

XIII. *On Gasterolichenes: a New Type of the group Lichenes.*

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[PLATE 25.]

UNTIL recently the time-honoured division of Thallogens into three primary groups, *Algæ*, *Fungi*, and *Lichenes*, was retained, the most prominent morphological features of the last group consisting in the vegetative portion being composed of slender achlorophyllose threads mixed with chlorophyll-producing cells or gonidia, and the spores produced in asci. It was assumed that the gonidia were in organic continuity with the colourless threads, an assumption challenged by SCHWENDENER,* who considers a lichen as a combination of a fungus and an alga, an idea now widely entertained, nevertheless, curiously enough, numbering amongst its opponents most of the leading lichenologists and mycologists of the day, most of whom, it is important to remember, are distinguished as systematists rather than as biologists. Later researches have placed almost beyond doubt the truth of SCHWENDENER's theory. BORNET† has shown that in numerous instances the gonidia can with certainty be referred to some species of *Algæ*, and further succeeded in building up a lichen synthetically by sowing the spores of *Parmelia parietina* upon *Protococcus*. STAHL‡ also, by growing the spores and gonidia (*pleurococcus*) of *Endocarpon pusillum*, produced the lichen which bore perithecia and spermogonia. The same author has also demonstrated the presence of sexual organs of reproduction in a gelatinous lichen, *Collema microphyllum*, the female portion resembling the carpogonium, with its trichogyne, met with in the *Florideæ*. Spermatia, produced in the spermogonia, are the fertilising elements.

The discovery by MATTIROLO§ of a second type of lichen structure, *Hymenolichenes*, characterised by having the spores borne on basidia, the latter compacted into a

* "Untersuchungen über den Flechtenthallus," in NÄGELI'S 'Beiträge zur Wissensch. Botanik,' 1860, 1862, and 1868. See also 'Flora,' vol. 55, 1872 (Nos. 11-15).

† "Recherches sur les Gonidies des Lichens," 'Ann. Sci. Nat. (Bot.),' vol. 17, 1873.

‡ 'Beitr. zur Entwickel.-Gesch. der Flechten,' 1877.

§ "Contribuzioni allo Studio del genere *Cora*, Fr.," 'Nuovo Giorn. Botan. Ital.,' vol. 13, 1881, p. 245. (2 plates.) See also "Die Gruppe der Hymenolichenen," FRIED. JOHOW., 'Pringsheim, Jahrb. Botan.,' vol. 15, p. 361. (5 plates.)

continuous hymenium as in Hymenomycetous fungi, has also considerably strengthened SCHWENDENER'S theory, as the mutual relations between the two components can be more readily determined than in the older group of *Ascolichenes*.

It is somewhat remarkable that a re-arrangement of Thallogens was not attempted earlier, considering the difficulties experienced by cryptogamists of half-a-century ago in locating the genera now included under *Hymenolichenes* and *Gasterolichenes*. *Dictyonema* was first described as an alga by C. A. AGARDH,* who placed it in the *Confervoidae* next to *Hydrodictyon*, yet he appears to have been uncertain about its true position, owing to the numerous colourless anastomosing threads, and concludes with the remark, "Forsan Lichenis species!" NEES afterwards removed the genus to Fungi, changing the name to *Dichonema*, but was in turn quite as much perplexed on account of the numerous chlorophyll-bearing cells, and at the end of the generic description says, "Forsan thallus Cœnogonii." The same remarks apply to the genus *Cora*, described by FRIES† as a fungus, stating that at one time he considered it as belonging to Lichenes. In like manner, the Rev. M. J. BERKELEY, in the description of *Emericella*, clearly recognised the lichenose structure, suggested by the presence of green cells along with colourless threads, and also called special attention to the absolute agreement between the green cells and the *Palmella* previously described as an alga in the same work, finally pointing out that it differed from lichens in the mode of spore-formation. It is remarkable how nearly SCHWENDENER'S views were anticipated in this instance by BERKELEY.

The genera already mentioned, along with *Laudatea*, JOH., *Rhipidonema*, MATT., *Emericella*, BERK., and *Trichocoma*, JUNGH., although universally acknowledged as Thallogens, are equally rejected by those lichenologists and mycologists opposed to SCHWENDENER'S views; their peculiar non-ascigerous fructification alienating them from Lichens, and the chlorophyllose cells from Fungi, while algologists appear unable to reconcile themselves to the idea of an alga producing such fungal-like organs of fructification on the colourless hyphæ.

