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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.

Botany - 6
Harvard
U. R. Thaxter
1891-1892

Cultures: special fungi (pure) and grass mixed cultures as sources of material.
Sterilization - dry heat 140C for 20 minutes.
Moist heat more effective: discontinuous - by boiling tubes in a can - 4 times successive half days.
Heat under pressure - autoclave - 120° ½ h. enough.
Sometimes better to sterilize at a lower temperature than boiling. Blood serum below 70°
Sterile liquids can sometimes be obtained by filtration thru porcelain filter
Culture media: Vegetable, Animal and Synthetic media
Animal: meat dung, egg, feathers, horn, blood serum
Veget. Fruit, vegetables, cornstalks, meal, potatoes etc
Some will grow on one and not on others - or will → certain fructifications on one - not on another.
Artificial media may → color reactions not given on potato etc.
Two types: liquid or solid media - may sterilize the media or use as sources of material. Feathers → forms not found elsewhere. A large and varied flora on dung. Bird dung → peculiar forms different from rat or mouse dung.
Liquid media not so important except for gross effects. Only means formerly used for isolation. Dilute to say less than 1 in a drop - then examine under scope till get a single one: Hansen working on yeast stuck to this method.
Mostly use gelatinous base: Glycerine jelly just used and in stiff - add 150 g. gelatine to 1 l. of liquid medium
Agar-agar - Choudrus ie even better one can make his own. Gelatine melts too easily - can be improved

by adding agar. Will sort out liquefying and non-liquefying bacteria. Is clear. 50g gel. to 7½g. agar to l. → good non-melting medium.

Stock peptone broth gelatine used in bacteriological laboratories: Meat decoction - heat to coagulation and the albumenis will coagulate and clear the liquid (urea) 20g of agar to liter → good agar. If keeping to keep cultures 40g to liter is better (Transfer 3 times a year). Add beaten egg white to l quart of agar. Heat quickly and egg will coagulate and carry up sediment. Potato-agar is best medium known - Almost everything grows on it

Dipping tubes (cotton plugs) in paraffin will preserve for some 9 months when standing.

Bacteria in Relation to Plant Diseases Smith 3 Vols → many cases of synthetic media.

Monday Feb. 19 1917.

Potato agar: Big potato 1 l. water. Wash potato thoroly. 30-40g agar for stiff or 20 for ordinary. Cut to cubes. Bacon or peel potato, wash again slice thin / l. of water. Simmer slowly 3/4 h. till fluid is opalescent. Don't let potato go to pieces. Get tubes ready. make plugs. Have to fit moderately tight. These are to be Later sterilized. Decant potato water add agar. mix well. filter thru cloth if necessary. Fill tube 1/3 full for tube cultures & 1/2 full for plates. Care that no nutrient gets on sides of tube. Put in cage and then in autoclave 10-15 lbs. for 1/2 h. Cool down autoclave till N reaches 0. Lay tubes on slant

Separation

Plate cultures: Use used square glass plates but two covers, or flat bottle or "roll tube" method - put gel into tube and get film on inside. Best is Petri-dish Melt agar in tube - cool to about 47°. (so can be readily borne in hand) I don't know material can dilute twice and make 3 cultures. Put drop in tube of agar and draw into plate. Sometimes certain moulds grow very fast. These can be removed by sterilized spatula.

Large cover glass can be used as a plate - invert over a dish and watch development.

For fungi an acid material is good - e.g. orange juice - this inhibits bacteria and is favorable for fungi. Certain viscous bacteria may adhere and → compound colonies - can try again if any danger.

For transferring a clone of plasmium soil is better than wire. Use a hand lens in making transfer. Well to pick out on needle tip a bit of agar and then touch to single sporangium.

Add lemon water to the solution (to milk sugar) then one can get color reaction.

Pipette method: Barber working on mutations in bacteria and yeast. Put on cover glass several drops - one contains stuff to be tested - put ...

Spores can be plunged on to a gelatine plate also. Good for water fungi. Some algae will grow on plated plates.

The perfect stage of an Ascofuste will often appear in a large culture (flask)

Feb. 23, 1917

Drop cultures: Van Tieghem cell - seal on ring with Kinge cement with vaseline and wax to seal on cover glass. The Ward Cell Slender dish good - use large cover glasses.

To prepare cell put water in bottom with some Pleurococcus to → oxygen if culture is to be long. Use sterilized covers - use weak agar, weak gelatine, etc. Dip platinum loop in liquid and apply, invert quickly, apply vaseline to top of cell, set glass on lightly. Inject from pure culture - heat end of glass rod and run around edge to set the vaseline; Can watch germination etc.

To obtain culture of a form large enough to break one can obtain pure culture from the uncontaminated surface (mushroom cultures) Corn Smut can be also so obtained.

Spore Cultures:

Fill crystallizing dish half full of moist sphagnum cover with moist filter paper - separate the material into bits on the paper.

Some grow more rapidly and there may be an antagonism, one can sometimes thus cut out pure mycelia for transfer. Sometimes two varying fungi will attract one another and where they meet one may get fructifications of one - due to some chemical stimulus.

Most spores on dung have been ingested

Ruminant animal dung not so good

Flowers, nuts, leaves, stems etc all good

External conditions have much to do with. Choudromyces needs high temperature

Dont remove cover of cultures-collapse.

To mount: Use forceps - disturb as little as possible

Father of Bacterial classific. F. Cohn "Biologie der Pflanzen" Morphol. classif - and recog. relationships to Blue Greens and so lumped together. Ward has published various classifications. (historical). Cohn used Gleogenae (Nägeli forms) etc. So no physiological basis.

Later observers worked from medical point of view etc so species became an "utter mess" Migula recently has tried to prepare a handbook. In Cohn's time Bacteria lower plants were in the era of the polymorphic craze Tulasne had much to do with this. Fungi were shown to be polymorphic and so widely differing forms were thrown together. Some schools went so far as to lump most bacteria into a few species. Billroth believed that Coccobacterium septicum was the only one. Zopf published on higher filamentous bacteria. Said vegetative conditions were varied: went thru various bacillus, coccus spirillum forms which ~~varied~~ propagated as such. Such inner forms are however only reproductive portions. Later students don't put credence in.

A. De Bary; Winogradsky. Migula(?) Fischer etc are authoritative. Pasteur! Koch etc advanced the medical side.

Life Cycles of Bacteria. Journal Agr. Res. Vol VI # 18

Streptococcus - chain forms. Micrococcus - remain separate
Planosarcina - clusted Sarcina, Planococcus - motile.
Bacterium - immobile, Bacillus clusted all over, Pseudomonas 1 cilia at end.
Spirosoma - no motion; microspira - tiny motile;
Spirillum motile and larger.
Mycobacteriales filamentous and branch. May run over to Fungi.
Beggiatoa - Sulphur forms

then use needle to detach - then to disentangle drop water on it from some height. If delicate put a bit of glass under the cover glass. To prepare glass take thinnest cover glass in paper and run over table edge. Save for future use. Touch preeis with glycerine needle.

R.E Schuh Howard Univ: Washington called Kings Cement. To remove a glycerine ~~slide~~ cover, add water Use alcohol on cloth (pointed) to clean off glycerine. if excess glycerine draw off with blotting paper. If a second ring is needed use ashphalt and turn-table

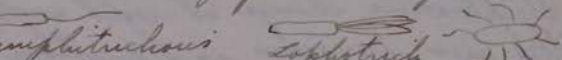
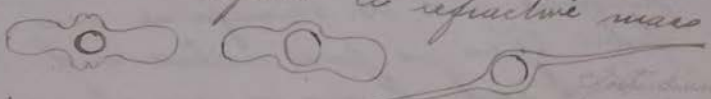
To locate material put in soft glycerine jelley and allow to concentrate with bit of glass near. Put on horseshoe drop of glycerine draw over the jilley to avoid air and put on cover and seal.

Micrometer eyepiece: disc with scale. On a slide is an absolute scale of hundredths of a m m. Look them and see at what points lines on eyepiece scale coincide with slide scale: eg. 60 divis of eyepiece = 21 on absolute Then $60 = \frac{21}{100}$ m m.

or $60 = \frac{210}{1000}$ or $1 = \frac{210}{60}$ μ or $1 = 3.5$ μ.

Camera lucida: Simplest type best.

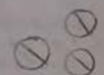
Bacteria: Leeuwenhoek (La wen hok) 1683 wrote - a weaver - ground lenses - made good objectives and fundamental observations: corpuscles, spermatozoa, bacteria (Bacillus buccalis maximus) from mouth. Called animals Next significant 100 years after 1786 Mueller O.F. used Spirillum, Bacillus etc for names; 1838 Ehrenberg Published on Infusoria including Bacteria, in some detail. Recog. latter as distinct class. 1852-53 first recorded idea that they were plants (C. Robin) and Perty. (Vegetable Parasites that grow on

kept the medium in good state for yeast and vice versa perhaps O_2 from yeast - for B. vermiforme is an anerobe
Other similar combinations are known "Kefir" Gift of Allah. Found on "buches" originally. Used for fermenting milk - Skin bags of milk are shaken with the "seed" Lactic acid, alcohol and O_2 are formed. Later turns to a ropy acid material. See Smith's summary of Literature
B. caucasicus is found in it  2 spores
Ciliation and motility are other characters used to separate Spirochaetae are probably animals.
Ciliation is by many considered of prime importance.
Three types 
monotrichous amphitrichous lophotrich peritrichous
It believed that cilia come from interior of cell
 Some say it arises in a blepharoplast
Spore characters and spore formation. A. one endospore sometimes more. Perhaps never more than 2. Don't know whether true arthrospores exist or not. In Mycobacteriaceae there are true arthrospores which cast off walls when germinating. Cladothrix multiplies by fragmentation and parts are called "conidia or arthrospores"
Does sporulation take place in motile or quiescent stage. In producing a spore not all the protoplasm is used as may still swim 
Another character is the change or non change in shape. In Bacillus sporonema  , the rod constricts in middle  and almost divides. Then the two halves unite to → spore. A reductive mass forms at equator 

Sexual reprod. prob. does not occur in Bacteria. They vary however ∞ in shape. The variations may be fairly constant in culture.

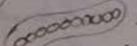
Brefeld wrote very voluminously on Bacteria and Fungi.

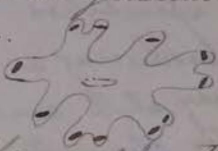
How to handle Bacteria in Classification: Rods may have various type of termini  etc. Rod may be cylindrical or cuneate or fusiform (e.g. Clostridium) or clavate or capitate  . Involution forms must be considered too. Among cocci the variations are not so marked - run into rods.

As to divisions: Do they divide in one plane?  Micrococcus

Streptococcus always at right angles to chain.

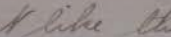
May have divisions in 2 directions  or in ∞. Sarcina divides in three directions. Tetracoccus

Cohn's laid stress on zoöglœa forms - but not of great importance. Aquatic zoöglœa should be more studied. Leuconostoc - really a bacterium - in Southern sugar factories → gelatinous masses around sugar exits.  Looks like a colorless Nostoc - Really a Streptococcus. Gives "viscous fermentation".

Bacterium vermiforme  . In a pure condition this (Van Tieg. call) may locomote like a desmid by secreting jelly behind. Or a single rod may divide and secrete gelatinous stuff on sides also to → a colony.  and separate. Fellow in middle has divided.

Ginger Beer "Seed". Used all over the world. First studied (ours) by Marshall Ward. Used in England for Ginger Beer. Such "seed" is a very impure with yeasts, molds and bacteria. Ward decided that S. pyriforme and B. vermiforme were the essential forms. Grew in pure culture and then combined.

Ward said it was a case of symbiosis. the bacterium

Plectridium → a sporocyst like this  . Spore may form anywhere in middle, at end. In chain forms may be  . Spores may be cylindrical, oval, etc. may be brown, red, green. In mass the color shows that it is sporulating. Sometimes the spores are peculiar  .

