

THE MYXOMYCETES OF PICTOU COUNTY.—By CLARENCE L. MOORE, M. A., Supervisor of Public Schools in Sydney, Nova Scotia.

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The present paper embodies the results of studies of our Nova Scotia forms of Myxomycetes carried on during the summers of 1905 and 1906. It is here presented as a contribution to our knowledge of the flora of the Province and of the distribution of these organisms which, though generally small and inconspicuous, present in their life histories features of great interest to the biologist. The group is one which has been almost totally ignored by students of our fauna and flora, the only reference to be found to it in any of our local scientific literature being in a paper by the late Dr. Somers on Nova Scotia fungi, published in the transactions of the Nova Scotia Institute of Science. Dr. Somers there lists two of our common forms, viz.: *Lycogala epidendrum* Fr. and *Aethalium septicum* Fr. [*Fuligo ovata* (Schæff) Macbr.]. These two species are also enumerated by Dr. A. H. MacKay in his provisional list of the Nova Scotia fungi, published in the transactions of the same society (Vol. XI, Part I, pp. 122-143).

In the following general discussion of the Myxomycetes, I am necessarily indebted for many facts to the writings of various students of the group, a list of whose works which I have freely consulted will be found at the conclusion of this paper.

Life History. The life history of typical Myxomycetes may be briefly sketched as follows: Under suitable conditions of temperature and moisture the spores germinate, the walls cracking open and the contents escaping in the form of small protoplasmic globules. These soon exhibit amœboid movements,

and, before long, each becomes somewhat elongated or pear-shaped and develops a flagellum, by means of which it is able to move rapidly through the water with a characteristic jerking motion. During this stage the "swarmers," so called, increase rapidly in number by division; but eventually they settle down, the flagella are withdrawn and they again assume the amœboid form, creeping over the substratum. Soon a number of the amœbæ coalesce to form a small protoplasmic mass which continues to exhibit amœboid movements as a whole and characteristic internal protoplasmic streamings. The plasmodium, as the protoplasmic mass is now called, increases in size by fusion with other amœbæ and by the ingestion and assimilation of food material until the condition of maturity is attained which leads to the fruiting or reproductive phase. The whole plasmodium now becomes heaped up into a number of protuberances into which the whole of its protoplasm passes, with the exception, in some cases, of a small portion which remains behind to form a film-like coating over the substratum and which is known as the hypothallus. When these protuberances are distinct from each other they are known as sporangia, and these may be either sessile or stipitate. The stipe may be prolonged into or through the cavity of the sporangium to form a columella. When the sporangia are vein like or sinuous, retaining largely the characteristic form of the plasmodium, the fructification is described as plasmodiocarpous, or as a plasmodiocarp. In other cases the sporangia are partially fused together, the walls between them may be imperfectly developed and their individuality to a certain extent lost. Such a form of fructification is known as an æthaliium and is well exemplified by such a species as *Fuligo ovata*.

The protoplasm of the interior of the sporangia is for the most part converted into spores; but a residual portion frequently gives rise to a capillitium. This may consist of a network of threads or tubules extending throughout the cavity of

the sporangium, with points of attachment to the walls of the latter, or to the columella when present, or to both. The threads or tubules frequently present expansions or thickenings, generally at the nodes of the net, and the expansions may take the form of vesicles filled with granules of the carbonate of lime. In other cases the capillitium consists of simple or branched free threads or elaters exhibiting, as in the Trichias, spiral markings and recalling the elaters of some of the Hepatics.

The spores are small and for the most part spherical. In the different species they vary in size from 3μ — 20μ in diameter, a great many falling between the limits, 7μ — 12μ . They are provided with a firm cellulose wall which may be almost smooth but more frequently exhibits thickenings, in the form of spines, warts or reticulating bands. Those of a great many species germinate readily when placed in water at a temperature in the vicinity of 20 degs. C., and cases are recorded where the power of germination has been retained by spores preserved in the herbarium for several years. The time required for germination varies with the species, those of some species germinating in a few hours after being placed in water, while others require several days. My own observations on the germination of spores have been wholly confined to those of *Fuligo orata*. These I found to germinate readily in ordinary tap water in from four to five hours after immersion. The material used had in every instance been in collection for several months.

The Swarmers. The swarmers, which are developed from the germinating spores, exhibit a hyaline peripheral and granular interior portion. During the flagellate stage they are generally more or less pear shaped, the flagellum projecting from the narrow anterior end. Near this end, also, is found the nucleus and in the broader, posterior part, one or more contractile vacuoles. The posterior border is rendered more or less irregular by pseudopodia which are continually projected and

retracted. Food material is apparently absorbed in solution, but a series of observations recorded by Mr. Arthur Lister (Linn. Journ. Botany, Vol. 25), establishes the fact that, in some instances at least, living bacteria constitute no inconsiderable portion of the food of the swarmers. His observations were made on the swarm cells of *Stemonitis fusca*, *Trichia fragilis* and *Chondrioderma 'difforme*. In all these cases, bacteria were seized and drawn into the body of the swarmer by means of pseudopodia projected from the posterior end. The ingested bacteria were stored in vacuoles where they were gradually digested. The process completed, the vacuoles were observed to rise to the surface of the swarmer as bubbles and discharge their contents of refuse and undigested material.

Preparatory to undergoing division the swarm cell withdraws its flagellum and rounds off. The nucleus then divides by karyokinesis, the two daughter cells develop flagella and the swarmer form is resumed.

The swarmers frequently pass into a resting condition, rounding off and developing a thin wall. In this form they are known as microcysts. After being dessicated and remoistened the wall breaks open and the escaping contents resume the swarmer form.

In the fusion of the swarmers to form plasmodia the nuclei do not appear to be involved, but these persist as the nuclei of the plasmodium.

The Plasmodium. The Myxomycetes exhibit two types of plasmodia, the first forming a network of vein-like strands which spreads over the surface of the substratum or within its larger cavities; the second is more watery in consistency and lives in the interstices of decaying wood, from which it issues only for fructification. The first type is characteristic of the Physaraceae and the plasmodia of various members of this order have furnished most of the material for the investigation of the morphology and physiology of the living plasmodium. This consists

of a hyaline protoplasmic ground substance which, in the periphery, is free from granules, but within is filled with plasmodic grains and frequently grains of carbonate of lime, and shews also numerous vacuoles. The interior is also traversed by a network of channels in which streaming movements are continually going on. The flow in these channels is rythmic, persisting in one direction for a period of from one to two minutes, then reversing and continuing in the opposite direction for a similar period. The streaming, however, continues for a somewhat longer period in the direction of the general movement of the plasmodium. This advances by the ectosare pushing out in the direction of movement followed by a flow of the interior granular substance. Then follows a short pause, during which the advancing margin withdraws somewhat, but some of the gain made is retained. The next onward movement of the ectosare carries the border beyond the line previously attained. In this way, by a series of pulsations, a general onward movement of the mass is accomplished.

Numerous nuclei are observable in the substance of the plasmodium, and, as its mass increases, there is a corresponding increase in the number of nuclei by karyokinetic division. The nuclei are undoubtedly those of the original swarmers which coalesced to form the plasmodium, and the product of their division.

In addition to the nuclei, plasmodic granules and refuse or semi-digested material, there are found in the interior of the plasmodia of many species, granules of the carbonate of lime. Associated with the granules, more particularly those of lime, are the pigments which impart to many plasmodia bright and characteristic colors. The plasmodia of *Physarum virescens* and *Fuligo ovata*, for example, exhibit bright shades of yellow, that of *Physarum globuliferum* has a delicate lavender coloring, that of *Lycogala epidendrum* a faint rose. The prevailing color among plasmodia, however, is a watery or opaque white or grey.

A series of careful experiments conducted by Rosanoff (Mem. de la soc. Imp. des. Sc. nat. de Cherbourg, T. XIV) on the plasmodium of *Fuligo ovata* seems to establish that, in this case at least, the plasmodium is strongly negatively geotropic, the general movement of the plasmodium on an inclined surface invariably taking place against the force of gravity. The same investigator observed a like tendency to progress against the centrifugal force when the plasmodium was placed upon a rotating plate.

This negative geotropism is exhibited by many species in connection with the fruiting phase, and appears to be an adaptation to provide for more effectual spore disposal. Preparatory to fruiting, the plasmodic mass will ascend and often almost completely envelop blades of grass, moss plants, etc., and these points of vantage gained the transformation into nature sporangia takes place with astonishing rapidity. Particularly noticeable for this tendency are the plasmodia of *Physarum virescens* and *Physarum cinereum*; but the characteristic is exhibited in a greater or less degree by almost all species.

Plasmodia also shew a marked sensitiveness to temperature changes. That of *Fuligo ovata* is positively thermotropic up to 33 degrees C.—34 degrees C., but becomes negatively so above that point. An exposure to a temperature of 2 degrees C. does not kill this plasmodium, but all movement ceases and a prolonged exposure at that point eventually results in death. The maximum temperature in the case of this species is 52 deg. C.—53 deg. C.