The object of the present communication is to describe a third type of lichen structure, resulting from the consortism of Fungi belonging to the *Gasteromycetes*, order *Trichogastres*, with unicellular algæ. Following the rule suggested by MATTIROLLO,‡ the present section will take the name of *Gasterolichenes*.

The type *Emericella varicolor*, BERK., is described by the Rev. M. J. BERKELEY§ as follows:—"On the confines of *Myxogastres* we have the little group consisting of *Coniocybe*, *Byssophyton*, and a new genus, to which I have given the name of *Emericella*. These are in habit more or less Lichenose, but differ from *Calicium* and allied genera in the total absence of asci. *Emericella*, of which a figure is subjoined, consists of

* 'Syst. Alg.,' p. 85.

† E. FRIES, 'Pl. homon.,' p. 303.

‡ "Contribuzioni allo Studio del genere *Cora*, Fr.," 'Nuovo Giorn. Botan. Ital.,' vol. 13, 1881, p. 245. (2 plates.)

§ 'Intr. Crypt. Bot.' p. 340. (Cum ic.)

little oblong or clavate masses, varying in colour from yellow to green or grey. A vertical section shows a little peridium above, filled with threads and globose purplish spores, remarkable for a border of long spines, all situated in the same plane. The peridium is supported by a spongy central column, giving off threads which are terminated by large globose bodies resembling closely the gonidia of Lichens, but growing very much like the *Palmella** figured at p. 118. Dr. MONTAGNE has observed these bodies to become blue with iodine, but this is not confirmed by myself or Mr. BROOME. I have, in fact, tried various preparations of iodine, and the addition of sulphuric acid has given no blue tinge. The general colour of the plant does not arise from these bodies so much as from the fine threads on which they grow. Increase in many cases certainly takes place exactly as in the *Palmella*, by the division of the central nucleus, and in one instance I have observed two of them to be confluent. This very curious fungus was gathered by my son, Lieutenant EMERIC SREATFIELD BERKELEY, in his garden at Bowenpilly, near Secunderabad. I have named it *Emericella varicolor*, and it is certainly one of the most curious that has ever come under my notice."

The plant is gregarious in habit and resembles in external appearance such Fungi as *Diderma* or *Tubulina*, and, although stated by BERKELEY to be on the confines of *Myxogastres*, is arranged by that author under *Trichogastres*. The shape varies from cylindrical to turbinate, measuring from two to three lines high by two lines in diameter. In structure, the genus approaches *Lycoperdon*, with which it agrees in the single membranaceous peridium and well-developed sterile base. The hyphæ of the sterile stem-like base are thick-walled, about 8μ in diameter, and form an interlaced central column surrounded by a loose peripheral plexus of branched hyphæ, which pass uninterruptedly upwards and form the peridium. The dense capillitium is continuous with the sterile base, and consists of branched tapering hyphæ of a pale yellow colour when viewed by transmitted light. The spores are purple-brown in the mass, globose, and furnished with a row of spines, all situated in one plane; diameter, including the spines, about 12μ . In *Trichogastres* the hyphæ concerned with reproduction have usually very thin walls, and disappear soon after the formation of the spores; consequently the mode of attachment of the spores could not be ascertained. Dehiscence takes place by the disintegration of the upper portion of the peridium, as in *Lycoperdon calatum*, the persistent capillitium remaining attached to the more or less marginate stem-like base. The alga is *Palmella botryoides*, GREV., which appears to differ in its larger size, and in being connected by green threads, from the plant described by RABENHORST† under the same name. The cells are sub-globose or broadly elliptical, varying from 20μ to 39μ in longest diameter, and furnished with a very thick, hyaline, lamellose cell-wall. From the chlorophyllose portion of the cell a green eseptate filament passes through the cell-wall, where it is joined at some distance to a

* The *Palmella* alluded to is *P. botryoides*, GREV.

