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Ramification of Temperature on Anopheline Populace

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Abstract –
The global climate is changing at a faster rate than ever before and it is the biggest challenge to mankind today. Global warming is blamed to be caused by emission of Green House Gases. Warm and humid conditions are best for mosquito survival. The changing seasonal temperatures provide a wide range for mosquito bionomics facilitating an invariable increase in their population. Mosquitoes are highly sensitive to climatic conditions. A study was conducted on the pupa of Anopheles stephensi to see the effect of changing temperature conditions. The results showed that at higher temperatures of 30°-40° C there is significant shortening of pupal period by 0.33 days and a record adult emergence of 90% and 30% respectively. The gradual increase of atmospheric temperatures in different seasons due to global warming is becoming a favorable factor for increase in mosquito population and Malaria incidence cases. Since the species prefers standing water for breeding, it is suggested to monitor the fish population in those water bodies. In urban areas sewerage is the utmost favorable breeding ground for the species, cleaner sewerage system is necessary. Plantation of trees and maintaining green belts around the urban areas is also necessary to reduce the increase in temperature.
Keywords- *Adult emergence, Anopheles Stephensi , Global warming, Pupae.*

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I. Introduction

Mosquitoes are universal in distribution and are very harmful causing nuisance by their bites and acting as vectors for different diseases such as malaria, dengue, encephalitis and yellow fever. Change in climatic conditions play an important role in increase of mosquito population and subsequent spread of mosquito borne diseases. As mosquitoes are highly sensitive to climatic variability any change in environment will have a direct impact on the bionomics of mosquito and affect the pattern of disease they cause. Most vector-borne diseases exhibit a distinct seasonal pattern suggesting that they are weather sensitive. The behavior, development and population of mosquitoes are strongly influenced by climate.

II. Materials And Methods –

The adults of *Anopheles Stephensi* collected from the field using a fine plastic net were kept in mosquito cages (70cm x 60 cm x 60cm) which were covered with white muslin cloth. The colony was maintained at optimum condition of 28 ± 1°C temperature and 70-80% RH. The mosquitoes were fed on water soaked raisins and 10% glucose solution soaked in cotton pads. The females were offered blood meal on back and belly shaved rabbit during night o alternate days. Eggs were collected in plastic bowls containing water and kept in the same water for emergence of first instar larvae. The newly hatched larvae were transferred to white enamel trays (30cm x 25cm x 5cm). The larvae were fed on powdered yeast. The water of the rearing trays was changed every third day to avoid decay. The pupae were separated from rearing trays and transferred to the adult cages for further propagation.

Light was provided to the colony by two 40 watt fluorescent tubes and a 60 watt bulb with a photoperiodicity of 10-1/2 hours darkness and 1-1/4 hours of dusk.

Effect of temperature on survival and development of pupae –
Method of treatment - Immersion
Number of pupa - 20 (in 5 replicates & 1 control each)
Temperature & humidity - 28 ± 1°C, 70-80 % RH

Dark: light period -14: 10 (in hours)
Container used - Glass jars
Period of treatment - Up to adult emergence
Factors - Varying atmospheric temperatures (0°, 10°, 20°, 28°, 30°, 40°, 50°C)

The pupae were kept under varying atmospheric temperatures up to adult emergence. Separate control sets were also run simultaneously for comparison. The following observations were recorded –

a) Pupal mortality.
b) Pupal period.
c) Adult emergence.
d) Flight activity.
e) Morphological deformity in pupa & adults.

III. Results

Pupa:

