On account of the occasional failure of this treatment, Kocher proposed to extirpate the mucosa of the sinus. This radical intervention may be performed by a number of comparatively new procedures, viz.:

Nebinger-Praun Method.—The anterior wall is opened by horizontal and vertical incisions and entirely removed. The mucosa is curetted, and the naso-frontal duct dilated. The wound is drained through the external opening.

Jansen Method.—The orbital wall of the sinus is removed and the cavity curetted.

Killian's Method.—This consists in opening the sinus through the frontal wall with temporary resection of the nasal bone. The infundibular cells are broken up to such an extent that free drainage of the sinus by way of the nasal fossæ is insured.

Luc-Ogston Method.—Both frontal and ethmoidal sinuses are opened, and a wide communication is established between the former and the nose. A drain is then passed between these two cavities and the external wound closed.

Czerny Method.—Osteoplastic opening of the sinus. Operation finished as in preceding.

Kuhnt's Method.—The anterior wall of the sinus is removed, together with all the diseased mucous membrane and the upper portion of the fronto-nasal canal. This operation is preferred by most surgeons. According to Hajek, the only objection to its general employment is that it makes no provision for attacking the infundibular cells of the ethmoid, which are almost invariably diseased in empyema of the frontal sinus.

Killian sums up the subject of surgical intervention in chronic empyema of the frontal sinus as follows:

The supra-orbital margin must be preserved, even if only a narrow bridge remains; otherwise great disfigurement results. The general theory of most of these operations involves the opening up of a passage between the sinus and nose for the purpose of drainage through the latter. This passage may be natural or artificial. But these communications often heal up prematurely by granulation, and a permanent passage is insured only after resection of the nasal bone or nasal process of the superior maxillary. This form of intervention also gives access to the ethmoid labyrinth.

The technique of Winkler is representative of our modern knowledge of the treatment of chronic frontal-sinus disease. This procedure is as follows:

1. Tampon the posterior nares.
2. Make an incision through the eyebrow (do not shave the latter beforehand).
3. Exploratory puncture through the incision with probing. An alternative now presents itself, viz.: (*a*) Resect the anterior and orbital walls, leaving the orbital margin; or (*b*) perform temporary osteoplastic resection. If permanent resection is to be performed, the technique is as follows:
4. Remove the anterior wall of the sinus with bone forceps or Winkler's saw, the latter being preferable in fixing the upper limit of the orbital bridge.
5. The floor of the sinus is removed with chisel and forceps, the orbital margin being left as a bridge.
6. Extirpation of the mucous membrane of the sinus.
7. The original incision is prolonged beyond the bridge of the nose and beyond the extremity of the nasal bone.
8. The nasal bone and a small portion of the frontal bone are divided with the chisel; the nasal process of the superior maxillary is then divided with the saw.
9. The skin-bone flaps are now turned backward.
10. Diseased ethmoid cells are removed with bone forceps and curette, and a communication is established between the sinus and nose.
11. The flaps are replaced. Sutures may be applied at once or after two days. No irrigation is allowed until two or three weeks have elapsed.

If an osteoplastic procedure has been chosen, the technique is as follows: The skin is pushed back beneath the orbital margin, and the bone separated from the latter with the chisel. At the outer and middle limits of the sinus this margin is chiselled through. The flap of bone and integument is turned upward and outward. All œdematous and fibrous proliferation, carious bone, etc., are removed with the curette.

INJURIES.—In traumatism of the frontal sinus the violence is always direct. Sharp violence is usually due to knife thrusts and sword cuts; while blunt traumatism proceeds from a great variety of objects, including projectiles, flying fragments, etc. The frontal sinus is occasionally injured by horse kicks, blows of the fist, falls upon the face, and the like. The external wall is almost invariably the part injured. Autopsies occasionally reveal the presence of injury of the cranial wall, such accidents being quite generally fatal. The character of the injury varies from simple fissure or indentation to compound fracture and comminution. Hæmatoma of the sinus usually coexists.

The symptoms of injury of this sinus are either local or cerebral. If the violence does not lay open the sinus, the blood escapes by the nose. Epistaxis and pain are practically the sole symptoms of this type of fracture. While these traumatisms tend to recover without sequelæ, the injury doubtless produces sinusitis in certain cases. A peculiar type of traumatism sometimes seen is detachment of the lining membrane of the sinus.

If the cavity is opened subcutaneously by the violence, respiratory movements are seen in the superjacent skin, and subcutaneous emphysema is readily produced, which may extend indefinitely. It tends to subside spontaneously in a few days.

Trauma with complete exposure of the cavity is of frequent occurrence. This class of wounds is readily infected either at the time of the injury or afterward, so that abscess, periostitis, necrosis, fistula, and endocranial complications may result. If infection does not occur, these compound wounds heal readily. One sequela which may occur independently of infection, however, is pneumatocele.

Diagnosis is usually made without any difficulty. In fracture, emphysema readily occurs. Rhinoscopy is useful in detecting hemorrhage from the sinus.

After injury has occurred infection may be prevented by antiseptic irrigation. The possibility of latent injury of the cranial wall must always be borne in mind. As a general rule the treatment of all subcutaneous injuries is expectant, save when cerebral complications are to be feared or when sinusitis develops. On the other hand, open wounds always require active surgical intervention. The opening should be enlarged, the sinus cleaned, spicula of bone and foreign bodies removed, the cranial wall carefully scrutinized for possible injury, and the cavity well drained. Antisepsis will certainly prevent grave endocranial complications. In very extensive wounds a plastic operation is required.

FOREIGN BODIES.—With a very few exceptions all recorded cases of foreign bodies in the frontal sinus have consisted of projectiles, chiefly from old-fashioned weapons. The velocity of modern projectiles, aside from revolver shots, is too considerable for them to be arrested within the sinus.