† 'Flor. Eur. Alg.', vol. 3, p. 33.

similar thread from another cell, the two forming a common stem, on which several pairs of cells are supported on similar lateral bifurcating threads. These pairs of cells originate from the fission of a single cell, each half of the parent cell giving origin to a green filament, the bifurcation of which is at first included in the cell-wall. The alga occupies interspaces in the loose peripheral portion of the base of the fungus, and also passes up into the loose texture of the peridium, giving the yellowish-green tint to every external part of the plant before dehiscence. The tips of lateral branches of hyphæ are frequently seen closely investing and even penetrating the algal cells. *Trichocoma paradoxa*, JUNGH., is the type of a second genus of *Gasterolichenes*. This plant was first discovered by JUNGHUHN in Java, and was described as a fungus,* its very anomalous structure causing the author much uncertainty in referring it to any of the known divisions of Fungi. Finally it was placed in the *Hyphomycetes*, on account of some resemblance to such compact forms as *Stilbum*. MONTAGNE† afterwards considered it as having more affinity with the *Gasteromycetes*, in which family it has up to the present remained.

In habit the plant is gregarious, growing horizontally on decayed trunks or branches, in shape more or less cylindrical, and varying from three quarters to an inch and a half in height, by half an inch or more in diameter. The sterile basal portion is cup-shaped, and consists of thick-walled, esepstate, much-branched hyphæ, compacted into a dense pseudo-parenchymatous tissue. From the margin of this cup the hyphæ pass upwards and form a loose membranaceous peridium. The capillitium arises from the sterile basal portion, and consists of erect branched threads tapering upwards and compacted into a cylindrical tuft, which after the disappearance of the evanescent peridium resembles a camel's-hair brush springing from the cup-like base. In young specimens traces of the reproductive hyphæ may sometimes be met with, bearing basidia and sterigmata, proving the spores to be true basidiospores, as in *Lycoperdon*. The spores are brown, tinged with purple, in the mass, elliptical and coarsely warted, measuring about $6\mu \times 3\mu$. The alga belongs to KUTZING's genus *Botryococcus*, and forms a stratum at the base of the capillitium. In the dry plant this layer is bright-yellow, but the alga becomes green when moistened, especially if a small quantity of potassic hydrate is added to the water. The colonies vary in size, measuring on an average 25μ , and are generally invested with hyphæ, which in the "gonidial layer" assume a yellow tinge.

In addition to the locality given above, this species is represented in the Kew Herbarium from Sikkim, East Nepaul, Nilgiris, and Ceylon.

A smaller plant, included with *T. paradoxa* in the Kew Herbarium collection, proves on examination to be a new species, characterised as follows:—

Trichocoma lævispora. Receptaculum basilare rotundato-cupulatum. Flocci elongati, comosi, in capitulum cylindricum persistens collecti, sporidiis subglobosis, lævibus,

* 'Verhand. van het Batav. Genootsch. van Kunsten en Wetensch.,' Batav., 1839.

† "Cryptogames de Java," 'Ann. Sci. Nat. (Bot.),' vol. 16, 1841, p. 308.

$4\mu \times 3\mu$. From half to two-thirds of an inch high. On rotten wood, Lower Carolina; resembling *T. paradoxa* in general appearance and structure, but differing in its smaller size and sub-globose smooth spores.

The group Lichenes can be divided into two natural sections, characterised by the nature of the fruit, which agrees with that produced by the two sections of Fungi, *Ascomycetes* and *Basidiomycetes* respectively. Each section can be further divided into two sub-sections, depending upon the exposed or concealed hymenium.

A.—*Ascolichenes*. Sporidia produced in asci.

I. *Discolichenes*. Hymenial surface exposed, as in *Discomycetes*.

II. *Pyrenolichenes*. Hymenial surface concealed in a perithecium, as in *Pyrenomycetes*.

B.—*Basidiolichenes*. Spores produced on basidia.

I. *Hymenolichenes*. Hymenial surface naked, as in *Hymenomycetes*.

II. *Gasterolichenes*. Hymenial surface concealed in a peridium, as in *Trichogastres*.

DESCRIPTION OF THE PLATE.

Fig. 1. *Emericella varicolor*, BERK., nat. size.

Fig. 2. The same in a young state, $\times 50$.

Fig. 3. The same after dehiscence, $\times 50$.

Fig. 4. Section of same before dehiscence, $\times 50$.

Fig. 5. Section of same after dehiscence, $\times 50$.

Fig. 6. Vertical section of same after dehiscence, showing the peripheral "gonidial layer," *a*, the central hyphal column, *b*, and the capillitium with its spores, *c*. $\times 300$.

