THE EFFECT OF CHLOROPHOS AND TEMPERATURE ON THE RESPIRATORY RHYTHM OF FLIES

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THE EFFECT OF CHLOROPHOS AND TEMPERATURE ON THE RESPIRATORY RHYTHM OF FLIES

[Following is the translation of an article by O. N. Vinogradskaya, Institute of Medical Parasitology and Tropical Medicine imeni Ye. I. Martsinovskogo, USSR Ministry of Public Health and the Faculty of Medical Parasitology, Central Institute for the Improvement of Doctors, Moscow, published in the Russian-language periodical Med. Parasit. i Parasit. Bolez. (Medical Parasitology and Parasitic Diseases), No 5, 1964, pages 527--532. It was submitted on 1 Feb 1964. Translation performed by Sp/7 Charles T. Ostertag, Jr.]

At the present time chlorophos is extensively used for combatting flies and other arthropods. Meanwhile the effect of this preparation on flies has still been studied insufficiently. The mission of the present work was clearing up the influence of chlorophos on the respiratory rhythm of flies. It is known that the evaporation of water in diptera, as well as in many other insects, is accomplished through the spiracles (Vinogradskaya, 1960), and therefore a calculation of the time for the ventilation of the tracheal system or of the open position of the spiracles makes it possible for us to judge to a certain degree the loss of water by the insects under the effect of insecticides.

Earlier we established on mosquitoes that following the effect of DDT there was a significant increase in the loss of water by these insects in connection with the prolonged periods of ventilation, apparently caused by the increasing intensity of metabolism.

Chlorophos acts not only as a contact and intestinal poison, but also as a fumigant (Vashkov and Shneyder, 1962). Under the effect of chlorophos significant morphological and physiological changes take place in the hemolymph of flies, and this is expressed in the deformation of formed elements and the significant loss in weight, apparently due to the loss of water by the insects. Thus, in 30--60 minutes following the application of chlorophos the weight of flies is decreased by 62%, and following 5 hours it is 10 times less than in control flies (Zakolodkina, 1959). According to Derbeneva-Ukhova and Lineva (1959), with an increase in temperature there is an increase in the effectiveness of chlorophos. It is known that females are less sensitive to chlorophos than males.

Materials and Methods

The tests were conducted in 1958 and 1959 in the Entomology Department of the IMPi TM (Institute of Medical Parasitology and Tropical Medicine).

In 1958 the object of the investigation were female and male Musca domestica L. from a laboratory culture which was sensitive to insecticides. In 1959 the object of the investigation were female and male Calliphora uralensis Vill. and Calliphora erythrocephala Mg. which were caught in the garden at the institute. Such a change was carried out in connection with the fact that on flies of the genus Calliphora the working of the spiracles could be better distinguished.

Observations of the flies were carried out under a binocular in daylight which was directed onto the sides of the flies' thoraces with the help of a mirror (as our observations of mosquitoes showed, electric lighting of various intensities causes changes in the respiratory rhythm). The flies were attached behind the wings to a cork and observations were made of the working of the prothoracic spiracles. Before the onset of the observations, the pili which closed the slit of the peritreme in the spiracles were drawn apart with dissecting needles, which made it possible during the tests to easily distinguish the opening and closing of the spiracle. During the operation of the respiratory rhythm a stopwatch was used to calculate the duration of the open and closed position of the spiracles. The calculation of the time of the open position of the spiracles was attested to with the duration of ventilation of the tracheal system (in seconds for 1 min. of observation). In the tests with M. domestica specific doses of chlorophos were placed on the insurface of guaze containers with a calculation of 0.008g per M2, and one gram per square meter of surface. All told 10 tests were carried out with M. domestica. Before the test the normal respiratory rhythm was determined for each fly. The flies were kept in the container which was treated with chlorophos for 5 minutes, after which they were immediately attached to the cork for observation under the binocular.

