International Research Journal of

ANIMAL AND VETERINARY SCIENCES

Volume 01 | Issue 01 | 2019

SciRange
PUBLICATIONS
www.scirange.com

SciRange Open Access

International Research Journal of Animal and Veterinary Sciences Research Article

pISSN: 2663-7154, eISSN: 2663-7162

Studies on the Biocontrol of the Filarial Vector Mosquito, *Culex quinquefasciatus* Employing *Gambusia affinis*

[1]Selvi Hepzibah, [2]A. Surendran and [1]A. Joseph Thatheyus

[1]PG and Research Department of Zoology, The American College, Madurai, Tamil Nadu, India
[2]PG Department of Food Science and Nutrition, The American College, Madurai, Tamil Nadu, India

ARTICLE INFORMATION

Received: November 05, 2018

Accepted: November 28, 2018

Published: March 15, 2019

Corresponding Author:
A. Joseph Thatheyus,
PG and Research Department of Zoology, The American College,
Madurai, Tamil Nadu, India

ABSTRACT

Larval control of the filarial vector mosquito *Culex quinquefasciatus* was determined by employing the fingerlings of the mosquito fish, *Gambusia affinis* in 1 and 24 h. Effects of prey density, water volume, aquatic plant, container shape, predator density and time of the day on the rate of predation were assessed. Fingerlings of mosquito fish have the potential to control the larvae of the filarial vector, *Culex quinquefasciatus*. It was concluded that control can be done through physical, chemical and biological methods.

Key words: *Gambusia affinis*, *Culex quinquefasciatus*, Biocontrol, vector mosquito, predation

INTRODUCTION

Diseases transmitted by the vectors are one of the major problems in a number of countries over the different control strategies. Among the different types of vectors, mosquitoes are the major group, which are responsible for the transmission of several life-threatening and dreadful diseases like malaria, yellow fever, dengue fever, chikungunya, filariasis, encephalitis and so on to human beings. Other than, transmission of diseases, they also act as nuisance pest to man and animals. Applications of pesticides in mosquito control operations have several restrictions due to development of resistance, environmental pollution problems and public health issues[1,2]. So, it is evident to find out appropriate straightforward sustainable methods for mosquito control.

Biological control that means utilization of living organisms to control vector population is one of the conventional and more effective eco-friendly approaches. Fishes those feed on the immature stages of mosquitoes (called larvivorous fish) are used as biological control agents all over the world for a long period of time[3,4]. The use of fish for mosquito control has definite advantage in that it does not harm the non-target organisms especially the predators in the ecosystem. Above 253 fish species have been employed for the biocontrol of mosquitoes due to their effective predatory activity[5-8]. However, reports about the application of fishes in mosquito control operations are very much limited[9,10]. Further investigations in this area would be more valuable for the better implementation of fishes in mosquito control.

Gambusia affinis which is commonly called the 'mosquito fish' has been used for mosquito control. It belongs to the family Poecillidae like guppies, topminnows and killi fish. Mosquito fish prefers quiet shallow ponds, lakes, ditches, drains, marshes and sluggish creeks with clear water and aquatic vegetation. Their life span is short, probably less than fifteen months. They are ovoviviparous (live bearers). It reaches maturity in four to ten weeks. Mosquito fish eats a variety of macro-invertebrates which includes mosquito larvae, other small insect larvae, zooplankton and aquatic plants such as algae and diatoms. It does not provide 100% control in all types of mosquito habitats, but in certain situations, it was believed that they can help reduce mosquito populations[8]. Hence in the current research, an attempt has been made to study the biocontrol potential of the mosquito fish, *G. affinis* against the larvae of *Cx. quinquefasciatus*.

MATERIALS AND METHODS

Collection of experimental organisms: *G. affinis* fingerlings were collected from a private fish farm at Madurai, Tamil Nadu, India. They were acclimated to laboratory conditions for fifteen days in a well aerated tank and maintained under room temperature till the commencement of the experiment. Fishes of uniform weight (4 g) were chosen for the study. Fishes were fed on fish feed before the experiment, but the fishes were subjected to starvation for one day before the commencement of the experiments.

Mosquito larvae were collected from the Kiruthamal channel, Madurai, Tamil Nadu, India and the species were identified as *Cx. quinquefasciatus*. From the collection, third instar larvae were selected for the experiments.