Intense illumination has also been found to check movements of the plasmodium, and in unequal illumination it moves towards the shade; in varying moisture towards the more moist side. The direction and rapidity of movement is also strongly influenced by the presence of appropriate nourishment and, moreover, the plasmodium shews a marked power of discrimination in this connection. A series of very interesting observations

by Mr. Arthur Lister on the plasmodium of *Badhamia utricularis* are reported in the Annals of Botany, Vol. 2, No. 5. He found that the plasmodium of this species could be raised from a sluggish and scarcely moving condition to one of great activity by supplying it with *Agaricus campestris*, *Boletus flavus* or with the prepared hymenial surface of *Stereum hirsutum*. When *Agaricus fasciularis* was supplied, the plasmodium for three hours refused it altogether, but when at last invaded, in one instance the section was rejected and never touched again and in another the plasmodium which had partaken of this fungus exhibited the most pronounced symptoms of disorder. Mr. Lister also found that starch, after being treated with warm water was readily absorbed and digested by the plasmodium of this species, but that perfectly raw starch remained unaffected.

The process of digestion appears generally to take place in the streaming granular interior substance; but in one instance at least, a like power of digestion was exhibited by the hyaline margin, in which the dissolution of fungus hyphæ was observed to take place.

Resting State. When subjected to a slow drying process, young plasmodia may pass into a resting form, known as macrocysts. The plasmodium breaks up irregularly, each part rounds off and surrounds itself with a wall which becomes thickened and laminated. When placed in water the contents of these cysts swell up and issue forth as amœboid bodies. Macrocysts of this kind occur in *Perichæna* and *Fuligo*.

Another resting form sometimes occurs in fully developed plasmodia. A plasmodium comes to rest and forms a number of lumps of almost horn-like consistency, frequently connected by strands of similar material. These lumps and strands consist wholly of comparatively large cells filled with a granular, generally colored plasma. These forms are designated sclerotia and exhibit the wintering condition of plasmodia. When the sclerotia are brought into contact with water, each cell swells

up and becomes an amœboid body and all fuse together to again form a motile plasmodium.

Sporangia. The structure and peculiarities of the sporangia capillitium and spores, in so far as illustrated by our known Nova Scotia forms, are more or less fully set out in the detailed descriptions of the species in my collection.

In this connection it may be stated that in the evolution of the Myxomycetes, the most prominent feature is the gradual perfecting of the mechanical contrivances to effectuate spore dispersal. The most primitive form of fructification must be regarded as the plasmodiocarp, consisting of a limiting membrane enclosing a mass of spores which only escape by its gradual breaking down. Such forms we find in the less specialized families of the *Cribrariaceæ*.

Starting from this simple form there offshoot two main lines of development exhibiting the gradual perfecting of two distinct forms of adaptation for insuring effectual spore dispersal.

The first consists in the modification of the sporangial wall, its thickenings becoming discontinuous so that the breaking down of the thinner, more delicate areas facilitates the escape of the enclosed spores. This line of development is exhibited through the *Cribrarias* to *Dictydium cancellatum*, where it reaches its highest expression. In this species, the walls of the ripe sporangium become reduced to a mere framework of ribs connected by delicate transverse threads, the whole structure dangling on the end of the stipe which is weak and tenuous at its upper extremity.

The second consists in the development of a capillitium, either with or without a columella. The highest forms with columella are found among the *Stemonitaceæ* in such genera as *Stemonitis*, *Comatricha* and *Lamproderma*. The most perfect adaptations for securing spore dispersal, however, are found in forms destitute of a columella, such as the *Arcyrias* and *Tri-*

chias; in the former in their highly elastic capillitial nets and in the latter in their free elastic elaters.

The terminal twig in the direct line of development from the primitive plasmodiocarp is, undoubtedly, represented by *Lyccgala epidendrum* in which we have a highly specialized æthaliium, composed of sporangia destitute of capillitium. The walls of the interwoven sporangia, however, persist to form a pseudo-capillitium of tubules, the lumina of which represent the interstices between the individual sporangia.

Historical and Systematic. The appearance of the *Systema Mycologicum* of Fries in 1829 marks the first great advance in the systematic study of the Myxomycetes. Previous to this, many species had been recognized, and more or less accurately described, but they were distributed among the various groups of the Fungi—Gasteromycetes, Hymenomycetes, Discomycetes and Mucors. Fries was the first to grasp their essential unity in structure and in development, and accordingly he collected the hitherto scattered genera and species into a distinct group under the name *Myxogastres*, characterised as “*primitus mucilaginosi, fluxiles.*” That he fully appreciated the marked peculiarities of the vegetative phase of these organisms in comparison with that of other fungi, is clearly shown in his discussion of the group. “*Vegetatio,*” he says, “*maxime singularis a reliquorum fungorum prorsus diversa,*” and in consequence of this knowledge he should, perhaps, have set off the group from the fungi, or at least have given them an independent position in that class. He, however, placed them as a sub-order of the Gasteromycetes, misled by the striking analogies between their mature fructifications, the sporangia, capillitium and spores, and the corresponding structures in that group. The limits of the genera (17) and species according to the form and structure of the fruit bodies were demarked by him with such systematic insight that in great part they still remain.

All of the forms assigned to the Myxogastres by Fries were Myxomycetes producing spores in closed sporangia—the *Endosporeæ* of modern writers. He did not recognize the close relationship to these, of such forms as *Ceratiomyxa*—the modern *Exosporeæ*—and these he assigned to the genus *Ceratium*, of the order *Cephalotrichei*, class *Hyphomycetes*.

In 1833, Link recognizing the fundamental distinction between the Myxogastres and the remaining Gasteromycetes, proposed to erect them into a new order of the class Fungi, under the title Myxomycetes. In the same year this term was also used by Wallroth.

From the time of the publication of the *Systema Mycologicum* until 1864, little advance was made in a knowledge of the Myxomycetes; but in that year was published the results of deBary's work on the group. It was this investigator who first followed the history of these organisms from the germination of the spore through the swarmer, amoeboid and plasmodic phases to fructification and spore formation. Impressed with the remarkable similarity between the life history of these organisms and that of undoubted animal forms, he was constrained to assign them a place without the vegetable, but not necessarily within the animal kingdom. With the Myxomycetes as previously understood, he united the *Acrasieæ* of Van Tieghem, a small group inhabiting the excrement of animals, and proposed for the whole group the term Mycetozoa. Under this head, however, he still retained the term Myxomycetes for the section so named by Link.

The *Acrasieæ* are saprophytes, the plasmodia of which are formed by the aggregation, without fusion, of amoeboid bodies. These latter arise directly from the germinating spores and the flagellate stage is wanting. In fructification, these amoeboid bodies aggregate in large numbers, creeping up against one another and finally each becomes surrounded by a firm membrane and functions as a spore. In many forms some of the

amœbæ do not give rise to spores, but soon become rigid and united together to form a simple or branched stock. The other amœbæ creeping up on this finally come to rest and form an aggregation of free spores.

The distinction between these organisms and the true Myxomycetes appears to be an essential one, and consists in this—that in the former no true plasmodia are produced, the coalescing amœbæ retaining throughout their individuality.

In 1875, Rostafinski, a pupil of deBary, published a monograph of the group, and, adopting the view of the latter that the life history of the Myxomycetes indicated a wide separation from the fungi, he suppressed that name altogether and adopted instead deBary's Mycetozoa. As this monograph has to a large extent formed the basis of all subsequent systematic work on the group, I insert an outline of Rostafinski's system:

MYCETOZOA.

Division I. EXOSPOREÆ (Ceratium).

Division II. ENDOSPOREÆ.

Sub-division I. AMAUROSPOREÆ. Spores violet or violet brown.

Section A. ATRICHÆ. Fructification without a capillitium, Protodermeæ.

Section B. TRICHOPHORÆ. Fructification always with a capillitium.

Order I. Calcareæ. Cienkowskiaceæ, Physaraceæ, Didymiaceæ, Spumariaceæ

Order II. Amaurochætææ. Stemonitaceæ, Enerthenemaceæ, Amaurochætaceæ, Breyeldiaceæ, Echinosteliaceæ.

Sub-division II. LAMPROSPOREÆ. Spores variously colored, never violet.

Section A. ATRICHÆ. Fructification without a capillitium.

Order I. Anemææ. Dictyosteliaceæ, Liceaceæ, Clathroptychiaceæ.

Order II. Heterodermeæ. Cribrariaceæ.

Section B. TRICHOPHORÆ. Fructification always with a capillitium.

Order I. Reticulariææ. Reticulariaceæ.

Order II. Calonemææ. Trichiaceæ, Arcyriaceæ, Perichæenaceæ.

Zopf in his treatment of these organisms (Die Pilzthiere oder Schleimpilze, 1885), united with them the **Monadineae**, a group mostly aquatic and embracing such forms as *Vampyrella*, *Bursulla*, *Pseudospora*, *Protomyxa*, etc. He also includes in the **Monadineae**, *Plasmodiophora* and *Tetramyxa*, forms which as will be seen, are regarded by most subsequent students as more nearly related to the true Myxomycetes. The second sub-division in Zopf's system is the **Eumycetozoa** with the same limitations as deBary's Mycetozoa.

