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EFFECT OF ABIOTIC FACTORS ON THE PREDATORY EFFICIENCY OF THE COMMON CARP, *CYPRINUS CARPIO COMMUNIS*

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ABSTRACT

Mosquito borne diseases persist to be a foremost problem in almost all tropical and subtropical countries. The use of larvivorous fishes is presently the most popular biological method for reducing mosquito larvae population as higher doses of chemical insecticides used during the earlier days to control the mosquito caused adverse environmental consequences to non-target organisms. The abiotic factors such as volume, space and depth are important factors that influence the various heterogenic functions of biotic components directly or indirectly in aquatic environment. Hence the present study has been undertaken to determine the effect of volume of water and space of aquarium on the predatory behaviour of the common carp, *Cyprinus carpio communis*. The results suggested that increasing prey density significantly influenced the number of mosquito larvae consumed by the fish with increasing aquaria volume. The rate of attack was influenced by the volume of water and space of the aquaria in all the tested prey densities or predator size.

KEY WORDS: predatory efficiency, prey density, *Cyprinus carpio communis*, *Anopheles* mosquito larva.

INTRODUCTION

Mosquitoes are recognized as the pathogenic vectors for transmission of mosquito borne diseases throughout the world such as encephalitis, malaria, yellow fever, dengue and filariasis.[1] Mosquito borne diseases persist to be a major problem in almost all tropical and subtropical countries. The control of mosquito population currently relies on various chemical and biological approaches in different parts of the world. The higher doses of chemical insecticides had resulted in adverse environmental consequences to non-target organisms. The increasing resistance of mosquitoes to chemical insecticides has now brought about a stimulation of interest in biological approach.[4]

Mosquito control by both biotic and abiotic factors of environment is a major important problem of the present century.[9] It is well known that predation by the larvivorous fish alters the number and composition of mosquito larvae.[5] In the predator-prey system, the functional responses of either species are considerably influenced by the properties .of the other component. Early theories of trophic ecology are based on the assumption that predatory rates are proportional to prey abundance. Such assumptions have little significance in forecasting the success of predation as well as the stocking rate of the predator in the natural system.[3]

In India, mosquito fish (*Gambusia affinis*) and guppy (*Poecilia reticulata*) have been successfully utilized as the mosquito biocontrol agent for a long time(Singaravelu *et al.*, 1997,[12] Sandipan Gupta and Samir Banerjee,2013[11]) Mosquito biocontrol by larvivorous fishes needs the establishment of the predatory fish species in infested water bodies and the efficiency of these predatory fishes in mosquito biocontrol depends on abiotic factors such as volume of water, prey size preference, predation efficiency etc. There are several reports regarding mosquito control by natural predators like fishes,[15] insects[7] and spiders.[14] Studies on the prey-predator system pertaining to the influence of abiotic factors on the predatory efficiency of the fish is quite meagre.Hence the present study has been undertaken to determine the effect of volume of water and space of aquarium on the predatory behaviour of the common carp, *Cyprinus carpio communis* on its prey *Anopheles* mosquito larva.

MATERIALS AND METHODS

Collection and Acclimatization of the Fishes

The common carp, *Cyprinus carpio communis* were collected from a natural habitat, located at Pechipparai Dam, Kanyakumari District. The fishes were then taken to the laboratory and were then kept in 5 L glass tanks at a density of 4 fish/tank with proper aeration, similar photoperiod (12 L: 12 D) and temperature (27 ± 2º C).

They were then acclimatized to laboratory condition for one week and were supplied with commercial feed ad-libitum.

Collection of Mosquito Larvae

The egg rafts of Anopheles mosquito were brought in the laboratory from near by puddles. The collected sample was washed thoroughly with tap water and then different instar stages (stage I, stage II, stage III and stage IV) and pupae were obtained from the heterogeneous population. The hatched larvae were maintained in enamel trays with tap water into which yeast tablets were added which served as food for the larvae.

Bioassays

Effect of volume of water on the predatory behaviour of *cyprinus carpio communis*

The fishes were divided into three weight classes(500mg,750 mg and 1 gm) and were reared individually. The effect of volume of water on the predatory behaviour of *Cyprinus carpio communis* was investigated using fishes of three different weight groups. From each weight group, the individuals were separated and allowed to grow in containers containing 100 ml,200 ml and 400 ml of water. A minimum of ten larvae of Anopheles (fourth instar) were introduced into each container. The number of larvae predated by *Cyprinus carpio communis* for a period of I hour was recorded. The individuals of 10,15 and 25 larvae per container were also tested at different densities.