These projectiles may heal in the sinus, but as a rule a fistula results. Sinusitis is almost invariably set up. These foreign bodies may remain in the sinus for an indefinite period, even amounting to twenty-five years.

Diagnosis was formerly by no means easy, and exploratory incisions were occasionally necessary. To-day the employment of the Roentgen rays insures rapid recognition of foreign bodies in this locality.

A special type of foreign body in the frontal sinus is the animate, consisting of mature insects or larvæ which reach this cavity by way of the nasal chambers. The recorded material, however, is almost all ancient.

NEW FORMATIONS.—Of benign tumors of the sinus, osteoma is the only one which receives consideration from modern authorities, for polypi and cysts are now regarded as incidental features of chronic sinusitis. Even osteomata are held by some to be of inflammatory origin. They may be attached to the bone by a broad base or peduncle, or they may be simply embedded in the mucosa. They may even lie loose in the sinus. These formations are practically confined to the periods of childhood and adolescence.

In structure the nucleus and peduncle are cancellous and the rest of the mass of ivory-like hardness. The osteoma may attain the size of an apple. Its growth beyond a certain limit expands the walls of the sinus. The cranial cavity is often encroached upon, as are also the opposite sinus and orbit; but so gradual is the enlargement that little functional disturbance results. Exceptionally, severe ocular disturbances, cerebral compression, etc., are produced.

Osteoma may be complicated with sinusitis in all its phases. It also closely simulates dilating sinusitis, so that exploratory puncture may be necessary for differentiation.

The indication in osteoma is immediate extirpation. In former years the mortality from this intervention was very great. As the operation itself is not difficult, the danger must lie solely in the possibility of infection.

Of malignant growths originating in the frontal sinus such a small number are upon record that hardly anything need be said on the subject. The few cases in literature were all sarcomata, which grew rapidly and broke into the contiguous cavities. Carcinoma has never been known to originate in the sinus, and even the cases of secondary invasion are of extremely rare occurrence.

George Ryerson Fowler.

[1] Killian: Heymann's Handbuch der Laryngologie und Rhinologie, Bd. iii., 1900.
[2] Hajek: Pathologie und Therapie der entzündlichen Erkrankungen der Nebenhöhlen der Nase, Leipzig u. Wien, 1899.

FRY'S MINERAL SPRING.—Jasper County, Iowa.

POST-OFFICE.—Colfax. Hotels: Fry's and five others.

This is one of a group of ten well-known mineral springs located at Colfax, on the line of the Chicago, Rock Island and Pacific Railroad. Like all the others of the group, this spring has an artesian flow and proceeds from a depth of between 300 and 400 feet. The water of this spring has been analyzed by Dr. Heinrichs, Professor of Chemistry, Iowa State University, and also by Professor Haines, M.D., Chair of Chemistry and Toxicology, Rush Medical College, Chicago. The results obtained are as follows:

ONE UNITED STATES GALLON CONTAINS:

Analysis by Dr. Heinrichs. Solids.	Grains.	Analysis by Dr. Haines. Solids.	Grains.
Sodium chloride	3.85	Sodium chloride	3.842
Sodium sulphate	78.86	Sodium sulphate	77.344
Potassium sulphate	.41	Potassium sulphate	.620
Magnesium sulphate	31.87	Calcium sulphate	31.750
Calcium sulphate	13.07	Magnesium sulphate	10.230
Calcium carbonate	17.51	Magnesium bicarbonate	25.939
Iron carbonate	.67	Iron bicarbonate	.258
Silica	.29	Alumina	.068
Lithia	Trace.	Silica	.710
Carbon dioxide	7.18	Organic matter	Trace.
Total	153.71	Total	150.751

As seen by the analyses, the water is quite strongly impregnated with mineral ingredients, but not sufficiently so to mar its pleasant taste. Ample bathing facilities are provided. The elevation of the location is 1,100 feet above the sea-level, the surrounding country being of a hilly character. The waters of the spring have been found efficacious in rheumatism, dyspepsia, general debility, and in diseases of the blood, liver, kidneys, and nervous system.

James K. Crook.

FULTON WELLS.—Los Angeles County, California. Hotel and cottages. This resort is located about three miles north of Norwalk station on the Los Angeles Railroad, and thirteen miles from Los Angeles City. The wells were bored by Dr. Fulton, and the resort is conducted by that gentleman. The two principal wells are 350 feet deep and flow copiously. Anderson's analysis shows the following results:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Sodium chloride	9.60
Sodium bicarbonate	2.90
Sodium sulphate	.95
Magnesium bicarbonate	17.46
Ferrous carbonate	11.75
Calcium carbonate	12.62
Calcium sulphate	23.41
Silica	2.56
Organic matter	Trace.
Total	81.25
Free carbonic acid gas	Excess.
Free sulphureted hydrogen	Excess.
Temperature of water, 64° F.	

This water may be described as a heavy alkaline-chalybeate. It enjoys considerable reputation in the treatment of anæmia, malarial troubles, atonic dyspepsia, congestion of the liver, etc. A large hotel, comfortable cottages, and excellent bathing facilities have been provided for guests.

James K. Crook.

FUMITORY.—The plant *Fumaria officinalis* (fam. *Fumariaceæ*), an annual herb with branching stem, smooth and glaucous compound leaves, and small, rather irregular flowers in axillary racemes; the pods are one-sided, and the juice of the stems and leaves is not milky; in other respects of structure it accords with the poppy family. Fumitory is indigenous to Europe, and an introduced plant in the United States.

The leaves or the flowering herb are collected for use; they have a bitter, saline taste but no odor. They contain a crystalline, bitter alkaline base, *fumarine*, *fumaric acid*, and a large amount of carbonate of soda.

