## III. Supplement to a Paper, read February 17, 1859, "On the Influence of White Light, of the different Coloured Rays and of Darkness, on the Development, Growth, and Nutrition of Animals*." By Horace Dobell, M.D. &c. Communicated by James Paget, Esq. Received September 23, 1859.

The apparatus used in the following experiments, was described in my Paper; but in the present instance, only two of the cells were employed, viz. that exposed to ordinary white light, and that from which all light is excluded. In order more effectually to prevent the possible admission of light, the following precautions were adopted with the dark cell:—1. The perforated zinc floor was covered with thick brown paper. 2. The under surface of the lid was lined with black cloth, to secure accurate adjustment when shut. 3. The opaque black glass was covered with an additional coat of black oil-paint. 4. The lid was never opened in any light except that of a candle or of gas.

March 20th, 1859.—A number of ova of the Silkworm (*Bombyx mori*), all of the same age, were placed in each of the two cells. No change was observed until *May* 18*th* (sixty days after the commencement of the experiments), when one larva emerged from the ovum in each cell; and during twelve days, larvæ continued to emerge in the light and in the dark at the same rate.

June 9th.—Sixteen larvæ, as nearly as possible of the same size, were selected in each cell, and the rest removed. The experiments then proceeded with these thirty-two individuals, and no death occurred from first to last.

* Proceedings of the Royal Society, vol. ix. p. 644.

The following Table shows the day on which each larva began to spin; the day on which the perfect insect escaped from the pupa; and hence the number of days occupied by the metamorphosis.

| Light. | | | Darkness. | | |
|---|---|---|---|---|---|
| Day of beginning to spin. | Day of escape of the Moth. | Number of days occupied by metamorphosis. | Day of beginning to spin. | Day of escape of the Moth. | Number of days occupied by metamorphosis. |
| July 1 | July 18 | 18 days inclusive | June 30 | July 18 | 19 days inclusive |
| „ 2 | „ 19 | 18 „ „ | „ 30 | „ 18 | 19 „ „ |
| „ 2 | „ 19 | 18 „ „ | „ 30 | „ 18 | 19 „ „ |
| „ 2 | „ 18 | 17 „ „ | „ 30 | „ 18 | 19 „ „ |
| „ 2 | „ 18 | 17 „ „ | „ 30 | „ 21 | 22 „ „ |
| „ 2 | „ 19 | 18 „ „ | July 1 | „ 18 | 18 „ „ |
| „ 2 | „ 19 | 18 „ „ | „ 1 | „ 18 | 18 „ „ |
| „ 3 | „ 19 | 17 „ „ | „ 2 | „ 18 | 17 „ „ |
| „ 3 | „ 21 | 19 „ „ | „ 2 | „ 19 | 18 „ „ |
| „ 4 | „ 20 | 17 „ „ | „ 2 | „ 20 | 19 „ „ |
| „ 4 | „ 20 | 17 „ „ | „ 2 | „ 19 | 18 „ „ |
| „ 4 | „ 20 | 17 „ „ | „ 2 | „ 20 | 19 „ „ |
| „ 4 | „ 21 | 18 „ „ | „ 2 | „ 21 | 20 „ „ |
| „ 4 | „ 21 | 18 „ „ | „ 3 | „ 21 | 19 „ „ |
| „ 5 | „ 21 | 17 „ „ | „ 3 | „ 20 | 18 „ „ |
| „ 6 | „ 24 | 19 „ „ | „ 4 | „ 21 | 18 „ „ |

From this it is seen that the mean period occupied by the metamorphosis in the *darkened cell* was eighteen days fifteen hours, and in the *light cell* seventeen days sixteen hours.

The longest and shortest periods in the *darkened cell* twenty-two days and seventeen days, in the *light cell* nineteen days and seventeen days.

June 9th.—On selection of sixteen of the largest larvæ from the inhabitants of each cell, it was noted that, when sixteen were selected from the *darkened cell* and several of *similar size* removed, only four could be found as large in the *white cell*, the remaining twelve selected were therefore of a rather smaller size. This difference in the two cells became less obvious afterwards, but, throughout the experiments, there was a slight difference of size in favour of the darkened cell.

With these exceptions, no difference could be detected between the results obtained in the cell from which light was completely excluded and in that exposed to its full influence.

The larvæ, the silk produced, and the moths from the two cells,

when placed side by side, could not be distinguished from one another.

The ova were of the same colour when first deposited, and underwent the same changes of appearance, at the same time, in the dark and in the light.

So far, therefore, as the direct agency of light is concerned in the development, growth, nutrition, and coloration of animals, the results of these experiments closely correspond with those already recorded in my Paper.

IV. "On the Effects produced in Human Blood-corpuscles by Sherry Wine, &c." By WILLIAM ADDISON, Esq., F.R.S., Fellow of the Royal College of Physicians, London. Received September 10, 1859.

(Abstract.)

