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Population Dynamics of Mosquito Larvae in Village Ponds and its Correlation with Physico-Chemical Parameters

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Abstract: ***Different standing water bodies act as breeding grounds of mosquitoes, thus responsible for the spread of diseases. A survey was conducted to study the population dynamics of mosquito larvae in three village ponds of Ludhiana district (Punjab), India. For this purpose water samples were collected at monthly intervals from July 2011 to June 2012 and larval density (LD/L) and larval density index (LDI%) of mosquito larvae were calculated. Three types of mosquito larvae i.e. Aedes, Anopheles and Culex were found and their LD was recorded to be maximum in rainy season from all the sampling sites. Culex larvae were the predominant type followed by Aedes and Anopheles larvae. Estimation of different types of physic-chemical parameters analysed from pond water samples at monthly intervals revealed a significant positive correlation of temperature and alkalinity with larval population, while dissolved oxygen showed a negative association, other parameters tested were found to show non-significant correlation.***

Key words: Mosquito larvae, Population dynamics, Physico-chemical parameters, Village ponds

1. Introduction

Mosquitoes occur worldwide from the tropics to Arctic and are known to spread deadly diseases like dengue, yellow fever and chickungunya transmitted mostly by the genus *Aedes*, malaria by genus *Anopheles* and filaria or encephalitis transmitted by the genus *Culex* (Eldridge and Edman, 2000). Mosquitoes breed in varied habitats and different genera have shown specific habitat and breeding preferences like *Anopheles* species are associated with fresh water habitats, whereas *Culex* species may also be found in polluted conditions including septic tanks and *Aedes* species breeds in peri-domestic and other small water collections including desert coolers (Parthiban and David, 2007).

Evaluation of larval mosquito habitats in terms of species composition and resources can help in understanding the bio-ecology and related control measures of mosquitoes more appropriately (Aditya et al. 2006). Also, proper identification of different species of mosquito and monitoring of their population level is of a paramount importance for their control. An intelligent information system would help us to control the disease in advance and also provide advice to government and public health professionals to take action (Tsai et al. 2012). For effective larval control of mosquitoes, a sound understanding of the factors responsible for spatio-temporal variation in larval production is essential (Kenea et al. 2011). These diseased situations can be best tackled by improving the knowledge about the vectors and their habitats. Since good health is a pre-requisite to economic development, there is a need to focus on these vectors in order to put them in right perspective.

2. Materials and Methods

Three ponds one each from Noorwala, Kasabad and Kaneja villages located in Ludhiana district of Punjab (India) were selected. Collection of water samples was done at monthly intervals from July 2011 to June 2012. Three different breeding sites were selected from each pond and water samples were collected with plastic dipper (1000 ml) by scooping water three times per site. These samples were carried to the laboratory and mosquito larval density (LD) *i.e.* number of mosquito larvae/L of water sample was counted manually. Mosquito larvae were extracted with the help of dropper and brush from the water samples and then were preserved and identified under the microscope on the basis of their morphological features by following the standard keys (Rueda, 2004; Becker et al. 2010). After the identification step, number of larvae of specific type were counted and relative larval density index (LDI%) was calculated by using the following formula:

$$\text{LDI (\%)} = \frac{\text{Number of larvae of one specific type}}{\text{Total number of larvae}} \times 100$$

Different types of physico-chemical parameters like water temperature, secchi disc transparency (SDT), pH, dissolved oxygen (DO), free carbon dioxide (FCO_2), alkalinity, total hardness (TH) and total dissolved solids (TDS) were analysed from all the water samples collected at monthly intervals from the selected ponds.

