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Chironomid Larvae Inhibiting Effectiveness of Guppy in Monitoring Vector Mosquito Populations

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Abstract

The predacious fish guppies (*Poecilia reticulata*) are effective biological agents to control the vector mosquito populations round the globe. In municipality drains, though they are able to keep the density of vector mosquito populations in check, they failed to monitor the mosquito populations occurring in some drains of Kolkata where chironomid larvae are thriving at large, simultaneously, with the mosquito larvae. This compelled to have a clear data sheet on the rate of predation of guppy on the mosquito larvae and the chironomid larvae. It was revealed that an adult guppy consumed 634.1 ± 9.25 SE, 473.4 ± 3.34, 180.6 ± 3.4 and 102.5± 3.85; 542.5 ± 10.57, 385.3 ± 3.21, 177.0 ± 1.34 and 80.4 ± 1.78, and 679.2 ± 6.11, 512.5 ±4.26, 191.7 ± 2.51 and 119.6 ± 2.48 1st, 2nd, 3rd and 4th instar of the mosquitoes *Anopheles stephensi*, *Culex quinquefasciatus* and the chironomid *Chironomus stratipenis* daily, respectively when the prey-larvae belonging to each instar morph were available for predation, separately. But, the results of the experiments with the supply of *Ch. stratipenis* either with *An. stephensi* or with *Cx. quinquefasciatu*s indicated that, on average the rate of destruction was reduced by 45.34% in An. stephensi and by 43.61% in *Cx. quinquefasciatus.*

Key words : Mosquito larvae, Chironomid larvae, Guppy, Mosquito control, Non-effectiveness.

Guppies (*Poecilia reticulata*) feed voraciously on the mosquito larvae (1—7). Therefore, they have been introduced in many parts of the globe to control the vector mosquito populations with a view to get rid of the hazards to mosquito-borne diseases (4.5, 8–10). Though in most cases guppies are well established in the introduced areas mosquito problems remained unchanged except in certain pockets of the trial areas. This compelled us to visit the guppy-inhabited municipality drains of Kolkata in recent past. It is revealed that *P. reticulata* are feeding almost with equal preference on the larvae of *Chironomas stratipenis* in all the drains where they are occurring. To be sure and to determine predation rate we carried out some experiments in the laboratory by offering different instar larvae of *Anopheles stephensi* , *Culex quinquefasciatus* and *Chironomas stratipenis* to the guppy *P. reticulata,* and the results are communicated.

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Methods

Required number plastic containers each measuring 15 cm in diameter and 7 cm in depth were taken for experimentations. In each container 700 ml pond water was added.The instar larvae of An. stephensi, *Cx.quinquefasciatus*, *Ch. stratipenis* and the guppies *P. reticulata* were procured from the laboratory culture stock as well as from their natural habitats in the municipality drains of Kolkata. The experiments were designed in the following ways.

Experiment 1A : One guppy was exposed to 1000 first instar *An. stephensi* for 24 hours.

Experiment 1B : One guppy was exposed to 1000 first instar *Cx. quinquefasciatus* for 24 hours.

Experiment 1C : One guppy was exposed to 1000 first instar *Ch. stratipenis* for 24 hours.

Experiment IIA : One guppy was exposed to 1000 second instar *An. stephensi* for 24 hours.

Experiment IIB : One guppy was exposed to 1000 second instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIC : One guppy was exposed to 1000 second instar *Ch. stratipenis* for 24 hours.

Experiment IIIA : One guppy was exposed to 1000 third instar *An. stephensi* for 24 hours.

Experiment IIIB : One guppy was exposed to 1000 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIIC : One guppy was exposed to 1000 third instar *Ch. stratipenis* for 24 hours.

Experiment IVA : One guppy was exposed to 1000 fourth instar *An. stephensi* for 24 hours.

Experiment IVB : One guppy was exposed to 1000 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IVC : One guppy was exposed to 1000 fourth instar *Ch.stratipenis* for 24 hours.

Experiment VA : One guppy was exposed to 500 first instar *An. stephensi* and 500 first instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VB : One guppy was exposed to 500 first instar *Cx. quinquefasciatus* and 500 first instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIA : One guppy was exposed to 500 second instar *An. stephensi* and 500 first instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIB : One guppy was exposed to 500 second instar *Cx. quinquefasciatus* and 500 second instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIIA : One guppy was exposed to 500 third instar *An. stephensi* and 500 third instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIIB : One guppy was exposed to 500 third instar *Cx. quinquefasciatus* and 500 third instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIIIA : One guppy exposed to 500 fourth instar *An. stephensi* and 500 fourth instar *Ch. stratipenis* together (total 1000) for 24 hours.

