On some Anomalous Cells developed within the interior of the Vascular and Cellular Tissues of the Fossil Plants of the Coal-Measures.

BY

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With Plate XVIII.

IN the eighth of my series of memoirs 'On the Organisation of the Fossil Plants of the Coal-measures[1],' I described the vascular axis of a Fern, *Rachiopteris corrugata*, Will., the vessels of which were filled with cells apparently identical with the thylosis found in some living plants. In Part x of the same series[2] I subsequently described the petiole of another Fern, *Rachiopteris insignis*, Will., the vessels of the fibro-vascular bundle of which were filled with cells of a similar kind. In Part ix. of the same series[3] I further described a number of Lycopodiaceous macrospores, the interiors of many of which were occupied by some remarkable accumulations of cells of various sizes and arranged in diversified ways. During the last ten years there have accumulated in my cabinets various other examples of parasitic or saprophytic cells, lodged within the tissues of fossil plants, revealing a condition of things existing at the Carboniferous epoch not undeserving the attention of botanists. In most of these instances what may for the sake of distinction be recognised as the *intrusive* cells are lodged

[1] Phil. Trans., vol. 167, Part i. p. 214, Pl. 6, Figs, 15, 16.

[2] Phil. Trans., Part ii. 1880, p. 506, Pl. 16, Figs. 19–20, and 21.

[3] Phil. Trans., Part ii, 1878, p. 345, Pl. 23, Figs. 65, 66, 66 A, 66 B.

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within the interior of *host*-cells, which latter almost always belong to the cortex of the invaded plant. In a smaller number of instances the hosts are the vessels or tracheids of fibro-vascular bundles. It is somewhat more than probable that these two types of hosts, the cellular and the vascular, may have sheltered two distinct types of organism.

Fig. 1 represents a fragment of the bark of some unknown plant from the productive Halifax beds. It consists of cells variable in size and form, which in the figure are enlarged 124 diameters. Considerably more than the half of these cells are more or less filled with smaller cells, which vary greatly in size as well as in the way in which they are grouped. Thus at *a* we have one solitary spherical cell $\frac{1}{600}$ of an inch in diameter. At the lower part of the host-cell, *b*, we have a group of cells similar to *a*, the remainder of the host being empty. At *c* we have a host-cell packed with intrusive cells of various sizes; at the upper and lower parts of the cavity these cells approximate to about $\frac{1}{900}$ (all these measurements are given in fractional parts of an inch) in diameter; but those occupying its centre are much smaller, averaging about $\frac{1}{1800}$. At *d* a host-cell has its cavity densely filled with very small cells, approximating to a mean diameter of $\frac{1}{3600}$; whilst in another host-cell belonging to the same fragment of bark, but not included in the figure, the intrusive cells average even less than $\frac{1}{7000}$ in diameter.

We thus see that in the fragment from which Fig. 1 is taken, numerous host-cells are filled with intrusive ones of every size intermediate between $\frac{1}{600}$ and $\frac{1}{7000}$; yet their aspects, and the way in which they are aggregated, indicate that whatever may be their nature, they represent varied conditions of some common vegetable organism. Whenever free from contact with one another they are perfectly spherical, whatever their dimensions; but they frequently form small clustered groups when, mutually compressing one another, they exhibit the familiar aspects of parenchymatous tissue.

Fig. 2 is a single host-cell from the same specimen as Fig. 1, enlarged to 262 diameters. It illustrates several conditions of common occurrence amongst these objects. At *a*, *a*, we have some isolated spherical cells. At *b*, *b*, are similar ones, but of much smaller dimensions. At *c* is an oval cluster of a form that is not uncommon. It looks like a group of cells, of various sizes, enclosed either within a mother-cell or within some viscid substance that binds the cluster together in a defined manner. At *d* is a somewhat less defined but otherwise similar cluster, though of larger size.

Fig. 3 is another host-cell from the same fragment of bark, but in which all the contained cells retain their spherical form.

Fig. 4 is a host-cell from another fragment of bark; in its centre is a single free spherical cell, whilst numerous others exhibit a tendency to adhere to the hostal cell-wall. At the lower end of the host a cluster of cells cohere, forming a small parenchymatous mass.