Fumitory is an old European house remedy for "visceral, obstructive, hepatic, and scorbutic troubles." It is but little employed at present.

ALLIED PLANTS.—*Corydalis* and *Dicentra* ("Dicentra") are pretty flowers, some species of which are cultivated for ornament, and yield drugs which are used to a slight extent. There are several other species of *Fumaria* which have been employed also in medicine.

W. P. Bolles.

FUNGI, EDIBLE AND POISONOUS.—The fungi include a series of plants of very diverse characters, varying among themselves as widely in size, structure, and other characters as do the higher and better known seed-bearing plants. All, however, possess the common characteristics of absence of chlorophyl and some method of reproduction by spores. The first character will distinguish the fungi from other cellular plants like the algæ, while the latter will distinguish them from higher parasitic plants like the dodders, beech-drops, and broomrapes. All fungi, lacking chlorophyl, must live on some form of organized matter; this they may derive directly from living plant or animal tissues, in which case they are true parasites; others and by far the greater number draw their nourishment from dead or decaying matter and are known as saprophytes.

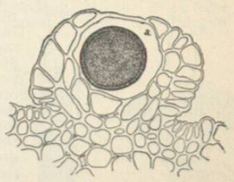

FIG. 2233.—*Synchytrium mercurialis*, producing a Gall on the Epidermis of *Mercurialis perennis*. The fungus is parasitic in a single cell and the resting spore shown at *a*. (After Woronin.)

In structure, some of the simplest consist of minute, naked masses of protoplasm living parasitically within a single vegetable cell which may be a pollen grain, a diatom, the cell of a filamentous alga, or an epidermal cell of one of the higher plants (Fig. 2233); others, like yeast, consist of single cells enclosed in a cellulose covering which does not differ essentially from that of the higher plants; these cells are free floating and derive their nourishment either from saccharine solutions or those containing amylace-

ous substances capable of being transformed into sugar. The more highly organized fungi consist of fine thread-like filaments known as hyphæ which develop primarily from the germination of spores; these hyphæ may be either septate or form continuous capillary tubes and often form a web-like tangle known as mycelium; such a mass entangled with compost, forms the so-called "spawn" from which the ordinary mushrooms of cultivation are grown, and such are the cobwebby films of mould seen on manure piles or on the surface of fruit exposed to a warm moist air. At other times numerous threads of the mycelium become joined to form cord-like strands which sometimes attain the length of many feet. Many of the conspicuous forms of fungi such as the puff-balls and ordinary mushrooms are compacted masses of mycelium variously hardened and sometimes mingled with more or less vesicular cells of various sorts; some very hard tissues like those of the woody bracket fungi are developed in the same way, the hardness and toughness depending on the compactness of the fibres and the thickening of their cell walls. The ordinary structures we know as mushrooms, for example, consist merely of the reproductive portion of the plant, and in a general way correspond more or less closely to the fruit of the higher plants; the vegetative portion frequently consists of extensive masses of mycelium concealed underneath the ground, and ramifying in every direction to secure from stores of decomposing vegetable matter the supply of nourishment necessary for their life. This not only serves for their food but from it they manufacture the material from which the reproductive parts above ground are rapidly developed at an opportune time.

FIG. 2234.—Yeast Cells of *Saccharomyces cerevisiæ* Budding Normally.

Besides developing fungus cellulose which differs only slightly from ordinary cellulose in its reactions, various fungi develop various carbohydrates like sugar, mannite, glycogen, gums, and the like; organic acids especially oxalic, malic, and citric; aromatic acids, fats, ethereal oils, coloring matters of diverse types, resins, albuminous compounds, and alkaloids. The last-named compounds are the sources of poisons found in various mushrooms; while to various combinations of some of the former are to be attributed the nutritious properties and flavors of the various forms of edible mushrooms.

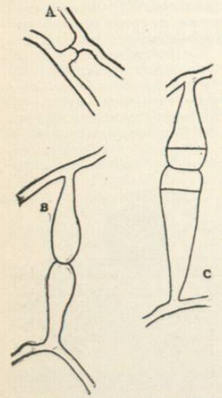

FIG. 2235.—Process of Conjugation in *Mucor stolonifer*, One of the Mucorales. *A*, Two hyphal branches approaching; *B*, the same still further advanced; *C*, suspensors cut apart from the conjugating cells (*gametes*) by septa. The union of the gametes finally produces a zygospore as seen in Fig. 2245. (After De Bary.)

Reproduction is accomplished in various ways. In unicellular forms it may take place by budding (*gemmation*) as in the yeast (Fig. 2234), by self-division (*fission*) as in the bacteria, or by free cell formation (*internal cell division*). In one of the great classes of the fungi, the spores are produced in membranous sacs called *asci* (Fig. 2241), and in the common mushroom they are borne on spicules (*sterigmata*) which rise from enlarged cells known as *basidia* (Fig. 2242). In the various groups of fungi reproductive bodies are produced in a variety of ways which has given rise to an extensive diversity of terms in common use in various works on fungi; some of the more common of these forms are as follows:

1. *Sexual Methods of Reproduction.*

(*a*) By the union of similar elements (*conjugation*) resulting in the formation of a so-called zygospore; the sexual method of reproduction in the ordinary black mould of bread is an example (Fig. 2235).

(*b*) By the union of dissimilar elements resulting in the formation of an oöspore; the sexual reproduction of the downy mildew found parasitic within the leaves of many plants in a good example (Fig. 2236).

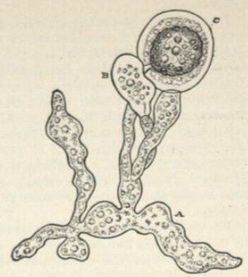

FIG. 2236.—Sexual Reproduction of *Peronospora*; *A*, Mycelium; *B*, antherid; *C*, egg. These structures form inside the leaf of the host.

