lately, and has determined the amounts of both copper and iron present in various kinds of oysters by electrolytic methods. He finds the green Marennes oyster contains about 0·4 mgrme. (say ·006 grains) of copper, which agrees pretty closely with the figures given by previous writers. This seems to be the normal amount present in all oysters, white or green, and due to the hæmocyanin of the blood. Dr. Thorpe, however, finds that the green Falmouth oysters have, on the average, each ·023 grains of copper, which falls to the normal amount (·006) on re-laying in another locality, and which is "obviously caused by the mechanical retention of cupriferous particles" (Thorpe, NATURE, p. 107). If Dr. Thorpe means by this that copper mud is entangled in the water and food passages of the oyster, is it not possible that, although the oyster is green, and copper is present, the colour may be due—as in most green oysters—to another cause? This mere entanglement (more or less accidental) of copper-bearing material in the passages of the oyster may also be the explanation of the extraordinarily high figure reported by Mr. Lowe—a figure (·04 grammes) as large, I may remark, as that of the *total ash* in the case of some of my oysters investigated by Dr. Kohn. W. A. HERDMAN.

Liverpool, February 6.

### Immunity from Snake-Bite.

IN regard to the immunity from the danger of a second bite which a non-lethal dose of snake venom affords an animal, and also in regard to the question of antitoxin, I would suggest that the comparatively simple case of the sting of bees might be investigated.

The keeper of an apiary once told me that when he first took charge of it, he was laid up for some days by the intense inflammation due to the stings, but that he soon became quite indifferent to the venom. I myself saw him stung several times during a few minutes while he was emptying one hive into another. He had no protection over his hands and face, and, except for the sharp prick of the actual sting, he suffered no ill-effects.

May not the stinging liquid, generally assumed to be formic acid, be of the same nature as snake venom? Might not formic acid have the same effect? R. C. T. EVANS.

## SUBJECTIVE COLOUR PHENOMENA.

IN a recent communication to the Royal Society,[1] I described a series of optical experiments which originated in an attempt to account for the colour phenomena exhibited by Mr. C. E. Benham's "Artificial Spectrum Top" (NATURE, vol. li. p. 113). The chief of these experiments are of an exceedingly simple character, and can easily be repeated without the employment of any special apparatus. They demonstrate the formation, under certain conditions, of transient bands of colour along the boundaries between light and dark surfaces.

Let a hole, half an inch square, be cut with a sharp knife in the middle of a sheet of thick brown paper about 15 inches square. The hole is to be covered with gummed white paper taken from the edge of a sheet of postage stamps ("stamp paper"); a small translucent window is thus formed. Across the middle of the window a common pin is to be fixed, like a bar, by means of narrow strips of stamp paper at its two ends. Holding the brown paper in the left-hand between the eyes and a lamp, the observer directs his eyes upon the translucent window; then he conceals it from view by interposing a screen, such as a thin book with a dark cover. After a few seconds, and without moving the eyes in the meantime, he suddenly withdraws the screen; then, if everything is right, and the observer is not unaccustomed to subjective visual experiments, the window will, for a moment after its exposure, appear to be surrounded by a narrow red border, while the pin also will at first appear bright red, not turning black until after the lapse of about one-tenth of a second. The effect is seen best when the lamp is at a certain distance from the brown paper. This distance must be found by trial; in my own case an eight-candle power lamp gives good results when it is about 12 inches behind the paper. The observer's eye should be 10 or 12 inches away from the translucent window.

When once the red border has been detected, it becomes very conspicuous; the difficulty in the first instance being not to see it, but to know that one sees it. The phenomenon is, without doubt, constantly met with, and habitually ignored, in daily life. Since my first observation of it I have many times noticed flashes of red upon the black letters of a book, or upon the edges of the page: bright metallic or polished objects often show a red border when they pass across the field of vision in consequence of a movement of the eyes, and it was an accidental observation of this kind that suggested an experiment like the following:—

Holding the brown paper between his eyes and the lamp, as before, the observer moves it rather quickly either up and down, or round and round in a small circle an inch or two in diameter. The moving window will, owing to persistence, form a straight or circular luminous streak, which will appear to be bordered on both sides with bright red. No person, however unpractised, to whom I have shown this experiment, has failed to see the red border at once. As before, the intensity of the illumination must be properly regulated; so also must the speed of the movement. With strong illumination the red border is very narrow, and is lined with greenish-blue; or the red colour may even be altogether absent.