3. Results and Discussion

The overall population dynamics of mosquito larvae in different ponds *i.e.* Noorwala, Kasabad and Kaneja villages showed the similar trend, as larval population density was found to be at its highest level during July to August, indicating the higher infestation of mosquitoes in rainy season. These results coincided with the findings of Simsek (2004) who also observed higher larval density of mosquito larvae during monsoons. In the current study it was observed that peak of the mosquito larvae population (LD/L) coincided with the peak during vegetative season in July-August with its value 76.66±2.88, 100.00±28.11 and

64.66±8.01 respectively at Noorwala, Kasabad and Kaneja village (Table 1).This may be due to the fact that beginning of rainy season cause formation of several breeding sites for mosquitoes (Mukhtar et al. 2003, Maimusa et al. 2012). Under the extreme conditions of cold *i.e.* from November or December to February months no mosquito larvae were found. However with the arrival of spring season in March their count increased suddenly followed by fall in their count till the month of June at all the locations (Table 1). Overall three types of mosquito larvae (based on their morphological features) were found, these were *Aedes, Anopheles* and *Culex*, showing seasonal variation in their percent larval density index (LDI) from July 2011 to June 2012 from all the sampling sites. High percentage of LDI of *Culex* type larvae indicated its predominance followed by *Aedes* and then *Anopheles* throughout the year (Table 1).

Comparative annual larval density index (%) of different types of mosquito larvae at the various village ponds of Ludhiana district also indicated higher population of *Culex* in all the ponds. Annual LDI recorded for *Culex* was 62.49% at Noorwala village, 76.81% at Kasabad and 56.65% at Kaneja village pond (Fig. 1). The occurrence of *Culex* genus in all the ponds showed that they are very versatile and highly adapted to different types of environments found at the sampling sites. *Culex* has been able to thrive in habitats with higher densities of other aquatic invertebrates and is more tolerant to inter-specific association among invertebrates as compared to any other type of mosquito larvae, which make this group most abundant at all the sampling sites (Muturi et al. 2008). WHO (1996) reported that even stagnant polluted water bodies are also a favoured breeding habitat of *Culex*. However, LDI for *Aedes* was found to be 22.73%, 17.56% and 34.43% respectively at village Noorwala, Kasabad and Kaneja (Fig. 1). According to Lopes et al. (2002) *Aedes* mosquito larvae usually breed in artificial breeding sites which may be the reason for less *Aedes* mosquito larvae population from the village ponds in the current study. *Anopheles* larval density was minimum in all the village ponds, as it was found to be 14.76% at Noorwala pond, 5.61% at Kasabad pond, 8.91% at Kaneja village pond (Fig. 1). The less abundance of *Anopheles* larvae in the water samples collected from the selected sites might be due to the reason that *Anopheles* breeds in clear to slightly turbid water, which is a less available condition in ponds (Keating et al. 2004). Also another fact is that in these large and natural permanent water bodies predation rate is quite high (Sunhara et al. 2002).

Annual variation in different physico-chemical parameters analysed from the water samples has been depicted in table 2 and these values of different parameters were correlated with mosquito larval density in the respective ponds. The statistical correlation analysis indicated that only three parameters viz., temperature, alkalinity and dissolved oxygen were found to be significantly correlated with larval population, while rest of the factors including SDT, pH, FCO_2, TH and TDS showed non-significant correlation. A significant positive correlation of temperature and alkalinity with larval count was found at all the selected village ponds (Table 3). Ranjeeta et al. (2008) and Chanderasekar et al. (2012) have also observed a positive correlation between temperature of water body and mosquito larval population. Temperature is regarded as one of the most important factors in aquatic ecology which affects both spawning and growth of larvae and pupae of mosquitoes (Tiimub et al. 2012). Conditions such as high temperature, abundant water, abundand sunshine and high alkalinity are conducive for the breeding of many species of mosquitoes (Opoku et al. 2007). Another important environmental factor which was found to be negatively correlated with mosquito larval density was alkalinity of the pond water (Table 3). This is because of the fact that DO is inversely proportional to temperature of water body. As temperature increases DO intensity of water declines (Haque et al. 2004). Mosquito larval population in a particular water body depends on lots of other ecological factors also. Thus a full understanding of these factors is a pre-requisite in planning effective vector control measures.