(*c*) By the union of dissimilar elements, which, followed by the growth of an alternate stage (known as a sporophyte), results in the formation of a sporocarp or so-called spore fruit such as is seen in the common surface mildews of many common plants (Figs. 2237).

2. *Asexual Forms of Reproduction.*

(*a*) The formation of ciliated swarm spores within the cell by the ordinary processes of internal cell division.

(*b*) The formation of solitary conidia on simple or branching hyphæ as in the mould-like growth of the downy mildew that appears on the under surface of many leaves (Fig. 2248).

(*c*) The formation of conidia in chains by the successive cutting off of the ends of certain hyphæ as in the common green mould (Fig. 2252, *C*), the powdery mildew (Fig. 2253, *A*), and the peach rot (Fig. 2238).

(*d*) The formation of sporangia or membranous receptacles containing large numbers of spores formed by a process of internal cell division. Such a type is readily seen in the ordinary method of reproduction of the common mould of manure (Fig. 2246).

(*e*) The formation of pycnidia or special receptacles of more or less elaborate structure, from the walls of which the conidia are produced; such a structure is found in the ordinary leaf-spot disease of the pear (Fig. 2240) and other similar parasitic and often saprophytic fungi.

While many terms are employed for the various reproductive bodies of fungi, it is perhaps better to use only the two terms conidia and spores. In the lower fungi in which there occurs both a sexual and an asexual method of reproduction the term spore is limited to the sexual product, and the term *conidium* (plu. *conidia*) to the asexual. Following the same analogy the characteristic final or mature reproductive body in the higher fungi is also called a spore, even though it does not represent the result of sexual reproduction, while any earlier or simpler methods of reproduction are regarded as conidial. Following the same analogy, the spore production among the hosts of imperfect fungi (*fungi imperfecti*) is also regarded as conidial.

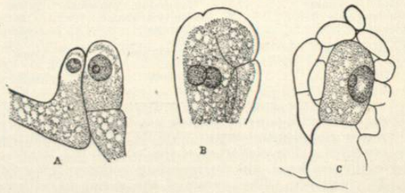

FIG. 2237.—Stages in the Sexual Process of *Sphærotheca Castagnei*, one of the common Powdery Mildews. At *A*, the two sexual cells are distinct; at *B*, they are fusing; and at *C*, the young sporocarp is forming. The mature stage of the sporocarp is shown in Fig. 2253. (After Harper.)

By the above discussion it will be seen that the same fungus possesses more than one method of reproduction,

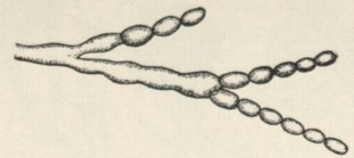

FIG. 2238.—*Monilia fructigena*, the Common Rot of Plums and Peaches; a fragment of a hypha bearing spores produced in chains.

and the case is complicated when a parasitic form has one stage of its growth on one plant and the spores or conidia of this stage are then transferred to another host plant and the final growth and a different method of reproduction take place in its new place of abode. Still more complicated are the many cases in which a fungus is parasitic during its conidial stage and passes through its spore-producing stage on some organic substratum as a saprophyte.

Fungi are of economic importance in a great number of ways: 1. As household pests they invade fruit either fresh or preserved, cereals or other starchy cooked foods, cheese, clothing, and many other things under the name of moulds. 2. As parasites on living plants they prey upon fruits, grains, grasses, the foliage of shade trees, weeds, and many other plants in the form of leaf blights, mildews, rusts, smuts, leaf spots, anthracnoses and the like, often causing immense losses to farmers and fruit growers. 3. As aquatic parasites they attack fish, particularly the young fish in the hatcheries, and often cause considerable destruction. 4. As aerial parasites on living animals they attack flies, grasshoppers, clover weevils, the pupæ of moths and butterflies, and many other animals, sometimes even producing skin diseases in man. 5. In laboratory work with bacteria they often form a disturbing element and a knowledge of their kind and nature becomes a necessity to those who make extensive plate cultures and tube cultures. These moulds are likely to be either (*a*) True Mucoraceæ, (*b*) Conidial stages of certain Aspergillaceæ like the common green mould, or (*c*) Hyphomycetes or moulds with only a conidial reproduction; in some of the latter the spores are light-colored, in others they may be dark-colored or even black.* 6. As agents of fermentation they form the active element of yeast and so are directly concerned in the production of bread and beer, and in all alcoholic fermentation, as well as in the later stages of acetic fermentation. 7. As an article of food they are extensively in use among all peoples whether civilized or not. 8. As destructive agents of timber either in living standing trees or in the form of ties or building material they form a prominent factor in engineering. 9. As remedial agents they are directly concerned with medicine, and finally as malignant poisons they appeal to members of the medical profession for the treatment of the victims of their work.

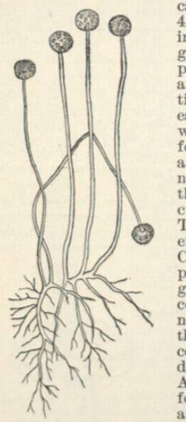

FIG. 2239.—*Mucor mucedo*, showing Root-like Hyphæ and Sporangia filled with Spores at the Summit of Aerial Hyphæ.

* A preliminary paper on these forms has been prepared by Dr. Jelliffe, "Some Laboratory Moulds." Journal of Pharmacology, Nov., 1897.

There are three principal groups of fungi that may be distinguished as follows:

CLASS I. PHYCOMYCETES — the algal fungi, including mould-like saprophytes as well as various parasites of both animals and plants. These in addition to the more ordinary method of asexual reproduction have a sexual method not unlike that which occurs among various forms of the simpler green algæ, and many of them in fact appear to be little short of degenerate algæ that have lost their power of developing chlorophyl and with it the power of fixing carbon from the carbonic oxide of the air.

