# *EFFICACY OF SOME COMMON AQUARIUM FISHES AS BIOCONTROL AGENT OF PREADULT MOSQUITOES*

A. Ghosh [1], I. Bhattacharjee [1], M. Ganguly [1], S. Mondal [1] and G. Chandra [1]

***Abstract.*** *Predation experiment using* Betta splendens, Pseudotropheus tropheops, Osphronemus gorami *and* Pterophyllum scalare *were conducted against IVth instar Anopheline larvae and pupae with varying prey and predator densities.Ranking of individual predatory efficacy showed the sequence:* P. tropheops > B. splendens > O. gorami > P. scalare *against larval form and* B. splendens > O. gorami >P. tropheops > P. scalare *against pupal form of* Anopheles stephensi *during 24 hours experiment in laboratory condition. Predation under co-existence in interspecific and intraspecific combinations revealed the significance of predatory efficacy with reference to prey density and water volume (search area).*

*Key word: mosquitoes, biocontrol agent, fish*

## INTRODUCTION

*Anopheles stephensi* is a recognized vector of Malaria [(1)]. Mosquitoes, chiefly *Anopheles* and *Culex*, have been incriminated as vectors of some common diseases, such as malaria and filaria respectively that lead to the concept of mosquito control as a strategy for eradicating those communicable diseases [(2)].

Resistance to insecticides has necessitated utilization of biological agents to control larval mosquitoes [(3-7)]. Mosquitoes of the larvivorous fishes have been seriously considered as potent biocontrol agents [(8-12)]. Aquarium fish like *Carrasius auratus* has been reported to be larvivorous in habit [(13)]. But information regarding the larvivorous and pupaevorous potentiality of other aquarium fishes is scanty. Hence it is essential to understand the predator-prey response in some common aquarium fishes, so that maximum level of control could be achieved. Predator-prey interaction has been received much attention in the recent past [(14)]. Optimal foraging theory [(15)] predicts inclusion of the most profitable prey items in predator's diet [(16,17)]. Predatory efficacy of larvivorous fishes gets altered under the stress of prey densities to which it gets exposed [(18)]. Present study was conducted to assess the role of four aquarium fishes, *Betta splendens*, *Pseudotropheus tropheops*, *Osphro-nemus gorami* and *Pterophyllum scalare* as biocontrol agents against preadult anopheline.

## MATERIALS AND METHODS

Aquarium fishes *B. splendens*, *P. tropheops*, *O. gorami* and *P. scalare* were collected from Industrial fish and fishery division, Burdwan and were acclimatized. Larval and pupal form of *Anopheles stephensi* were collected from local habitats. Newly emerged IVth instar larvae and pupae were used as prey species. The water quality was maintained at $15^0$C and pH was 7.5. Abrupt changes in the quality of holding water during rearing and experimentation were avoided. Predation experiments were conducted in 1 litre and 2 litres of tap water in glass aquarium (measuring 9×9×20 cm). For the experiments,

[1]Burdwan University, West Bengal, India

eight fishes such as two of *B. splendens* (Length 5 cm and 5.2 cm and weight 3.0 g and 3.1 g respectively), two of *P. tropheops* (Length 4.9 cm and 5.0 cm and weight 3.1 g and 3.16 g respectively), two of *O. gorami* (Length 5.2 cm and 5.1 cm and weight 3.3 g and 3.18 g respectively) and two of *P. scalare* (Length 5.1 cm and 5.3 cm and weight 3.01 g and 3.21 g respectively) were used as predators and IVth instar larvae and pupae of *An. stephensi* were selected as prey. The daily feeding rate with individual predator was recorded at an interval of three hours. Three replications were made and the mean value with standard error was calculated.

In the next phase of the experiment, the variations in the predatory potentiality were observed with change in the number of prey, predator and water volume (search area). Change in the larval and pupal consumption rate in interspecific and intra-specific combination with change in water volume was also recorded. Statistical significance of predation was analyzed by the application of 't' test and regression equation was established using statistical package 'SPSS'. The morbid larval and pupal forms were not considered as consumed.

## RESULTS

Three hourly and daily consumption rates (mean value of three experiments) of *B. splendens*, *P. tropheops*, *O. gorami* and *P. scalare* on larvae and pupae of *An. stephensi* had been presented in Table. 1. When a 24 hour period was divided into two phases namely dark phase (17.00 hr to 5.00 hr ) and light phase from (5.00 hr to 17.00 hr) it was observed that during dark phase *B. splendens*, *P. tropheops*, *O. gorami* and *P. scalare* consumed 102, 107, 64 and 15 larvae and 158, 77, 104, and 54 pupae respectively. The corresponding figures for light phase were 136,140, 116 and 25 larvae and 161, 109, 113 and 58 pupae respectively (Table 1).

Variations in daily larval and pupal feeding rates of individual fish species with variation in water volume and predator density had been depicted in Table 2. Variation in daily larval and pupal feeding potentialities of mixed population of four aquarium fishes depending on varied predator density and water volume had been accommodated in Table 3.

