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BIOLOGICAL CONTROL OF MOSQUITOES BY AQUATIC PLANARIA

Suprakash Kar and A. K. Aditya

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Abstract. This paper presents an idea of biological control of mosquitoes by their predators, the planarians. The suggested technique for biological control would be of special interest, because unlike pesticides, it does not cause secondary environmental effects as pollutant. The aim of the paper is to demonstrate the potential application of planarians as predators of the mosquitoes at their developmental stage.

Key words: environment, mosquito, planaria, prey-predator

Suprakash Kar, Ajit Kumar Aditya, Department of Zoology, Developmental Biology Laboratory (DSA-UGC), Visva-Bharati, Santiniketan-731 235, INDIA
E-mail: a_k_aditya@ yahoo.com

Introduction

In India, the status of mosquitoes, as the carrier of different parasites and acting as secondary host of different diseases is a menace to human existence. They are indirectly fostered by the inexorable condition of the society to grow, increase number and some times even to the extent of causing baneful effect. This is necessarily due to the ignorance of the life cycle of mosquitoes by the common men. Oils and insoluble surfactants such as Arosurf 'Monomolecular Surface Film', insect juvenile hormone analogues such as methoprene, and natural enemies can be introduced as biological control agents (Laird and Miles 1985) against the aquatic stages of mosquitoes. Certain pesticides and chemicals can significantly and effectively control the population of mosquitoes. The chemicals, however, pollute the entire water of the breeding areas, causing additional environmental problems.

These harmful chemicals can no doubt destroy the mosquitoes but at the same time directly/indirectly being accumulated in the different members of the food chain and get magnified causing damage to the members of higher tropic level. The 'biological control' becomes very effective measure to avoid such hazards. Microbial control agents including bacteria such as *Bacillus thuringiensis israelensis*, which is commercially available for application to mosquito larval habitats and the fungi *Coelomomyces* and *Culicinomyces* (Meritt *et al.* 1992, Clements 1992) are also in practice for such purpose. Parasitic nematodes have also been suggested for biological control of mosquito larvae. The dragonfly larvae (Sebastian *et al.* 1990), the water boatman *Notonecta* (Guthrie 1989), the magnificent predatory mosquito *Toxorhynchites*, and fishes such as the mosquito fish *Gambusia affinis* or the guppy *Poecilia reticulata* (Cutris 1991) are some of the potentially useful predators for control of the mosquitoes.

The purpose of the present work is to demonstrate as to demonstrate how the larvae of the mosquitoes can be destroyed by planarians, *Dugesia bengalensis* which feed on them. A suitable technique for biologically controlling the development as well as checking the population of mosquitoes has been adopted by producing large number of its predators. In this context, planarians, the free-living helminthes play a very important role. These organisms can be cultured very easily in the stagnant water with other microorganisms (Kawakatsu *et al.* 1983, Aditya *et al.* 1989, 1991) and also in ponds and lakes. They breed by both asexual (by binary fission, Aditya *et al.* 1987) and sexual processes and these organisms are carnivorous in habit (Kawakatsu *et al.* 1975) and can tolerate a temperature range up to 32°C.

Materials and Methods

The culture of the mosquitoes (both *Anopheles* and *Culex*) and their predators (Planarian: *Dugesia bengalensis*) is being maintained in the laboratory separately. The cement cisterns and some large containers with wide-open mouth are used for this purpose.

The planarians being maintained in small tanks (1.5′ × 1′ × 1.5′) / enamel trays (1′ × 6″ × 1.5″) and with proper and careful handling and with food supplement might yield to considerably increased number within short time. The planarians are usually supplied with fresh goat liver twice a week and after feeding on every occasion the culture medium is changed regularly. Normally they reproduce asexually by binary fission which takes place at mid night (Ghosh 1988). The reproduction by sexual means takes place during breeding season extending from November to March. They are hermaphrodite but cross-fertilization is the rule. They produce cocoon and each cocoon liberates four to six juveniles which grow and attain maturity in course of about 30 days. The young planarians can subsist upon the prey and lead their independent life. The maintenance and culture of planarians (Fig. 1) are less expensive as they can live on goat liver/yolk of egg as ready-made food during culture and experimental work. They require careful handling during summer periods (above 32°C) when they are kept in cool temperature.