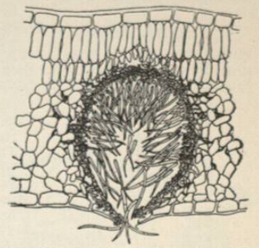

FIG. 2240.—Section of a Pear Leaf taken through one of the Pycnidia of a Leaf Spot caused by *Septoria pirina*. The darkened portions are caused by the fungus mycelium and the spores are formed from the inner wall of the pycnidium and escape at its mouth. (After Duggar.)

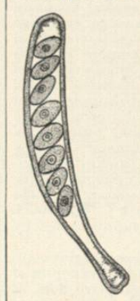

FIG. 2241.—Ascus containing Spores. (See also Figs. 2251, 2252, 2253, 2256, and 2257.

The other two classes of fungi represent distinctly higher types of fungi, whose relations to other members of the plant world are not so clearly marked. These classes are distinguished from the above by their more complicated structure and by the rarity of sexual processes, and are distinguished from each other by the method of spore production which is very characteristic and easily determined in mature material.

CLASS II. ASCOMYCETES, or spore-sac fungi, are characterized by the production of spores in membranous sacs known as *asci* (sing. *ascus*) (Fig. 2241). This character can be readily seen in any mature fungus by making a section for the microscope and examining it for the sacs containing the spores, or, most usually they can be made out from crushed fragments of the spore-bearing surface of the fungus without the trouble of making sections. With the exception of the morels common in spring and *Gyromitra*, which is not very common with us, none of the larger fleshy fungi belong to the Ascomycetes, but rather to the next class.

CLASS III. BASIDIOMYCETES. — These are characterized by bearing the spores naked on enlarged cells known as basidia (Fig. 2242). This class includes besides the parasitic rusts and smuts, all the ordinary mushrooms and toadstools (except the morel

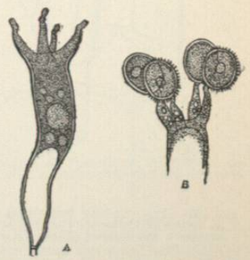

FIG. 2242.—Two Basidia. *A*, With sterigmata bearing very young spores, and *B*, a later development with spores mature.

noted above), bracket fungi so commonly shelving from trees and stumps, puff-balls and stink-horns, thus including the largest number of conspicuous forms of fleshy fungi as well as the principal forms which contain poisonous principles.

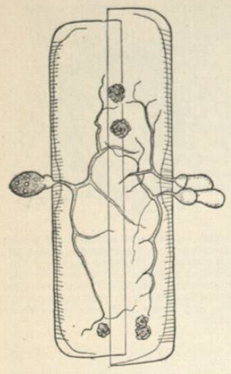

FIG. 2243. — *Septocarpus corynephorus*, One of the Chytridiales, Parasitic on a Diatom. (After Zopf.)

Besides the above groups there are two others closely related in habit and often associated with fungi. These are the bacteria which form the great group often known as the *Schizomycetes* which find a closer alliance with the blue-green algæ (*Cyanophyceæ*), and the slime moulds or *Mycetozoa* which find their alliance in the active form at least with certain of the lowest animals. In their later stages they have some superficial relations with the puff-balls, but really stand at the opposite extreme of the scale.

The general literature on the subject of the fungi is very extensive, but large portions of the earlier writings are now of interest from a historical standpoint mainly. For advanced students of the subject, De Bary's "Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria," is still the standard treatise, though it should be supplemented by Brefeld's antagonistic views in his "Untersuchungen aus dem Gesammtgebiete der Mykologie," published in twelve quarto parts (1872–1895). A summary of Brefeld's system may be found in von Tafel's "Vergleichende Morphologie der Pilze" (1892). For the physiology of the fungi, the best general treatment is found in Zopf's "Die Pilze," found in Schenck's "Handbuch der Botanik" (1890), but this must be supplemented by later investigations.

The literature relating to the American fungi is copious but very much scattered and except for synopses of certain small groups no manual or descriptive flora of our American species has been attempted. A guide to

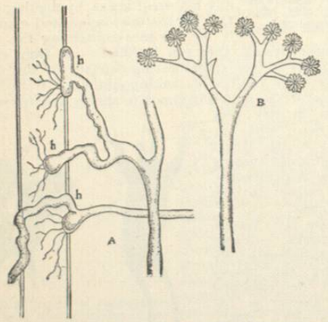

FIG. 2244.—*Piptocephalis freseniana*, a Mould Parasitic on *Mucor*. *A*, Portion of hyphæ showing the haustoria, *h*, *h*, *h*, by which it is attached to the hypha of *Mucor*; *B*, conidia. (After Brefeld.)

the systematic study of the American species with full generic synopses and extended references to our scattered literature is found in Underwood's "Moulds, Mildews and Mushrooms" (1899), and this will serve as a general introduction to the study of our fungi. The literature

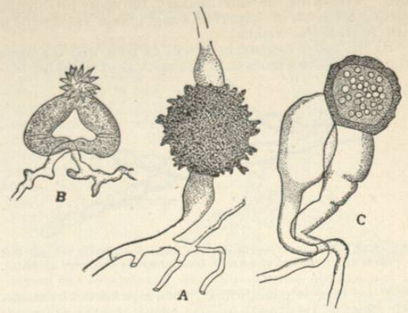

FIG. 2245.—Various Forms of Conjugation in the Mucorales, showing the Zygospore Formation. *A*, *Mucor mucedo*; *B*, *Piptocephalis freseniana*; *C*, *Pilobolus crystallinus*. (After Brefeld.)

bearing on particular groups and that relating to the edible species will be referred to under special heads.

CLASS I.—PHYCOMYCETES (*Algal Fungi*).

