

- 1c. Spore, highly magnified.
- 2. *Lamproderma insessum*. A group of four sporangia on lichen.
- 2a. Capillitium and spores with fragment of sporangium-wall.
- 2b. Spore, highly magnified.

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## PRESIDENTIAL ADDRESS.

*By Gulielma Lister, F.L.S.*

### THE PAST STUDENTS OF MYCETOZOA AND THEIR WORK.

When I was engaged in the task of revising the Nomenclature of the Mycetozoa with the view of adopting the earliest reliable specific names I had occasion to consult a number of the older books that deal with these organisms. I soon became much interested in the writers of these books, and could not but be often impressed by the faithful and beautiful work they accomplished, with very simple appliances, and with little assistance from those who had lived before to guide them.

I have put together a short account of the progress of the study of Mycetozoa, and have added notes on the lives of some of those whose observation and insight have in the past cleared away so many difficulties for us.

If Mycetozoa were observed at all by the earlier Naturalists, they were considered to be Fungi, and Fungi were regarded as objects of superstition and mystery, rather than as living plants.

Writing in the second half of the 16th century, the German herbalist Hieronymus Bock gave expression to the opinion of the times when he writes, in his chapter on Fungi: "Mushrooms are neither herbs nor roots, neither flowers nor seeds, but merely the superfluous moisture of the earth and trees, of wood and other rotten things."

Again, the Italian botanist Cesalpino, whose philosophical views on the importance of the *fructification* induced a great advance in the method of classifying flowering plants, writes in 1583: "Some plants have no seed: these are the most imperfect, and spring from decaying substances: they have only to feed themselves and grow, and are unable to produce their like:

they are a sort of intermediate existences between plants and inanimate nature."

At the beginning of the 18th century a more scientific spirit was awakening.

One of the first references that we have to any species of the Mycetozoa is that given by the French botanist *Joseph Pitton de Tournefort*, the man to whose genius we owe the first classification of plants in clearly-defined genera. Writing in the year 1700 in his book entitled "*Institutiones Rei Herbariae*" (or "Arrangement of Plants") he described among the Puff-Balls, a "*Lycoperdon sanguineum sphericum*," which later writers are probably right in thinking referred to the young rosy aethalia of *Lycogala epidendrum* (L.) Fr.

The first detailed description of a species of this group we find in an account given in 1727 of "the Flowers of Tan," "*Les Fleurs de la Tannée*" (or *Fuligo septica* Gmel. as we now call it) by the Frenchman Jean Marchant (son of the Nicholas Marchant after whom the Liverwort "*Marchantia*" was named). This paper is entitled (translated) "On a remarkable growth which appears on the bark of the Oak beaten and reduced to powder, commonly called Tan." After describing the beautiful pale-yellow foam-like masses that unaccountably appear on heaps of spent Tan, he goes on to say that "after a few days vegetation ceases; it condenses and forms a golden-yellow crust beneath which is a very fine black powder, like that of *Lycoperdon*." This he thinks may be "the Tan dissolved and reduced to impalpable powder." He accounts for the appearance as the result of the fermentation of the Tan soaked in exhalations from hides treated there, and aided by the air. He says, "As it has neither roots, leaves, flowers or seeds it bears more relation to sponges than to any other plant." (Sponges were then considered to be plants). He therefore names it "*Spongia fugax, mollis, flava et amoena, in pulvere coriario nascens*," "A sponge fugacious, soft, yellow and pleasing, appearing on powdered Tan."

Two years later we meet with a great advance in the treatment of Fungi, and with them of the Mycetozoa. This we owe to the Italian botanist Pier Antonio Micheli. Micheli was born at Florence in 1679. His parents were poor and cared little for their son's education. But his thirst for knowledge, and especially of natural knowledge, was insatiable. He taught himself Latin, and became so proficient in botany that he gained royal favour and was appointed botanist to the Grand Duke of Tuscany, with the charge of the public gardens in Florence. This post he held till his death in 1737.

It is interesting to compare the various estimates of Micheli's work that have come down to us. Dr. William Sherard of

Oxford, founder of the Sherardian chair of botany in the University, knew Micheli well and had much correspondence with him; he held him in high esteem, and writes of him "no man is more exact and faithful than he is." Micheli is described by his contemporary the Swiss botanist Haller as "a gardener, illiterate and poor, but most studious of wild plants, and a great investigator of Fungi, Mosses, Lichens and Grasses." The distinguished Swedish mycologist Fries, writing in 1829, describes the dark chaos that reigned with regard to any recognition of the Myxogastres (as he calls the Mycetozoa) "until the immortal Micheli kindled such a brilliant light that his immediate successors were not able to bear it." In our own day Prof. Vines writes of Micheli's work being of peculiar interest in that it contains the earliest results of the application of the microscope to the study of Cryptogams, and of his being the first to discover the fact that the spores of Fungi are capable of germinating and reproducing the plant.