Fig. 5 is a host-cell from a transverse section of a stem or rhizome of the type of the genus *Anachoropteris* of Corda, but which is giving off a petiolar branch, apparently identical with my *Rachiopteris insignis*[1]. Many of the cells of the inner layer of the cortex of the *Anachoropteris* are in a condition very similar to those of Fig. 1. Fig. 6 represents one of these host-cells, in which we have two clusters of intrusive cells, *a* and *b*. At *c* one of the cells of the group *b* is filled with a cluster of daughter-cells. Innumerable figures might be drawn from the above section showing various shapes, sizes, and grouping of its intrusive cells; reference will be made to the vessels of this specimen later on.

Figs. 6, 7, and 8 are three free cells from another parenchymatous fragment, which respectively contain one, two, and four free spherical intrusive cells. Fig. 9 is a host-cell from the *outer* bark of a section of *Lyginodendron Oldhamianum*, isolated cells of which contain intrusive cells in very varied conditions of size and grouping. These host-cells are few in number compared with those of the cortex which are entirely empty.

[1] Memoir x. Phil. Trans. Part ii. 1880, p. 507.

This Fig. 9 presents a single cluster of closely adherent cells, reminding us of those seen at Fig. 2, *c*.

Fig. 10 is a host-cell from the outer bark of another example of *Lyginodendron Oldhamianum*, in which single host-cells are isolated as in Fig. 9. In this specimen, as in some others, the intrusive cells are very irregular in size and form, whilst the spaces within the host which the cells do not occupy are filled with a dark brown carbonaceous substance that has somewhat the appearance of having once been in a fluid or semi-fluid state. There is evidently some connection between the presence of this dark substance and that of the intrusive cells, since the former is very rarely found in the cells of the cortex in which intrusive cells are not present. The above observations apply equally to the bark from which Fig. 9 was taken.

I have thus far limited my descriptions to specimens in which the intrusive cells occur in various examples of parenchyma, chiefly cortical. But my cabinets contain several examples in which the interiors of scalariform vessels or tracheids are occupied by cells. In previous memoirs I have described two such cases. The first was in Memoir viii, where I dealt with my *Rachiopteris corrugata*[1], and the second in Memoir x[2]. Since these descriptions were published I have met with a third example in which similar cells occur in the vessels of the inner or non-exogenous zone ('*étui medullaire*' of Brongniart), of a yet undescribed species of *Lepidodendron*.

Fig. 11 represents two of the smaller vessels of the vascular bundles of *Rachiopteris insignis*, as seen in a transverse section of that petiole, and Fig. 12 is part of a longitudinal section of a larger vessel from the same bundle. Each of these figures is enlarged 200 diameters. The contained cells fill the entire interior of each of these vessels.

Fig. 13 is a transverse section of two similar vessels, and Fig. 14 a longitudinal one of a single vessel, from the inner

[1] Phil. Trans. vol. 161, Part i. p. 214, Pl. 6, Figs. 15, 16.

[2] Phil. Trans. Part ii. 1880, p. 506, Pl. 16, Figs. 20, 21.

vascular cylinder of the *Lepidodendron* referred to above. In the latter example the cells are less densely packed within the vessels than in the former one; hence they retain more of their primitive spherical form.

In my memoir ix[1], I figured and described a selection from a very large number of macrospores belonging to a species of Lycopodiaceous strobilus, and the endosporal cavities of these spores are more or less filled with cells of various sizes and conditions. In many instances these cells are free; in others they are combined into a parenchymatous tissue. In most of the examples the cells are seen to be located within an inner membrane, *c*, which I assume is the endosporal membrane lining the very thick exosporium. Two of these macrospores are represented in Figs. 15 and 16, the former being enlarged 570 diameters, and the latter 250 diameters. The thick exosporium, *a*, of these spores is always clothed externally by numerous simple or branched hair-like appendages, *b*. Both the above examples contain numerous cells, the two specimens representing sufficiently closely the two extremes of the average sizes to which these cells attain. Those of Fig. 15 have a mean diameter of about $\frac{1}{300}$ of an inch. In Fig. 16 two or three, as at *c*, are larger than the rest, being $\frac{1}{800}$ in diameter, but most of the cells in this specimen have a maximum diameter of about $\frac{1}{1800}$ of an inch.

