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Predatory Activity of *Cyprinus carpio* Linn. Against the Filarial Vector Mosquito, *Culex quinquefasciatus* Say

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ABSTRACT

Mosquitoes become a menace all over the world causing nuisance to humans and spreading many vector-borne diseases. As chemical control of mosquitoes causes environmental pollution, control of mosquitoes employing organisms gained importance. In the present study, common carp fingerlings were used for the control of the larvae of *Culex quinquefasciatus* which is a vector of filariasis. After 1 h and 1 day treatment, effects of prey density, water volume, presence of aquatic plant, container shape, predator density and time of the day on the predation of common carp over mosquito larvae were studied. Rate of predation by common carp increased with the increase in prey density. It also increase with the increase in volume of water upto 600 mL. Presence of *Hydrilla* enhanced the rate of predation. Consumption of larvae was the maximum when the container was in a square shape. Increase in prey density also caused an increase in the rate of predation. Common carp fingerlings can be effective in shallow ponds with vegetation. It was than concluded that Larvivorous fishes like common carp can be effectively used in vector control programme.

Key words: *Cyprinus carpio*, *Culex quinquefasciatus*, predation, vector mosquito, biocontrol

INTRODUCTION

A healthy and disease free society is the backbone of a nation. Many people in developing countries suffer from devastating diseases transmitted by mosquitoes. Mosquitoes are pestiferous insects which are responsible for the spread of various dangerous diseases. In India, the most important disease transmitting mosquitoes belong to the genera, *Anopheles, Culex, Aedes* and *Mansonia*. Malaria, Filaria, Japanese Encephalitis, Dengue and Dengue Haemorrhagic fever are the major mosquito-borne diseases[1]. All species of mosquitoes are not carriers of dangerous diseases. Some species cause only biting nuisance. The effects of mosquito biting are pain, irritation, loss of sleep, loss of blood and allergic reactions. There are also other effects like the loss of concentration in studies and work. Ultimately it leads to loss of productivity and hence mosquito control is mandatory[2].

Culex quinquefasciatus, the common house mosquito, is a potential vector of filaria throughout India and transmits bancroftian filariasis. *Cx. quinquefasciatus* is the most abundant house mosquito in towns and cities of the tropical countries. *Culex* mosquitoes develop in polluted ponds, marshes, tanks, street gutters and water barrels.

Rapid urbanization and industrialization without adequate drainage facilities are responsible for its increased spread. The life cycle from egg to adult may be completed in ten to fourteen days, but it is prolonged by cool weather. The Government organizations reduce the mosquito population in many ways. Mosquito control can be done through antilarval and antiadult measures. Physical, chemical and biological methods are adopted in antilarval measures. Among them, chemical control of mosquitoes is not favored because of insecticide resistance among vectors and creation of environmental imbalance. Therefore alternative control methods are needed[3].

Biological control of mosquito larvae with predators and other biocontrol agents would be more effective and an eco-friendly approach. Introducing predators into the ecosystem may provide sustained biological control of vector populations. The selection of a biological control agent should be based on its self replicating capacity, preference for the target vector population in the presence of alternate natural prey, adaptability to the introduced environment and overall interaction with indigenous organisms[4]. Larvivorous fishes, which feed on the immature stages of mosquitoes, have shown better results among other biological control agents. The use of fish for mosquito control has definite advantage in that it does not harm the non-targeted organisms especially the predators in the ecosystem. All over the world, above 253 fish species have been employed in the biocontrol of mosquitoes due to their effective predatory activity[5-8]. Common carp (*Cyprinus carpio*) is found in canals, creeks, swamps, ponds and lakes. It mainly feeds on aquatic insects, crustaceans, annelids, mollusks, weeds and tree seeds, wild rice, aquatic plants and algae, mainly by grabbing in sediments. It helps to control the mosquito population in an indirect way by keeping the pond clear[9]. Therefore in the present work, an attempt has been made to study the predatory activity of the common carp, *C. caprio* against the larvae of *Cx. quinquefasciatus*.

