falling tide brings the weight of the embryo on to its point, until it has reached the position of the lower specimen in the figure.

The success of this method depends upon the action of ripples of the water, but on an exposed shore the waves will merely throw the embryo about as any other floating stick. Suitably shaped and fairly numerous crevices in the rock are usually met with near high-tide mark, the surface of the flats lower down being smoother and its crevices too shallow, or filled in with hard sand. In short, the conditions requisite to planting are generally those suitable for the life of the adult trees, but, as in the case of other trees, those conditions are sometimes found where the embryo can never develop into the adult. Embryos are often planted too low down the shore (I have even met with one, bearing two unfolded leaves, at low tide in the sand of the boat channel of the reef on the open coast), but in this case they will be usually floated off again by succeeding tides.

There are thus *two* adaptations of the mangrove, ensuring that, in the case of those trees which are growing in mud, too many embryos shall not be swept out to sea, and also that those which are so removed shall have a good chance of taking root in fresh localities. The mangrove has thus an effective means of dispersal, and it is probable that the juxtaposition of trees from different sources, whereby continued in-and-in fertilization is avoided, is just as important for them as for the great majority of living things. Furthermore, this adaptation for dispersal enables the embryos to be planted on surfaces to which the formerly known method is inapplicable.

CYRIL CROSSLAND.

CAMBRIDGE.

EXPLOSIVE DISCHARGE OF ANTHEROZOIDS IN FEGATELLA CONICA.—*Fegatella* (*Conocephalus*) *conica* is one of the commonest liverworts in the neighbourhood of Leeds. It grows in great abundance in moist and shaded places, especially on stones beside streams. In the beginning of July a large supply of male plants was collected, bearing young antheridial receptacles, which, as is well known, are sessile in this genus, and have the form of oval cushions, each situated at the anterior end of one of the branches of the thallus. Most of these plants were put into shallow vessels, covered with sheets of glass, and set in a shaded place. After a few

days the plants were examined for the purpose of selecting material to show the development of the receptacles, and whilst looking over them in bright sunlight the writer observed a number of jets of fine spray arising from the upper surface of the plants. On closer examination it was found that in every case these jets, which issued in an explosive manner and sometimes reached a height of above two inches, proceeded from the little conical prominences with which the upper surface of the male receptacle is studded. On holding a glass slide a little above the surface of a receptacle and catching the spray as it escaped, it was found that it consisted of water containing antherozoids, some of which were still enclosed within the wall of the mother-cell, whilst others were free. The antherozoids of *Fegatella* are much larger than in the remaining Marchantiales which have been examined, and approach in this respect those of *Pellia*; the spirally coiled body consists usually of two complete turns, the anterior end bearing two long cilia, whilst in most cases the thicker posterior end carries a small vesicle, doubtless representing the remains of the mother-cell.

The writer has found that the discharges only take place on warm, sunny days, and are especially frequent when the plants are exposed to direct sunlight; they were not observed on dull days, nor when the plants were shaded. On bringing plants out of shade into sunlight the discharges began almost immediately, continued in rapid succession for several minutes, then became less frequent, and finally ceased. This phenomenon occurs in *Fegatella* plants growing in their natural surroundings, the writer having, after careful watching, several times observed it on the spot. It does not appear to have been hitherto described by writers on the Bryophyta. In some Fungi, e.g. *Pilobolus*[1], *Ascobolus*, the spores are violently ejected by means of water-pressure giving rise to jets of spray.

Fegatella is strictly dioecious, and very often the male and female plants are widely separated from each other, since they do not usually occur mingled together, but form large patches, each consisting of either male or female plants. It is not at all uncommon to find a patch of female plants in fruit, although removed several feet from the nearest male plants, and it is reasonable to suppose that the fertilization of the archegonia may possibly have been effected in consequence of the antherozoids being ejected explosively from the

[1] Cf. Scott, Structural Botany, pt. ii, p. 230.

male plants and carried to the female plants by air-currents, each antherozoid being surrounded by a thin film of water.