Germination: Brefeld studied in detail. Studied B. subtilis and B. anthracis & which were by some claimed to be identical but hay bacillus germinates on side  but other breaks open at end. Sometimes gradually enlarges by stretching wall, or may stretch and dissolve the wall or may break open. May perforate at both ends. or circumferential germination. Horseshoe germination  

Forms of cultures vary much. Ordinary descriptions are based on physiology.

Cell structure: Some believe there is a definite nucleus but probably such "nuclei" are incipient spores. Others say ☆ to Ganglycear - a central body. Some say nuclear material is diffused thru the cell

Size is very variable Some are beyond vision - filtrable Polymyxa's germs are perhaps just visible. The blood red form on bread .0015 m.m. while Beggiatoa mirabilis is very large Billhousia mirabilis grows on mud has rods over 80 μ in length and over 30 μ in diameter. Visible with hand lens. Interior is an anastomosing mass of threads and between the meshes are large masses of $CaCO_3$ while in the meshes are sulphur grains and also chromatic granules (nuclear). ∴ Bacteria show such threads and "meta chromatic granules".

Plant Diseases: Once denied that Bacteria could get in three general types: (1) Local (leaf spot diseases) enter thru stoma - may spread together and destroy leaf.

2. Affects leaves generally e.g. Pear Blight - blossoms, tips etc attacked and die back. One of first studied. Attacks pears, apples, quinces. Carried by bees in [illegible]

Lessons on west coast

(3) Tumor-like diseases on ∞ plants. Crown gall of interest to physicians. Smith has long worked on and finds parallelism to human cancer. Organisms are few in the tumors and plate cultures must be used. Bulletin goes into theories of action of organism - local stimulation but removes an osmotic intubation and permit excess food to pass into cells. Not a secretion of acid or other irritant.

May enter thru stomata and follow bundles. One gall on olive branches. Locust grow like ~~pear~~ crown gall which comes on roses, blackberries etc due to Bacillus tumefaciens. Inoculations succeed on sugar beet.

Pear blight (Bacteria → oozy mass under ~~pear~~ bark

Cotton spot - gains entrance thru stomata

Cucurbit wilt "chews up" the bundles.

Mycobacteria: Fungus-like bacteria. Here you have branching of typical Bacilli (B tuberculosis does this) perhaps an involution. Perhaps Pseudomas radicicola can be said to branch. Actinomyces. This is technically the ray fungus which causes lumpjaw. But recently other genera have been thrown into it. Actinomyces have very fine branching mycelia fraction of a μ - branches obviously to → a coherent mycelium. On agar most species grow into air and → characteristic fructifications. Common in air - a prominent constituent in earth flora - widely spread A. bovis → lumpjaw in cattle and may even attack ~~pear~~ man. Sores discharge grains which sectioned →  radiate masses. Never any other form is seen. Grows on agar if → a mycelium but never sporulates so do wild forms. These latter

may grow up and form characteristic branchings. At tips of the branches come spirals of spores. These germinate like fungal spores. Septa are rare. Thaxter says a true fungus - not a Bacteriuni. Def. ficult genus with ~ species.

Scab of Potato is caused by an Actinomycete ("Deep Scab")

Nitrogen fixing Bacteria:

Two types - One changing Organic products to nitrates

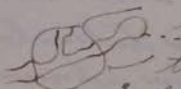
Planococci

Nitrate bacteria are rod forms.

Some attempt to grow artificially these Nitrification Bacteria. Certain Rocky Mountain deposits must be slightly changed to nitrates - idea is to use the microbe on a large scale to make commercially available.

Nitrogen fixing forms: Azotobacter one of these. Some say if cultivated with tubercle organisms the fixing power is increased.

Tubercle bacteria: Long known - even in Roman times advantage of Legumes as soil renovators known. Middle of last century (1858)? Gasperini studied such root deformations. Literature voluminous. Smith → review with 300 papers. Such hypertrophies are called Mycodomatia. Attacks thru root hairs. Enters hair and then multiplies to → a strand which runs up the hair till reaches cortex where runs straight to endodermis and stimulates formation of a secondary root which grows out thru cortex. These are unlike ordinary roots cause all parts are of same diameter; may dichotomize or trichotomize. At apex is a loose "cap". Bundles are split apart. Great mass of apical meristem → big medulla. At apex are the strands. From the swellings the bacteria are "shed" off.



Nucleus is stimulated to divide: and cells separate. The strands are compared to Myxobacteriaceae but latter have peculiar fruitification. In older tubercles the indiv. begin to assume Y or V forms. Some say several individuals in each "cyst" or Y. There are races of these Pseudomonas bacteria which attack specific crops. Experiments in cultures of both plant and bacteria seem to show some specificity. Some forms will parasitize various Legumes - others not.

Pseudomonas radicicola has various synonyms. Some say soils have much to do with passage to new hosts. Tubercles a. attack the more superficial roots - don't go deeply. Some believe there is a beneficial balance where excess harms the plant and plant has power to ward off such excess. It is said when roots are loaded there is no N fixation. Coffee plantations are sometimes set with Leguminous trees. Theobroma too is set out with a " " the Inocarpus) for "shade". Vary much in virulence - some strains attack more vigorously.

Pure cultures of the host show that there is great benefit from these bacteria.

How caused: Supposed that host devoured dead bodies of Bacteria. Some say however that N fixation is at a maximum before involution forms appear. Further the total N in the Bacterial bodies is very small and the plant gets far more. This suggests a continuous process of transfer.

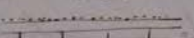
Moore tried educating by growing on media with less and less N. Finally got a strain which forms very large masses. Dried on cotton - sent to experimenters who soaked seed in infected water. Due to original experiment with Moore's cultures were successful.

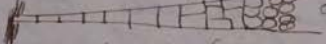
Alder has tubercular masses with dichotomized members. An abnormal root here has an apical [illegible] roots it is claimed that

secondary roots n. occur in abundance.
(Some marine forms of Bacteria are said to precipitate $CaCO_3$).

The mycorrhizae seem to be annuals, like legume tubercles. Several kinds may live on one tree. They may be mycelia of Basidiomycetes. Alder mycodomatia seem to be perennial. Some prothallia (Lycopods) have same mycorrhiza. Hepatics also may have same.

Iron Bacteria (Chlamydobacteriales): Most are filamentous- a few cocci. A good physiological group. Have same relation to manganese as to Iron. Once thot to obtain energy from Fe and Mn compounds. European water supplies may have epidemics of these which may choke up pipes. Means devised for treating. Can be cultivated without Fe or Mn. and are then colorless but in waters they precipitate Ferric hydroxide in sheaths. They take in Ferrous carbonate and change it. Form "bog iron ore".

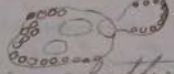
Clathrocystis aeruginosa blue-green.  - sends out "conidia". Shows false branching. The water supplies are treated by running them over coke towers - takes out the organic matter which Mölisch thinks necessary.

Chlamydothrix is commonest form. Differs in being a simple filament, very rarely branched. The "conidia" may be motile and may settle on an old filament and simulate false branching. Crenothrix is much like a ~~Nostoc~~ blue-green with much false branching like Rivulariaceae - (base and apex). Crenothrix is an attached form  Sheath is very thin. many twisted together. ~~Flint~~ Siderocapsa

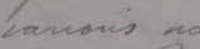
Gallionella is a spiral form often, is one of very commonest - a coccus form. tiny capsulated Cocci like a brown scum.

P. radicola occurs and sometimes with a fungus.
These rods of P. radicola may pass into cocci it is said (These may be involution forms.) The Such mycodomatia occur on Myrica, Alnus, Ceanothus In Podocarpus tuberculate occur non-branching. Most common is seen in Cycads. Zamia has little secondary roots running upward and bearing mycodomatia. There are also phycodomatia on such roots. ~~No doubt.~~ Cycas has alga, (Anabaena) Pseudomonas & Azotobacteria. So a "tetrasymbiont". Zamia seeds wont grow in sterilized soils.
Another association is between Rubiaceae and Myrsinaceae. Psychotria bacteriophora; ~~a tropical genus forms a~~ bears small tumors ~~(nodules)~~ ~~small tumor on Rubiaceae~~. The bacteria occur in various parts - leaf buds in seed, gain access thru stomata to intercellular spaces and spread between cells. Cells are hypertrophied, then killed. Gets into ovary, even enters ovule with pollen tube and so seed is infected for next generation. In pure culture they ⇒ nodulation forms. Not grown in sterilized soil are yellow and sickly but add bacteria and they become luxuriant. N is fixed. Mycobacterium rubiacearum.
Mycorrhiza: Known since Gasperini (1850 ?) Very common association - Some ⇒ mycodomatia, others indefinite. Two classes: ectotropic & endotropic: Former on outside and may push between cells. In oaks gives an envelope. Also on saprophytes Monotropa hacd. Cast off in perennials each year. In endotropic plants it enters the cells themselves. Coralloiza shows well. Nearly all orchids have such "Orchidomycin". What they do can't be said. The host is said to digest the fungus but no N fixed - this is uncertain. Ectotropic types may be mere parasites.
Endotropic occur on Ericaceae, Gymnospermae & the [illegible] bacteria] mycodomatia

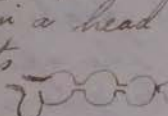
Beggiatoales: Never seen to form spores. Here pass over adverse seasons not known. Thiobacteria sig contain sulphur. Billhouzia can't stand here because the only motion is like Oscillatoria. Beggiatoa may ~~may~~ pass into a sulphur-monad condition ⊛ The filaments sometimes show cross areae (walls)? and indentations opposite these. Contains S. and moves. Thiothrix is like Beggiatoa but is more slender and attached in tufts.  Contents of apical region divide into coccus like particles each containing a grain of sulphur. These settle down and vegetate. Thiothrix doesn't move. Beggiatoa alba in fresh water. Rhodobacteriales. Probably many unknown. ⊖ in tropics. Of interest from Bacterial. Physiol. and Morphol. standpoint. Both salt and fresh water but commoner in former. Salt marshes, tide pools of decaying seaweed. Color water pink. "Red fish" due to Rhodobact. Mölisch studied both Rhod. Bact. and Red ones. worked with pure cultures. They are anaerobic. Put sea animals or plants in corked receptacle in bright light → cultures. ⊖ forms appear. Molisch. Divided into 2 groups: Athiorhodaceae and Thiorhodaceae. Englemann had considered Bacteriopurpurin the equivalent of Chlorophyll. Its spectrum differs from Chlorophyll. Englemann put red zoöglea in a cell and introduced motile spirillae which moved around while ⊖ was present (in dark). Then throwing a spectrum on the culture the spirillae once more wiggle and collect in the absorption bands ⊖ to Bacteriopurpurin. Mölisch repeats and says not so - that Englemann had green algae present. Molisch finds a red coloring pigment and in Chloroplasts. The green is sol in Alcohol but is not Chlorophyll and can not photosynthesize. Thaxter doesn't commit himself. Mölisch believes the red pigment acts as

organic material. Red color is in the protoplasm.
Lamphrocystis (bright + cyst) Once called Chlorocystis
Colonia, Rosco persecina. A coccus form living in
colonies (zoogloea) The cocci are distributed around
the periphery of the colony  Buds fall off and
leave holes. Colony become saturate. Some blue-
green show same.
Some forms are Beggiatoa-like, others spirillae.
Thiodictyon: → rods or spindles  . As it grows
older the individuals and colony begin to move
and form a net. A portion will separate
off and a new colony will start up.