MATERIALS AND METHODS

Collection of experimental organisms: *C. carpio* 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 was 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 *C. caprio* 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 *C. carpio* 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 *C. carpio* 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 of the day: 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 predatory potential of *C. carpio* and the following results were obtained. Figure 1 indicates the effect of prey density on the predation of *C. caprio* in 1 h. Predation increased in direct proportion with the prey density. Figure 2 shows the effect of volume of water on the predation of *C. carpio* in 1 h. As the volume of water increased upto 600 mL, predation also increased. In 700 and 800 mL, the consumption of larvae decreased. Figure 3 exhibits the effect of prey density on the predation of common carp in 24 h. Increase in prey density resulted in an increase in predation rate. 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 and when the volume of water was 700 and 800 mL the consumption of larvae decreased suddenly.

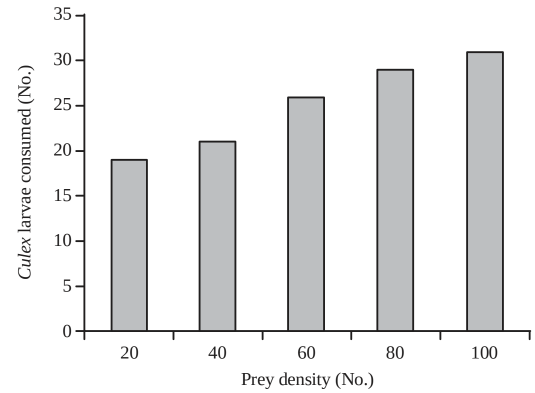

Fig. 1: Effect of prey density on the predation of *Cyprinus carpio* in 1 h

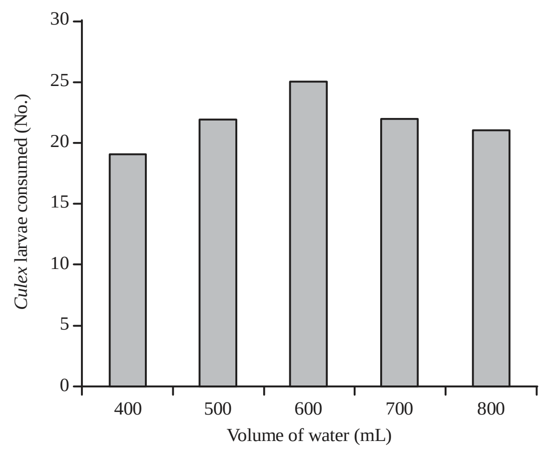

Fig. 2: Effect of volume of water on the predation of *Cyprinus carpio* in 1 h

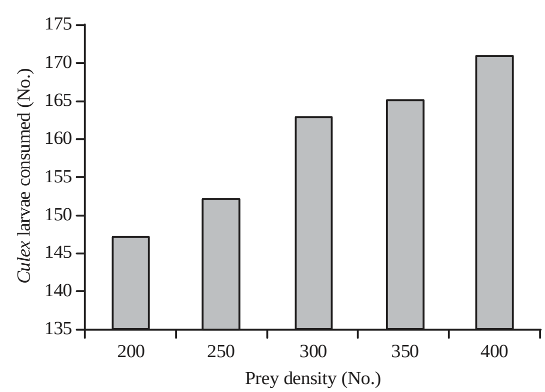

Fig. 3: Effect of prey density on the predation of *Cyprinus caprio* in 24 h

Figure 5 divulges the influence of *Hydrilla* plant on the predation of *C. carpio* in 1 h. In the case of using *Hydrilla* plant, it enhanced the process of predation. Figure 6 shows

