Notes on Chondrioderma difforme and other Mycetozoa.

BY

ARTHUR LISTER.

With Plate XVI.

THE life-history of the Mycetozoa has been carefully worked out by De Bary, Cienkowski, and other naturalists on the Continent; they have described the emerging of the amoeboid swarm-cells from the spores, and their union to form the plasmodium, and they have told of the change of the plasmodium into sporangia.

There is difficulty in following this remarkable history in almost all the members of the group; the single species, which appears to stand apart as affording facilities for observation, and which has been more especially studied, is that which has received the name of *Chrondrioderma difforme*, although it is a great question whether it should not be classed under the genus *Didymium*, as proposed by De Bary (Mycetozoa, 1864).

I propose in the present paper to describe my observations on this species, and on some others where similarities or differences have presented themselves having relation to characters under consideration.

Chrondrioderma difforme is an inhabitant of rotting leaves; the sporangia may be met with in most seasons of the year, as chalk-white spots on fallen leaves which have accumulated in moist woods and shaded places; they vary in shape from hemispherical or flattened discs to irregular forms which may come under Rostafinski's term of plasmodiocarp, and in size

[Annals of Botany, Vol. IV. No. XIV. May 1890.]

from a fraction of a millimeter to 3–4 m.m. in diameter (Fig. 1).

Under ordinary conditions, the sporangium is found attached throughout its lower surface to a leaf by means of a membranous wall possessing a thickened margin of a more or less deep orange colour (Fig. 2). Adnate to this wall is a layer, usually of a purplish tint, which gives rise to the capillitium, and extends upwards as a delicate membrane enclosing the spore-cavity; numerous aggregations of chalk-granules are embedded between these two basal layers; outside the delicate upper membrane, and often extending on to the leaf slightly beyond the thickened margin, is a thin eggshell-like crust composed of crystals of calcium carbonate, usually closely compacted together. This outer calcareous wall is either attached to the upper membrane, or, less frequently, is separated from it by shrinking of the interior, and stands as a somewhat domed roof with a more or less considerable intervening cavity.

The capillitium extends among the mass of spores, connecting the lower with the upper part of the inner membrane, and consists of flattened threads, broad at their base and forking again and again into delicate extremities; the threads are sometimes filiform and anastomosing, either uniform or with expansions containing granules of calcium carbonate or refuse matter; they are often interrupted with dark bands or knots, such as are commonly seen in the capillitium of the genus *Didymium*. The colour of the capillitium varies from deep purple to pale yellow; or both the stout and delicate forms may be colourless. The spores measure 10–14 μ and are smooth, of a dark brownish purple colour; one side of the spore is usually thinner and paler in tint than the other, and is marked with a few reticulated dark lines. In drying, the paler side contracts towards the thicker and darker one, which retains its rounded form; it is along the lines of reticulation that the spore-wall breaks on the emerging of the swarm-cell.

In order to follow carefully the development of the

sporangia, I adopted a method of cultivation recommended by Professor Bayley Balfour. Wet blotting-paper was placed on a plate and sprinkled over with some seeds of garden cress; with these were sown the spores from a single sporangium of *Chondrioderma difforme* collected in a shady wood, and the cultivation was covered with a bell-jar. A similar preparation was also made with the spores from a sporangium taken from a heap of leaves on my premises; the sporangia of both cultivations (which I will call respectively A and B), showed well-developed capillitium, but the former was of a bolder and darker type than the latter.

In the course of twelve days several small yellow plasmodia with diverging veins were observed on the blotting-paper sown with the spores of sporangium A, and on the following day one of these had contracted into an orange-coloured hemisphere about 1 m.m. in diameter, which became dark purplish brown in the course of the day; next morning it was grey, changing to the usual chalk-white when dry. On examination, the spores were found perfectly mature and normal; the capillitium, though less abundant than in the parent, was fairly pronounced, and the thickened margin of the base of the sporangium was of the same dark orange colour as in the original gathering.

In the meantime fresh sporangia were rapidly appearing, and in three weeks from the date of sowing, two hundred and fifty sporangia were counted on the roots and stems of the cress and on the blotting-paper.

A small plasmodium from this cultivation was carefully lifted, together with a few fibres of the blotting-paper, and placed on a glass slide for examination under the microscope. The rhythmic streaming was clearly observed, and it was evident that the yellow colour was due to the minute protoplasmic granules and not to foreign matter in suspension; it was afterwards placed under a wine-glass, where it formed into a sporangium in a few hours.