The author has found that when a small drop of fresh blood is placed beside a similar drop of sherry wine on a slip of glass, and viewed with the microscope, after being covered as usual with a thin piece of glass, certain changes are seen to take place in the blood as it mingles with the wine, which are thus described:—

"In those parts where the wine is mingling with the blood—at the outer edges of the mass—various altered corpuscles will be seen. They float in the fluid, separated from each other, having now no longer any disposition to adhere together in rolls. Their outlines are altered, and sundry markings appear in their interior. After a short time—perhaps ten minutes, sometimes sooner—numerous corpuscles will be observed throwing out matter from their interior; two, five, or ten molecular spots fringing their circumference. Some of these molecules grow larger and seem coloured; others of them elongate into tails or filaments, which frequently attain to an extraordinary length, and wave about in a very remarkable manner. They all terminate, at the extremity farthest from the corpuscle, in a round globular enlargement. A single corpuscle may very frequently be seen with five or six of these tails.

"During the observation of these phenomena, numerous molecular particles are seen continually passing from the corpuscles; they

all the parties were alive and in frequent intercourse with the author and with each other.

I have only further, in Mr. Brown's name also, to do an act of justice to the memory of Lavoisier, by relieving it from the obloquy which has rested upon it from his supposed persistence in unjustly claiming priority for himself. The following extract from a Report to the Academy of Sciences on M. Seguin's experiments, dated 28th August 1790, and signed Lavoisier, Brisson, Meusnier, and Laplace, the last named being the reporter, will prove that Lavoisier was not unmindful of the appeal which had been addressed to him by Blagden some years previously, and that he distinctly resigned the priority of discovery to Cavendish :—

"M. Macquer a observé dans son Dictionnaire de Chimie que la combustion des gaz hydrogène et oxygène produit une quantité d'eau sensible ; mais il n'a pas connu toute l'importance de cette observation, qu'il se contenta de présenter, sans en tirer aucune conséquence. M. Cavendish paroît avoir remarqué le premier que l'eau produite dans cette combustion est le résultat de la combinaison des deux gaz, et qu'elle est d'un poids égal au leur. Plusieurs expériences faites en grand et d'une manière très-précise, par MM. Lavoisier, La Place, Monge, Meusnier, et par M. Lefevre de Gineau, ont confirmé cette découverte importante, sur laquelle il ne doit maintenant rester aucun doute."—*Annales de Chimie*, tome 7, pp. 258–9.

JOHN J. BENNETT.

II. "On the Influence of White Light, of the different Coloured Rays and of Darkness, on the Development, Growth, and Nutrition of Animals." By HORACE DOBELL, M.D., Licentiate of the Royal College of Physicians, &c. &c. Communicated by JAMES PAGET, Esq. Received January 10, 1859.

(Abstract.)

In this communication the author laid before the Society the particulars of a series of experiments, having for their object to discover what influence is exerted by ordinary light, by the different coloured rays, and by darkness on the development, growth, and nutrition of animals.

After referring to the experiments of Edwards, Higginbottom, E. Forbes, Morren, Wöhler, Hannon, Moleschott, and Béclard, the results of which were shown to be somewhat contradictory, the author described the precautions taken by himself to avoid sources of fallacy.

The original experiments detailed in this Paper were conducted in the years 1855, 1856, 1857, 1858. The subjects selected were the Ova and Larvæ of the Silkworm (*Bombyx mori*) and of the Frog (*Rana temporaria*). A comparative experiment in the vegetable kingdom was also made on the Sweet Pea (*Lathyrus odoratus*). An apparatus contrived for the experiments on Tadpoles was described and figured; it secured the following desiderata:—

1. That each of six compartments or cells should be supplied with water from the same source, at the same time, subject to the same changes, and capable of being refreshed without interfering with the cells.

2. That each of the cells should be placed in the same condition with respect to the supply of air and of food.

3. That during exposure for examination of the animals, the whole series should be opened the same length of time and to the same extent.

4. That each cell should receive no light but that transmitted by its proper cover.

One of these six cells was open to the air and to light; one was covered with ordinary white glass; one was made completely dark by a covering of blackened opaque glass; one was covered with blue, one with greenish yellow, and one with red glass. The transmitting and absorbing powers of these glasses were detailed from experiments made upon them by Mr. Cornelius Hanbury, jun., and by the author.

The apparatus used for the Silkworms was, in all essential particulars, the same as that for the Tadpoles, only without water.

A tabulated analysis of the daily journal kept during the experiments was given, and its separate items compared and discussed; after which the author concluded his Paper with the following *résumé*.

"If we may venture to reason on so small a number of observations, so far as the results of these experiments are concerned, the following propositions may be advanced.

"*All other conditions being the same,* (1.) *The Ova of Insects* are not directly influenced in their development by white light, by the different coloured rays, or by darkness.

"(2.) *The Larvæ of Insects* are not directly influenced in their development, growth, nutrition, or metamorphoses by white light, by the different coloured rays, or by darkness.