Effect of space on the predatory behaviour of *cyprinus carpio communis*

The effect of volume of water on the predatory behaviour of *Cyprinus carpio communis* was investigated using containers of different volume (550,1000,1500 ml) each containing constant volume of 500 ml of water. The fish in each basin was also tested at different prey densities of 10,15 and 25 larvae per container. Each observation was repeated and an average result was calculated.

RESULTS AND DISCUSSION

The predatory behaviour of the common carp, *Cyprinus carpio communis* of different weight groups was studied as the function of the volume of water and space of the aquarium at different prey density.The number of the fourth instar larvae of Anopheles consumed by the common carp increased when the volume of water was increased and the space of the container was maintained constant.The number of prey predated by the fish increased with increasing size of the predator.

The results are tabulated In Table 1 and 2. *Cyprinus carpio communis* of weight 500 mg consumed 3.2,5.4 and 6.3 larvae of Anopheles in 100,200 and 400 ml of water respectively at a prey density of 10 larva/container. It consumed 6.3, 7.5 and 7.8 larvae in 100,200 and 400 ml of water respectively at the prey density of the larvae/container. When the prey density was increased to 25 larvae/container,it consumed 7.3,9.5 and 10.3 larvae respectively.

The medium sized fish (750 mg) consumed 3.4, 8.3 and 9.5 larvae in 100,200 and 400 ml of water respectively at prey densities of 10 larvae/container. When the prey density was raised to 15 larvae/container, it consumed 7.4,11.3 and 13.2 larvae.In the prey density of 25 larvae/container, the fish consumed 7.8,10 and 16.2 larvae in 100,200 and 400 ml of water respectively.

The fish with 1 gm body weight consumed 6.3,9.5 and 10 larvae in 100,200 and 400 ml of water respectively at prey density of 10 larvae/container. In the prey density of 15 larvae/container, it consumed 12.5,13.3 and 14.6 larvae in 100ml,200 ml and 400 ml of water respectively. In the prey density of 25 larvae/container, it consumed 8.0,16.2 and 18.8 larvae in 100ml,200 ml and 400 ml of water respectively.

The number of larvae consumed by the weight group of 500 mg,750 mg and 1 gm of fish exposed to different space was presented in Table-2.Fishes of different weight groups showed that the number of larvae consumed by the fish increased with increased prey density in all the tested volume. The fish with 500 mg body weight consumed 2.6,5.3 and 6.4 larvae in containers with volume of 550,1000 and 1500 ml respectively in the larval density of 10 larvae/container. It also consumed 7.4,8.2 and 9.5 larvae in containers of 550,1000 and 1500 ml respectively in the larval density of 15 larvae/container. In the larval density of 25 larvae/container, the consumption of larvae by fish was 5.6, 6.4 and 12.2 larvae/containers of 550,1000 and 1500 ml respectively.

Cyprinus carpio communis of 75 mg consumed 8.3,9.2 and 10 larvae consumed 8.3,9.2 and10 larvae when exposed to the prey density of 10 larvae/containers in 550 ml,1000 ml and 1500 ml capacity containers. It consumed 13.3,14.1 and 15 larvae when exposed to the prey density of 15 larvae/container with a capacity of 550 ml,1000 ml and 1500 ml respectively. In the prey density of 25 larvae/container, it consumed 10.4,16.2 and 18.2 in ml,1000 ml and 1500 ml containers.

The fish with the weight of 1 gm consumed all the larvae in all the three containers in the larval density of 10 larvae/container. In the prey density of 15 larvae/container, the fish consumed all the 15 larvae in all the three containers. It consumed 13.3, 18.0 and 20 larvae in of 550,1000 and 1500 ml respectively when exposed to the prey density of 25 larvae/container.

The number of larvae predated increased with increasing volume of water. This is in confirmation with Reddy and Pandian(1973)[2] in *Gambusia affinis*. The increase in the number predated in the increasing volume of water may be due to the fact that *Cyprinus carpio communis* is an active fish that consumes more number of prey organisms. The reverse result was obtained in *Mystus vitistus* where the predation decreases with the increasing volume of water.

