plant—is readily induced to make its appearance from the cut ends of the stems and leaves of these plants. Prof. Correns has done a useful service in bringing together, in a classified manner, the numerous methods employed by mosses to ensure their propagation and dispersal by means less expensive than by the production of spores. The readily friable stems of some species of *Andreaea*, the easily detached branchlets of *Dicranum*, are instances, well known to muscologists, of a large class of propagative bodies. These simpler forms of reproduction are also widely spread amongst plants other than mosses, and in some cases—e.g. *Lycopodium Selago*—the superficial resemblance is rather striking. Less obvious are the subterranean bulbils or buds, such as are met with in *Dicranella*, *Barbula*, or *Funaria*, in which special tuberous bodies are formed. *Dicranella heteromalla* affords a pretty example of a form transitional from the simple to the more complex types, inasmuch as the subterraneous bulbils of this moss are little more than rows of swollen rhizoid-cells arranged somewhat like a string of beads. Many of these bulbils are regarded by Correns rather as of the nature of food reservoirs than as brood bodies; but it is at least certain that they are in most cases able to function in the latter capacity as well as in that of mere storehouses of food-reserves.

Other and very common cases of brood bodies are afforded by the so-called "*folia fragilia*"—leaves which readily become detached from the parent plant, and with greater or less intervention of protonematal filaments give birth to new individuals. Oftentimes the leaves destined to this end undergo considerable contraction in size, and, indeed, may assume a totally rudimentary appearance.

Again, as in some species of *Orthotrichum*, cells grow out from the ends of leaves, and the sausage-shaped proliferations, after detachment from the parent plant, grow out to filaments, on which new plants arise.

The above are only a few of the many forms cited by Correns of gametophytic reproductions in the mosses by vegetative means. But as Pringsheim long ago pointed out, it is also possible to reproduce these plants from the sporophyte generation, especially from cut fragments of the seta or stalk of the moss-capsule. These are far more interesting, as they resemble the curious aposporic development met with in a number of ferns. Indeed, these latter offer, perhaps, a means of attacking the details of the phenomena of apospory with a greater chance of success than in the case of the ferns, since they seem more easily induced by simpler experimental devices than is the case with the higher plants.

A general synopsis of the various types and forms of brood-bodies forms a useful adjunct to the main descriptive part of a book on which the author has evidently expended much labour, and which should earn for him the gratitude of all those muscologists who are not merely describers of species, as well as of botanists who seem too often rather to be disposed to ignore an important section of the vegetable kingdom.

Village Notes, and Some Other Papers. By Pamela Tennant. Pp. xii + 204; 13 plates. (London William Heinemann, 1900.)

THESE notes reveal some of the humour and pathos of rural life in South Wilts, and here and there they lightly touch natural scenes and objects other than human. The plates, which are reproductions from original photographs of Wiltshire views, are excellent, and the book itself is a dainty volume suitable for a drawing room table. Reference is made to the "pernicious habit of 'underlining' in their letters" which some people adopt, yet we notice an abundance of italicised words in the book, and they are equivalent to the underlined words so severely condemned.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Conductivity produced in Gases by the Motion of Negatively-charged Ions.

RECENT researches have shown that gases are rendered conductors of electricity when negatively-charged ions move through them with a high velocity. Thus the kathode rays and the Lenard rays possess the property of ionising gases through which they pass (J. J. Thomson, "The Discharge of Electricity through Gases"). Becquerel (*Comptes rendus*, March 26, 1900) also has recently shown that the conductivity produced by radium is due to small negatively-charged particles given off by the radio-active substance. In these cases the charged particles which ionise the gas move with velocities nearly equal to the velocity of light.

Some experiments which I have recently made show that ions which are produced in air by the action of Röntgen rays will produce other ions when they move through the gas with a velocity which is small compared with the velocity of light.

When Röntgen rays are sent through a gas, at atmospheric pressure, the current between two electrodes immersed in the gas increases in proportion to the electric force, when the force is small. For large forces the current attains a value which is practically constant.

When the pressure of the gas is reduced, the connection between conductivity and electromotive force is more complicated. The accompanying tables show the connection between current and electric force for air at 2 and ·8 mm. pressure. At these pressures the current is practically constant for forces of about 10 volts per centimetre, and when forces of this order are acting, all the ions are produced directly by the rays. When the electric force is increased these ions produce others, so that the current again increases.

