



Original Research Article

Biology of the filarial vector, *Culex quinquefasciatus* (Diptera: Culicidae)

K.Manimegalai^{1*} and S.Sukanya¹

Associate Professor, Department of Zoology, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India.

*Corresponding author

ABSTRACT

Keywords

Life cycle,
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The present investigation is an attempt to study the biology of *Culex quinquefasciatus* under the Laboratory condition. The study on biology which includes life cycle, habitat preference, and their behavior help us to understand the role played by the vector mosquitoes in the transmission diseases like malaria, filarial, Dengue and Dengue hemorrhagic fever etc., A knowledge of the breeding, resting and biting, longevity of vector species is, therefore essential for organizing anti-vector measure.

Introduction

Diptera is one of the largest orders of insecta consisting of more than 85,000 species and it includes a large number of vectors. The predominant groups among these are mosquitoes which are placed under the suborder, Nematocera and family Culicidae. More than 3100 species of mosquitoes belonging to 34 genera have been recorded and arranged under three sub families namely, Anophelinae, Culicinae and Toxorhynchitinae (Knight and Stone, 1977). The genus *Culex* was first named and described by Linnaeus in 1735. Following this Meigen in 1818 described two more genera, *Aedes* and *Anopheles*.

Mosquitoes are cosmopolitan in distribution and are prevalent throughout

the tropical and temperate regions and their distribution extends northwards into the Arctic Circle. Only in Antarctica and in a few islands they are absent (Rajendran, 2000). These insects are very successful species found in different climatic conditions, occupy special niches in the environment and breed within a short period of time.

C. quinquefasciatus is an obligatory ectoparasitic vector since it plays a major role in the transmission of the nocturnal periodic form of *Bancroftian filariasis* all over the world (WHO, 1972). It is the most common mosquito prevalent in both urban and rural India. As the vector of bancroftian filariasis it poses an important public health problem, particularly among low socio-economic communities in India.

Though the disease is not fatal, it causes severe morbidity in affected communities. An integrated approach involving chemical treatments and suitable vector control measures can only check the growing population of filarial vectors.

The life cycle from egg to adult stage may be completed in 10 to 14 days, but it is prolonged by cold weather. The short life cycle, one time insemination and high prodigality of production are probably the key factors for the successful proliferation and spread of mosquitoes. Menon and Rajagopalan (1981) observed the survival rates of the immatures of *C. fatigans* in drains in the urban areas and in wells in the villages of Delhi which are found to be the major breeding habitats. Livingstone and Krishnamoorthy (1978 and 1982) reported that mosquitoes belonging to *Aedes spp.* and *Culex spp.* are the tree hole breeding mosquitoes in Maruthamalai scrub jungle.

Meillion *et al.* (1967b) noticed the continuous emergence of equal number of males and females of *C. quinquefasciatus* from the breeding sites. In regions where the seasons are more distinct, females of *C. quinquefasciatus* emerge in large number than males (Hayes, 1975). Adult mosquitoes emerge with low energy reserves which they gradually build up by sugar feeding from plant sap and the carbohydrates thus obtained serve to sustain their daily activities (O'Meara, 1987 and Yuval, 1992).

Males of *C. quinquefasciatus* live only for 1– 2 weeks but females may live up to 2 months. Both male and female mosquitoes feed on plant sap to obtain energy for flight. Females take blood meal to provide

proteins for the development of eggs. Saliva of the mosquito plays a very important role because of the anti platelet activity and also as it serves as a vehicle for the transmission of pathogens to the host (Ribeiro *et al.*, 1984).

Materials and Methods

Biology of *Culex quinquefasciatus*

Egg rafts of *C. quinquefasciatus* were collected from study area and observed under stereobinocular microscope. Biology of *C. quinquefasciatus* was studied to elicit information on egg, larval duration, pupal duration and adult emergence.

Laboratory culture of larvae

Hay infusion method was adopted for culturing mosquito larvae. Hay was taken, cut into small pieces and boiled in 5 litres of water for 20 minutes. After cooling, this water was poured into buckets and kept in different areas where mosquitoes were abundant. After one or two days eggs were laid by female mosquitoes in clusters forming an egg raft. The egg rafts were collected and maintained in the laboratory and reared in enamel trays containing culture medium provided with powdered dog biscuits and yeast in the ratio of 3:1 as the nutrient source.

Results and Discussion

Biology of *Culex quinquefasciatus*

Mosquitoes are ancient group of insects which have persisted for millions of years. Through the process of evolution, nature has superbly perfected them that they may survive under the most adverse and diverse of environmental conditions.

Nature has succeeded in combining in them certain advantageous characteristics, the combination of which is not found in other groups of insects. If diversity of species, habits, number of individuals and persistence in geological time are the measures, mosquitoes are undoubtedly one of the “successful groups among the insects” of biological evolution. A study of mosquito population in Coimbatore indicated *C. quinquefasciatus* as one of the predominant species in this locality and it is the vector of bancroftian filariasis.

