D-5404
[1-4]

RESEARCH ARTICLE Agricultural Science Digest

Investigation on Larvicidal Efficacy of Two Native Ornamental Murrels of Assam under Controlled Condition

Aparajita Gogoi[1], Shyama Prasad Biswas[2]

10.18805/ag.D-5404

ABSTRACT

Background: It is widely reported that exotic larvicidal fishes like *Gambusia* and *Poecilia* have adverse impact on the native aquatic fauna. The present study highlights the efficacy of two colourful native murrels, primarily designated as ornamental fish, *Channa bleheri* and *Channa stewartii* as biocontrol agent of mosquito larvae.

Methods: Live specimens of *Channa bleheri* and *C. stewartii,* collected from the wetlands of Tinsukia district of Upper Assam, were assessed for their larvivorous potential at individual and group levels during day and night by dividing the specimens into two size groups. After 12 hour and 24 hour starvation, the test specimens (mean size for small group 8.67 - 9.17 cm and that of large group 11.63-13.27 cm) were given known number of mosquito larvae and recorded the consumption rate.

Result: The predation rate varied from 33.3±4.36 to 71.6±5.15/min for *Channa bleheri* and that of *C. stewartii* from 16.3±0.95 to 68.2±2.77/min. In both species, smaller sized specimens were better performers as predators. Predation rate at 12 and 24 hrs of starvation and between day and night proved that these native murrels are excellent predators of mosquito larvae.

Key words: Biocontrol, *Channa bleheri*, *Channa stewartii,* Mosquito larvae.

INTRODUCTION

Mosquito-borne diseases persist as one of the most prevalent threats to human health all over the world. According to World Health Organization 2017 report, there were 219 million cases of malaria across 90 countries. Control of mosquitoes using insecticides is expensive, harmful to the environment and can lead to pesticide resistance in mosquitoes (Chandra *et al.,* 2008). There are some other alternative approaches with organic pesticides and biological control (Howard *et al.,* 2007). Use of fishes for control of mosquito larvae has been practiced in many countries of the world (Neng *et al*., 1987; Morton *et al.,* 1988; Kim *et al.,* 1994 and Hurst *et al*., 2004). Fish as biocontrol agents is a safe, cheap and effective alternative strategy to chemical control (Kusumawathie *et al.,* 2008) yet proof for their outcome is very scarce (Walshe *et al.,* 2017). Also, the use of some non-native larvivorous fish for mosquito control leads to serious ecological concerns (Azevedo-Santos *et al.* 2016; El-Sabaawi *et al.,* 2016). Widely used larvicidal fishes like *Gambusia affinis* and *Poecilia reticulata* are invasive and highly competitive with the native fishes (Hurlbert and Mulla, 1981; Bence, 1988).

Bhattacharjee *et al.* (2009) assessed indigenous air-breathing fishes as suitable predators of mosquito larvae. Phukon and Biswas (2011 and 2013) worked on larvicidal potential of certain locally available fishes of Assam. Rao *et al.* (2015) also studied the larvicidal efficacy of four indigenous ornamental fish species. Therefore, the present study was designed to evaluate the larvicidal potential of *Channa bleheri* and *Channa stewartii* under laboratory condition.

MATERIALS AND METHODS

Collection of sample and acclimatization

Two prominent indigenous ornamental murrels (Biswas *et al*., 2007), *C. stewartii* (Fig 1A) and *C. bleheri* (Fig 1B) were collected from wetlands of Tinsukia district (27°53' N, 95°65' E) of Assam, India during March-April, 2019. Live specimens were brought to the Department of Zoology, Digboi College, Assam, identified as per Talwar and Jhingran (1991) and acclimatized them properly in separate enclosures. The period of experiments was from June to August 2019, as availability of mosquito larvae is maximum during monsoon. Both *Channa bleheri* and *Channa stewartii* were sorted out into two size groups- large and small. Weight of the experimental fishes were taken by a digital balance. Group A *Channa bleheri* ranged from 11.0 to 15.5 cm (10.9-30.8gm) having mean length 13.27±2.25 cm and weight 21.0±9.95 gm and that of Group B was 8.5 - 10.0cm (7.7-8.9gm) with mean length 9.17± 0.76 cm and weight 8.2±0.62 gm. For *Channa stewartii,* size of Group A ranged from 10.0 to 13.0 cm (9.3-14.9 gm) having mean length 11.63±1.52 cm and weight 12.43±2.85 gm; Group B 8.0 - 9.2 cm (6.8-12.0g) having mean length 8.67±0.61 cm and weight 9.27±2.61