In case of individual culture of the four species, it was observed that water volume was inversely related whereas number of predator positively related to the larval and pupal feeding rate (Table 2). For convenience the relevant regression equation obtained from experimental data are given below:

The equation for larval feeding rate

$X_1 = 206.7500 - 0.53X_2 + 0.847\ X_3,$
$R = 0.9988$ (for *B. splendens* )

$X_1 = 202.25 - 0.48\ X_2 + 0.862\ X_3,$
$R = 0.9871$ (for *P. tropheops)*

$X_1 = 149.25 - 0.52\ X_2 + 0.830\ X_3,$
$R = o.9784$ (for *O. gorami*)

$X_1 = -2.750 - 0.01\ X_2 + 0.971\ X_3,$
$R = 0.97088$ (for *P. scalare )*

The equation for pupal feeding rate

$X_1 = 297.25 - 0.53\ X_2 + 0.841\ X_3,$
$R = 0.9784$ (for *B. splendens )*

$X_1 = 231.5 - 0.90\ X_2 + 0.438\ X_3,$
$R = 0.9986$(for *P. tropheops)*

$X_1 = 239.25 - 0.712\ X_2 + 000.630\ X_3,$
$R = 9913$ (for *O. gorami* )

$X_1 = 50.00 - 0.34\ X_2 + 0.990\ X_3,$
$R = 0.9921$, (for *P. scalare )*

The analysis of regression equation with mixed polyculture (Table 3) showed that both larval and pupal feeding rate had linear relationship with water volume

**Table 1. Three Hourly and Daily Consumption Rates (Averages of 3 Experiments) of Different Aquarium Fishes on Larvae and Pupae of *Anopheles stephensi***

| Name of The Fish Species | Life Stage of *A. stephensi* | Amount of Water ( in liter | Average Consumption At An Interval Of Three Hours. | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 17.00 pm to 20.00 pm | 20.00 pm to 11.00 pm | 11.00 pm to 2.00 am | 2.00 am to 5.00 am | 5.00 am to 8.00 am | 8.00 am to 11.00 am | 11.00 am to 14.00 pm | 14.00 pm to 17.00 pm | |
| ***Betta splendens*** | Larva | 1 | 25 ± 3.214 | 34 ± 3.305 | 24 ± 3.176 | 45 ± 5.595 | 32 ± 2.97 | 38 ± 3.812 | 42 ± 4.73 | 50± 6.698 | 238± 27.536 |
| | Pupa | 1 | 21 ± 2.081 | 41 ± 4.513 | 32 ± 3.626 | 38 ± 3.768 | 22 ± 3.379 | 33 ± 3.079 | 40 ±4.350 | 40 ± 4.619 | 319± 35.389 |
| ***Pseudotropheus tropheops*** | Larva | 1 | 24 ± 2.645 | 05 ± 2.081 | 30 ± 2.0 | 30 ± 2.00 | 26 ± 3.214 | 28± 1.527 | 45 ± 2.516 | 28 ± 1.00 | 247± 25.368 |
| | Pupa | 1 | 26 ± 4.00 | 19 ± 1.00 | 27 ± 3.054 | 23± 2.081 | 29 ± 4.725 | 29 ± 3.054 | 40 ± 3.214 | 24 ± 3.511 | 186± 16.254 |
| ***Osphronemus gorami*** | Larva | 1 | 14 ± 5.25 | 33 ± 3.079 | 13 ± 5.561 | 22 ± 3.453 | 28 ± 3.317 | 26 ± 3.346 | 32 ± 2.964 | 27 ± 3.511 | 180± 32.562 |
| | Pupa | 1 | 19 ± 4.897 | 21 ± 3.509 | 18 ± 4.359 | 28 ± 3.618 | 27 ± 2.780 | 28 ± 4.163 | 29 ± 3.469 | 32 ± 2.081 | 217± 26.760 |
| ***Pterophyllum scalare*** | Larva | 1 | 05± 1.00 | 15 ± 2.081 | 02± 1.00 | 12 ± 1.527 | 02 ± 1.0 | 15 ± 1.527 | 13 ± 2.081 | 16 ± 1.00 | 40 ± 9.608 |
| | Pupa | 1 | 03 ± 1.00 | 14 ± 3.179 | 05 ± 1.527 | 13 ± 1.527 | 00 | 12± 2.00 | 10± 2.00 | 15 ± 3.214 | 112 ± 16.055 |

