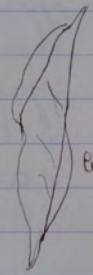

pistil

shadymnow


section


leaf

Wallflower


leaf

Candytuft


flower

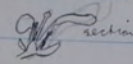

x2


x2

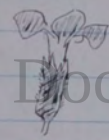

stamen

sepals


pistil

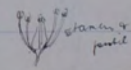

section

Purple flower

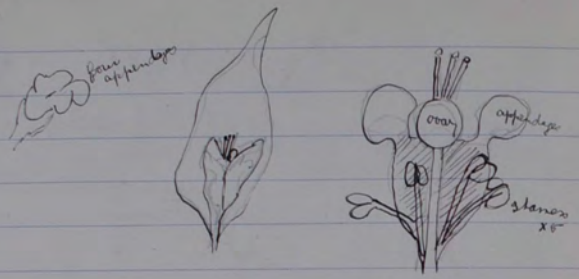



stamen + pistil

Small yellow flower

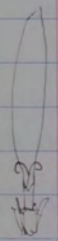

stamen + pistil

Fruit of whitlow grass



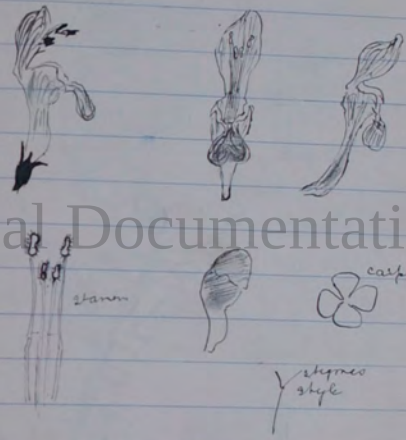
A species of spurge

Marguerite

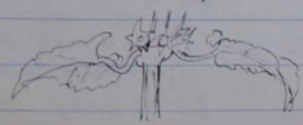


forget me not

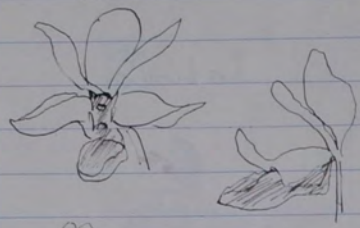
Labiatae

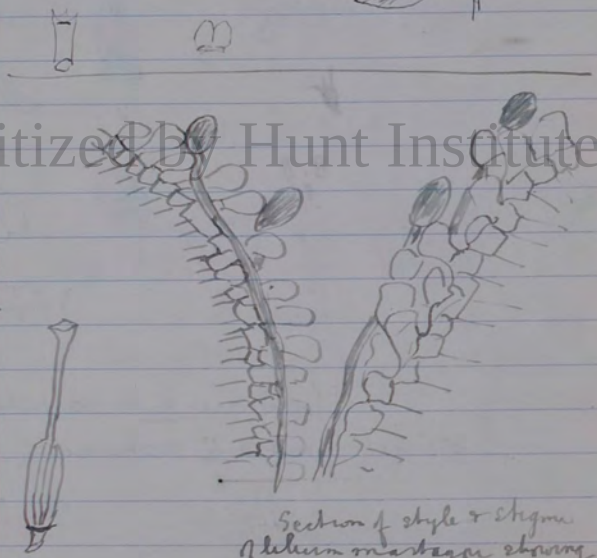


There are two carpels which divide into 4 achenes



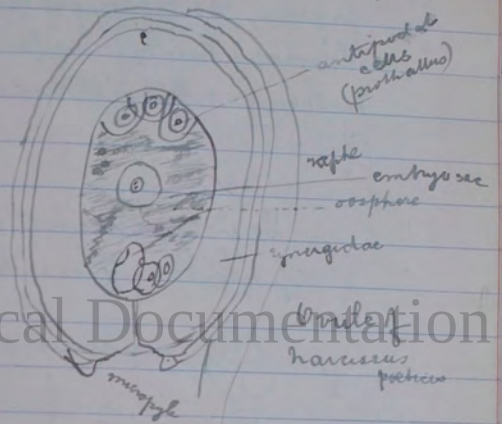
Veronica



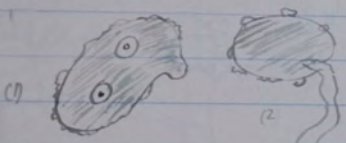


Section of style & stigma
of lilium martagon showing
pollen grains & tubes

Reproduction of Flowering Plants



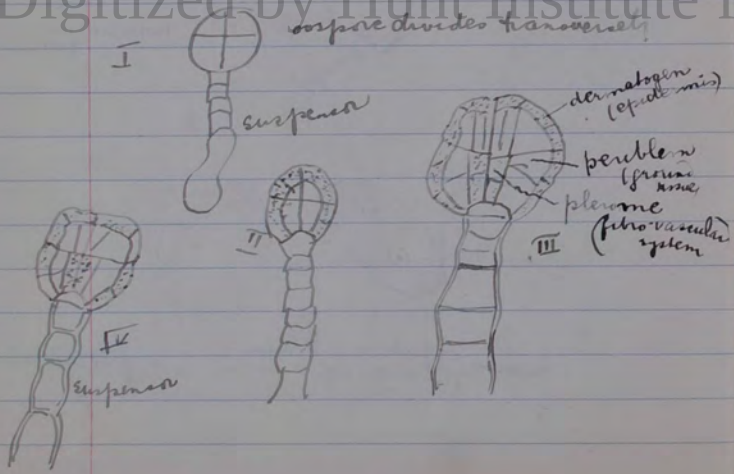
Orchis
Narcissus
pollen

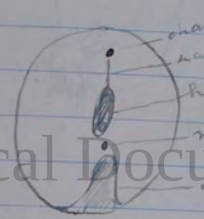


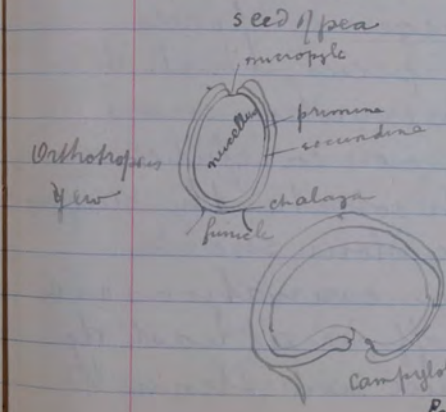
Pollen grains of lilium
martagon showing 2 nuclei (1) & pollen tube (2)

Nucellus usually disappears but occasionally persists, as in pepper, to form perisperm. Endosperm persists in wheat. Nothing persists except embryo in pea.

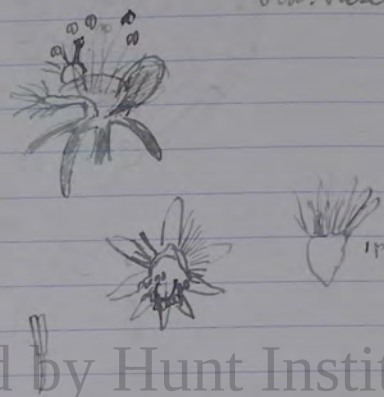
Development of oospore of Shepherd's purse into a seed







Mignonette
Ord. Resedaceae



Origin of species

1 In every species, which to a cursory observation seems constant, more careful observation shows to be constantly varying in shape, colour, size etc

2 The extreme variations as a rule die off, or at least do not produce seed. Hence the general type remains unaltered provided the circumstances remain unchanged

If however, circumstances change, certain varieties may now be better suited than the original type, in which case they will crowd out the original type

3. Generally the changes will be such that one variety will be better suited to one district, & one to another; thus a number of different species will be developed from one original species.

Thus in woods are found white anemones
" marsh " " marsh marygolds
" fields " " yellow buttercups
" water " " water crowfoots

4. A species once established often persists through long ages, but finally some competitor is pretty sure to come into the field even better suited, & so crowd out the former species, sometimes entirely, & sometimes the old species will exist in special localities

Thus — The reptilian fishes have on the whole disappeared, (fossils of them being found in the Devonian) but they have recently been found in the mouth of the amazon, & certain Australian & African rivers, where they have been better suited to the locality than fishes or reptiles.

Origin of Continents

The earth was first a molten mass, which cooled on the outside & formed a crust Then the inside began to contract & cool, & so caused wrinkles to appear on the crust. These main wrinkles are the Continents But as the inside went on contracting there was constant oscillation, thus causing one part to be covered with water at one time & another to be dry.