[1]Department of Zoology, Digboi College, Digboi-786 171, Assam, India.
[2]Department of Life Sciences, Dibrugarh University, Dibrugarh-786 004, Assam, India.

Corresponding Author: Aparajita Gogoi, Department of Zoology, Digboi College, Digboi-786 171, Assam, India.
Email: gogoia65@gmail.com

How to cite this article: Gogoi, A. and Biswas, S.P. (2021). Investigation on Larvicidal Efficacy of Two Native Ornamental Murrels of Assam under Controlled Condition. Agricultural Science Digest. DOI: 10.18805/ag.D-5404.

Submitted: 04-06-2021 **Accepted:** 21-08-2021 **Online:** 30-09-2021

gm. Collected fishes were stocked in 1% $KMnO_4$ treated water at 25 - 26°C and fed them commercial food 'Tokyu' (Sanyal and Ghosh, 2014).

Feeding experiments

The target species were introduced in three 8 litre glass aquaria of equal size (12″ x 12″ x12″) to observe the consumption efficacy. The experiments were conducted in two size groups of each fish species both at individual (9 fishes) and group (27 fishes) level as well as during daytime in natural light and evening time with artificial light (tube light). During daytime experiments, the fishes were kept in glass aquaria with indirect sunlight. In case of group, three fishes of each batch were introduced into three different aquaria. The fishes were kept in starvation for 12 and 24 hrs. prior to the actual feeding experiments. Known numbers of larvae (n=100) were offered (Rao *et al*., 2015; Bano and Serajuddin, 2016) to the experimental fishes both in the case of individual and group fish triplicates. Predation rate/ hour of test fishes was calculated by taking the difference of initial and final no. of larvae. Water temperature of rearing enclosures was also recorded twice a week and pH of water was recorded with a digital pH meter. Average temperature of water was maintained at 25 - 26°C and pH at around 8.3. All the experiments were performed following the ethical guidelines for fishes.

Culture of mosquito larvae was done in a separate tank. Cut pieces of potato were placed and about 250 gm of cow dung was mixed to attract mosquitoes to lay eggs. Mosquito larvae were harvested with a fine net with small mesh size, stored in glass container and then 4th instar larvae were sorted out to feed the experimental fishes (Das, 2012). Each trial was repeated three times with three sets of fishes for individual and group and the mean consumption rate/min and standard deviation were calculated using MS Excel 2007.

RESULTS AND DISCUSSION

The results on the predation rate of the selected murrels after different intervals of starvation and also under daylight and artificial light in evening hours were given in Table (1-4) and elaborated as follows:-

Predation rate of *Channa stewartii* at different experimental set-up

During daytime, mean consumption of mosquito larvae by individual *Channa stewartii* (Group A) (10-13cm) was 19.0±2.88/min and in group 28.9±4.16/min at 12 hr of starvation whereas it was 30.9±4.21/min and 38.4±5.10/min by individual and group respectively at 24 hr starvation. In the evening, however, the mean consumption was recorded as 16.3±0.95/min and 27.1±1.85/min after 12 hr of starvation at individual and group level respectively. After 24 hr starvation, the mean consumption by individual *C. stewartii* was 28.7±2.50/min and 34.4±4.05/min by the group during evening hours (Table 1).

After 12 hr of starvation, *C. stewartii* (Group B) (8.0-9.2 cm) predated more larvae than the adult individual during daytime (Table 2). Mean consumption by individual *C. stewartii* was 36.2±2.63/min and that of larger (Group A) was 19.0±2.88/min. Mean consumption by smaller specimens was recorded as 36.2±2.63/min by individual and that of in group as 44.2±3.07/min. After an interval of 24hr starvation, individual *C. stewartii* (8.0-9.2cm) showed the daytime mean consumption of 51.2±5.20/min and in group 68.2±2.77/min.