In my memoir x[2], I represented similar cells in the interior of the spores to which, in a previous memoir, I gave the provisional name of Zygosporites, and in Plate 18, Figs. 42 and 45 of the same memoir, similar cells were shown, occupying the macrospores of my *Strobilus Traquairia*. In Plate 17, Figs. 25 and 31 (loc. cit.), similar cells are seen in several species of the curious reproductive bodies, belonging to some, as yet, unknown plants, and to which bodies I have assigned the provisional name of *Sporocarpan*. I have not thought it necessary to reproduce all these anomalous forms in the present memoir. These aspects are approximately represented

[1] Phil. Trans. Part ii. p. 345 *et seq.*, Pl. 23, Figs. 65, 66, 66 A, 66 B, 66 C.

[2] Phil. Trans. Part ii. 1880, Pl. 19, Fig. 55.

in the two macrospores, Figs. 15 and 16, though I am far from concluding that all these various examples of contained cells are homologous.

The question remains, what are these intrusive cells? So far as Figs. 11, 12, 13 and 14 are concerned, I think we shall not risk making any great mistake in concluding that we have in them genuine examples of the so-called thylosis. The structures so named vary in different examples, but it appears to me that the specimens now described approximate sufficiently closely to the general type of thylosis to be legitimately recognised as examples of it. But it is otherwise with the forms represented in Figs. 1–9, where the intrusive cells are included, not within vessels, but within various modifications of parenchymatous tissue. The most conspicuous feature presented by these intrusive cells is the great differences in their sizes, as well as in the modes in which they are aggregated, even within the same host-cell. These differences are so great as to suggest, at the first glance, that we have more than one kind of object even within one host-cell. But opposing this conclusion is the fact that varied as are the forms, sizes, and groupings of these intrusive cells, we find every possible gradation between even the most distinct varieties; hence I conclude that whatever these objects may be, they all belong to one type of vegetable organism. At the same time we cannot identify them with any of the thylosis. If the description of the origin and development of these thylosis[1], given by Max Reess, be correct, they can only find their way into the interiors of elementary tissues whose walls are furnished with points that are weak because of their thinness. The vessels represented in Figs. 11–14 were so far scalariform as to present such areas of weakness, rendering it at least possible that the cells which they contain *may* be thylosis. But the walls of the parenchymatous cells which contain the intrusive ones now figured, exhibit no indications whatever of having had any such thin

[1] See Professor M. Ward's English Translation of Sachs' Physiology of Plants, p. 581.

spots; hence we cannot apply Reess' explanation to their origin and nature.

The question, may these objects have a fungoid character, suggests itself. Of all the hundreds of host-cells that I have examined no one has contained the slightest trace of a hyphal filament, hence the presumption against the fungoid idea is a strong one. Assuming the accuracy of this reasoning, and yet remembering that the objects in question must have had some sort of an origin, the question arises can these cells be algoid ones? In the second edition of the English translation of Sachs' Text-book of Botany, we have at p. 247 some remarks that may bear upon the question. After referring to the fact that colonies of *Nostoc* have long been known to exist within the cavities of cryptogamic plants, in some of which cases the germs developed into round balls, the author adds, 'The entrance of *Nostoc* into the parenchyma of a dicotyledonous plant, *Gunnera*, is brought about, according to Reinke, in a different manner; the deeper lying cells of the outer part of the stem, themselves covered by layers of parenchyma, are densely filled with colonies of the Alga.' Now if the germs of a *Nostoc* could thus find their way into the deeper layers of a cortical tissue, there is no reason why another and lower unicellular Alga should not be able to do the same. Whether or not this is the true explanation, the fact that during the Carboniferous age some unicellular vegetable organisms did find their way even into the deeper cortical tissues of various plants of high organisation is certainly true, and the instance of the *Gunnera* appears to present the nearest approach that living plants have hitherto supplied to what has occurred in the Carboniferous ones.

But the still more curious cases of the macrospores, like Figs. 14 and 15, remain for consideration. When recording these instances in my memoir referred to above, I was strongly inclined to believe that what I then spoke of as endosporal cells were normal developments from an endosporal protoplasm. And I am still far from certain that this idea is not a true one. At the same time the absence of all similar growths from the macrospores of living Selaginelleae affords a strong argument against such a conclusion. When I showed my specimens to my friend, Hermann Graf zu Solms-Laubach, of Göttingen, he at once concluded that the intrusive cells were either parasitic or saprophytic. On a later day I also showed them to Professor de Bary, of Strassburg, but, whilst recognising their existence as an indisputable morphological fact, he, with his wonted philosophic caution, hesitated to pronounce any opinion as to their nature. Under these circumstances it would be presumptuous for me to pronounce dogmatically when so high an authority shrinks from doing so. Nevertheless the facts appear to be sufficiently interesting to be put on record, hoping that research may some day throw a more definite light on the explanation of them.