Under the bell-jar, covering the spores from cultivation B, sporangia made their appearance in twelve days, and

increased in number in the same manner as in the other experiment; but these differed from the first in having the plasmodium almost entirely colourless and the bases of the sporangia only faintly tinged with yellow.

A subsequent cultivation was made with cress-seeds and the spores from a sporangium with strikingly dark capillitium (Fig. 4 *a*). In the course of 11 weeks 310 sporangia were produced on the blotting-paper and cress-stalks; the capillitium in these varied in tint from that of the parent to colourless, and in amount from abundance to scarcity. (Fig. 4 *b* and *c*.)[1]

In order to ascertain whether the time of the development of sporangia depended on the condition of the young cress-plants, three pieces of wet blotting-paper were sown with cress-seeds on the same day, and covered with bell-jars. The spores of three sporangia from the cultivation producing 310 fruits were sown; those from one at the same time as the cress; from another four days after, when the seeds had sprouted; and from the third eight days after the cress was sown. In the first, a sporangium appeared on the thirteenth day, on the following day there were three; the numbers increasing day by day to 5, 20, 24, 40, 80, 125. Under the second bell-jar, three sporangia appeared twelve days after the spores were sown or sixteen days after the cress. The daily increase in numbers was as follows, 5, 10, 20, 40, 50. Under the third, four sporangia were seen on the tenth day from sowing the spores, but the blotting-paper was allowed to become too wet, which checked further increase.

[1] In subsequent examinations of many sporangia from this large cultivation, the spores were usually found to be of the normal size and dark purple brown in colour, but in a few they were pale violet, and varied much in form and dimensions. I had little doubt that these were imperfectly developed, and that I should find, as I have often done in other species when the spores have not properly matured, that germination would not take place. To test the point a large number were placed in water under a cover-slip; next morning almost all had hatched, large and small, regular in form and irregular, the swarm-cells were as vigorous as those from the dark spores, and in a few days many had coalesced into young plasmodia.

I have frequently met with considerable difference of colour in the spores of some species f *Didymium* and *Stemonitis*, but not to the extent exhibited in this case.

From these, and many other experiments, it appears that sporangia of *Chondrioderma difforme* form from ten to fourteen days after the spores are sown with cress-seeds. The most rapid development I have met with was in an experiment with green unripe seeds of *Plantago lanceolata* which had been steeped in water for several hours; seven of these seeds were placed on wet tissue-paper in a watch-glass with spores from cultivation A: on the ninth day a sporangium was formed, and near it a branching yellow plasmodium showed active streaming movement; many more sporangia developed during the next few days [1].

I have tried other seeds with mucilaginous testae without obtaining sporangia, though no doubt there must be some as favourable to their growth as the above.

Cienkowski's experiment, in which plasmodia appeared four days after sowing the spores, and sporangia on the following day [2], would seem to be an exceptional experience.

The following observations relate to further details of development. Spores from two small sporangia from the cultivation A, each containing capillitium in fair abundance of the type of Fig. 3, were sown with seven cress-seeds on a ring of blotting-paper in a watch-glass. In eighteen days, 10 sporangia had ripened on the cress and on the paper. The plasmodium was of the same yellow colour as in the former generation, but the sporangia showed a marked difference in the capillitium. Some were repetitions of the parents in all respects; others contained only a few threads, and these varied in colour and thickness, and one, though equalling the parents in size, had no capillitium whatever. The spores, as a rule, were well developed and only varied in size from 10 μ to 14 μ; but in some sporangia many were abnormal, measuring from 20 μ to 40 μ, others were still larger and of irregular form; but this variation in the size of the spores always occurs, in every species I have cultivated, when grown under unfavourable conditions.

[1] I need hardly say that as good results are obtained when ripe plantain-seeds are used.

[2] De Bary, Fungi, Mycetozoa, etc., Eng. ed. p. 433.

Another sowing of spores from the cultivation B was made in two watch-glasses on tissue-paper with three and four cress-seeds. In ten days plasmodia were detected, almost hyaline in colour; the thin tissue-paper allowed the streaming movement to be observed under the microscope very clearly.

In a few days from this time, eight sporangia had formed in each watch-glass, and these varied like the last described in having the capillitium well developed or absent and either darker than that of the parent or colourless. The basal wall was in some cases almost free from colour, in others it had nearly as much orange tint as many that had formed from the yellow plasmodium [1].

