

that the combustion will take a cloud of finely divided solid matter from the bottom of the tube along which the flame will be propagated and be driven out at the other end. *A* (see figure) is a wooden box 12 inches long, 3 broad, and 4 deep, closed on all sides, with the exception of a rectangular hole ($\frac{1}{2}$ x $\frac{1}{2}$) inches, into which is inserted a long narrow rectangular tube (*B*), also of wood, which may be as long or more in length, as the upper half of this tube is hinged, and along the bottom it carries a thin layer of finely-divided dry substance, or, what is better in the lacrose-case, hypochlorite powder. Into the wooden box, which in my apparatus has a cubic content of more than a gallon (*C* liter), is placed about a pint (say 1 liter) of water; this can be most readily effected by pouring this amount of water into the box, and displacing it over the water-trough by a current of the gas. The opening is then closed by a sliding lid, and the gaseous contents are steadily and slowly shaking the box for a minute or so. The end of the long tube facing which the powder or dust has been stirred, and the lid is pushed down) is then inserted into the box, and the gaseous mixture is led by throwing a lighted taper through a small hole (*D*) at the end just where the tube enters the box. The mixture of coal-gas and air explodes, and the flame rushes along the whole length of the tube with astonishing velocity, and is driven, often to a distance of six or seven feet, out at the other end, and is followed by a cloud of soot.

The experiment is unaccompanied by danger, and is so simple that it may be readily performed in a lecture-room. I showed it some time since to a number of others and others engaged in coal-mining, and it seemed to bring home to them far more forcibly than possibly any amount of mere description would have done, the real character of the phenomenon. T. K. THOMAS

THE PHOTOGRAPHIC SPECTRUM OF THE GREAT NEBULA IN ORION¹

LAST evening (March 21) I succeeded in obtaining a photograph of the spectrum of the great nebula in Orion, extending from a little below *F* to beyond *H* in the ultraviolet.

The same spectrograph and special arrangements, attached to the 18-inch Cassegrain telescope with meridian apparatus belonging to the Royal Society, were employed which have been described in my paper on "The Photographic Spectrum of Stars" (*Phil. Trans.*, 1880, p. 574).

The exposure was limited by the coming up of clouds to forty-five minutes. The opening of the slit was made wider than during my work on the stars.

The photographic plate shows a spectrum of bright lines, and also a narrower continuous spectrum which I think must be due to stellar light. The bright lines forming the impulsion in the "filament's mouth" of the nebula were kept close to the side of the slit, so that the light from the adjacent brighter part of the nebula might enter the slit.

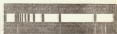
Outside this stronger continuous spectrum I suspect to be a remarkably fine trace of a continuous spectrum. In the diagram which accompanies this paper the spectrum of bright lines only is shown, which is certainly due to the light of the nebula.

In my paper on the visible spectrum of the nebula in Orion, and other nebulae (*Phil. Trans.*, 1884, p. 417, and 1884, p. 340; also *Proc. Roy. Soc.*, 1885, p. 30, and 1879, p. 260), I found four bright lines. The brightest line, wave-length 5009, is coincident with the line tetrahedral component of the double line which is strongest in the spectrum of strontes. The second line has a wave-length of 5177 in Angstrom's scale. The other two lines are

coincident with two lines of hydrogen, H β or *F*, and H γ or *G*.

In the photograph, these lines which had been observed in the stellar spectrum are faint, but can be satisfactorily recognized and measured. In addition to these known lines, the photograph shows a relatively strong line in the ultra-violet, which has a wave-length 3730, or nearly so. The wide slit does not permit of quite the same accuracy of determination of position as was possible in the case of the spectra of stars. For the same reason, I cannot be certain whether this new line is really single, or is double or multiple. In the diagram the line is represented broad, to indicate its relative great intensity.

This line appears to correspond to ϵ of the typical spectrum of saline vapors (*Phil. Trans.*, 1850, p. 571). In these stars the line is less strong than the hydrogen line near *G*; but in the nebula, it is much more intense than



H γ . In the nebula, the hydrogen lines *F* and H γ are thin and diffuse, while in the stellar stars they are broad, and winged at the edges. The typical spectrum has been added, for the sake of comparison, to the diagram.