THE OWENS COLLEGE BOTANICAL LABORATORY,
January 9, 1888.

EXPLANATION OF FIGURES IN PLATE XVIII.

Illustrating Professor Williamson's paper on some Anomalous Cells developed within the tissues of the Fossil Plants of the Coal-Measures.

Note. The cabinet number appended to each description is that of the specimen in my collection from which the figure was taken. W. C. W.

Fig. 1. Fragment of parenchymatous bark, most of the cells of which contain intrusive cells. x 124. Cabinet number, 1638.

Fig. 2. A single cell from the same specimen as Fig. 1. x 262. Cabinet number, 1638.

Fig. 3. Another cell from the specimen Fig. 1. x 262. Cabinet number, 1638.

Fig. 4. A single cell from another bark-fragment. x 400. Cabinet number, 1639.

Fig. 5. A cell from the bark of a transverse section of a stem of *Rachiopteris corrugata*, Will. x 400. Cabinet number, 264.

Figs. 6-8. Three cells from a parenchymatous fragment. x 400. Cabinet number, 1642.

Fig. 9. Single cell from the outer bark of a transverse section of a stem of *Lyginodendron Oldhamianum*. x 400. Cabinet number, 1640.

Fig. 10. Single cell from a tangential section of the outer bark of another specimen of *Lyginodendron Oldhamianum*. x 400. Cabinet number, 1146.

Fig. 11. Two small vessels from the vascular bundle of a transverse section of the petiole *Rachiopteris insignis*, Will. x 600. Cabinet number, 265.

Fig. 12. Longitudinal section of part of a vessel of the vascular axis of an oblique section of a petiole of *Rachiopteris insignis.* x 200. Cabinet number, 265.

Fig. 13. Two vessels from a transverse section of a stem of the inner vascular cylinder of a small undescribed form of *Lepidodendron.* x 200. Cabinet number, 418.

Fig. 14. Part of a vessel from a longitudinal section of the specimen Fig. 13. x 200. Cabinet number, 419.

Fig. 15. A Lepidodendroid macrospore. x 570. Cabinet number, 610.

Fig. 16. A macrospore of the same type as Fig. 15, but containing very small cells. x 120. Cabinet number, 612.

Fig. 1.