It appears from the following investigation that the new ions are produced by the collisions between negatively-charged ions and the molecules of the gas.

Let us suppose that n negative ions are moving in a gas between two parallel plates at a distance d apart. Let X be the electric force between the plates $\left(=\frac{V_1 - V_2}{d}\right)$, and p the pressure of the gas. In going a distance dx the n ions produce $\alpha \times n \times dx$ others, where α is a constant depending on X, p, and the temperature, which is constant in these experiments. (The coefficient α is practically zero for small values of X, unless p is also small).

$$\therefore \quad dn = \alpha n dx$$
$$\text{and } n = n_0 E^{\alpha x}$$

Hence n_0 ions starting at a distance x from one of the plates will give rise to $n_0(E^{\alpha x} - 1)$ others. When the ions arrive at the plate, the formation of new ions ceases and the current stops, although the electromotive force is kept on. Let n_0 be the number per unit volume produced by the rays. The total number of ions produced will therefore be

$$\int_0^d n_0 E^{\alpha x} dx = \frac{n_0}{\alpha}(E^{\alpha d} - 1)$$

per unit area, $n_0 d$ being the number produced by the rays. Hence

$$\frac{c}{c_0} = \frac{1}{\alpha d}(E^{\alpha d} - 1)$$

where c is the current for a large force X, and c_0 the current composed of ions produced by the rays.

The following experiments were made in order to test the accuracy of this formula for currents produced between two parallel plates whose distance apart could be varied.

The rays fell normally on one of the plates, which was made of thin aluminium, and after passing through the air between the plates, the rays were completely stopped by the second plate, which was of brass. The plates were 10 centimetres in diameter, and the rays were allowed to fall on a circular area at the centre 4 centimetres in diameter. The conductivity was thus confined to a region where the force was constant. A large part of the conductivity (c_0) arises from the secondary radiation from the brass disc. At high pressures the secondary effect is principally confined to a layer of gas near the surface (John S. Townsend, *Camb. Phil. Proc.*, vol. x. Part iv.), but when the pressure is low the secondary rays are not so rapidly absorbed by the gas, and the ionisation (n_0) between the plates is nearly uniform.

The ratios of $\frac{c}{c_0}$ were determined for different forces, the air being at a pressure of two millimetres. When the strength of the rays was reduced to $\frac{1}{3}$ of its original value it was found that the ratios $\frac{c}{c_0}$ were unaltered. This shows that α is independent of n_0 and is some function of X and p.

The plates were then set at one centimetre apart, and the values of c were determined for different forces. The results, corresponding to a pressure 2 and ·8 mm., are given in the second columns of the accompanying tables. The numbers given are the mean between the currents in opposite directions. With this form of apparatus, however, there were only very small differences found in the conductivity when the electromotive forces were reversed. The plates were then set at two centimetres apart, and the currents found in this case for pressures 2·14 and ·8 mm. are given in the third columns of the tables.

The force X is given in volts per centimetre.

TABLE I.—*Air at pressure 2 mm.*

X	$c(d=1)$	$c(d=2)$	Calculated values of $c(d=1)$
20	28	49·5	28
40	28·2	51	28·4
80	29·5	55	29·5
120	36	81	35·5
160	51	173	50
180	64·5	293	63

TABLE II.—*Air at pressure ·8 mm.*

X	$c(d=1)$	$c(d=2)$	Calculated values of $c(d=1)$
10	10	17·7	10
20	10·5	19	10·5
40	12	24·5	12
80	17	53·5	17
120	31	190	29
165	61	990	62·5
186	82	2180	84

The tables show that the current increases more rapidly with X when the plates are two centimetres apart than when they are one centimetre apart. This effect cannot be attributed to a surface action which would be independent of d when X remains constant.

From the formula $\frac{c}{c_0} = \frac{1}{\alpha d}\left(E^{\alpha d} - 1\right)$ we can deduce the values of α from the third columns of the tables, by making $d=2$ and c_0 the smallest value of c. From values of α thus obtained, the ratios $\frac{c}{c_0}$ for the different forces corresponding to plates 1 centimetre ($d=1$) were calculated. The values of c found in this manner are given in the fourth columns, and they show a good agreement with the experimental determinations.