Micheli's great work, published in 1729, is entitled (translating from the Latin) "New genera of Plants, arranged after the method of Tournefort, in which 1900 plants are enumerated, of which 1400 have not before been observed, while others are referred to their proper places: with additional notes and observations regarding planting, origin and nutriment of fungi, mucors and allied plants." It is a handsome quarto volume with bold and spirited illustrations.

The Fungi are arranged in genera, which are divided again into subgenera or "*ordines*," carefully defined by natural characters. In the division of Fungi defined as "very simple plants containing seeds in the inner part" we meet with four genera that refer to Mycetozoa. Under the names *Clathroides* and *Clathroidastrum* we have undoubted descriptions of *Arcyria* and *Stemonitis* respectively. The figures, although rather diagrammatic, show the characters of the elastic capillitium and persistent cup of *Arcyria*, and the long columella and network of capillitium of *Stemonitis*. Under the new genus *Lycogala* are described five species, including our *Lycogala epidendrum* (L.) Fr. and *Reticularia Lycoperdon* Bull. Under *Mucilago* Micheli describes nine species seen occurring in a mucilaginous state: most of the descriptions refer to young sporangia, but in his "*white branched Mucilago resembling the roots and fibres of trees*" we have the earliest mention of a network of creeping plasmodium. Amongst the other species of *Mucilago* we recognize with the aid of the illustrations, *Fuligo septica* (L.) Gmel., *Mucilago spongiosa* (Leyss.) Morg. and immature sporangia of probably *Physarum*, *Didymium* and *Comatricha*. The description and illustration of *Puccinia*

*ramosa* &c., undoubtedly refer to *Ceratiomyxa fruticulosa* (Muell.) Macbr.

At this time, of course, no separate specific names had yet been given: each species could only be referred to by quoting the whole description, and was therefore expressed in as few words as possible; thus what we take to be *Arcyria denudata* (L.) Sheldon is described as *Clathroides purpureum pediculo donatum*," or "the purple *Clathroides* provided with a stalk," and what is probably a sessile *Trichia*, as "*Clathroides flavescens pediculo carens*" or "the yellow *Clathroides* without a stalk." Short notes with fuller characters and references to localities were often added, but the object of the writer is simply to distinguish one species from another, and not to aim after a critical description.

Following on the lines laid down by Micheli, Albrecht von Haller,\* the great Swiss anatomist and physiologist, also a botanist, poet and patriot, published in 1742 "A systematic and descriptive List of Plants indigenous to Switzerland." It is dedicated to Frederick, Prince of Wales, eldest son of our George II., to whom Haller had been appointed physician. The two folio volumes are profusely and carefully illustrated. The Swiss Mycetozoa appear in the same genera as those given by Micheli, with the addition of two new ones, *Embolus* and *Sphaerocephalus*, which contain in the light of our present knowledge a curious assemblage of species of *Physarum*, *Comatricha*, *Trichia* and others. Haller's caution is shown by the way Micheli's genus *Clathroides* is referred to doubtfully as "*An Clathroides*." Amongst the five species described under this questionable genus we have an undoubted description and illustration of *Hemitrichia Vesparium*.

A further and fuller account of the plants of Switzerland was published by Haller twenty years later, in 1762. During these twenty years he had found time in his amazingly active life to make almost yearly pilgrimages to study the flora of different parts of his native land, reference to which is made in his preface. He writes of having especially consulted the works of Linnaeus; but the Linnaean classification was too artificial to please him, and he does not adopt the binomial nomenclature. In this volume Haller creates a new genus *Trichia* to include some of the Mycetozoa, but it is far from being the *Trichia* as we now define it, and not only brings together species having little natural affinity, but serves to obscure the more natural classification of Micheli.

From the painstaking and concise writing of Haller we turn to the work of his contemporary, our fellow-countryman Dr.

\* Born 1708; died 1777.

John Hill\* (knight of the Swedish Order of the Polar Star) whose "History of Plants," published in 1751, forms a section of a larger work entitled "A General Natural History, or New and Accurate Descriptions of the Animals, Vegetables and Minerals of the Different parts of the World," &c., &c. Hill's descriptions are often picturesque but he permits his theories to over-rule his facts. He is determined to recognize male and female flowers even in the obscure Fungi. Among the Mycetoza, his new and artificial genus *Arcyria* unites our present *Arcyria* with *Trichia* and *Stemonitis*. It is defined in the following mysterious terms:—" *Arcyria*, a genus of fungusses consisting of a head of a reticulated structure, not hollow, arising out of a case or volva containing distinct male and female flowers: the male are of oblong anthers only, arranged together by fours in the summit of the same filament which adheres to the ridges of the reticulation. The female flower we see no part of but the seeds which are small and of an oval figure." After describing three species with some care, giving ample details as to where he has found them, he disposes of the remaining species with the light touch familiar to him. He says: "The three other species are easily distinguished by their names, the yellow *Arcyria* without pedicles, the black very small *Arcyria* with short pedicles, and the deep brown *Arcyria* with shorter heads." His new genus *Physarum* is equally artificial.