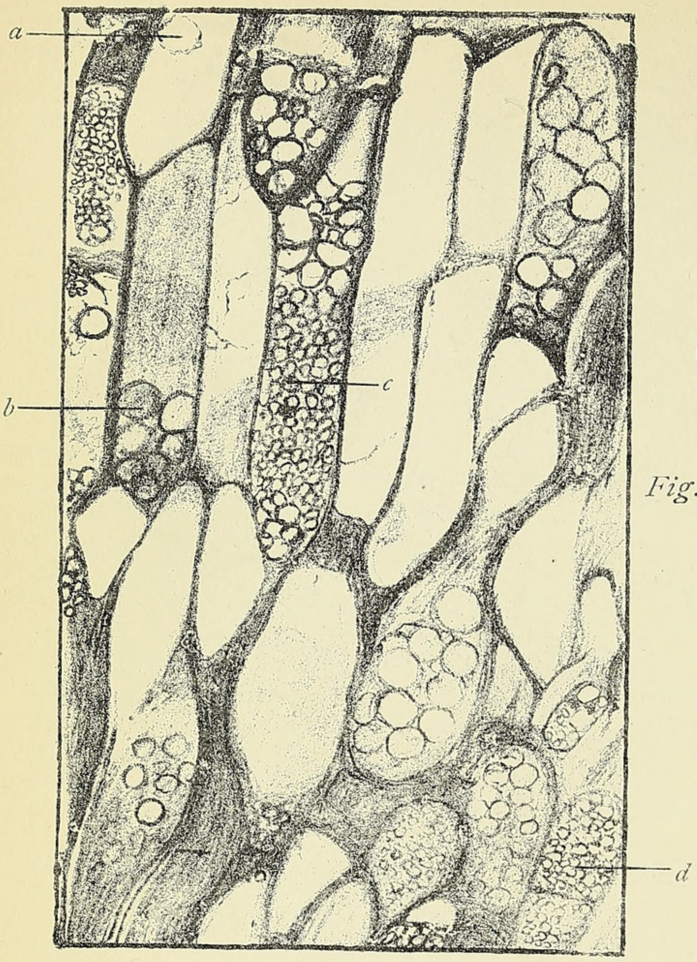


Fig. 9.

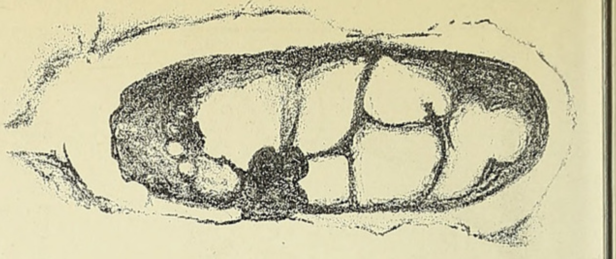


Fig. 6.

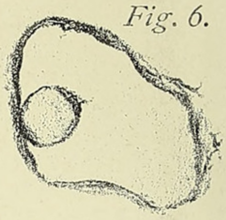


Fig. 8.

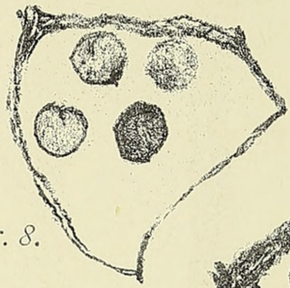


Fig. 7.

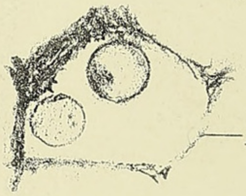


Fig. 16.

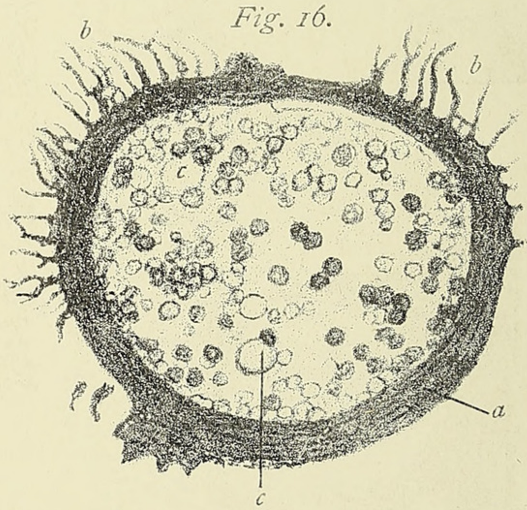


Fig. 2.

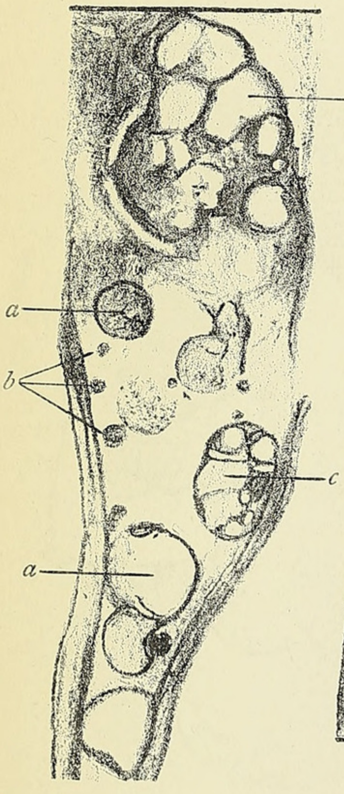
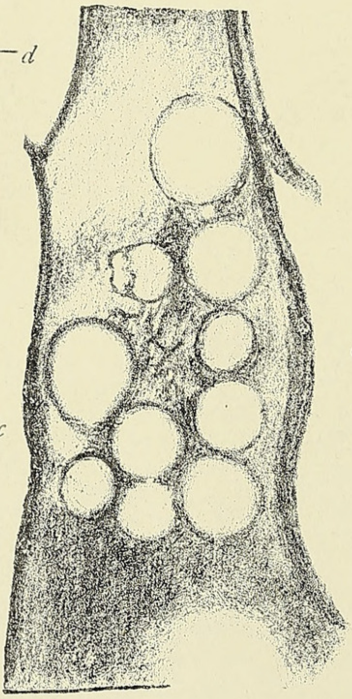


Fig. 3.