4. Conclusion

Annual collection of water samples from three village ponds of Ludhiana district revealed almost a similar population dynamics trend at all the selected sites *i.e.* maximum larval density in rainy season, less in summer and no mosquito larvae during extreme winter and summer seasons. Three types of mosquito larvae viz; *Culex*, *Anopheles* and *Aedes* were observed at these sampling sites and *Culex* was most abundant genus followed by *Aedes* and then *Anopheles*. Mosquito larval population was found to be positively correlated with temperature and alkalinity and negatively correlated with DO at all the village ponds selected for the present study.

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Legends to Figures

[1] Fig 1: Annual larval density index (LDI%) of different types of mosquito larvae at three village ponds of Ludhiana district.

Author Profile

Dr. D.K. Kocher is working as Associate Professor in Department of Zoology, Punjab Agricultural University, Ludhiana, Punjab, India in the field of Parasitology and presently the Principal Investigator of a two year competitive project "Assessment of Copepods as Bio-control agents of Mosquito larvae in Standing Water bodies of Punjab", sponsored by 'Department of Science and Technology', Ministry of Science, Govt. of India.

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Table 1: Annual population dynamics of mosquito larvae collected from the water samples of three village ponds of Ludhiana district

		Year 2011					Year 2012			
Mosquito larvae population		**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**March**	**April**	**May**	**June**
Noorwala village pond										
Total	LD/L	70.66±5.19	76.66±2.88	51.33±0.54	11.33±2.00	6.00±0.46	48.00±6.78	32.66±4.41	36.66±2.70	0.00±0.00
Culex	LDI (%)	49.00	74.80	50.60	64.70	0.00	54.10	75.50	87.20	0.00
Aedes	LDI (%)	26.40	12.10	18.10	35.30	0.00	45.80	24.50	12.70	0.00
Anopheles	LDI (%)	24.50	13.00	31.10	0.00	100.0	0.00	0.00	0.00	0.00

Kasabad village pond										
Total	LD/L	79.33±14.22	100.00±28.11	25.33±2.17	10.00±2.49	0.00±0.00	61.33±8.23	44.66±14.61	45.33±7.90	16.6±3.80
Culex	LDI (%)	82.30	78.66	28.93	100.00	0.00	67.43	85.56	55.87	92.00
Aedes	LDI (%)	5.04	15.33	37.14	0.00	0.00	32.63	8.02	44.12	7.92
Anopheles	LDI (%)	12.60	6.00	33.99	0.00	0.00	0.00	6.91	0.00	0.00
Kaneja village pond										
Total	LD/L	61.33±8.00	64.66±8.01	10.00±1.63	17.3±1.06	0.00±0.00	33.33±3.81	54.66±5.68	24.00±1.88	00.0±0.00
Culex	LDI (%)	75.00	85.50	33.30	46.10	0.00	26.00	73.20	50.00	0.00
Aedes	LDI (%)	16.30	8.20	33.30	46.10	0.00	40.00	24.40	50.00	0.00
Anopheles	LDI (%)	8.70	6.20	33.30	7.70	0.00	34.00	2.40	0.00	0.00

- Data from Dec. To Feb. months is not given as no larvae were found during these months from any of the selected village ponds
- LD represents larval density
- LDI represents larval density index

Table 2: Annual variation in different physic-chemical parameters of pond water at three village ponds of Ludhiana district