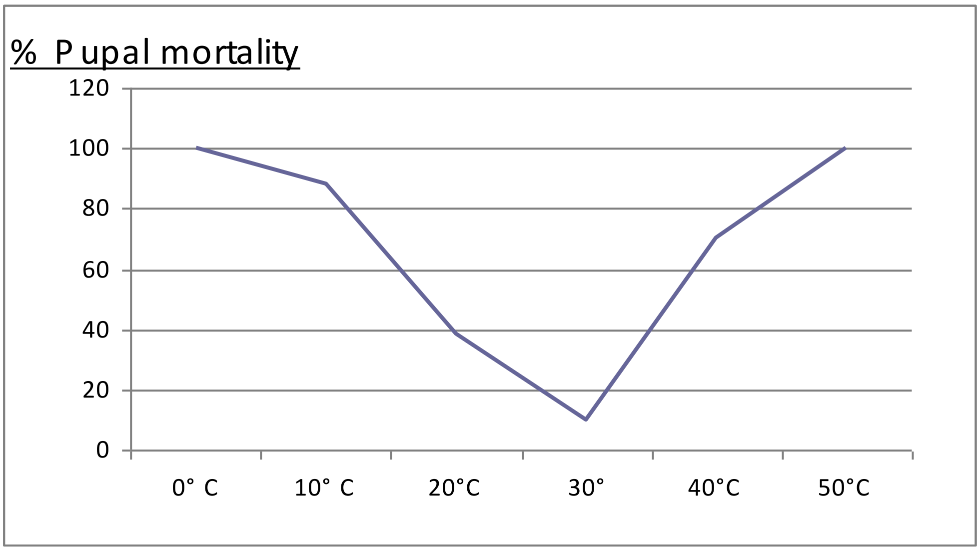
➢ Mortality -

Mortality increases at high & low temperatures. Loosening of head appendages is seen in the dead pupa. Maximum mortality occurs during pupal-adult transformation. Adults fail to emerge from pupal exuvia. At high temperatures the pupae remain active for an hour or so. They sink to the bottom frequently to find the cooler water zone but ultimately die on the water surface. At low temperatures the pupae become quite inactive & sink down when disturbed. The pupae manage to survive as adults only when they are returned to optimum condition of temperature & humidity.

Maximum mortality of 100 % is recorded at the extreme temperature of 0° & 50°C. The data recorded is given below –

Temperature	% Pupal mortality	% Correct mortality
0°	100.00	100.00
10°	88.30	88.30
20°	38.33	38.33
30°	10.00	10.00
40°	70.00	70.00
50°	100.00	100.00
Control	0.00	-

Graphical presentation of pupal mortality is given below-



Temperature °C

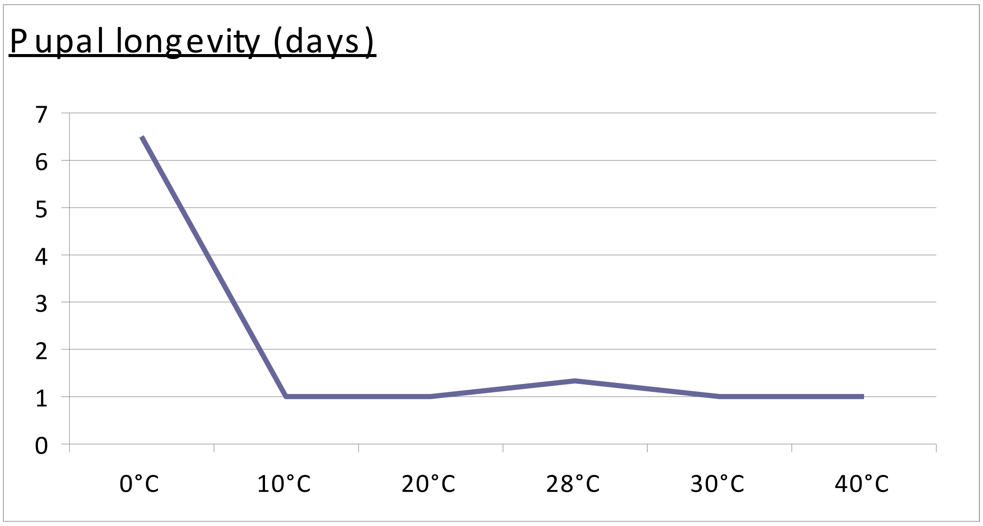
➢ <u>Pupal period -</u>

Significant prolongation in the pupal period is observed at all the low temperatures. However there is shortening of pupal period at high temperatures. The pupal periods shorten by 0.33 days at high temperatures and prolong by 1.31 to 5.17 days at low temperatures.

The data recorded is given below –

Temperature	Pupal longevity
0°	6.5 ± 0.00^d
10°	1.0 ± 0.03^d
20°	1.0 ± 0.00^d
30°	1.0 ± 0.00^d
40°	1.0 ± 0.00^d
50°	-
Control	1.33 ± 0.03^d

Graphical presentation of pupal longevity is given below-



<u>Temperature °C</u>

Significant Level -

P > 0.05 = Not significant. (a)

P < 0.05, P < 0.02 or P < 0.02 = Significant. (b)

P <0.01 or P = 0.01 = Highly significant. (c)

P < 0.001 or P = 0.001 = Very highly significant. (d)