The Phycomycetes contain five orders of plants:

1. CHYTRIDIALES, which are mostly unicellular endoparasites on algæ, diatoms, infusoria, or rarely on the higher plants; their organization is extremely simple (Fig. 2243) and their method of reproduction is for the most part asexual. Except for the parasitic species of *Synchytrium* (Fig. 2233) the forms have not been studied in this country.

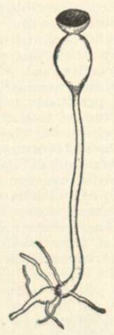

FIG. 2246.—Sporangium of *Pilobolus Kleinii*, one of the Crystalline Moulds Growing on Horse Manure. (After Brefeld.)

2. MUCORALES, containing the common black-moulds of the household, reproducing asexually by conidia produced either in sporangia as in the common *Mucor mucedo* and *Mucor stolonifer* (Fig. 2239) or more rarely in clusters at the ends of branches as in *Piptocephalis* (Fig. 2244, *B*). A second but less usual method of reproduction is sexual by conjugation as is seen in *Mucor* (Fig. 2245, *A*), *Piptocephalis* (Fig. 2245, *B*), or *Pilobolus* (Fig. 2245, *C*). The last-named fungus is a beautiful but ephemeral plant which appears in crystalline clusters on the surface of horse manure either in stables or often in the open woods. Its sporangial form is most commonly seen as in Fig. 2246.

FIG. 2247.—A Larva of the Clover Weevil Affected with *Empusa*, one of the Entomophthorales, coiled about the top of a blade of grass, which is the usual position assumed in the last stages of life. (After Arthur.)

3. ENTOMOPHTHORALES, with similar methods of reproduction as those noted on the last order, but differing widely in habit, living parasitically on insects which they destroy after feeding on their substance. A most familiar example is seen in the fly fungus in which the infested insect attaches itself to a window pane or the wall and becomes surrounded by a halo of white formed by the

conidia. Another species attacks the clover weevil in its larval stage, when the worm crawls to the top of a blade of grass, coils itself around in a regular way and dies (Fig. 2247). Another form attacks the ordinary grasshopper, and he crawls up to a convenient thistle or mullein stalk and dies clasping his perch in a death grip.

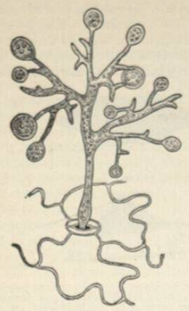

FIG. 2248. — Conidiophores of *Peronospora* emerging from a Stoma on the Under Side of a Leaf, and Bearing Conidia of Various Degrees of Development. (After Kny.)

4. SAPROLEGNIALES are water moulds which grow either saprophytically on dead flies or dead fish in the water which is their usual habit, or occasionally become destructive parasites of young fish in hatcheries or more rarely in open streams. Their methods of reproduction are quite similar to those described in the next order, except that they are primarily adapted to the aquatic habit of the plant producing them.

5. PERONOSPORALES, including the downy mildews and the white rusts parasitic on many cultivated plants and occasionally occurring on weeds and wild plants. The potato rot and the downy mildew of the grape leaf which also produces brown rot* in the fruit represent two widespread and destructive diseases caused by members of this order. Reproduction is asexual by means of conidia forming mould-like patches on the under surface of the leaf formed of the minute tree-like conidiophores which bear dust like conidia (Fig. 2248). This method of reproduction is for the purpose of rapidly spreading the disease. A second method of reproduction is sexual by means of the direct fertilization of an egg cell by a differentiated male cell known as an antherid (Fig. 2236); this takes place within the substance of the leaf, and the resting spore resulting from the process of fertilization remains over winter, and on germinating in the spring produces a new crop of the mildew. The mycelium of the fungus penetrates the interior tissues of the plant and draws the nourishment from the cells by means of haustoria, as seen in Fig. 2249. A second member of this order forms the white rust of common crucifers, being most common on shepherd's purse and radish. In this species (*Albugo candida*) the conidiospores are borne in chains (Fig. 2250), many parallel rows forming a white blister underneath the epidermis of the plant. Other species are found on the Canada thistle, amaranth, morning-glory, salsify, and ragweed.

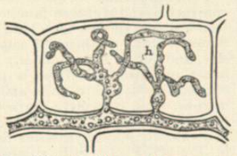

FIG. 2249.—Mycelium of *Peronospora* between the Cells of its Host and Sending Haustoria, *h*, into the Cell. (After Kny.)

FIG. 2250.—Conidia of *Albugo candida*, the White Rust of Crucifers, Borne in Chains. (After De Bary.)

The best systematic treatment of the groups of this class, particularly the orders Mucorales and Chytridiales, may be found in Rabenhorst's "Kryptogamen Flora Deutschlands, Oesterreichs und der Schweiz," Pilze, Abtheilung IV. Only the parasitic species and the water moulds have been specially studied in our flora by Farlow, Thaxter, Humphrey, and Swingle.

* Not the *black rot* of the grape which is caused by a very distinct fungus.

CLASS II.—ASCOMYCETES (*Spore-sac Fungi*).