I cannot say positively, that the lines of hydrogen between H γ and the line at 3730 are absent. If they exist in the spectrum of the nebula, they must be relatively very feeble. I suspect, indeed, some very faint lines at this part of the spectrum, and possibly beyond λ 3730, but I am not certain of their presence. I hope, by longer exposures and with more sensitive plates, to obtain information on this and other points. It is, perhaps, not too much to hope, that the further knowledge of the spectrum of the nebula afforded us by photography, may lead, by the help of instrumental experiments, to more definite information as to the state of things existing in those bodies.

THE ACTION OF CARBONATE OF AMMONIA ON THE ROOTS OF CERTAIN PLANTS, AND ON COLIFORM BODIES²

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THE observations which led to the first of these papers were originally made many years ago on *Euphorbia pulchra*, and have now been extended to other genera. A point of *E. pulchra* having been dug up and carefully washed, the smaller roots may be placed under the microscope without further preparation, the thicker roots may be examined by means of sections. If such roots are left, before being examined, in a solution of carbonate of ammonia (1 to 2 per cent) for a short time (varying from a few minutes to several hours), they present a wonderfully changed appearance. The most striking alteration is that the surface of the root assumes a longitudinally striped appearance, due to longitudinal rows of darker brown cells, alternating with lighter coloured rows. The darker colour is seen under a high power to be due to the presence of innumerable rounded granules of a brown tint, which the lighter coloured cells are without. Similar brown granules are deposited in cells situated throughout the parenchyma, and especially in the elongated mucilage cells surrounding the vascular bundles.

The granules are apparently neither viscinous nor fatty, for they are not removed by alcohol or ether; they are

¹ *Proc. Roy. Soc.*, Lond. Series, March 24, by William Houston, Esq., F.R.S., F.R.I.

² Abstract by Mr. Charles Darwin, of my paper by Mr. Charles Darwin read before the Linnean Society on March 21.

however, slowly acted on by caustic potash, and seem to be of the nature of protein.

It will be observed that the most remarkable part of the phenomenon is that the granules are only formed in some of the external cells, and that these cells are, before the treatment with ammonia, indistinguishable in shape or by their contents from their fellows, which are unaffected by the solution.

There is, however, a curious functional difference between the two classes of cells, namely, that the granular cells do not produce root-hairs, which arise exclusively from the cells of the light-colored roots. With this it may be compared an observation of Pfeffer's, that the root-hairs of the grasses of Maryland grow only from certain definite cells. He describes a similar class of things in *Hydrocharis*, but with these exceptions it seems not to have been hitherto suspected that root-hairs arise from cells in any way specialised.

In connection with this fact, the theory suggests itself that the light-colored cells have been adapted in consequence of the granules having been used up in the development of the root-hairs. But this view is not compatible with the fact that light-colored cells may arise by buds which have not produced root-hairs. Again, in the case of *Cyclaneta*, root-hairs are produced from granular cells. Effects similar to those just described were observed in some other Equisetacean plants, e.g. *Phyllanthus compressus*, though not in all the genera of this family which were observed. Amongst genera belonging to other families may be mentioned *Dioscorea* and *Cyclaneta*, as showing the phenomenon especially well. Although 40 genera were observed, of these 17 were comparatively well on, and it is to a slight degree, making together 26 genera, while the roots of the remaining 14 genera were not well on in any plain manner.

Before attempting to draw any conclusions, a few more details must be taken into account. The root must be alive, otherwise no precipitation will take place; the process is therefore a vital one, and seems in some measure to resemble "aggregation," as it occurs in the testicles of *Drosophila*. In both cases carbonate of ammonia in the most efficient reagent, but other salts, such as nitrate of ammonia, produce a similar effect. What the nature of the process may be, must remain doubtful. The view here suggested is that the granular matter is of the nature of an secretion; the arrangement of the dark-colored cells in roots agrees with what we know of the disposition of certain cells whose function is admittedly to contain secretions. The granules are, moreover, deposited in the lower extending cells of the root-cap where they cannot take part in the life of the root; and this fact points in the same direction.