This scheme of classification is open to criticism for, while it is perhaps not possible to draw a sharp line between the *Monadinae* and the true Myxomycetes, it is undoubtedly true that the former appear to be in the direct line of ascent to the rhizopods and heliozoa and hence to the whole series of animal forms. Moreover, while the characteristic plasmodium formation is exhibited in a number of them, for example *Protomyxa*, it is in the great majority unknown.

Schröter (Engler & Prantls Die Nat. Pflanzenfamilien) adopts the term Myxomycetes which he uses synonymously with de Bary's Mycetozoa; but he admits into the group such forms as *Plasmodiophora*, which were excluded by the latter as doubtful.

He divides the Myxomycetes into three principal groups:

- A. Mature fructification consisting of a mass of free spores.
1. Saprophytes—the amœboid bodies uniting in masses but not fusing.

Acrasieae.

2. Parasitic in the interior of living plant cells—so far as known true plasmodia.

Phytomyxinae.

- B. Spores produced in the interior of sporangia, or on the outside of discoid or columnar fructifications.

Myxogasteres.

Massee in his monograph (1892) uses the Friesian term,

Myxogastres with the limits originally assigned it—that is, as co-extensive with the *Endosporeæ* of Rostafinski's classification and narrower than the *Myxogasteres* of Schroter which is a synonym of Rostafinski's *Mycetozoa*.

Lister, on the other hand, accepts the group *Mycetozoa* as established by Rostafinski, but excludes *Dictyostelium*, one of the *Acrasieæ*, which had been admitted by the latter evidently through a misapprehension of the nature of its plasmodium. "We have thus," he says, "a clearly defined group of organisms separated from all others by the following combination of characters. A spore provided with a spore wall produces on germination an amœboid swarm cell which soon acquires a flagellum. The swarm cells multiply by division and subsequently coalesce to form a plasmodium which exhibits a rythmic streaming. The plasmodium gives rise to fruits which consist of supporting structures and spores. In the *Endosporeæ* these have the form of sporangia each having a wall within which the free spores are developed. A capillitium or system of threads, forming a scaffolding among the spores is present in most genera. In the *Exosporeæ* the fruits consist of sporophores bearing numerous spores on their surface." (A monograph of the *Mycetozoa*, p. 2.)

Macbride in his *North American Slime Moulds* (1899), uses the term "*Myomycetes* (Link) de Bary," as a general title, but includes in the group such forms as *Plasmodiophora* which, as has been said, were excluded by de Bary in his treatment of the group as being of doubtful affinity. As thus limited, the group embraces the *Phytomyxinæ* and *Myxogasteres* of Schroeter's system.

Macbride groups the *Myxomycetes* as thus defined into three main divisions or sub-classes:

A. Parasitic in the cells of living plants.

Sub-class. **Phytomyxinæ.**

B. Saprophytic, developed in connection with decaying vegetable material.

(a) With free spores.

Sub-class. **Exosporeae.**

(b) With spores in receptacles or sporangia.

Sub-class. **Myxogastres.**

The correctness, however, of including in the group such forms as *Plasmodiophora* may well be questioned. It still remains unsettled as to whether these form true plasmodia, the production of which must be taken as the great outstanding feature in the life history of the remaining members of the class. This doubt might well be considered sufficient ground for their exclusion.

In the account of Nova Scotia forms which follows, I have, however, adopted the classification and nomenclature of Macbride *in toto*. The description of species have been compiled from collections of my own made during the summers 1905 and 1906 in the vicinity of Pictou town and in various other parts of Pictou county. The list of forms is undoubtedly far from exhaustive, but I think will be found to include most of our common Nova Scotia species and some which will probably be found to be of rather rare occurrence.

One form I have described as a new species. I may say that a portion of the gathering from which the description is compiled was submitted to Dr. Macbride, who reported it tentatively as *Margarita metallica* Lister, a species hitherto unknown from this continent. A careful comparison with the description of *Margarita metallica* as given by Lister has led me to the conclusion that we have here a distinct species of the genus *Margarita*.

In determining spore characteristics a Leitz 1/12 oil immersion objective was used in combination with a No. 5 eyepiece affording a magnification of 1200 diameters. Except where otherwise indicated, the drawings are camera lucida sketches made during my studies of the various species.

In the foregoing account of the group I have refrained from discussing the vexed question as to whether these organisms should be assigned to the animal or to the vegetable kingdom; whether they belong to the province of the zoologist or the botanist. This question does not appear to me to be one of very great moment. All students agree that the group is a terminal one and distinct from the main line of development of plants and of animals alike. "The most characteristic morphological peculiarity of the plants," says Huxley, "is the investment of each of its component cells by a sac, the walls of which contain cellulose or some closely analogous compound; and the most characteristic physiological peculiarity of the plant is its power of manufacturing protein from chemical compounds of a less complex nature."

"The most characteristic morphological peculiarity of the animal is the absence of such cellulose investment. The most characteristic physiological peculiarity is the want of power to manufacture protein out of simpler compounds."

Applying the foregoing as criteria it is clear that the Myxomycetes in their vegetative phase shew undoubted affinities with the lower animal forms while in their fruiting phase plant characteristics predominate.

The view as to their true position in the world of organized things which seems to commend itself most is that formulated by Shröter. "At the same point where the Schizomycetous series takes rise, there began certain other lines of development among the most primitive protoplasmic masses. Through the amœba one of these lines gave rise on the one hand to Rhizopods and Sponges in the animal kingdom; on the other hand to the Myxomycetes among the fungi."

MYXOMYCETES (Link) de Bary.

Organisms destitute of chlorophyll of which the vegetative phase consists of a naked mass of protoplasm. Reproduction takes place by means of spores which are produced either (1)

free or (2) externally on columnar or membranous sporophores or (3) in closed capsules or sporangia. In germinating the spores produce amoeboid bodies which pass through a ciliated stage and which eventually fuse to form a multinuclear protoplasmic mass, the plasmodium, which gives rise to the fructifications.

Sub-class 1. PHYTOMYXINÆ.—Mature fruit bodies converted into an aggregation of free spores. Parasitic in cells of living plants.

Sub-class 2. EXOSPOREÆ.—Spores formed superficially on membranous or columnar sporophores. Saprophytic.

Sub-class 3. MYXOGASTRES.—Spores formed within sporangia. Saprophytic.

PHYTOMYXINÆ Schröter.

Parasitic in the cells of living plants. The spores are formed by the simultaneous division of the mature plasmodium and lie free in the cells of the host.

Genus, *Plasmodiophora* Woronin.

The only representation of the genus and sub-class which has come under my observation is:

1. *Plasmodiophora brassicæ* Woronin.—This species is parasitic on various cruciferæ such as the turnip, cabbage, rape and kale, producing in these plants the disease popularly known as "Club root." The roots of infected plants exhibit irregular and distorted growth, become covered with irregular protuberances and swellings and eventually decay. A section through one of these swellings shews the enlarged parenchymatous cells almost completely filled either with plasmodium (?) of the parasite or with the spores. These are spherical and about 1.5μ in diameter.

What is probably the same parasite also occurs here on species of wild mustard and is pretty generally distributed through-

out the county, although only in a few districts does it appear to occasion serious damage to crops. From one district, however, namely, that of Lower Mount Thom, the loss is reported as amounting to 25 per cent. of the total turnip crop of the present year (1906).

EXOSPOREÆ Rost.

Genus, *Ceratiomyxa* Schröter.

Ripe fruit bodies consist of membranous processes which may be columnar and in tufts or may form a net-work. The surface of these processes or sporophores is divided into a great number of polygonal areas, obscurely indicated in the mature fruit, from the center of each of which arises a delicate stalk supporting a single spore.

The phenomena exhibited in *Ceratiomyxa* in connection with spore germination and the development of the swarm cells differ markedly from those presented in this connection by members of the *Endosporeæ*. The mature spores germinate very readily in water, the contents escaping in the form of an ellipsoid mass of protoplasm which remains quiescent for some hours. Amœboid movements may then be observed and by successive constrictions the original spore mass becomes divided into eight small spherules which continue connected together until each develops a flagellum. By the lashing of these the associated group may swim about for some time but eventually the individuals break apart and their subsequent development resembles in all respects that observed in the *Endosporeæ*.

2 *Ceratiomyxa fructiculosa* (Muell.) Macbr.—Fructification white, forming mould like patches on decaying wood in shaded situations. The sporophores are columnar, white; the spores colorless by transmitted light, large, elliptical or ovoid. They measure $6-8\mu \times 10-14\mu$ and the delicate stalks on which they are supported average 15μ in length.

Found on decaying pine logs.

3. *Ceratiomyxa porioides* (Alb. & Schw.) Schröter.—In this species the plate-like sporophores are connected together after the manner of a honeycomb, giving the fructification the appearance of a small, sessile, upturned polyporus. The plasmodium is watery white and after emerging for fructification forms a mucilaginous porose layer extending over a considerable area. The spores are similar to those of the preceding species.