In the 1959 tests with C. uralensis and C. erythrocephala the method of applying the chlorophos was changed. The chlorophos was applied by the contact method in the Nabokov and Laryukhin eksposimeter [? exposure device] or by the fumigant method. During the contact method the chlorophos was placed on a cardboard plate and contact in the exposure device lasted for 5 minutes. Following this the observations of the flies on the cork lasted 80--90 min. In the fumigant method the chlorophos treated cardboard plate (10 x 10 cm in size) was placed at a distance of 8 cm from the fly, which was attached to the cork, and in this manner the effect of the chlorophos was realized throughout the entire period of observation. The dose of chlorophos in these tests was 2 grams per one square meter. When carrying out the observations the temperature and humidity of the surrounding air were always taken into consideration. The conditions in the test and the control were always the same. With C. erythrocephala 5 tests were conducted and with C. uralensis -- 19.

Results

The conditions in the test and the control were always the same. The results of the tests are presented in figures 1--6. The curves were compiled

on the basis of the average results of the observations which were obtained when carrying out a series of tests of the same type. It must be noted that in flies a clear rhythm [1] of closing and opening the spiracles is not always observed.

Footnote 1. By clear rhythm we mean the successively repeating change of periods, which are similar in duration, of the open and closed position of the spiracles, which was observed by us in mosquitoes (Vinogradskaya, 1960).

In M. domestica at a temperature of from 18.8 up to 25° an increase is observed in the duration of ventilation of the tracheal system under the action of chlorophos following an increase in its concentration (see figure 1).

The tests with Calliphora (mainly C. uralensis) made it possible to expose the effect of temperature and a deficit of humidity, and also the contact and fumigant effect of chlorophos on females and males. The results of the tests on the duration of ventilation of the tracheal system of flies depending on the temperature are depicted in figure 2. A difference is noted in the reaction to temperature on the part of the females and males of this species. In males, with an increase of temperature there is an increase in the duration of ventilation of the tracheal system, and in the females a decrease. This may be appraised as a protective adaptation in females for the preservation of water in the body during increased temperatures. In the males this adaptation is absent. The stated phenomenon may be one of the reasons for the greater duration of life for the females in comparison with the males.

A change in the deficit of humidity also was reflected in the duration of ventilation of the tracheal system. In the males an increase in the deficit of air humidity is accompanied by a successive increase in the duration of the ventilation of the tracheal system. In the females during a deficit of humidity from 10 to 25 mm the duration of ventilation is decreased, and with a further increase of it ventilation is extended. This speaks for the unfavorable influence of a high deficit of humidity (see figure 3).

The results of the tests on the study of the effect of chlorophos on male Calliphora uralensis is depicted in figure 4, on females in figure 5.

Both following the contact as well as during the fumigant effect of the insecticide in the males there was observed a significant increase in the duration of ventilation of the tracheal system. Following contact the spiracles are open for a lengthy interval of time and in 55--60 minutes of the test they hardly closed, apparently causing a great loss of water and the subsequent death of the insects.

In the female C. uralensis following the contact and fumigant effect there was observed a lengthening of the periods of ventilation of the tracheal system in comparison with the control during the first 20 minutes of the test. In longer periods ventilations decreased and in an hour almost reached normal.

Thus, both in males and females, following contact as well as during the fumigant effect of chlorophos, the duration of the periods of ventilation is considerably increased in comparison with the control; consequently it can be assumed that the dehydration of the bodies of flies promotes their death following poisoning with this preparation. Following the tests the flies were transplanted to clean test tubes where they died usually in the course of 2--5 hours.

In the female C. erythrocephala following contact and during the fumigant effect there is observed an increase in the duration of the periods of ventilation, which is especially perceptible with the contact effect, when the spiracles remain open all the time.

Conclusions

1. The tests on female and male Musca domestica L., Calliphora uralensis Vill. and C. erythrocephala Mg. showed that chlorophos, both during the contact and fumigant method of application, changed the respiratory rhythm of flies in the direction of lengthening the periods of ventilation of the tracheal system.

2. It can be proposed that the death of flies following chlorophos poisoning is promoted by the prolonged opening of the spiracles, ensuring a better entry of the insecticide through the tracheal system, and also the dehydration of the flies from the loss of water.

