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Influence of certain physico-chemical factors upon the larval population of *Mansonia* mosquitoes (Culicidae: Diptera) in Trivandrum City, India

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Abstract. A year round study was conducted in Trivandrum city during the period of March 1984 to February 1985 to elucidate the relation between certain physico-chemical factors and seasonal density of *Mansonia* larvae (Culicidae: Diptera). *Mansonia uniformis* was found to be the predominant species during this period, whereas *Mansonia annulifera* was less than 10% of the total *Mansonia* collected. The period of high prevalence was found to be January-March. Out of the 6 physico-chemical factors studied Na^+, K^+, and pH showed statistically significant correlation with the larval density, while Ca^{++}, Mg^{++} and rainfall showed no significant relation.

Keywords. *Mansonia*; larval density; physico-chemical factors.

1. Introduction

Mansonia mosquitoes are known to be the principal vectors of Brugian filariasis in Kerala. They are found to breed in water rich in decaying organic matters (Burton 1959). The existing information shows that 3 species of *Mansonia* viz *Ma. annulifera*, *Ma. uniformis* and *Ma. indiana* are prevalent in Kerala. The former two have been incriminated as vectors of Brugian filariasis and are present in Trivandrum City (Jaswant Singh *et al* 1956; Nair and Roy 1958; Nair 1962; Chandrasekharan *et al* 1976). The attachment preference of *M. annulifera* and *M. uniformis* larvae to various aquatic plants in Kerala was studied in detail by Burton (1959). Despite the importance of *Mansonia* in the transmission of the disease, relatively little is known about the population dynamics of these mosquitoes in relation to physico-chemical factors.

The present study relates to the seasonal variations in larval population of *Mansonia* mosquitoes in Trivandrum City, and its relationship, if any, to certain physico-chemical factors of the larval habitats.

2. Material and methods

2.1 *Study area*

The present study was carried out in a low lying area (Kannanmoola) within Trivandrum City limits. The canal which runs through the study area is stocked with aquatic plants like *Eichhornia speciosa* affording continuous breeding of *Mansonia* mosquitoes. In the study area the canal is about 3 metres deep with running water in the centre and the vegetation stocked on both sides. This canal empties into a lake approximately 3 km away from the study area. Larval collections were made from different parts of the canal and nearby uncultivated paddy field with growth of aquatic vegetation such as *E. speciosa.*

2.2 *Larval collection*

Larval collections were made during the period of March 1984 to February 1985. Since *Mansonia* larvae are found attached to the roots of aquatic plants (in the present case *E. speciosa*), the plants were removed and shaken vigorously in a plastic basin containing water. The detached larvae were picked up using glass droppers from the silt and counted (Gillet 1971). Collections were made twice a week between 8·30 and 11·30 am. About 150 plants were examined at each collection. Larval density was calculated by computing the number of larvae/plant. As the larvae had to be used for further studies in the laboratory no attempt was made to identify the species of *Mansonia* larvae for fear of injuring them and minimum disturbances to the field collected larvae was preferred. The larvae were held in the laboratory until emergence and the proportion and pattern of emergence were studied.

2.3 *Chemical analyses of water samples*

Water samples for chemical analyses were procured from the same area of larval collection. After determining the pH, the samples were assayed for Na^+, K^+, Ca^{++} and Mg^{++}. Flame photometric method was employed using MK-1/MK-11/Type 125 Systronic for the quantitative analysis of Na^+ and K^+ whereas Complexometric titration was employed using EDTA as primary standard for Ca^{++} and Mg^{++} (American Public Health Association 1960). Water samples for the study were collected twice a month (during the first and last week of each month).

2.4 *Statistical analyses*

Statistical analyses for possible correlation between pH, ionic concentration of Na^+, K^+, Ca^{++}, Mg^{++} and fluctuations of larval density were studied by using Simple Correlation, Partial Correlation and Student's '*t*' test. Though larval collections were made twice a week, the data used for statistical analyses were only those of the day on which water collections were made.

3. Results

From 2826 *Eichhornia* plants screened during the period of study (March 1984 to February 1985), a total of 11495 *Mansonia* larvae were recovered. The major peak of larval density was during January to March, whence there was a sharp decline followed by a slight increase in density during the period August–October. However, the increase in density during August–October was not as high as that of January–March. The maximum larval density (9·45 larvae/plant) was found in March and the minimum (1·11 larvae/plant) in October (figure 1, table 1).

