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Chironomid Larvae Hindering Potentiality of Water-Bugs in Regulating Vector Mosquito Populations in Kolkata, India

M. K. PRAMANIK AND S. K. RAUT

Ecology & Ethology Laboratory, Department of Zoology, University of Calcutta
Kolkata 700019, India

Abstract

The adult morph of water-bugs, *Sphaerodema annulatum, S. rusticum* were exposed to different densities viz. 50, 100, 150 and 200 third and fourth instars of *Culex quinquefasciatus* and *Chironomus stratipenis* to note the rate of predation under laboratory conditions. It is revealed that an adult *S. annulatum* consumed on average 29.8 ± SEO.42, 49.2 ± 1.27, 60.4 ± 1.27 and 75.4 ± 1.74 third instar and, 33.1 ± 0.65, 58.4 ± 0.85, 69.0 ± 0.77, and 80.9 ± 1.11 fourth instar mosquito larvae ; and 42.8 ± 0.52, 74.5 ± 0.78, 94.6 ± 0.71, and 135.5 ± 1.28 third instar and, 38.7 ± 0.55, 71.3 ± 1.03, 88.7 ± 0.84, and 109.1 ± 1.87 fourth instar chironomid larvae daily (24 h), respectively in respect to the number of prey individuals offered. On the otherhand, an adult *S. rusticum* consumed on average 20.1 ± 0.43, 35.6 ± 0.51, 49.2 ± 1.63, and 59.5 ± 1.61 third instar, and 27.6 ± 0.65, 48.7 ± 0.96, 59.9 ±1.48, and 69.0 ± 2.05 fourth instar mosquito larvae ; and 34.3 ± 0.94, 64 ± 1.0, 75.9 ± 1.14, and 123.2 ± 2.15 third instar, and 30.2 ± 1.18, 61.2 ±0.77, 70.2 ± 1.58 and 102 ± 1.31 fourth instar chironomid larvae, respectively, daily.
Key words : Mosquito larvae, Chironomid larvae, Water-bugs, Predation, Biocontrol.

To combat mosquito-borne diseases various attempts are being made to control the vector mosquitoes through the effective use of biological agents (1—7). In recent years in Kolkata we had the opportunity to note how chironomid larvae inhibiting the effectiveness of certain biocontrol agents of the mosquito species occurring in Kolkata (8, 9). In Kolkata, in many drains water-bugs *Sphaerodema annulatum* and *S. rusticum* were seen to feed on the mosquito and chironomid larvae almost regularly. Since, in certain localities municipal drains are inhabitated by both mosquito and chironomid larvae it is essential to have a clear idea regarding predation preference of the water-bugs, the effective natural enemies of larval mosquito, under such a situation, prior to introduction of the same to monitor larval mosquito population. Accordingly, we designed some experiments by offering the mosquito *(Culex quinquefasciatus)* and chironomid *(Chironomus stratipenis)* larvae as prey, at different densities to the water-bugs *S. annulation* and *S. rusticum* in laboratory conditions and the findings are presented.

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Methods

Required number plastic containers each measuring 15 cm in diameter and 7 cm in depth, were taken for experiments. In each container 700 ml pond water was added. The third and fourth instar *Cx. quinquefasciatus* and *Ch. stratipenis* and the adult water-bugs *S. annulatum* and *S. rusticum* were procured from their natural habitats from time to time as per requirement of the following experiments :

Experiment 1A : One *S. annulatum* was exposed to 50 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment 1B : One *S. annulatum* was exposed to 100 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment 1C : One *S. annulatum* was exposed to 150 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment 1D : One *S. annulatum* was exposed to 200 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment 1a : One *S. annulatum* was exposed to 50 third instar *Ch. stratipenis* for 24 hours.

Experiment 1b : One *S. annulatum* was exposed to 100 third instar *Ch. stratipenis* for 24 hours.

Experiment 1c : One *S. annulatum* was exposed to 150 third instar *Ch. stratipenis* for 24 hours.

Experiment 1d : One *S. annulatum* was exposed to 200 third instar *Ch. stratipenis* for 24 hours.

Experiment IIA : One *S. rusticum* was exposed to 50 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIB : One *S. rusticum* was exposed to 100 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIC : One *S. rusticum* was exposed to 150 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment IID : One *S. rusticum* was exposed to 200 third instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIa : One *S. rusticum* was exposed to 50 third instar *Ch. stratipenis* for 24 hours.

Experiment IIb : One *S. rusticum* was exposed to 100 third instar *Ch. stratipenis* for 24 hours.

Experiment IIc : One *S. rusticum* was exposed to 150 third instar *Ch. stratipenis* for 24 hours.

Experiment IId : One *S. rusticum* was exposed to 200 third instar *Ch. stratipenis* for 24 hours.

Experiment IIIA : One *S. annulatum* was exposed to 50 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIIB : One *S. annulatum* was exposed to 100 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIIC : One *S. annulatus* was exposed to 100 fourth instar *Cx.quinquefasciatus* for 24 hours.

Experiment IIID : One *S. annulatum* was exposed to 200 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IIIa : One *S. annulatum* was exposed to 50 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IIIb : One *S. annulatum* was exposed to 100 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IIIc : One *S. annulatum* was exposed to 150 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IIId : One *S. annulatum* was exposed to 200 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IVA : One *S. rusticum* was exposed to 50 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IVB : One *S. rusticum* was exposed to 100 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IVC : One *S. rusticum* was exposed to 150 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IVD : One *S. rusticum* was exposed to 200 fourth instar *Cx. quinquefasciatus* for 24 hours.