Amoebobacter: Rods or cocci  Encyst in a
double wall  and rest. Under good conditions wall
dissolves and individuals come out. They still cohere
but have a slow amoeboid motion. Colony also
moves and portions may separate off. Finally young
colonies once more encyst.
Myxobacteriales: Checquered history. First found des-
cribed as a gastromycete. About middle of 19th cent.
one described from decaying equals from Ga. Called an
Aspergillus (A. crocatus) Not seen again. Schröder
published on one or two. About 25 years ago their
true nature was determined. Individuals are always
rods. Differences are based on colonies not on individ-
uals. They swim bend slowly and also slip along. As
they grow they → a pseudoplasmodium (a. pink like
a Rhodobact.). Won't grow in pure culture. Seem to
need some other bacteria present.
Vegetate for a rather definite period as rods in a
plasmodial condition, followed by a pseudo fructification,
when they are urged by a common impulse to (spores
impulse?)
Divide into 2 groups: Myxococcaceae and
Chondromycetaceae. Former individuals transfo-

directly into spores. The rods run together toward a center - heap up into a mass - sessile or stalked by a dried gummed thru which new individuals may continually arise. Stalk becomes smaller and drier with a hard ~~cellular~~ wall. The individuals now begin to pass into spore conditions  Then germinate in various ways. Often leave a distinct wall behind  Divides to → a new vegetative mass.

Colors vary ~~from~~ pink. yellow. white orange.

Differences lie upon character of pseudofructification Chondromyces branch to ultimate heads which form papillae passing thru a stage ; then by movement of band ~~to~~ bacteria get the bullet shape . In another species there is a final impulse which → this shape . Another species forms radiating branches  in a head and there segment into chains of cysts  In vegetative condition the rods are long and slim Multiply by fission - a sort of constriction and pulling apart. Stained rods show no nuclei but do show metachromatic granules; thin motions bending and slipping. May not be bacteria. Arthur Meyer says they are Myxotoa based on fact that one can't get any evidence of wall as opposed to contents. Jahn says they are bacteria. Is it a transitional group - are they allied to Rhodobacteria. They show similar motion.

Old lichens - decaying in moist chamber a. given them. Polyangium vitellinum is sometimes found on wet boards - tiny yellow masses of jelly with cysts imbedded. ~~of~~ dung. forms are scattered by insects.

In some plate cultures bacteria may be pushed up thru a hard surface as a corkscrew. [illegible]

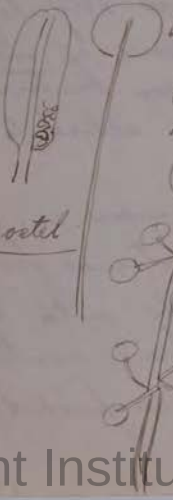
Acrasieae: All amoeboid - soft with good pseudopods or hard. Perhaps latter don't engulf food. May scarcely change forms.

Sappinia: fresh cow-dung with surface scraped up Amoeba will appear with nucleus and contractile vacuole At time of veget. forms a secretion on lower side to → a stalk.  May encyst into a walled spore. When ∞ grow together they may crawl up on straws etc - pile up in masses.

Guttulinopsis vegetates for a period - then like Myx. bacteria a center of attraction forms and a varied mass forms. The individuals are slightly modified to form pseudospores. Some spp of Guttulinopsis go farther. Some of the basal ones become specialized for support to give a considerable stalk. These will secrete ~~stalks~~ walls and carry up the pseudospores

Guttulina forms true spores in place of pseudospores

Dictyosteliaceae: D. mucoroides. The spores produce amoeba which multiply rapidly to give a colony. They then swarm together to a mass. A papilla arises in the middle. The apical ones transform - secrete walls with vacuoles. Stalk is added to above till there is formed a stalked mass of amoebae which form spores.



Dictyostel

Polysphondylium secretes little secondary whorls (verticillate). Violet in color

(Chondromyceteae spts have a pseudogermination - rods begin to appear and from base stream out the rods. If spts remain attached they may germinate apically and form secondary spts)

Acraeales and Labyrinthulales were once called Sorophoreae. Guttulina etc amoeba are rhombic and fuse, move slowly without long pseudopodia. Some say that certain bacteria must be present for food. Color depends much on food present. If Bacterium prodigiosum is used the color is pink. Do they ingest Bacteria wholly or do they ~~eat~~ kill and absorb the remains? Myxobacteria too like Bacteria present. If they absorb food they are like plants. In Dictyostelium and Polysphondylium ingestion is prob. more common but in fructification they turn into real plant cells and spores. Neither animals nor plants.

35° is about the optimum for Chondromyces. The "bacteria" of Myxobacteriaceae may possibly be amoebae.

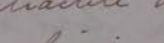
Labyrinthulales: Rare and curious. Best account by Zopf. Feed on dead seaweed - saprophytes. Zopfia form is a parasite on Vaucheria. Vegetative state not like Acrasieae or like Myxomyc. No plasmodium, or no separate amoebae. There is a definite axeae. somewhat intermediate. The individuals in the mass are united by filamentous pseudopods, don't produce engulfing pseudopods. Divide by construction or may send out pseudopode to unite with others. This → a so-called "net plasmodium" which may move as a whole (viz by contraction of individuals) Feed by absorption. Enter filament of Vaucheria and divide to → net. After vegetative condition the massing impulse is seen leading to fructification. Don't grow into a stalk but in the mass they secrete walls and definite spores are formed. After resting they germinate by letting out single amoebae

Diplophrys grows on dung - is bright yellow ?

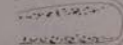
found on Porcupine dung. Amoebae are fusiform, fusiform with pseudopods. Division may be oblique

Vegetates much as other. Reproduction is more striking. Individuals heap up into a pustule, then into a stalked fructification with spores at the top  . These are probably to be regarded as a side shoot from the general tide. The walls of the individuals in the stack are gelatinous (perhaps a secretion).

Myxogastrales (Myxomycetes): Large number genera and spp. All over earth and just about same species. Some limited in habitat & distrib. Rotting wood, leaves, few on dung. One only on bark (oaks) another on chestnut burs.

All → spores: these germinate  and set free a naked protoplast with contractile vacuole and amoeboid motion. Then develops a cilium  connected with the nucleus. It is still amoeboid but moves with a jumping motion. May next divide to → new zoospores. Finally pass to a myxamoeboid condition and this is the first phase of their vegetative life (swarm spore and amoeba).

The second phase is plasmodial. Jahn working on cytology says - like Sachs that cellularity now shows itself. The amoebae approximate and fuse (conjugate) Another enters and so on to → a plasmodium. This is a phase in vegetative life. The nuclei divide to → a large net-like plasmodium. Its edge has channels of streaming with contractile vacuoles. There is thick hyaloplasm on outside with pigmented portion next and fluid portion in center. Ingests like an animal in food vacuole or by absorption



Will so absorb a soft fungus. So a combination of animal and plant.

If these strands should secrete cellulose the thing would be a fungus. Plasmodia vary from note to solids, colorless red, yellow. They are aphelotropic, hydrotropic. After vegetative period they reverse the tropisms. The plasmodium begins to run together

Term plasmodium can only be applied to condition of vegetative body in Myxogastres.

Myxamoebae may contract and encyst (microcyste).

Small plasmodia may encyst as a whole (macrocyst).

A sclerotium is a hardening and compacting of the plasmodium into a cheesy condition of rounded parts which have thick cellulose walls and will remain resting for years. These rounded masses contain small plasmodia. A single plasmodium may fragment and spread - can be artificially so propagated. Smaller ones may fuse. Sclerotia are said to retain vitality 20 years. They are much influenced by weather (viz plasmodia.) The running together before fructification is homologous to same in Acrasiales. If however egests solid foreign substances Stemonitis &c begins to rise in papillae - protoplasm flows up thro the dried base (tubular). The stalk then is a hardened secretion from the plasmodium. Sometimes some of the nuclei will organize cells with walls in the stalk. The upper surface secretes a cellulose wall. In Stemonitis a definite apical columella is secreted (not cellulose).

Some forms → coherent sporangia but some of the marginal ones may remain free. True actuhal types however → a big sporangium. In such forms the protoplasm becomes full of nuclei. Cleavage planes start at the surface and run in and meet planes from the nuclei. Each ~~pte~~ segment is a uninucleate cell finally binucleate pieces form (○○○) then divide into uninucleate pieces (○○).

Jahn first said that there was a fusion and then reduction but admits mistake. Nott says that myxamoebal nuclei unite and reduction takes place just before spores form.

Cepilliteum: A young Fuchsia shows the mass traversed by vacuoles! Each vacuole shows a radiation of threads into the protoplasm () In cases of

branched threads vacuoles unite. On the surface of the vacuole walls form - granules appear there and → the ornamentation.

The Calcarei take up lime - in fructification they may secrete on the surface or → calcareous walls to the capillitium & the inside etc. Aethalium septicum is the big living one.

Exosporeae → but 2 spp which bear spores exogenously - very variable - spores may be borne on fingers or on pit like walls. Its plasmodium is large, white. Rises up to digits. Protoplasm divides into lumpy pieces ~~at~~ distally From each arises a papilla which swells to a spore and branches in the protoplasm. Jahn and Olive both say a reduction. Jahn says at base, Olive says in upper part. Anyway there are 4 nuclei in the ripe spore. The spore bursts suddenly when germinating and a naked protoplast comes out and passes thru changes 2 lobed, 4 lobed, 8 lobed  - finally 8 bodies which pull apart and swim away as swarm cells 

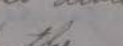
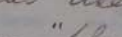
Myxogastrales are probably modern and highly spec.

Plasmodiophorales: Uncertain position; all parasitic: P. brassicae familiar. Rotation is only remedy. Attacks other crucifers besides Brassicas.

Woronin - student of De Bary - wrote together - first studied Plasmodiophora. Said spores → amoebae which enter by root hair or superficial cell and "fuse with protoplasm of host cell." Disagreement as to whether it passes from cell to cell or whether there is mere distrib. by division of host cells. Are these protoplasmic masses plasmodia - may be no fusion.

Sporulation → strange nuclear conditions - not all agree. May be reduction divisions. Portions secrete walls and → spores. Tumor decays and sets spores free.

most important other form produces a scab of potato. Here several big pieces of work have been done. Not very destructive but unsightly. Scraping off the powder one finds ∞ spore balls -  - These → amoebae. The earliest stage seen is amoeba in a host cell. Amoba divides and becomes ∞ nucleate  Host cell also divides rapidly. After parasite has used up the cell - the amoebae unite to → a "plasmodium" and the nuclei are said to disappear and reappear as granules scattered thru the plasmodium. They then reform in new places and conjugate in pairs - then divide (reduction division) and → spores.

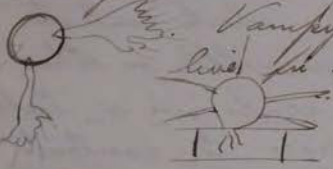
Nucleus of these forms has a ring around  Ring splits when nucleus divides 

The naked amoeboid vegetative bodies point to Myxomycetes. A similar condition but nearer fungi or even animals is the group:

Myxozoidia }
Monadineae }

(Amoeboid bodies are not naturally animal for any naked protoplast will take on this condition - even in Chytridiales

All parasitic - some endo- some ecto: Leptophrys → veget. condit like Myxomycetes. Curious amoebae  Several may come together by means of pseudopods. Eventually it rounds up to → a cyst: rests; later germinates by means of several amoebae

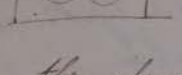


Vampyrella: includes heliozoon-like forms. Live in algae or "Aufsitzend" on host cells. (pseudopod). In reprod. may secrete a wall and give few parts inside which exit as amoebae; or the contents may roll up. secrete a thick wall - Former a zoöcyst; latter a sporocyst.

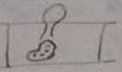
Polysporella also attacks algae. Reproductive bodies enter the alga- vegetate as naked bodies and at last are converted into zoöcysts or sporocyst. Latter encysts and contents become several thick walled bodies. Former → zoospores. Wall breaks and the zöospore-amoeba like bodies escape ⊙ ~~~ ⊙. U. look like zoospores of Chytridiales. Escape into cavity of host cell- bore thru wall into water and later bore into another cell. The thick walled spores also divide up into zoospores upon germination. They are used to tide over adverse conditions.

