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Mosquito control using *Badis badis* (Hamilton, 1822) [Teleostei: Perciformes] in ground water (domestic well): Preliminary findings of a laboratory trial.

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Abstract
Food preference and predation potentiality experiments using *Badia badis* (Hamilton) was studied under laboratory conditions to destroy the mosquito breeding ground in domestic well at Jalpaiguri District of West Bengal. The fish were sampled from the water bodies of Moraghat forest and were maintained in two glass aquariums with chemically untreated well water which was sieved through a phytoplankton net to exclude larvae and planktons. To determine the feeding preference on mosquito larvae, selected fish were kept over night before experiment for acclimatization and starvation. Mosquito larvae were collected several wells and introduced in first aquarium. Remaining larvae were counted every 3 hours interval from 6 am to 6 pm and after counting the number of consumed larvae at every 3-hour interval, the same numbers of larvae were replenished within the glass beaker to maintain the constant prey density. The authors conducted a similar experiment to determine the feeding preference on commercially available fish pellets. In this experiment, formulated fish pellets were given initially in second aquarium and remaining pellets were counted every 3 hours interval from 6 am to 6 pm. The experiment showed greater feeding preference for mosquito larvae than formulated fish diet. The predation potentiality or feeding capability result showed a 3.6 cm length fish could consume 29 larvae per day with predatory index 37.66. The present study concludes that introduction of indigenous *Badis badis* can effectively reduce mosquito larvae in domestic well (groundwater) and also suggests that this species may help to prevent the mosquito borne diseases biologically.

Keywords: *Badis badis*, Bot-koi, mosquito breeding ground, domestic well, groundwater, Jalpaiguri.

1. Introduction
The sub Himalayan Duars belt of Jalpaiguri District in West Bengal is an endemic area of different mosquito borne diseases. Major mosquito fauna of Jalpaiguri District comprises *Anopheles* (species density 3.79% to 12.24%), *Culex* (20.32%), *Aedes* (7.55%) etc. [9] and are the well-known biological vectors of malaria, filariasis, yellow fever, dengue fever, Cikungunia, Japanese Encephalitis etc. They are noxious, females lay eggs in the stagnant water of dams, marshy lands, canals, and untreated domestic wells. The eggs after 2-3 days of incubation hatch into larvae which are commonly called "wigglers" or "wrigglers", and must live in water from 7 to 14 days depending on water temperature. In order to control and prevent the mosquito borne diseases, four different measures may be developed. One of them is destruction of larvae. It is an easier and more convenient than the control of adults. Vector biologists use different biological agents for destruction of larvae. Since 1937, fish have been employed for controlling mosquito larvae. Larvae feeding fish are commonly called larvivorous fish. Application of larvivorous fish to eliminate mosquito larvae is considered an environmentally friendly method [13, 3, 8]. Almost 200 fish species are known to feed on mosquito larvae [6]. Diverse types of perciformes fish (both indigenous and exotic) have been used so far in this operational technique [1, 10, 5]. However, there are no reports on *Badis badis* for destruction of mosquito breeding ground in domestic well. The authors performed a laboratory trial to evaluate the food preference and potentiality of *Badis badis* to eradicate mosquito larvae from domestic wells.

2. Materials and Methods-

Laboratory trials were carried out to determine the feeding preference of Bot-koi, *Badis badis* (Hamilton, 1822) on mosquito larvae and commercially available fish pellets. The fish (total body length 3.6-4.3 cm and body weight 0.77-1.43 gm) were collected from water bodies of Moraghat forest (latitude26°47'28.04"N to 26°37'48.33"N, longitude 88°59'.57.38"E to 89°.00'.55.65"E and 473 to 267 ft. elevation.), transported through polythin packet containing water and were maintained in a glass aquarium (Measurement – 2ft. x 1.5ft. x 1ft.) of department of Zoology, A. C. College with chemically untreated well water. The water was sieved through a phytoplankton net to exclude larvae, planktons. Prior seven days of experiment, collected fish were kept in the aquarium for acclimatization. To determine the feeding preference on mosquito larvae, selected fish were kept over night before experiment in two separate glass aquariums containing well water for starvation. Mosquito larvae were collected by plankton net from several wells. Twenty-five mosquito larvae were introduced in first aquarium and remaining larvae were counted every 3 h interval from 6 am to 6 pm. The number of larvae consumed by individual fish species was noted at an interval of 3 h from 6 am to 6 pm [4]. After counting the number of consumed larvae at every 3h interval, the same numbers of larvae were replenished within the glass aquarium to maintain the fixed prey density. The authors conducted a similar experiment to determine the feeding preference on commercially available fish pellets. In this experiment, 25 pellets were put initially in second aquarium and remaining pellets were counted every 3 h interval from 6 am to 6 pm. The laboratory trial was carried out for six consecutive days. Statistical analysis using Student's *t*-test was performed to determine feeding preference at different time points by SPSS-16. In an additional experiment under same laboratory conditions, a single fish (length 3.6cm and weight 0.77 gm) was used to determine the predatory index. One hundred mosquito larvae were introduced into a separate aquarium for three consecutive days with *Badis badis* and remaining larvae were counted after 24 h, 48 h, and 72 h. The predatory index was calculated as the number of larvae consumed by the fish per gram body weight per day [12].