The above definitions seem absurdly inadequate, but they bring home to us the immense advantage that came with the introduction of the binomial system of nomenclature, when by the adoption of separate specific names there was no longer any object in limiting the descriptions to a few words, but each author was free to make them as full and detailed as he wished.

We now come to the time of Linnaeus.† His life is well known to us,—his happy childhood in a beautiful part of the south of Sweden, where his father, the pastor of a country parish, and his mother, both fostered his love of nature;—his strenuous days as a medical student at the Universities of Lund and Upsala, when in spite of poverty, his indomitable energy and enthusiasm for the study of living things triumphed over all difficulties,—his genius for making friends and attracting disciples who assisted him in his labours, his prosperity and fame as his powers became recognized at home and abroad, and, finally—the last years of his life marred by ill-health,—all these are familiar to us.

When we try to realize the vast amount of labour undertaken by Linnaeus in gathering together the work of his predecessors

\* Born 1716; died 1775.

† Born 1707; died 1778.

on all living creatures, in studying them himself to some extent, in classifying them and applying to them his method of binomial nomenclature, it is perhaps not surprising that the little-known group of Fungi should have received but slight attention at his hands. We learn moreover from Fries that Linnaeus had a strong preference for flowering plants, and took little interest in Fungi, which he regarded as "a pack of rovers, robbing what Flora leaves when she retires to her winter quarters." In the second edition of his "Species Plantarum," published in 1763, 1,515 pages are devoted to Phanerogams, and only 17 pages to Fungi; seven species of Mycetozoa are very briefly described under the fungus genera *Lycoperdon*, *Clathrus* and *Mucor*.

The work of Linnaeus however, with its widespread influence and the criticism it evoked, gave an immense impetus to the study of botany. Most of the botanists of the later years of the eighteenth century followed their master in devoting themselves chiefly to describing and classifying flowering plants.

Of those who wrote on Fungi, and with them, on Mycetozoa, the following may be mentioned,—Giovanni Antonio Scopoli,\* the Tyrolese botanist and mineralogist, author of "Flora Carniolica"; and Jakob Christian Schäffer,† author of an illustrated work on the Fungi of Bavaria, in three volumes, where six Mycetozoa are mentioned under the genus *Mucor*.

There are four men, however, whose names should be especially remembered in connection with Mycetozoa for the good work they did in description and illustration;—they are Adolph Batsch, Pierre Bulliard, Heinrich Schrader and Charles Persoon.

A. J. G. K. Batsch was born in 1761 at Jena, where he became a professor in the University, and where he died at the age of 41. When only 22 he published his "Elenchus Fungorum" or "Treatise on Fungi," giving an account of the Fungi found in the neighbourhood of Jena. The descriptions, written in parallel columns of German and Latin, are accompanied by carefully drawn coloured engravings of some of the more interesting species, among which we recognize eight species of Mycetozoa. The illustrations of "*Mucor cancellatus*" (*Dictydium cancellatum* (Batsch) Macbr., as we now call it) are especially good. The account and figure of *Hemitrichia Vesparium* (Batsch) Macbr., described as "*Lycoperdon Vesparium*, der zellige rothe Wollenschwam" are also convincing.

Pierre Bulliard was born at Aubepierre, France, in 1742. The first part of his celebrated "Histoire des Champignons de la France" appeared in 1791. Two years later he died, and

\* Born 1723; died 1788.

† Born 1718; died 1790.

the remainder of the work was published posthumously. It consists of a thick quarto volume of text, with accompanying volumes of coloured plates. Fungi are here divided into four classes, according to whether the spores are produced within the fruiting body, or all over its surface, or on the upper part only or over the lower part only. Mycetozoa are placed among the Puff-balls in the first class, having spores produced internally. They appear under four genera, *Lycoperdon* and *Sphaerocarpus*, *Reticularia* and *Trichia*: the two latter are recognized as developing from a soft juicy condition, but *Sphaerocarpus* is described as not being mucilaginous in youth. In the light of what we know now the classification is valueless, and the thirty odd species described are arranged in hopeless confusion as regards natural relationship; but when we turn to the plates our estimation of the importance of Bulliard's book at once rises. The illustrations are in many cases so excellent that the species depicted can be identified with certainty. Thus we have in "Champignons de la France" a standard work which has been referred to by all later writers on fungi, and which it is impossible rightly to ignore.

Heinrich Adolph Schrader was born at Hildesheim in 1767. He became professor of botany at Göttingen, and wrote several books on flowering plants. But the work that interests us here is his "Nova Genera Plantarum," published in 1797. The new genera he describes all refer to Mycetozoa; they are *Cribraria*, *Dictydium*, *Licea*, *Didymium*, all of which we still retain with some slight alteration of definition at the present time. He remarks that although these plants are usually placed with the fungi, they all develop from a pulpy and mucilaginous condition. His descriptions of twenty-seven species included under the four genera show a great advance on the work of previous authors. Schrader had, no doubt, the benefit of the advice of Persoon, who was twelve years his senior, and whom he describes as being most friendly to him, "*amicissimus Persoonius*."\* The way in which he deals with the puzzling genus *Cribraria* is masterly, and the characters of the species described are on the whole surprisingly well depicted in his illustrations.