Experiment carried out with Group B during evening hours revealed mean consumption by individual fish was 27.5±3.26/min and in group was 37.6±2.88/min after 12hr starvation; whereas the mean consumption by individual fish was 46.3±3.33/min and in group 56.9±5.08/min after 24 hr starvation in the evening (Table 2).

Predation rate of *Channa bleheri* at different experimental set up

C. bleheri (Group A) showed mean predation rate of 37.4±3.49/min by individual fish after 12 hr of starvation during daytime and that of 42.8±1.09/min when in group. After 12 hr of starvation, predation in the evening was 33.4±2.25/min and 38.0±2.17/min by the same individual fish and group respectively. Again after 24 hr starvation, *C. bleheri* exhibited mean consumption of 40.6±6.22/min by individual fish and 51.8±3.17/min in group during daytime. But at the same interval of starvation during night the species showed mean consumption of 33.3±4.36/min at individual level and 42.3±2.02/min by group (Table 3).

Table 1: Feeding rate of Group A (Large size) *C. stewartii.*

Time of experiment	Water Temp (°C)	Mean consumption rate/min			
		12 hr starvation		24 hr starvation	
		Individual	Group	Individual	Group
Daytime	26	19.0±2.88	28.9±4.16	30.9±4.21	38.4±5.10
Evening	25	16.3±0.95	27.1±1.85	28.7±2.50	34.4±4.05

Table 2: Feeding rate of Group B (Small size) *C. stewartii.*

Time of experiment	Water Temp (°C)	Mean consumption rate /min			
		12 hr starvation		24 hr starvation	
		Individual	Group	Individual	Group
Daytime	26	36.2±2.63	44.2±3.07	51.2±5.20	68.2 ± 2.77
Evening	25	27.5±3.26	37.6±2.88	46.3±3.33	56.9± 5.08

During daytime, Group B *C. bleheri* (8.5-10.0cm) after 12 hr starvation mean consumption was 45.4±6.50 /min by individual fish and 54.7±4.44/min by group whereas the same size group had mean consumption of 53.8±4.52/min and 71.6±5.15/min by individual fish and group respectively after 24 hr of starvation (Table 4). In contrast, when larvae were provided to the fasting group after 12 hr interval at night hours, the mean consumption by individual fish was 45.2±5.00/min and that of group was 49.7±6.00/min (Table 4).

During evening, after 24 hr starvation, *C. bleheri* (Group B) had mean consumption of 47.9±4.55/min and 58.2±11.18/ min at individual and group level respectively (Table 4). In the evening, the consumption was found to be less than daytime predation both at individual as well as group level of both the species.

Feeding intensity in both the murrels under natural and artificial light varied depending on their size. Consumption of larvae during daytime was observed to be higher than that of evening time. It was observed that during the first 10-15 minutes of feeding experiment, the fishes consumed maximum numbers of mosquito larvae and then it gradually slowed down. Fishes when in groups, consumed large number of larvae than the individual fishes. Also, variation in predation rate of mosquito larvae at 12 and 24 hrs of starvation was quite prominent in both the species. Feeding behaviour indicated that both the fish species are diurnal feeders.

Group A (larger size fishes) of both the experimental species consumed mosquito larvae fairly well. However, smaller size (Group B) *C. bleheri* had the least consumption time after 24 hrs starvation both individual and group level. Among the larvicidal fish used across the globe, the native fishes were found to be better performer for biological control (Howard *et al*. 2007; Chandra *et al*. 2008; Kendie, 2020). Studies were also made to assess the larvicidal efficacy of some native fish species of Assam – *Channa gachua*, *Puntius sophore* and *Trichogaster fasciata* and the murrel, *Channa gachua* showed the highest larvicidal efficacy (Phukon and Biswas, 2013). Similar study was also carried out on indigenous fish with exotic *Gambusia affinis* by Bano and Serajuddin (2016). The present study showed that efficacy of smaller specimens of *C. bleheri* were better than those of the larger specimens at individual and group levels. Phukon and Biswas (2011) however, found that among three size groups of *Channa gachua*, the largest size group consumed highest number of mosquito larvae. The present study also revealed *C. stewartii* as an efficient predator was in accordance with that of Das (2012), who also reported it as an efficient consumer of mosquito larvae among five species of potential ornamental fishes.