Some sporangia formed under water at the bottom of the watch-glass, and here there was no development of the calcareous upper wall, or it was represented by a few scattered crystals; in point of fact exactly resembling those described by Professor Marshall Ward as growing on the submerged roots of hyacinth [2].

A curious intermediate form was noticed in some sporangia which had developed when partly covered with water: in these the chalk was distributed in irregular patches over the inner membrane and was overspread by an outer membrane, giving a tough character to the sporangium; thus a double membraneous wall was formed embracing the whole spore-cavity, the patches of chalk lying, as it were in pockets, between the two layers. From the base of one of these sporangia arose irregular columns, or lumps of aggregated chalk-granules enclosed in diverticula of the inner membrane, and taking the place of normal capillitium; in another, one

[1] The varied colour of the plasmodium is interesting in relation to what we find in different gatherings of *Trichia fallax*. In the neighbourhood of Lyme Regis, where this species is very common, it rises out of decayed wood, either in rose-coloured or pure white plasmodium. As a rule, we do not find these colours mixed together; on one stump all will be red, on another all white. The sporangia, capillitium, and spores appear to be perfectly identical, whether developed from the red or white plasmodium.

[2] Studies from the Biological Laboratories of Owens College, vol. i, Pl. III.

or more of these columns formed the base of a capillitium-thread, in another again they were mixed with threads of the usual kind.

Similar aggregations of chalk-granules in the basal portion of the capillitium are not unusual in *Didymium squamulosum.*

Besides the method of cultivation already described, the spores of many Mycetozoa may be caused to germinate under a cover slip on a glass slide, or in a hanging drop, a plan given by Professor Marshall Ward (loc. cit.). A pad of a few thicknesses of blotting-paper with a hole about $\frac{3}{4}$ inch in diameter is wetted and laid on a glass-slide, a drop of water containing spores is placed on a square cover-slip and inverted over the central opening; the spores are thus kept in a moist chamber allowing access of oxygen through the porous substance of the blotting paper, while the wet pad prevents the drop from drying. Experiments with this method will be referred to hereafter.

The time that spores take to germinate varies greatly not only in different species but in different gatherings of the same species. Those of a specimen of *Stemonitis fusca* gathered in the autumn of 1888 produced swarm-cells in abundance within an hour and a half of their being placed in water under a thin cover-slip; after six months' preservation, they germinated almost equally quickly, and after thirteen months, although they took a longer time, vast numbers of swarm-cells were hatched within twelve hours. Another gathering of the same species in the spring of 1889, examined at the time of collecting, began to germinate in four hours, and in twelve hours nearly all the spores had hatched. In other gatherings germination did not begin until twelve hours, and after several days many spores were still unburst. In others again, though well ripened and in fine condition, I have not succeeded in obtaining swarm-cells at all.

The large spores of *Amaurochaete* germinate in from two to four hours, and this is but little delayed after they have remained for a year and a half in a cabinet.

The spores of *Ceratium hydnoides*, gathered more than a year ago, still give birth to their remarkable swarm-cells abundantly, in about twelve hours after being placed in pure rain-water[1].

With many other species I have had similar results, germination taking place in from six hours to several days, but with some I have failed altogether. My experience with *Stemonitis fusca* leads me to suppose that in these last I may only have been unsuccessful in obtaining favourable specimens. Nearly all my experiments have been made with filtered rain-water.

The conditions under which the spores are placed have a marked influence on the development of swarm-cells. Thus the spores of the specimen of *Stemonitis fusca* above mentioned, where germination takes place rapidly, will remain at the bottom of a test-tube half filled with water for many days, if not permanently, without germinating, while if some of these spores are taken out of the test-tube where they have lain for some days, and placed by means of a pipette under a cover-slip on a glass slide, the swarm-cells appear in the course of an hour or two. This has been the case with several other species which I have treated in the same manner, though it is by no means a constant rule.

Arcyria punicea, *Perichaena corticalis*, *Badhamia panicea* and some others have germinated almost equally rapidly under a cover-slip, in a hanging drop, or at the bottom of a test-tube.

In the numerous gatherings and cultivations of *Chrondrioderma difforme* which I have examined, the spores have been very constant in the time they take to hatch. Under a cover-slip or in a hanging drop the swarm-cells begin to emerge in six to eight hours. Although deep immersion delays, yet it does not prevent their germination.

