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THE EFFECT OF APHOLATE ON OXYGEN CONSUMPTION OF THE EGGS OF HOUSE FLIES, *MUSCA DOMESTICA* L.

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ABSTRACTS

House flies were fed on a skim milk diet at different levels of apholate content namely, 0, 0.15, 0.25 and 0.5%, for five days after emergence. The effects of apholate on oxygen consumption of eggs were measured by a conventional Warburg respirometer at 25°C. The results are shown in Figure I, and discussions pertaining to the results are given.

I. INTRODUCTION

It is well known that apholate is a chemical capable of causing sexual sterility. LaBracque in 1961 showed that apholate causes the sterility of the type similar to to that induced by radiation and it is an effective sterilant of both sexes of house flies.

In 1963, Gouch and his coworkers (1) took a field experiment on house flies with a corn meal bait containing 0.75% of apholate. They found that the house fly population decreased from 63 per grid to 5 to 20 during the first 7 week and remained between 0 and 3 per grid during the following 5 weeks. The egg hatching rate was 81% before treatment, but decreased to 12 to 49% while applications were made once every week for 7 weeks and 2 to 26% thereafter. Painter and Kilgore (3) reported that apholate at the concentration as low as 0.1% in the diet could reduce the viability significantly. Higher concentration levels, such as 0.25 to 1.0%, resulted in lower egg laying rate, even causing almost complete non-viability.

Apholate also has significant toxicity to boll weevils (*Anthonomus grandis* Boheman) and the effective sterilizing dosages resulted in high mortalities (2). The application of apholate to common malaria mosquitoes (*Anopheles quadrimaculatus* Say) has the same successful sterilized result (8).

Both the laboratory experiment and the field tests have indicated that apholate is a good chemical to eradicate house flies. Although much work has been done on the use of chemosterilants for the control of insects, very little has been known about the metabolism of the eggs laid by the treated insects. So far, studies on the oxygen consumption of house fly eggs were made to correlate the temperature changes and diapause with the embryonic

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development (4-7). This paper presents the rate of oxygen consumption of the eggs laid by the apholate treated flies.

II. MATERIALS AND METHODS

A pure strain of house flies, *Musca domestica* L.* was used in this experiment. The house flies were fed on a skim milk diet (7 gm skim milk powder and 65 ml water) containing 0, 0.15, 0.25 or 0.50% of apholate** (2, 2, 4, 4, 6, 6-hexahydro-2, 2, 4, 4, 6, 6-hexakis-(1-aziridinyl) 1, 3, 5, 2, 4, 6, triazatriphosphorine) for five days after emergence. Eggs were collected by the aid of a camel hair brush.

Oxygen consumption was measured by the use of a conventional Warburg respirometer at 25°C. Fifty eggs were placed in the main chamber of a monometric flask and 0.2 ml of 20% KOH and a paper wick were placed in the center well to absorb carbon dioxide. After 15 minutes of temperature equilibration, the monometer was adjusted to take the zero time reading. Readings from 5 hours after the egg laying were recorded every one hour for a period of ten hours.

III. RESULTS AND DISCUSSION

The rate of oxygen consumption during the causes of egg development expressed as microleters of oxygen consumed per 50 eggs per hour is shown in *Fig. I.*

The lenght of time for the embryo development of the house flies in this experiment was found to be around 12 hours. From the histological observation of the embryonic development of the house fly, the rate of oxygen consumption of the egg under the experimentation could be correlated roughtly with the embryonic development in the egg. This is examined in each period of the embryonic development as following:

The first period (0-5 hours): There was no embryo formed before the third hour. As the distinct embryo was completely formed at the 5th hour, the oxygen consumption was 10.7 cu.mm/hr.

The second period (5-7 hours): The oxygen consumption rate increased. It seems to correlate with the increase in the embryonic activity.

The third period (7-8 hours): The oxygen consumption was going up and reached to peak I. At this period, the rudimentary intestine was formed and appendages showed their characteristic structure visibly. Therefore the amount of energy required was comparatively high.

The fourth period (9-11 hours): There was a sudden drop of oxygen uptake after peak I was reached. This drop can not be explained at this time.

