THE CHEMORECEPTORS OF CERTAIN DIPTEROUS LARVAE

IN spite of the frequency with which the larvae of such dipterous insects as the blow-flies are used in experimental work, the correct assignment of function to certain of their sense organs is seldom made. The most conspicuous of these organs are two pairs which are located in papillae on the oral lobes. Each organ consists of a compact group of cells connected by a relatively large nerve to the larval brain and communicating with the exterior at the end of the papilla. The first mention of these which has been found in the literature was made by Newport,[1] who, in a description of the larva of *Oestrus ovis,* called them "organs of vision." From their position and structure Weismann[2] later ascribed to them the sense of touch, and recently, in a study of the structure and development of *Drosophila,* Strasburger[3] holds this same view. In his monograph on *Calliphora* Lowne[4] speaks of them as "eye-like organs," and it is to his description that reference is most often made. Hewitt[5] states that they are the only obvious sense organs found on the larva of the house-fly, *Musca domestica,* and concludes, "Judging from their structure the organs appear to be of an optical nature, and this is the usual view which is held with regard to their function."

With few exceptions, notably Patten[6] and Crozier and Kropp,[7] most investigators who have used blow-fly larvae in studies of their responses to light have accepted these earlier decisions, based entirely on anatomical studies, that the organs on the oral lobes are the photoreceptors. The work of Pouchet[8] has been almost completely overlooked, and unfortunately so, since he showed in a series of simple convincing experiments that these organs in question could not be the only light receptors, for, when they were destroyed by cautery, the larvae still reacted normally to stimulation by light.

The experiments performed by Pouchet have been repeated on *Lucilia sericata* with similar results. These organs are certainly not the photoreceptors of blow-fly larvae. Are they organs of touch or do they serve some other function? The results of the following experiment answer this question. Three pairs of filter flasks were connected by way of their side arms and a piece of decaying meat placed in one member of each of two pairs. Larvae were introduced into the other member of a pair; the flasks were stoppered and left in the dark for one hour. A count was then made of the larvae in each of the flasks. Table 1 gives a summary of the results of five separate tests:

TABLE 1

	Normal larvae		Larvae with oral papillae removed		Normal larvae	
Flask	1	2	3	4	5	6
		(food)		(food)		
Distribution of larvae at beginning of tests	70	0	70	0	70	0
Distribution of larvae at the end of tests.	6	64	59	11	50	20

The great majority of the normal larvae passed from Flask 1 to Flask 2, presumably being attracted there by the odor from the meat. Only eleven of the seventy larvae with the receptors in question destroyed passed from Flask 3 to Flask 4, and this perhaps by chance, for in the control with normal larvae and no meat in the second flask twenty larvae wandered through the connecting passageway and were found in Flask 6, where there was nothing to attract them.

Thus it appears that at least one pair of the two pairs of sense organs on the oral lobes of *Lucilia sericata* is olfactory in function. There is some evidence from their structure that the two pairs do not serve the same purpose. The more dorsal ones have a central cavity with a valve-like structure guarding the opening of each to the exterior. The ventral organs are solid and the ends of the elongated sensory cells protrude through the opening in the papilla in such a manner that they may come in direct contact with the substrate. It is possible that the dorsal organs are olfactory and the ventral ones gustatory, although there is no experimental proof that this is the case.

The photoreceptors of blow-fly larvae remain to be identified. The cauterizing of various parts of the oral lobes and segments of the so-called "head" does not affect in any marked way the response to light. It is possible that the photoreceptors are scattered throughout the head region and that it is difficult to eliminate them all without serious injury to the larva. Viallanes[9] described and figured a complex network of nerve cells lying under the hypodermis of dipterous larvae, and in addition occasional groups of cells which he termed "peripheral ganglia." In cross sections of the anterior end of *Lucilia sericata* two clusters of sensory cells have been found, located one on either side of the prothorax. Their position is

[1] G. Newport, "Insecta." Todd's "Cyclopedia of Anatomy and Physiology," London, 1836–39.

[2] A. Weismann, *Zeitschr. f. wiss. Zool.,* 14: 187, 1864.

[3] E. H. Strasburger, "Drosophila melanogaster Meig, Eine Einfuhrung in den Bau und die Entwicklung." Julius Springer, Berlin, 1935.

[4] B. T. Lowne, "The Anatomy, Physiology, Morphology, and Development of the Blow-fly." Vol. I, R. H. Porter, London, 1890.

[5] G. G. Hewitt, *Quart. Jour. Micro. Sci.,* 52: 495, 1908.

[6] B. M. Patten, *Jour. Exp. Zool.,* 17: 213, 1914.