It is well known that the abiotic parameters, particularly water temperature and dissolved oxygen have a great role in feeding as well as survival of fish. Both the selected

Fig 1A: *Channa bleheri*.

Fig 1B: *Channa stewartii.*

Table 3: Feeding rate of Group A (Large size) *C. bleheri.*

Time of experiment	Water Temp (°C)	Mean consumption rate /min			
		12 hr starvation		24hr starvation	
		Individual	Group	Individual	Group
Daytime	26	37.4± 3.49	42.8±1.09	40.6±6.22	51.8 ± 3.17
Evening	25	33.4±2.25	38.0±2.17	33.3±4.36	42.3± 2.02

Table 4: Feeding rate of Group B (Small size) *C. bleheri.*

Time of experiment	Water Temp (°C)	Mean consumption rate /min			
		12 hr starvation		24hr starvation	
		Individual	Group	Individual	Group
Daytime	26°	45.4± 6.50	54.7±4.44	53.8±4.52	71.6±5.15
Evening	25p	45.2±5.00	49.7±6.00	47.9±4.55	58.2±11.18

species are air-breathing murrels, well adapted to live and propagate in ditches, ponds and wetlands; hence dissolved oxygen is not a very important factor for them. However, all *Channa* species hibernate and as such feeding intensity of murrels is very low in natural condition during winter. In the present study, no significant difference in feeding intensity was noticed as water temperature was always maintained around 25°C in the rearing enclosures.

Both *C. bleheri* and *C. stewartii* during 1 hour observation, revealed as efficient predators of mosquito larvae as they consumed a considerable number of 4th instar larvae in two different starvation periods both at daytime and evening. It may be concluded that fry and fingerlings of the selected murrels are highly potential agents for effective controlling of mosquito larvae. Further, both the experimental fishes are insectivorous in feeding habit and breed naturally in wetlands (Nayak *et al*., 2020). There is alarming degradation in the freshwater biodiversity due to entry of several exotic fishes in India (Kumar, 2000). Use of potential native fishes as a part of vector management programme hitherto been unexploited and both *Channa bleheri* and *Channa stewartii* have proved their potential as larvicidal fishes.

REFERENCES

Azevedo-Santos, V.M., Vtule, J.R., Pelicice, F., Garcia-Berthou, E. and Simberloff, D. (2016). Non-native fish to control *Aedes* mosquitoes: A controversial, harmful tool. BioScience. 67: 84-90. http://doi.org/10.1093/biosci/biw 156.

Bano, F. and Serajuddin, M. (2016). Comparative study of larvicidal efficacy of four indigenous fish with an exotic Top Water Minnow, *Gambusia affinis*. Journal of Ecophysiology and Occupational Health. 16(1 and 2): 7-12.

Bence, J.R. (1988). Indirect effects and biological control of mosquitoes by mosquito fish. Journal of Applied Ecology. 25: 505-521.

Bhattacharjee, I., Gautam, A. and Goutam, C. (2009). Laboratory and Field assessment of the potential of larvivorous, air-breathing fishes as predators of culicine mosquitoes. Biological Control. 49(2): 126-133.

Biswas, S.P., Das, J.N., Sarkar, U.K. and Lakra, W.S. (2007). Ornamental Fishes of North East India - An Atlas. NBFGR (ICAR) Publication, Lucknow, 111.

Chandra, G., Bhattacharjee, I., Chatterjee, S.N. and Ghosh, A. (2008). Mosquito control by larvivorous fish. Indian Journal of Medical Research. 127(1): 13-27.

Das, S.K. (2012). A preliminary note on assessment of a few indigenous ornamental fishes of Northeast India as potential predators of mosquito larvae. Indian Journal of Hill Farming. 25(1): 63-65.

