GEMMAE OF *FUNARIA HYGROMETRICA*

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Although the gametophyte and the sporophyte of *Funaria hygrometrica* have been studied as much, or more, than any other moss, little attention has been given to the development, structure and regeneration of the gemmae. Janzen (5), Correns (2), Goebel (3), and Schimper (6) have observed, mentioned and/or illustrated what they termed "Brutkörper" or "Brutknollen." "Brutknollen" of *Funaria*, illustrated by Schimper, do not resemble those observed in this study. (1) "Brutkörper," similar to those of *Funaria*, have been observed in other mosses (2, 3, 6, 7).

Capsules of *Funaria hygrometrica* were collected one-half mile west of Burn's Ditch Bridge on route U. S. 12 on the south side of the highway during June, 1937. The spores of these capsules were sown on damp, sterilized soil in 5 inch deep, 9-inch flower pots, and covered with specially made celluloid lids which permitted adequate ventilation. All cultures were watered from below with a weak potassium permanganate solution.

The average size of a protonemal cell from a soil culture is 18 microns in width by 73 microns in length. On or near the 28th day after the spores were sown many of the terminal cells of the protonema had developed gemmae. While the cells of the protonema vary greatly in length, it is apparent that from one to several of these cells may have participated in the development of gemmae (figs. 1-2). Cross walls were laid down at rather regular intervals cutting the original cell, or cells, into short ones which, when elongated, were about 51 microns. These short cells grew in width to 44 microns. Thus those newly formed were nearly isodiametric. Frequently, very short ones occurred separating several short cells in the branch from others. These shorter cells were sometimes well supplied with chloroplasts and at other times hyaline. When hyaline the branch easily broke away from the remaining cells. Within a few hours after walls had been formed at right angles to the axis, other walls parallel to the axis were laid down. Often a single short cell divided twice longitudinally. Other cells divided diagonally. Eventually, many of these newly formed cells became almost spherical or hemi-spherical. Cells remaining rectangular in outline were thicker through the center than on the edge.

Division continued until a column or a grape-like cluster was developed (figs. 3-5). These columns and clusters varied greatly in length, but some of the longest were not more than 250 microns to 300 microns. When young the cells were thin-walled and contained many chloroplasts. These columns and clusters were often branched and eventually were cut from the plant by a hyaline cell which, being brittle, separated the cluster from the plant at the slightest touch. Gurlitt (4) observed short hyaline cells in *Funaria hygrometrica*, which she called Trennzellen, since they separated a short living portion from another living portion of the protonema.

When transplanted to agar each thin walled cell of a gemmae regenerated a protonema within 28 days during the short cloudy days of winter. In the summer such cells taken from the apex of a leafy plant were mounted in water on a slide and kept in a moist chamber. Within 20 hours after mounting, the terminal cell of many of these groups had regenerated a protonema. By the time leafy plants were well established these structures and the remainder of the protonema had disappeared.

During an interval when the work was discontinued, ten 9-inch flower pots containing soil cultures of *Funaria* were stacked in a column in a corner of a room in the University of Chicago greenhouses. In May all but one of these appeared dead and were discarded. The one showing some life was watered and placed in the room exposed to the sunlight. This culture soon appeared to be dead and the pot was pushed under a low greenhouse table and left unattended until July 21, when it was again watered and placed in a cool room of the green-

house under diffused light. Four days later signs of life were evident. Microscopic examination disclosed gemmae similar to those described above. They differed in several respects from those previously observed (figs. 1-4). They were dark brown in color, without chloroplasts, and possessed thick cell walls in contrast to the thin walls of the cells well supplied with chlorophyll which appeared early in the life history of the plant (Figs. 6-8). The apparent rejuvenation of this culture was the result of the germination of these structures (fig. 10). A few chloroplasts had by this time appeared in the old cells of the germinating gemmae.

In the summer of 1940 plants bearing mature gemmae were placed on agar and covered with the Petri dish cover. A day later young leafy plants had developed directly from these gemmae. Observations indicate that protonemata develop from either young or mature gemmae of few cells, but leafy plants develop directly from the more complex mature gem-