Other experiments for different pressures have also been made, and they all show an agreement with the present theory.

For the purpose of deciding whether it is the positive or negative ions which produce other ions by their rapid motion through the gas, we may mention the following experimental results. When the lines of force in the gas are not parallel, large differences in current were obtained on reversing the electromotive force. Thus, when the conductivity takes place between two electrodes one inside the other, it was found that for high electromotive forces the current is much greater when the ions go towards the inner electrode.

Thus, with an apparatus consisting of a small spherical electrode surrounded by a large electrode made of thin aluminium, the currents, when the outside electrode was positive, were 14 for a potential difference of 40 volts, and 34 for a potential difference of 300 volts; when the outside electrode was negative the currents were 14 and 174 for the same voltages. In these experiments the pressure was about 2 mm. The positive and negative ions produced by the rays are generated nearly uniformly throughout the area between the electrodes. When the large electrode is positive only a few of the negative ions pass through the region round the small electrode where the force is big, and the current only increases from 14 to 34. When the electromotive force is reversed all the negative ions produced by the rays come into the region where the force is big, and the current is thereby increased from 14 to 174. It is therefore evident that the increase of conductivity must be attributed to the rapid motion of the negative ions.

I hope in a future paper to give a fuller account of the above experiments, and also to point out some of the applications of this theory to the passage of electricity through gases. I may mention that the high conductivities obtained with ultra-violet light (Stoletow, *Journal de Physique* (2), 9, pp. 463-473, 1890), at pressures of about 1 millimetre, may be explained by this theory.

Approximate values of the energy of translation of the negative ion when producing another ion by a collision can also be obtained from the coefficients α. J. S. TOWNSEND.

Trinity College, Cambridge.

A Remarkable Hailstorm.

I HEREWITH enclose you prints, from untouched negatives, of hailstones which fell at Northampton on Friday, July 20.

The drawing board measures 19½" by 17", and the average circumference of the hailstones upwards of five inches. These are by no means the largest that fell, according to the statements of trustworthy persons, but were typical of what fell in my garden.

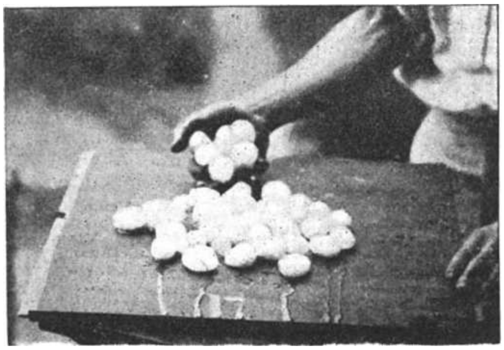

FIG. 1.—Group of hailstones which fell at Northampton on July 20. Size of board 19½ in. by 17 in.

The majority of the stones were somewhat flattened, as shown in the front of the photograph, but many were nearly spherical like those in my hand (Fig. 1).

The stones were extremely dense and well frozen, and buried themselves in the garden soil. Where they fell on hard surfaces, they usually broke into fragments which rebounded to considerable heights, while glass roofs suffered enormous damage all over the area, some twelve miles by six, covered by the storm. I have a piece of glass 5/16ths of an inch in thickness many hundred square feet of which were broken at the various factories in the town.

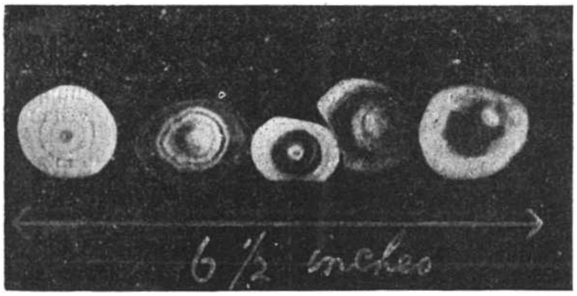

FIG. 2.—Sections of hailstones (Northampton, July 20).

The sections (Fig. 2) were an afterthought and show the structure exceptionally well in two instances.

J. G. ROBERTS.

Northampton and County School, July 30.