An understanding of biology of mosquitoes is an essential prerequisite for developing strategies, if not to control and eradicate the population totally at least to manage the mosquito population effectively. Therefore, the present investigation is an attempt to study the biology of *C. quinquefasciatus* under the laboratory conditions (Plate)

Egg

Culex mosquitoes lay their eggs on the surface of fresh or stagnant water. The water may be in tin cans, barrels, horse troughs, ornamental ponds, swimming pools, puddles, creeks, ditches, or marshy areas. Mosquitoes prefer water sheltered from the wind by grass and weeds. *Culex* mosquitoes usually lay their eggs at night. A mosquito may lay a raft of eggs every third night during its life span. Eggs are laid one at a time, stuck together to form a raft of about 200- 300 eggs. A raft of eggs looks like a speck of soot floating on the water and is about 1/4 inch long and 1/8 inch wide. Tiny mosquito larvae emerge from the eggs within 24 hours

Under the laboratory conditions the female *C. quinquefasciatus* laid eggs on the

surface of hay culture medium with rich organic content. Eggs were elongate oval and white when laid. However, after one hour they turned dark. The eggs were laid in clusters forming an egg raft which appeared like a tiny piece of black velvet or dirt on the water surface. The number of eggs per raft ranged from 103 – 260 with a mean of 190.9 ± 44.08 ($n = 20$; $X \pm SD$).

Incubation period

Incubation period ranged from 3 to 5 days, the mean being 3.8 ± 0.6 days. The minimum percentage of hatching recorded was 77.77 and the maximum was 100. The first instar larva was 1.74 ± 0.23 mm long and 0.3 ± 0.06 mm broad. The stadial period extended upto 2.30 ± 0.30 days. The length of second instar larva was 3.09 ± 0.12 mm, breadth was 0.72 ± 0.08 mm and the larval duration was 2.1 ± 0.30 days. The third instar larva was 5.04 ± 0.85 mm long, 1.04 ± 0.10 mm broad and the larval duration was 2.2 ± 0.51 days. The length of the fourth instar larva was 5.17 ± 0.29 mm, width was 1.27 ± 0.07 mm and the larval duration was 2.1 ± 0.43 days

Pupae

The pupae are commonly referred to as “tumbler” as they tumble through water and are very active unlike pupae of other insects. The pupae were comma shaped, 3.84 ± 0.17 mm long and 1.29 ± 0.14 mm broad. Pupae moved in a somersault fashion through the water. This is a non feeding stage during which the adult body including the organs are developed. They respire through two trumpets like tubes located on the thorax.

Adult

Adult mosquitoes are terrestrial and capable of flight. With piercing – sucking mouth parts, the females feed mostly on animal blood and plant sap. The males are purely phytosuccivorous forms feeding on plant sap. Antennae of males have dense bristles, used to find the female by detecting the odour of the female.

Habits of mosquitoes feeding habits

Mosquito adults feed on flower nectar, juices, and decaying matter for flight energy. The larvae are filter feeders of organic particulates. The larval and pupal stages can be found in a variety of aquatic habitats including: discarded containers, tires, temporary woodland pools, rain cans, tree and crab holes, salt marshes, and irrigation ditches. All mosquitoes feed on nectar and other plant juices, but female mosquitoes usually require additional protein from a blood meal for the development of their ovaries and eggs. One blood meal is often required before a female mosquito lays each batch of egg.

Feeding during larval stage is accomplished through injection of particles filtered from the water column or surface, removal and injection of surface biofilms, shredding of leaves and predation of other larvae and insects of their own size or smaller.

Resting habits

There are mosquitoes that rest during the day and emerge in the dim light of dawn and evening. Some feed at night, other during bright daylight; still others, like the vector of La Crosse encephalitis, are most active in late afternoon. Mosquitoes lay

eggs in tree holes, discarded tires, decorative fountains, flowerpot trays, elephant footprints, pitcher plants, empty cans, forest ponds, salt marshes and low spots in the yard. The whole process from egg to blood-thirsty adult is accomplished in about ten days, and four to five days after her last blood meal, the female is ready to feed and lay again.

Breeding habits

Mosquitoes cannot breed successfully in flowing water and streams and can breed only when flowing water dries up and leave shallow, stagnant puddles in the stream bed. Mosquito larvae associated with permanent bodies of water generally live where the water is shallow (1 ft or less). Weeds, debris, emergent grasses or some sort of aquatic vegetation shelters the mosquito larvae from fish and other predators. Relatively few mosquito species actually breed in permanent bodies of water such as marshes or swamps. Most of the mosquito species associated with marshes or swamps actually breed in temporary pools along the margins of these habitats. *Culex pipiens* lay its eggs in rafts of about 150-350 eggs in polluted or foul water body. Mosquito breeding ground includes catch basins, ditches, rain barrels, ground pools, clogged rain gutters, neglected birdfeeders with standing water, and areas that contain organic waste materials.