The following experiments relating to the formation of plasmodium under a cover-slip and in a hanging drop fur-

[1] De Bary mentions (loc. cit., p. 448) that the spores of *Ceratium* do not germinate in pure water, but only in a suitable nutrient solution.

nished some points of interest. I may mention that in preparing spores for cultivation, a drop of methylated spirit is first applied to expel the air from among them and water is immediately added; the spirit does not appear to have any injurious effect, for even minute spores, such as those of *Lycogala*, germinate freely after the process.

Spores of *Chondrioderma difforme* prepared in this manner were covered with a thin glass square, supported on one side to prevent pressure. In a few hours swarm-cells were produced, and increased rapidly by division for some days, when a large number changed to microcysts, the resting stage described by De Bary[1], and a great proportion of the remainder assumed a sluggish amoeboid condition. After an interval of several days a number of the amoeboid bodies were seen to unite and form small plasmodia; their nuclei were observed to remain distinct after many had coalesced (Fig. 5).

The plasmodia increased daily in size and numbers. I once observed two approach each other with very slow movement (Fig. 6); there appeared to be no mutual attraction until they were only separated by a distance of 40 μ, when a lobe from one was pushed out towards its companion, the intervening swarm-cells were thrust aside, and they came into contact; the hyaloplasm of each blended at a single point, and a thin stream of granular matter was seen to pass, then with a return flow of the streaming in the larger of the two the channel was widened and a gush of its contents poured into the smaller one, when union was complete, and the system of circulation became common to both (Fig. 7).

Many microcysts were incorporated by the plasmodia (Figs. 6 *a* and 7 *a*), and lay enclosed in vacuoles for three or four hours, during which time they became gradually and entirely assimilated—the sluggish amoeboid cells were often seen to be absorbed in the same manner. Thirteen separate plasmodia were counted in the preparation, and no other instance of union between them was seen to take place during the thirty-five days that the observation lasted.

[1] loc. cit., p. 427.

The form and character of the plasmodia were the same as given by Professor Marshall Ward, and so well described by him in the volume before mentioned (Pl. V).

In a cultivation in a hanging drop, fifty-two small plasmodia were counted distributed over the convex surface four days after sowing the spores in a drop of rain-water. In this experiment it was noticed that the young plasmodia exerted an attracting influence over the surrounding swarm-cells in a more evident manner than under the cover-slip. The coalescence of amoeboid swarm-cells was observed as in the former case, but no union of plasmodia was seen to occur; several of the latter became encysted with a double membranous envelope of a faintly yellow tint, somewhat corresponding with those described by Zopf [1].

Although no sporangia were produced in these experiments, in which only pure water was used, in six subsequent cultivations in hanging drops, when portions of the mucilaginous testa of cress or plantain seeds were added, well-formed sporangia with characteristic capillitium and spores made their appearance in about a fortnight after sowing the spores.

In tracing the development of these sporangia the following observations were made. The spores hatched the day after sowing. The plasmodia began to form on the fourth day; they increased in size during the three following days, but retained the same nearly hyaline appearance as at first; they were slightly turbid with faint protoplasmic particles. On the seventh day minute refracting granules of calcareous matter appeared for the first time; on the eleventh day the calcareous granules were larger and more numerous, showing conspicuously in the streaming currents; on about the fourteenth day a sporangium was formed, usually at some point where it was exposed to the air, and in this case the calcareous wall was fully developed; some minute sporangia which formed under water had no calcareous wall or capillitium though the spores were perfectly normal.

The calcareous matter is discharged from the plasmodium

[1] Encyk. der Nat. Wiss. 1ste Abt. 41 Lief., p. 170.

immediately after it has taken the sporangium-form. On one occasion this change was closely watched in the case of a submerged sporangium; the chalk granules were at first distributed over the surface, but in a short time they slipped off and were deposited in a little heap at the side.

On another occasion, when possibly some movement had produced a rupture in the soft wall of an immersed sporangium, a portion of the spore-plasma protruded through the rent, and was observed to branch into lobes and to divide into spores in the same manner as was noticed in the spore-formation of *Brefeldia maxima*, described in Annals of Botany, Vol. II. p. 18; each young spore, on constricting itself off, contained for a time a fluctuating vacuole, as was observed in the case of *Brefeldia*.

