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Anopheles breeding in relation to aquatic vegetation and certain physico-chemical parameters in rice fields of Purnia district

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Abstract

***Anopheles* breeding in relation to aquatic vegetation and certain physico-chemical parameters was studied in rice fields of Purnia district. Association of larvae with different types of aquatic vegetation in different proportions was observed. Maximum *Anopheles* larvae were found associated with green and blue green algae. It indicates that algae encountered mosquito breeding by providing food and shelter followed by *Ipomea, Hydrilla* and water hyacinth. Among physico-chemical parameters pH, temperature, turbidity, electrical conductivity, DO, nitrate, carbonate and phosphate showed positive correlation while chloride and bicarbonate showed negative correlation. It can be concluded that aquatic vegetation usually growing in rice fields influences *Anopheles* breeding and their abundance varies with the occurrence and intensity of each aquatic plant. Physico-chemical factors also exert impact on larval survival and emergence. Thus, such factors should be considered when designing an integrated vector control program. However, a detailed study on the role of other interrelated factors such as predator-parasitie relationship, cultivation practices, emergence rate etc is needed for full understanding of the subject. Although the specific soil type was not analyzed in this survey, other reports indicated that there is variation in development of *Anopheles* larva among the different soil types.**

Keywords*: Malaria, Anopheles, Aquatic vegetation, Physico-chemical factors, Emergence rate, Purnia*

Introduction

Due to standing water in rice fields, a variety of plant species grow, which provide food and shelter of different mosquitoes species and offers favourable conditions for oviposition and subsequent larval development. Rice fields are efficient breeding ground of malaria vector. The type and density of aquatic vegetation in larval habitats may also affect the abundance of mosquito larvae through their effect on water temperature, surface characteristics, water chemistry and predation rate (Carnevale *et al*., 1999).As from an agricultural point of view the rice crop is the main crop of Purnia district. Rice cultivation is done in 99000 acres out of which in 15000 acres cultivation of rice is done by Sri Vidhi'. The gross production of rice is 80 – 85 quintal per acre in Sri Vidhi and in rest it 36 – 40 quintal per acre. It is of peculiar importance from the point of view of malaria owing to the fact that it is the only main crop grown in water. So, the present work was undertaken which deals with the abundance and breeding of *Anopheles* mosquito in rice fields because the diversity and abundance of *Anopheles* larvae has significant influence on the resulting adult mosquito population and hence the dynamics of malaria transmission. A vast majority of area is used in this district for rice cultivation.

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Material and Methods

The present studies were conducted in the villages of Purnia east and Kasba blocks of Purnia district. These villages are well known for rice cultivation. Five rice fields were selected in the studied villages. All the rice fields were monitored at weekly intervals for mosquito larval abundance and the occurrence of weed species for a period of two years covering four cropping seasons begining from June 2010. Random samples were also collected from the rice fields. A standard larval (enamel) dipper (9.5 cm. diameter and 300ml capacity) was used for collecting the mosquito larvae. About 5 – 10 dips were taken along the perimeter of each rice field. Immatures collected were counted instar-wise and brought to the laboratory in plastic containers for adult emergence. Samples of floating and submerged aquatic vegetations occurring in the vicinity of rice plants were collected every week along with the larvae and were identified. Some uncommon plant species were identified in the department with the help of Botany teacher.Water samples were collected from the same rice fields and were brought to the laboratory for Physico-chemical analysis. All the samples were analysed according to APHA (1998) and Trivedy and Goel (1984).

Results and Discussion

Altogether eleven plant species of different genera were encountered in studied rice fields (Table – 1). Algae were found floating on the water surface and Some times formed an algal bloom which mainly belonged to green and blue green algae. Water hyacinth (*Eichhorina crassipes*) were also observed in some rice fields due to overflow of water from nearby areas of water infested with hyacinth plants or irrigation of rice fields with the infested water. The relative abundance of *Anopheles* in relation to different aquatic plants is shown in the Table - 2. Maximum larvae were found associated with algae. It indicates that algae encountered mosquito breeding by providing food and shelter. Positive correlation between the presence of green algae and high number of mosquito's larvae has been also

Table-1. List of aquatic plants found in rice fields.

Plants	**Groups**	**Nature**
1. Algae		
a) *Nostoc*	Blue- green algae	
b) *Spirogyra*	Green algae	
c) *Anabaena*	Blue- green algae	Free floating
d) *Cladophora*	Green algae	
e) *Pithophora*	Green algae	
f) *Oscillatoria limnatica*	Blue-green algae	
g) *Phacus*	Euglenoids	
h) *Chara*		
i)*Ulothrix*		
2. *Eichhorina crassipes*	Monocotyledons	Floating
3. *Hydrilla verticillata*	Monocotyledons	Submerged
4. *Ipomea aquatica*	Dicotyledons	Erect, creeping
5. *Lemna minor*	Monocotyledons	Floating
6. *Azolla pinnata*	Pteridophyte	Erect
7. *Marsellia* sp.	Pteridophyte	Erect
8. *Ceratophyllum* sp.	Dicotyledons	Submerged
9. Grasses (*Cynadon dactylon*)	Monocotyledons	Erect

Table 2. Percent composition of anophelines in rice fields in relation to aquatic vegetation.