Prey density: In the first set of experiments, 500 mL of water was taken separately in five different beakers. In these beakers, 20, 40, 60, 80 and 100 larvae were introduced individually for 1 h experiment. Then, one *G. affinis* fingerling was introduced in each beaker and the time was noted. After 1 h, the fishes were removed and the remaining larvae were counted. From this, the number of larvae consumed was determined. The experiments were conducted in triplicates and the average was taken for each prey density. Similar experiments were conducted for a period of 24 h but the number of larvae introduced in the beakers was 200, 250, 300, 350 and 400.

Effect of water volume: In the second set of experiments 400, 500, 600, 700 and 800 mL of water was taken separately in five different beakers. One hundred *Cx. quinquefasciatus* larvae were introduced in each beaker for 1 h experiment. Then one *G. affinis* fingerling was allowed in each beaker and the time was noted. After 1 h, the fishes were removed, the remaining larvae were counted and the number of larvae consumed was determined. The experiments were conducted in triplicates and the average was taken to find out the influence of water volume. The same experiment was carried out for 24 h with the prey density of 200 larvae in each beaker.

Influence of aquatic plants: In the third set of experiments, 500 mL of water was taken in two different beakers. Two hundred *Cx. quinquefasciatus* larvae were introduced in each beaker for the 1 h experiment. In this, one *G. affinis* fingerling was allowed in each beaker. Few branches of *Hydrilla* plants were put in one beaker only and the time was noted. After 1 h the fishes were removed from the respective beakers, the remaining larvae were counted and the number of larvae consumed was determined. The experiments were conducted in triplicates and the average was taken for both the sets. Similar experiments were conducted for a period of 24 h to find out the influence of *Hydrilla* plant on the predation.

Container shape: In the next set of experiments, influence of the shape of the container on the predation was studied. Different shapes of containers such as oval, round, rectangle and square were taken with 500 mL of water. Two hundred *Culex* larvae and one common carp fingerling were introduced in each container and the time was noted. After 1 h the fishes were removed, the remaining larvae were counted and the number of larvae consumed was determined. The experiments were conducted in triplicates and the average was calculated. The same experiment was conducted for 24 h also.

Number of predators: In another set of experiments the influence of number of predators on the predation was studied. For this, 500 mL of water was taken in three separate beakers and two hundred larvae were introduced in each beaker. Then one, two and three common carp fingerlings were allowed individually in each beaker respectively and the time was noted. After 1 h, the fishes were removed, the remaining larvae were counted and the number of larvae consumed was determined. The experiments were conducted in triplicate and the mean was calculated. The same experiment was conducted for 24 h but the number of larvae introduced in each beaker was kept as 600.

Influence of time: In the last set of experiments, the influence of time of the day on the predation of the fish species was studied. For this, 500 mL of water was taken in one beaker with two hundred larvae and one common carp fingerling. The experiment was started at 7 pm and continued till 7 pm the next day. After every 1 h the fishes were removed, the remaining larvae were counted and the number of larvae consumed was determined. Again the fishes were reintroduced. The experiments were conducted in triplicates and the mean was calculated.

RESULTS

Experiments were conducted for testing the biocontrol efficiency of *G. affinis* and the following results were obtained. Figure 1 indicates the biocontrol activity of *G. affinis* in 1 h. As the prey density increases the number of larvae consumed also increases. Figure 2 exhibits the biocontrol activity of *G. affinis* in 24 h. Predation increased in direct proportion with the prey density. Predation increased with the increase in prey density. Figure 3 shows the effect of volume of water on the biocontrol activity of *G. affinis* in 1 h. As the volume of water increased upto 600 mL, predation also increased. When volume of water was 700 and 800 mL, the consumption of larvae decreased. Effect of volume of water on the predation of *C. carpio* in 24 h is shown in Fig. 4. As the volume of water increased upto 600 mL the predation also increased. When the volume of water was 700 and 800 mL, the consumption of larvae decreased.

Figure 5 divulges the influence of *Hydrilla* plant on the biocontrol activity of *G. affinis* in 1 h. In the case of using *Hydrilla* plant, it enhanced the process of biocontrol activity. Figure 6 shows the influence of *Hydrilla* on the biocontrol activity of *G. affinis* in 24 h. Here also *Hydrilla* enhanced the predation of *Culex* larvae.