3. Results and Discussions

The laboratory trials showed significant positive consequence (Table 1). The *Badis badis* exhibited grater feeding preference on mosquito larvae than formulated fish pellets and rate of food consumption is presented in figure 1. The feeding capability result showed that a 3.6 cm length bot-koi could consume average 29 larvae per day. The predatory index for mosquito larvae was found to be 37.66 (Table-2).

Table 1: Food items, food preference and rate of feeding of *Badis badis*.

Duration	6 am - 9 am		9 am – 12 pm		12 pm – 15 pm		15 pm -18 pm	
Food Items	Larva	Artificial food	Larva	Artificial food	Larva	Artificial food	Larva	Artificial food
Mean±S.E.	11.667±0.558	1.167± 0.307	10.333± 0.333	1.50± 0.224	11.833± 0.477	1.00± 0.258	10.33± 0.558	0.667± 0.211
SD	1.3663	0.7528	0.8165	0.5477	1.1690	0.6324	1.3663	0.5164
Variance	1.867	0.567	0.667	0.3	1.367	0.4	1.867	0.267
T value	30.7408***(P≤0.001)		18.5084***(P≤0.001)		18.0278***(P≤0.001)		14.5*** (P≤0.001)	

Table 2: Laboratory trials for feeding potential of *Badis badis* on mosquito larvae.

Length(cm)	Weight(gm)	No of larvae consumption/day			Average	Predatory Index
		1 st day	2 nd day	3 rd day		
3.6	0.77	33	30	24	29	37.66

Badis badis (Hamilton, 1822) which belongs to the order perciformes and family badidae [7] is locally called bot-koi (Figure 2). It is a tropical fresh water fish and occurs solitarily in rivers, ponds, ditches and swamps of India, Bhutan, Bangladesh, Pakistan and Nepal. It is a benthopalagic, carnivorous, harmless and non-commercial fish that can tolerate the changing physico-chemical parameters and common pollutants of its habitat.

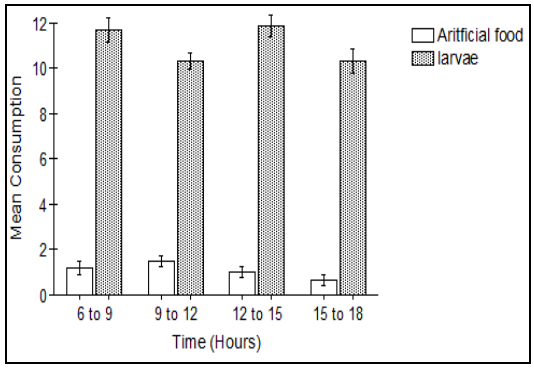

Fig 1: Mean consumption rate of artificial food pellets and mosquito larvae by *Badis badis*.

Fig 2: *Badis badis* (Hamilton, 1822)

These characters indicate that it is a good larvivorous fish.
The laboratory trial showed that *Badis badis* preferred to feed on mosquito larvae than formulated fish diet. The significant preference for larval feeding over a formulated fish diet is a signal of high carnivoracity and lofty preference of life food.
Small sized fish are suitable for mosquito control and it was detected by the calculation of predatory index of *Oreochromis mossambicus* [12, 2, 11]. Chand and Yadav [2] (1994) further reported that the rate of larval consumption increase with body length. The present observation is in the agreement with the above statements. The present study showed that introduction of indigenous *Badis badis* can effectively reduce mosquito larvae in domestic well (groundwater) at Jalpaiguri District of West Bengal and suggests that this species may help to prevent the mosquito borne diseases from this district.

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