it should be placed in shallow water on a sloping bank and partially embedded in the mud or sand so that the bottom of the funnel is even with the bottom of the pond. The rest of the trap extends out toward the deeper water. A dead fish wired securely to the bottom of the trap makes an excellent bait. Attracted by this bait, the crayfish crawl into the trap and seem to be unable to find their way back out. A single night-set with such a trap will reward the trapper with at least a water bucket full of crayfish for laboratory use, or for the more immediate purpose of supplying the camp with an exceedingly delectable breakfast.

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SPECIAL ARTICLES

NOTE ON THE RELATION BETWEEN THE PHOTIC STIMULUS AND THE RATE OF LOCOMOTION IN DROSOPHILA

IT is a fact demonstrated by many investigators that *Drosophila melanogaster* (ampelophila) is negatively geotropic and positively phototropic. In addition it is also known that light acts as a kinetic stimulus as well as a directive one. When the individual is illuminated, therefore, its movement is determined by the three factors operating simultaneously. If light acts in opposition to gravity the rate of upward crawling of the fly is lowered; and if light acts with gravity the rate is increased. Since the stimulus of gravity is always constant, and the photokinetic stimulus constant within wide limits, the rate of upward crawling is a measure of the effect of the phototropic stimulus.

Definite quantitative results have been obtained by measuring with a stop-watch the time necessary for wild flies to crawl to the top of a glass cylinder under three different intensities of light. Illuminated from above with a light of 1,500 candle meters the time taken for 50 per cent. of the experimental flies to reach the top (a distance of 172 mm) was found to be 6.17 seconds. With an intensity of 750 c.m., 7.6 seconds; and with an intensity of 75 c.m., 10.89 seconds. Each of these determinations is the average of 50 trials with 87 animals selected from five different cultures. The age of the flies varied between six and nine days. Under the illumination of a ruby lamp giving only enough light to enable observation, the time consumed in reaching the top was 11.3 seconds. There is then a definite relationship between the intensity of illumination and the rate of movement, which may be expressed by the Weber-Fechner law, as was done in the case of the Japanese beetle.[1] Figure 1 expresses this relationship.

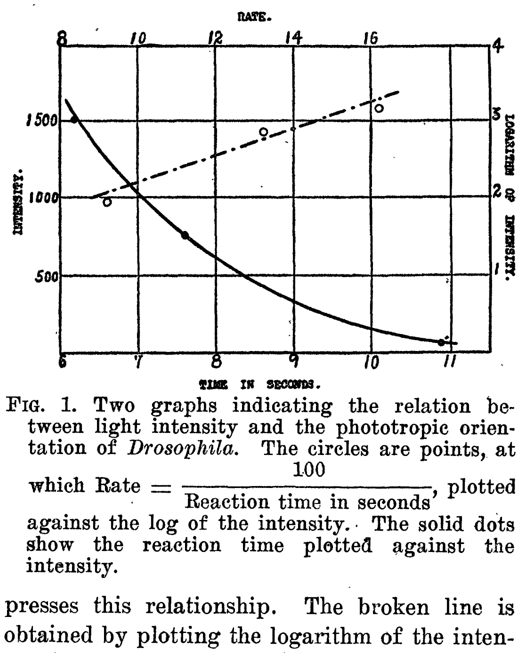

FIG. 1. Two graphs indicating the relation between light intensity and the phototropic orientation of *Drosophila*. The circles are points, at which Rate $= \dfrac{100}{\text{Reaction time in seconds}}$, plotted against the log of the intensity. The solid dots show the reaction time plotted against the intensity.

The broken line is obtained by plotting the logarithm of the intensity against the rate of locomotion, where rate equals 100 divided by the reaction time in seconds. From this graph it may be concluded that the sensation is proportional to the logarithm of the intensity of the stimulus. The continuous line is obtained by plotting the reaction time in seconds against the intensity of light and leads to the same conclusion.