		Year 2011					
Village	**Parameter**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Noorwala	Tempt. (^{0}C)	30.33±0.27	29.00±0.00	22.00±0.34	22.00±0.23	17.1±0.13	10.50±0.23
Kasabad		30.00±0.05	29.00±0.11	23.00±0.23	23.00±0.23	18.00±0.0	10.50±0.13
Kaneja		32.10±0.13	29.50±0.23	23.00±0.23	22.16±0.13	18.00±0.00	10.42±0.04
Noorwala	SDT (cm)	8.75±0.09	5.95±0.09	4.00±0.13	4.25±0.06	2.00±0.13	22.00±0.27
Kasabad		4.25±0.65	0.00±0.00	2.00±0.36	2.00±0.89	1.00±0.06	0.00±0.00
Kaneja		5.75±0.05	5.00±0.12	5.75±0.06	5.75±0.48	5.75±1.05	0.00±0.00
Noorwala	pH	7.27±0.01	7.39±0.00	7.74±0.00	7.78±0.00	9.41±0.01	7.93±0.04
Kasabad		7.40±0.05	7.92±0.00	6.12±0.01	6.53±0.01	10.40±0.01	5.53±0.05
Kaneja		9.71±0.00	8.83±0.01	8.13±0.01	7.84±0.06	7.71±0.01	7.45±0.01
Noorwala	FCO_2 (mg/L)	1.16±0.16	1.23±0.11	1.56±0.03	0.56±0.01	0.23±0.03	0.11±0.01
Kasabad		2.03±0.03	2.50±0.14	1.76±0.03	0.56±0.01	0.63±0.15	0.13±0.09
Kaneja		0.26±0.03	1.26±0.03	1.53±0.07	0.70±0.05	0.83±0.13	0.20±0.03
Noorwala	DO	2.80±0.05	2.66±0.01	2.20±0.19	2.46±0.06	1.06±0.06	4.63±0.82
Kasabad		5.53±0.02	3.36±0.07	3.30±0.12	3.13±0.07	5.43±0.70	3.66±0.19
Kaneja		3.73±0.03	3.30±0.08	3.43±0.01	2.50±0.15	1.70±0.33	5.83±0.71
Noorwala	TDS (ppm)	0.87±0.43	0.47±0.07	0.65±0.35	0.77±0.20	1.25±0.14	2.13±0.14
Kasabad		1.29±0.07	1.18±0.12	1.24±0.28	1.28±0.06	1.15±0.29	0.96±0.40
Kaneja		1.20±0.07	0.45±0.08	1.08±0.08	1.16±0.40	1.48±0.01	0.45±0.28
Noorwala	Alk. (mg/L)	116.66±1.32	178.00±0.80	178.72±0.54	118.51±2.48	116.62±1.44	103.33±1.32
Kasabad		138.00±1.60	145.0±1.08	131.0±0.94	117.51±1.44	109.59±0.27	104.00±0.81
Kaneja		100.00±0.76	191.33±0.94	186.71±1.08	147.50±1.44	133.33±1.32	137.57±1.32
Noorwala	TH (mg/L)	103.33±0.71	108.86±1.24	128.33±1.43	179.33±1.43	144.0±1.31	140.0±1.63
Kasabad		170.0±1.63	268.33±0.56	295.61±0.91	326.00±2.16	160.0±1.76	126.68±2.24
Kaneja		106.66±0.79	110.3.3±0.54	123.66±1.08	194.0±1.05	262.59±1.08	113.31±0.80