When larvae hatch they remain in the mosquito breeding till they attain adulthood. Some female *Culex pipiens* travel a distance in search of a blood meal required for the development of it eggs. The entire process of egg to adult mosquito, otherwise known as the mosquito breeding cycle, can take up to

two weeks, depending on the weather condition.

Hibernation

Mosquitoes are cold-blooded and prefer temperatures above 80 degrees. At temperatures less than 50 degrees, they shut down for the winter. The adult females of some species find holes where they wait for warmer weather, while others lay their eggs in freezing water and die. The eggs hatch only when the temperature rises.

Dispersal

Mosquito dispersal is a key behavioral factor that affects the persistence and resurgence of several vector-borne diseases. Spatial heterogeneity of mosquito resources, such as hosts and breeding sites, affects mosquito dispersal behavior and consequently affects mosquito population structures, human exposure to vectors, and the ability to control disease transmission.

Life span

Average lifespan of the mosquito is less than two months with males having the shortest life span which usually is 10 days or less, and females about six to eight weeks, under ideal conditions. The females lay eggs about every three days during this period. Females of hibernating species may live up to six months.

Several workers have attempted to study the biology of mosquitoes (Iyengar, 1952; Krishnamurthi and Pal, 1958; Clements, 1963; Meillen *et al.*, 1967b; Subra, 1971 a & b; Subra, 1973 and Yasuno *et al.*, 1975). In the present study on biology of *C. quinquefasciatus*, the incubation period

extended upto 3.8 days and 190.9 eggs / raft were observed. Subra (1973) reported an incubation period of 24 – 36 h and 155 eggs / raft in *C. quinquefasciatus* in Kenya. The differences in the incubation period may be due to low temperature prevailing in the month of January in Coimbatore during which period the study was carried out.

Chadee (1994) while studying the life table of *C. quinquefasciatus* observed the fate of 1,092 eggs and found that the length of the life cycle was 9.5 days with a larval duration of 7.5 days. Larval duration in the present investigation was 8.7 days and total developmental period was 12.8 days in the months of January. According to Meillon *et al.* (1967a) the duration of larval stages was 118 h for males and 135 h for females. In the present observation, the larval duration was found to be 209 h. This prolonged developmental period might be attributed to cool climatic conditions in January during which period the study was carried out.

Yan *et al.* (1991) conducted experiments on two sets of *C. quinquefasciatus*, one with the rich supply of food and the other with a shortage of food. The results showed that food supply affected the survival and development of the larvae and influenced the parameters of adult population. The variation in the larval duration in the present study may be attributed to the climatic conditions and normal supply of nutrients in the medium.

The biology of mosquitoes, thus reveals that mosquitoes are the most successful species have been mosquitoes have diversified behaviour broad range of habit preferences, and their ecological tolerance have made them a group which is selected through natural selection.

Table.1 Biology of *Culex quinquefasciatus*

S.No	Parameters	Days X ± SD	Parameters	Percentage
1.	Incubation period	3.8 ± 0.62	Hatchability	94.87 ± 5.11
2.	Larval duration		Larval survival	100
	i. I instar	2.3 ± 0.30		
	ii. II instar	2.1 ± 0.30		
	iii. III instar	2.2 ± 0.51		
	iv. IV instar	2.1 ± 0.43	Pupal survival	100
3.	Pupal duration	2.05 ± 0.22	Adult emergence	100

Table.2 Morphometric analysis of larvae and pupae

S. No	Develop mental Stages	Head		Thorax		Abdomen		Total	
		Length	Width	Length	Width	Length	Width	Length	Width
1.	Larval Instars I instar	0.36±0.0 5	0.33±0.0 6	0.32±0.0 7	0.31±0.0 6	1.05±0.3 0	0.23±0.0 5	1.74±0.2 3	0.3±0.0 6
2.	II instar	0.54±0.0 8	0.64±0.1 3	0.56±0.0 6	0.72±0.0 8	1.99±0.0 6	0.52±0.0 9	3.09±0.1 2	0.72±0. 08
3.	III instar	0.90±0.1 1	1.01±0.0 7	0.98±0.1 6	1.04±0.1 0	3.16±0.7 2	0.74±0.1 1	5.04±0.8 5	1.04±0. 10
4.	IV instar	0.79±0.0 8	0.96±0.0 9	1.00±0.0 3	1.27±0.0 7	3.38±0.3 1	0.95±0.0 9	5.17±0.2 9	1.27±0. 07
5.	Pupa	Cephalothorax							
		1.27±0.0 4	1.29±0.1 4			2.56±0.1 9	0.66±0.0 9	3.84±0.1 7	1.29±0. 14

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