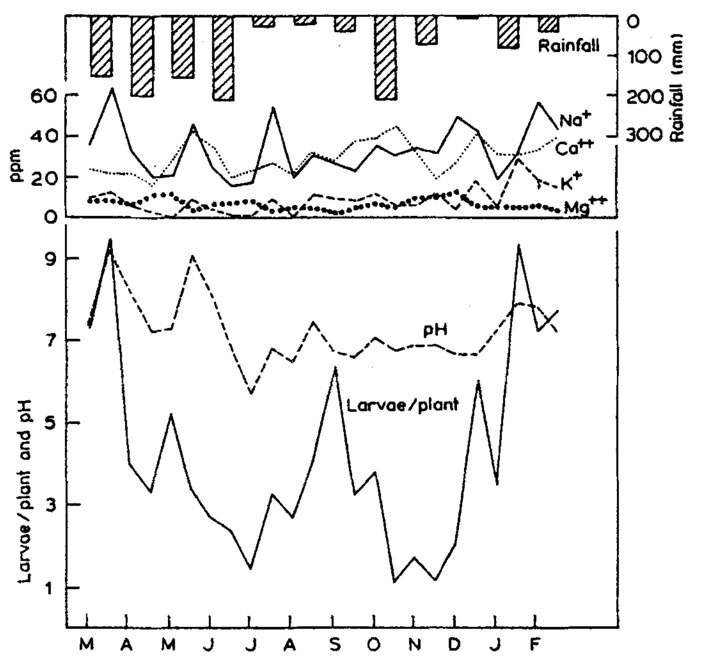

Figure 1. Fluctuations of larval population, pH, Na^+, K^+, Ca^{++}, Mg^{++} and rainfall during 1984 March to 1985 February.

3.1 *Chemical analyses of water*

The results of the chemical analyses are given in figure 1 and table 1. The pH of the water samples ranged from 5·76 to 9·2. Larval density and pH showed a positive correlation which was significant at 5% level. In other words the density of *Mansonia* larvae reached its peak when pH was >7 and it was lowest when pH was <7.

As it is evident from figure 1 wide fluctuations were observed in the concentration of Na^+ and Ca^{++} but not in the concentration of Mg^{++} and K^+. Statistical analyses showed that there is a positive correlation between the larval density and the concentration of K^+ and Na^+. The influence indicate a rise in larval density corresponding to a rise in concentration of these ions. This was found more applicable with regard to the concentration of K^+ (significant at 1% level), which showed a clear increase during the months of January, February and March, the 3 months of highest larval density. From table 1 and figure 1 it is evident that the concentration of K^+ showed an increase toward the end of January (29 ppm). The increase was sustained in February (average 17 ppm) and March (average 11·5 ppm). Na^+ does not exhibit such a clear cut correlation though statistically significant at 5% level. Though not statistically significant the coefficient of correlation with regard to Mg^{++} and larval density gave negative value (table 2). Statistical analyses did not show any significant correlation between monthly larval density and monthly total rain fall.

Na^+ and K^+ appeared to have a mutual influence quantitatively as it is evident from the correlation matrix (table 2). When the concentration of Na^+ increases there

Table 1. Physico-chemical factors of *Mansonia* breeding water and larval density.

Month	Larval density/plant	Na^+ ppm	K^+ ppm	Ca^{++} ppm	Mg^{++} ppm	pH	Rainfall (mm)
1984 March	7·29	36	10	24	9	7·42	151
	9·45	64	13	22	9	9·20	
April	3·96	34	6	22	7	8·20	197
	3·31	20	3	16	12	7·23	
May	5·23	21	0	28	12	7·32	153·7
	3·41	47	10	44	5	9·10	
June	2·70	25	5	36	7·3	8·11	205·5
	2·35	16	2	20	7·5	6·75	
July	1·47	18	2	24	9	5·76	26
	3·25	15	10	28	4	6·85	
Aug.	2·71	21	2	22	6	6·50	21
	4·12	32	12	32	5	7·50	
Sept.	6·37	28	10	28	3	6·81	40·2
	3·32	24	9	38	5	6·67	
Oct.	3·79	36	12	40	7·5	7·09	205·1
	1·11	32	6·8	46	6	6·80	
Nov.	1·68	35	7	34	10	6·92	71·8
	1·55	32	12	20	11	—	
Dec.	2·07	50	5	28	13·3	6·72	2·7
	6·07	43	18	42	6	—	
1985 Jan.	3·54	19	6	32	6	7·28	81·7
	9·38	33	29	32	5	7·93	
Feb.	7·28	57	19	34	6	7·86	40·2
	7·75	44	15	40	3·8	7·27	

Table 2. Results of statistical analyses.