Found on decaying hemlock blocks

Lister in his monograph of the Mycetozoa includes both of the foregoing species in *Ceratiomyxa mucida* Schröter.

Myxogastres (Fries) Macbr.

Myxomycetes in which the spores are developed in sporangia. The germinating spores produce amœboid swimmers which eventually lose their flagella and become amœboid bodies. They multiply by division and, later, fuse to form plasmodia. In the mature condition fruit bodies are formed consisting chiefly of spores enclosed in a structureless limiting membrane, the peridium, which may consist of one or two layers. In most cases the sporangia contain in addition to the spores a structure consisting of filaments or tubules, of characteristic form, the capillitium.

Order I.

PHYSARACEÆ.

Capillitium present, generally containing lime deposits in the form of amorphous granules which are aggregated in vesicular expansions of the capillitial threads forming the so-called lime knots. Lime granules also occur in connection with the peridium and stipe.

In the family Physareæ the lime deposits occur both in the peridium and in the capillitium which is intricate. In the family Didymieæ the capillitium is comparatively simple and the lime deposits are confined to the peridium.

Family, PHYSAREÆ.

This family is represented in my collection by seven species distributed through four genera, viz.: *Fuligo*, *Physarum*, *Tilmadoche* and *Leocarpus*.

Genus, **Fuligo** (Haller) Pers.

In this genus the sporangia are elongated and interwoven to form a thick cake-like fruit body or æthaliium in which it is impossible to trace the individual sporangia. The outer portion of the æthaliium forms a hard calcareous crust and the whole rests upon a well developed hypothallus. The capillitium is well developed, consisting of a filamentous net with irregular lime vesicles.

4. *Fuligo ovata* (Schæff) Macbr.—Æthalia pulvinate resting on a well developed spongiöse hypothallus; frequently covering an area of several square centimetres and in some cases attaining a height of two centimetres. The outer calcareous crust varies much in the extent to which it is developed, in some instances, being thick and firm, in others, scarcely evident. The crust also varies in color from white to orange. The capillitium consists of a net of hyaline filamentous tubules flattened at the angles. The lime knots are irregular in shape and in some gatherings almost wanting. Spores violet colored by transmitted light, smooth, 7—10 μ in diameter.

This is a common species with us occurring everywhere on moss, rotten wood, etc.

Genus, **Physarum** (Persoon) Rost.

In this genus the capillitium consists of irregularly branching filamentous tubules united to form a net with vesicular expansions, generally at the nodes, containing amorphous lime granules. The ends of the capillitial filaments are attached to the peridium which at maturity ruptures irregularly.

In all the species which I have collected the fructification consists of distinct sporangia.

5. *Physarum virescens* Ditmar.—Plasmodium lemon color. Sporangia clustered in heaps, greenish yellow in color, sessile or very short stipitate. The aggregate habit gives rise to considerable irregularity and frequently sporangia fuse together. When regular they are obovoid or spherical in shape and about .2^{mm} broad. The yellow color of the peridium is due to small lime granules. Capillitium rather scanty, the hyaline threads delicate, the lime knots fusiform or irregular in shape, yellow or orange yellow in color. Spores violet brown by transmitted light, delicately warted, 7—9.5 μ in diameter.

On moss.

6. *Physarum cinereum* (Batsch) Pers.—Sporangia small, about one-third of a millimetre in diameter, sessile, closely crowded and superimposed covering considerable areas. They are frequently irregular and contorted. The peridium is membranous, grey in color from numerous included lime granules; in old fructifications, when many of the sporangia have split open, this color may be concealed by the purple brown of the spores in mass. Capillitium dense with irregular, angular and branching white lime knots which are frequently confluent. The hyaline threads are short. Spores violet brown by transmitted light almost smooth, 10—11.5 μ in diameter.

Found fruiting on moss and blades of grass, sometimes completely covering these with its heaped sporangia; also on decaying wood.

7. *Physarum globuliferum* (Bull.) Pers.—Plasmodium pale lavender in color. Sporangia stipitate, erect, spherical, about .45^{mm} in diameter, white from encrusting lime granules. Stipe white, brittle, tapering upward about .9^{mm} in length. Columella not evident. Capillitium abundant and delicate, the lime knots small, white. Spores violet tinted by transmitted light, almost smooth, 8 μ in diameter. They show in this species a tendency to adhere in clusters.

On decaying *Abies balsamea*. Not common.

Genus, **Tilmadoche** (Fries) Rost.

In this genus the capillitial filaments regularly branch dichotomously, anastomose sparingly and terminate in delicate free ends. The lime knots are small and fusiform. In all the species the sporangia are distinct.

8. *Tilmadoche alba* (Bull) Macbr.—Sporangia grey or white, spherical, stipitate, nodding, about .4^{mm} in diameter. Peridium with crowded clusters of included white lime granules. Stipe short and stout, about equal to the diameter of the sporangium or slightly exceeding it, subulate, dark in color below, pale towards the upper part. The capillitial threads arise from the base of the sporangium, branch dichotomously with flattened expansions at the axils, and are provided with numerous small, white lime knots. Spores violet tinted by transmitted light, smooth, about 8 μ in diameter.

On decaying conifers, fairly common.

9. *Tilmadoche viridis* (Bull) Saccardo.—Sporangia scattered, yellow or orange in color with a cast of green, stipitate, spherical, nodding. Peridium with numerous included lime granules. Stipe about 1^{mm} long, tapering upward, furrowed, twisted at the top; dark below from refuse material becoming pale above. Sporangia about .5^{mm} in diameter. Capillitium abundant persisting as a tuft after the dispersal of the spores. Lime knots orange colored and fusiform, generally small. The capillitial threads are delicate, branch frequently and are not expanded at the axils. Spores violet colored by transmitted light, nearly smooth, 9—10 μ in diameter.

On decaying *Fagus ferruginea*.

Genus, **Leocarpus** (Link) Rost.

Peridium double, the outer thick, calcareous, brittle and shining. Capillitium consists partly of hyaline threads and partly of broad anastomosing tubules filled with colored lime granules.

10. *Leocarpus fragilis* (Dickson) Rost.—Sporangia obovoid, 1.8^{mm} long, .9^{mm} broad, shining, brown in color. Peridium double, stipe very weak, straw colored, not supporting the sporangia which generally lie on the substratum anchored by the weak, thread-like stipes. Capillitium forming a net the terminal branches united with the inner peridium. The net consists partly of hyaline tubules somewhat expanded at the nodes and partly of broader, more expanded tubules packed with dark colored lime granules. Spores violet colored by transmitted light, spinulose, 12—14 μ in diameter.

On decaying *Abies balsamea*, moss, leaves, etc.

In all of my collections the sporangia are numerous and crowded.

Family, DIDYMIEÆ.

Characterized among the Physaraceæ by the calcareous deposits being confined to the peridium. The family is represented in my collections by but two species, the first of which appears to be one of our commonest Myxomycetes.

Genus, *Didymium* (Schrad) Fr.

Fruit bodies separate sporangia or plasmodiocarps. Peridium simple or double, the outer wall covered more or less completely with lime crystals which generally lie loosely upon it or more rarely are united into a firm crust. Columella wanting or present and hemispherical or disc shaped. Capillitium filamentous, free from lime.

11. *Didymium melanospermum* (Pers.) Macbr.—Sporangia gregarious covering areas of several square centimetres in extent; light ashen grey or almost white in color; depressed hemispherical deeply umbilicate below, stipulate, about .75^{mm} in diameter. Columella hemispherical. Stipe black, short, stout below tapering upward, one-sixth of a millimetre or less in height, the sporangia in fact sometimes apparently sessile. Peridium thickly frosted with stellate lime crystals. Hypothal-

lus evident. Capillitium consisting of delicate flexuous threads sparingly branched extending from the columella to the peridium to which the ends are attached. Spores large, purplish brown by transmitted light, distinctly warted, 10—12 μ in diameter.

One of our most common species occurring on decaying wood and bark of various trees—more commonly those of deciduous species.

12. *Didymium minus* Lister.—This species differs from the last in its smaller sporangia, .5—.6^{mm} in diameter, its relatively longer and more slender stipe imparting a more trim and erect appearance. The spores also are smaller, 9.5—10 μ in diameter, delicately roughened.

On fallen leaves of *Fagus ferruginea*.

Lister regards this as merely a well marked variety of *Didymium farinaceum* Schrader, of which *Didymium melanosperum* (Schæff.) Macbr. is a synonym.

Order II.

STEMONITACEÆ.

Capillitium present, formed of solid strands, plate or filaments. Columella usually well developed and from this the capillitium arises and by repeated branching and anastomosing forms a more or less complicated network. Spores in mass dark violet or more rarely brown.

Family, STEMONITEÆ.

Fructification when mature generally consisting of distinct sporangia. Peridium delicate soon disappearing, destitute of lime. Capillitium usually arising from a columella, formed of solid filaments without lime.

This family is represented in my collection by six species and two genera.

Genus, *Stemonitis* (Gleditsch) Rost.