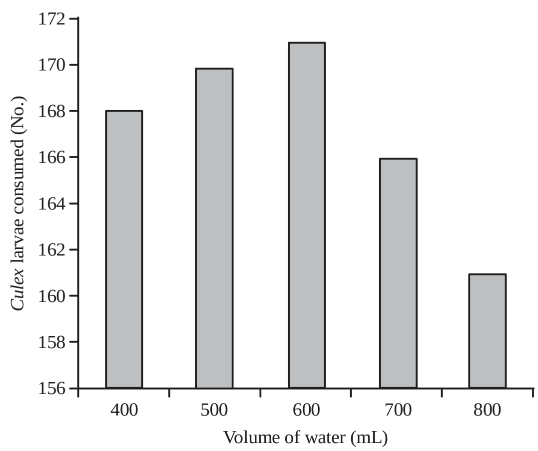

Fig. 4: Effect of volume of water on the predation of *Cyprinus caprio* in 24 h

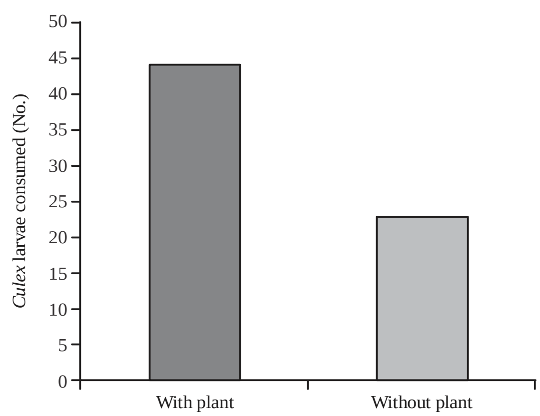

Fig. 5: Influence of *Hydrilla* on the predation of *Cyprinus carpio* in 1 h

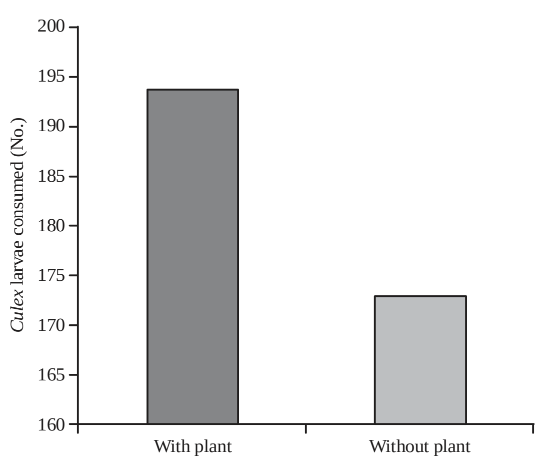

Fig. 6: Influence of *Hydrilla* on the predation of *Cyprinus carpio* in 24 h

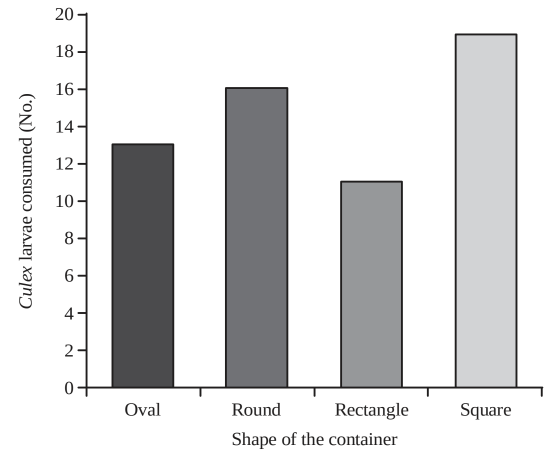

Fig. 7: Influence of container shape on the predation of *Cyprinus carpio* in 1 h

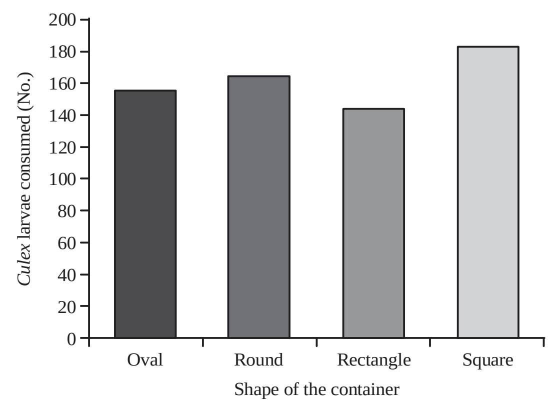

Fig. 8: Influence of container shape on the predation of *Cyprinus carpio* in 24 h

the influence of *Hydrilla* on the predation of *C. carpio* in 24 h. Here also *Hydrilla* enhanced the predation of *Culex* larvae. Figure 7 indicates the influence of the shape of the container on the predation of *C. carpio* in 1 h. Consumption of larvae was maximum in square container and minimum in rectangular container. But it was moderate in round and oval containers. When round and oval containers were compared, larval predation was higher in round container.

Figure 8 shows the influence of shape of container on the predation of *C. carpio* in 24 h. It was similar to that of 1 h experiment results. In 24 h experiment the consumption of *Culex* larvae was not so predominant as in 1 h experiment.

Figure 9 indicates the influence of number of predators on the predation of *C. carpio* in 1 h. When the number of predators increased, the number of larvae consumed also increased.