Phycomycetes

Archimycetes (Chytridiales) Lowest (true)? Fungi. Miscellaneous forms not coherent. Resemblances may be due to similar habits. Most are parasites. U. reproduce by zoospores- which may be 1-2 ciliate, amoeboid, may hop, creep, etc. Veget. condit → 1 clear line. Myxochytridiales look toward Myxomycetes. Their veget body is a naked protoplast while Myxochyt. have walled cells. Former group may have amoeboid or motionless body. Common in water cultures -. Saprolegnia etc. Potentilla Fragaria → bright galls on wet meadows. Common



Olpidium is non- sexual. Olpidiopsis has such process. Olpidium seen on Spirogyra: a naked mass of protoplasm. At maturity secretes a wall and acts like Polysphonella. Contents divide and then the sporangium forms a tube thru which contents escape as biciliate zoospores. These settle on other algal filaments secretes a wall- sends in a tube which opens at end and discharges its contents into the host cell. Vegetative mass may so blend with host as to be very difficult to see.



Finally secretes wall and → a zoocyst

Olpidiopsis goes thru about same life cycle. ∠ a get into one host cell and a. → zoocysts. but in cultures (unfavorable) two protoplasts may adhere  One enlarges - contents pass into one and forms a  thick wall.

Saprolegnia shows one sp. in terminal or intercalary swellings.

Pleotrachelus: on Mucor & Pilobolus. No great importance; ~~is~~ rare. Induces formation of zygotes of Pilobolus (Zopf.) Bright orange. Has many efferent tubes

Woronina & Synchyt. are zoosp. forms.

Woronina comes on water moulds. W. glomerata comes on Vaucheria. Zopf. has studied. Vegetates in host cells as amoebae which are connected by threads (pseudopods) and more or less fused with host. The diseased portion is set off by an abnormal septum. At maturity these amoebae round up. In vegetative life they have taken in solid matter from host. this they excrete. then secrete walls and so → sori of zoocysts which germinate thru a tube to → biciliate zoospores. Or they may form sporocysts with winged reticulations. It germinates by a tube which → zoospores. Tube may branch.

Synchytriaceae: 2 or 3 genera: Synchytrium vegetates in epidermal cell which may distend into the palisade tissue or even. Today or may not cause hypertrophy. All parasitic on higher plants. One common on Anemone. Naked mass of protoplasm at first uninucleate. Gets food from surrounding cells. Later nucleus begins to divide (Ruggi(?) says amitosis with no ~~mitosis~~ chromosomes. Sometimes however 4 chromosomes have been seen. So mass becomes ∞ nucleate

Syn. S. decipiens when not going into a resting condition. Cleavage planes now form and cut up contents into ∞ nucleate pieces these too will cut up and may stop in

∝ nucleate condition called protospores. In some spp the cleavage goes on to → uninucleate spores. Some of these → same. also some Myxomycetes. If uninucleate pieces form they then divide up and become multinucleate. The pieces swell and give polygonal pieces separated by hyaline double walls and thus → sporangia in a sorus. At maturity when leaf shrivels the epidermis ruptures and sporangia ooze out. Contents divides into zoospores. Common on Ampelopsis sp. is C. dendritica - orange colored - in glass of water it quickly discharges zoospores ○—○. Zoospores infect new cells. 2 or more may get into same host cell.

Late in the season (not in C. dendritica) resting spores form. Probably the sori except in C. dendritica. In others however the whole parasite becomes contracted, secretes a dense wall and rests. In spring this spore is converted into a sorus etc.

A few economic: Red Cranberry gall.

Woroninella is like Synchytrium - sporangia in diverse situations. But zoospores are biciliate. So perhaps number of cilia is not very important.

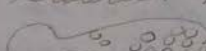
All these Hypochytridiales are naked in veget. condition.

Hypochytridiales: Alfred Fischer is best on Chytridiales. All have walled vegetative cells.

Rhizidiaceae: Body → an ampulla associated with absorptive apparatus.

Rhizophydium is very simple - the ampulla = the real zoospore. One on pollen grain ○. Have 2 phases. 1st vegetative → 1 or 2 ciliate zoospores which swim to new pollen grains. Or it may secrete a thick wall and rest.

Rhizidiomyces → a swelling inside the host cell. In Endophlyctis there is large ampulla inside the cell. The zoospore remains outside and is of no account.

Rhodochytrium is very similar. Obelidium has a very extensive mycelial-like rhizoidal system. Some have a sexual phase. Zygorhizidium  Lives on Desmids. Some large & others small. The small one may send out a filament and conjugate with the larger which → a zygospore. Best known however is Polyphagus found on cysts of Euglena. Parasite is first small - secretes a very thin wall. Nucleus has chromidial masses around  and "pseudopods" run out and branch connect with Euglenoid cysts. As it grows the branches become stouter. Finally its wall bulges out to a vesicle  and → a zoosporangium which → uniciliate zoospores with oil globule & nucleus. In another state the vegetative state (small) may send a tube over to another  Euglena cyst. (Sometimes the vegetative individual will encyst and become a resting spore (cyst).) Sometimes in the sexual condition there is oogamy or again heterogamy - very varied. The contents of both pass into a swelling: this → two nuclei in the zygote. Chromidial material is now thrown out from the nuclei and aggregates into 2 masses. These finally fuse but the nuclei remain distinct. Thick wall forms (rough). Under favorable conditions the spore germinates into a bladder into which the nuclei pair and unite. The fusion nucleus divides to → nuclei to 100 ± zoospores.

Cryptochytriaceae (includes Cladochytriaceae)

Cryptochytrium parasitic on higher plants. Rhizidiaceous and also filamentous - Zoospore settles on

epidermis and hypertrophied tissue grows up around. Rhizoids are called filaments. ~~From~~ The rhizoids may pass into other cells and disorganize the tissue. The spore may germinate and send hyphae directly into the tissues which → the thick walled bodies.

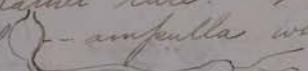
These threads are supposed to be mycelia. Some say that this is a sexual process and that the hyphae are different. Anyway one passes from the ampulla type of previous forms to an additive mass of mycelia.

In Cladochytrium Alismatis

Cross partition forms at and a new sporangium is "blown up" into the old one. Thus several may be formed. This suggests the water moulds

Some of the zoospores may enter and → mycelium which → swollen septate bodies.

Amoebochytrium: Rather rare. → Fine filaments with swellings and → ampulla which = zoospore. It turns into a zoosporangium which emits amoebae which later secrete walls.



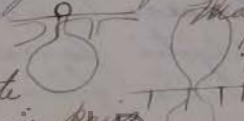
Zygochytrium seen only once in Russia on a fly

yellow- → zoosporangium. In some doubt. If so it leads straight to Zygomycetes.

Harpochytrium on Saprolegnias etc

Zoosporang. ----

Among Algae is a small group. the Characeae (Characium). They are practically the same except green in color. There are other such examples Chlorochytrium is a grass green alga - parasitic! Zoospore sends tube into host → cyst. Later sends out a vesicle with bulgate



may secrete wall

Rhodochytrium pushes down rhizoid between host which enlarges to → an ampulla which sends rhizoids to fibro-vascular bundles. One kind is deep seated and connected with the "button" (zoospore) at top., the other has a bag like swelling in mouth. The nucleus divides 2 times → zoospores with reddish cast.

Starch is abundant. Whole thing is reddish. Zoospores may conjugate or infect directly. This is an algal history but other characters are either algal or fungal. Endophlyctes too stays outside as an ampulla.

Hyphochytrid - point to Animals thru Woronina etc - run to Pampyella and Plasmodiophorales. May have come from Algae. Myxos and Mycos may be polyphyletic. Synchytrium may come from Rhodochytrium; passages to Myxos to Mycos are easy - wall of latter often very thin and Myxos may secrete wall and later become naked again. Perhaps Mycos came from Algae. Charaxinus or Harpochytrium. Myxos can lead thru Zygochytrium to Zygomycetes. Ancylistales run straight to higher Oömycetes.

Zygomycetes

Fairly well defined by isogamy but not absolute. Sometimes Zygos and Oomycets are called Siphomycetes. Both are alga-like. Exceptions: septations do occur commonly in connexion with repod. Basidiobolus often segments. 5 or 6 Genera of Entomophthorales: some are not entomogenous. Very delicate and not commonly seen.

E. muscae: Fly sticks trunk on outside and dies. Hyphae enter body - avoids vital parts - breaks up into portions 5-7 days later fly is filled with rounded hyphal bodies. Fly about 4-5 o'clock dies. Evening moisture causes hyphal bodies to germinate - Make way out between segments and end swells and pp. goes into it. has fatty globules. Septa form and fall up

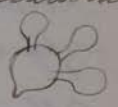
the prolop A papilla grows larger Double wall forms
absorbs moisture pressure on
septum drives it in. Contrary
force presses back and spore is shot off. Pressure
burst the hyphea and sticky prots plasm is shot out
around the spore. If doesn't hit a fly may germinate
and → new hyphea. Or under drought may → thicker
walled spore. Sm some forms a third spore
type ← forms → tubulate protusion
which bears a thick walled spore.
The hyphal bodies may produce chlamydospores or
body itself may produce such an "azygospore". One section
of genus → these. There are sometimes 2 spo on 1 mycl
Sexual stage may produce zygosp from → or
Empusa has ~~conidia~~ nuclear conidia
Entomophthora / " → "
Grasshoppers die embracing grass blades
Aphids send out rhizoids. Some moths may be fastened
before death occurs so can't get away.
Zygospore are rather rare. Conidia are produced as a
→ most effective distribution: Grasshoppers climb up.
Woolly Bear Caterpillar climbs up too. But resting spores
may occur under logs or in grass. So psychological
effect varies. E. Aulicae attacks Brown Tail very
easily. In Artif. work. Diseased caterpillars put with
uninfected ones. Living ones are distributed - they
carry the infection. From 50-100 o/o can be destroyed
outdoors. It has kept the Brown Tail down. Insect
parasites will probably keep them down. Whole
matter is in infancy.

Is there hetero- and homothallism in Entomophthorae? Cultivation is almost impossible. One form from Hawaii does grow on agar. Most however seem to depend on fat.

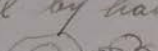
One on Caddis-flies: Myelium doesn't remain in body but hyphal bodies grow out and conjugate and after zygospore is formed branches grow up around it and become indurated thus fastening the mass of zygospores to stones etc. An adaptation to running water.

Of Entomogenous forms a few outside Entomophthora are Massospora Cicada (17 year) End of abdomen breaks off and they walk around spreading the spores. Two kinds of spores Hyphal bodies send off conidia. What does the fungus do during the 17 year intervals? Never worked out.

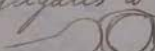
Boudiercella perhaps on Dipterous parasites on Mushrooms Secondary conidia are sent out in large numbers. 1 This has been cultivated.



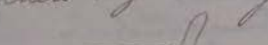
Completoria grows in cells of Few prothalli - Passes from cell to cell by haustoria which produces a mass of hyphal bodies. These send out filaments and shoot off conidia. The hyphal bodies will also → resting spores.



Conidiobolus Found by Brefeld - Careless worker. Parasitic on fungi. Conjugates to → zygotes - one gamete larger than other.

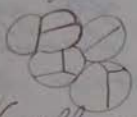


Basidiobolus: Produces basidia - grows on dung of reptiles or Amphibia. Toad dung good - also newts and lizards. Few species. Put on clean slide in moist chamber - will shoot off conidia. Grows well on agar. Is made up of cells (unnucleate). The cells then begin to germinate Takes about 8 days (on agar)



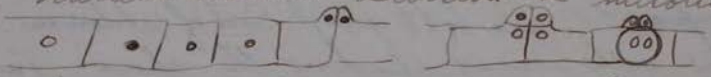
May form secondary spores. In dry conditions may give exactly condition of Entomophthora. This fixes its position with the latter even though aberrant.