In this way we get coral & chalk in England. For England could not have been totally under water as the wrinkles were permanent, & the coral clay etc could only have been laid in very shallow

water
Besides we find estuarine fossils in rocks of all the Geological periods. Therefore there must have been a shallow sea there
The islands in the great oceans could never have been part of a continent, for they contain no sedimentary rocks; they must have been Volcanic or Coralic

Conclusion We where there are continental masses now there always have been, although there has been some little oscillation. Because of the deposits formed there must have been a shallow mediterranean sea over central Europe. Therefore some countries must have been divided or separated, tending to diversify animals

Ice Glacier In Scotland & Wales are found ice-scratches running down the valleys, not parallel with the strata. In the beds of the valleys are irregular rocks, ground down & polished called "roches moutonnées". Besides this we get "travelled blocks" of material of the Cumberland Mts in the Isle of Man. We never find them except in countries where there were glaciers once, Geologically tolerably recently. Also there is a deposit called the Till covering all over Scotland

N. Ireland & Isle of Man. It consists of a fine stiff clay with ice-scratched stones embedded in it.

If you mix it with water you get the same appearance as glacier water.

The travelled rocks among the Jura show that Switzerland must have been ice capped

Moraines similar to those found in Glaciers are found in Scotland.

The several glacial period have much altered species— Sometimes whole species have been killed out altogether

Causes of the Glacial epoch.

The earth's orbit is an ellipse with the sun in one of the foci Therefore at one part of its course the earth is near the sun, perihelion, & at another further from the sun aphelion. The difference of distances now is about 3 million miles. The earth's axis is inclined 23½° so that the Northern Hemisphere has summer in aphelion, & winter in perihelion, therefore our winters are milder, & several days shorter than those of the Southern hemisphere while the summers are cooler & longer.

The space of the earth's orbit varies considerably; it can be

calculated that in previous ages the eccentricity was greater, i.e. the ellipse was longer & flatter than now. 210,000 years ago the ellipse was so long & flat that the earth was 10½ million miles nearer to the sun in perihelion than in aphelion & there was 280 yrs difference in the seasons.

The Northern Hemisphere then had Summer in perihelia so that it must have had a very short hot Summer & long cold winter.

This would be enough to cause the average winter temperature in England to be 39° lower than it now is, namely than 37° Fahr. = -2 Fahr. i.e. 34° of frost. Quite enough to account, together with the long winter, for the vast masses of snow & ice in any country which receives a certain amount of moisture.

It is found that in NE Siberia & the district round the Hudson's Bay, whose average temperature is lowest in the world are yet not glaciated, as Greenland at a higher temperature is.

We find that low lands are never covered with perpetual snow & ice & apparently never have been. Highlands do condense water

into snow are all-essential to glaciation. From the sudden thaw which takes place in Siberia we see that warm winds have more of influence in producing a thaw than the increase of sunheat.
Thus we see that astronomical causes alone will not produce a glacial epoch, but if at any time we have high land in the North & South pole regions during a period of high eccentricity & winter in aphelion, (these combined caused) will cause a glacial epoch. The last period of high eccentricity began 20,000 yrs ago, & ended 8,000 yrs ago. Calculation tells us that there must have been a period of still higher eccentricity 500,000 (Still higher) Dr Knoll maintains these two previous glacial epochs, but the fossil remains of plants & animals in beds of that period show that all over central Europe, Greenland & even Spitzbergen, Siberia, & islands North of the Asian continent the land was then covered with a vegetation corresponding to what we find now in the Southern & middle United States

Examples On W. Greenland fossils are found of Chestnuts, sassafras, magnolia
In Spitzbergen
Swamp Cypress, water lilies, oaks
iris planes etc

There is abundant evidence that for about 3 million yrs before the arrival of the last glacial epoch the climate of the Northern hemisphere was much warmer than it is at present, & though it varied at different periods from semi-tropical (sycamore, cypress) to N. Temperate, it was never as cold as now.