Fig. 7. Portion of the alga *Palmella botryoides*, GREV. Cells of plant, *a*; supporting threads of same, *b*; hyphæ surrounding and entering the algal cells, *c* $\times 600$.

Fig. 8. Spores of same, $\times 600$.

Fig. 9. *Trichocoma paradoxa*, JUNGH., nat. size.

Figs. 10 and 11. Sections of same, nat. size.

Fig. 12. Section of same, showing sterile basal cup, *a*; "gonidial layer," *b*; and capillitium with spores, *c*. $\times 300$.

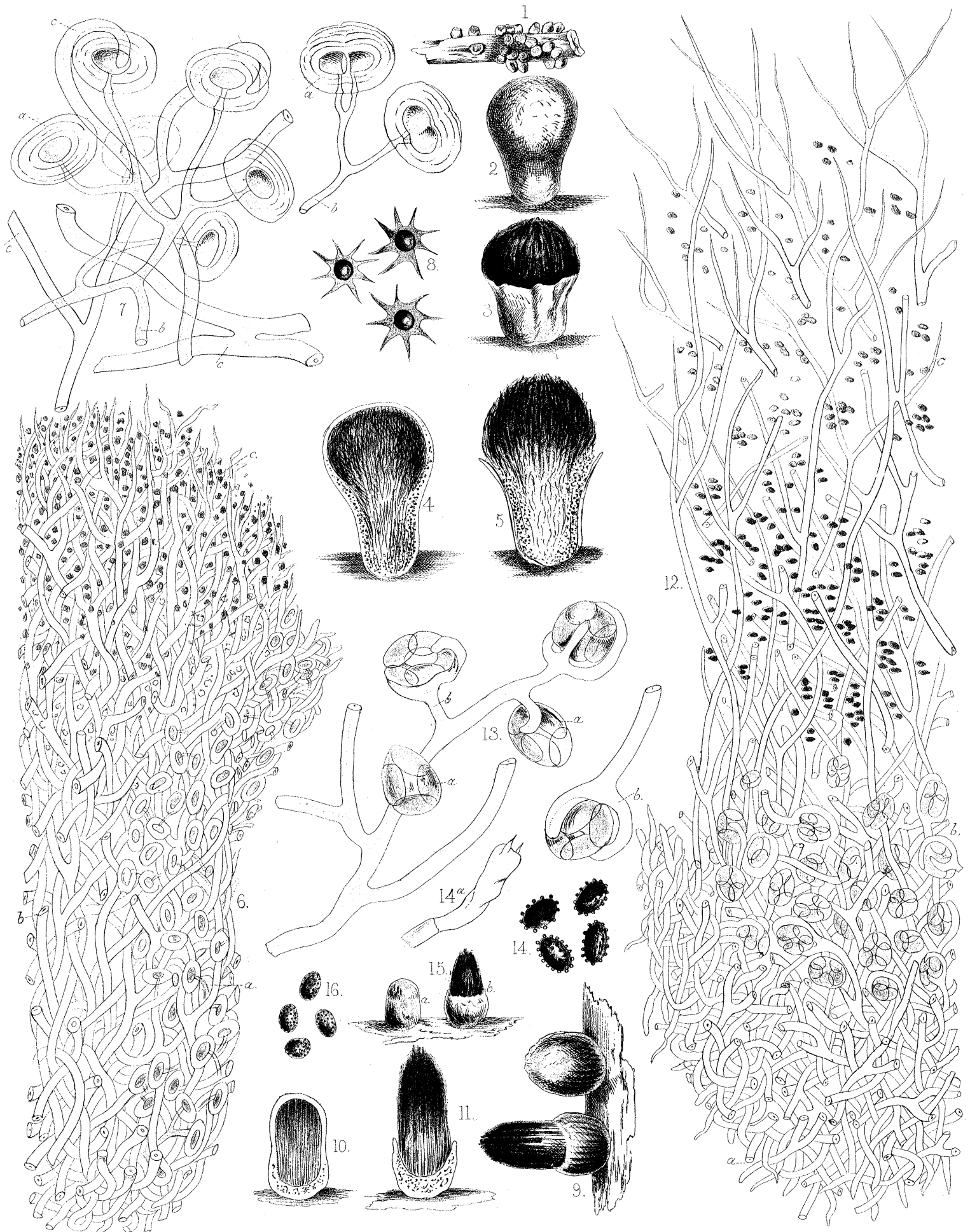
Fig. 13. Colonies of the alga, a species of *Botryococcus*, accompanied by hyphæ. $\times 600$.