Sporangia standing close together, before maturity forming a slimy mass which only later divides into the individual sporangia. A columella is present and from this the capillitial filaments branch out on all sides and, repeatedly dividing and anastomosing with one another, form at the periphery a characteristic more or less close meshed net. Peridium evanescent.

13. *Stemonitis fusca* (Roth.) Rost.—Sporangia cylindrical growing in tufts on a well developed hypothallus, purplish black in color, becoming pallid after spore dispersal. Total height about 5^{mm}. Stipe black, about one-third the total height. Columella becoming sinuous some distance below the summit of the sporangium, but traceable almost to the apex. The capillitial branches arise from the columella at right angles and anastomosing form an open interior scaffolding of dark brown threads with flat expansions at the junctions. The peripheral net formed by the anastomosing of the ultimate capillitial branches shews polygonal meshes varying considerably in size. Peridial processes conspicuous. Spores pale violet by transmitted light, smooth, 7—8 μ in diameter.

On decaying *Pinus strobus* and other conifers.

14. *Stemonitis maxima* Schweinitz.—Sporangia in tufts, cylindrical, stipitate, purple black in color becoming grey with a purple tint after spore dispersal. Total height about 15^{mm}. Stipe black, about one-half the total height. Hypothallus thin, transparent and shining. Columella dissipated near the apex in capillitial branches. The peripheral net of uniform, small meshes, the peridial processes short. Interior scaffolding open. Spores violaceous grey by transmitted light, regularly and beautifully reticulated, 7—8 μ in diameter.

On decaying *Fagus ferruginea*.

15. *Stemonitis smithii*, Macbr.—Sporangia forming dense clusters on a well developed hypothallus, cylindrical, stipitate.

Total height about 12^{mm}. Stipe black, about one-third the total height. Columella dissolving in capillitial branches some distance below the apex. The interior scaffolding is made up of strong, brown, generally uniformly thickened threads which do not shew the same tendency to form flat expansions such as are exhibited in the two preceding species. Spores almost colorless by transmitted light, smooth, 6—7 μ in diameter.

Common in coniferous woods.

Genus, **Comatricha** (Preuss) Rost.

Sporangia isolated, cylindrical, ovoid or spherical, stipitate. Stipe continued up into the columella and giving off branches which anastomose more or less freely to form the capillitium, the ultimate tips free. Peripheral net generally wanting but in some cases imperfectly developed.

16. *Comatricha nigra* (Pers) Schröter.—Sporangia scattered, erect, ovoid, stipitate. Stipe relatively long, slender and tapering upward, about 2^{mm} in length. Expanded capillitium .3^{mm} x .6^{mm}. Peridium evanescent. Hypothallus none. Columella extending to about the middle of the sporangium where it dissolves in capillitial branches. Capillitium consisting of a tangled net of dark brown, stiff, uniformly thickened threads which arise from all parts of the columella, branching and anastomosing to form the net. Free ends and short peridial processes are numerous at the periphery. Spores violaceous brown by transmitted light, smooth or nearly so, 7—9 μ in diameter.

A very neat, trim looking little species found on decaying *Abies balsamea* and other conifers.

17. *Comatricha stemonitis* (Scop.) Sheldon.—Sporangia gregarious, cylindrical, stipitate. Total height, 3—4^{mm}. Stipe black and shining one-fourth to one-third the total height. Hypothallus distinct. Columella reaching nearly to the summit of the sporangium, becoming weak and flexuous in its upper

parts, or, in some cases, terminating abruptly at the apex of the sporangium in an enlarged extremity which gives rise to a number of branches. Interior scaffolding of the capillitium dense, of stout purplish brown threads. Peripheral net stemonitis-like but discontinuous and generally more fully developed towards the base of the sporangium. Free ends common, often bifurcated. Spores violaceous grey by transmitted light, marked with a few scattered, umbo-like warts, the areas between these roughened, warted, or reticulated, 6—7.5 μ in diameter.

On decaying conifers.

This appears to be a very variable species. The only constant spore character is the presence of the umbo-like warts. I have specimens in which the surface between these is beautifully reticulated, others in which it is roughened, and still others where it is minutely warted. The extent to which a peripheral net is developed is also subject to great variation.

Family, LAMPRODERMEÆ.

This family is characterized by the capillitium being developed chiefly or solely from the summit of the columella. It is represented in my collections by but one species of the genus *Lamproderma*.

Genus, *Lamproderma* Rost.

Sporangia distinct, stipitate. Stipe black. Capillitium consisting of branched anastomosing threads radiating from the upper part of the columella. The peridium is shining, iridescent and somewhat persistent, particularly at the base of the sporangium.

18. *Lamproderma arcyronema* Rost.—Sporangia distinct, gregarious, stipitate. Total height 1^{mm} or slightly exceeding this. Stipe relatively long, tapering upward about .6^{mm} in length. Diameter of expanded capillitium about .5^{mm}. Peridium falling away except at the base where it persists as a collar. Columella reaching to about the middle of the spor-

angium where it divides into the primary branches of the capillitium. These repeatedly divide and anastomose to form a crisped net of purple brown threads. Free ends short. Spores pale purplish grey by transmitted light, nearly smooth, 6—7 μ in diameter.

On decaying *Abies balsamea*, not rare.

Order III.

CRIBRARIACEÆ.

This order is characterized by the entire absence of a capillitium and by the color of the spores which are either pallid or some shade of brown without any violet tint. In the less highly developed forms the fructifications are plasmodiocarpous or æthaloid; in the higher forms they consist of distinct sporangia. In these, too, the peridium becomes locally thickened and at maturity the unthickened portions break away, leaving the modified portions in the form of a closed net of flat bands or plates.

Family, LICEÆ.

Fructification plasmodiocarpous.

The family is represented in my collections by a single species.

Genus, *Licea* (Schrader) Rost.

The generic characteristics are well exemplified by—

19. *Licea variabilis* Schrader.—Fructification plasmodiocarpous, irregular, annulate, repent, varying greatly in size, dark red brown in color. The peridium is double, the outer opaque, filled with particles of refuse matter; the inner smooth, delicate, translucent. Spores pale yellowish by transmitted light, large, strongly spinulose, 13—14 μ in diameter.

On decaying *Pinus strobus*, not common.

Family, TUBIFEREÆ.

Fructification æthaloid, the sporangia tubular, seated on a well developed hypothallus, closely appressed, numerous and in

one or more series; typically rupturing irregularly at the apex. This family is represented in my collections by two species.

Genus, **Linbladia** Fries.

Sporangia compacted on a spongy hypothallus in one or more series, short, tubular. When in a single series sometimes distinct and short stipitate. Peridium containing numerous dark granules. Spores olivaceous.

20. *Linbladia effusa* (Ehr.) Rost.—Sporangia compacted in a thick spongy hypothallus in a single series (in all of my collections), tubular, about 1^{mm} high and .5—.75^{mm} in diameter, almost black. Walls of the sporangia membranous with numerous small, round, dark granules. Fructifications frequently covering considerable areas, as large as 20 x 15^{cm}. Spores almost colorless by transmitted light, smooth, 6.5—7 μ in diameter.

On decaying logs and on leaf mould in coniferous woods. Common.

Genus, **Tubifera** Gmelin.

Fructification aethaloid formed of closely appressed cylindrical sporangia seated on a well developed hypothallus. The side walls are grown together but the individual sporangia are nevertheless, clearly discernible. Sporangia rupturing at the apex.

21. *Tubifera ferruginosa* (Batsch Macbr.—Sporangia long, tubular, cylindrical or prismatic from mutual pressure, convex above, appressed together to form a pulvinate aethalium, sessile on a well developed hypothallus. Walls of the sporangia membranous. Spore mass umber brown. The aethalia may cover an area of several square centimetres. The individual sporangia are from 2^{mm} to 4^{mm} in height and about .5^{mm} in diameter. Spores almost colorless by transmitted light, delicately reticulated over the greater portion of their surface, 6.5—7 μ in diameter.

On decaying *Psuga canadensis* and other conifers. Common.

Family, CRIBRARIEÆ.

Fructifications of distinct sporangia. The peridium becomes locally thickened and at maturity the unmodified parts fall away, leaving the thickened portions in the form of a closed net of flat bands or plates. The plasmodia live in decaying wood and issue from this for fructification in the form of small, slimy lumps, each of which gives rise to a sporangium.

The family is represented in my collections by four species, three of which belong to the genus *Cribraria* and one to the genus *Dietydium*.

Genus, *Cribraria* (Pers) Schrader.

Sporangia distinct, stipitate. The thickenings of the peridium take the form of a delicate persistent net of band-like filaments with thickenings at the nodes. The lower part of the peridium generally persists in toto to form the so-called calyculus, strengthened by radiating ribs marked by dark plasmodic granules.

22. *Cribraria argillacea* Persoon.—Sporangia umber brown, crowded, spherical, stipitate, about .5^{mm} in diameter. Stipe brown, stout, short, about .3^{mm} long. Peridium persistent and in the lower part marked by thickenings in the form of broad, dark brown, radiating bands with numerous plasmodic granules; above this the bands become narrower and anastomose, but do not present thickenings at the nodes; on the top of the sporangia there is observable, here and there, a tendency to form thickenings at the nodes, and the net becomes more typically *cribraria* like. Spores light brown in mass, pale by transmitted light, distinctly warted, about 6.5 μ in diameter.