The above experiments show that when a luminous image (not too bright) is suddenly formed upon the retina, it appears at first to be surrounded by a red border.

The following is a way of showing the same effect by reflected instead of by transmitted light. Two or three black lines, about as thick and as long as an ordinary pin, are drawn upon a small piece of white paper, which is placed upon a table and illuminated by strong lamp-light (not daylight). A black book is interposed between the observer's eyes and the paper, and then very suddenly withdrawn; the lines, when first seen, appear to be red, quickly changing to black. So far the observation is a rather difficult one, but by a very simple device it is possible to obliterate the image of the lines before the redness has had time to disappear; the colour then becomes easily perceptible. A thin black book is held horizontally in the right hand by its left-hand bottom corner, the thumb being uppermost; between the thumb and the book is inserted the right-hand bottom corner of a sheet of white note-paper; the upper right and left corners of the paper and the book respectively are separated, so as to form a triangular open space between them. The book is held an inch or two above the black-lined paper, covering it completely; then the hand is quickly moved from left to right in such a manner that the lines are for a moment exposed to view through the gap between the book and the note-paper, the movement being stopped as soon as the lines are covered by the paper. During the brief glimpse that will be had of the lines while they are beneath the gap, they will, if the illumination is correct, appear to be of a brilliant red hue. It must be ascertained by a preliminary trial that neither the book nor the note-paper casts a shadow upon the black lines when the gap is passing over them.

By a further simple contrivance the red images may be made visible almost continuously for an indefinite time. Upon a disc of white cardboard, from 3½ to 6 inches in diameter, two straight lines are drawn from the centre to the circumference, containing an angle of about 45°; the portion enclosed by the lines is cut out nearly up to the centre, a rim about ¼ inch wide being left at the circumference; the remainder of the disc is divided into two equal parts by a straight line from the centre to the circumference, opposite the opening, and one of these parts is painted black with ink. A pin is passed through

[1] "On Subjective Colour Phenomena attending sudden Changes of Illumination." (*Proc. Roy. Soc.*, December 17, 1896.)

the centre of the disc in such a manner that the unprepared face of the disc may rest upon the pin's head (a lady's hat-pin is better for the purpose than a small one); the pin-hole must be sufficiently large to allow the disc to turn freely. Holding this arrangement by the pointed end of the pin (which should be directed vertically upwards) above a design in black lines upon a white ground —any drawing, writing, or printing will do, provided that the lines are not too thick—the observer spins the disc by striking its edge tangentially with his finger in the direction such that the gap follows the black portion, and is followed by the white portion of the disc. If the disc makes five or six turns per second, and the before-mentioned precautions as to illumination and shadows are duly observed, the black lines of the design, seen through the opening in the disc, will appear bright red, and, owing to persistence, the impression will be almost continuous.

When the disc is made to turn in the reverse direction, the lines appear to become (subjectively) blue instead of red. This appearance is partly, if not altogether, illusory. Careful observation shows that the subjective blue tint is not formed upon the lines themselves, which remain black, or rather grey, but upon the white ground just outside them. This and other experiments detailed in the paper indicate that when a dark patch is suddenly formed upon a bright ground, the patch appears for a moment to be surrounded externally by a blue border.

We have then to account for the two facts, that in the formation of these transient coloured fringes, the red originates in a portion of the retina which has not been exposed to the direct action of light, while the blue originates in a portion which is subjected to steady illumination. The effects must, I think, be attributed to sympathetic affection of the red nerve fibres. When the various nerve fibres of the Young-Helmholtz theory are suddenly stimulated by ordinary white or yellow light of moderate intensity, the immediately surrounding red nerve fibres are for a short period excited sympathetically, while the violet and green are not so, or in a much less degree. And, again, when light is suddenly cut off from a patch in a bright field, there occurs an insensitive reaction in the red fibres just outside the darkened patch, in virtue of which they cease for a short time to respond to the luminous stimulus, in sympathy with those inside the patch. The green and violet fibres, by continuing to respond uninterruptedly, give rise to the sensation of a blue border. There is reason to believe that with intense illumination, such as sunlight, these effects are reversed, the sympathetic affection of the red fibres being in such case less than that of the green and violet instead of greater.

The above-mentioned are a few among many curious phenomena which exhibited themselves in the course of my experiments. It appears probable that a careful study of the subjective effects produced by intermittent illumination would lead to valuable results, tending to clear up many doubtful points in the theory of colour vision. SHELFORD BIDWELL.