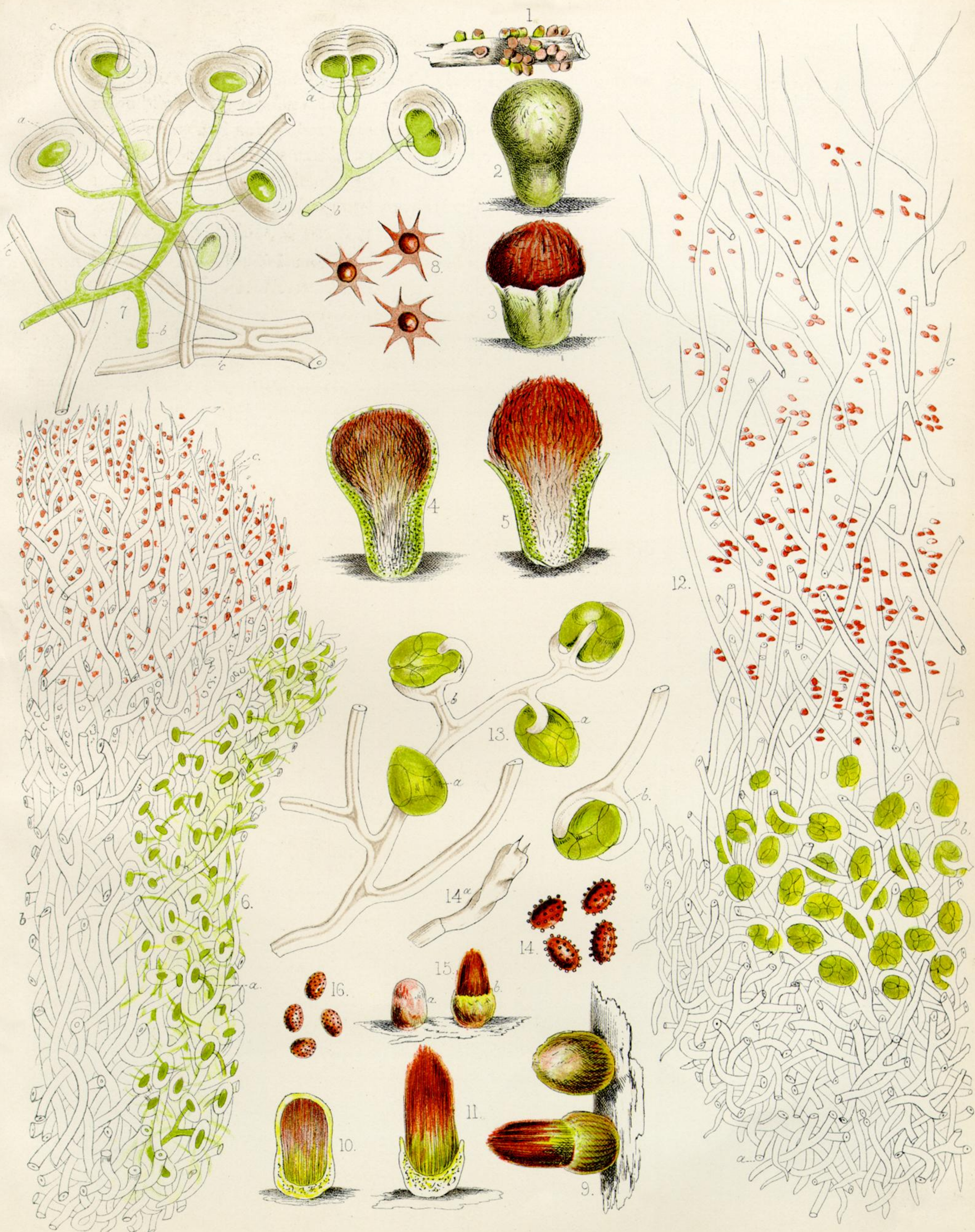
Fig. 14. Spores of same, $\times 600$.

Fig. 14A. Basidium, with sterigmata of same, $\times 600$.

Fig. 15. *Trichocoma lavispora*, MASS. *a*, before rupture of peridium; *b*, after disappearance of peridium; nat. size.

Fig. 16. Spores of same, $\times 600$.





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