With Charles Persoon the study of Mycetozoa makes a great stride, and in his work we feel to be more in touch with modern times. Persoon was born in 1755, at the Cape of Good Hope, then a Dutch colony. His father was a Dutchman, and his mother a Hottentot. His parents both died when he was a youth. With the sum of money bequeathed him by his father he came to Germany, and there devoted himself heart and soul to the pursuit of his favourite study botany, and especially to the study of

\* See Nov. Gen. Pl., p. 22.

Fungi. Travelling from one university to another, he eagerly absorbed all that had been written on the subject, and made himself a name by the extent of his knowledge, and by his able writings. The series of his "*Observationes Mycologicae*" appeared in the years 1794, 1795 and 1799. His greatest work, "*Synopsis Methodica Fungorum*," was published in 1801 at Göttingen. But fame did not bring money. Persoon was utterly unbusinesslike, and it was as a poor man that he came to Paris in 1802. At first he was well received in scientific circles, but to quote his Italian biographer Fée, "the French could excuse all defects but one, and that Persoon possessed in a high degree. He was uncouth and grotesque in appearance." Neglected and struggling with abject poverty, he continued to carry on his work and an extensive correspondence with distinguished botanists, while he lived in a wretched garret of a tenement house in a poor quarter of the city. His landlady could not understand how her strange lodger, who seldom could pay his rent, should receive packages addressed "To the very learned and very illustrious Prince of Mycologists." It was in 1825 that Fée visited him in Paris, and found him in this miserable state. He tried to obtain assistance for him from wealthy friends, but Persoon for long rejected all offers of help, saying that it would displease him to receive aid in a manner that might cause him shame for having accepted it. Fée, however, persisted in his efforts, and Persoon was at length induced, as a Dutch subject, to part with his precious collections to the government of Holland in return for an annual pension of 800 florins. So his herbarium was packed, marked with government seals, and shipped off to Leyden. Henceforth Persoon lived in bodily comfort, but he never recovered from the humiliation of having parted with collections that represented to him so much of his life. It was as an embittered and lonely old man that he died in 1837 at the age of 82.

When my father and I visited Leyden in 1892 we called at the Reyks Museum and enquired what Mycetozoa they had in their herbarium. After being shown various modern gatherings from different parts of the world, a drawer was opened in which were exhibited a number of the actual specimens of Persoon's collection. They were kept in small open boxes without lids; but in spite of this the sporangia were in very fair preservation, and they probably show their characters as well to-day as when they were gathered more than a hundred years ago.

Persoon's "*Synopsis Methodica Fungorum*" is a modest little volume printed on 706 pages of thin paper, to which are added a few copper-plate engravings. The Fungi are arranged in classes, orders, genera and species, each division being defined by a few natural characters, after the manner adopted for



Flowering Plants by the great French botanist Antoin de Jessieu in his "Genera Plantarum" published in 1788.

In contrast with the work of most of his predecessors on Mycetoza, Persoon had a wonderful aptitude for perceiving the natural relations of species and genera. In his Synopsis, although they are still included in the same Order as the Puff-balls and *Mucor*, they stand all together, grouped under eleven genera, all of which are retained at the present time, and which indeed form the basis of our present classification. The eighty species he describes are also for the most part retained. His descriptions give usually a good idea of the general features of the species as seen under a pocket lens. Copious references are given to the works of previous authors.

It is to be noted that of two genera only, *Lycogala* and *Fuligo*, does Persoon mention their semi-fluid condition in youth, "*interno primo pulposa*"; of *Arcyria punicea* and also of *Stemonitis fasciculata* he writes '*primo mollis*.' But besides the genera dealing with the mature state of the sporangia, he describes in another part of his book the obscure genus *Mesenterica* of Tode, in which may be recognized a description of the plasmodium stage of various species of Mycetoza.

I may here refer to the graphic account and the illustration of creeping plasmodium given by Tode in his "Fungi of Mecklenburg," published in 1790, under the name *Mesenterica tremeloides*. Tode had, however, no idea as to the real nature of his so-called fungus. He regarded the thick margin of the plasmodium to be undoubtedly the seat of fructification: he remarks "this delicate plant disappears after twelve hours in warm air, leaving no trace behind save certain clusters of minute scales (*bracteolae*).

Persoon in his "Synopsis Fungorum" does not suggest that *Mesenterica* may be only a stage in the life history of some other genus; but in his "Fungi Europaei," published in 1823, where he changes the name *Mesenterica* to *Phlebomorpha*, after briefly describing *Phlebomorpha rufa*, he adds "this does not appear to be the young state of a *Physarum*, which indeed consists of a very fluid amorphous mass." It is evident that he did not realize the true significance of this "*Mesenterica*" or "*Phlebomorpha*," and its connection with genera of the Mycetoza he had described.