Vegetative cells may pass into Palmella. State there may except to → resting spores.



Sexual repro peculiar:

adjacent cells of a filament ~~may~~ will conjugate. Nucleus passes up. Nucleus divides. Division ie mitotic. The



upper nuclei disappear. The wall between lower too disappears. They approximate - a wall forms. So spore looks like this  Later the nuclei unite. The upper parts suggest polar bodies.

All great groups of insects are attacked by Entomophthoras. Also on Phalangids, Myriapods

Mucorales

200 - 300 spp. Saprophytes - parasites - former in majority ~ coprophilous. Some strictly parasitic on other fungi. Choanephoraceae → types which seem to pass from saprophytic to parasitic condition.

White to yellowish - green, blue, red - some mimite. Phycomyces grows over 1 ft. high.

Veget. body a coenocyte - septa only in repro. Branches end in attenuations. Contents different from Entomophthoras when Mucors produce zygospores. Protoplasm in filaments → streaming motion. Wall is prob. chitinous to some extent - prob. near cellulose. Nuclei very small - (Entomophthorales large) and numerous.

Methods of repro: sporangia, → endogenous spores by cleavage of contents of mother cell. One modif. → chlamydospores - rare. Phycomyces cuts off

"sporangium" and forms a thick walled cyst.
Chlamydospores not rare. Zygorhynchus →
Most mucors → Chlamydospores
by differentiation of contents.
Another reproductive body is the acroconidium.
Syncephalis nodosa. & Mortierella form these.
The latter may → these almost entirely.
Conidia too are formed as in Cunninghamella
Choanephoraceae → same - There may be 1 spored sporangia.
Sclerotia form in some - Filaments from a branch will
intertwine, form thick walls and separate off
In liquid cultures they may → something
like hyphal bodies - yeast like.
Sex Process → zygospores. One gamete may mature
without conjugation and → azygospores. There may
form where two species are not closely related.
Mucoraceae → sporangium with intruded columella
(a septum separating off a terminal cell)
Mortierellaceae are u. saprophytic with fine mycelium
and coarse reproductive filaments. and no columellae
Spores often very large and ornamented.

Choanephoraceae. Are flowers of Malvaceae, Cucurbitaceae (All → conidia) Cunninghamella is a
saprophyte. Choanephora & Blakeslea are part parasitic
Former has also sporangia of ordinary type.
Spores purple with appendages
Blakeslea have similar sporangia
and spores but sporangia vary from normal type
to But each division → 3 separate spores
So not conidia.

Thamnidium → large terminal sporangia and also whorls of sporangiola. Here it is a regular phenomenon.

Chaetocladiaceae: A form parasitic on other Mucors. Non-sex repro peculiar. Group of branches form some sterile, others dichotomize and end in 1 spored sporangiola. 2 spp.

Cephalidiaceae: Head starts like Cunninghamella but not pear shaped sporangia containing spores. In other genera the mass becomes viscous and adapted for insect distribution.

Endogonaceae: One in spruce woods with sphagnum. Some big orange mass on Sphagnum. No sexual stage known. Some hypogael. Orange mass consists of zygotes.

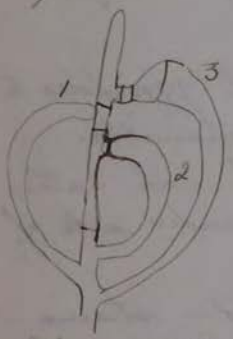
Sporangia may → dry dehiscence, wet dehiscence. Rhizopus has extreme tension of sporangia which explode. Some Mucors have a hard indehiscent sporangium. Other forms rupture slowly.

Pilobolus — Shoots off sporangia
Gelatinous ring — at base of sporangium gives way.

Two variations in Mucorales Syncytium: protospores or on to 1 nucleus then back to ∞. Same in Mucorales. Pilobolus protoplasm in head has tangential vacuoles there → cleavage planes to surface. Phycomyces has flat columella. Many nuclei the dense protoplasm cleaves from outside and from triangular vacuoles in the mass. These 2 nucleate masses divide to → masses with several nuclei [(Common on Agarics) zygotes on sub umbella.] These masses are protospores which become spores. In Pilobolus [illegible] by constriction

to → bi nucleate pieces which become the spores. May have no phylog. significance.

Zygospores: type of conjugation. Absidia → 2 similar gametes with suspensors. Others (Zygorhynchus → Sporangium - a contact stimulus - two branches never grow toward one another - one is active



So all variations from isogamy to heterogamy. Enveloping apparatus may appear as in Absidia where fingers grow up around. Phycomyces has branching hairs - branched net around spore.

Mortierella → hull of hyphae around spore

Some species → a very thick dense wall around

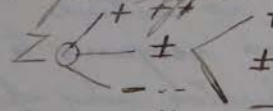
Heterogamous type - Brefeld says the hyphae are concerned with germination and the spore is a reservoir of food. Probably untrue. 1. the zygote grows into a promycelium. Wall cracks. Filament may branch but main hyphae produces a sporangium. In a nutrient solution however it puts out a mycelium with ∞ sporangia.

Zygospore formation has received much attention. In general the Mucors → 2 sexes. ♂ + ♀ in a single mycelium; or those with ♂ in one and ♀ in another. One is homothallic the other heterothallic (+ & −).

Germination: homothallics are rare - perhaps 1/2 doz; most Zygorhynchus forms live in soil. Others are isogamous. If a spore germinates the mycelium is homothallic. A heterothallic type however does something at time of germination so that the sporangium is either + or − entirely. Other situation seen in

This is heterothallic (or neutral

Put together and mycelia conjugate + x −. Germinate the zygospores however one get a homothallic type which may form zygotes with itself. In water however the zygote germinates and → sporangium with 3 spore types +, − and neutral



Not known to be definite ratio.

External conditions affect the formation of zygospores to some extent (moisture, temperature) Cunninghamella needs moisture, 28°C, and darkness with rich rather than poor food. —— forms zygotes on under side of toadstools.

Blakeslee found a Mucor with both + and − strains and used these as a test for others. Plant the sp. to be tested in the center of a plate with a + on one side and − on the other. If the sp. is a − strain, there will be a strong production of progametes on the + side. When such isolated strains (+ x −) are combined again they too will produce zygotes.

Progametes will form when the species or even genera are different - a few gametes may form but hybrid zygotes do not form.

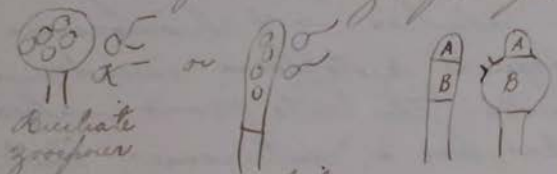
When a homothallic form is planted with a heterothallic two lines of progametes form (-101+) Such progametes often cut off a gamete which becomes an azygospore.

Cytology of conjugation: Conflicting testimony. When the zygote is formed there is mixture of + and − nuclei which unite in pairs. Possibly all but 2 degenerate and these unite (This is seen in some Albugo sps.) Progamous forms

Economic importance

Some → active fermentation. One has been used on commercial scale to make alcohol from potatoes. Disease produc. forms rare. In Rhizopus stem is a very active poison

The Oomycetales lead to Oomycetes. - Myzocytium & Lagrodium Monoblepharis found 1870 by Cohn in Paris. Lived 25 years. Only fungus with motile sperm; in now running water - reticulated protoplasm. Walls supposed to be cellulose. Oogonia or Zoösporangia are formed.



Renate Zoospore

or

Uncinate Zoöspore

A → amoeboid manner which bear a cilium and creep down to opening in B and one fuses with egg. B secretes a wall and → oöspore

In Vaucheria ~~this~~ a similar process occurs but Vaucheria has x-ciliate zoospore like Monoblepharis.

Saprolegniales: in water on moss, flies, frog fishes - attack fish spawn in hatcheries, trout, salmon, vegetation - are purely saprophytes, some become semi parasites; all with near cellulose end → cellulose reaction Simple multinucleate coenocyte - strands of protoplasm in the hyphae. Reserve carbohydrate masses mend breaks Under unfav. condit. reprod. is by fragmentation, probably pathological. Zoospore formation advances from Aplanes where each part in the sporangium excepts - later germinate by sending out filaments

Dictyuchus walled cells emit zoospore

Achyla - spores escape after exit in hollow mass at apex then later → another zoospore - Diplanetic.

Saprolegnia - Zoospores escape unwalled. Each comes to rest - secretes wall - later → another zoospore which → new plant. Proliferation of zoosporangia common here

Pythiopsis Zoospores come out and grow directly into new plant. Of course all naked cells secrete wall before germinating.

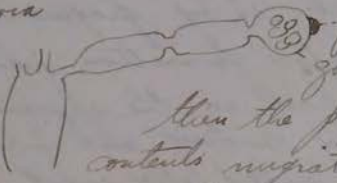
Sex repod. Pythium gonapodyoides - secrete walls in oogonium without antheridium.

Or: a large number of nuclei go into oogonium before it is cut off. reduction → 4 chromosomes instead of 8. The oogonial protoplasm rounds into balls around the nuclei. The balls become naked oospheres - each nucleus has a "centrosome" Antheridium may come from same plant or another (androgynous or heterous). It divides into cells each of which sends in a tube, winds around egg and discharges its nucleus into oosphere. It may fertilize several eggs. Oospore forms. At germination it → a zoosporangium on a filament. 1 nucleus from egg + 1 from antheridium unites to → oospore.

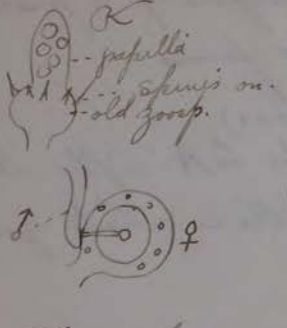
Saprolegnia can be cultivated by sowing spores on ts gelatine

Leptomitales: Veget body is segmented. water plants

Rhizopora



The sporangium divides into round bodies Then the papilla stretches out and the contents migrate into it and exit as



Sex repro: Nuclei in oogonium are arranged peripherally


<antheridial filament
oogonium

The antherid. filament always comes down to same position and cuts off its tip as an antheridium

The supernumerary nuclei organize only wall cells that surround the oospore in water as sour apples

Grow on vegetables

♂ comes from same filament as ♀.

Here we have a type close to algae for Dichotomosiphon has similar segmented body. It is allied to Vaucheria The relations of ♂ and ♀ are similar in both. In the algae instead of a ♂ with a tube motile sperm are formed that penetrate the ♀

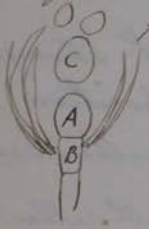
Chlora and Rhodochytrium, Chaoacium, Monoblepharis and Dichotomosiphon are algae resembling fungi.

Amylostales are parasitic on algae, pollen grains and desmids. They → biciliate zoospores and also conjugate

Pythiales: Water to land transition. Some on insects others → damping off. Filaments slender Zoosporangia lateral terminal or intercalary. May let out contents as mass of undifferentiated protoplasm that → a wave like mort. - revolving and streaming due to zoöspore anlagen; then biciliate zoospores break apart and move away. Zoosporangia may be conidial and germinate by tubes. Sexual stage → 1 egg only. Fruit (seen by De Bary) which known to pass gonoplasm into egg

Filaments may grow up around the zoosporang. to protect it. Peroplasm remains over after egg forms.

(Myriophylliums → multiciliate zoospores)



A slips up to C and B proliferates to A. After this goes on several times the → the ~ ciliate zoospores. This belongs to Pythiales.