The fifth period (9-11 hours): The oxygen consumption went up again and reached the maximum.

This rise could be reasonably explained by the fact that the heart of the embryo was formed and beat along with the movement of the lateral body wall and the gut. At this time, the larva was ready to hatch, thus the energy required was enormously large. As a result of these, peak II was reached.

The sixth period (11-12 hours): After peak II was reached, there was a sudden drop of oxygen consumption. This drop seems to be due to the completion of synthetic work responsible for the larval formation.

The seventh period (12-15 hours): The oxygen consumption went up gradually. It is correlated with the metabolic activity of the larva after hatching. Increasing oxygen consumption repre-

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* The strain of the house flies, *Musca domestica* L. was obtained from the Agricultural Research Institute of Taiwan where it was acquired from the London School of Hygiens and has been reared for years.

** The chemical apholate was contributed by chemical division Olin, New York, U.S.A.

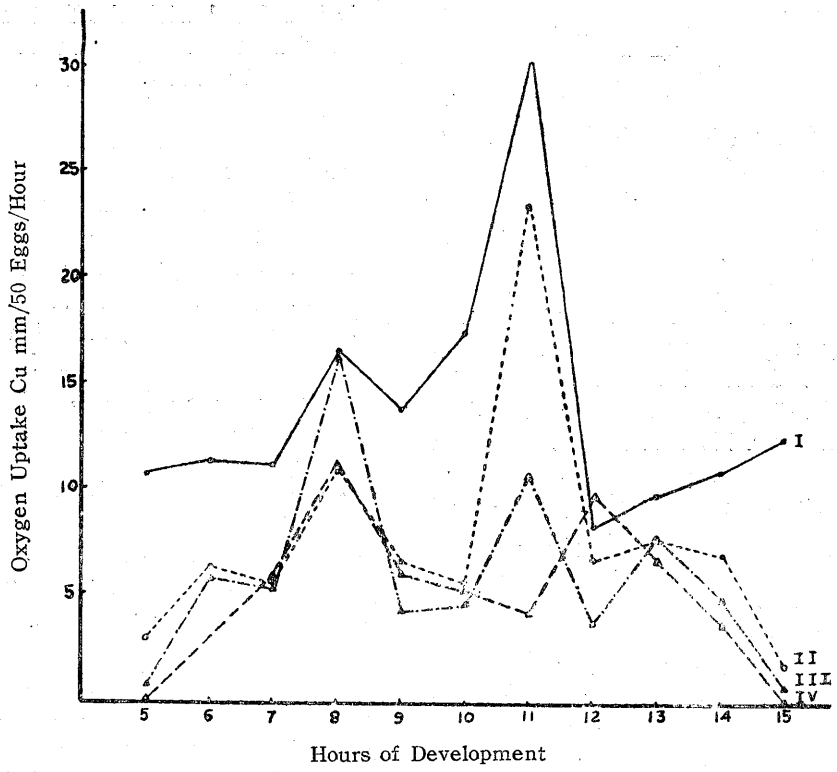

Fig. I. The Rates of Oxygen Uptake of Eggs of House Flies
Curve I The partial quantities of oxygen uptake of the eggs laid by the house flies fed with normal diet.
Curve II fed with 0.15% apholate-diet.
Curve III fed with 0.25% apholate-diet.
Curve IV fed with 0.50% apholate-diet.

sents the increase in the motility of the larva.

Rakshpal (4) divided the period of the embryonic development of the egg of *Gryllus* into three periods: the anatrepsis, the katatrepsis and the prehatching period. It is significant that the periods of the embryonic development of the untreated house flies used in this experiment can also be separated into several periods which are correlated with the growth and differentiation of the embryoes. The period between the 3rd to the 5th corresponds to the anatrepsis. The katatrepsis means the second period of this experiment. The third period is called as the postkatatrepsis. The prehatching period corresponds to the fifth period in our description. This period is signified by the enormous rise in the oxygen uptake as the growth of the larva takes place.

Evidence is presented in this study that apholate treated eggs showed decrease in oxygen consumption rate. The higher the concentration of apholate fed, the more the decrease in oxygen consumption, but there was significant change of the oxygen uptake pattern except at the higher

apholate level.