	L	Na^+	K^+	Ca^{++}	Mg^{++}	pH
L	1	0·446[a] (2·337)	0·673[b] (4·268)	0·038	−0·297	0·497[a] (2·68)
Na^+		1	0·522[a] (2·869)	0·238	−0·109	0·484[a] (2·590)
K^+			1	0·358	−0·438[b] (4·73)	0·329
Ca^{++}				1	−0·480[b] (4·80)	0·105
Mg^{++}					1	−0·098
pH						1

Number in parentheses indicates '*t*' value; [a]Significant at 5% level; [b]Significant at 1% level. *Mansonia* larvae per *E. speciosa*.

is a corresponding increase of K^+ also. A positive correlation of Na^+ and pH was also evident. When the concentration of Na^+ increases a corresponding increase of pH also was observed. A negative correlation seems to exist between K^+/Mg^{++} and Ca^{++}/Mg^{++}. The *t*-values relating to these correlations showed a statistical significance at 1% level. When the concentration of one ion increases the concentration of the other decreases (figure 1).

4. Discussion

The results of the adult collection from the field (Daniel *et al* 1986) as well as emergence of adults in the laboratory from the field collected larvae revealed *Ma. uniformis* to be the predominating species constituting 90% of the total *Mansonia* collected, the rest being *Ma. annulifera*. This clearly indicate that *Ma. annulifera* is an unimportant member in the *Mansonia* population in the study area. Though larval identification was not carried out in the present work these observations indicate that the species involved in larval analysis was mainly *Ma. uniformis*. *Pistia stratiotes* was found to be the favourable host plant for *Ma. annulifera*. But the replacement of *P. stratiotes* by *Salvinia auriculata* in many places of Kerala dropped the incidence of *Ma. annulifera* considerably (Joseph *et al* 1963; Chandrasekharan *et al* 1976). Our earlier studies have indicated that the reduction in *Ma. annulifera* populations has some correlation with the disappearance of *P. stratiotes* for the study area. Collections made in the study area during 1983 showed that the population of *P. stratiotes* was more and so was the population of *Ma. annulifera*.

The existing literature on the biology of *Mansonia* mosquitoes shows that the type of correlation between the physico-chemical factors and seasonal larval density of *Mansonia* brought out in the present study has not been elicited earlier.

The present study revealed that out of the 6 physico-chemical factors analysed (Na^+, K^+, Ca^{++}, Mg^{++}, pH and rainfall) 3 (Na^+, K^+ and pH) had significant influence on the density of *Mansonia* larvae. However the studies conducted by Khamala (1971) showed that the physical and chemical nature of water (sedimentary solids, suspended solids, dissolved organic matter, total nitrogen and pH) did not appear to be significant for *Ma. africana* and *Ma. uniformis*.

Earlier workers have presented contradictory views about the seasonal prevalence of *Mansonia* mosquitoes. Studies carried out at Ernakulam showed that the densities of both *Ma. annulifera* and *Ma. uniformis* were higher during post monsoon months (Pal *et al* 1960). However, according to Chandrasekharan *et al* (1976) *Ma. annulifera* is a premonsoon species (January–June) whereas *Ma. uniformis* is a postmonsoon species (July–November). In the present study the high prevalence of *Mansonia* larvae was noticed from January–March and low in July, October and November. The adult collections made in the study area also showed a similar pattern of prevalence (Daniel *et al* 1986).

Iyengar (1938) suggested that breeding of *Mansonioids* is reduced following heavy rainfall due to dilution of organic matter and breeding is dense if there is low or no rainfall. Similar observations were made in *Culex pipiens fatigans* also (Sarkar *et al* 1978). But the present study does not support such a contention.

It appears from the present study that, like the larvae of *Aedes vittatus*, *Ae. albopictus*, *Ae. aegypti* (Sehgal and Pillai 1970) and *Cx. p. fatigans* (De-Alwis and Munasinghe 1971; Kaul *et al* 1977; Sinha 1976; Sarkar *et al* 1978), *Mansonia* larvae are also alkilinophilic.

The tolerance of mosquito larvae to various elements differ from species to species. Hangstrum and Gunstream (1971) examined the concentration of inorganic ions in water samples from a large number of sources in relation to 8 species of mosquito larvae. They separated these species of mosquitoes into two groups, 'Species limited' and 'Species wide spread' in their distribution. The results showed that the widely distributed species of mosquitoes must be less selective and have a broader range of tolerance for inorganic ions than species of limited distribution. Salinity of the natural breeding water analysed in February (the period of peak larval density) showed to be 0·076 g of NaCl/litre (WHO 1975). A laboratory study using artificial sea water showed that the larvae of both species of *Mansonia* were able to tolerate a dilution of 6 × and above (unpublished observation). Sodium chloride concentration of 6 × diluted artificial sea water would be about 5·36 g of NaCl/litre. It thus appears that *Mansonia* larvae can tolerate a wide range of salinity. How far the larvae are exposed to such a wide range of salinity variation in their natural breeding areas is yet to be elucidated.

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