		Year 2012					
Village	**Parameter**	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**
Noorwala	Tempt.(0C)	12.00±0.00	17.33±0.27	17.52±0.25	19.00±0.00	21.50±0.02	28.00±0.00
Kasabad		12.00±0.27	17.00±0.0	17.30±0.13	18.28±0.27	22.00±0.0	28.0±0.0
Kaneja		11.10±0.13	17.00±0.02	17.82±0.12	18.90±0.04	22.00±0.11	27.00±0.13
Noorwala	SDT (cm)	18.00±0.46	14.50±0.23	9.66±0.12	4.00±0.23	5.66±0.01	0.00±0.00
Kasabad		0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	3.76±0.13	0.00±0.00
Kaneja		0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	2.09±0.29	0.00±0.00
Noorwala	pH	7.99±0.00	8.54±0.01	8.47±0.00	7.92±0.01	7.06±0.02	8.46±0.00
Kasabad		7.66±0.05	7.96±0.01	7.73±0.01	7.60±0.01	7.68±0.02	7.73±0.01
Kaneja		7.23±0.01	6.22±0.01	7.62±0.01	7.99±0.02	7.04±0.02	8.12±0.00
Noorwala	FCO_2 (mg/L)	0.13±0.00	0.70±0.01	1.73±0.07	4.33±0.54	2.66±0.27	8.00±0.94
Kasabad		0.23±0.03	1.30±0.12	1.50±0.13	5.00±0.00	4.00±0.00	0.00±0.00
Kaneja		0.26±0.11	0.93±0.05	1.23±0.11	2.66±0.54	4.66±0.27	0.00±0.00
Noorwala	DO	2.66±0.15	3.25±0.16	3.46±0.17	1.43±0.05	1.19±0.15	5.53±0.05
Kasabad		2.25±0.70	1.75±0.07	1.67±0.07	1.63±0.27	1.40±0.08	1.63±0.17
Kaneja		3.43±0.01	5.28±0.15	1.76±0.09	1.46±0.10	1.06±0.10	0.86±0.05

Noorwala	TDS (ppm)	0.33±0.08	0.69±0.05	0.85±0.02	0.79±0.07	0.84±0.06	0.85±0.16
Kasabad		0.92±0.16	1.03±0.01	1.33±0.11	1.98±0.23	0.92±0.06	1.17±0.17
Kaneja		0.49±0.13	0.50±0.07	1.52±0.22	1.64±0.13	0.80±0.01	1.46±0.14
Noorwala	Alk. (mg/L)	106.62±1.08	149.0±0.81	176.62±1.08	174.37±0.71	169.3±0.27	164.00±1.24
Kasabad		117.00±1.08	179.00±0.47	171.33±0.80	179.66±0.92	168.58±0.54	182.66±0.54
Kaneja		135.72±0.54	145.63±0.54	158.49±0.92	176.32±0.69	166.0±0.81	194.00±0.47
Noorwala	TH(mg/L)	110.0±1.31	125.0±1.20	192.33±1.08	204.62±1.31	220.0±0.54	198.66±1.08
Kasabad		132.00±1.96	131.66±1.33	232.28±0.94	233.33±2.72	273.3±2.18	203.3±2.72
Kaneja		125.60±0.80	113.33±0.80	282.0±0.86	182.0±1.05	228.0±1.05	142.6±1.02

Tempt. –Temperature, SDT- Secchi disc transparency, FCO_2- Free carbon dioxide, DO- Dissolved oxygen, TDS- Total dissolved solids, Alk.- Alkalinity, TH- Total hardness

Table 3: Correlation of some important physico-chemical parameters with mosquito larval population from the water samples of three village ponds of Ludhiana district of Punjab

Parameters	*Value of correlation coefficient*		
	Noorwala village pond	*Kasabad village pond*	*Kaneja village pond*
Temperature	0.6548	0.4926	0.5825
Alkalinity	0.4938	0.4406	0.5270
Dissolve oxygen (DO)	-0.2858	-0.0779	-0.1668

Value >0.3246 represents significant value for correlation

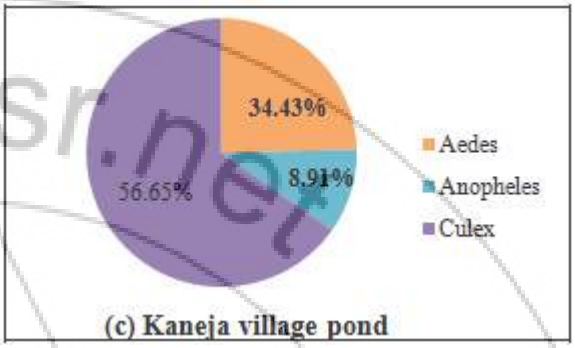

Figure 1: Annual larval density index (LDI%) of different types of mosquito larvae at three village ponds of Ludhiana district