On decaying *Abies balsamea*. Rare. The largest fructification which I have seen covers an area 5 x 5^{mm}.

23. *Cribraria macrocarpa* Schrader.—Sporangia gregarious, spherical, stipitate, nodding, umber brown or yellowish brown in color, about .7^{mm} in diameter. Stipe about 1.5^{mm} long, .08^{mm}

in diameter, at the base, tapering upward. Calyculus with radiating ribs, the margin toothed, the teeth merging into the net above. The nodes are flattened, elongated and confluent near the calyculus; in the upper parts, prominent, polygonal and angular, the angles continued into the connecting threads. These latter are delicate and free ends are common. The meshes of the net are 3—5sided. Spores almost colorless by transmitted light, slightly roughened. $5-6\mu$ in diameter.

This is with us a rather common species forming large fructifications on decaying *Psuga canadensis* and other conifers. The largest fructification which I have met with was $30 \times 10\text{cm}$.

24. *Cribraria dictydioides* Cke and Balf.—Sporangia gregarious, spherical, small, $.5\text{mm}$ in diameter, cernuous. Stipe 1mm long, dark. Calyculus well developed marked with radiating lines of dark plasmodic granules, the margin denticulate. The nodes of the net are dark brown, connected by rather broad hyaline threads radiating from the angles. Free ends numerous. In the lower part of the net the nodes are more elongated and branching. Spores almost colorless by transmitted light, faintly warted, $7-8\mu$ in diameter.

On decaying conifers of various species. Not rare.

Genus, **Dictydium** (Schrad.) Rost.

Sporangia distinct. Peridium with narrow band-like thickenings on the inner surface, radiating from the attachment of the stipe to the top of the sporangium and connected by delicate transverse thickenings. In the mature condition, the unthickened portions disappear and the thickenings persist as a basket-like structure with rectangular meshes, enclosing the spore mass.

25. *Dictydium cancellatum* (Batsch.) Macbr.—Sporangia closely gregarious, depressed globose, cernuous. The older sporangia become umbilicate at the top; $.5\text{mm}$ in diameter or slightly larger. Stipe $.6-2.4\text{mm}$ in length, tapering upward, at the top weak, twisted and white. Calyculus generally wanting.

Spores brown or purplish in mass, reddish by transmitted light, smooth, 6.5—7.5 μ in diameter.

This is undoubtedly our most common Myxomycete occurring on decaying wood of a variety of deciduous and coniferous trees, but much more frequently of the latter.

Order IV.

LYCOGALACEÆ.

Sporangia fused together to form an æthaliium with a tough membranous outer covering. Capillitium consisting of branched smooth or wrinkled tubules. The order contains but a single genus, represented in my collections by one species.

Genus, **Lycogala** Micheli.

Æthalia conical or depressed globose, with an outer covering consisting of two sharply defined layers; the outer containing vesicles filled with air and traversed by flattened tubes which are continuous with the tubes of the capillitium. Capillitium a system of branching tubules arising as above stated and with numerous free, rounded ends.

26. *Lycogala epidendrum* (Buxb.) Fries.—Æthalia depressed globose, most commonly appearing in clusters on decaying wood; they often vary in size in the same cluster from 3^{mm} to 1^{cm} in diameter. Color pinkish grey. Cortex papery, the spores escaping by an irregular rupture at the apex. Capillitium consisting of numerous branched tubules with wrinkled and roughened walls and numerous rounded free ends. Spore mass pinkish grey. Spores almost colorless by transmitted light, their surfaces roughened in ridges, which on some parts take the form of an irregular reticulation 6—7 μ in diameter.

This is the most puffball-like of the Myxomycetes. It is very common on decaying conifers from which the plasmodium issues in the form of rosy globular masses of protoplasm. With us it is the first to appear in the spring, beginning to fruit about the first of June.

Order V.

MARGARITACEÆ.

This order is thus characterized by Lister: "Sporangia normally sessile, sporangium wall single, smooth, translucent; capillitium abundant, not consisting of separate elaters nor combined into a net; spores pinkish or yellowish grey."

Genus, *Margarita* Lister.

"Sporangia globose; capillitium a profuse web of coiled hair-like, sparingly branched, slender, solid threads with indistinct attachments to the sporangium wall."

27. *Margarita pictoviana* Sp. Nov.—Sporangia small, depressed globose, sessile, clustered, at times confluent and irregular in form, brown in color with a metallic lustre when fresh, .5—1^m in diameter when regular. Peridium single, smooth translucent pale yellowish by transmitted light with scattered included concolorous granules. Capillitium not copious, of delicate somewhat flattened hair-like threads papillose along both margins, the flattened surface roughened, rarely branching and occasionally shewing attachments to the peridium; threads about 2 μ in maximum diameter. Spores pale yellowish by transmitted light, spinulose 11—13.5 μ in diameter. Spore mass pinkish grey. Collected on decorticated decaying *Psuga canadensis* at Pictou, N. S., September 23rd, 1905.

Order VI.

TRICHIACEÆ.

Fructifications of distinct sporangia, rarely plasmodiocarpous. Capillitium consisting of definite threads, free or attached to the sporangial wall or united to form an elastic net. Generally marked with thickenings in the forms of warts, spines, spirals, rings, cogs, etc.

Family, ARCYIEÆ.

Characterized by the capillitium forming a distinct elastic net attached below to the sporangial wall. The thickenings on the threads take the form of spines, warts, cogs, half ring, etc., often arranged in a spiral but never take the form of continuous spiral bands. The family is represented in my collections by four species all of the genus *Arcyria*.

Genus, *Arcyria* (Hill) Pers.

Fructifications of distinct stipitate sporangia; the peridium evanescent above, persistent below as a calyculus. Capillitium a more or less elastic net without free ends, attached below to the interior of the stipe or to the calyculus. The threads or tubules are marked with spines, cogs, half rings, etc. The stipe is hollow and filled with spore-like cells or vesicles.

28. *Arcyria nutans* (Bull.) Grev.—Sporangia cylindrical, distinct, stipitate crowded on a well developed hypothallus, dusky yellow in color and about 7^{mm} in total height. Stipe generally long, 5^{mm} in length, and weak, filled with spore-like vesicles. Capillitium expanding to form a very loose, drooping net, dusky yellow in color, one-half to three-fourth of a centimetre in length, loosely attached to the calyculus, the tubules are marked with close-set spines and cogs arranged in an open spiral, and in addition to these their surface frequently shew faint reticulations. Calyculus spinulose within. Spores pale by transmitted light, very slightly roughened, 7—10 μ in diameter.

A common species occurring on decaying wood of various conifers.

29. *Arcyria incarnata*, Persoon.—Sporangia closely crowded, cylindrical, stipitate, 1—1.5^{mm} in total height. Stipe short, about .25^{mm} long, or reduced to a mere point beneath the calyculus, dark colored, furrowed and filled with spore-like cells. Calyculus plicate to the margin and spinulose.

Capillitium a loose net of pink or rose-colored threads, 3—3.5 wide, attached by a few strands which run to the centre of the stipe. The strands or tubules are marked with rather distant cogs and half rings arranged in an open spiral. Perforated plate-like expansions are found here and there at the nodes, more particularly in the lower portion of the net. Free ends are occasionally found but are rare. Spores colorless by transmitted light, almost smooth or slightly roughened and with a few scattered warts, 7—8 μ in diameter.

A common species found on decaying *Populus tremuloides*, *Fagus ferruginea* and *Abies balsamea*.

30. *Arcyria denudata* (Linn.) Sheldon.—Sporangia gregarious, cylindrical stipitate; total height with expanded capillitium 3—4^{mm}. Stipe about 1^{mm}, filled with spore-like cells 12—14 μ in diameter. Calyculus plicate, smooth; capillitium, a net of rosy threads fading to dusky yellow, 3—4 μ wide and adorned with distant cogs and half rings arranged in the form of an open spiral. Near the calyculus the threads are almost smooth. The capillitium is attached to the calyculus at many points and hence is not deciduous. Spores colorless by transmitted light, smooth, about 7 μ in diameter.

Found on decaying conifers; not rare.

31. *Arcyria cinerea* (Bull.) Pers.—Sporangia gregarious, cylindrical or somewhat broader at the base, stipitate, ash colored. Stipe variable in length, in some gatherings .75^{mm} long, in others, the sporangia are almost sessile. Total height of sporangia with expanded capillitium, 2—2.5^{mm}. Stipe dark, of almost uniform thickness, hollow, filled with spore-like cells. Calyculus plicate at the base. Capillitium a close net attached at many points to the calyculus. The peripheral portions of the net consist of threads or tubules 3—3.5 μ wide adorned with close-set spines and presenting many plate-like expansions at the nodes and elsewhere. The interior portions of the net and also the part near the calyculus consist of tubules somewhat wider

and almost smooth. Spores colorless by transmitted light, granular, 6—7 μ in diameter. The fructifications of this species are with us frequently large, in some cases, extending over an area 20—30^{cm} long and several centimetres wide, with numerous sporangia.