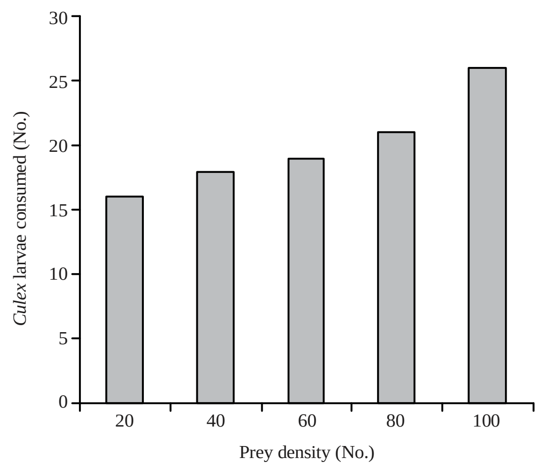

Fig. 1: Effect of prey density on the predation of *Gambusia affinis* in 1 h

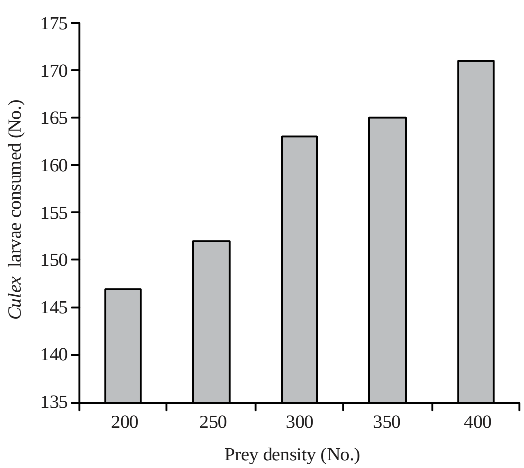

Fig. 2: Effect of prey density on the predation of *Gambusia affinis* in 24 h

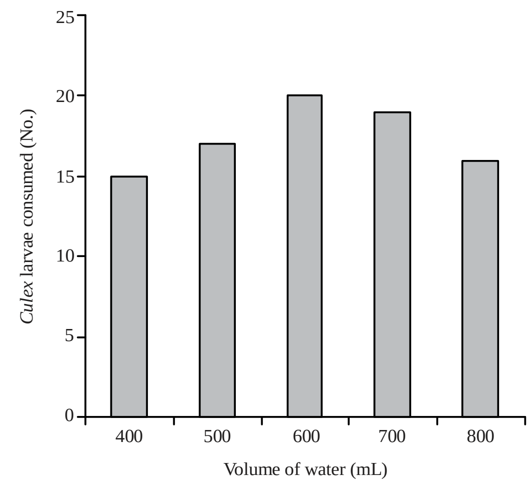

Fig. 3: Effect of volume of water on the predation of *Gambusia affinis* in 1 h

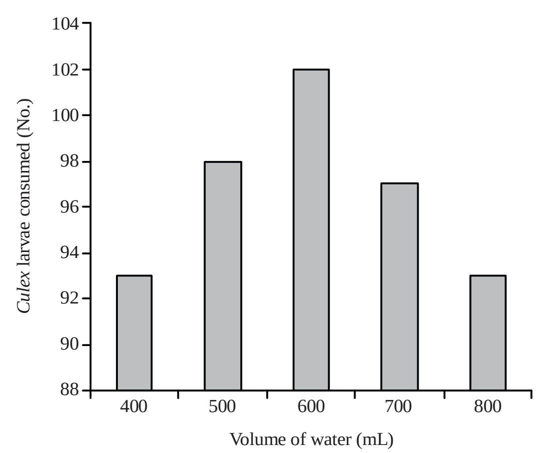

Fig. 4: Effect of volume of water on the predation of *Gambusia affinis* in 24 h

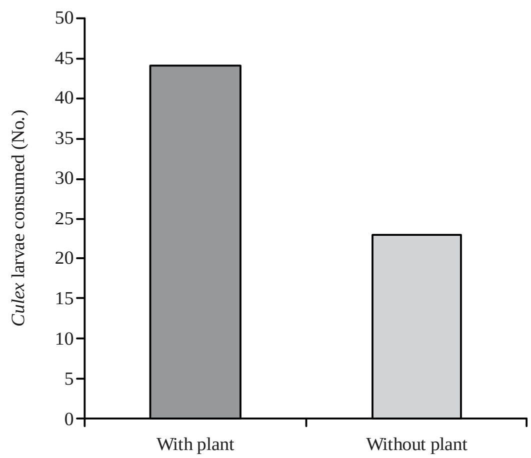

Fig. 5: Influence of *Hydrilla* on the predation of *Gambusia affinis* in 1 h

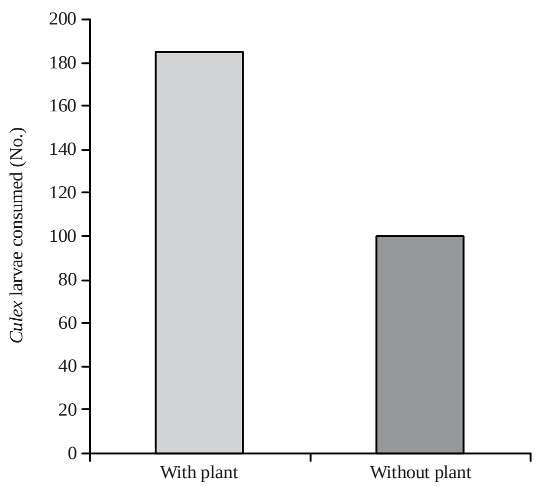

Fig. 6: Influence of *Hydrilla* on the predation of *Gambusia affinis* in 24 h

Figure 7 exhibits the influence of the shape of the container on the biocontrol activity of *G. affinis* in 1 h. Consumption of larvae was maximum in oval container and minimum in square container. The biocontrol activity was minimum in square container; moderate in