

THE INFLUENCE OF OXYGEN, PARTIAL VACUUM, TEMPERATURE,
RELATIVE HUMIDITY COMBINED WITH GAMMA RADIATION ON THE MOSQUITO,
CULEX PIPIENS COMPLEX L.

I. EFFECT OF EXPOSURE TO TEMPERATURE AND RELATIVE HUMIDITY ALONE.

By

M. HAFEZ*, A. M. ABDEL-RAHMAN*, A. Z. OSMAN**,
A. M. WAKID*** AND M. K. HAFEZ****

*Entomology Department, Faculty of Science, Cairo University, Cairo, Egypt

**Middle Eastern Regional Radioisotope Centre for the Arab Countries, Dokki, Cairo, Egypt

***Radiobiology Department, Nuclear Research Centre, Atomic Energy Authority, Cairo, Egypt

****Academy of Scientific Research and Technology, Cairo, Egypt

تأثير الأوكسجين والتفريغ الجزئي ودرجة الحرارة والرطوبة
النسبية مع أشعة جاما على بعوضة الكيولكس بينز
١ - تأثير درجة الحرارة والرطوبة النسبية وحدهما
(بدون إشعاع)

محمود حافظ و أمينة عبدالرحمن و عزمي زكي عثمان
عبد الفتاح مجاهد واكد و مديحة كامل حافظ

أظهرت النتائج أن درجة ١٠ م هي أنسب درجات الحرارة المؤثرة على نسبة الوفيات في العذارى المعاملة ، تليها درجات ٢٢ ، ٢٠ ثم ٢٦ م . كما أظهرت النتائج زيادة تدريجية في نسبة الوفيات مع زيادة مدة التعريض لهذه الدرجات (١/٢ - ٤٨ ساعة) . وعند تعريض العذارى لفترات زمنية مختلفة (١/٢ - ٤٨ ساعة) لمستويات رطوبة نسبية مماثلة ازدادت الوفيات مع نقص هذه المستويات . وقد أظهرت النتائج تأثير غير معنوي على نسبة الوفيات في حالة التعريض لفترات زمنية قصيرة بينما زادت نسبة الوفيات بزيادة فترة التعريض .

Key Words: Effect of temperature, relative humidity, *Culex pipiens*.

ABSTRACT

The results revealed that a temperature of 10°C was the most effective temperature on pupal mortality of *Culex pipiens* complex L. followed by 32°C then 20 and 26°C. There was a gradual increase in pupal mortality with increasing the time of exposure to temperatures.

The pupal mortality increased with decreasing the relative humidity levels at the same time of exposure. Exposure for short time periods did not affect significantly the pupal mortality. Increasing the exposure time increased mortality.

INTRODUCTION

In a previous work (Wakid *et al*, 1993) the effect of oxygen and partial vacuum on the pupal mortality of *Culex pipiens* complex L. was investigated. In the present work the other two physical factors i.e. temperature and relative humidity are studied as to their lethal effect on the same species.

MATERIAL AND METHODS

The stock colony of *Culex pipiens* complex L. was successfully maintained in the laboratory at room temperature of 24-28°C and 60-70% R.H. The colony has been maintained up till the end of the work in the Entomology Laboratory, The Middle Eastern Regional Radioisotope Centre for the Arab Countries, Dokki, Cairo. The insects were reared as described by Abdel-Malek and Ahmed, (1972). The effect of temperature on the mosquito was investigated by applying

three temperature levels, relatively low temperature ($10\pm 2^\circ\text{C}$ and $20\pm 2^\circ\text{C}$), a moderate temperature ($26\pm 2^\circ\text{C}$) and a high temperature ($32\pm 2^\circ\text{C}$). The first temperature degree ($10\pm 2^\circ\text{C}$) was achieved by a refrigerator whose temperature was $10\pm 2^\circ\text{C}$. The temperature was controlled automatically by a thermostat switch. The other low temperature degrees (20°C), was applied in the laboratory in the cold months of the year from November to February in the years 1987, 1988 and 1989, during which time the temperature could be controlled between $18\text{--}22^\circ\text{C}$. The effects of the moderate temperature degree ($26\pm 2^\circ\text{C}$) were studied in the room temperature which was controlled at this temperature for maintaining the stock culture. In the experiments dealing with the effects of the high level temperature ($32\pm 2^\circ\text{C}$) a thermoregulated incubator was used.

Each treatment was carried out as follows: Samples of newly formed pupae were placed over water-soaked cotton pads in Petridishes and exposed to the used temperature levels for the desired time. Then pupae were exposed to the ordinary conditions till emergence. The optimum temperature degree was determined according to the median lethal dose after 24 hours exposure, and the optimum time of exposure to that degree was determined according to percent mortality of pupae.