The volume, space and depth are important factors which influences the various heterogenic functions of biotic components directly or indirectly in aquatic environment. The present work reports that the space of the aquaria has significantly influenced the number of larvae predated by *Cyprinus carpio communis*. The number of larvae predated by the fish increased with increased aquaria space.

The predatory behaviour in response to prey density may be altered in a spatially hetereogenous environment.[6] From the present result, it was found that the increasing prey density significantly influenced the number of larvae consumed by *Cyprinus carpio communis* with increasing aquaria volume. The present work reports that the rate of attack also increases with increasing prey density in all the tested space. This is confirmation with the work done by Vasantha *et al*(1983)[13] in *Mystus vitistus*.

The body size has significant influence in the number of larvae predated by *Cyprinus carpio communis* irrespective of aquaria volume or space. The number of larvae predated by the fish increases with increasing body size at all the prey densities. Similar results were reported by Pandian *et al*(1978)[10] in *Mesogamphus lineatus*. This may be due to high requirement of food by the large fish for their metabolic activities.

Table 1: Predation by *Cyprinus carpio communis* on the larva of Anopheles as a function of body size.volume of water and prey density.

Volume of water	Prey Density	Number of larvae consumed		
		S	M	L
100 ml	10	3.2	3.4	6.3
200 ml		5.4	8.3	9.5
400 ml		6.3	9.5	10..0
100 ml	15	6.3	7.4	12.5
200 ml		7.5	11.3	13.3
400 ml		7.8	13.2	14.6
100 ml	25	7.3	7.8	8.0
200 ml		9.5	10.0	1.2
400 ml		10.3	16.2	18.8

S = small fish M= medium fish L = large fish.

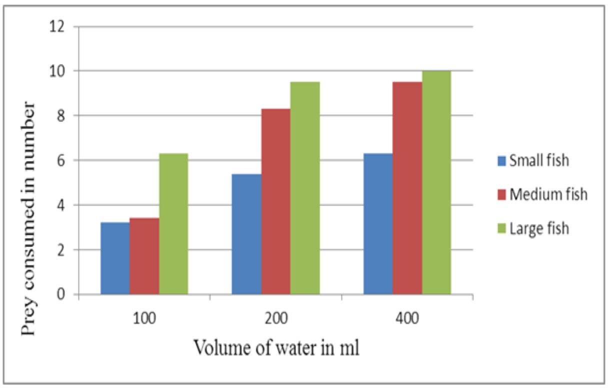

Fig 1: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 10 larvae/container(as a function of body size.volume of water and prey density).

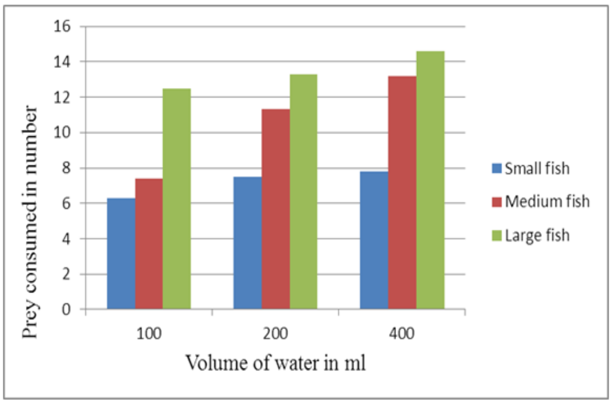

Fig 2: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 15 larvae/container (as a function of body size.volume of water and prey density).

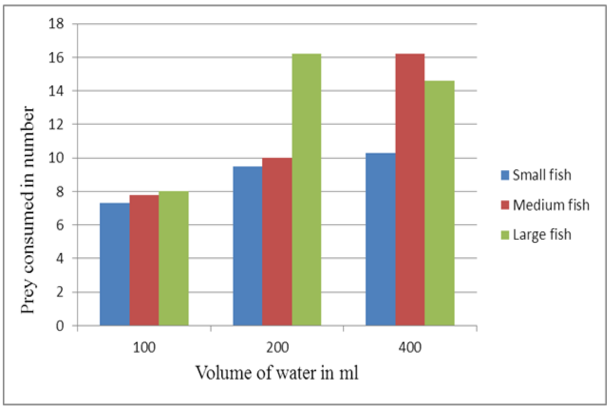

Fig 3: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 25 larvae/container (as a function of body size.volume of water and prey density).