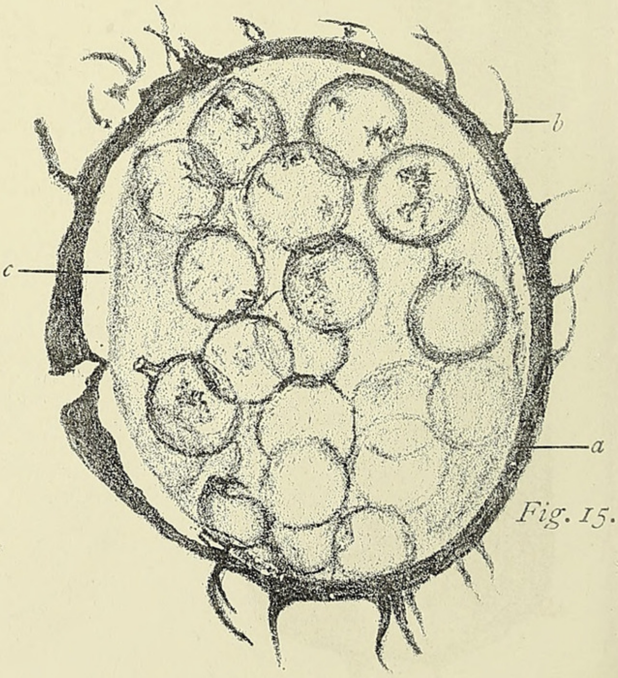
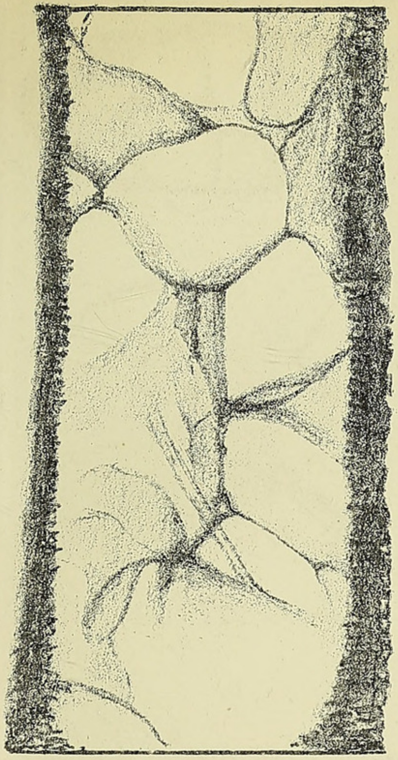


Fig. 15.

W. C. Williamson, del.

WILLIAMSON.—ON ANOMALOUS CELLS IN FOSSIL PLANTS.

Fig. 12.



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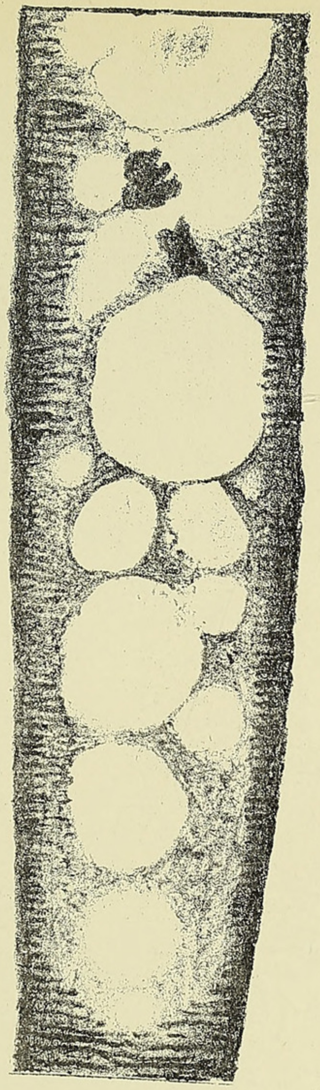


Fig. 11.