## *A NATIONAL PHYSICAL LABORATORY.*

THE Marquis of Salisbury received at the Foreign Office on Tuesday a deputation of representatives of science who asked the Government to establish a national physical laboratory at a cost of £30,000 for buildings, and £5000 a year for maintenance. The *Times* gives the following report of the proceedings.

The deputation consisted of Lord Raleigh, Lord Lister, Sir John Evans, Sir Douglas Galton, Sir Henry Roscoe, Sir Andrew Noble, Prof. W. G. Adams, Prof. W. Chandler Roberts-Austen (Iron and Steel Institute), Prof. W. E. Ayrton, Mr. J. Wolfe Barry (President of the Civil Engineers), Prof. R. B. Clifton, Prof. G. H. Darwin, Mr. Francis Galton, Mr. R. T. Glazebrook, Prof. W. M. Hicks, Dr. J. Hopkinson, Prof. J. V. Jones, Prof. John Perry, Mr. W. H. Preece, Prof. William Ramsay, Prof. A. W. Rücker, Mr. Robert H. Scott (Meteorological Office), Mr. W. N. Shaw, Mr. J. Wilson Swan, Prof. Silvanus Thompson, Prof. W. A. Tilden, Prof. Michael Foster, and Mr. G. Griffith, Secretary of the British Association.

Lord Lister said it fell to his lot to introduce the deputation, as being President of the British Association, with which the idea of a national physical laboratory originated, and also of the Royal Society, which took an equal interest in the matter. Lord Kelvin desired him to say that he was unavoidably absent; he was in full sympathy with their object, and would have been present had it been possible.

Prof. Rücker said the scheme consisted of two parts, which, although closely connected, must be regarded as separate. The first was the proposal for the establishment of a national physical laboratory, and the second was a suggestion of a particular method for giving effect to it. There were certain types of physical investigation which were too laborious and lengthy to be undertaken by individuals or by the staff of an institution the primary duty of which was to teach, but which, on the other hand, were too closely connected with the advancement of knowledge and with research to be undertaken by the staff of a Government department. Of these types, the first was the investigation of slow changes in the properties of matter which persisted through long periods of years. Lord Kelvin had made a beginning in the investigation of these in his laboratory at Glasgow, but it was not too much to say that, although the properties to be investigated might prove to be of great importance both to scientific theory and to industry, very little was known about them at present, or was likely to be known, except by an organised effort such as they now suggested. The second task they wished to undertake was the testing and verification of instruments useful alike to industry and research. Something had been done in this country to meet this want. Standards of various kinds were in charge of the Standards and Electrical Departments of the Board of Trade, but the work which they proposed had a wider scope than that of either of those most useful departments; and the institution which in this country most nearly approached the ideal at which they were aiming was the Kew Observatory. But the permanent endowment of Kew amounted to only £447 per annum, derived from a bequest of the late Thos. Gassiot. Kew was the central observatory of the Meteorological Council, where meteorological instruments of all sorts, photographic lenses, compasses, and many other things were tested and verified; and in the last two years the average number of instruments per annum submitted to investigation had exceeded 21,000. Paris was the seat of the International Bureau of Weights and Measures; and some ten years ago the Physikalisch-Technische Reichsanstalt was founded near Berlin to carry out work of the type which he had just described. Like Kew, it received a private benefaction the gift of the late Dr. Werner Siemens, but this had been largely supplemented by the German Government. At Kew they had to thank the State for the site and the use of an old building. In Germany new buildings had been provided, at the cost of about £200,000, and the annual outlay upon the Reichsanstalt amounted to £15,000. The researches carried out, both in Berlin and in Paris, had in the comparatively short space of ten years produced remarkable results. To give one instance:—Mecurial thermometers were subject to errors which made them very difficult to use for accurate work. Researches on glass carried out in these foreign laboratories resulted in the discovery of a material free from many of the objections which might be urged against ordinary glass, and a prolonged study of the thermometer resulted in increasing the accuracy of mercurial thermometers five-fold. As a consequence of this no high-class mercurial thermometers were now made in this country, and we had to send abroad for them; in fact, at Kew itself our thermometric standards were a series of instruments which had come from Paris, and would have to be sent there to be verified if any accident or careless handling should throw a doubt upon their indications. At the Reichsanstalt there was a large department specially devoted to the investigation of problems useful to industry, and it was understood that instrument-makers, when in doubt as to the best construction of some new and delicate instrument, could obtain help from the experts in the National Laboratory. They were very anxious, therefore, that at Kew, or elsewhere, an institution should be