3. In female C. uralensis following an increase of the surrounding air temperature up to 30°, the periods of ventilation of the tracheal system are reduced, which may be evaluated as a protective adaptation for enduring unfavorable conditions of the external environment. In males ~~(evidently an error in the Russian text)~~ of this species in a temperature of 30° the periods of ventilation are extended, and consequently this adaptation is absent.

Literature

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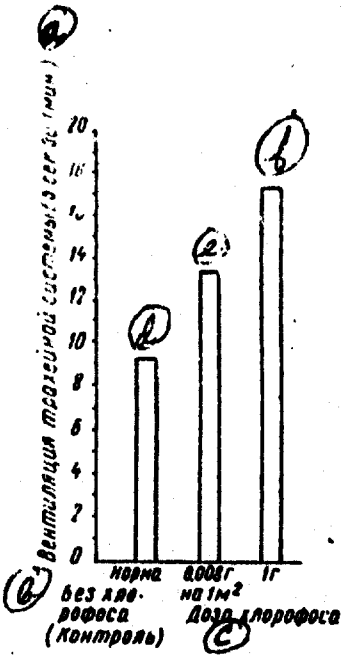

Figure 1. Duration of ventilation of the tracheal system in Musca domestica with various doses of chlorophos. Conditions of the tests and the control: Temperature from 18 up to 25° and deficit of humidity from 11.9 to 20.8 mm.

a - ventilation of tracheal system (in seconds for one minute)
b - without chlorophos (control)
c - dose of chlorophos
d - standard
e - 0.008 g per 1 m^2
f - 1 g

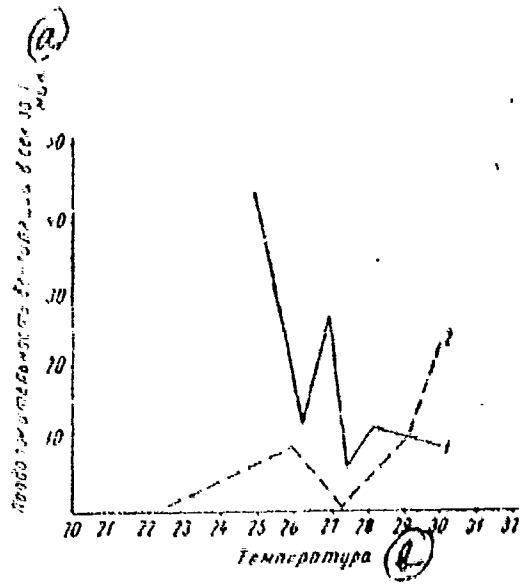

Figure 2. Duration of ventilation of tracheal system in flies depending on the temperature. a - duration of ventilation in seconds for one minute; b - temperature. 1 - Calliphora uralensis females; 2 - C. uralensis males.

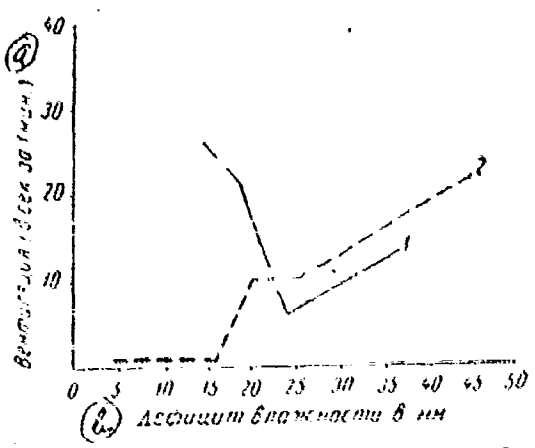

Figure 3. Duration of ventilation of tracheal system of flies depending on the deficit of air humidity. a - ventilation (in seconds for one minute); b - deficit of humidity in mm. 1 - C. uralensis females; 2 - C. uralensis males.