rectangular and round containers and maximum in oval container. Figure 8 shows the influence of shape of container on the biocontrol activity of *G. affinis* in 24 h. The results were similar to that of 1 h experiment. In 24 h experiment, the consumption of *Culex* larvae was not as predominant as in 1 h experiment.

Figure 9 indicates the influence of number of predators on the biocontrol activity of *G. affinis* in 1 h. When the number of predators increased, the number of larvae consumed also

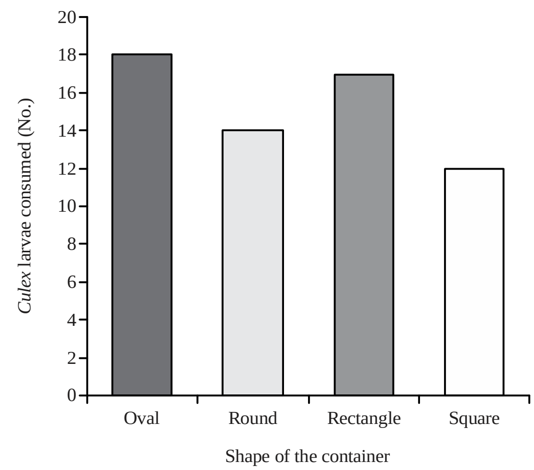

Fig. 7: Influence of container shape on the predation of *Gambusia affinis* in 1 h

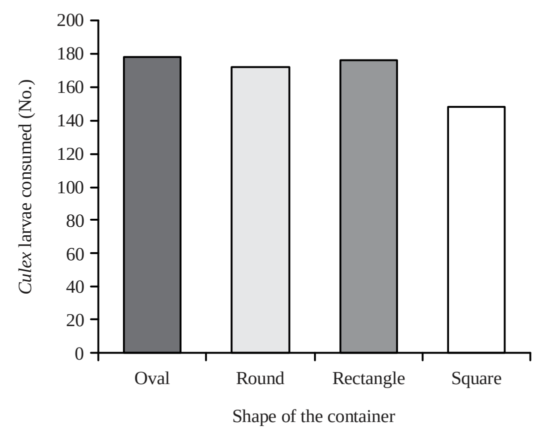

Fig. 8: Influence of container shape on the predation of *Gambusia affinis* in 24 h

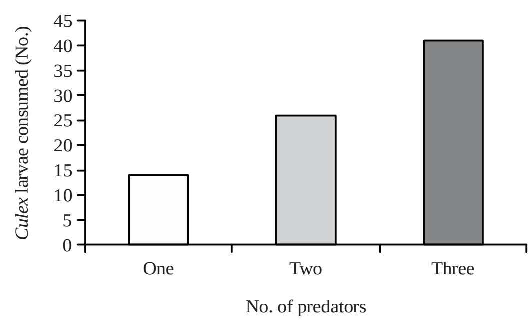

Fig. 9: Influence of number of predators on the predation of *Gambusia affinis* in 1 h

increased. Figure 10 exhibits the increase in the number of predators resulted in the increase in consumption in 24 h.