"(3.) *The Larvæ of Batrachia Reptiles* are not directly influenced in their development, growth, nutrition, or metamorphoses by white light, by the different coloured rays, or by darkness.

"(4.) *The Materials necessary to the Colour of Insects and Reptiles* are prepared equally under the influence of white light, of the different coloured rays, and of darkness."

These results are so opposed to preconceived ideas upon the subject to which they relate, that they cannot fail to excite some surprise and incredulity; when, however, they are carefully considered, they assume a theoretical probability, which assists us in believing that the practical results are without fallacy.

(*a.*) With regard to the *development of the ovum*, when we consider the unity of plan which appears to preside over the germs of the simplest and of the most complicated forms, and the infinite variety of external conditions in which these germs are placed throughout the animal kingdom, we are led to the conclusion that their development must be so arranged as to be independent of the direct influence of light.

(*b.*) That *after emerging from the ovum* the animal is not directly influenced by light, is more difficult, at first, to believe, because experience seems to have taught us that "to live without light is to live without health;" but this familiar fact may be at once disposed of in the argument and explained by its coincident, that, under ordinary circumstances, the admission of light is inseparably connected with,

1. The regulation of external temperature.
2. The free circulation of a respiratory medium.
3. Those processes of vegetable life and of inorganic change upon which the proper condition of the respiratory medium depends.

Speaking generally then, it must be admitted that light is essential to the development, growth, and nutrition of animals, but only *in-*

*directly*. In the foregoing experiments, the usual coincidents of light, a proper supply of food, a due aëration of the respiratory medium, a properly regulated external temperature, &c. having been provided in each cell, the direct influence of light only being changed, no corresponding change occurred in the animal life.

In the vegetable kingdom the case is quite different, and the experiments on *Lathyrus odoratus* recorded in this paper demonstrate again, what has been shown by numerous other experimenters, that *light as a direct agent* is essential to the nutritive processes of plants. An interesting exception occurs, however, in the vegetable kingdom, which serves to strengthen the probability that the conclusions arrived at concerning animals are correct, viz. that fungi—which derive their nutriment, like animals, from organic compounds already prepared for them—perform their vital functions without dependence on the influence of light.

Under the head of colour, it would seem that the familiar phenomenon of *etiolation* witnessed in plants which have been deprived of light, has led to erroneous anticipations as to the effect which alterations of light would produce upon the development of the colouring materials in animals.

In the experiments here recorded, it is seen that neither white light, nor the different coloured rays, nor darkness altered the development of those materials, necessary to the exhibition of colour, when the animal was seen in ordinary light. The experiments of Dr. Gladstone, on plants, also show that the development of colouring matter in the petals of flowers is independent of the influence of light; that flowers raised under the different coloured rays and in darkness have the same colour in their petals as when raised in ordinary light. Thus, even in vegetables, *etiolation* is confined to those parts of the plant which depend for their colour upon the condition of the chlorophyl, to the green appearance of which some portion of the solar beam is evidently essential.

Although, therefore, at first sight, the results of my experiments under the head of colour may appear questionable, I think we must rather throw the question upon the correctness of our preconceived notions on the subject; and the facts elicited by Prof. Edward Forbes (referred to in the Paper), while retaining all their value and interest as assistants in determining the depths of primeval seas,

cannot, I think, be taken as evidence against the correctness of my observations. On the other hand, the results of my experiments may be found to put a new construction upon the facts observed by Prof. Forbes. He discovered that increased depth of sea corresponds with diminished light, and that both of these conditions again correspond with peculiar changes in colour, and ultimately with loss of colour in the shells inhabiting these depths; but there is no evidence to show that these colourless shells have developed any materials capable of manifesting colour after exposure to the influence of light; whereas my own and other experiments show that the *etiolated* stalks and leaves of plants speedily manifest the characteristic colour of the chlorophyl if placed in the sun's rays.

So far, therefore, as our present knowledge on the subject justifies any conclusion, the varieties of colour and the absence of colour in the mollusks are physiologically separated from the phenomena of etiolation in plants, and may be placed in the same category as the varieties of colour and the absence of colour in the corollas of flowers, which depend upon the development of materials having certain optical properties.

The beautiful facts observed by Prof. Forbes, instead of being regarded as the consequence of imperfect exposure to light, must, I think, take rank with the phenomena of coloration observed throughout the animal kingdom, such as the peculiar markings of reptiles, birds, and wild animals, according to their different habitats and modes of life; the colours of the upper and lower surfaces of fish, and the like, which cannot be shown to depend upon the exposure or non-exposure to light with which they frequently, but not always, coincide. These facts appear only to form a part of the vast and perfect plan of creation, in which everything that exists is suited in every particular to the conditions of its existence; thus, those mollusks which are designed to inhabit depths scarcely permeable to light, can have no need, and hence have no provision, for elements, to the manifestation of which light is an essential condition.