Experiment VIIIB : One guppy was exposed to 500 fourth instar *Cx. quinquefasciatus* and 500 fourth instar Ch. *stratipenis* together (total 1000) for 24 hours.

Each experiment was repeated ten times. In all cases five trials were made by using adult but same sized male and the remaining five trials were made by using adult but same sized female *P. reticulata.* For each trial prey and predator individuals were used afresh. The predator was fed based on its need prior to using the same for the experimental purpose. By the end of 24 hours of experimentation period the number of left over prey larvae was counted to determine the number of larvae consumed by the guppy. Mean and standard error (SE) were calculated on the bases of the data obtained in the trials concerned. One way ANOVA was applied (11) to justify whether the predation rate varied significantly with the prey species and/or with the instar stages of the prey larvae concerned.

Results

The guppy *P. reticulata* consumed *An. stephensi*, *Cx. quinquefasciatus* and *Ch. stratipenis* at different rates as could be revealed from the results of the following experiments.

Experiment 1A : A guppy consumed 588 to 668 (average 634.1 ± 9.25) first instar *An. stephensi* daily.

Experiment 1B : A guppy consumed 496 to 593 (average 542.5 ±10.57) first instar *Cx. quinquefasciatus* daily.

Experiment 1 C : A guppy consumed 648 to 705 (average 679.2 ± 6.11) first instar *Ch. stratipenis* daily.

Experiment IIA : A guppy consumed 366 to 398 (average 385.3 ± 3.21) second instar *Cx. quinquefasciatus* daily.

Experiment IIB : A guppy consumed 366 to 398 (average 385.3 ± 3.21) second instar *Cx. quinquefasciatus* daily.

Experiment IIC : A guppy consumed 492 to 532 (average 512.5 ± 4.26) second instar *Ch. stratipenis* daily.

Experiment IIIA : A guppy consumed 174 to 185 (average 180.6 ± 3.4) third instar *An.stephensi* daily.

Experiment IIIB : A guppy consumed 115 to 119 (average 177.0 ± 1.34) third in star *Cx. quinquefasciatus* daily.

Experiment IIIC : A guppy consumed 188 to 198 (average 191.7 ± 2.51) third instar *Ch. stratipenis* daily.

Experiment IVA : A guppy consumed 97 to 110 (average 102.5 ± 3.85) fourth instar *An. stephensi* daily.

Experiment IVB : A guppy consumed 78 to 82 (average 80.4 ± 1.78) fourth instar *Cx. quinquefasciatus* daily.

Experiment IVC : A guppy consumed 116 to 125 (average 119.6 ± 2.48) fourth instar *Ch. stratipenis* daily.

Experiment VA : A guppy consumed 325 to 378 (average 346.5 ± 5.12) and 352–394 (average 368.4 ± 3.62) first instar *An. stephensi* and Ch. stratipenis respective, daily.

Experiment VB : A guppy consumed 285 to 327 (average 305.9 ± 4.15) and 324 – 365 (average 343.2 ± 4.39) first instar *Cx. quinquefasciatus* and *Ch. stratipenis* respectively, daily.

Experiment VIA : A guppy consumed 238 to 256 (average 247.6 ± 1.93) and 264—286 (average 273.8 ± 2.24) second instar *An. stephensi.* and *Ch. stratipenis* respectively, daily.

Experiment VIB : A guppy consumed 182 to 202 (average 181.6 ± 3.77) and 264–279 (average 269 ± 1.75) second instar *Cx. quinquefasciatus* and *Ch.stratipenis* respectively, daily.

Experiment VIIA : A guppy consumed 82 to 93 (average 88.3 ± 3.49) and 126—145 (average 136.6 ± 5.69) third instar *An. stephensi* and *Ch.stratipenis* respectively, daily.

Experiment VIIB : A guppy consumed 75 to 83 (average 78.7 ± 2.68) and 115—139 (average 127.5 ± 7.47) third instar *Cx. quinquefasciatus* and *Ch. stratipenis* respectively, daily.

Experiment VIIIA : A guppy consumed 52 to 62 (average 57 ± 2.24) and 59–87 (average 75.3 ± 5.13) fourth instar *An. stephensi* and *Ch. stratipenis* respectively, daily.

Experiment VIIIB : A guppy consumed 37 to 54 (average 44 ± 3.77) and 71—88 (average 79 ± 5.29) fourth instar *Cx. quinquefasciatus* and *Ch. stratipenis* respectively, daily.