Fig. 1 Photograph showing a group of moving planarians in a culture

The different groups of mosquitoes are kept in different cisterns. They are allowed to lay eggs on the surface of the water of the tanks covered with nylon nets in the experimental condition. Mainly two groups of mosquitoes *Anopheles* and *Culex* are cultured separately. The food of mosquito larvae is the mixture of yeast and sugar, in the ratio of 5:1 and it is served at 4 to 5 days interval (Agriculture and Agri-Food Canada Insect Identification Sheet No. 86, 1983). Each life-stage/larval-stage (egg—larva—pupa) of two groups is exposed separately into large petridishes (6" diameter, depth 1") containing 7 days starved planaria in the culture medium.

Experimental design is set up into two batches. Each batch possesses three numbers of large petridishes (6" diameter, 1" depth) each one containing 5 numbers of 7 days starved matured planarians. Each life stage (egg—larva—pupa) of 50 numbers of *Anopheles* mosquitoes is exposed to the planarians of the first batch of the three petridishes separately. In the same manner, each life stage of *Culex* mosquitoes is exposed to planarians of second batch of three petridishes containing planaria. Close observation is made at each hour. It is important to note that number of larvae ingested by the planarian is measured by counting the larval exoskeleton at each hour of interval. This experiment is repeated three times for accuracy.

Result and Discussion

Continuous observation has revealed that the planarians have selective choice for the eggs/larval/pupal stages and at the same time for the different groups of mosquitoes. It has been observed that in both cases (*Anopheles* and *Culex*) larval forms are more palatable to the planarians than the other forms i.e. eggs and pupa. It also has been noticed that the planarians generally avoid very small mosquito larvae (first stage of larval form) because of their fast movement. Out of the different stages of larval forms of the mosquitoes, planarian mostly prefer 2nd and 3rd stage of larval form of mosquitoes (*Anopheles* and *Culex*) where the exoskeleton does not get so hardened as the last one (i.e. imago/adult). In the experimental set up it is noticed that five starved planaria can feed 25 number of *Anopheles* mosquito larvae within first 6 hours and the second 6 hours these planaria feed only 8 number of *Anopheles* larvae. But in case of *Culex* larvae, it has been found that five starved planaria can feed only 10 number of *Culex* larvae within first 6 hours which is very less than the intake of *Anopheles* larvae and as the time passes the feeding rate is also declines (Table 1).

Table 1. Comparison between the intake/feeding of larvae of different species of mosquitoes by five numbers of planarian (*Dugesia bengalensis*)

	1st hr	2nd hr	3rd hr	4th hr	5th hr	6th hr	7th hr	8th hr	9th hr	10th hr	11th hr	12th hr
Anopheles	12	4	1	5	-	3	-	-	4	-	3	1
Culex	6	1	-	1	-	2	-	-	-	4	-	1

Table 2 also support that consumption rate at first 6 hours of *Anopheles* larvae is much higher (52.08%) than that that of the *Culex* larvae (20.83%) by the planarians. From this observation it is clear that the planaria prefers and has a distinct choice for the *Anopheles* larvae than that of *Culex* larvae (Fig. 2). This type of food preference might be due to the larval posture (parallel to the water surface) which helps the planaria to hold or attack and capture *Anopheles* larvae easily when the hungry planaria float on the water surface. Planarians usually move by creeping on the substratum or simply by swimming or floating on the surface of the water. The *Anopheles* larvae remain in floating posture and it becomes easier for the planarians to have entrée on them. It is not clear as to why the planaria does not prefer the eggs and the pupal stages of both the mosquitoes but the disliking of pupal stage might be the harder chitinous cuticle.

Table 2. Rate of consumption of different mosquito larvae by the planarian at first and second 6 hr

	First 6 hr	Second 6 hr
Anopheles	52.08%	16.67%
Culex	20.83%	10.42%

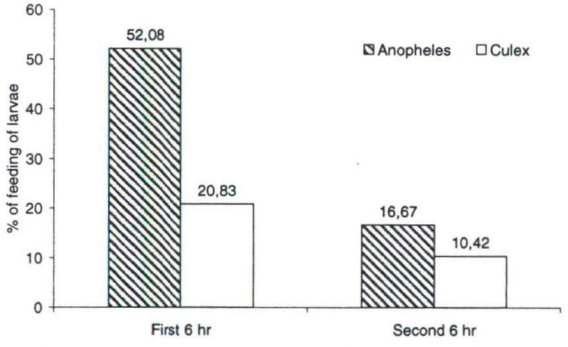

Fig. 2 Comparision of % of feeding of different type of mosquito larvae by the planarian (D. bengalensis)