As stated above, the Ascomycetes are characterized by the fact that they bear their spores in asci or membranous sacs. Besides this method of spore production some of

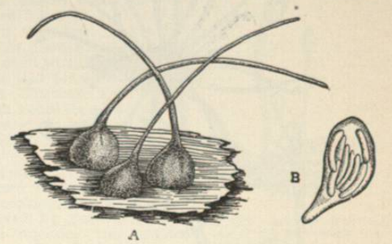

FIG. 2251.—*Ceratostomella pilifera*, one of the Saprophytic Sphæriales. *A*, Three perithecia on a fragment of decaying wood showing the long-beaked perithecia; *B*, ascus, containing the allantoid spores. (After Lindau.)

them have other methods of reproduction by means of conidia and other forms of asexually produced spores. The reproductive processes are sometimes complicated by the fact that the different stages of the reproduction are borne on distinct plants and appear at different times of the year, and moreover bear little resemblance to each other. For example, the common ergot appears as a parasitic mould-like fungus in the flowers of rye at one season of the year followed by the formation of the dark hard kernels that take the place of the rye grains and that are known officinally as ergot. The ascosporic stage of the fungus does not appear until the following spring, when the kernels (*sclerotia*) of ergot, after lying on the ground all winter as they do in nature, send up

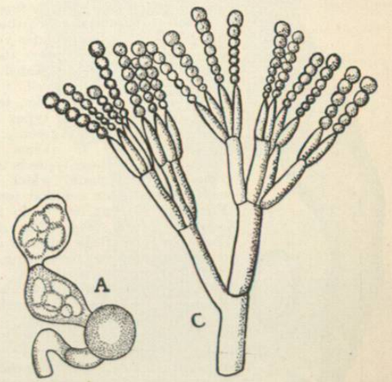

FIG. 2252.—Asci, *A*, and Conidia, *C*, of *Penicillium crustaceum*, the Ordinary Green Mould. (After Brefeld.) The asci are formed in chains.

short stems which bear rounded heads in which the perithecia bearing the asci with their spores are found.

The asci in the simpler forms are naked and more or less separate from each other; in successively higher forms the asci are found in rounded perithecia (Fig. 2253), in

conical perforate perithecia (Fig. 2255, *B*), or in long-beaked perforate perithecia (Fig. 2251); in some cases the perithecia are free from each other and in others, as in the

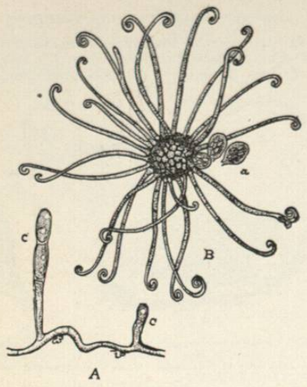

FIG. 2253.—Reproduction of *Uncinula necator*, the Powdery Mildew of the Grape. *A*, Conidial stage showing two conidia at *c*, and one just forming at *c'*; *B*, sporocarp, the result of the sexual process shown in Fig. 2252, showing the escaping asci at *a*. (After Scribner.)

common *Xylaria polymorpha* (Fig. 2254), they are embedded in a stroma composed of compacted hyphæ often very hard. The great majority of the members of this class of fungi are small and inconspicuous; only a few are fleshy and at the same time of sufficient size to warrant their use as food.

Besides less conspicuous orders the more common forms of Ascomycetes are included in the following orders:

1. SACCHAROMYCETALES.—These include the yeast plants which are of economic importance in all matters connected with fermentation. In these the ordinary method of reproduction is by budding (Fig. 2234), but under certain conditions of nutrition they form what have been regarded as free ascospores four in a cell.

FIG. 2254.—*Xylaria polymorpha*, showing the Plant Natural Size, and a Section at *A* of the Stroma showing the Perithecia around the Margin.

2. ASPERGILLALES.—In this group are found two types of fungi, both, however, agreeing in bearing the asci in skeins or chains. One of these types is the common green mould which is well known in its conidial form (Fig. 2252, *C*), but less so in its ascosporic form (Fig. 2252, *A*). The other type of the order is an underground form resembling a truffle but reputed poisonous. It is, however, too small and too uncommon to be considered worthy of much attention here.

3. PERISPORIALES.—This group includes, besides a few less conspicuous plants, the important group of the Erysiphaceæ or powdery mildews, which are commonly found as parasites on a wide range of hosts among which may be mentioned the hop, grape, gooseberry, lilac, and many others. The perithecia are attached to the surface of the leaf of the host rising from a cobwebby mycelium which draws its nourishment from the epidermal cells; the perithecium is developed from a rather obscure but no less certain sexual reproduction, shown in Fig. 2237, and develops a series of curious appendages around its periphery which are often of complicated and beautiful structure. The perithecia are spherical and imperforate, but they can be easily ruptured under a cover glass when the asci and

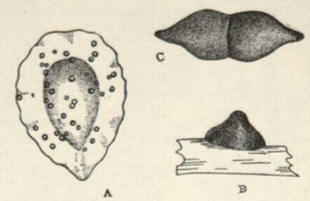

FIG. 2255.—*Caryospora putaminum*, one of the Sphæriales. *A*, Inside of a peach pit showing the scattered perithecia, natural size; *B*, a single perithecium viewed from the side; and *C*, a single spore which is apparently two-celled but has two additional minute cells at the apices.

spores may be studied (Fig. 2253, *B*). A little earlier in the season the conidia are developed (Fig. 2253, *A*) and by their means the mildew is rapidly spread over other plants. The group has been carefully studied by Salmon* and furnishes a delightful introduction to the study of the parasitic fungi.

4. SPHÆRIALES.—This is the largest order of the Ascomycetes, and eighteen families represented by over sixteen hundred species have been described from the United States. Many of them are small or even microscopic in size, and only a few are in any way conspicuous; of the latter, one stromatic form is quite common growing in clusters about old stumps and known as *Xylaria polymorpha*, from its woody character (Fig. 2254). Another form is common on old peach pits that have remained out of doors over winter; this has discrete perithecia as shown in Fig. 2258, *A*. Still another type has long-beaked perithecia (Fig. 2251). The plants of this and three other small orders have formerly been known under the

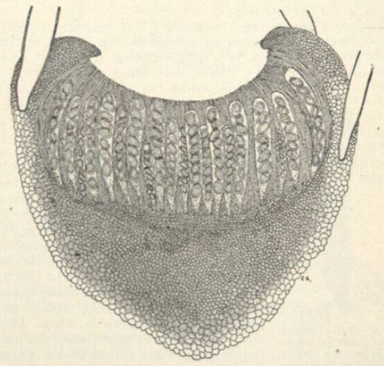

FIG. 2256.—*Lasiobolus equinus*, One of the Cup Fungi (Pezizales). Section through the entire plant, showing the asci in position mixed with the sterile paraphyses. (After Durand.)

name of Pyrenomycetes and our species have been treated by Ellis and Everhart.† The species of the Sordariaceæ

* Salmon: "A Monograph of the Erysiphaceæ." Illustrated with nine plates. Memoirs Torrey Club, vol. ix.