Figure 11 indicates the predatory pattern of the fish *G. affinis* in 24 h. The consumption of larvae was high during

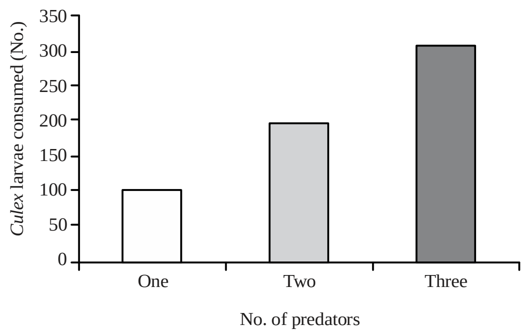

Fig. 10: Influence of number of predators on the predation of *Gambusia affinis* in 24 h

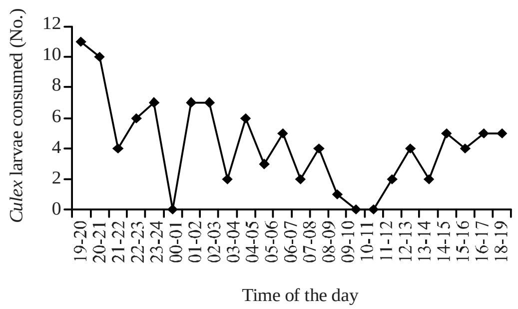

Fig. 11: Predatory pattern of the fish, *Gambusia affinis*

19-20 h but it decreased as time went on. The experiment was commenced at 19 h. The consumption of larvae increased between 23-24 h and then it decreased suddenly. There was no consumption between 0 to 1 h. The consumption reached its peak during 1-2 h and 2-3 h and later it showed a decline. There was no consumption of larvae during 0-1 h, 10-11 and 11-12 h i.e., after 6th, 16th and 17th h of commencement of the experiment.

DISCUSSION

Mosquitoes are nuisance to human beings and spread dreadful diseases like Malaria, Filariasis, Dengue, Yellow fever, Chikungunya and Japanese Encephalitis. *Anopheles, Culex* and *Aedes* mosquitoes are mainly responsible for the various vector borne diseases. Several types of control methods have been developed and adopted for vector control. The use of fishes in the control of mosquitoes was well documented since early 1900s and it has been highly regarded as an adjunct to chemical pesticides. Singaravelu *et al.*[11] studied the predatory efficiency of *Gambusia affinis* on the larvae of *Aedes aegypti*. The role of predation was found to be dependent on prey density. Chatterjee and Chandra[12] reported the biocontrol efficacy of *G. affinis* under experimental conditions in the laboratory. They revealed that the feeding rate increased with the increase in prey density. In the current study also similar effect of prey density on the biocontrol activity of *G. affinis* was observed against the larvae of *Cx. quinquefasciatus*. Influence of number of predators on the biocontrol activity of *G. affinis* was also noticed. In this study, as the prey and predator densities increased the number of larvae consumed also increased.

Biocontrol activity studies employing *C. carpio*, *Ctenopharygdon idella*, *Oreochromis niloticus niloticus* and *Clarias gariepinus* were conducted against fourth instar *Anopheles stephensi* larvae at varying prey and predator densities. The relative consumption rates of these four fish species on *Anopheles stephensi* larvae during 24 h experiments under laboratory conditions were *Cl. gariepinus > C. idella > C. carpio > O. n. niloticus*. Two and four fishes of each species were allowed to feed on *An. stephensi* larvae, in variable amount of pond water (2 and 4 L, respectively) over 24 h period. They reported that biocontrol activity was positively related with prey density and inversely related with water volume i.e. search area[13]. In the present work, effect of volume of water on the biocontrol activity of *G. affinis* was observed. As the volume of water increased upto 600 mL the consumption also increased. When volume of water was 700 and 800 mL the consumption of larvae decreased.

G. affinis is an excellent biocontrol agent. As accurate assessment was revealed in a statement by Kligler[14]: "Their usefulness as larvae destroyers under local conditions, where vegetation is abundant and microfauna rich enough to supply their needs without great trouble is limited. In moderately clear canals, on the other hand, or in pools having a limited food supply, they yielded excellent result". In the present study similar trends were also observed. When *Hydrilla* plant was used, the consumption of larvae was more and when *Hydrilla* plant was not used the consumption was less. Sabatinelli *et al.*[15] reported that in Grand Comore Island, the indigenous fish, *Poecilia reticulata* effectively suppressed larval and adult population on *Anopheles gambiae* in wash basins and cisterns by 85 percent in a single year using 3-5 fish in a water surface of 1 m^2. Gupta *et al.*[16] reported that in India *Poecilia reticulata* effectively reduced the breeding of *Anopheles stephensi* and *Anopheles subpictus* population breeding in containers, by 86 percent using 5-10 fish in a water surface of 1 m^2.