The species most closely allied to *Chondrioderma difforme* appears to be *Didymium dubium*, which differs chiefly in the character of the outer wall and in having smaller and paler spores and a more profuse capillitium. The plan of the sporangium is precisely the same, and it has the same isolated habit; it is only recorded in Saccardo's Sylloge Fungorum as occurring in Bohemia, but is fairly abundant among dead leaves in one locality near Lyme Regis. It is interesting, in connection with the subject of this paper in being liable to much variation.

The typical spores are nearly or quite smooth, of a pale violet-brown colour, and measure 7–9 μ, but specimens are not infrequent with large spores nearly uniform in size, the extremes ranging from 12–15 μ, and distinctly echinulate. The capillitium is dense, dark, and rigid, anastomosing at the extremities, but it is sometimes delicate and flexuose, though always coloured. The outer crust is a loose aggregation of large and very beautiful stellate crystals, but now and then we find it closely compacted, with but slightly crystalline character, and nearly resembling that of *Chondrioderma difforme*. I have not succeeded in obtaining the plasmodium of *Didymium dubium* from a cultivation of the spores in a hanging drop or with cress-seeds on blotting-paper, although

the swarm-cells make their appearance in great abundance. The plasmodium is very inconspicuous. I have had dead leaves kept wet under a bell-jar, among which it must have crawled for many days, but, though carefully watched, the first indication of its presence was the appearance of a pale young sporangium, which developed into the normal form.

The only species, besides *Chondrioderma difforme*, with which I have obtained plasmodium in a hanging drop is *Stemonitis fusca*. Swarm-cells appeared the day after sowing the spores, and in twelve days a small plasmodium was seen; this increased to considerable dimensions, principally, as it appeared, by the absorption of microcysts, as described p. 9, but at the end of a fortnight it changed into macrocysts without further development. This plasmodium exhibited several curious peculiarities as compared with that of species found on dead leaves, etc., which may perhaps be owing to its natural habitat being the substance of rotten wood.

At a meeting of the Linnean Society, in April, 1889, I described the mode of feeding which I had observed in the swarm-cells of *Stemonitis fusca*. I have since been able to watch the same process in the swarm-cells of several other species. Those of *Perichaena corticalis* afforded an interesting instance, because of the great activity of the bacilli which abounded in the preparation, and as showing the voracity of a few individual swarm-cells. One was noticed which already contained four vacuoles stuffed with bacilli, probably six to eight in each. It was observed to throw out several long pseudopodia from the posterior region, to which active bacilli became attached. In the course of twelve minutes four were seen under a Beck's $\frac{1}{10}^{th}$ immersion lens to be drawn in and conveyed into freshly formed vacuoles.

I have repeatedly seen bacteria taken by swarm-cells of *Chondrioderma difforme* in the manner above described, and it would appear that bacteria form their principal food[1]. On one occasion I had a favourable opportunity for observing the

[1] The vacuoles in the plasmodium of *Chondrioderma difforme* are frequently seen to contain bacteria.

digestion of bacilli on account of the quiescent state assumed by a swarm-cell, which remained with little active movement for an hour and a half. On the previous evening I had placed some spores of *Chondrioderma difforme* in water under a thin cover-slip; on the following morning swarm-cells were in great abundance in the pure water. I introduced a drop containing multitudes of bacilli from a glass in which a piece of *Stereum hirsutum* had been soaking for several days. In a short time a number of the swarm-cells were seen, attended by bacilli, some of which were attached to their pseudopodia, and some were already enclosed in vacuoles. The swarm-cell in question had taken an amoeboid form, occasionally producing and again withdrawing the cilium, while from time to time thin pseudopodia were extended from the opposite end, but more frequently the posterior region expanded into a somewhat funnel-shaped mouth. Into such an expansion a stout bacillus about 2 μ long was seen to enter; in the course of a few seconds it was enclosed with a noticeable amount of water, by the folding over of the lips of the funnel, and conveyed into the body-substance; a few minutes after, another bacillus was taken in, much in the same manner, but no globule of water was introduced. Ten minutes later a large bacillus 4 $\mu \times 0{\cdot}75\,\mu$ was caught by a prolongation of one side of the funnel, and in the course of half a minute a tube-like extension of protoplasmic substance invested the bacillus, and it was drawn in (Fig. 8). It remained for a short time in direct contact with the granular matter of the body, but was soon surrounded with an oval vacuole (Fig. 9). The swarm-cell continued inactive for nearly an hour, when it assumed an extended form, and shortly after swam away with rapid jogging movement (Fig. 10). Constant observation was maintained during this hour, and the bacilli were seen gradually to dissolve in the vacuoles in which they lay, until at length all trace of them had disappeared together with their containing vacuoles, and only the contracting vacuole remained in the homogeneous granular substance of the swarm-cell.