**Table 2. Variations in Daily Larval and Pupal Feeding Rates of Different Fishes With Variations in Water Volume and Predator Density**

| Name Of The Fish | Number of Fish | Amount of Water (in litre) | Mean Larval Consumption Per Day | Mean Pupal Consumption Per Day | RESULT OF 't' (comparison between pupal and larval feeding rate) |
|---|---|---|---|---|---|
| *Betta splendens* | 1 | 1 | 238 ± 5.131 | 319 ± 4.041 | 35.02 |
| | | 2 | 185 ± 5.567 | 283 ± 4.163 | 41.35 |
| | 2 | 1 | 311 ± 7.023 | 398 ± 2.645 | 36.82 |
| | | 2 | 267 ± 3.054 | 345 ± 8.326 | 30.43 |
| **Pseudotropheus tropheops** | 1 | 1 | 247 ± 7.55 | 186 ± 3.214 | 24.469 (negative) |
| | | 2 | 185 ± 4.714 | 107 ± 4.582 | 33.207 (negative) |
| | 2 | 1 | 315 ± 4.359 | 232 ± 6.082 | 33.80 (negative) |
| | | 2 | 284 ± 7.001 | 143 ± 8.1444 | 47.68 (negative) |
| *Osphronemus gorami* | 1 | 1 | 180 ± 5.567 | 217 ± 6.244 | 14.168 |
| | | 2 | 134 ± 6.244 | 147 ± 9.165 | 1.461 |
| | 2 | 1 | 333 ± 4.041 | 301 ± 3.797 | 15.045 (negative) |
| | | 2 | 226 ± 3.605 | 202 ± 3.605 | 11.764 (negative) |
| *Pterophyllum scalare* | 1 | 1 | 40 ± 2.516 | 112 ± 4.509 | 35.75 |
| | | 2 | 30 ± 4.509 | 67 ± 3.605 | 17.70 |
| | 2 | 1 | 69 ± 4.163 | 189 ± 4.582 | 53.40 |
| | | 2 | 78 ± 1.5275 | 168 ± 6.506 | 41.78 |

and number of predators. In both cases this linear relationship holds good fit because multiple correlation in both cases were close to one. It was also found that water volume had inverse relationship whereas number of predators had positive relationship with feeding rate.

<u>The equation for polyculture larval feeding rate</u>

$X_{1.23} = 662.7500 - 0.53 X_2 + 0.836 X_3$,
$R = 0.99048$

<u>The equation for polyculture pupal feeding rate</u>

$X_{1.23} = 686.500 - 0.38 X_2 + 0.920 X_3$,
$R = .99371$.

## DISCUSSION

The results obtained from present sets of experiment indicated clearly that all the fish species explored had mosquito larval and pupal feeding potentialities. Specieswise comparison revealed that larval feeding rate of *Pseudotropheus tropheops* was higher (though not significantly in all cases) than those of *Betta splendens* ($P>0.05$; $t=2.851$), ***Osphronemus*** *go rami* ($P<0.05$; $t = 20.9636$) and *P. scalare* ($P<0.05$; $t = 79.1977$). Pupal feeding rate was higher in *B. splendens* than those of *O. gorami* ($P<0.05$; $t=45.991$), *P. scalare* ($P<0.05$; $t = 53.788$) and *P. tropheops* ($P<0.05$; $t = 37.5176$). Pupal consumption rate was higher ($P<0.005$) than larval consumption rate in each species of

**Table 3. Variation in Daily Larval and Pupal Consumption by Mixed Population of Four Aquarium Fishes With Variations in Water Volume and Predator Density**

| Species Composition | Amount of Water (In Litre) | Number of Fish | Daily Larval Feeding Rate | Daily Pupal Feeding Rate | Result Of "T"(in Comparision Pupal to Larval Feeding Rate ) |
|---|---|---|---|---|---|
| ***Betta splendens* + *Pseudotropheus tropheops* + *Osphronemus gorami* + *Pterophyllum scalare*** | 1 | 4 (1 each) | 768 ± 16.197 | 891 ± 11.533 | 30.74 |
| | | 8(2 each) | 1203 ± 13 | 1324 ± 7.00 | 35.61 |
| | 2 | 4 (1 each) | 592 ± 9.165 | 780 ± 7.635 | 60.450 |
| | | 8 (2 each) | 904 ± 3.055 | 1119 ± 8.090 | 84.81 |

*B. splendens* (t=35.02), *O. gorami* (t = 14.168) and *P. scalare* (t = 35.75). This preferential feeding on pupa could be explained as an adaptation to reduce energy cost of prey capture by an opportunistic predator (pupae are less active than larvae). An opportunistic predator will select a prey that could be approached and captured with less expenditure of energy [19], though this idea could not satisfy the feeding habit of *P. tropheops* where larval feeding rate was higher ($P<0.05$) than that of pupal feeding rate ($t = 24.469$ ).

The study also revealed that all the fish predators were more active during light phase (5.00 to17.00 hours) in comparision to dark phase (17.00 to 5.00 hours) in a 24 hours period, evidenced by higher ($P<0.05$) larval and pupal consumption rates. Both in case of individual culture and polyculture it was apparent that water volume had an inverse relationship whereas number of predators had positive relationship with feeding rate.

As these four fishes are active, hardy, prolific freshwater breeder, breed in stagnant water [20] and have very high larval and pupal feeding efficacy, they can effectively be used for the control of *An. stephensi,* and presumably, against other mosquitoes in field condition.

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