Of British authors who towards the end of the 18th century wrote on Fungi and described some species of Mycetoza the two following may be noted, although they did little original work on the subject.

James Dickson, born in Peeblesshire in 1738, a nurseryman and student of cryptogams, and one of the First Fellows of the Linnean Society, was the author of "*Fasciculus Plantarum*

*Cryptogarum Britannicae* " (1785), which contains the first description and illustration of the familiar species *Leocarpus fragilis* (Dicks.) Rost. under the name *Lycoperdon fragile*: and James Sowerby,\* the London artist, whose drawings in "English Botany" are familiar to us; his beautiful "Coloured Figures of English Fungi and Mushrooms," published between the years 1797-1809, contain some of the best illustrations of *Mycetozoa* that had yet appeared.

At the beginning of the nineteenth century we have the Danish writer, Christian Schumacher,† publishing a "*Descriptive list of the plants of North and East Zealand*," Zealand being the island on which Copenhagen is situated. A hundred species of *Mycetozoa* are briefly described under the genera of Persoon's "Synopsis." There are no illustrations. Of these hundred species 72 are of Schumacher's own naming, from which we may infer either that his opportunities for consulting the works of previous authors were very limited, or that he had a strong preference for using his own name as an authority. It is rather pathetic to see how posterity has dealt with his work. Of the 72 names he gave, only two are retained at the present day. Of the rest either they refer to species that had been described before, or they are accompanied by descriptions that are too vague for identification.

One turns with relief from studying such a book as Schumacher's, to the "*Conspectus Fungorum*" of Albertini and Schweinitz.

Ludwig von Schweinitz was born in 1780 at Bethlehem, Pennsylvania, a colony of Moravian brethren founded by his maternal grandfather, the religious reformer Count von Zinzendorf. It was due to the energy and enthusiasm of Count Zinzendorf that the obscure body of men known as Moravian Brothers, the descendants of the followers of John Huss living in Moravia, was organized into one of the great missionary and educational influences of the world.

Schweinitz was devoted all his life to the interests of his community; he was also an ardent lover of botany. At the age of eighteen he accompanied his father to Germany, where he was sent to study in the theological college of Niesky in Saxony. Here one of the professors, Johannes von Albertini, a man of character with a strong taste for natural history, became his intimate friend. The outcome of their botanical studies was the publication in 1805 of "*Conspectus Fungorum*," or translated in full "A list of Fungi growing in the neighbourhood of Niesky in Upper Lusatia, after the method of Persoon

\* Born 1757; died 1822.

† Born 1757; died 1830.

It is an octavo volume written in Latin, with careful coloured illustrations, and containing full and graphic descriptions of the new species introduced. Seventy-three species of Mycetozoa are enumerated, as Fungi of course, of which nine are new. Six of these are still retained under the specific names given by Albertini and Schweinitz.

After an active life of travel and adventure Schweinitz returned to America, where amongst other botanical works, he published two papers on North American Fungi, entitled "*Synopsis Fungorum Carolinae Superioris*," which appeared in 1822, and "*Synopsis Fungorum in America boreali media degentium*," written in 1832. They are valuable records of the knowledge of North American Fungi and incidentally of the Mycetozoa also of that day, but the Latin descriptions are tantalizingly short and lack the informing notes that add so much to the value of Schweinitz' first book written in conjunction with Albertini.

Fortunately the herbarium made by Schweinitz is preserved in Philadelphia, and in it a certain number of his types are still to be seen. After a life devoted to his work, he died in 1834 at the age of 54.

With a brief mention only of the German botanists Link, Ditmar and Ehrenberg, of the Norwegian Sommerfelt, and of the great Swiss botanist Augustin de Candolle, all of whom described some Mycetozoa in their writings on Fungi in the first third of the 19th century, we come to by far the most eminent mycologist of his day in the person of Elias Fries.

Fries was born in 1794 at Femsjö, a village in the south of Sweden, where his father was a pastor of the Lutheran Church. Being an only child, he was encouraged from an early age to cultivate the love of nature, in order that, to use Fries' own words, "the children of Flora might be to him friends who did not desert him afterwards, but were always true." Even as a boy he was especially attracted by Fungi, and with the aid of Lijebblad's Swedish Flora, he tried to make out the names of the specimens he found in the woods, never doubting at first that all would be there described: but finding the task hopeless, he set himself to make descriptions of all the Fungi he met with, giving them temporary names; thus he learnt to distinguish between 300 and 400 species before leaving school. While working for his degree of doctor of philosophy at Lund, all his spare time was occupied with botany, which he could now study with the help of the best books of the day.