Goebel [1] has suggested that the fertilization of the archegonia in the dioecious Marchantiales, which so often form isolated patches, might be effected by means of rain-drops falling upon the male receptacles and then splashing over the female plants. In the case of Mosses, in which similar conditions prevail, it was suggested by Kienitz-Gerloff [2], and later confirmed by the observations of Gayet [3], that small animals, especially insects, creeping over the patches of male and female plants may, especially in dry seasons, be instrumental in bringing antherozoids into contact with the archegonia.

The examination of sections through antheridial receptacles of different ages shows that the development of the antheridia is accompanied by that of air-spaces, which arise in the same manner as the chambers of the thallus, and whose sides are formed of cells containing abundant chloroplasts. Each antheridium becomes during its development sunk in a deep cavity, formed in essentially the same way as the air-spaces. As the antheridium grows in size, its cavity becomes flask-shaped, having a long neck opening above on the surface of the receptacle by a small pore which occupies the summit of one of the conical prominences already mentioned. Owing to the lateral pressure exerted by the growing antheridia, the air-spaces between the antheridial cavities become compressed and finally obliterated below, but in the upper portion of the receptacle they remain as wide chambers, each opening above by a pore of the 'compound' or 'barrel-shaped' type, the cells surrounding it being arranged in four or five superposed rings. The cells lining the chamber project inwards, and are often long, pointed, and colourless: exactly similar pointed cells are found in the air-chambers of the thallus, but they do not appear to have been previously described in the case of the male receptacle. As shown by the experiments of Kamerling [4], it is from these colourless cells that water-vapour is given off into the air-chambers of the thallus, and very probably they have the same function here. In vertical sections the mature receptacle is seen to be divided into three well-marked zones:—(1)

[1] Organographie der Pflanzen, p. 310.
[2] Botanische Zeitung, 44. Jahrg. (1886), p. 250.
[3] Ann. des Sci. Nat., sér. 8, t. 3 (1897), p. 241.
[4] Zur Biologie u. Physiologie d. Marchantiaceen, Flora, 1897, p. 50 of reprint.

an upper zone of chlorophyll-bearing tissue, containing numerous air-spaces and traversed by the passages leading down to the antheridial cavities; (2) a middle zone of compact tissue, in which are embedded the antheridia, and which consists of large colourless cells, including scattered mucilage-sacs; (3) a lower zone continuous with