Pythiales: Transitional from water to land forms
Reproduction, zoosporangia etc are similar to Phytophthoras.
Not common in lab. cultures - rarely on flies. Damping off disease → easily (use seedling in water), P. one found on sweet-corn stems in water, filaments run out into water. to → zoosporangia- protoplasm swells actively and escapes as a whirling mass which divides to give biciliate zoospores. Other sporangia resting on the stem become coniocated with filaments and later a secondary zoosporangium pushes out.
Attack palms in India.
Sex repod: DeBary first saw gonoplasm pass into egg- only one egg is formed. Perigynium is also seen this is applied to oospore wall. All protop. of Saprolegniales is used in egg formation.
Anacylistales Intracellular habit simulates Chytridiales
2 main genera Lagenidium & Myzocytium
Vegetative body is segmented as in Leptomitales with constrictions.
Olpidium may be parasitized
In sex repod- an affluent tube forms and sets free reniform zoospores with lateral cilia: so similar to a Chytrid. In sex repod ♂ ♀ adjacent segments conjug.
Lagenidium may → ♂ and ♀ plants. ♂ are smaller ♂ ♀ Or they may be ♯ ♀.

(Saprolegnia → diplanetic condition. The two zoospores are different: the first ones are pointed ♂ while the second are ♀.

Peronosporales: Some on water plants but the group proper have attained to the land. ∞ on herbaceous plants - flowering plants in all cases. (Peronos- wool) All related to host by branching mycelia which are intercellular and haustorial. Latter may be button-like or branching. Often very destructive - local or extended ∞ of economic importance. Most can be controlled.

Albugo (Cystopus) Blister Rust - one on Sweet Potato

Peronospora (old genus name - now much split up. Phytophthora is giving increasing number of spp. ∞ in tropics: 10-12 now known. Theobroma has one destructive spp. One on tobacco in Java etc - Some on Tea. Pythiacystis. Serious on citrus crops in Calif. → ∞ zoosporangia. Oospores unknown.

Peronospora: → Sporophores or (sporangiophores) branched and ending branchlets which are terminal and final. May be complex or revert to Pedocephalum condition. Plasmopara → zoosporangia which germinate to → remform zoöspores. Some spp → swollen (Edocephe) heads bearing spores.

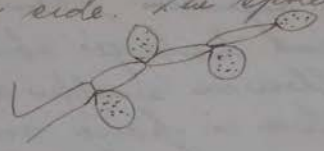
Sex repro is much as in Albugo - one egg. peri-plasm etc. Oöspore usually ornamented.

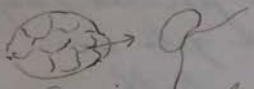
(Some spp → only hyphal germination

Phytophthora Lima bean sp. (P. phaseoli). Found around New Haven first - now spreading. Perhaps Peruvian like its host. Oöspores are found only in seed and a bean grower had been using seeds from Peru.

Peronospora cubensis: Cuba - found in middle of 19 cent. Also sporadic in Japan, Europe, Asia. Phytophthora conidiophore continually proliferates

showing spores to one side. The spores → both kinds of germination





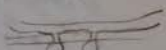
Swim in dew- secrete wall and → hyphal germination
Other spores will → straight hyphal germination. So a transition type.

Sex reproduction: Recently artificially cultivated and true resting spores are found. Other spp → these readily. Some seem to be chlamydospores but it there is something like this

A- This filament passes thru the other and → an oogonium. At maturity → this penetrated cell is called the antheridium.

or albugo

septum which contracts inward and a firm wall is formed on both sides of it. Hence leaves an isthmus.
Haustoria are button shaped



Sex. repod: Oogonium terminal as is also the antheridium

Much variation among species. Simplest case Oog. contains ∞ nucleate protoplasm; central portion differentiates till finally only one nucleus remains in egg - others lie in periplasm. ~~Nar~~ this nucleus is a large coenocentrum Antheridium discharges into egg a single ♂ nucleus Periplasm is used up to form a wall. The fusion nucleus divides ∞ and → a multinucleate oospore. In Alb. portulacae. First mitosis is zero. with gonation and nuclei take up a peripheral position with spindles extended radially. In egg itself later there are 100- 200 nuclei

spindles

Now comes a second mitosis of these to →

from egg into the ~~oogonium~~ antheridium. Then an antheridial tube develops

and discharges about as many ♂ nuclei. These are smaller and more pointed. They fuse in pairs and so one gets an ultimate stage like other. Both gametes are coenogametes. Probably Mucors are similar. It is claimed that there is reduction on germination. Germination is by zoospores. Inner wall protrudes as a vesicle into which zoospores swarm and then exit. The spores are sensitive to temperature - optimum is 10° C. even to 0. Not much germinat. above 25°. Some forms will attack only certain parts of host. Pythiales point to a possible path of emergence from water.

- - - - -

Eumycetes (Mycomycetes)

Phylogeny all balled up
Protobasidii: have septate basidia
Hemibasidii: Smuts - black - yellow red, colorless spores. Often very abundant, or in small masses. Hosts. Mostly herbac. angiosperms - espec. on Gramineae & Cyperaceae. Terrestrial - some aquatic on water plants (one on Lemna) Tend to attack reprod. organs but may be on leaves stems or even roots. Onion, Violet, Polygonum, Hypoxys, Caryophylls, Anemones are attacked. Good Monograph by Clinton. Injury varies ∝. May → hypertrophy or practically none. One on Caryophylls (Ustilago, parasitizes the anthers. Lychnis dioica, dioecious) anthers are stuffed full. When ♀ is attacked it produces stamens (traumatic reversion). Invasion may be local or general thruout host.
Corn Smut may → local infection at some one point. Corn ~~Oats~~ not destructive in Europe

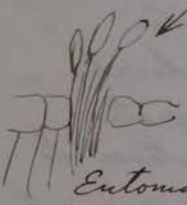
due to fact that onions are sowed in seed bed and transplanted. We drill them. Smut only enters in early stages.

If corn is sprayed with Bordeaux will avoid 2nd type - treat seed - or plant with sulphur or with formalin

3rd type. Infection takes place thru pistil - loose smut of wheat. thereby enters seed. Seeds look perfectly normal.

Sometimes true aerial conidiophores are produced

Monday May 7. 1917.



Entomola. → white patches on Ragweed. looks like downy mildew but really a smut. Resting spores also develop in the tissue. Upon germination the smut fructifications are seen.

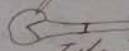
Smut spores may be discrete or compound, variously ornamented. It may be together and thence to all stages of complication. Sporogonium → mass all of which are functional. May be very regular or lumpy and wide. Urocystis → bladdery pseudospores around the functional - for protection or air conduction. → are very resistant. Will remain 8-10 years in soil. Onion Smut thus takes long time to eliminate.

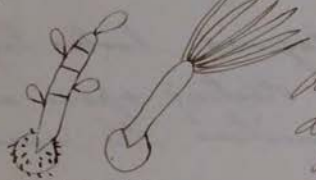
Some Urocystis spp may → sogens of functional spores Doassansia is the acme of differentiation with spores forming an outer layer. Many forms around Fresh Pond.

Curious parallelism exists between a certain F. imperfecti found on onions (decayed onions almost solid to give

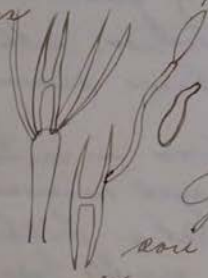
Called a bulbil. Vary from simple type with one spore to massive

Pedilospora →

These bulbils are imperfect conditions of Ascomycets
Melanospora spp. also → same bulbils.
Germination characters of Hemibasidii are important.
2 types: Spore when naturally germinating [(without nutrient solutions). Same with Mucors.]
may germinate very soon - same season - but a rest
till following spring. Produce a promycelium -
a hypha of limited growth producing spores unlike
those from which it arose. Character of promycel.
→ 2 main groups. I Protohemibasidii: Promyc.
is transversely septate. II Autohemibasidii " is
unicellular with apical spores. This indicates a
parallelism to the 2 groups of Basidiomycetes
Perhaps no relation whatever to
Basidiomycetes. Spore may germinate
differently e.g.  or without
sporidia.
Type I.


Ustilago Entyloma

Heads of Type II vary much in number
The sporidia behave in 2 manners. (Even when not
formed Type I the joints of mycel. behave like
them. They may fuse rather like yeast 
commonly happens however that they conjugate
in pairs  . These may → filaments directly
or → secondary sporidia. Same with Tilletiaceous
forms



Interpreted variously. De Bary
said a sexual process. Others said
mere anastomosis. Sporidia spores
germinate thus  to → anastomosis.
Cytology much mixed up. Young
sori of smut spores → spore anlagen
which are binucleate

Protobasidii

Septate fasciae:

Uredinales largest group - attack vascular plants - some on Vasc. Cryptogams. Almost nothing without some rust. Loss by rusts is greater than from any other parasite. White Pine Blister rust - attacks currant in one stage - Hollyhocks rust - keeps over on Malva rotundifolia. Came from S. Am. went to Spain and also to Calif. But came from Europe first.

Life history of rust: Produce first spermogonia on Barberry which → spermatia on upper side of leaf. Mallow rust has only 2 spore forms - teleutosori germinate in place to → aecidia which reinfect to → teleutospores again.

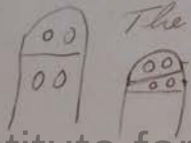
Arthur has elaborated a system of nomenclature - No European botanist has adopted.

Interesting biologically and cytologically.

Once certain theories believed in some function to spermatia but they are now believed to be functional They are not functional pycnospores: No evidence of a trichogyne. If they were once sexual cells it is curious that they persist so copiously.

Young aecidium → weft of mycelia which arrange themselves below the up id columnar fashion: These are uninucleate. The nucleus divides and cuts off a small apical cell. The upper cell elongates. Then two columns unite. They are n. about equal in size. Only one of these produces an apical (buffer) cell - the other cell may be younger. The nuclei then enter the synkaryon condition.

These two nuclei divide simultaneously The apical divides again Hence spores 1. spore cell ... intermediary cell are separated by intermediary cells. These soon

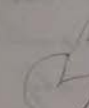


cells of mycelium too may be 2 nucleate for some distance back. ~~Rouce~~ This is seen not only in conjugate sporidial mycelia but in others as well. Nuclei are said to pass over - union is very doubtful This would → 2 nuclei in the mycelial cells

But suppose no conjugation - then there is something like apogamy. Two cells will turn into 1 and → binucleate chlamydospore. (viz partition wall disappears). As spore matures the nuclei fuse. Clamp connections are formed in some prompcel which do not → sporidia. Auto forms are more definite in fructification. Hemi forms (Ustilago maydis) → big irregular masses.

Remedies:
When attack is at germination can treat seed - formalin hot water.
Local infections above ground - Bordeaux etc.
Germination in nutrients → very different appearances
Corn Smut on agar will become yeast like
Will grow for years and → nothing else. Can may form mycelia with definite spores.

Protomyces: On tumors of higher plants → small infections - filled with filaments which → terminal or intercalary spores like Entoloma: when this spore has wintered over and germinates to → a vesicle into which ∞ sporidia escape These fuse in H pairs like smuts. and also resemble some Ascomycetes De Bary referred back to Hyphochytriaceae - this is far fetched in all respects.



heterogamy. The synkaryon condition persists till teleutospores germinate. Teleutospores vary very much. Uromyces has 1 celled " . At maturity a fusion nucleus is formed. At germination comes synapsis and reduction: 4 nuclei form which enter the sporidia. Spermogonia have haploid condition.

Aecidial = Stage I, II = Uredo III = Teleuto stage 0 = Spermog.

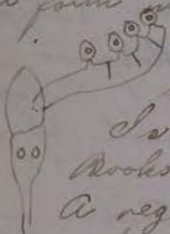
Variations: I II III; 0 II III; 0 III; 0 I III; I III, II III; III; 0 I; II; 0 I II III.