At the commencement of the observation this granular

protoplasm was much more turbid than at the close, when it was remarkably hyaline; the swarm-cell appeared also to have increased in size, though this was difficult to determine by measurement in consequence of its changing form. No rejection of refuse matter took place while the observation lasted.

In the same preparation I watched a swarm-cell creeping in a straight line with the strange snail-like movement, so difficult to understand. In its course it came to a small group of motionless bacilli lying against the glass; immediately it changed its linear form and spread itself out, covering four of the bacilli. In about two minutes it resumed its former shape and movement and crept away carrying off two of the bacilli in vacuoles.

These observations seem to confirm the opinion of De Bary that the organisms under consideration should be classed among the animal rather than the vegetable kingdom, which led him in 1858 to adopt the term Mycetozoa in place of that of Myxomycetes for the group. When a creeping swarm-cell is watched, with the projecting cilium placed immediately in advance of the nucleus, which never shifts its position, and when, as in the last-mentioned case, we note the manner in which the vibrating extremity of the cilium appeared to detect the presence of the bacilli before the swarm-cell spread itself over them; again, when we observe the creeping action suddenly change, and raising itself from the decumbent attitude, with a few lashing strokes of the cilium the swarm-cell releases its foot-hold and swims away; and when to these remarkable movements is added the process of ingestion which has been described; we cannot but feel the force of the conclusion at which De Bary arrived, if indeed a distinct line of demarcation between the two kingdoms can be said to exist.

Another point of interest which these experiments bring out is the variation which occurs in the progeny of a common parent when the natural conditions are slightly altered by cultivation.

The calcareous wall of the sporangium may be either closely

compacted, or composed of stellate crystals loosely combined; it may be scattered in patches and enclosed in a double membrane, or may be entirely wanting.

The capillitium may be well developed, composed of stout forking threads, or may be of delicate form (a variation shown as strikingly in *Didymium dubium*), or it may be absent altogether, and the spores may vary both in colour and dimensions.

The colour of the membranous wall of the sporangia, as well as of the threads of the capillitium, varies widely in different fruits of the same stock, and there is often a slight though well-marked difference of colour in the plasmodia.

When these varying characters are seen in the one species in which the life-history has been followed through successive generations, one is led to anticipate that if methods should be discovered for cultivating other kinds which have hitherto baffled our endeavours, we should find that many closely allied forms which are at present considered as distinct species, may be traced to a common parentage in this most variable group.

The following is a list of species in which I have observed the formation of sporangia from the plasmodium, with the colour of the latter appended. A large proportion of these were obtained by collecting rotting leaves on which plasmodium was seen, or betrayed by the peculiar odour attaching to it; they were preserved under bell-jars and frequently supplied with fresh rain-water, and, after some weeks of little promise, unexpected sporangia would often make their appearance on the leaves.

Species.	Colour of Plasmodium.
Amaurochaete atra	yellowish white.
Arcyria cinerea	greyish white.
—— *ferruginea*	rose.
—— *incarnata*	white.
—— *nutans* (buff variety)	white.
—— *nutans* (red variety)	white.
—— *punicea*	white.

Species.	Colour of Plasmodium.
Badhamia panicea	greyish white.
—— *utricularis*	orange yellow.
Brefeldia maxima	pure white.
Chondrioderma difforme	white to orange yellow.
—— *Michelii*	opaque white.
—— *spumarioide*	watery white.
Clathroptychium rugulosum	rose.
Comatricha Friesiana	watery white.
—— *typhina*	watery white.
Cornuvia metallica	colourless.
Craterium aureum	lemon yellow.
—— *leucocephalum*	yellow.
—— *vulgare*	yellow.
Cribraria argillacea	lead coloured in rising sporangia.
—— *aurantiaca*	sap green.
Diachaea leucopoda	white.
Dictydium cernuum	purple in rising sporangia.
Didymium clavus	grey.
—— *dubium*	colourless.
—— *microcarpon*	brownish grey.
—— *squamulosum*	watery white.
Enteridium olivaceum	rose.
Fuligo varians	yellow.
Hemiarcyria rubiformis	purple in rising sporangia.
Lamproderma iridea (Cke.)	colourless.
Lycogala epidendrum	rose.
Physarum compressum	greyish white.
—— *leucophaeum*	watery white to greenish.
—— *leucopus*	opaque white.
Reticularia lycoperdon	white.
Spumaria alba	white.
Stemonitis ferruginea	lemon yellow.
—— *fusca*	white.
Tilmadoche mutabilis	yellow.
Trichia affinis	pure white.