His first paper, "*Observationes Mycologicae*," part 1, was published in 1815, and from that time, almost to the year of his death in 1878, a series of valuable works continued to appear as the result of his knowledge and zeal. He not only compiled

the standard systematic works of the day on Fungi and Lichens, but published a complete Flora of the whole of Scandinavia; he also wrote on practical botany, on the nomenclature of plants, on the history of botany, and published many articles popularizing the study of plants. His scientific writings are in Latin, the language in which as a boy he had been accustomed to converse with his father. They are characterized by their vigour of style, accuracy of patient observation, and courtesy towards the work of his contemporaries and predecessors.

As to his personal character I will quote the words of his fellow countryman, Lundström, to whose memoir of Fries I am indebted for these notes on his life.\* "His lively interest in his science, and his affectionate regard for all who pursued it, procured him the veneration and love of all; and those who participated in a more confidential intercourse with him, cannot praise their good fortune enough in having had the happiness of the acquaintance of a man so noble and so good as Fries." He died in 1878, at the age of 84.

The account of the Mycetozoa given by Fries in the third part of "*Systema Mycologicum*," published in 1829, was by far the best work on the subject that had yet been written, and is still a treasure-house of interesting observation and historical information.

For the first time this group, though still included in the Order *Gasteromycetes*, is separated from the Puff-balls, and given a suborder to itself, the *Myxogastres*, which is characterized by being in a young state "mucilaginous and flowing," instead of hard and fleshy. So impressed was Fries with the importance of the different aspects of the "mucilaginous state" as he called the plasmodium, whether it was seen emerging from wood to form sporangia in a cushion-like mass, or whether it crept over the surface in a network of veins, that he distinguishes four different appearances of the plasmodium by name; viz., the "*Lycogala* state," where the plasmodium emerges to form a compact mass resembling the mature fructification,—as in *Lycogala*; the "*Mucilago* state," where the plasmodium and fructification alike appear as an irregular mass, as in *Fuligo*; the "*Mesenterica* state," where the plasmodium consists of a superficial network of veins from which the sporangia are at length formed by concentration at many points, as in *Diachaea*; and the "*Embolus* state," where the plasmodium emerges in a cushion-like mass and then divides into many separate sporangia, as in *Stemonitis*.

Fries gives a graphic account of how his attention was first drawn to the swiftness of growth of the "*Mesenterica*" stage,

\* See Journ. Bot. xvii. (N.S. viii.), p. 33.

from his having by chance placed some of the young "*Mesenterica*" of *Diachaea* in his cap, and how he was moved to admiration by finding that in the space of one hour much of it had spread out there to form an elegant white network.

The classification of species he adopts is essentially that of Persoon, whom he refers to as most reliable, "*probatissimus*," but it is modified to include six new genera. The descriptions of both genera and species, with the ample explanatory and historical notes accompanying them, and the full synonymy, are all admirably prepared. Minute details that could only be seen with the microscope he does not refer to. Thus characters which we regard as obvious nowadays, such as the presence or absence of calcareous deposits about the sporangium-wall, or the peculiar markings on the capillitium threads, were apparently unrecognized by Fries, although the spiral markings of the elaters of *Trichia* had been described and figured by R. A. Hedwig as early as 1802.\*

Although Fries belonged to the older school of botanists who believed in the immutability of species, he yet possessed an instinct which enabled him to arrange these species with a wonderful appreciation of their natural affinity. Sachs, in his "History of Botany," refers to there being, in Fries' opinion, "something supernatural," as he expressed it, in this natural affinity of organisms, which makes a natural system possible. He considered that each division of such a natural system, each genus, might be regarded as expressing an *idea*, and these ideas together might be explained as representing the original plan of Creation.

But still the difficulty remained, and continued to remain in the minds of all thinking men, until Darwin's theory of descent gave the clue to natural affinity, and the doctrine of immutability of species could be dismissed for ever.

A contemporary and disciple of Fries was our countryman the Rev. Miles Berkeley. Berkeley was born at Oundle, Northamptonshire, in 1803, and was therefore only nine years younger than Fries. Educated at Rugby and Christ's College, Cambridge, he took holy orders and settled as a curate at Margate. Here, besides his professional duties, he seems to have occupied himself with natural history generally. His first publications were on Mollusca and Algae, but he must have acquired also a considerable knowledge of Fungi for him to have received a proposal from Sir William Hooker that he should write the section on Agarics for the volume on Fungi in "Smith's

\* See *Observationum Botanicorum*, fasc. primus, Tab. x., xi. C. C. Schmiedel had also figured spirals on the elaters of a species of *Trichia*, but the value of his observation is impaired by his having drawn spiral markings on threads forming the net of the sporangium of what is clearly *Cribraria purpurea* Schrad. See Schmiedel,  *Ic. Plant.* (1762-1776) Pl. xxiv., xxxiii.