In the current study, influence of container shape on the biocontrol of *G. affinis* showed maximum in oval shape container and minimum in square shape container. *G. affinis* exhibited variation and this may be due to the behavioral change. Ghosh *et al.*[13] observed three hourly and daily consumption rates of different exotic fishes (*Cyprinus carpio, Ctenopharygdon idella, Oreochromis niloticus niloticus* and *Clarias gariepinus*) on the larvae and pupae of *Anopheles stephensi*. They reported that the change in the dark versus light phases probably exhibited some behavioral response with no practical significance in control strategy. In the present work, 24 h predatory pattern of *G. affinis* was noticed. Predatory pattern of the fish *G. affinis* showed that consumption of larvae reached its peak between 23-24 h, 1-2 h and 2-3 h. There was no consumption of larvae between 0-1, 10-11 and 11-12 h.

CONCLUSION

Therefore, it was concluded that mosquito control can be done through physical, chemical and biological methods. Mosquitoes are indeed cocking a snook at coils and mats used to keep them away. Repellents, vapourisers are no longer effective in driving away mosquitoes. Larvivorous fishes can be used to control mosquito larvae. These fishes are foremost natural enemies of mosquito larvae.

REFERENCES

1. Kumar, N.S., R. Hegde, S. Badiger and K.G. Kiran, 2017. A study of mosquito borne diseases awareness, attitude and practices among the rural population in Karnataka, India. Int. J. Community Med. Public Health, 4: 4178-4181.
2. Sarwar, M., 2016. Mosquito-Borne Viral Infections and Diseases among Persons and Interfering with the Vector Activities. Int. J. Vaccines and Vaccination, 3: 1-7.
3. Service, M.W., 1983. Biological control of mosquitoes, has it a future? Mosquito News, 43: 113-120.
4. Chandra, G.I., S.N. Bhattacharjee, A. Chatterjee and A. Ghosh, 2008. Mosquito control by larvivorus fish. Indian J. Med. Res., 127: 13-27.
5. Fletcher, M., A. Teklchaimanot and G. Yemane, 1992. Control of mosquito larvae in the port city of Assam by an indigenous larvivorous fish, *Aphanicus dispar.* Acta Tropica, 52: 155-166.
6. Mohamed, A.A., 2003. Study of larvivorous fish for malaria vector control in Solamia. East Mediterr. Health J., 9: 618-626.
7. Yildiram, O. and A. Karacuha, 2007. A preliminary study on determination of *Aphanius chantreis* feeding behavior on mosquito larvae. Acta Tropica, 102: 172-175.
8. Sathe, T.V., 2014. Biological control of mosquitoes. Recent Trends Biol. Pest Control, 2: 11-20.
9. Haq, S.U. and R.S. Yadav, 2003. Developing larvivorous fish network for mosquito control in urban areas: a case study. ICMR Bulletin, 33: 69-73.
10. Annabel, F.V., A. Howard, G. Zhou and F.X. Omlin, 2007. Malaria mosquito control using edible fish in western Kenya: Preliminary findings of a controlled study. BMC Public Health, 7: 199 -202.
11. Singaravelu, G., S. Mahalingam and K. Jayabharati, 1997. Predatory efficiency of larvivorous fish *Gambusia affinis* on the mosquito larvae of *Aedes aegypti* and *Anopheles stephensi*. Curr. Sci., 72: 572-574.
12. Chatterjee, S.N. and G. Chandra, 1997. Laboratory trials on the feeding pattern of *Anopheles subpictus, Culex quinquefasciatus* and *Armigeres subalbatus* larvae by *Gambusia affinis.* Sci. Cult., 63: 51-52.
13. Ghosh, A., S. Mondal, I. Bhattacharjee and G. Chandra, 2005. Biological control of vector mosquitoes by some common exotic fish predators. Turk. J. Biol., 29: 167-171.
14. Kligler, I.J., 1930. The epidemiology and control of malaria in Palestine. University of Chicago Press, Chicago, IL., pp: 240.
15. Sabatinelli, G., S. Blanchy, G. Majori and Papakay, 1991. Impact of the use of the larvivorous fish *Poecillia reticulata* on malaria transmission in RFI of Comoros. Ann. Parasitol. Hum. Comp., 66: 84-8.
16. Gupta, D.K., R.M. Bhatt, R.C. Sharma, A.S. Gautam and S. Rajnikant, 1992. Intradomestic mosquito breeding sources and their management. Indian J. Malariol., 29: 41-46.