Species.	Colour of Plasmodium.
Trichia fallax	white and rose.
—— *varia*	white.

The plasmodium of most species inhabiting dead leaves is discoloured by foreign matter in suspension until a short time before the change to sporangia takes place.

EXPLANATION OF FIGURES IN PLATE XVI.

Illustrating Mr. Arthur Lister's Notes on *Chondrioderma difforme* and other Mycetozoa.

Fig. 1. Two sporangia of *Chondrioderma difforme* on elm leaf, showing outer calcareous and membraneous walls. × 40.

Fig. 2. Base of sporangium, the spores removed, showing fragment of calcareous wall (*a*), attached to thickened margin (*b*), with capillitium springing from the membranous inner wall (*c*). × 100.

Fig, 3. Capillitium of usual character in well-developed specimens.

Fig. 4. (*a*) Capillitium of sporangium from elm leaf, the spores of which were sown on blotting-paper with seeds of garden cress. 310 sporangia were developed in this cultivation during eleven weeks; (*b*) capillitium from one of these sporangia in which the threads were abundant; (*c*) capillitium from a cluster of four from the same cultivation, in each of which the threads were very scanty and colourless.

Fig. 5. Early formation of plasmodium, the nucleus of each of the swarm-cells of which it is composed remaining distinct.

Fig. 6. Two plasmodia approaching each other and about to coalesce: in one of them six spores are temporarily incorporated: (*a*) a microcyst enclosed in a vacuole, (*b*) amoeboid swarm-cells and microcysts.

Fig. 7. The two plasmodia after coalescence, drawn ten minutes after Fig. 6.

Fig. 8. Swarm-cell with the cilium withdrawn, embracing a bacillus, two smaller bacilli having been ingested a few minutes previously.

Fig. 9. The same swarm-cell with bacillus enclosed in a vacuole.

Fig. 10. The same after an interval of an hour having resumed active movement, the bacilli and their enclosing vacuoles having disappeared.

Fig. 1.

