Comparative Toxicity of DDT Isomers and Related Compounds to Mosquito Larvae and Fish[1]

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Laboratory and field investigations conducted during the last three years have shown that DDT is highly toxic to both mosquito larvae and fish (*1*). Because of its toxic effects on fish, the usefulness of DDT in mosquito control is at present restricted to areas where no danger of poisoning fish exists. The studies here described were made with the purpose of ascertaining to what extent certain isomers and analogues of DDT vary in their toxic properties to fish and mosquito larvae. Accordingly, toxicological tests were carried out on mosquito larvae, *Aëdes aegypti*, and on goldfish, *Carassius auratus*, with two isomers and two analogues of DDT, and with DDT-technical grade as follows:

(1) DDT—Technical grade [Dichlorodiphenyl trichloroethane]
(2) p,p'-DDT isomer [1-trichloro-2,2-bis(p-chlorophenyl)ethane]
(3) o,p'-DDT isomer [1-trichloro-2-o-chlorophenyl-2-p-chlorophenylethane]
(4) DDD analogue [1-dichloro-2,2-bis(p-chlorophenyl)-ethane]
(5) Methoxy (CH_3-O) analogue [Di(p-methoxyphenyl)-trichloroethane]

The tests on mosquito larvae were made in beakers, each containing 200 cc. of distilled water and about 50–60 fourth-instar larvae of *A. aegypti*. One cc. or less (depending on the dilution in parts per million desired) of ethanol containing various concentrations of the toxicants was dispersed in each beaker. Preliminary check tests showed that such small amounts of ethanol alone had no effect on the larvae. Each concentration was run in four replications, giving a minimum of 200 larvae per test. At the end of 48 hours the dead and live larvae were counted. During this period some of the larvae had pupated, and the live pupae were included with the surviving larvae.

The results, summarized in Table 1, show that the o,p'-DDT isomer is decidedly less toxic to larvae than any one of the other four compounds tested, requiring about 2.5 ppm to produce 100 per cent mortality, as compared with 0.1–0.2 ppm for the other compounds. In concentrations of 0.05 ppm or lower the methoxy analogue proved less toxic to larvae than either the DDD analogue or DDT. No significant difference in toxicity between technical DDT and the pure p,p'-DDT isomer was observed in the concentration here tested.

The tests on goldfish were made in glass jars, each containing 3 l. of water and 5 fish, 6–9 months old. About 1 cc. or less, as required, of ethanol solutions containing various concentrations of the toxicants was stirred into jars. The highest amount of alcohol added to any one of the jars was 1.2 cc., or .04 per cent. In this manner, dilutions ranging from .06 to 4 ppm of toxicant in water were obtained. The tests were repeated four times, giving a total of 20 fish per dilution. Observations were continued for four days without feeding. During this period the dead fish were removed as soon as they were noticed.

TABLE 1

COMPARATIVE TOXICITY OF DDT (TECHNICAL), TWO DDT-ISOMERS, AND TWO DDT ANALOGUES TO LARVAE OF *A. aegypti*

Dilution (ppm)	DDT (Technical)	Larvae dead in 48 hours (%)			
		p,p'-DDT isomer	o,p'-DDT isomer	DDD analogue	Methoxy analogue
5.0	—	—	100	—	—
2.5	—	—	94	—	—
1.0	100	100	90	100	100
0.5	100	100	75	100	100
0.2	100	100	22	100	100
0.1	100	100	6	100	88
0.05	100	100	4	100	40
0.025	90	92	3	81	9
0.012	75	75	—	73	3
0.010	35	40	—	65	—

Check—0.5 per cent alcohol = 3 per cent larvae dead

TABLE 2

COMPARATIVE TOXICITY OF DDT (TECHNICAL), TWO DDT ISOMERS, AND TWO DDT ANALOGUES TO *C. auratus*

Dilution (ppm)	DDT (Technical)	Dead after 4 days (%)			
		p,p'-DDT isomer	o,p'-DDT isomer	DDD analogue	Methoxy analogue
4.0	—	—	100	100	—
2.0	—	—	80	100	—
1.0	100	100	50	60	100
0.5	100	100	15	25	100
0.25	100	100	10	10	100
0.125	40	90	—	—	90
0.0625	10	60	—	—	60

Check—.04 per cent alcohol = 10 per cent fish dead

The results, summarized in Table 2, show that the o,p'-DDT isomer and the DDD analogue are definitely less toxic than any one of the other three compounds, both requiring about 2–4 ppm to give 100 per cent mortality, as compared with only 0.25 ppm for the other compounds. In lower con-

[1] Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Entomology.

centrations, such as 0.06 ppm, the p,p'-DDT isomer and the methoxy analogue showed higher toxicity than did the technical DDT.