The planarians had been reported to play a paramount role in maintaining the water quality in Europe (Kenk 1972). Various literatures are available in this particular field (Curtis 1902, Teshirogi *et al.* 1981, Reynoldson 1981). Kawakatsu *et al.* (1980) are of the opinion that the planarians can maintain the water quality by destroying different microorganisms, larvae of different animals including chironomids and those of a few species of mosquitoes, including *Culex*. The fasting planarians move very fast along the floor margin of the containers and very often float to the surface of the water in search of any prey (Fig. 3A). The mosquito larva is captured by the planarian which encircles (Fig. 3B) the larva strongly and inserts the proboscis through any terminal end (mouth or tail end) of the larva and sucks the entire fluid. After the meal, the planarian leaves the exoskeleton and goes down the floor of the container. Therefore, it will not be unlikely that the planarians in large number will be of great help in eradicating the mosquitoes from the locality effectively.

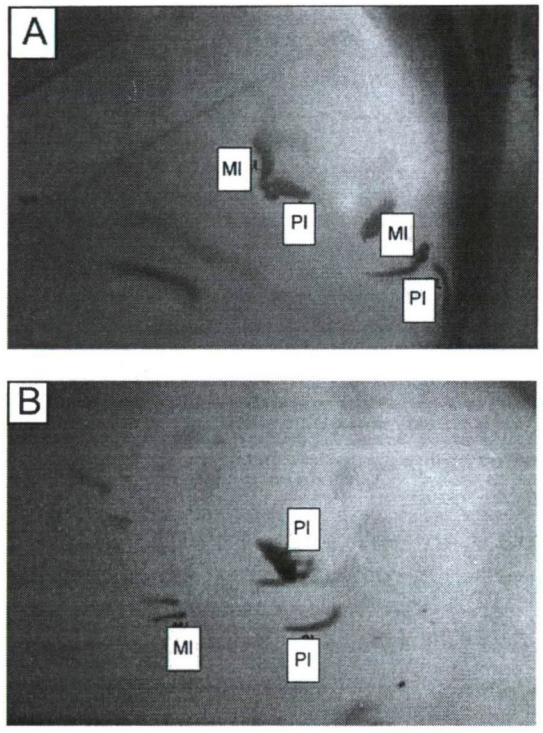

Fig. 3. Photographs showing the prey-predator relationship between mosquito larvae and the planarians; note the planaria moving towards the larva for attacking and in other it has captured the prey (A). A planarian has encircled the prey and is feeding (B). [Pl — Planaria , Ml — Mosquito larva]

The result would directly be applicable for taking remedial measure to counteract the harmful population influx of the different parasites of different disease bearing mosquitoes in the country. The surface-active agents can help to disrupt the surface forces that enable mosquito larvae to hang at the water surface, and help to reduce these the population of mosqauito larvae. Guthrie (1989) has been described the natural history of some surface-dwelling insects and outlines methods for exploring the effects on them of contaminants that alter surface forces. It has also been reported that the bacterium *Bacillus thuringiensis israelensis* is used as a mosquito control agent, sometimes in combination with a surface-active agent that helps to hold the

bacteria at the surface where the mosquito larvae will come in contact (Meritt *et al.* 1992, Clements 1992). Sih (1986) has also suggested that mosquito larvae alter their dive timing in the presence of certain predators, perhaps reduce their vulnerability by spending less time in the region where predators are most likely to find them and that this predator effect is mediated by a water-borne chemical. Such type of behaviour has not been noticed in this case. The planarians in turn are non-pathogenic, harmless, nontoxic and easy handling creatures. Kawakatsu *et al.* (1980) have also reported about the predator-prey relationship between planarians and mosquito larvae respectively. This interesting phenomenon suggests that the planarians like mosquito larvae and the small drains, and the swamp areas are ideal breeding sites of mosquitoes where planarians could easily live and multiply. The planarians become the predator of the mosquito larvae in natural condition.

The study of planaria with reference to destruction of mosquitoes at least for checking of the same is expected to have great promise to the biologists in general and people at large.

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