It was found by McEwen[2] that the mutants

[1] Moore, A. R., and Cole, W. H.: "The response of *Popillia japonica* to light and the Weber-Fechner law," *Jour. Gen. Physiol.*, 3: 331, January, 1921.

[2] McEwen, R. S.: "The reactions to light and to gravity in *Drosophila* and its mutants," *Jour. Exp. Zool.*, 25: 49, February, 1918.

of *Drosophila* known as *white* and *vestigial* show variations from the reactions of wild flies to light. He decided that the *vestigial* flies are not oriented by light, a conclusion apparently verified by experiments in which wild flies, whose wings had been removed, were used. The *white* race oriented positively to light, but with less regularity and precision. In my experiments it was also found that *white* flies are less precise in their photic orientation, it being many times impossible to secure satisfactory readings on 50 per cent. of the individuals, since after reaching the top of the cylinder some would crawl back to the bottom, even under an intensity of 1,500 c.m. No results, therefore, are presented for the *whites*. In the case of *vestigial* flies it was found that a mechanical factor retarded orientation. When the glass cylinder was used for these flies it was discovered that the reason they did not reach the top was because they continually lost their foothold, when part way up, and fell back to the bottom. This also happens with wild flies whose wings are normal, but immediately the wings are spread and the animal secures a new foothold very near where he was before. The upward movement is then continued, very little time having been lost. This difficulty with *vestigials* was removed by lining the cylinder with very thin Japanese rice paper. This may easily be done by moistening the paper, pressing it against the glass and allowing it to dry. With paper-lined cylinders the *vestigial* flies are strongly phototropic and reach the top in almost the same time as wild ones. The results are as follows: with illumination of 1,500 candle meters the time was 6.81 seconds; with 750 c.m., 7.92 seconds; and with 75 c.m., 11.1 seconds. In darkness the time for *vestigials* was 12.2 seconds. From this data it is evident that *vestigial Drosophila* is positively phototropic, the degree being only slightly less than in wild flies, as measured by the rate of locomotion. Some of this difference is undoubtedly due to the aid rendered by the flying of the wild individuals, although, as far as possible, all cases of extended flight were omitted from the averages.

It may be stated, therefore, that the effect of light on the locomotion of *Drosophila melanogaster* is related to the intensity of the photic stimulus according to the Weber-Fechner law, and secondly that the race of flies known as *vestigial* is positively phototropic, and may be demonstrated as such if the animals are given a rough surface on which to crawl.

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THE STRUCTURE OF BENZENE

THE writer has shown, in his thesis for the master's degree[1] and in an article soon to be published, that the benzene model first proposed by Körner,[2] and later advocated by Marsh,[3] Vaubel,[4] and others, interpreted in the light of the Lewis theory of the atom,[5] has a sound theoretical basis. By applying a theory of conjugation resembling in many respects that presented by Erlenmeyer, Jr., in 1901,[6] all objections to this benzene structure but one—that ortho and meta di-substitution products should, according to the theory, give stereoisomers which have not yet been resolved—have been removed.

In this model the six carbon tetrahedra have their bases all in the same plane, the hydrogen atoms and the points of the tetrahedra to which they are bonded being alternately above and below this plane. There are six electrons grouped around the center of each hexagon, and two at each of the hexagon corners and on the centerlines between each hydrogen and the carbon to which it is bonded.

In a paper written in October, 1920,[7] the

1 Written in April, 1920; on file in the Library of the University of California.

2 *Gaz. chim.*, 4: 444 (1874).

3 *Phil. Mag.*, 26: 426 (1888).

4 *J. prakt. Chem.*, [2] 44: 137 (1891); 49: 308 (1894); 50: 58 (1894. "Lehrbuch der theoretischen Chemie [J. Springer, Berlin, 1903],I, 468.

5 *J. Am. Chem. Soc.*, 38: 762 (1916).

6 *Ann.*, 316: 43, 71, 75 (1901).

7 This paper was revised and submitted for publication in April, 1921. It is expected that it will soon be published.