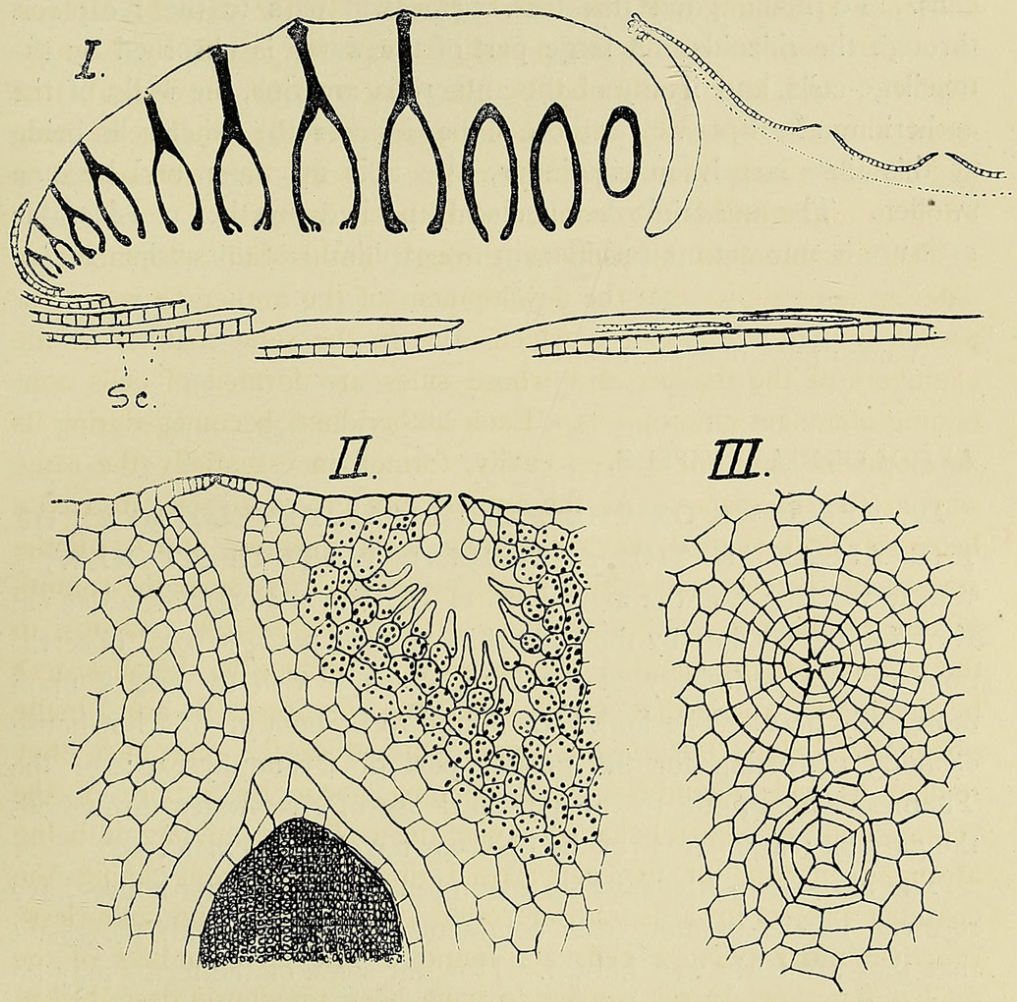

FIG. 17.—I. Longitudinal section through anterior end of thallus, with a male receptacle; × 20. The antheridial cavities are deeply shaded; *Sc.*, ventral scales. II. Part of the same section, × 200, showing on the left the upper portion of an antheridium and its cavity, on the right an air-chamber, opening by a 'barrel-shaped' pore. III. Surface-view of part of receptacle, showing two pores; the upper opens into an antheridial cavity, the lower into an air-chamber.

the midrib of the thallus and consisting of compact tissue, traversed by strings of mucilage-cells, and bearing the rhizoids and ventral scales beneath.

From these structural features it is clear that the male receptacle

has a well-developed assimilating tissue system, together with abundant mucilage-containing cells. Now, under circumstances which favour assimilation, e.g. strong light, sufficient warmth, and a dry atmosphere, an active transpiration-current will be set up, water-vapour being given off in the air-spaces through the pointed inward-projecting cells. To make good this loss, water will pass to the receptacle through the rhizoids. A large part of the water is absorbed by the mucilage-cells, and if any of the antheridia are ripe, the walls of the antheridium itself, as well as those of the antherozoid mother-cells, being at this time largely mucilaginous, also take up water and become swollen. The antheridia being closely packed together considerable pressure is thus set up, resulting in the expulsion of the antherozoids.

F. CAVERS.

YORKSHIRE COLLEGE, LEEDS.

ALGOLOGICAL NOTES.—

IV. REMARKS ON THE PERIODICAL DEVELOPMENT OF THE ALGAE IN THE ARTIFICIAL WATERS AT KEW.— Whilst working out the algal flora of the Royal Botanic Gardens at Kew for publication by the authorities, I have made several observations on the periodicity of the flora, which I wish to remark upon more fully here. The flora [1] was found to be built up of a hot-house element, consisting for the greater part of Cyanophyceae; of the Thames element, due to the universal use of river-water throughout the gardens; and, lastly of the open-air terrestrial element.

The blue-green Algae, which abound in every moist hot-house, have received much attention from continental algologists, with the result that they are fairly well known. How far some of the forms may be looked upon as truly exotic and as introduced together with the higher plants, cultivated in the houses, it is difficult to say [2]. It should be observed that some of these blue-green forms (e. g. *Symphyosiphon*

[1] The constitution of the flora will be more fully discussed in the introduction to the algal flora of Kew Gardens. (See The Fauna and Flora of the Roya l Botanic Gardens, Kew, which is to be published in the course of this year.)

[2] A large number of the blue-green Algae, which occur in the moist heat of greenhouses, have also been observed in hot springs of different parts of Europe, notably those of Carlsbad; this seems to show that they are now truly indigenous in Europe, but can only exist under the peculiar conditions (i. e. high temperature and moisture) found at these particular spots.