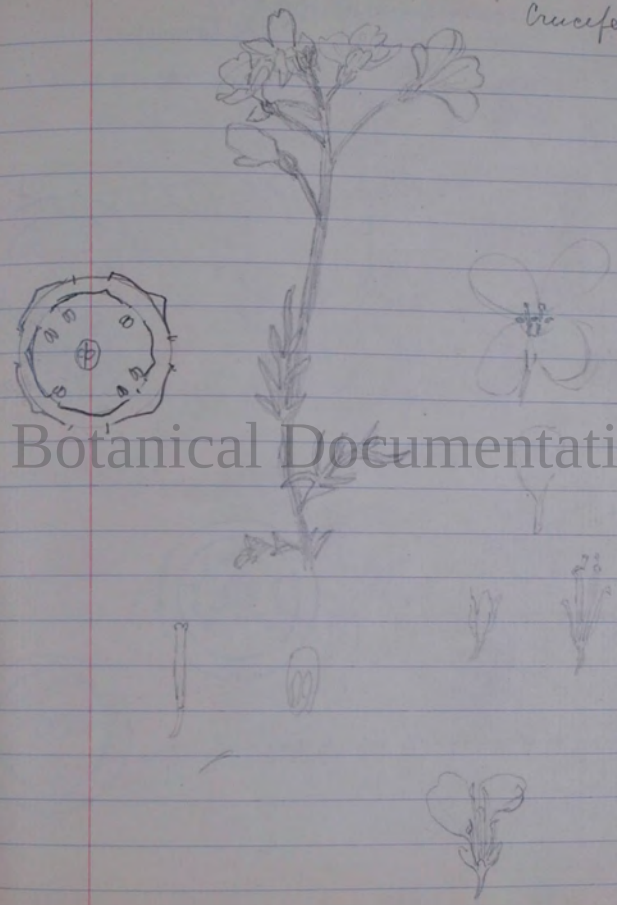
Thus Dr Kroll's little supposition is quite absurd

This is explained by geographical consideration.

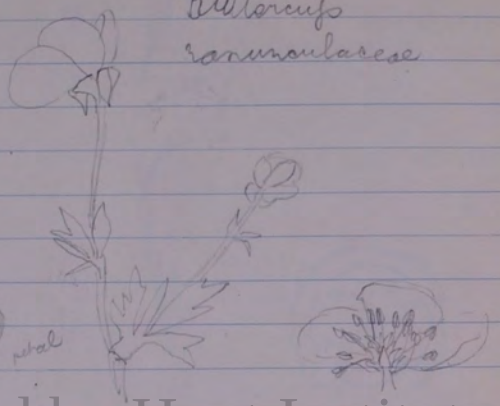
Geologists are able to determine that 500,000 yrs ago, arrangement of land & sea in the Northern hemisphere was very different from now

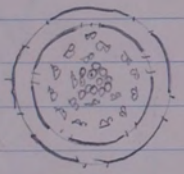
It is almost certain that Northern Germany, etc was underwater, so that the Baltic communicated with the Black & Caspian Seas, & by present valley of Euphrates with P