English Flora," of which Hooker was editor. Later, Berkeley undertook to complete the whole volume, when Hooker writes: "I have now to express my cordial acknowledgments, in which I am satisfied I shall be joined by every botanist in the country, to the Rev. M. J. Berkeley for having undertaken to prepare the whole of this vast family for the press, and it is certain the task could not have fallen into better hands."

This book, published in 1836, at once took its place as the standard work on British Fungi. The classification, and definitions of genera and species are those of the "*Systema Mycologicum*" of Fries. The notes on the species are Berkeley's own. They bring together an immense amount of information collected by others, and abound in original and critical observations. Of the "Myxogastres," 63 species are recorded for Britain, four of which are described as new, but these four are not now considered worthy of specific rank. He warmly expresses gratitude for the help given him by "that assiduous and faithful observer," Thomas Purton, author of "the Midland Flora," whose valuable notes were placed at Berkeley's service; also for the assistance he received from Dr. Robert Kaye Greville of Edinburgh, author of a beautifully illustrated "Scottish Cryptogamic Flora," published between the years 1823 and 1829, a work that unfortunately came to an untimely end for want of funds.

From this time Berkeley was an enthusiastic investigator of Fungi, and in spite of the many difficulties he had to contend with he continued to pursue the study with unwearied interest to the end of his life. After leaving Margate in 1833 he became rector of Kingscliffe, Northamptonshire; later, in 1868, he became vicar of Sibbertoft in Leicestershire, where he remained till his death. He married, and had a large family. For some years, to increase a modest income, he kept a school for boys. He was at this time the first authority in the country on plant diseases and Fungi. Specimens from all parts, from home and abroad, poured in for his critical examination, and the only leisure he could obtain in which to study and write on them was found by rising very early in the morning before school hours,—a severe tax on one whose health was often far from strong.

Berkeley's work on Mycetoza appears chiefly in his papers on the Fungi that were sent him by collectors from abroad, and consists of lists of the species found, and descriptions of new species. Such papers are those "On the Fungi of North America," "On the Fungi of Cuba," and "On the Fungi of Ceylon" written in conjunction with his friend and fellow-worker Christopher Broome. The types of these species are preserved to us partly in Berkeley's herbarium at Kew, partly

in the British Museum in the collection of Broome, with whom he shared many specimens.

In reading Berkeley's descriptions of Mycetozoa, one is struck, even in his later papers, with how little use he seems to have made of modern microscopical appliances. He presents us with an excellent idea of the object before him as seen under a good pocket lens, but as regards details of structure his observations show little advance on those made by Fries thirty or forty years before. In some cases, however, spore measurements are given that are fairly correct. He made a curious mistake in thinking that the clusters of spores in the sporangia of his new genus *Badhamia* were enclosed in a hyaline sac that afterwards bursts or is absorbed. This was an idea he firmly adhered to. It was quoted by him as an argument in favour of the Myxogastres being true Fungi, rather than allied to animals, a view that had been recently brought forward by de Bary, as the result of his investigation into their life history. Berkeley writes as follows on the subject, in 1860, in *Outlines of British Fungology*:—"A large group of Fungi, containing multitudes of the most exquisite microscopic objects, is distinguished by the early conditions being creamy or mucilaginous. They differ in many respects from other Fungi, and especially because they seem often quite independent of the substance on which they are developed. . . . In consequence of this, and of some other peculiarities in the substance of which they are formed resembling that of which certain *Infusoria* are composed, a very excellent observer, Dr. de Bary has lately expressed the formal opinion that they are animals, but a sufficient answer to this is the fact that some species have spiral vessels" (he alludes of course to the elaters of *Trichia*), "and have their spores surrounded by a distinct sac." On a further page he adds cautiously:—"Though, however, I have myself little doubt as to these productions being vegetables as well as other Fungi, and I am supported in this view by Fries, than whom no one is more eminent for tact and nice discrimination, it is right that I should not speak too positively, as the two brothers Tulasne, who have added so much to our knowledge of Fungi, incline rather, as it should seem, to de Bary's views, which they corroborate in some degree by the fact that many of these productions contain in their outer coat a notable quantity of carbonate of lime";—a curious argument to support the animal affinities of the Mycetozoa!

These quotations are given to show the views held by Berkeley with regard to the position of the Mycetozoa; but it must not be supposed he was indifferent to the great discoveries that were being made by the investigations of the new school of Continental, and especially of German botanists, into the life-

history of Fungi and Cryptogams generally. On the contrary he followed them with intense interest, and was only scornful of those British writers whose ignorance led them to make light of what they did not understand.

Considering the comparatively secluded life led by Berkeley, it seems astonishing how much good scientific work he managed to accomplish in his country parsonage. Besides contributing largely to our knowledge of Fungi, he was the first to make the study of Fungi in any way popular in this country. This he did by such works as "Introduction to Cryptogamic Botany," "Outlines of British Fungology," and by many popular articles; also by the genial encouragement he gave to all who applied to him for advice.

Berkeley died in 1889 at the age of 86.

