A New Physical Theory of the Mode of Action of DDT

Investigations of temperature (15.5 ± 1.5 °C and 26.25 ± 1.25 °C) effects on the spontaneous electrical activity of the crural nerve of *Schistocerca gregaria* Forsk. treated with DDT have shown: (1) a definite positive straight line relationship between log dosage and log impulse frequency, (2) a positive temperature coefficient of impulse frequency both in treated and untreated insects, (3) a negative temperature coefficient of % increase in impulse frequency in treated insects (Figure 1), and (4) occurrence of blocks, i.e. a sort of breakdown in the electrical activity of the nerve at lower temperatures but not at higher temperatures (Figure 2). The last observation, i.e. the occurrence of blocks only at lower temperatures, implies that the physico-chemical processes involved in the transmission of impulses may be such as would make the occurrence of breakdown more probable at lower temperatures. A number of workers have demonstrated that the emergence of the spike potential of nerve impulse is associated with the ionic transport (especially of Na^+ and K^+) across the cell membrane (HODGKIN[1]). Further, WALDEN[2] has shown that the product of the ionic speed and the viscosity of the medium is a constant. Also it is well established that the viscosity of colloidal systems increases with decrease in temperature. Hence interpreting our present observation in the light of the three abovementioned phenomena well established by previous workers, it is theorized that the occurrence of blocks in the nerve activity at lower temperatures is a reflection of a disturbance in the ionic transport across the nerve membrane, and that the increase in the viscosity of the matrix of neuron membrane at lower temperatures is responsible for a sort of hindrance in this ionic transport. Following the foregoing line of thought the mode of action of DDT can be visualized as given below:

As established in the present investigations, DDT increases the frequency of nerve impulses, i.e. the frequency of ionic transport across the neuron membrane. This frequency is bound to have an upper critical limit depending on the viscosity of the neuron matrix which in turn depends on the prevailing temperature. Hence, blocks occur in impulse transmission as a result of interference when the DDT dose increases the impulse frequency beyond the critical limit imposed by the viscosity of the matrix at a particular temperature. This interpretation regarding the mode of action of DDT satisfactorily fits in with the general observation that DDT first leads to excitation followed by paralysis and death. One can easily visualize that the state of non-coordinated movements which follow initial excitation may correspond to the occurrence of reversible blocks in the nerve activity, while death may be the result of a permament block. Finally, of course, it must be admitted that much more work will be needed to confirm this theory, the present value of which is that it provides a useful working hypothesis for further work. Full experimental details will be published elsewhere.

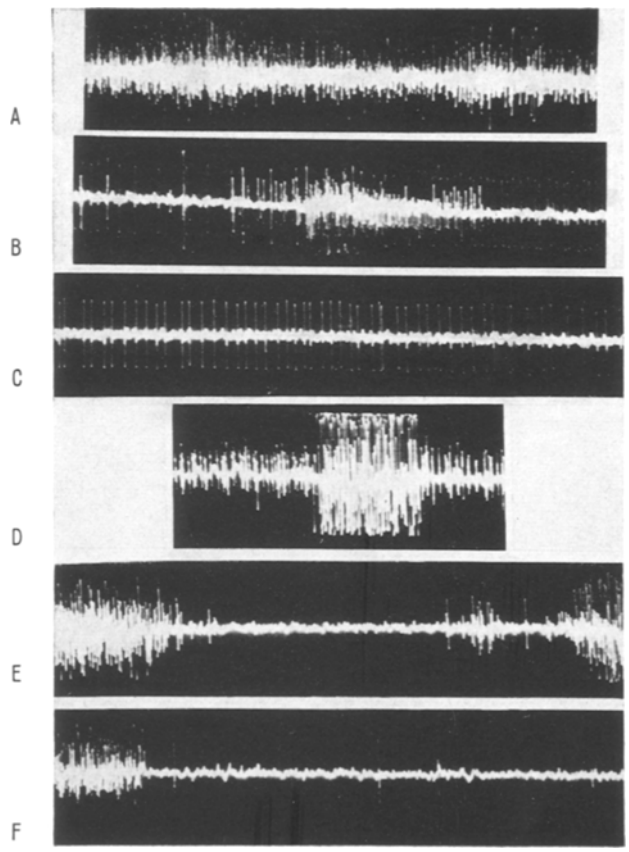

Fig. 2. Effect of temperature (15.5 ± 1.5 °C and 26.25 ± 1.25 °C) on the pattern of electrical activity in the crural nerve of *Schistocerca gregaria* treated with DDT. A, B, C and D occur at both the temperatures while E and F occur only at the lower temperature.

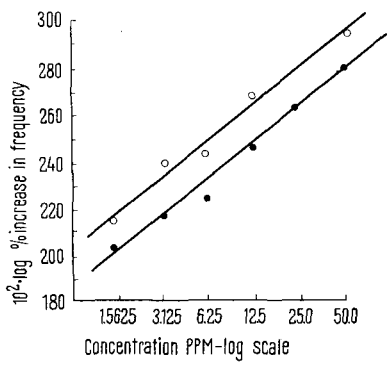

Fig. 1. Effect of temperature on DDT action on the % increase in the frequency of impulses. o——o 15.5 ± 1.5 °C; •——• 26.25 ± 1.25 °C.

Résumé. Les relations quantitatives ont été établies entre la fréquence des impulsions et les dessins d'activité électrique de la nervure crurale de *Schistocerca gregaria* Forsk., d'une part et la température et le dosage de DDT d'autre part. Ces données-ci ont rendu possible une nouvelle hypothèse de l'action du DDT.

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[1] A. L. HODGKIN, Biol. Rev. *26*, 339 (1951).
[2] P. WALDEN, Z. phys. Chem. *55*, 207 (1906).