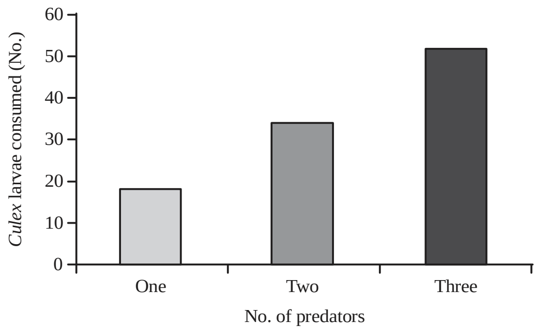

Fig. 9: Influence of number of predators on the predation of *Cyprinus carpio* in 1 h

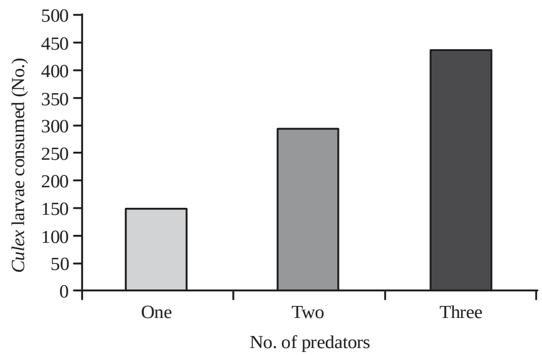

Fig. 10: Influence of number of predators on the predation of *Cyprinus carpio* in 24 h

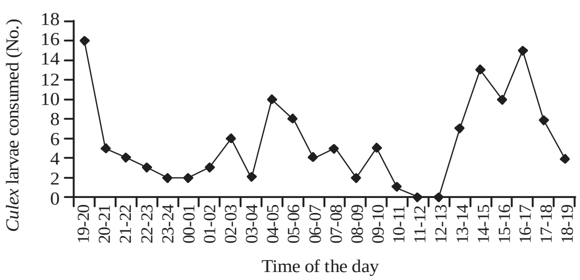

Fig. 11: Predatory pattern of the fish, *Cyprinus carpio*

Figure 10 exhibits the influence of number of predators on the predation of *C. carpio* in 24 h. Increase in the number of predators resulted in the increase in consumption.

Figure 11 divulges the predatory pattern of the fish, *C. carpio* in 24 h. The consumption reached the peak between 14-15 h and 16-17 h. There was no consumption of larvae between 11-12 and 12-13 h i.e., after 17th and 18th h of the 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 is well documented since early 1900s and it has been highly regarded as an adjunct to chemical pesticides. Singaravelu *et al.*[10] 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[11] reported the feeding *G. affinis* on mosquito larvae under laboratory conditions. They stated that the feeding rate increased with the increase in prey density. In the present study also similar effect of prey density on the predation of larvivorous fishes such as *C. carpio* was observed. Influence of number of predators on the predation of *C. carpio* was also noticed. In the present study, as the prey and predator densities increased the number of larvae consumed also increased.

Predation experiments 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[12]. The relative feeding rates of these four fish species on the larvae of *Anopheles stephensi* under laboratory conditions were in the order of *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 predatory potential was directly proportional to prey density and inversely related to water volume i.e., search area. In the present work, effect of volume of water on the predation of *C. carpio* 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.

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.*[13] reported *Poecilia reticulata* effectively controlling larval and adult population of *Anopheles gambiae* in washbasins and cisterns by 85%. Gupta *et al.*[14] reported that *Poecilia reticulata* effectively reduced the breeding of *Anopheles stephensi* and *Anopheles subpictus* population breeding in containers, by 86% using 5-10 fish in a water surface of 1 m^2.

In the present study, influence of container shape on the predation of *C. carpio* showed that consumption of larvae was maximum in square shape container and minimum in rectangle shape container. *C. carpio* exhibited variation and this may be due to the behavioural change. Ghosh *et al.*[12] observed three hourly and daily consumption rates of different exotic fishes (*C. 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 behavioural response with no practical significance in control strategy. In the present work, 24 h predatory pattern of *C. carpio* was noticed. Predatory pattern of the fish *C. carpio* showed that consumption of larvae reached its peak between 4-5, 14-15 and 16-17 h. There was no consumption of larvae between 11-12 and 12-13 h.

CONCLUSION

It was concluded that mosquito control can be done effectively through biological method. Larvivorous fishes like common carp can be used to control mosquito larvae as these fishes are foremost natural enemies of mosquito larvae.

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