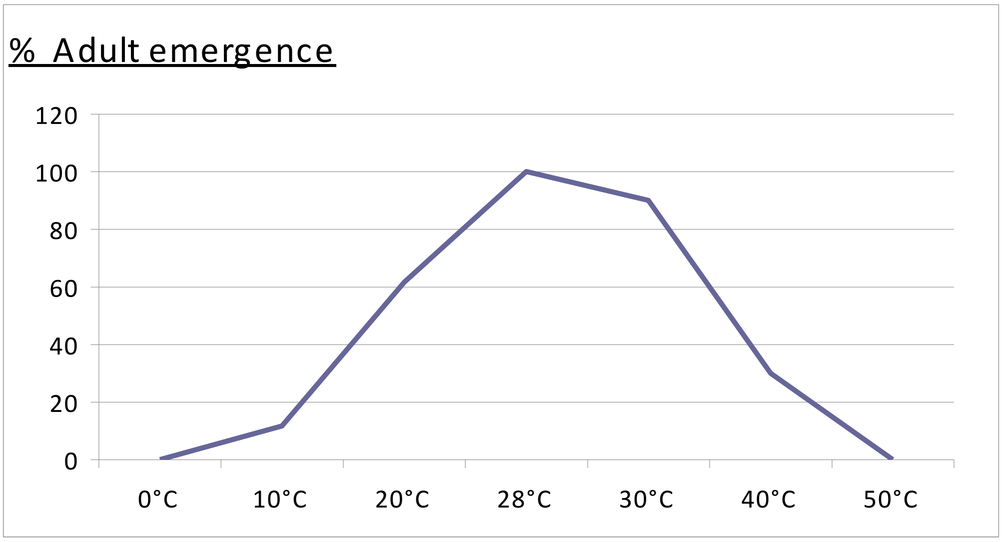
➢ <u>Adult emergence –</u>

Fall in adult emergence is recorded at all the temperatures above and below the optimum temperature. Adults emerged from the pupae subjected to low temperatures showed morphological abnormalities. The wings, legs, abdomen and mouth parts of the adults remain entangled in pupal exuvia. The adults that escape death exhibit a poor flight response. At low temperatures the adults could not fly normally. They could fly only to a very short distance. At high temperature the adults so emerged rested on the water surface with the wings parallel to the water surface. Few adults would crawl rather than fly even when disturbed.

The data at different temperatures is given below –

Temperature	% Adult emergence
0°	-
10°	11.66
20°	61.66
30°	90.0
40°	30.0
50°	-
Control	100.0

Graphical presentation of Adult emergence is given below-



Temperature °C

IV. Discussion

On exposure of pupae to different temperatures it is seen that there is an increase in the pupal mortality at both, high and low temperatures resulting in comparatively lesser adult emergence. A slight decrease in the pupal period is observed at high temperatures whereas at low temperatures the pupal period increases considerably. 100% mortality is recorded at 0°C and 50°C. Lal (1953) reported that the thermal death point of the pupae of *Anopheles subpictus* was 44°C and the pupae of *Anopheles Stephensi* and *Anopheles subpictus* were killed by prolonged exposure to 10°C.

The pupal period was found to decrease at high temperatures and increase at low temperatures. Nielsen and Haeger (1954) stated that the time spent in the pupal stage was inversely proportional to the temperature. Bar–Zeev (1957) reported that the pupae of *Anopheles subpictus* and *Anopheles Stephensi* were killed by prolonged exposure to 8°C. Van den Heuvel (1961) worked at 11 different temperatures between 15°C and 34°C, found that the effect of temperature was least in the first instar and greatest in the pupa.

The pupal period was shortened at 30°C and 40°C but was prolonged considerably at 10°C and 20°C. Huffaker (1944) studied about the development of larval and pupal stages and found that development as a whole was most rapid at 31°C.

At extreme high & low temperatures there was no adult emergence as 100% pupal mortality occurred. The dead pupae showed loosening of all the appendages. At higher temperatures the dead pupae sank to the bottom possibly due to the release of large air spaces in between the “wing cases”. At 30°C adult emergence was quite satisfactory & was found to be 90% followed by 61.66% at 20°C, 30% at 40°C & 11.66% at 10°C. Pal(1945) observed that under laboratory conditions, *Anopheles culicifacies* pupae hatched well at 28 to 32°C but when the temperature was elevated to 36°C & 40°C only 30-40% hatched out

V. Conclusion

The observation recorded coincides with those of the above workers. The length of the pupal stage of the *Anopheles Stephensi* varies with temperature. It is inversely proportional to temperature indicating that slight increase in seasonal temperature would definitely lead to an increase in number of adult Anophelines emerging out of the newly hatched pupae.

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