A fairly common species found on the decaying wood of various deciduous and coniferous trees.

Family, TRICHIEÆ.

Capillitium consisting of free elaters or of tubules connected to form a loose net with many free ends. The elaters or tubules are marked with spiral thickenings.

This family is represented in my collections by six species, three of the genus *Hemitrichia* and three of the genus *Trichia*.

Genus, *Hemitrichia* Rost.

Capillitium consisting of a net of branching anastomosing tubules with many free ends, and marked with regular spiral thickenings.

32. *Hemitrichia vesparium* (Batsch) Macbr.—Sporangia crowded, sessile, clavate, of a deep red color and with a metallic lustre. Capillitium a loose net of orange colored threads about 6 μ wide with numerous free ends. The threads are adorned with a number of spiral bands and beset with numerous long spines. Spores yellowish by transmitted light, strongly warted, 10—11 μ in diameter.

On decaying *Populus tremuloides*. Rare.

33. *Hemitrichia stipata* (Schw.) Macbr.—Sporangia closely crowded on a well developed hypothallus, stipitate, cylindrical or somewhat irregular from mutual pressure. Copper colored and shining when fresh becoming dark red brown when old. Total height about 1.5^{mm}. Stipe short, .5^{mm} in length, dark red brown, striate, hollow, filled with spore-like cells. The lower part of the peridium persists as a plicate calyculus to which the capillitium is attached at a few points. Capillitium a loose net

with many free swollen ends, the threads beset with short spines and adorned with a number of very faint spiral lines. The threads or tubules are about 3.5μ wide. Spores colorless by transmitted light, marked with a few small scattered warts, 6.5 — 8.5μ in diameter.

On decaying *Populus grandidentata*. Not common.

34. *Hemitrichia stipitata* Masee.—Sporangia scattered, stipitate, obovoid, dusky yellow. Total height with expanded capillitium about 2.5^{mm} . Stipe about one-half the total height, dark colored, hollow, filled with spore-like cells. The lower portion of the peridium persists as a calyculus extending to about one-third the height of the capillitium, its interior surface covered by minute papillæ. The capillitium consists of a close net of even brown threads, 6 — 6.5μ wide, adorned with a number of regular spiral ridges, somewhat closely wound. Free ends are not evident. Spores colorless by transmitted light, minutely warted, about 7μ in diameter.

On decaying *Pinus strobus*. Common.

Genus, **Trichia** (Haller) Rost.

Capillitium of free elaters, simple or branched, and adorned with a number of spiral ridges. Sporangia sessile or stipitate. Spores generally yellow.

35. *Trichia inconspicua* Rostafinski.—Sporangia gregarious, small, spherical, ellipsoid reniform or arcuate, sessile, red brown in color. The elaters are brown, simple, 3 — 4μ wide, marked with a number of close-wound spiral ridges projecting sharply. The ends are somewhat swollen behind the curved or hooked tips which are sometimes bifurcated. Spores yellowish by transmitted light, papillose, about 10μ in diameter. The gathering which I have referred to this species combines many of the characteristics of *Trichia inconspicua* Rost., and *Trichia contorta* (Ditmar) Rost, as given by Dr. Macbride (N. A. Slime moulds, pp. 210, 211.) The sporangia shew a strong tendency

to form elongated, curved plasmodiocarps, while the elaters are long, slender and even (with the exception of the extremities), and the spirals regularly wound. The extremities, on the other hand, are frequently swollen behind the curved tips.

On the inner side of fallen bark of *Fagus ferruginea*. Rare.

36. *Trichia varia* (Pers.) Rost. — Sporangia closely crowded, spherical, or contorted, dusky yellow, shining when fresh, sessile, about .75^{mm} in diameter when regular. Elaters simple, 4—5 μ wide, somewhat irregular in outline, marked with two spiral ridges irregularly wound and projecting sharply. They narrow abruptly at the ends, which are 12—14 μ long and marked almost to the tips with faint spiral lines. Immediately behind the ends, the elaters sometimes show a slight enlargement and spinous outgrowths, sometimes curved, are not uncommon. The ends also sometimes terminate in two or three sharp tips. Spores pale yellowish by transmitted light, almost smooth, 13—14 μ in diameter.

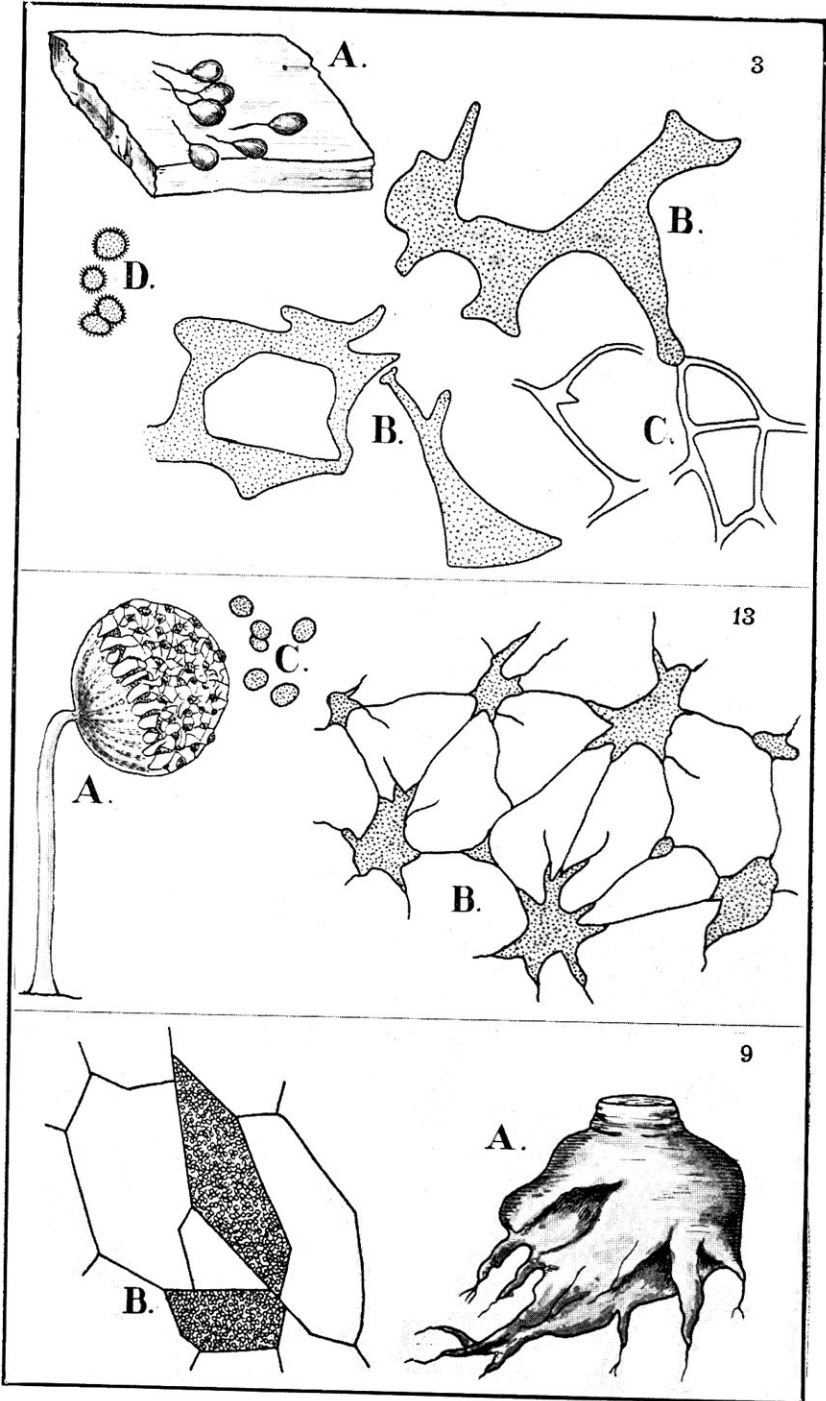
On decaying *Populus grandidentata*. Not common.

37. *Trichia decipiens* (Pers.) Macbr. — Sporangia closely gregarious, obovoid dusky yellow or olivaceous yellow, stipitate; total height about 2^{mm}, diameter .8^{mm}. Stipe furrowed, hollow, filled with spore-like cells. Elaters simple, about 5 μ wide, marked with three spiral ridges not traceable to the ends which are long and tapering. Spores almost colorless by transmitted light, reticulated, 11—12 μ in diameter.

On decaying *Populus grandidentata*. Not common.