Now if all ~~tele~~teleutospores must have 2 nuclei how about forms with absence of aecidia. Several ways of avoiding mixup. One on Potentilla (Phragmidium) → uredo, teleuto. This forms → 2 uredo forms in succession. The primary uredo is very like an aecidium with upright cells which cut off a terminal evanescent cell. Then

they unite. then a bud forms. Its nuclei divide. Upper becomes the uredospore and lower the stalk which is ∴ the homologue of the buffer cell.

From these spores the secondary uredosorus will → all binucleate spores.

A form with only teleutospores (mallow rust). Sporidia



are 1 nucleate - so is mycelium. To get 2 nucleate condit the veget. cells fuse.

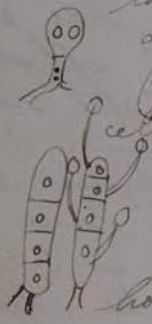
Is there any sexuality involved in this process. Brooks call an alternation of generation. A vegetative substitute for a once functional gamete (spermogonia)

Some are annual, some perennial and → hypertrophy (witches broom, tumors, cedar apples) any stage may produce. Thistle rust → 0 II III condit.

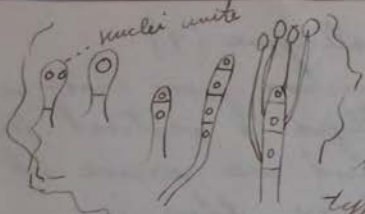
Racial idiosyncrasies: Gymnosporangia will attack certain apple trees and not others.

Cereal forms ~~etc~~ (P graminis). Barley forms won't attack wheat even when spored thru barberry.
Wintering over of barberry rust without barberries is still in question: seeds? (winter wheat) aredospores?
Mycoplasma theory of vegetative life (Erickson) believes that rusts live in a plasma conduit in cell something like Uromyces protoplasm. Only one other botanist believes. Says plasma goes out thru cell wall and → vegetative mycelium.

Coleosporium is a stepping stone to next group. At moment of Teleutospore formation. The anlage remains thin walled - before becoming really a spore the 2 nuclei fuse - hence must be called mature (cytologically). It now develops into a promycelium. It then sends out a sterigma from each cell (Moment of germinal of teleutosp of rusts vary much). With this Coleosporium we may homologize the jelly fungi. Other genera of rust show same thing.



Uromyces has 1 celled teleutospore - Gymnosporangium is a 2 celled - accidium called Roestelia is on Pyrus etc. Phragmidium - comp. fig. first seen here. Calyptospora → witches broom on Vaccinium - teleutospores in epidermal cells. Coronartium on Pinus. Endophyllum → accidium whose spores germinate by promycelia like a teleutospore.
Aeciculariales Jew's Ear. Toward mountains - more in south. Eaten by orientals. Destruction of N.Z. forests due to the trade. Gelatinous with hymenial surface. Jelly = outer wall of mycelia which → a meshwork. Certain filaments swell; are cut off - binucleate - enlarges → 2 cells then 4 cells



Stengmata project thru gelatinous surface. Ten exact parallel to Coleosporium. The hymenium is rather irregular not even as in typical Basidiomycetes. So the basidia are "telentosporic". This and other such forms are very resistant - last 2 years in dried condition.

Saccoblastia has pouch for nutrition

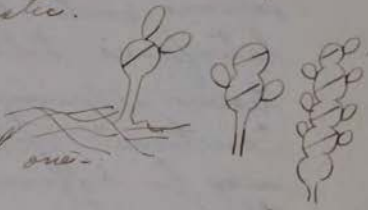
Pilacrella - seen twice - once in Europe - once here on potato culture

Auriculariales can be divided into Gymnocarpic and Angiocarpic forms.

Pilariales. On dead beeches commonly. Section → peridium on outside. branching hyphae inside

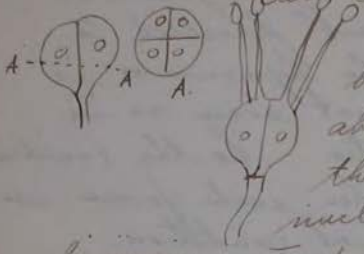
No stengmata - not gelatinous. The inner filaments often show clamp connections. This is a typical basidiomycete characteristic.

Sirobasidiales Tropical and few. First found in Brazil. New Eng. Bulges form below the terminal one. Found recently in New Eng.



(In the "Auriculariales etc we don't know how the binucleate condition is attained.) The "basidia" of Sirobasidium are obliquely linked. This brings us to Tremellales:

Same gelatinous condition - red, black, orange white. Mass made of gelatinous hyphae which end in rounded cells (hymenium irregular) - binucleate. The nuclei unite - divides twice and assoc. with it is an oblique or longit. division.



Each cell sends up a sterigma (4)
So there is transition from cross walled basidia, thro oblique to vertical. Now abolish the septa and we arrive at the Autobasidii; where there is nuclear division without cell (basidium) division. Tropical jelly fungi → parallel series of hymenial forms to Autobasidiomycetes viz. hydnums. polyporus etc. One native Tremellodon → hydnum condition.

Autobasidiomycetes

Basidium unicellular. Immense group. (Toadstools very very much - uninteresting). Are saprophytes, wound parasites or true parasites. Some grow on other toadstools etc. Mycelium copious but finally → the hymeniophore. the filaments show clamp connexions. Fructification although composed of filaments may be pseudoparenchymatous - various each tissues may be set apart. sclerenchyma latex-yielding tubes, resin ducts (traumatic?) Elastic tissue allowing for expansion. Phallus e.g. has "erections." Gelatinous tissue common. Elater may be differentiated. One genus has spiral thickenings around the elaters. "An identity of structure and function means nothing"!
Filaments of hymenium → cells uninucleate multinucleate, binucleate; latter not ∴ to Uredineae, and do not show synchronous division. Basidium however is. → same condition as teleutosp. etc; nuclei are paired - they unite and then reduce to → nuclei for spores. Basidium is → 4 spores but may → less or more. Early in

vegetat. history - the cells become binucleate but no pseudo-fumigation has been seen

(Teiuellar elec → conidia in addit to Basidiospores

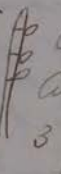
So binucleate condit of Basidiomycetes a true synkaryon? Probably more than accidental parallelism to ascos.

~~Rare cases~~. Nuclei pass in Basidium; it divide twice but sometimes more. When fusion nucleus divides asters are formed at apex of basidium. the aster comes in contact with membrane. Nuclei then migrate down and are connected with kinoplasmic strands to the aster.

Papilla now forms around the point where the aster lies the strands now contract and draw the nucleus up into the spore then the sterigma. Nucleus may divide in spore to → binucleate condition of spore.

Imperfect conditions of Protobas. are not found in Autobas. no accidia, uredia etc. If secondary forms do occur they are like the Ascomycetes.

Protobasidiomycetes - supposedly primitive and → the Autos. Some believe that Autobas. came from Ascomycetes: Basidium is said to be ~~=~~ to imperfect stages of these fungi. Certain of these (imperfect forms) may have septate mycelia with clamp connections as in Autobasid. imperfect forms are not as varied as in Ascomycetes: Pedocephalum is an imperfect type in 3 Basidiomycetes B. Remove all but 4 spores and → a basidium Such was Brefeld's idea. Basidium is sometimes called an ascus turned inside out.



If nuts are protos. and Basidios have come from Ascomyc then why are they (nuts) farthest away from Ascos.

Polysporus → on agar are Pedocephalum - will [illegible] Sometimes may → basidia but

rare. Brefeld thus reduces Dedocephalum to 4 spores and → a basidium. In Thelephoraceae 2 spo. → same thing; Coniomycetes (Deuteromycetes, → same; so no phylogenetic conclusions can be based on. Mucor so same. - merely a physiol. adaptation to spore many spores.

A certain condition parasitic on Lactarius → strange spores on surface of pileus.

A Thelephora also → imperfect condition.

No interest - no individuality about imperfect stages of Basidiomycetes.

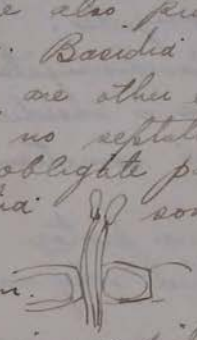
Sclerotia, Chlamydospores, basidiospores, Rhizomorpha, Rhizoctonia = a sclerotium of Thelephoraceae - comes on potato.

- - - - - - - -

Autobasidii

Dacryomycetales: Resemble Tremella - made up in same way - gelatinous filaments. 2 nuclei - fuse - divide into 4. Only two function at first. Later the other 2 nuclei may go up same sterigmata and → 2 more spores. So very like Tremella but no septation. The mature spores become elongated and septate and may → secondary spores. Imperfect spore forms are also produced.

Exobasidium may → same. Basidia don't → even hymenium but between them are other elements. So like protoe. in this respect but no septation in basidium. Exobasidium also is an obligate parasite. when young it → eptenal conidia something like Entyloma conidia. May suggest that agents have some connexion.



Tulasnellales: Group is growing rapidly. Look [illegible]

Hymenium irreg; whole is gelatinous. When mature 4 sessile bodies bud off. These germinate to → "secondary spores". Are the first ones sterigmata.

Hymenomycetales: Hypodnaceae: Hypho mycetous hymenomycetes - fluffy loose mycelia which → basidia - Saccardo has even put one genus into the Hyphomycetes.

Thelephoraceae: Hymenium even - very varied in habit

Hydnaceae Have hymenium on teeth } methods of
Polyporaceae Pore forms } enlarging surface

All these run into one another - folds lead to pits etc.

Plating the surface → gill forms (Agaricaceae)

Clavariae are merely modified ~~odd~~ Thelephoraceae.

Cora: Same fungus parasitises 3 genera of algae and → three genera of Lichens.

In all hymenomycetes there is an even hymenium, cystidia may be present, paraphyses - cystidia may keep the gills apart.

Spore discharge, dispersal etc investigated by Buller (?) Most Coprini (e.g.) - spores mature first at ~~##~~ bottom and gills begin to turn up - enzymes dissolve the general tissue which deliquesces upward. Woody polypori give continuous discharge of spores - violently - can be seen by "Tyndall effect". Force of discharge sends spore ~~distantly~~ horizontally about 1/2 way thro the pore - then it falls.

Coprinus comatus during its life → about 5 billion 240 million spores; Agaricus 1 billion 800 million.

Polyporus with continuous discharge (annual) 700 billion; Puffball (L. giganteum) 7 trillion.

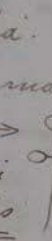
Economic importance: Wound parasites, some edible.
Armillaria, Agarics may be true parasites. Some
rots on lumber.
House fungus (Germany France etc) Merulius lachrymans
T. found in cellar ⇒ big patches of mycelium.
Perennial or Annual Some very old - may be xerophytic
and retain vitality for years when air dried

Gastromycetes - (Angiocarpeae)

Mature spores enclosed in cavities or thmost a solid
fruiting body. Even when ultimately exposed they are
formed in cavities
Simplest form (never been described). Protogaster.
no bigger than mustard seed a Cymenogaster
Many are subterranean. Basidia and spores variable
Lycoperdales: Geaster hygrometr. is a Plectobasidiatan
In " the mass ⇒ a chambered gleba with
peridium which becomes a dry powdery mass. enclos-
ing spores in capillitium.
Nidulariales: ½ doz genera 100± spp. ⇒ Cups like
peridium with egg like peridiola. When young it is
wholly enclosed. Peridiola are merely specialized cham-
bers.