† Ellis and Everhart: "The North American Pyrenomycetes," 1892.

have been made the subject of a recent study by Griffiths,* and this group furnishes a most valuable introduction to the study of the Ascomycetes in general and especially to the methods of cultivation in moist chambers.

5. TUBERALES.—The members of this order are all subterranean in their habits and include the edible truffle looked upon as one of the dainties of the epicure. The true truffle is found in Southern Europe, where either dogs or pigs are trained to dig them. They vary in size from an acorn to that of one's fist and have a warty appearance on the exterior. They are best when fresh, but are most commonly sold in a canned form. Two moderate-sized truffles sell in the market for about three francs (sixty cents). Various reports are current regarding their occurrence in this country, but so far the true edible truffle has not been reported. A large number of subterranean fungi have been found in California where they have been studied by the late Dr. Harkness, and if truffles are ever found in America they are more likely to occur either in California or in the Southwest where the climatic conditions more closely resemble those of Southern Europe.

6. PEZIZALES.—The cup-fungi form an extensive group which has been comparatively little studied in this coun-

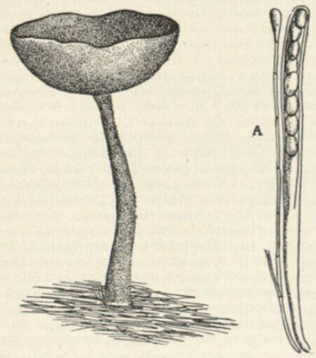

FIG. 2257.—*Peziza macropus*, One of the Cup Fungi (Pezizales), showing an Ascus with Spores and One of the Paraphyses at *A*. (After Lindau.)

try. They vary all the way from the size of a pinhead or even smaller to several inches across, some of the larger fleshy ones being used for food. They all bear the asci in a more or less concave layer in the bottom of the cup (Fig. 2256) and are normally closed above when young, but become concave, plane, or even convex as they mature. Some are stalked as shown in Fig. 2257, but the greater part are either very short-stalked or sessile.

7. HELVELLALES.—This, the highest order of the Ascomycetes, contains the largest species of any order and consequently those that are most likely to be concerned with the mycophagist. Two prominent types are represented by two families, which differ technically in the method of discharging their spores; the first include club-like or capitate forms, few of which are of sufficient size to furnish much of a meal though the gelatinous *Leotia* is sometimes eaten. *Mitrula phalloides* (Fig. 2258) is a fairly typical form of this family; in this species the ascospores are confined to the enlarged portion of the club. The other family, known as the Helvellaceæ, contains the morels, the gyromitras, and the helvellas, of which the first is by far the best-known group in this country, being quite widely known as the spring mushroom or in some places as *the* mushroom, it being the one most commonly used for food in certain regions. There

* Griffiths: "The Sordariaceæ of North America." Illustrated with nineteen plates. Memoirs Torrey Club, vol. xi., part i., 1901.

are several species of which the most common as well as the best known is *Morchella esculenta* (Fig. 2259). All the morels are edible and delicious articles of food; in Europe they are very commonly dried for winter use and sparingly used as a delicate flavor for soups. The only plant that by any possible chance would be mistaken for them is the *Phallus* or stink-horn fungus, but no one possessed of the sense of smell would possibly mistake that for an edible species. The morel has a hollow stem, hence the plants should be carefully split and cleansed inside before eating as they are likely to contain snails and other animals which also regard them as a delicacy. In cooking, the flavor is improved by parboiling them and rejecting the original water in which they are boiled.

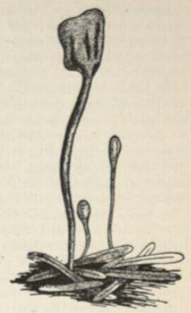

FIG. 2258.—*Mitrula phalloides*, one of the Helvellales, Natural size.

Gyromitra is a much larger fungus; *G. brunnea* has a chocolate-brown convoluted pileus and a white stem an inch or two thick; the whole plant is often five to seven inches high, and single specimens have been found that weigh as much as fourteen ounces; it has been found only

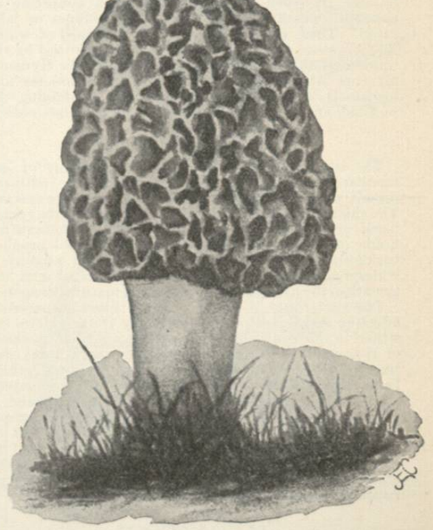

FIG. 2259.—*Morchella esculenta*, the Morel or Spring Mushroom. (Helvellales.) (Natural size.)

in the Ohio valley region. A second species is *Gyromitra esculenta* and is a much smaller plant with a wider distribution, though it is by no means as common in America as in Europe; it is two to three inches high with a strongly convoluted brown pileus, which ranges from