1. On the Action of Carbonate of Ammonium (Chlorophyll Death).—The effects of solution of carbonate of ammonia and of other salts on the testicles of *Drosophila*, etc., was described in "Insectivorous Plants," under the name of "aggregation." This process consists essentially in the appearance of curiously-shaped masses, of an olive-brown colour, which undergo striking changes of form. The masses were believed to be protoplasmic, but this conclusion has not been generally accepted, and has been called in question by such authorities as Cohn and Pfeffer. The present paper is intended to show that carbonate of ammonia causes a kind of aggregation in chlorophyll bodies; and as these are undoubtedly protoplasmic, the belief in the protoplasmic nature of the aggregated masses in *Dioscorea*, and other sensitive plants, is supported.

The changes which occur in the chlorophyll bodies may be well observed in the case of *Dioscorea*. If a young leaf is immersed for twenty-four hours in a solution of carbonate of ammonia (C) in water, and is then examined by making thin sections, the contrast with a normal leaf will be found strikingly gross. In most of the cells, not a

single chlorophyll-grain can be seen, but in their place are found masses of translucent yellowish-green matter of diversified shapes, resembling in a general way the aggregated masses in the testicles of *Drosophila*. The matter is not evidently derived from the chlorophyll-grains, but consists, in part, of matter deposited from the cell sap, which is often the first to be formed, and is afterwards surrounded by the green matter derived from the chlorophyll-grains.

The same process may be observed in *Dioscorea*, and here it is not necessary to make sections, as the chlorophyll-grains may be well seen at the bases of the testicles. Many observations were made in this way, and also by means of sections. In the case of *Dioscorea* it was possible to show that the chlorophyll-grains may recover from the action of the carbonate—and this is a fact of some importance. After placing drops of various solutions on the bases of leaves still attached to their plants, green spherules or green areas surrounding a central purple mass were to be found in the testicles. In this case it will be seen that the chlorophyll-grains join with the purple cell-contents in forming aggregated masses. These masses were observed to be in constant slow movement. The leaves were then syringed with water and left to themselves for some days. When again examined, the green spherules had in large part disappeared, and instead of them several chlorophyll-grains were found.

Other observations were made on *Dioscorea*, *Saururus*, *Prinos*, *Alchemilla*, *Dipsacus*, *Palafoxia*, *Cyclaneta*, and many other genera, with various results. In some cases the chlorophyll-grains disappeared, and the green masses were formed, in other cases hardly any effect was produced; it is shown again the chlorophyll-grains became condensed and formed various horn-like like masses in the bottoms of the cells.

In the case of *Sphagnum*, the effects of the carbonate were well marked, the spiral chlorophyll body bending up into curiously formed rounded and pear-shaped masses, which slowly changed their outline. Here the plainly-marked deposition of fine granular matter from the cell-sap was caused by the ammonia solution.

Finally, it may be pointed out that whether or not the aggregated form the facts here given in favour of the protoplasmic nature of the aggregates in *Dioscorea* be considered valid, the observations themselves possess some independent interest.

NOTES

In the New Code it is satisfactory to find that where it placed on a fair footing. While in elementary schools, the substance of instruction, in the form of "obligatory subjects," is reading, writing, and arithmetic, still the greater the optional subjects are such as to encourage teachers to make them a regular part of education. In the characteristics for other subjects, for example, we find geography and elementary science, and thus it is recommended, should be illustrated as far as possible, by maps, diagrams, specimens, and simple experiments. In geography the subjects for the different standards are carefully graduated: in Standard V, for example, such subjects as latitude and longitude, day and night, and the seasons, are not there; while Standard VI, among other subjects, see the "circumstances which determine climate;" and only Standard VII, "the ocean, currents, and tides; general arrangement of the planetary system, the phases of the moon." Under Elementary Science, again, the object of the instruction is stated to be the cultivation of "habits of exact observation, statement, and reasoning." For the first standards, lessons in "common objects, such as familiar animals, plants, and substances employed in ordinary life," are to be given. For Standard IV, there is required "a more advanced knowledge of special groups of common objects, such as (a) animals or plants, with particu-