Hymenogastrales ⇒ wet masses when ripe. Most are
subterranean or sub- subterranean (below leaves)
Chambers persist. Decay or is eaten by animals.
Phallales: Stink-horns "Fungus flowers". Stench
is for same purpose as odor of flowers. Often
striking in color etc. Basidia mature inside
peridium then carried up by expansion. Several
Hymenogastrialan forms lead over to Phallales

Plectobasidiales. Sclerodenna a common puffball with rather permanent gleba. One desert form has long stalk and spiral elaters (Looks like Toastol) No hymenium at all. Filaments run irregularly thru mass and form basidia without hymenium

Tylostoma → odd basidia. Calbostoma (vermilion) red almost below ground. At maturity is carried up by gelat. stalk. Tylostoma →  Calbostoma → almost an Podocephalum condition

"Genetic hyphae" stands thru

Hemiasci:

Ascomycetes

Protomycetales. Taphridium looks like Exoasci. Protomyces → weak on plants and forms chlamydospores intercalary, Germinate to → 4 spores inside a vesicle

Nuclei arrange themselves peripherally to → naked cells which divide into 4's - each of which becomes a spore. These conjugate. 

Taphridium → large intercalary swellings which do not rest but swell out under epidermis and acts like Protomyces. Are these vesicles asci? There is no union of nuclei - they are multinucleate. All are parasitic.

Ascoidales: All come in slime-flux of trees. Not much done on them in America. Ascodea is primitive, hyphal and → 2 types of repod. Filaments septate - Conidia acrogynous  Other → terminal cell  Opens at top and discharges. Then the basal septum bulges in and new sporang. unit is formed as in Saprolegnia.

Dipodascus - found in Peruvian Schleim-fluss first - later in Norway. Mycelium coarse septate, compound coenocyte - large conidial chains 

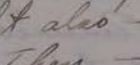
One nucleus in each is different from others. These nuclei unite 

Now grows up. Fusion nucleus divides to → ∝ spores in the protascus. These ooze out at top.

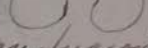
Protasci:

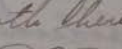
Saccharomycetales: will be converted into asci; contents may be in 4's 8's or irregular. What actually is a yeast. Mucors will ferment. will → alcoholic fermentation. ∝ smuts will grow in same way but → no " ". But some true yeasts won't do this. ∝ imperfect forms of Accomy. & Basidios. will pass into this condition. Hansen regarded all that sporulate as yeasts and others not. Gloeosporium will → alcoholic fermentation and it is said it will → spores. Some → diseases. "thrush" of babies; one malignant tumor. Blastomycosis is caused by some yeast like form.

Saccharomyces - colony on plaster slab etc will → spores  Such cells are called asci but not evident why. Comparisons with other forms lends some support to this idea.

Schizosaccharomyces: Other forms multiply by budding but this one multiplies by fission  - otherwise like yeast. It also → spores  due to conjugation. Then → 8 spores → 

S. Pombe: octosporus. First found on tropical fruits (Mowrai fruits and make plate cultures)

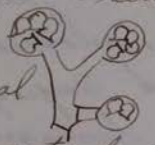
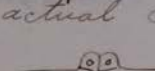
Zygosaccharomyces: a budding form  unites  It is said that nuclear fusion has been seen. The spores are smooth there

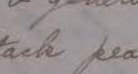
De Baryomyces: Found in Java  Spore forms in both ends or in one side.

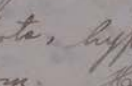
Schwanniomyces. Seeds not beaks but no conjug

 Saturn-like ring around.

Willia anomala → no conjugation but → 
Saccharomycodes: Tends to → filamente. In
isolated state it sporulates → 4 spores  when these
germinate they send out tubes and conjugate  in
the cell and also outside.
Saccharomycopsis: → transition to filamentous fungi
for grows either way. Contents turn into
"asci". 

Endomycetales Conidial forms but not yeasts. Are on
Amillaria etc. Pseudosexuality etc mixed. In
Endomyces sp  (Kats) Another sp. seems to be
partially sexual  so here  not really fused.
Some do → actual conjugation
Eremascus:  So pretty close
to Gymnoascus - also close to gymnoascales if asci = gymnoascales

Exoasci: Approx ascomycetes but in doubt as to
position: 2 genera; all parasit on Angios and Cryptos.
now. Attack peach, plum (plum pockets); chiefly on
Rosaceae → spots, hypertrophy etc. Whole region may
→ witches broom. Hypertrophies tracts of alder.
Mycelium perennial or sometimes annual. Pushes
between cells and works its way between cutis and
epidermis 

The cells become binucleate
by conjugation and nuclei ✕ unite to →
fusion nucleus.  From the "bodies" beneath the
cuticle asci are pushed up and → 8 ascospores
E coerulescens (?) on oak. Asci are full of minute
spores because original ascospores bud to → ∞

Magnusella: grows down into tissue and points to Taphrinia

Carposci:

Asci are borne in a definite structure or fruit. Angiocarpic forms are enclosed but there may be an opening in the fruit. Gymnocarpic forms → an open cup as in Lichens. Ascomycetes → 15-20000 spp. Basidiomycetes 10-15000. Former are marine or terrestrial, on algae or with algae → lichens. Practically all lichens are Ascomycetous. May be parasites on Basidiomycetes, other ascomyc., lichens, mosses etc. A large number occur on Gymnosp. and Angiosp. The imperfect or pycnidial forms do ∝ damage. ∝ are mostly parasites. ∝ ie saprophytes

Black knot, chestnut blight etc are examples of destructive forms. Latter a native of Asia on an ornamental chestnut there but when imported here it became destructive. May destroy host entirely.

Some attack not only trees but dressed lumber; they may destroy wood or harden it to an iron condition.

Imperfect forms do most of leaf damage - spots etc. Asci are formed late in season or the next year. Perfect forms → rise later to imperfect. So imperf. forms do the damage and perfect forms carry it over winter.

The ascus is the definitive characteristic. Ascospores are 4-8-∝ Some forms have septate spores - others may bud to → ∝ spores (myriosporic asci).

Spores vary in shape - ovoid common. Compound

original spore divides several times and then stops. Each division may behave like a separate spore

Saccardo bases genera on ascospore development: Ascomycetes are very polymorphic

Fungi Imperfecti: 1 Hyphomycetes - spores borne free to air on hyphae. 2 Sphaeropsidales: spores enclosed in a perithecium. F. imperfecti genera may be often polymorphic e.g. Cladosporium and Entyloma often mimic one another. In non-pycnidial forms large spores are often formed.

Tuberales: Underground: hymenium lines the inside like a closed Peziza. The mass is solid with definite asci producing regions. In Plectascales the asci are scattered all thru without reference to hymenial areas; may be open or closed.

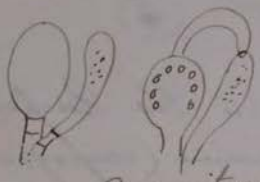
Tuberales - solid mass with asci assoc. with ascus producing areas which = hymenia turned in in cavities.
Plectascales: Cleistocarpic etc but asci irreg distributed
Perisporiales: " perithecia - asci are related to an ascigenous layer. Powdery mildews → conidia
Uncinula → gonary mass of appendages. Nothofagus → curious unculaa
Dothideales → compound stroma with holes in stroma in which asci are borne - no perithecium
Sphaeriales ~~may~~ → a definite perithecium - may be simple or fused into a stroma. Hypoxylon
Hypocreales: Soft, bright colored, fleshy - Polymorphic imperfect stages in same form.

Pezizales - Open apothecia - common
Helvellales Stalked or clavate forms - Morel → compound cup form.
(Cyttaria) → big galls on trees in Antarctic forests. At one season → fleshy masses bearing asci in cavities
Phacidiales
Hysteriales: ∠ forms → lichens. Like a Peziza folded over with hymenium inside 

Ascus history often very definite in the Carpoasci.
" is u. preceded by an ascogonium (carpogonium); this associates with variformed ♂ organs; separable sperm cells or fertilizing filaments.
Sphaerotheca: On leaves early in season → conidia later one sees knots  ♂♀ or ☿ One becomes larger - smaller cuts off a terminal

cell - each nunucleate - fusion ; not a real oogonium for no egg is formed. The carpogon. now bends up  From the stalk grow up paraphyses and peripheses. The subterminal cell (A) develops a single big accus  binucleate - these nuclei fuse - then reduce to → 8 ~~spores~~ nuclei which organize spores. Exemascus → something analagous but this acus in Sphaerotheca is formed indirectly - there is an elaboration of the zygote. In other genera there is same history up to stage A above but then the cell (A) begins to grow out to → filaments and products of the nuclear fusion go ~~grow~~ out into the ~~p~~ branches  There divide up and from one of the divisions comes an accus - the one transformed always has 2 nuclei which fuse and then reduce. This is stage A above carried a step further.

Pyronema: A Discomycete. Grows on burned soil - very common - rose colored begins white. In young condition:



Conjugation

Nuclei of carpogonium lie in periphery. The ♂ nuclei migrate thru the trichogyne into carpogonium. Harper says the nuclei unite here to → ~~con~~ many fusion nuclei

So gametes are cenogametes (cf. Albugo)

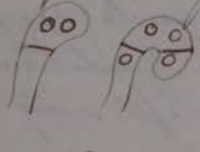
Carpogon. now begins to send out branches and into them the nuclei pass. Around the whole

mass grow sterile hyphae to → a cup. (apothecium). Some become paraphyses. Fertile hyphae

→ asci.

Some say the young fertile hyphae are multinuclei and said to be no fusion of ♂ and ♀ in the carpogone but that these pass in pairs into the filaments. Is this a synkaryon like the rusts. Thaxter accepts Harper. Daugeard says that carpog. fusing with antherid is non functional

Detail of ascus formation:



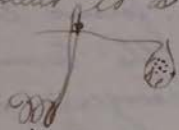
Then the upper two unite. The fusion nucleus divides and → the ascospore nuclei

Free cell formation now goes on

The ascogenous hyphae now bend around and organize the all wall. ~~Some~~

This does not take place in Exoasci or yeasts. Perhaps these degenerated

In Lichens the ♂ is not a fertilizing filament but ♂ element is a sperm cell which comes to a trichogyne



antheridium. One recently studied shows modification for trichogyne and sperm are contained in the thallus

Ascogonium

Eurotium

Trichogyne thus seeks the ♂

Laboulbenalis is the same thing in some cases. Laboulbenals are parasites on living insects - Spores in asci ~~of~~ 4; rarely 8. Spores are in pairs and thus discharged

H. unicell with terminal end.
Two main groups one unisex other hermaph.
Unisex forms → from 2 spores, one ♂ the other ♀ so that little ♂ and female will be together
The gelatinous envelope of the spore persists and covers the mature plant. Red Algae → exactly the same thing.
U. they → a black foot with thin spot for absorption. Foot may run into stems to → a rhizoid. U. not Vegetative characters vary much; 2 celled to ∞. No non-sexual reproduction. Hosts are all insects except Lepidoptera Certain spp have ecological limitations. 13 spp grow on common water beetle. Left wing sp. may have 1 sp. half way up wing etc; one on certain region of leg. etc
Another red algal condit is protoplasmic continuity between the cells. Whole veget system is reducible to a branching system.
Reprod: ♀ organ → carpogonium. (See infra).

~~If unisexual~~ Trichogyne may branch elaborately and branches coil. Exactly same is seen in Florideae
In hermaph. forms the antheridia develops from the terminal small cell of spore. Ascogenic cell is now cut off with supporting cells - it buds and → buds which are asci. There → 8 nuclei 4 of which disappear. Fault buds reveal nuclei in ascog. cell which → 2 nuclei to asci. These fuse and → reduction and free cell formation. Reprod. then is ascomycetous but also ∽ to Red Algae
Fertilization cuts off supporting cell in same way

Ascomycetes deviation: Floideae are similar in aquatic habits, vegetat. habit, reprod. but we have carpogones not asci. So Rusts also come from Ascomycetes – they have spermo. Not related to existing Floideae.

Brefeld calls ascus a sporangium. Some Mucorellae may have a weft of mycelia at base of sporophore; shorten the sporophore and → an ascomycete. There are certain ascomycetes with ∞ spores. Eremascus may be called a zygote. Sphaerotheca may be compared to Pythium. So ascus may be from zygotophore or oögonium or as Dangeard says: the ascus is the egg and to be compared with eggs of lower forms.