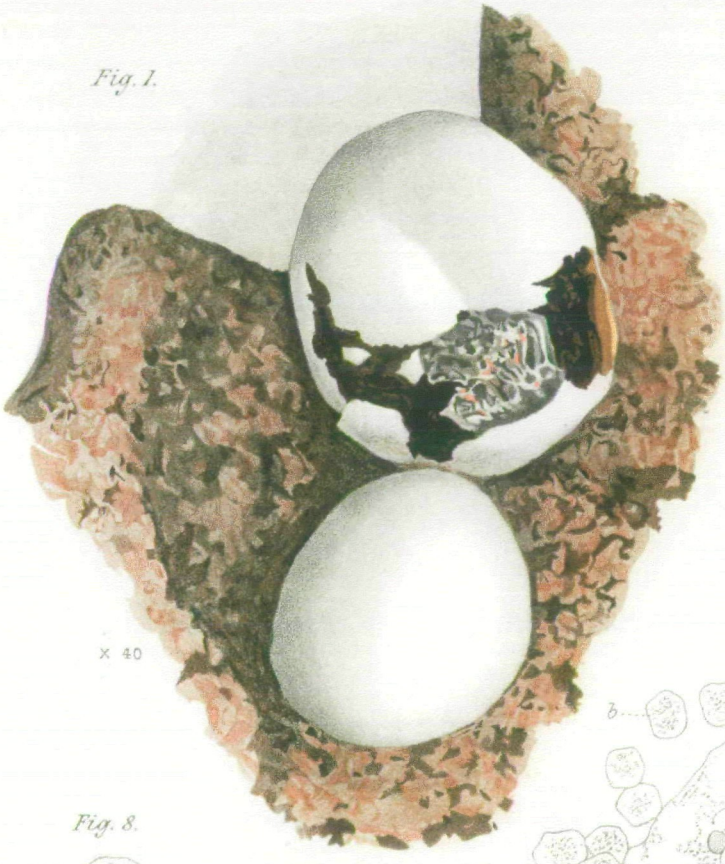


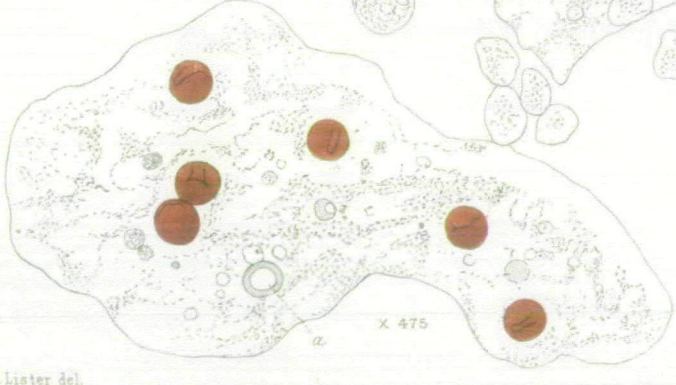
Fig. 2.

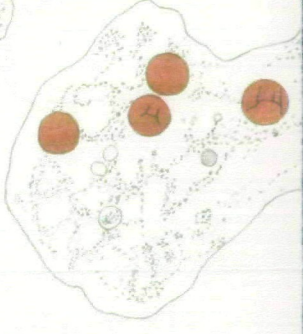
Fig. 8.

Fig. 9.

Fig. 10.

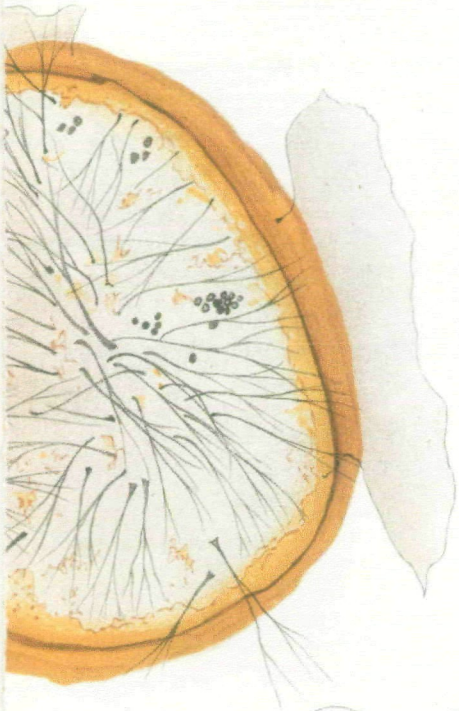
Fig. 6.





A. Lister del.

LISTER.— ON CHONDRIODERMA DIFFORME.



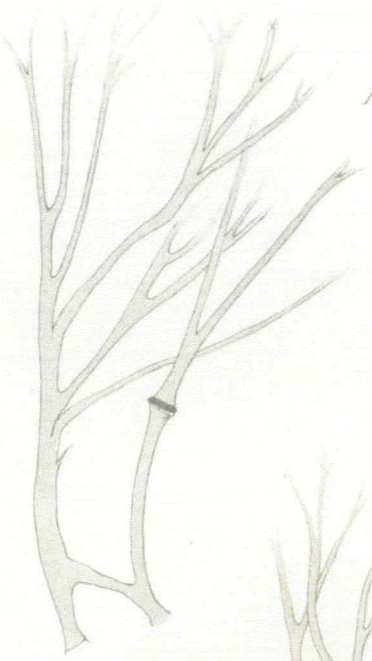
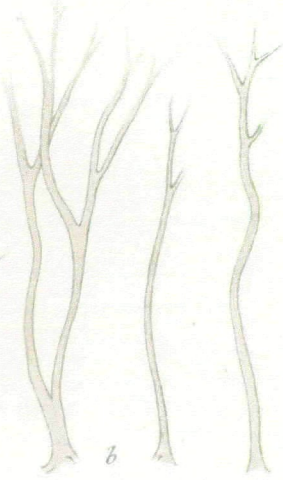


Fig. 3.
× 350



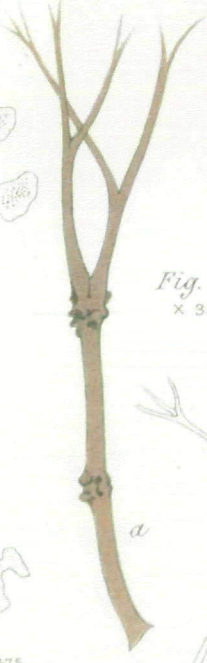


Fig. 4.
× 350

× 475

Fig. 5.

× 475

University Press, Oxford.