Letters to the Editor.

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Light of Glow-worms.

THE letter by Dr. Ramdas and Dr. Venkiteshwaran¹ on the "Spectrum of Glow-worm" will surely arouse interest in the fascinating subject of animal luminescence and stimulate photophysical research on the phenomenon. The writers note that their worm glowed only by night, could be stimulated by shaking, and that the light was apparently under voluntary control. These details I am able to supplement by other observations, which may be of value to research workers who wish to take up the subject.

In June-July 1919 I had an abundant supply of female *Lampyris noctiluca* L. from Looseley Row, Bucks. Their light was eclipsed immediately in sudden disturbance, presumably causing alarm, but could often be enhanced by concussion and always by nipping the luminous organ; though these displays were relatively transient, being succeeded by the negativism characteristic of 'alarm'. The light emitted by larvæ was more readily extinguished and less easily aroused than that of females.

Dissecting out the ventral nerve-cord, I found that crude chemical stimuli (sodium chloride, caustic soda, common acids) were without effect, but that momentary flashes could sometimes be produced by the mechanical stimulus of nipping the cord. Single induction coil shocks, if sufficiently strong, would produce momentary flashes of light, 'break' seeming more efficient than 'make'. Continuous faradisation produced a brilliant light, but my terminals were impromptu makeshifts without attempt at screening, so that I could not be absolutely sure the luminous organ had been affected by nerve-impulse and not by the current directly. Certainly, an even more vivid effect could be obtained by plunging the terminals into the tail of the insect, near or on the organ. It was possible to suspend the tail in fixative (Zenker's fluid, alcohol, formaldehyde, 5-10 per cent), and to keep the organs glowing by faradisation while fixation gradually took place. This was a very astonishing sight, and I have always hoped for an opportunity to extend these preliminary observations into a serious research. The light of isolated and crushed luminous organs could also be observed under the microscope, perhaps as a result of mechanical stimulation of residual nerves and end-organs, but sometimes in such thin smears that the effect seemed purely biochemical.

I also made up three batches to be kept—(1) in absolute dark, (2) with a little diffuse light during the day, (3) in the fullest light that could be applied at all times, namely, full diffuse daylight all day and a 60 candle-power electric light at about 3 yards at night. There were a dozen worms in each batch. At first all three batches kept the hours then current in the field, beginning to glow at 10-11.0 P.M. and ceasing at 1-4.0 A.M. After about the third day the habits of the illuminated batch began to be deranged, and after four or five days they would only glow at irregular intervals or on stimulus by shaking, which, however, was more uncertain than with normal worms. The other two batches kept their hours well until after about a fortnight, when senility and perhaps starvation began to produce their effects, the totally dark batch being the earlier deranged and

producing light by day as well as night. I concluded that external light was probably not needed for storage on the lines of chemical phosphorescence, but necessary to simulate natural conditions; at the same time, there was a remarkable automatic regulation of the hours of light which was not primarily dependent on external illumination, but could be upset by unusual conditions of environment.

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Mercury Line Spectrum in Fluorescence.

It was found by Fichtbauer¹ that mercury vapour of low density, illuminated by the radiation of a mercury arc, emits all the chief lines of the mercury spectrum in fluorescence. These experiments were extended by R. W. Wood,² who found, in accordance with the views of Fichtbauer, that the process is one of stepwise excitation, the mercury atom being raised in the first instance to the 2^3P_1 state by absorption of the resonance line, and next to, for example, the 2^3S_1 state by absorption of 4358. Emission of the visual triplet $2^3P_{012} - 2^3S_1$ then follows. Wood was able to verify this explanation by using an independent source to supply 4358.

No doubt is here expressed that this is in the main a correct account of what happens under the conditions used by these experimenters. I find, however, that when excitation is *by the resonance line alone*, and the other lines from the original source are suppressed by appropriate filters, it is still possible to observe the emission of these other lines in mercury vapour of, say, 2 mm. pressure. Thus a chlorine filter of 40 cm. thickness is absolutely opaque to the lines 3650, 3126, and 2967. Yet these lines are emitted when the vapour is excited through such a filter. Whatever the process may be by which the vapour is raised to the 3^3D_{321} state, it cannot be stepwise absorption, because the appropriate frequencies are not there to be absorbed. It is remarkable that the atom is raised to a level of 8.8 volts, whereas the excitation directly applied is only 4.86 volts.

I find, further, that in a rapid current of vapour the emission of these lines continues, even when the vapour has passed out of the region directly illuminated.

Much further work will doubtless be required to interpret these results. They are probably to be connected with the known ionisation of the vapour by the resonance line.

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¹ Phys. Zeit., 21, 635; 1920.

² Proc. Roy. Soc., A, 106, 679; 1924.

A Connexion between Fluorescence and Free Neutral Radicals.

MODERN physical theories¹ treat the fluorescence of all substances as the re-emission of previously absorbed radiation during the return of a chemical molecule to a stable form from an activated form, possessing a mean free life of 10^{-8} to 10^{-9} second. Since it has been shown that, in any atom, only the outermost, or valency, electrons are concerned in the absorption or emission of light waves of the visible order of frequency, it follows that fluorescent emission is necessarily concerned with the *re-formation of stable valency bonds* (or possibly stable 'lone-pairs' of electrons) from previously activated molecules.