Cuckoo flower
Cruciferae



Buttercup
Ranunculaceae

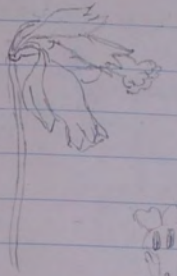




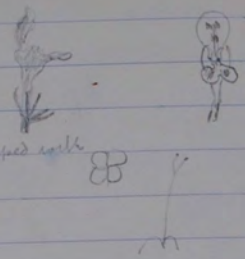
K5 C5 A∞ g∞

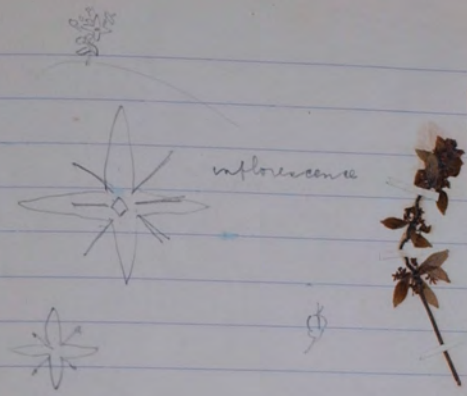
Cowslip Primulaceae

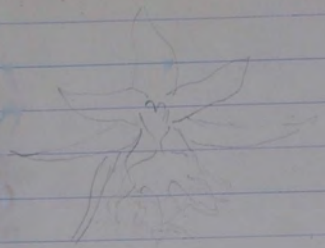
K(5) C(5) A 5 g

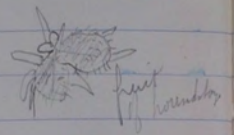


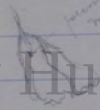
K 4 C(4) A 2 g

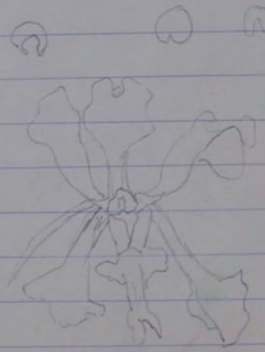


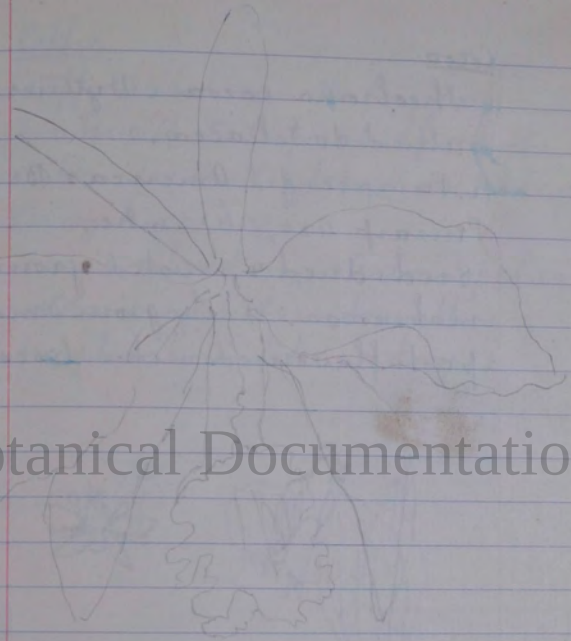


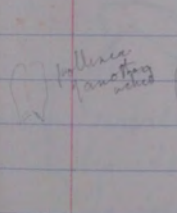


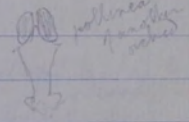






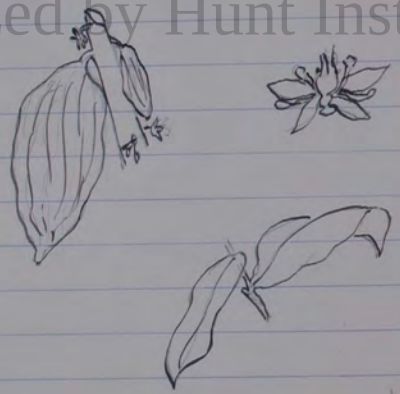






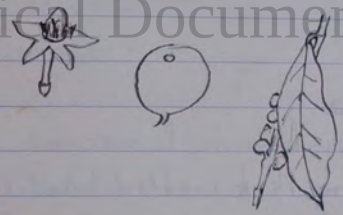
Cocoa

Theobroma cacoa . Byttneriaceae
Allied to Tiliaceae.
N. Provinces of S. America & Brazil.
Pericarp 4×2, 6×3 inches.
Seeds dried & roasted, ground to make cocoa. Finely ground made into a paste flavoured makes chocolate.



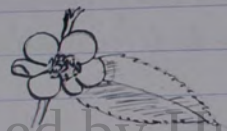
Coffee

Coffea arabica. Rubiaceae
Native of E. Tropical Africa, but cultivated in Ceylon, E & W Indies & Brazil.
Fruit about size & colour of cherry containing two seeds with a parchment-like endocarp



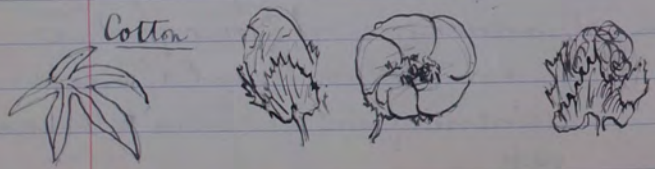
Rubiaceae
- Also Ipecacuanha from Cephaelis I. (root)
- Madder from rhizome of Rubia tinctorum from Levant & S Europe
- Quinene from Cinchona & Peruvian bark

Tea
Thea Chinensis. Ternströmiaceae
nat wefs N.E. Jungles of India
same order as Camellias
Allied to Hypericineæ



Flax
From Linum, Linaceae, fibres consist of long thick walled bast cells.
Linseed contains much oil

Cotton



Gossypium herbaceum. Malvaceae
hairs on seed

Bast
Bast of Russia matting is the liber of lime Tiliaceæ, torn into strips & roughly plaited. Principally imported from Russia

Jute
Is a fibre obtained from Corchorus longi-lustrous. Tiliaceae. India.