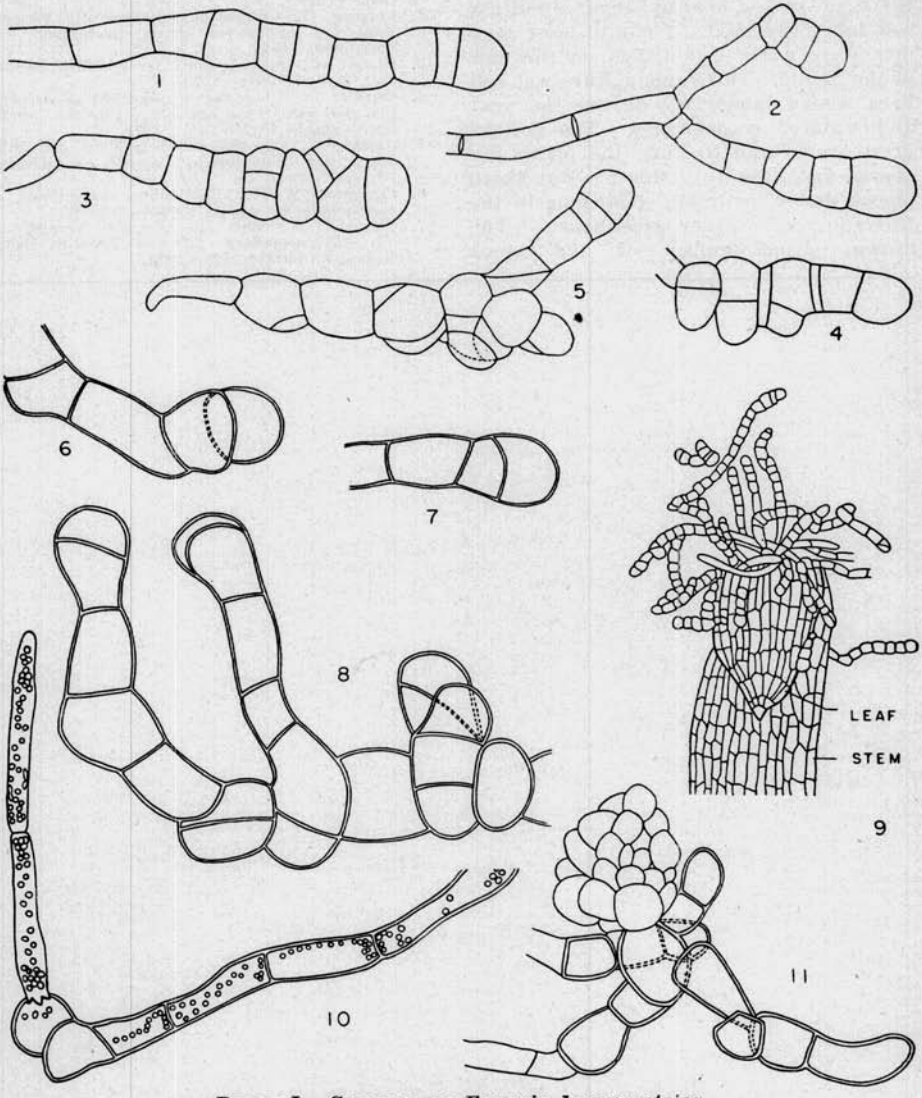

PLATE I.—GEMMAE OF *Funaria hygrometrica*.

mae, that is, from those clusters composed of a number of thick walled, brown cells, (fig. 11). Such gemmae have been known to be viable for as long as eight months.

Gemmae play an important role in the life of *Funaria*. Examination of moss tufts preserved during late winter revealed a dense thicket of young gemmae growing from the main axis of each plant. The culture from which this material was taken had been unattended for more than a month. In the fall of the same year a healthy, covered culture was left unwatered. A month later gemmae were again established on the axis of the plants. This same culture was left in a school laboratory during the year and watered occasionally. The culture grew brown and in June the plants appeared dead. In June this pot was again placed under favorable conditions in the University of Chicago greenhouses. The brown, dried apices of the much branched plants turned green and grew a new crown of leaves. In cases where most of the old apex had been destroyed a multitude of gemmae developed (fig. 9). Thus in a favorable environment *Funaria hygrometrica* may continue to thrive indefinitely even without the aid of spores.

LITERATURE CITED

1. Barkley, E. E., The influence of environmental factors on the growth, development, and structure of the gametophyte of *Funaria hygrometrica*. Unpublished. S. M. thesis, Univ. of Chicago. 1940.
2. Correns, C., Untersuchungen über die Vermehrung der Laubmoose durch Brutorgane und Stecklinge. 1899.
3. Goebel, K., Organographie der Pflanzen. Zweiter Teil, pp. 983-984. 1929.
4. Gurlitt, L., Uber den Einfluss der Konzentration der Nährlösung auf einige Pflanzen. Beih, Bot. Centbl. 35:279-341. 1918.
5. Janzen, P., Ein Mooseleben in Wort und Bild. Schr. der Naturforsch. Gesell, in Danzig. 12:1-44. 1909.
6. Schimper, W. P., Recherches anatomiques et morphologiques sur les mousses. 1848.
7. Warnstorf, C., Über die vegetative Vermehrung des *Pterygynandrum filiforme* (Timm) Hedw. Hedwigia. 55:378-380. 1914.