Type of vegetation	Larvae	Adults emerged
1. Without vegetation	15 (2.93%)	12
2. Algae	99 (19.37%)	61
2. *Eichhorina crassipes*	75 (14.67%)	80
3. *Hydrilla verticillata*	79 (15.45%)	52
4. *Ipomea aquatica*	95 (18.59%)	82
5. *Lemna minor*	35 (6.84%)	29
6. *Azolla pinnata*	20 (3.91%)	33
7. *Marsellia* sp.	39 (9.58%)	8
8. *Ceratophyllum* sp.	29 (5.67%)	18
9. Grasses (*Cynadon dactylon*)	25 (4.89%)	17

Table 3.Mean value of the physico-chemical parameters of water samples of rice fields.

Temperature	29.6^0C
Turbidity	35.6
pH	7.4
EC	560.3
DO_2	4.96
Chloride	120.4
Nitrate	44.2
Phosphate	1.8
Carbonates	44.9
Bicarbonates	280.8

(All values are in mg/l **,** except temperature, electrical conductivity, turbidity and pH)

reported by Schaefer *et al.*(1983) and Kramer and Garcia (1989). However, Russell and Rao (1942) have reported negative correlation between macroscopic algae in rice field and inhabiting mosquitoes in South**-** eastern Madras. Larvae were also found associated with *Ipomea*, *Hydrilla* and *Eichhorina crassipes.* Most anophelines prefer habitats with well-developed beds of submergent, floating leaf or emergent aquatic vegetation. Larvae are typically found in sites with abundant rooted aquatic vegetation. Investigators have suggested that aquatic vegetation promotes anopheline production because it provides a refuge for larvae from predators, such as *Gambusia affinis*.(Claudia, 1992). Additional hypotheses for the beneficial effects of aquatic vegetation include: enhanced food resources in vegetated regions, shelter from physical disturbance and favorable conditions for oviposition (Orr and Resh 1989). Studies by Rejmankova *et al.*, (1991 and 1993) demonstrated that there was a strong association between larval distribution and the distribution of some habitat factors such as cyanobacterial mats and filamentous algae. Minakawa *et al.*, (1999) in western Kenya did not detect any significant association between the occurrence of *An. gambiae* larvae and habitat variables. The association of *Anopheles* with *Hydrilla*, *Eichhorina crassipes* and *Ceratophyllum* plants has been reported by Sen (1941) in lower Bengal and Rajani *et al.*, (1996). Chandler and Highton (1975) reported that the growth of aquatic plants in rice fields in Kenya encouraged the breeding of many mosquito species. In the present investigation, the association of larvae with aquatic plants was observed minimum (3.91%) with *Azolla* plants. *Azolla* provides a mat-like structure on the surface of the habitat thus reducing penetration of sunlight which in turn affects photosynthetic activity of algae and other aquatic forms that serve as a food source for mosquito larvae (Rajendran, 1987 and Rajendran and Ruben, 1991).Rice is grown in water maintained at a depth between 3 and 10 cm. The shallow waters would enable gravid mosquitoes to view the substrate, considering that *Anopheles* prefers shallow habitats (Minakawa *et al.*, 1999; Gimning et al., 2001). Various chemical properties of the larval habitat related to vegetation such as pH, and concentration of ammonia, nitrate and sulphate affect larval development and survival (Carpenter, 1982: Victor and Mutero *et al*., 2004). In the present study, temperature, pH, turbidity, electrical conductivity (EC), DO, nitrate, phosphate and carbonate show positive correlation but chloride and bicarbonate show negative correlation. The optimum dissolved oxygen might have contributed for survival and breeding of *Anopheles* larvae (Oyewole *et al., 2009).* As conductivity is the measurement of the accumulation of ions in a solution, so presently there is no justification why conductivity is positively related with abundance of larvae. However, Burke *et al* (2010) reported negative association of conductivity with *Culex* larval presence. Present study reveals positive correlation with temperature supporting earlier findings in Sri Lanka by Amerasinghe *et al.*, (1995) and Piyartnea *et al.*, (2005). Also, temperature has been previously shown to be an important determinant of *Anopheles* breeding success in India, with the range 28–32^{0}C providing the optimum conditions for egg, larval and pupal development (Pal, 1945). In the present investigation the average temperature was 29.6^{0}C which was quite suitable for egg, larval and pupal development. Water pH remained around 7.0 throughout the cropping season, which was suitable for the breeding of *Anopheles* (Rajani *et al.*, 1996). However, the present findings disagree with Adebote *et al*., (2008), which reported the preference of anopheline species to low pH values, acidic nature. Positive association with turbidity indicates that *Anopheles* requires turbid water for oviposition.In this study *Anopheles* habitats were associated with light and vegetation. However, in the previous study by Van der Hoek *et al.*, (1998) the biological and physical characteristics could not well explain the preference for certain habitats by potential vectors of malaria. However, larvae may occur even in less suitable habitats, but the abundance will be greater in those habitats where the conditions are optimum for larval growth. It can be concluded that aquatic vegetation usually growing in rice fields influences *Anopheles* breeding and their abundance varies with the occurrence and intensity of each aquatic plant. Physico-chemical factors also exert impact on larval survival and emergence. Thus, such factors should be considered when designing an integrated vector control program. However, a detailed study on the role of other interrelated factors such as predator-parasitie relationship, cultivation practices, emergence rate etc is needed for full understanding of the subject. Although the specific soil type was not analyzed in this survey, other reports indicated that there is variation in development of *Anopheles* larva among the different soil types (Faehler *et al*., 2006).

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