The pattern of the embryonic development of the house flies fed with 0.15% apholate were similar to the normal embryoic development in a general way, except that the rate of oxygen uptake was more decreased. There were also two peaks obtained in the rate of oxygen consumption at the 8th hour and the 11th hour of the process of embryonic development. Between the 12th and 13th hour, as in the normal eggs oxygen consumption increased a while but declined again to hit the bottom, indicating that the eggs all died by the 15th hour. No larva could be found in the monometric flask after the experiment. This can be roughly explained as that although the embryo developed to the hatching stage, it does not have enough energy to hatch.

It would be of interest to point out that with the flies fed with 0.25% apholate-diet, the rate of oxygen consumption at peak I was higher than the flies fed with 0.15% apholate-diet, and peak II was much lower than peak I. Also, there was a small peak III formed at the 13th hour of the embryonic development, then the rate of oxygen uptake dropped to reach zero. Perhaps these can be explained that the diet with this concentration, it would stimulate the embryonic development than inhibite it. However, this has to be verified in future.

The eggs laid by 0.50% apholate treated house flies showed a respirative pattern distinct from others. The rate of oxygen consumption would indicate that there was embryonic development. However this development of the eggs would be at much slow rate. It reached peak I without attaining a prepeak plateau and peak II was reached about one hour later than that of other three curves. After that, the oxygen consumption dropped down immediately straight forwardly to the state of dealth. This is related with the fact of that the embryo died during the cause of its development and never reached the prehatching stage.

Apholate is considered to cause permanent sterility of ovipositor on many insects. Painter and Kilgore (3) found that when the adult house flies were treated with 0.1 and 0.25% apholate, only 0.25 to 0.01% of eggs were able to hatch. Smith and his co-workers (9) stated that chemosterilants may cause the insects not to produce ovum of sperm, or induce the deaith of ovum and sperm, or produce multiple dominant lethal mutations. Therefore, it is probable that, although fertelization takes place, they do not completely develop into mature progeny.

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V. LITERATURE CITED

1. GOUCK, H. K., D. W. Meiferr and J. B. Gehan. 1963. A field experiment with apholate as a chemosterilant for the control of house flies. *Jour. Econ. Entomol.* **56(4)**: 445–446.
2. LINDQUIST, D.A., L.J. GORZYCKI, M.S. MAYER, A.L. SCALES and T.B. DAVICH. 1964. Laboratory studies on sterilization of the Boll weevil with apholate. *Jour. Econ. Entomol.* **57(5)**: 745–750.
3. PAINTER, RUTH R. and W.W. KILGORE. 1964. Temporary and permanent sterilization of house flies with chemosterilants. *Jour. Econ. Entomol.* **57(1)**: 154–157.
4. RAKSHPAI, R. 1962a. Respiratory metabolism during embryogenesis of *Gryllus veletis* (Alesander & Bigelow) (Orthoptera, Gryllidae). *Physiol. Zool.* **35(1)**: 47–52.

5. RAKSHPAL, R. 1962b. Respiratory metabolism during embryogenesis of a diapeuse species of field cricket. *Gryllus pennsylvanicus* Burmeister (Orthoptera, Gryllidae). *Jour. Insect Physiol.* 8: 217–223.
6. RICHARDS, A.G. and S. SUANRAKSA. 1962. Energy expenditure during embryonic development underconstant versus variable temperature *Oncopeltus fasciatus* "Dallas"). *Ent. Exp. Appl. Amsterdam* 5: 167–178.
7. RICHARDS, A.G. 1964. The generality of temperature effect on developmental rate and on oxygen consumption in insect eggs. *Physiol. Zool.* 37(2): 199–212.
8. SCHMIDT, C.H., D.A. DAME and D.E. WEIDHASS. 1964. Radiosterilization *vs* chemosterilization in house flies and mosquitoes. *Jour. Econ. Entomol.* 57(5): 757–756.
9. SMITH, CARROLL N , G.C. LABREQUE and A.B. BORKEVEE. 1964. Insect chemosterilants. *Annual Rev. of Entomol.* 9: 268–284.