Potatoes
(Solanum tuberosum)
solanaceae. S.W. Coast of S. America
15% starch

Cayenne Pepper
Capsicum. Solanaceae

Tomato & Aubergine
Solanaceae

Tobacco
Nicotiana Solanaceae

Turpentine & Tar
From species of pine coniferae

Urticaceae

Hop
Mulberry
Fig
Breadfruit
Indiarubber
Hemp

Nutmeg
Celastraceae (spindle tree, British member)

Cloves

Cinnamon

Ginger

Artichoke Cynara Scolymus
Introduced into Pampas of
S. America

Jerusalem Artichoke
Helianthus tuberosus from
tropical America

Salsify & scorzonera chicory
Esculent root used to
Compositae mix with
coffee

Convolvulaceae

Jalap from Mexico
Sweet potatoes native of S. America

Polygonaceae

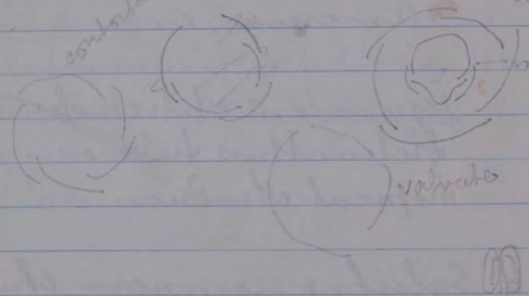
Chenopodiaceae Marigold Wurzel, beet, spinach
Polygonaceae Buckwheat

Foxglove digitalis purpurea

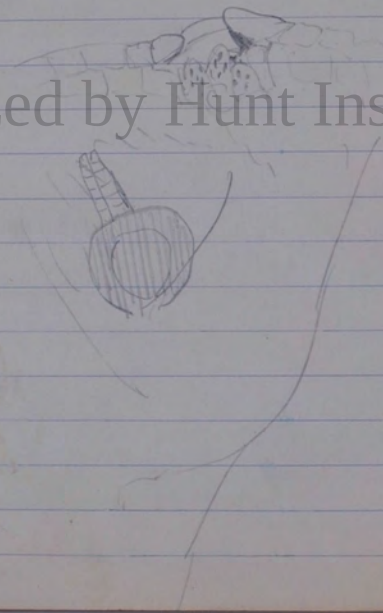
Syngenesia [illegible]

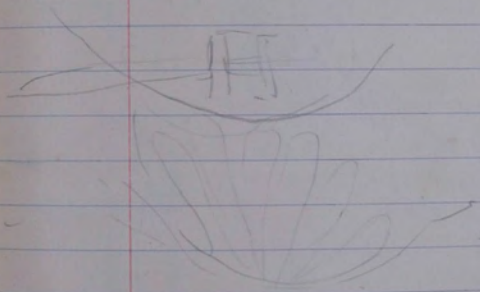
Marchantia polymorpha

Veronica [illegible]

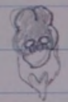


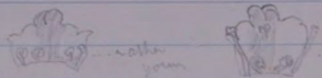
Water Vegetables
Sub "
Cryptogamia
Division
Musci
Order
Genus
Marchantia
Species
Polymorpha



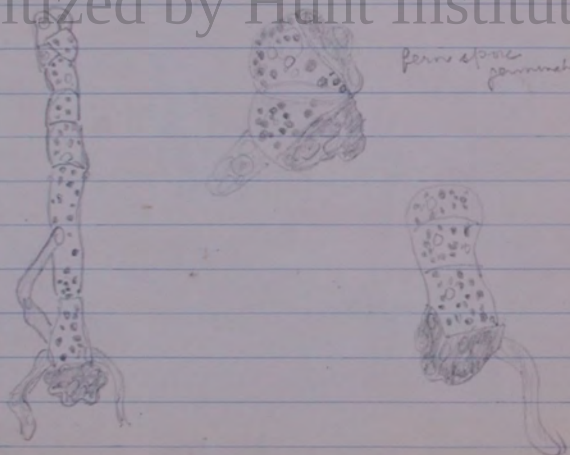


Figwort

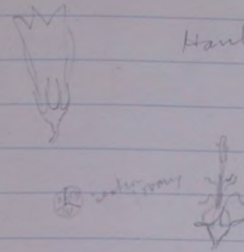




Fern



Harebell



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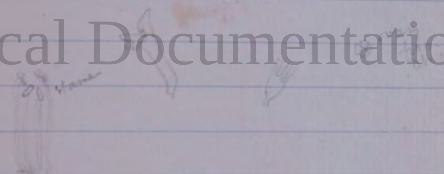
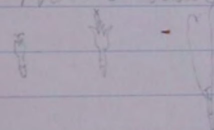
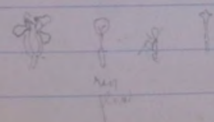


Moon daisy



Yarrow



12.4 ∞ 2

Crucifereae.
5.5.5.