Summary. The p,p'-DDT isomer is several times as toxic as the o,p'-DDT isomer to both goldfish and mosquito larvae. The methoxy analogue equals DDT in toxicity to fish, but is less toxic to mosquito larvae. On the other hand, the DDD analogue ranks about as high as DDT in toxicity to mosquito larvae, but appears to be less toxic to goldfish.

Reference

1. GINSBURG, J. M. *J. econ. Entomol.*, 1945, **38**, 274, 494; *Proc. annu. Meet. N. J. Mosquito Exterm. Ass.*, 1945, **32**, 45.

The Functions of the Intercortical Neurones in Sensorimotor Coordination and Thinking in Man[1]

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The manner in which the association pathways of the brain of man integrate the effects of stimulation to cause verbal and motor response represents a central problem of physiological psychology. Some aspects of this problem have been investigated experimentally by the study of individuals in whom the intercortical pathways were sectioned with the objective of controlling convulsions (*1*).

METHODS

Response times of three major types of reactions were measured before and after section of the principal nerve bands which connect the two cerebral cortices: (1) simple reaction to visual, auditory, and tactile stimuli; (2) visual discrimination reactions; (3) verbal reactions in free-word association, opposites association, and part-whole association. The discriminatory reactions studied consisted of reactions involving presumably uncrossed relations between the two cerebral hemispheres (stimulation of one hemiretina, excitation of one hemisphere, motor response originating in the excited hemisphere), and crossed relations between the two cerebral hemispheres (stimulation of one hemiretina, excitation of one hemisphere, motor response originating in the unexcited hemisphere). The anatomical relations which may be assumed to be concerned in these crossed and uncrossed reactions, four each of which were measured, are shown in Figs. 1A and 1B.

Suitable reaction time equipment consisting of timing devices, manually operated keys, voice keys, and essential electrical circuits were devised to make the measurements.

Six subjects were used in the principal part of the experiment. The responses of these individuals were measured preoperatively and postoperatively under the best obtainable conditions of their health and cooperation. The operative procedures concerned, as described in the neurosurgeon's notes taken at the time of operation, were as follows: (Subject 1) complete section of the corpus callosum; (Subject 3) complete section of the corpus callosum, and about one year later, section of the anterior commissure; (Subject 13) section of the corpus callosum except for 1 cm. at the tip of the splenium; (Subject 16) section of the corpus callosum except for a few fibers at the tip of the splenium and section of the left limb of the fornix; (Subject 19) section of the anterior two-thirds of the corpus callosum and bilateral section of the limbs of the fornix. Fig. 2 indicates the maximal and minimal extent of the section of the corpus callosum in these subjects.

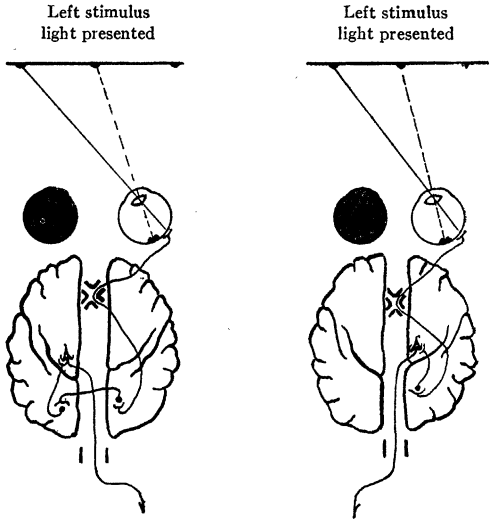

FIG. 1. The hypothetical difference between crossed (A) and uncrossed (B) visual discrimination reactions. (Instructions—A: respond to left light with right hand and to right light with left hand; B: respond to left light with left hand and to right light with right hand.)

THEORY

The extensive nerve connections between the two cortices make up, anatomically, a major part of the total associative mechanism of the brain. If this mechanism consists of a network of discrete neural paths for conducting impulses related to verbal activity and thinking, it seems reasonable that cutting the intercortical fibers would disturb numerous verbal associations. Furthermore, one would suppose that cutting these connecting fibers would disrupt specifically the crossed sensorimotor reactions, as described above, whereas the uncrossed reactions would not necessarily be disturbed.

RESULTS AND DISCUSSION

The results of the experiment are given in Table 1. Column 6 in the table presents the means of the differences between the preoperative and postoperative tests, and Column 7 gives the values of the *t*-ratios for these means.

The results show that the cortical association neurones connecting the two sides of the brain have a significant role in determining direct responses to visual, auditory, and tactile

[1] The present experiments were made possible by the cooperation of Dr. William P. Van Wagenen, who performed the neurosurgical operations, and by Dr. Andrew Akelaitis, who aided in some of the observations on the patients.