In an attempt to estimate the effect of relative humidity on *Culex pipiens*, a saturated aqueous solution of each of $\text{CaCl}_2\cdot 6\text{H}_2\text{O}$, $(\text{NH}_4)_2\text{SO}_4$ and $\text{NH}_4\text{H}_2\text{PO}_4$ with excess of the solid substance within a closed space (a flask 100 ml.) were held at 25°C . The humidity inside the flasks being 31.00%, 81.10% and 93.00%, respectively.

After 30 minutes incubation period, the flask was carefully opened and a sample of newly formed pupae were introduced inside. The pupae were kept on cotton pads in the upper surface of a glass tube (5x2 ml.) inside the flask, after which it was immediately covered. The optimum percent of relative humidity was determined according to the $\text{LD}_{50}/24\text{h}$ value.

Statistical analysis were done according to Witte (1989) and Renner (1970).

RESULTS AND DISCUSSION

Effect of Temperature:

Data recorded on Fig. 1 show the percent mortalities of pupae after treating with $32\pm 2^\circ\text{C}$, $26\pm 2^\circ\text{C}$, $20\pm 2^\circ\text{C}$ and $10\pm 2^\circ\text{C}$. Results reveal that, $10\pm 2^\circ\text{C}$ and $32\pm 2^\circ\text{C}$ were the most effective degrees of temperature applied as their initial kill after 24 hours from exposure were 49.66% and 17.83%, respectively, followed by $20\pm 2^\circ\text{C}$ with percentages mortality of 15.00 and 4.50, respectively, after the same period of exposure (i.e., 24 hours). Statistical analysis of these results showed the least response for moderate temperature ($26\pm 2^\circ\text{C}$) with the lowest mortality recorded showing insignificant differences from the untreated samples except after 32 and 48 hours of treatments. On the other hand, $10\pm 2^\circ\text{C}$ showed the most clear effect against *Culex pipiens* pupae, at all exposure periods.

Exposure for a short period (half an hour) resulted in the lowest percentage mortality which was slightly different ($P<0.05$) from the corresponding controls. As the exposure period was prolonged (till 48 hours), a highly significant ($P<0.01$) increase in pupal mortality was shown compared to untreated samples i.e., there was direct correlation between time of exposure and pupal mortalities.

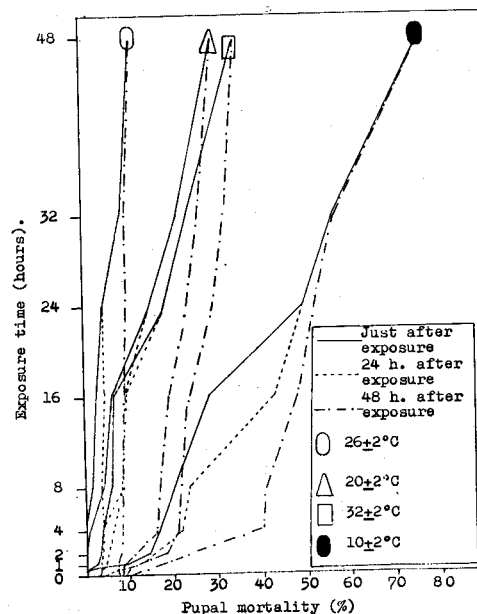


Fig. 1: Effects of oxygen alone on percentage mortality of *Culex pipiens* L. newly formed pupae.

The same gradual increase in mortalities was shown at $20\pm 2^\circ\text{C}$ and $32\pm 2^\circ\text{C}$ with increasing the exposure period. However, the effect was more detectable at $32\pm 2^\circ\text{C}$ than at 20°C . In the latter case the differences were significant at all exposure periods except short ones (less than 2 hours).

The median lethal dose was not reached even after 48 hours of exposure at any of the moderate or high temperature. However, at the lowest temperature ($10\pm 2^\circ\text{C}$) the percentage mortality reached 49.66% after 24 hours of exposure and 75.33% after 48 hours.

Effect of Relative Humidity:

Results illustrated on Fig. 2 indicated that, percentages mortality increased with decreasing the relative humidity levels at the same time of exposure. For example, 31% R.H. was sufficient to produce complete death of pupae (100%) by the end of 48 hours of exposure while this percent was found to be 44.00 and, 40.00 at 81.10% and 93.00%, respectively, after the same time, i.e., 48 hours of exposure, compared to 1.50 and 2.66%, respectively, in the controls.