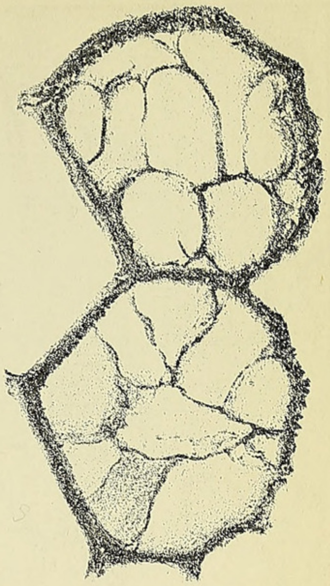


Fig. 4.

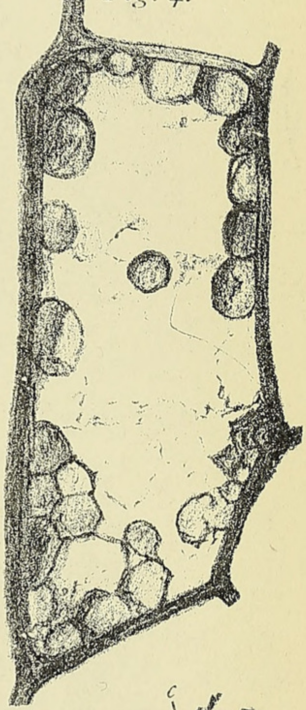


Fig. 10.

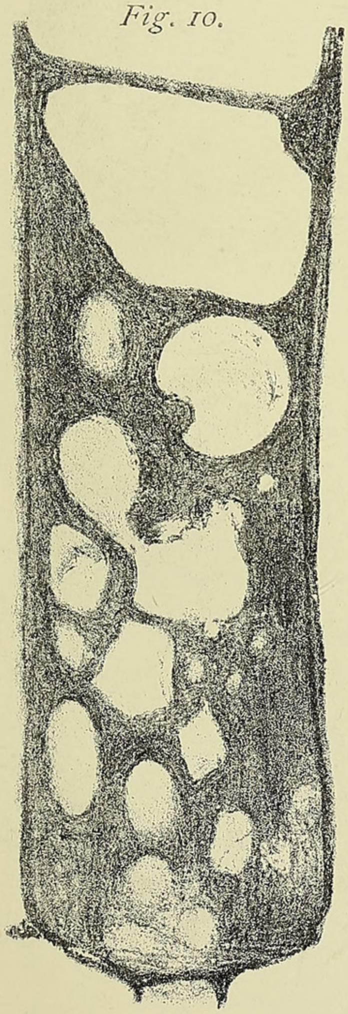
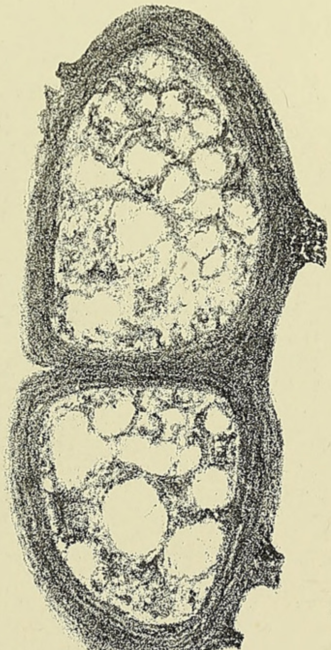


Fig. 13.



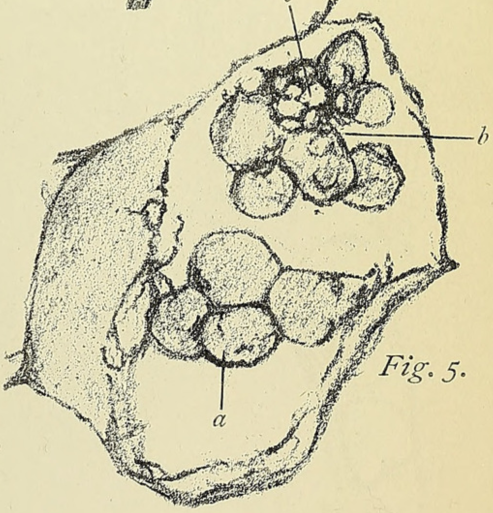


Fig. 5.

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