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Physico-chemical characteristics of larval hatritat waters of mosquitoes in and around Bangalore, Karnataka, India

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Abstract
Mosquitoes have been an important group of insects causing maximum nuisance and public health problems to human beings. This study was planned to determine the physico-chemical characteristics of breeding habitats of Mosquito larvae having emphasis on distribution and abundance of potential vectors from June-2016-May-2017 covering all the seasons in selected habitats.

Keywords: mosquito larvae, physico-chemical parameters, habitat, Bangalore

Introduction
A major reason for the study of mosquito larval ecology is to glean on factors that may determine oviposition, survival and the spatil and temporal distribution of important diseases vector species. Breeding water quality is an important determinant of whether female mosquito will lay their eggs, and whether the resulting immature stages will successfully complete their development to the adult stage. Mosquitoes are the most important group of insect vectors of human diseases such as malaria, chikungunya, filarriasis and dengue [1]. Mosquito larvae are found in habitats processing a wide range of physico-chemical factors [2, 3, 4, 5, 6]. Further, the larvae of mosquitoes in clear water of suitable pH, temperature and nutrient conditions have been found to thrive significantly [7]. Diagnostic and scientific research has shown that many mosquito species prefer habitats without oxygen tension whilst some breed in open sunlight pools [8]. In general, water of near neutral PH 6.8 7.2 is preferable for breeding of many species of mosquitoes [9]. Various chemical properties of the larval habitats absorbed in gutter, peri-domestic runoffand domestic areas are related to vegetation and a wide range of heavy metals, nutrients and physico-chemical characteristics of water, ranging from pH, optimum temperature, total suspended solids, total dissolved solids, EC, etc., have been found to affect larval development and survival [10].

Material and Methods
The present study carried out in and around Bangalore city from June-2016 May-2017. The climate of Bangalore city represents four distinct reasons being categorized as summer (mar-May), Monsoon (June-Aug) Post monsoon (Sept-Nov) and winter (Dec-Feb). Sampling was done between 7am to 10am using standard 300ml capacity dipper with a long handle. Water collected by dippers was emptied into a white enamel sorting tray, which was subsequently sorted out for mosquito larvae. Then the larvae were transferred into bowl and kept in cages to emerge into adults. The emerged adult mosquitoes were identified using morphological characteristics to genus level using standard keys and catalogs [12, 13, 14, 15]. Abundance of each type of mosquito larvae was determined as the mean frequency of occurrence per 100 drips [16].

Collection and Fixing of water samples
Water samples were collected concerently with larvae from the 03 habitat types using 1 litre plastic cans. The water was fixed immediately using standard procedure [17]. The physical features of water were recorded by observation while the depth of water was calculated using measuring stick.

Physico-chemical analysis of water samples
Water samples were analysed for the following physic-chemical parameter TDS, DO, conductivity, pH, Cl,No_3, Po_4,So_4, etc. using standard methods as described by APHA [17].

Table 1: A brief description about the habitats.

Habital Type	Description
Site-1; Freshwater Lake	Transparency high with relatively stagnant water with less amount of algal bloom at the edges, water perennially present.
Site-2: Swamp marshy areas	Water quality semi-transparent, relatively stagnant water, presence of algal bloom, presence of small pits, perennial water body.
Site-3; Irrigated drains	Water quality turbid, flowing water type, though flowing was not perennial but water accumulated in small blocks of mud can be found perennially.

Results and Discussion

3 sites were selected for the present study, the physical feature of which have been shown in table 1. At site 1 habitats representing fresh water Dasarahally Lake, where water was found to be permanently present. At site 2 habitat, representing swamp marshy areas were found at Hesaraghatta region. Water bodies found permanent and stagnant. Vegetation found to be thick, water being in range of slight turbid. At site 3 habitat representing Nelamangala irrigated lands which included irrigational drains where water was found perennially present with the zone being sun lighted water slowly moving and aquatic vegetation found.

Occurrence of mosquito larvae

The total mosquito larval (mean/100dips) abundance of the present study has been shown in Table 2, genera of mosquitoes were identified viz., *Culex*, *Anopheles* and *Aedes*. Among 3 genera *Culex* accounted the highest abundance of 217 during post monsoon at site-2 habitat (Swamp marshy areas) while *Aedes* registered highest value 62 at site-3 during monsoon period when frequent rainfall occur and *Anopheles* were recorded highest at site-3 during post monsoon period.