El-Sabawawi, R.W., Frauendorf, T.C., Marques, P.S., Mackenzie,R., Philip, D.A., *et al.* (2016). Biodiversity and ecosystem risks arising from using guppies to control mosquitoes. Biology Letters. 12, http://doi.org/10.1098/rsbl.2016.0590.

Howard, A.F., Zhou, G. and Omlin, F.X. (2007). Malaria mosquito control using edible fish in western Kenya: Preliminary findings of a controlled study. BMC Public Health. 7: 199.

Hurlbert, S.H. and Mulla, M.S. (1981). Impacts of mosquito fish (*Gambusia affinis*) predation on plankton communities. Hydrobiologia. 83: 125-151.

Hurst, T.P., Brown, M.D. and Kay, B.H. (2004). Laboratory evaluation of the predation efficacy of native Australian fish on *Culex annulirostris* (Diptera: Culicidae). Journal of the American Mosquito Control Association. 20(3): 286-291.

Kendie, F.A. (2020). Potential biological control agents against mosquito vector in the case of larvae stage: A review. World News of Natural Sciences. 28: 34-50.

Kim, H.C., Kim, M.S. and Yu, H.S. (1994). Biological control of vector mosquitoes by the use of fish predators, *Morocco oxycephalus* and *Misgurnus anguillicaudatus* in the laboratory and semi field rice paddy. Korean Journal of Entomology. 24: 269-284.

Kumar, A.B. (2000). Exotic fishes and Freshwater Fish Diversity. *Zoos'* Print Journal. 15(11): 363-367.

Kusumawathie, P.H.D., Wickremasinghe, A.R., Karunaweera, N.D. and Wijeyaratne, M.J.S. (2008). Costs and effectiveness of application of *Poecilia reticulate* (guppy) temephos in anopheline mosquito control in river basins below the major dams of Sri Lanka. Transactions of the Royal Society of Tropical Medicine and Hygiene. 102: 705-711, http://doi. org/10.1016/j.trstmh.2008.03.013.

Morton, R.M., Beumer, J.P. and Pollock, B.R. (1988). Fishes of a subtropical australian saltmarsh and their predation upon mosquitoes. Environmental biology of Fishes. 21: 185-194.

Nayak, N., Sonowal, J., Borah, R., Kachari, A. and Biswas, S.P. (2020). Feeding biology and food selection in rainbow snakehaed (*Channa bleheri*, Vierke 1991). NeBIO. 11(1): 51-55.

Neng, W., Shusen, W., Guangxin, H., Rongman, X., Guangkun, T. and Chen, Q. (1987). Control of *Aedes aegypti* Larvae in Household Water Containers by Chinese Cat Fish. Bulletin of the World Health Organization. 65: 503-506.

Phukon, H.K. and Biswas, S.P. (2011). Investigation on *Channa gachua* as a potential biological control agent of mosquitoes under laboratory conditions. Asian Journal of Experimental Biology. 2(4): 606- 611.

Phukon, H.K. and Biswas, S.P. (2013). An investigation on larvicidal efficacy of some indigenous fish species of Assam, India. Advances in Bioresearch. 3: 22-25.

Rao, J.C.S., Rao, K.G., Raju, C.S. and Simhachalam, G. (2015). Larvicidal efficacy of four indigenous ornamental fish species of lake Kolleru, India. Journal of Biodiversity and Environmental Sciences. 7(1): 164-172.

Sanyal, S. and Ghosh, S. (2014). Prey selectivity and efficient Biocontrol of Dengue by Guppies: Effects of alternative prey and habitat complexity. International Journal of Pure and Applied Zoology 2(4): 339-347.

Talwar, P.K. and Jhingran, A.G. (1991). Inland Fishes of India and Adjacent Countries, Vol. I and II. New Delhi: Oxford and IBH Co., Pvt. Ltd. New Delhi 1158 pp.

Walshe, D.P., Garner, P., Adeel, A.A., Pyke, G.H. and Burkot, T.R. (2017). Larvivorous fish for preventing malaria transmission. Cochrane Database of Systematic Reviews Issue 12: CD008090,http://doi.org/10.1002/14651858.CD008090. pub3.

World Health Organization (2017). World Malaria Report. 196 pp.