[7] W. J. Crozier and B. Kropp, *Jour. Gen. Physiol.,* 18: 743, 1935.

[8] G. Pouchet, *Rev. et Mag. de Zoöl.,* Sér. 2, 23: 129 and 225, 1871–72.

[9] H. Viallanes, *Ann. Sci. Nat. Zoöl.,* Sér. 6, 14: 1, 1882.

such that they might well be concerned with light reception, but carefully executed experiments will be necessary in order to make this matter certain.

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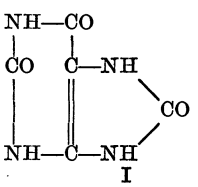
THE DISCOVERY AND IDENTIFICATION OF A NEW PURINE ALKALOID IN TEA

ALL the N-methyl derivatives of 2,6,8-trioxypurine I theoretically possible have been prepared synthetically, and we have to-day a very complete knowledge of their chemistry. Emil Fischer and Heinrich Biltz, with the collaboration of many coworkers, are the two investigators who have contributed the most to our present knowledge of the chemistry of these purines and their derivatives.



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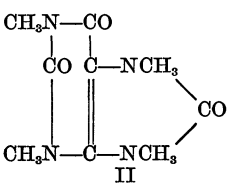

II

The occurrence of 2,6,8-trioxypurine as a product of purine catabolism in both the animal and plant kingdoms has been demonstrated conclusively, but, so far as the writer is aware, no N-methyl derivative of the purine I has, thus far, been shown to occur in nature. The author now presents this short note to report that the *tetramethyl-2,6,8-trioxypurine* represented by Formula II occurs in the mixture of purine alkaloids extracted from tea. It has been separated in a pure condition from such extracts, and has been shown to be identical with *1,3,7,9-tetramethyl-2,6,8-trioxypurine II* (tetramethyluric acid), which was first described by Emil Fischer[1] in 1884. Just as soon as proper and sufficient experimental material becomes available for the continuation of our plant extract researches, it is the intention of the author to search for this alkaloid and other N-methylated purines in the purine extracts of coffee and other plants. The results of this research program will be discussed in future papers to be presented for publication in the *Journal* of the American Chemical Society.

TREAT B. JOHNSON

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONDENSER DISCHARGE STIMULATOR FOR PHYSIOLOGICAL PURPOSES

THE stimulator described in this report has been designed for the determination of the adequate shape and duration of current pulses used as stimuli on the cerebral motor cortex.[1] It has been found a useful device for general stimulation experiments wherever an attempt is made to gain more information about the excitable structures responsible for a certain effect. It also provides for a selective stimulation[2] in mixed peripheral nerves or in mixed tracts or centers within the central nervous system.

The set-up is based on the principle of condenser discharges adapted to the relatively low resistance of the tissue to be stimulated through a single-stage power amplifier.[3] It allows stimulation with alternating single or double condenser discharges whose duration, *i.e.*, time constant, can be changed over a wide time range (from .01 to 100 or 1000 milliseconds) without any change at all in the amplitude (peak intensity) of the discharges. The stimulating voltage, up to 10 or 20 volts, is led off from a potentiometer of 2,000 ohms maximum resistance. Any influence of the stimulating circuit upon the time constant of the condenser system is excluded.

From a source of potential A two condensers C and C^1 of different capacities are charged by make of K over two identical resistances R and R^1 to the same voltage, and they discharge over the same two resistances and a common resistance S, low in comparison with R and R^1, when K is opened. The resulting potential wave between x and y has its shape and direction determined by the ratio of one capacity to the other. It represents an ordinary condenser discharge if one condenser is disconnected, and a double condenser discharge (see[3]) if both condensers are placed in the circuit. Any such potential wave between x and y causes in the plate circuit of the amplifier tube AT (Cunningham 2A3) a current wave of identical shape. The resting plate current of AT is compensated by another similar tube CT with adjustable heater resistance. Equilibrium between the two tubes, *i.e.*, absence of potential between the ends of the potentiometer p, is controlled by a high resistance galvanometer v. Both halves of the potentiometer are divided into twenty intervals of 50 ohms each. Provided that the stimulating current is always led off from two symmetrical steps on the corresponding halves of the potentiometer, the current in the stimulating circuit is only due to, and directly pro-

[1] O. A. M. Wyss and S. Obrador, *Am. Jour. Physiol.*, in press (1937).

[2] O. A. M. Wyss, *Schweiz. Arch. f. Neur. u. Psych.*, 28: 210, 1932.

[1] Emil Fischer, *Ber.* 17: 1784 (1884); also *Ber.* 30: 3009 (1897).

[3] *Idem.*, *Pflüger's Arch.*, 233: 754, 1934.