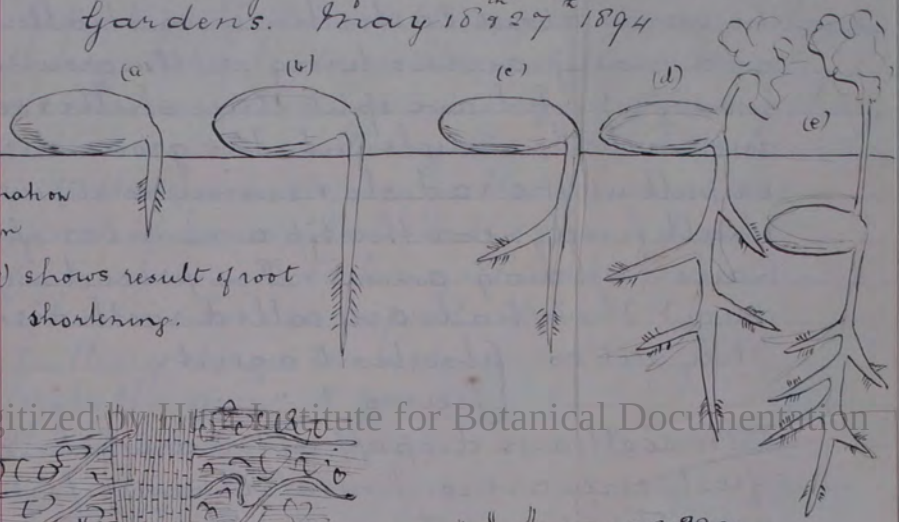
Life History of Gymnosperms

Gymnosperms are lowest flowering plants. Fertile leaves mixed up with bracts. Cones consist of leaves bearing sporangia
Leaves bearing sori are of two sorts.

Pollen sacs & ovules	sporangia
" grains [illegible]	[illegible]
Division of pollen grain endosperm & antheridial cells	prothallus
" pollen tube oosphere archegonia	antheridia & archegonia
oospore	oospore
embryo	embryo

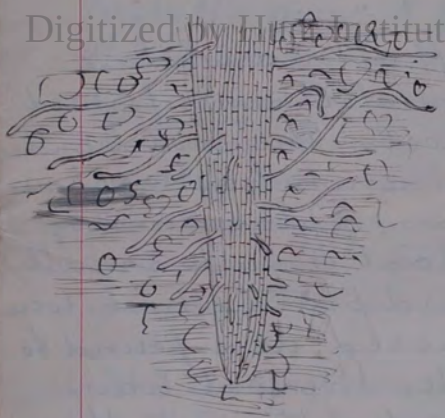
Roots

Lectures by Prof: Oliver at Botanical Gardens. May 18th & 27th 1894

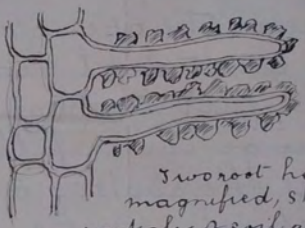


stages in germination of acorn

(c) shows result of root shortening.



Tip Root with root hairs



Two root hairs more magnified, shewing particles of soil adhering to them

The best way to study roots is to begin by watching germination. If we walk in the woods about Easter time we shall see a good many acorns lying on the ground, some of which have split their shells & sent down a little radicle into the ground. If we pull up the radicle & examine it, we shall find, near the tip a number of little hairs (See diagrams II & III on preceding page) These hairs are called roothairs. They act as { absorbent agents / living "

These roothairs drop off after a while, & fresh ones are continually being formed near the apex of the root. The root branches a great deal & each branch has root hairs. (In fact the root system of a plant is very extensive large even if the plant is quite small, & all the roots of a gourd plant, which were stretched out & measured, were found to be 15 miles long). After the root hairs drop off the older parts of the root, these parts contract. This buries the acorn below the surface of the ground. The root-shortening amounts to 10, or sometimes even 16% of the

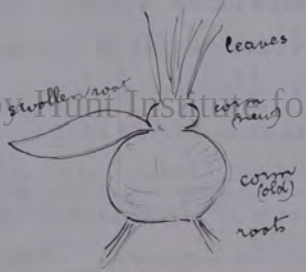
whole length. Root shortening is associated with increase of bulk in the root, & the water supply. If the water supply is much lessened the root shortening does not go on. Root shortening is of use in "pegging down" the runners of strawberry etc; in pulling seedlings into the ground; in pulling down the shoots of bramble into the ground in the autumn when long shoots are put out, whose ends are capable of taking root; in pulling down stumps of perennial herbs into the ground for the winter; in tightening the hold of the aerial roots of climbing plants on the stems of their neighbours etc.