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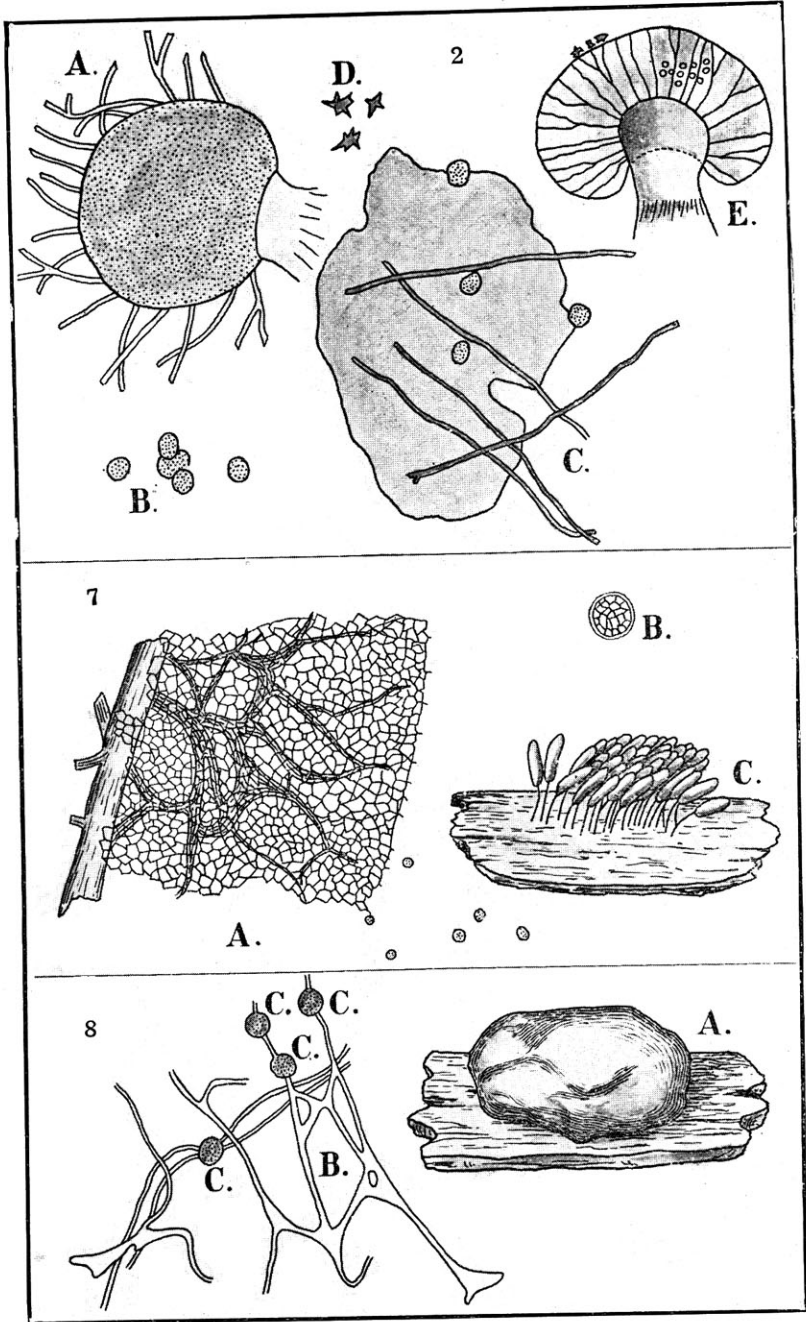


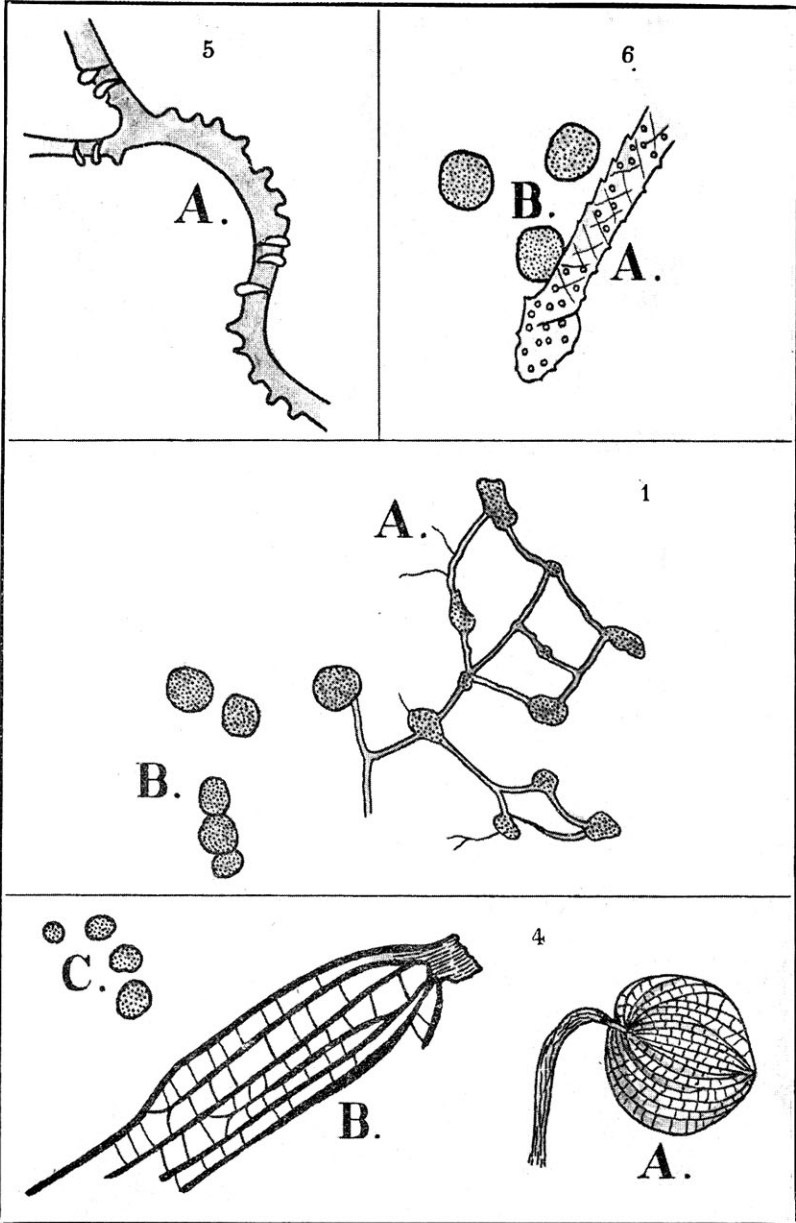
EXPLANATION OF PLATE IX.

- 3.—*Leocarpus fragilis* (Dicks.) Rost. A.—Sketch of a few sporangia shewing habit of growth. B.—A portion of that part of the capillitium filled with granules x 166. C.—Portion of hyaline part of same x 166. D.—A group of spores x 166.
- 13.—*Cribaria macrocarpa* Schrad. A.—Sketch of a sporangium. B.—Portion of wall of sporangium after spore dispersal taken from upper part of net x 166. C.—Spores x 300.
- 9.—*Plasmodiophora brassicae* Woron. A.—Sketch of a turnip shewing distorted growth due to parasite. B.—Portion of a section through one of the irregular swellings shewing cells filled with the spores of the species x 300.

EXPLANATION OF PLATE X

- 2.—*Didymium melanospermum* (Pers.) Macbr. A.—Columella shewing origin of capillitial filaments x 33. B.—Spores x 250. C.—Portion of the peridium with capillitial threads attached x 166. D.—Stellate lime crystals from peridium. E.—Diagrammatic section of sporangium shewing relations of columella, capillitium and peridium.
- 7.—*Stemonitis maxima* Schweinitz. A.—Portion of columella and capillitium x 500. B.—Spores x 500. C.—Sketch of cluster of sporangia, shewing habit of growth.
- 8.—*Fuligo ovata* (Schaeff.) Macbr. A.—Sketch of an aethalium shewing habit of growth. B.—Portion of capillitium x 300. C.—Spores x 300.





EXPLANATION OF PLATE XI.

- 5.—*Arcyria denudata* (Linn.) Sheldon. A.—A portion of tubule of capillitial net.
- 6.—*Hemitrichia stipata* (Schw.) Macbr. A.—Free end of a capillitial tubule x 450. B.—Spores x 450.
- 1.—*Physarum globuliferum* (Bull) Pers. A.—Portion of capillitium. B.—Spores x 450.
- 4.—*Dictydium cancellatum* (Batsch) Macbr. A.—Sketch of sporangium and upper part of stipe. B.—A portion of the wall of a sporangium after spore dispersal x 250. C.—Spores.

EXPLANATION OF PLATE XII.

- 14.—*Margarita pictoviana* Sp. nov. A.—Group of sporangia shewing habit of growth. B.—Spores x 750. C.—Portion of capillitial thread x 750.
- 12.—*Comatricha stemonitis* (Scop) Sheldon. A.—Terminal part of columella and capillitium in one collection made x 96. B.—Spores of same x 450.
- 11.—*Licea variabilis* Schrader. A.—Sketch of plasmodiocarpous fructification x 8. B.—Spores x 450.
- 10.—*Lycogala epidendrum* (Buxb.) Fries. A.—Sketch shewing a cluster of aethalia. B.—Portion of a capillitial tubule shewing free ends. C.—Spores.