We now pass to the work of the great master whose patient research and wide grasp of general principles enabled him to shed light on every subject he investigated. With Anton de Bary we feel that the study of Mycology is lifted to a higher plane.

Germany had at this time produced a brilliant circle of botanists, whose theories and discoveries were making a new epoch in the botanical world. Freed from the older traditions in which description and classification took too prominent a place, they attempted by minute investigation and reasoning to discover the principles of the development and life of plants. Nägeli, Hugo von Mohl, and Hofmeister were living, and profoundly influencing the thought of the time by their observations on histology and embryology.

De Bary was born at Frankfurt in 1831. He was the son of a medical practitioner, and himself entered the medical profession. Admiration of Von Mohl, then professor of botany at Tübingen, induced him to give up practice and come to Tübingen, where he took the position of Lecturer on Botany in the University. In later years he became professor of botany, first at Freiburg, then at Halle, and finally at Strassburg, where he remained until his death in 1888. The work that de Bary accomplished during his comparatively short life is amazing. Besides his investigations into the morphology, physiology and development of Fungi and Lichens, his studies extended to the higher Cryptogams and to Flowering plants. The late Prof. Marshall Ward, who worked under de Bary at Strassburg, writes of his enormous influence on the progress of Biology, of his unflinching honesty, rigorous self-criticism and modesty, of his marvellous grasp of detail and power of logical generalization, also of the keen appreciation he had for all good work. By his personal influence he attracted a band of enthusiastic students, very many of whom have since become eminent in science.



It is to de Bary that we owe the modern view of the position of the "Mycetozoa," or "Fungus-animals," as we may translate the name he gave to the group which consists for the most part of the "Myxogastres" of Fries. In his article entitled "Die Mycetozoa," published in 1859, of which a second edition appeared in 1864, he gives an account of his observations.

It was de Bary who first cultivated the spores and saw them give birth to nucleated "*swarm-cells*"; he watched the swarm-cells dividing in hosts in the field of the microscope; saw them withdraw their flagella and creep about as myxamoebæ. He inferred that it was by the union of such myxamoebæ that the young plasmodia abounding in his cultures were formed, but it was the Russian botanist Cienkowski, working contemporaneously, who first saw the actual union of myxamoebæ take place, and who gave the name "*plasmodium*" to those masses of naked protoplasm which Fries had called "*mesenterica*"; Cienkowski was also the first to notice the ingestion of solid food by the plasmodium, an observation that showed the animal affinities of these organisms. De Bary first described the structure of the plasmodium, and its remarkable rhythmic circulation; he also showed how the sporangia of all Mycetozoa arise from such plasmodia. He first described in detail the formation of the young sporangia, of the capillitium and of the spores. Summing up the observations of earlier authors, he described the minute structure of the different types of mature sporangia in a way that had never been done before. To the nuclear history of the Mycetozoa de Bary refers in a later book, "The Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria," published in 1884. Here he mentions the work of Strasburger, who had recently established the presence of numerous nuclei in the plasmodium, which presumably were the persistent nuclei of the swarm-cells and the products of their division; Strasburger had also observed the division of these nuclei by mitosis in the young sporangium prior to spore-formation.

With the further nuclear changes that occur in the plasmodium and swarm-cells, de Bary was not acquainted, and indeed this subject still presents problems that have not been solved with certainty.

De Bary's pupils carried on his methods in the spirit of their master. A number of them took up the study of Mycetozoa, prominent amongst whom were the Russian botanist Woronin, who with his friend Famintzin worked out the chief features in the life history of *Ceratiomyxa*, and the eminent Pole, Dr. Joseph Rostafinski, whose splendid "Monograph of Mycetozoa," compiled under de Bary's guidance, and beautifully illustrated, was published in 1875. This work became at once the standard

authority on the subject. But in spite of its great merits the full value of the book is hidden from most of us, for it is written in the Polish language. To a certain extent the main features are given in an English translation of the keys to the genera and species, with abstracts of the characters defining the British species, published by M. C. Cooke. In Saccardo's "*Sylloge Fungorum*," vol. VII., abstracts in Latin of the descriptions of Rostafinski's species also appear, but the elaborate critical and historical notes of the original volume have I think never been translated from the Polish.

Dr. Rostafinski is still alive, but it is to be feared that he must be reckoned among the past students of Mycetozoa, for he no longer works at the subject, and has embarked on the troubled waters of Polish politics. With his work we come practically to our own times, and here I bring this short account to a close.

I am aware that there are many others who have now passed away whom I have not mentioned, whose published writings and friendly correspondence gave invaluable assistance to my father when he was collecting materials for compiling "the British Museum Catalogue of Mycetozoa"; such were Prof. Axel Blytt, of Christiana, Dr. George Rex, the genial physician of Philadelphia, Mr. A. P. Morgan, of Ohio; but in this sketch it is the historical aspect of the subject that I wished to keep in view, and I have therefore aimed at referring chiefly to those in the past whose work has made landmarks in our knowledge of Mycetozoa.