Table 2: Predation by *Cyprinus carpio communis* on the larva of Anopheles as a function of body size ,aquaria volume and prey density.

Volume of water	Prey Density	Number of larvae consumed		
		S	M	L
550 ml	10	2.6	8.3	10.0
1000 ml		5.3	9.2	10.0
1500 ml		6.4	10.0	10..0
550 ml	15	7.4	13.3	15.0
1000 ml		8.2	14.1	15.0
1500 ml		9.5	15.0	15.0
550 ml	25	5.6	10.4	13.2
1000 ml		6.4	16.2	18.0
1500 ml		12.2	18.2	20.0

S = small fish M= medium fish L = large fish.

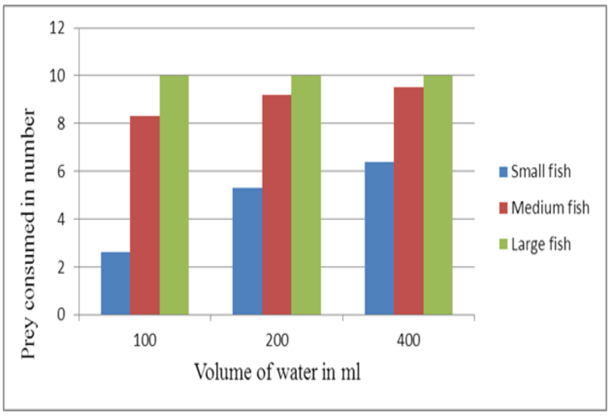

Fig 4: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 10 larvae/container(as a function of body size ,aquaria volume and prey density).

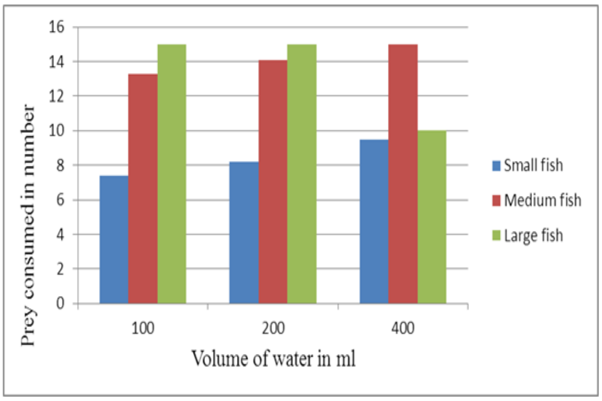

Fig 5: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 15 larvae/container(as a function of body size ,aquaria volume and prey density).

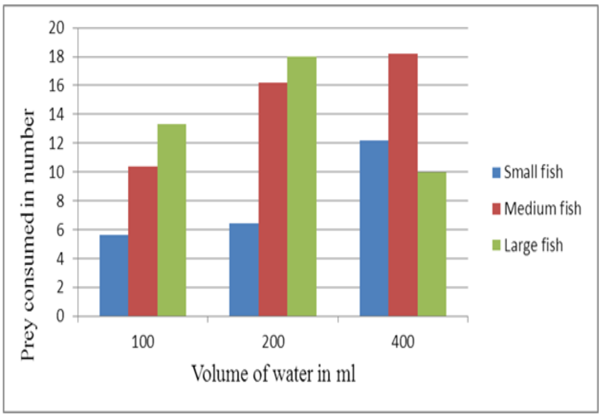

Fig 6: Effect of volume of water on the predatory efficiency of *C.carpio communis* in the prey density of 25 larvae/container (as a function of body size, aquaria volume and prey density).

CONCLUSION

The predatory behaviour of the common carp, *Cyprinus carpio communis* of different weight group was studied as the function of the volume of the water and space of the aquarium at different prey density. It was concluded that the predatory efficiency of the fish increases with increase in the volume of water. It also increases with increase in the space of the aquarium. The fish consumed mosquito larvae at a faster rate with increase in prey density. The rate of attack was influenced by the volume of water and space of the aquaria in all the tested prey densities or predator size.

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