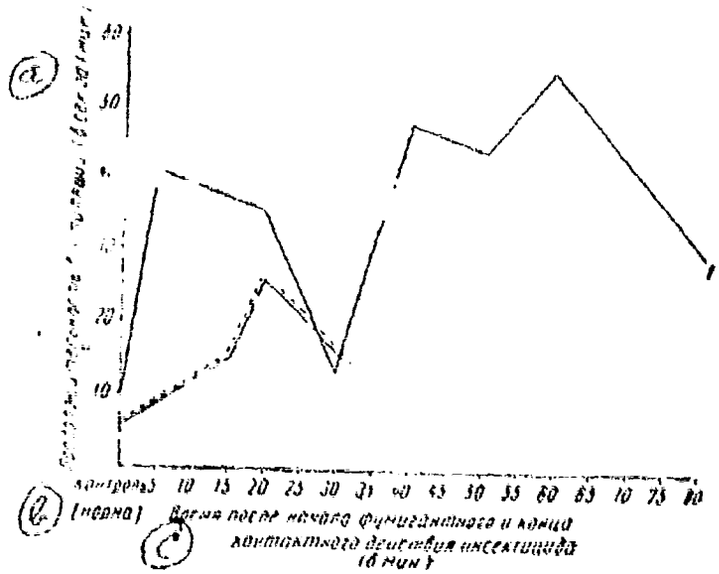

Figure 4. Effect of chlorophos on the respiratory rhythm of male C. uralensis. Dose of 2 g of technical preparation per 1 m^2. 1 - contact effect; 2 - fumigant effect. a - duration of ventilation (in seconds for one minute); b - control (standard); c - time following onset of fumigant and end of contact effect of the insecticide (in minutes).

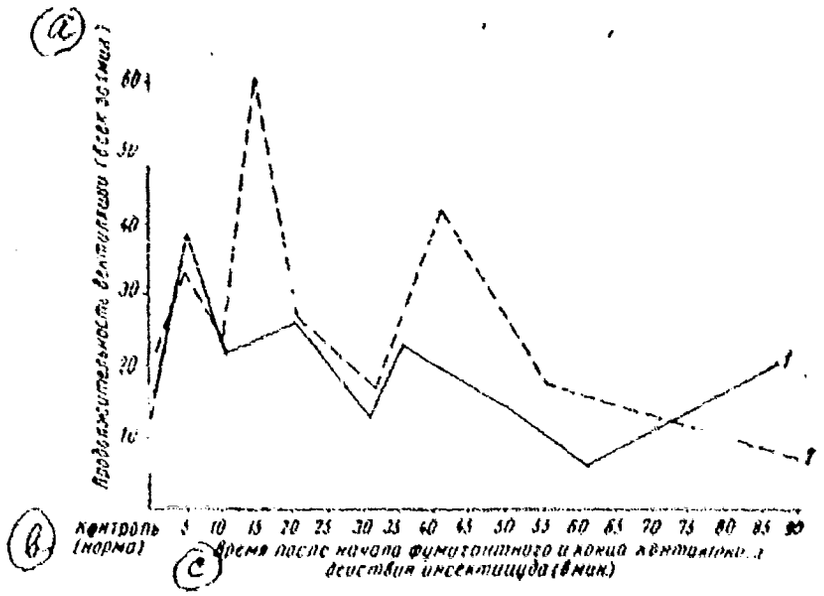

Figure 5. Effect of chlorophos on the respiratory rhythm of female C. uralensis. Legend same as figure 4.

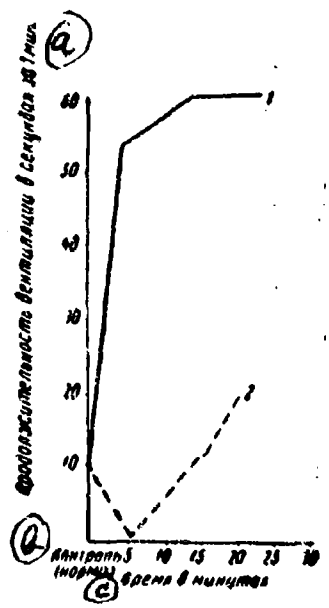

Figure 6. Effect of chlorophos on the respiratory rhythm of female C. erythrocephala. 1 - contact effect; 2 - fumigant effect. a - duration of ventilation in seconds for one minute; b - control; c - time in minutes.