Generally, as the exposure period was prolonged, gradual significant ($P<0.01$) increase in the percent mortalities was evident. However, the response of pupae to humidity levels examined did not show any significant differences approaching normal values during the first few hours from exposure, i.e., for less than 16 hours at 93% R.H. and for less than two hours at 81.1% and 31% R.H.

Regarding the median lethal time after exposure (LT_{50}), it was found that, neither 93% nor 81.1% R.H. could achieve 50% pupal mortality after any time tested, while at 31% R.H., 49.83% mortality was observed after only 4 hours after exposure.

In the present experiments on *Culex pipiens*, the temperature of 10°C was the most effective temperature on pupal mortality followed by 32°C then 20 and 26°C . There was a gradual increase in pupal mortality with increasing the time of exposure to temperature. The drastic effect of low temperature on the pupal mortality was also reported on other insect species by other authors, for example, by Hussein *et al.*

(1962), on *Pectinophora gossypiella* Sounders. They found that, exposure of the pupae to 9°C for 12, 24 and 30 days, resulted in a gradual decrease in the percentage of adults emerging, and abnormalities among the emerging adults. On the other hand, Amin *et al.* (1982) reported that, incubation of pupae of the Mediterranean fruit fly, *Ceratitidis capitata* Wied. at different temperature (5, 15 and 25°C) for two hours or two days did not affect adult emergence

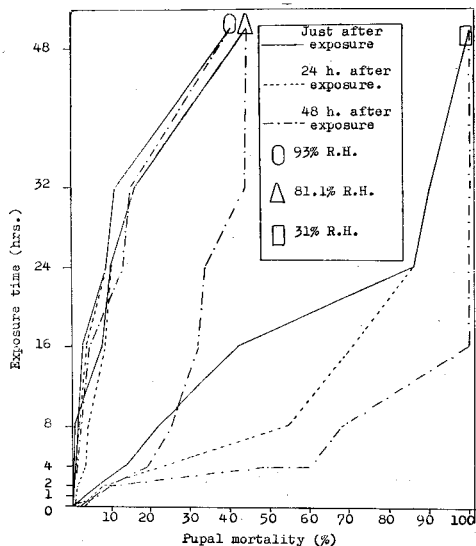


Fig. 2: Effects of partial vacuum alone on percentage mortality of *Culex pipiens* L. newly formed pupae..

The results on humidity effects revealed that, the pupal mortality increased with decreasing the relative humidity levels at the time of exposure. Exposure for short periods did not affect significantly the pupal mortality. Increasing the exposure time increased mortality. The importance of relative humidity as decisive factor affecting insects activity varied according to the species. For *Culex pipiens fatigans* Wied., procedures and techniques of mass rearing were described by Singh and Razdan (1977), who maintained the adult colonies at high relative humidity (80-85%). In the same time, Franke, (1981), indicated that, the decisive factor for *Aedes* spp. activity was related to humidity.

REFERENCES

- Abdel-Malek, A. A. and S. H. Ahmed, 1972.** Biological effects of gamma irradiation from Co^{60} on the developmental stages of *Culex pipiens molestus*. Acta Entomologica Bohemoslovaca, 69: 365.
- Amin, A. H., A. M. Wakid, A. Shoukry and A. M. Fadel, 1982.** Factors influencing sterility and vitality of the Mediterranean fruit fly, *Ceratitidis capitata*. II. Dose fractionation and temperature before irradiation. Isotope & Rad. Res., 14; 137.
- Franke, I., 1981.** Faunistic ecologic studies on mosquitoes of the District Erfurt East Germany with particular reference to the genus *Aedes hercynia*. Hercynia, 18: 65.
- Hussein, E. M. K., A. Shazli, S. K. Sawaf and H. Zaazou, 1962.** Some ecological aspects of the life history of the pink boll worm, *Pectinophora gossypiella*. III. The effect of temperature, humidity and cooling on diapause. J. Agr. Res., X: 65.
- Renner, E., 1970.** Mathematisch-Statistische Methoden in der Praktischer Arwendunge, Berlin and Hamburg, Paul Parey.
- Singh, K. R. P. and R. K. Razdan, 1977.** Mass rearing of *Culex pipiens fatigans* under ambient conditions. Indian J. Med. Res., 65: 86.
- Wakid, A. M., M. Hafez, A. Abdel-Rahman, A. Z. Osman and M. K. Hafez, 1993.** The influence of certain physical stresses on pupal mortality of *Culex pipiens* Complex L. I. effect of exposure to oxygen and partial vacuum. Qatar Univ. Sci. Bull. 13: next paper.
- Witte, R. S., 1989.** Statistics, Third edition, San Jose University.