A comparative account on the rate of consumption by a guppy on different instar stages of *An. stephensi, Cx. quinquefasciatus* and *Ch. stratipenis* are presented in Table 1. ANOVA tests indicated that prey species had no role to play with the consumption rate of guppy while instar stages had biggest effect (P>0.01) on the consumption rate of guppy. Since the guppy was satisfied by consuming less number of *An. stephens*i and *Ch. stratipensis* an attempt was made to calculate the amount that is, the number of An. stephensi and Ch. stratipenis to be required by a guppy in respect to *Cx. quinquefasciatus*. In calculation the consumption rate exhibited by

Table 1. Rate of consumption (average total number ± SE) on the instar larvae of *An. stephensi, Cx. quinquefasciatus* and *Ch. stratipenis* by a guppy (*P.reticulata*) during the period of 24 hours of a day while offered adlibitum, separately as regard to species.

Prey species	Instar stage First	Second	Third	Fourth
An. stephensi	634.1 ± 9.25	473.4 ± 3.34	180.6 ± 3.4	102.5 ± 3.85
Cx. quinquefasciatus	542.5 ± 10.57	385.3 ± 3.21	177 ± 1.34	80.4 ± 1.78
Ch. stratipenis	679.2 ± 6.11	512.5 ± 4.26	191.7 ± 2.51	111.7 ± 2.48

Table 2. Estimated rate of consumption (in number) on *An. stephensi* and *Ch. stratipenis* by the guppy (*P. reticulata)* considering the consumption rate of *Cx. quinquefasciatus* as 1, in respect to the instar larval stages of the prey species concerned.

Instar stage	*Cx. quinquefasciatus*	*An. stephensi*	*Ch.stratipenis*
First	1	1.17	1.25
Second	1	1.22	1.33
Third	1	1.02	1.08
Fourth	1	1.27	1.49

Table 3. Rate of consumption on different instar larvae of *An. stephensi, Cx. quinquefasciatus* and *Ch. stratipenis* by the guppy in respect to the fourth instar larva of the prey species concerned.

Prey species	Instar stage Fourth	Third	Second	First
An. stephensi	1	1.76	4.62	6.19
Cx. quinquefasciatus	1	2.2	4.8	6.75
Ch. stratipenis	1	1.6	4.3	5.68

a guppy on the *Cx. quinquefasciatus* was considered as 1. The results of these calculations are shown in Table 2. ANOVA tests indicated that the consumption rates of guppy differed significantly (P>0.01) with the prey species under study.

Table 3 presents the calculated data on the rate of consumption of first, second and third instar larva in respect to consumption of the fourth instar larva of each prey species under study. For calculation fourth instar larva was considered as the unit for comparison with other instar larvae of the respective prey species. ANOVA tests revealed that the prey species under consideration had no role to regulate the consumption rate of *P. reticulat*a while instar stages of these prey species had significant effect (P>0.01) on the consumption rate of the predator.

Discussion

Thus the larvae of *An. stephensi*, *Cx. quinquefasciatus* and *Ch. stratipenis* are almost equally preferred by the fishes *P. reticulata,* but the rate of consumption by the guppy varied to a great extent with the instar stages of the prey species. Therefore, it is clear that the guppy would consume these larvae irrespective of the prey species, *An.stephensi,Cx. quinquefasciatus* and *Ch. stratipenis* with little bit discrimination of the stage of the instars concerned. Accordingly, if a guppy is exposed to a large number of larvae belonging to the vector mosquito species viz. *An. stephensi* and *Cx. quinquefasciatus* along with the larvae of *Ch. stratipenis* it would consume all the three prey species almost equally depending upon the availability within the foraging range. Practically, the same situation has been noted in the present studies in the experiments carried out with the larvae of *An. stephensi* and *Ch. stratipenis*, and *Cx. quinquefasciatus* and *Ch. stratipenis* irrespective of instar stages.

Evidently, a guppy consumed on average 39.22 to 48.47% *An. stephensi* and 34.52 to 47.13% *Cx.quinquefasciatus* in presence of *Ch. stratipenis,* with respect to total number of mosquito and chironomid larvae consumed by the guppy during the period of 24 hours of a day.That is, in a common habitat of *Anopheles* and *Chironomus,* and *Culex* and Chironomus on average, consumption rate of P. reticulata is reduced by 56.36% on Anopheles and 59.97% on *Culex.* This suggests that *P. reticulata* though habituated to consume *Anopheles*, *Culex* and *Chironomus* almost in equal number while available for consumption in respect to species separately, they preferred *Chironomus* more over *Anopheles* and / or *Culex* when both mosquito and chironomid larvae are available for predation at large. Thus it is concluded that the guppies would not be proved effective to control the mosquitoes in the areas where chironomid larvae are found in sufficient numbers along with the larvae of *Anopheles* and *Culex*. So, under such a situation attention should be given either to release more number of *P. reticulata* or introduce any other kind of agents to reduce the number of chironomid larvae in the habitats concerned. Therefore, the phenomena of interactions and impact of several biocontrol agents occurring in the same habitat along with mosquito larvae should not be overlooked as have been pointed out by a number of workers (4, 12—18) and more specifically by Pramanik and Raut (19).

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