Among *Culex* mosquitoes, *Cx. barraudi*, *Cx. mimeticus*, and *Cx. quinquesfasciatus*. Species like *Cx. mimeticus* were very common in habitates like swampy areas. In *Anopheles* a total of 5 species viz., *An. annularis*, *An. calicifacies*, *An. nigerrimus*, *An. subpictus* and *An. stephensis* showed highest contribution in habitates like irrigated area and in peripheral area of lake two species viz., *Aedes aegypti Ae. Pseudotaeniatus*. present investigation reveals difference in breeding habitats of mosquitoes particularly in the physico-chemical characteristics. Most larvae are filter feeders ingesting anything smaller than about 10 microns by vibrating their mouth brushes and sweeping in particulate matter and small organisms from surrounding water can be observed [18]. Additionally, a low DO requirement of an aquatic habitat is an indirect reflection of lower concentration of TDS which in its respective higher concentrations could reduce transparency and increase oxygen deficiency. Mosquito's activity depends on a large extent on the temperature of the water they inhabit. Besides nutrition, temperature is the main factor that affects the development and growth of mosquito larvae [20].

Temperature of the study ranged between 20-26°, this temperature best for breeding of most mosquitos species viz. *Culex*, *Anopheles* and *Aedes* in the tropics [21]. In the present study pH ranged of 6.0-8.5 was found favourable for mosquito breeding, showing resemblance with findings on mosquito breeding in rock pools [25]. Conductivity ranged between 850 µS/cm to 1020 µS/cm. The presence of oxygen in water is a positive sign for growth, while its absence is signal of sever pollution in the present study DO ranged from 4.5mg/l - 6.0mg/ l breeding waters of *Aedes* showed higher oxygen content than those of *Culex* and *Anopheles* [11].

In the present study in turbid breeding sites, culicine larvae were much more likely to be present whereas *Anopheles* larvae were much more likely very less [26]. Conclusively, based on the study, the following physico-chemical parameters temperature, pH and Do were found to vary significantly with mosquito larvae abundance.

Table 2: Distribution and composition of the mosquito larvae 3-locations in Bangalore from June-16 to May-2017.

Species	Pre-monsoon			Monsoon			Post-monsoon		
	S1	S2	S3	S1	S2	S3	S-1	S-2	S-3
Cx. barraudi	06	08	04	06	04	02	10	16	08
Cx. mimeticus	28	34	30	16	18	22	48	66	36
Cx. quinquefasciatus	42	80	72	34	42	48	102	135	74
An. annularis	08	06	08	00	02	06	06	04	12
An. culicifacies	20	18	22	04	18	18	18	20	28
An. nigerrimus	46	38	52	10	12	40	39	48	62
An. subpictus	32	26	36	02	08	28	34	36	50
An. stepnensi	18	20	18	20	42	52	28	32	04
Ae. aegypti	26	32	38	38	52	68	46	42	21
Ae. pseudotaeniatus	02	04	06	05	10	12	10	08	08

Table 3: The Physico-chemical parameters of mosquito larval habitats.

Parameter	Pre-Monsoon			Monsoon			Post- Monsoon		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
Water Temperature °C	26	25.8	25.2	22	24	23	20	22	21
pH	6.8	6.9	7.0	7.5	7.2	7.5	7.5	7.4	7.4
Conductivity µs/cm	1750	1680	1650	1440	1320	1380	1640	1502	1552
Turbidity NTU	3.0	2.0	6.0	8.0	7.0	8.0	10	12	14
DO mg/l	4.0	5.8	5.2	5.2	6.0	5.8	5.5	4.8	6.0
TDS mg/l	1120	1108	998	926	872	902	1102	984	1006
Cl mg/l	102	86	92	88	74	80	92	90	90
NO_3 mg/l	0.05	0.08	0.04	0.06	0.1	0.08	0.05	0.06	0.04
PO_4 mg/l	0.53	0.38	0.56	0.40	0.24	0.12	0.32	0.38	0.34
SO_4 mg/l	42	40	40	38	32	38	40	38	40

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