Root shortening (shewn by pranovery furrows, is best seen in herbaceous plants ex caraway.

One of the functions of the root is to store surplus food material & carrot. The hemlock roots are thick & fleshy & store food, but they secrete a yellow evil smelling poison, which prevents animals & men from eating the roots.

The crocus forms corms. These corms are modifications of the stem. Each year a new corm is formed on the top of the old corm which withers up. Sometimes, if a great deal of food is coming down from the leaves

& it is not convenient for the new corm to receive all the supplies, a ~~the~~ root grows out between the old & new corms, & grows thick & fleshy with food, & forms a temporary storehouse. When the current from the leaves is lessened the new corm receives the food from the root & the temporary root shrivels up about the end of may, its use having gone.



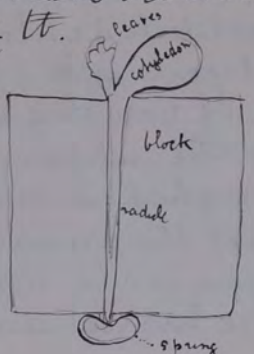
Corms & extra root of crocus

Some plants form aërial roots which go into the earth & support the plants. Examples are mangrove, certain palms, maize canyota urens etc.

Another curious modification of the roots is seen in the palm acanthoriza in which the thorny aërial roots form a quickset hedge to protect the base of the stem.

One orchid, grammatophyllum, besides

possessing aerial roots, has vertical branches from its aërial roots, which bear thorns. These vertical roots form a thick nest which catches organic odds & ends & they decompose & form food for the plant. Roots exert tremendous force. They have been known to push their way right through bulbs. In order to measure the amount of force exerted by a root a radicle of a bean was encased in an equal mixture of plaster of Paris & water. This soon hardened into a block. Then a spring was placed beneath the tip just touching it, & the amount of effect the root had on the spring was measured by seeing what weight had the same effect. The young root of a bean exerted a pressure equal to about $\frac{1}{2}$ lb.

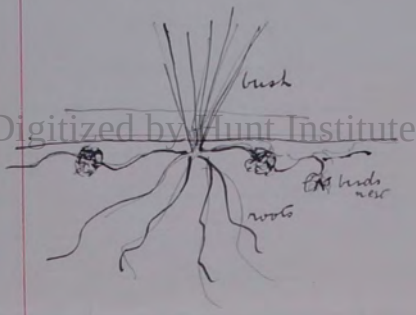



original form of spring.

Water usually falls on the outside of trees when the roots spread out so that the root hairs are on the outside. In some cases the water falls inwards, & the bulk of the roots are nearly vertically below the crown of the root

Very interesting structures are found on the roots of plants of the order ericaceae, or hazel, beech, oak & most forest trees, flowering plants destitute of chlorophyll such as certain orchids & broomrape (particularly bird's nest orchid) If you dig up a hazel bush you find on the uppermost roots which run through the rich vegetable soil on the surface of the ground, little matted tufts of fine roots, which look like bird's nests. The largest are about 1 in:

in diameter. The structure of the fibres of the bird's nests is unlike that of the other roots. They produce no root hairs but are covered with a felt like fungus which produces filaments which simulate root hairs. The roots are assisted by the fungus They do certain services for the fungus. The fungus is <u>not</u> a disease.



tip of root from bird's nest clothed with fungus.

1 Small leaved Elm. Ulmus Campestris
Elms reach 70 ft. 100 ft 120 ft in height
(D) seed Tree most propagated by suckers
Wood used for pumps chopsetts snaths

2 Wych Elm Ulmus montana
Has no suckers for propagation
"wyche" is supposed to mean "chest"
from use of wood in boxes etc

3 Ilex Quercus Ilex
Dark glossy green leaves Wood used for
axle-trees pins mallets wedges etc

4 Beech Fagus sylvatica
Straight pillared smooth grey trunk

5 Ash Fraxinus excelsior
"Keys" of ash. Light green leaves
Bark light ash colour

6 Wavy leaved oak Quercus pedunculata