Experiment IVa : One *S. rusticum* was exposed to 50 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IVb : One *S. rusticum* was exposed to 100 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IVc : One *S. rusticum* was exposed to 150 fourth instar *Ch. stratipenis* for 24 hours.

Experiment IVd : One *S. rusticum* was exposed to 200 fourth instar *Ch. stratipenis* for 24 hours.

Each experiment was repeated ten times and the mean and standard error (SE) were calculated to present the data. 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 water-bug. One-way analysis of variance (ANOVA) was applied (10) to justify whether the predation rate varied significantly with the prey species.

Results

The water-bugs *S. annulatum* and *S. rusticum* consumed *Cx. quinquefasciatus* and *Ch. stratipenis* larvae at different rates in different experiments in respect to the number of prey individuals offered.

Experiment IA : A. *S. annulatum* consumed 27 to 32 (average 29.8 ± 0.42) tiird instar *Cx. quinquefasciatus* daily (24 hours).

Experiment IB : A. *S. annulatum* consumed 45 to 58 (average 49.2 ± 1.27) third instar *Cx. quinquefasciatus* daily.

Experiment IC : A *S. annulatum* consumed 55 to 67 (average 60.4 ± 1.27) third instar *Cx. quinquefasciatus* daily.

Experiment ID : A *S. annulatum* consumed 64 to 82 (average 75.4 ± 1.74) third instar *Cx. quinquefasciatus* daily.

Experiment Ia : A *S. annulatum* consumed 40 to 45 (average 42.8 ± 0.52) third instar *Ch. stratipenis* daily.

Experiment Ib : A *S. annulatum* consumed 70 to 78 (average 74.5 ± 0.78) third instar *Ch. stratipenis* daily.

Experiment Ic : A *S. annulatum* consumed 90 to 98 (average 94.6 ± 0.71) third instar *Ch. stratipenis* daily.

Experiment Id : A *S. annulatum* consumed 125 to 140 (average 135.5 ± 1.28) third instar *Ch. stratipenis* daily.

Experiment IIA : A *S. rusticum* consumed 18 to 22 (average 20.1 ± 0.43) third instar *Cx. quinquefasciatus* daily.

Experiment IIB : A *S. rusticum* consumed 33 to 38 (average 35.6 ± 0.51) third instar *Cx. quinquefasciatus* daily.

Experiment IIC : A *S. rusticum* consumed 44 to 62 (average 49.2 ± 1.63) third instar *Cx. quinquefasciatus* daily.

Experiment IID : A *S. rusticum* consumed 52 to 72 (average 59.5 ± 1.61) third instar *Cx. quinquefasciatus* daily.

Experiment IIa : A *S. rusticum* consumed 30 to 38 (average 34.3 ± 0.94) third instar *Ch. stratipenis* daily.

Experiment IIb : A *S. rusticum* consumed 60 to 72 (average 64.0 ±1.0) third instar *Ch. stratipenis* daily.

Experiment IIc : A *S. rusticum* consumed 72 to 85 (average 75.9 ± 1.14) third instar *Ch. stratipenis* daily.

Experiment IId : A *S. rusticum* consumed 115 to 133 (average 123.2 ± 2.15) third instar *Ch. stratipenis* daily.

Experiment IIIA : A *S. annulatum* consumed 30 to 35 (average 33.1 ± 0.65) fourth instar *Cx. quinquefasciatus* daily.

Experiment IIIB : A *S. annulatum* consumed 54 to 62 (average 58.4 ± 0.85) fourth instar *Cx. quinquefasciatus* daily.

Experiment IIIC : A *S. annulatum* consumed 64 to 72 (average 69.0 ± 0.77) fourth instar *Cx. quinquefasciatus* daily.

Experiment IIID : A *S. annulatum* consumed 75 to 88 (average 80.9 ± 1.11) fourth instar *Cx. quinquefasciatus* daily.

Experiment IIIa : A *S. annulatum* consumed 36 to 41 (average 38.7 ± 0.55) fourth instar *Ch. stratipenis* daily.

Experiment IIIb : A *S. annulatum* consumed 68 to 79 (average 71.3 ± 1.03) fourth instar *Ch. stratipenis* daily.

Experiment IIIc : A *S. annulatum* consumed 85 to 94 (average 88.7 ± 0.84) fourth instar *Ch. stratipenis* daily.

Experiment IIId : A *S. annulatum* consumed 98 to 116 (average 109.1 ± 1.87) fourth instar *Ch. stratipenis* daily.

Experiment IVA : A *S. rusticum* consumed 25 to 32 (average 27.6 ± 0.65) fourth instar *Cx. quinquefasciatus* daily.

Experiment IVB : A *S. rusticum* consumed 44 to 53 (average 48.7 ± 0.96) fourth instar *Cx. quinquefasciatus* daily.

Experiment IVC : A *S. rusticum* consumed 53 to 68 (average 59.9 ± 1.48) fourth instar *Cx. quinquefasciatus* daily.

Experiment IVD : A *S. rusticum* consumed 62 to 82 (average 69.0 ± 2.05) fourth instar *Cx. quinquefasciatus* daily.

Experiment IVa : A *S. rusticum* consumed 25 to 36 (average 30.2 ± 1.18) fourth instar *Ch. stratipenis* daily.

Experiment IVb : A *S. rusticum* consumed 58 to 64 (average 61.2 ± 0.77) fourth instar *Ch. stratipenis* daily.

Experiment IVc : A *S. rusticum* consumed 64 to 78 (average 70.2 ± 1.58) fourth instar *Ch. stratipenis* daily.

Experiment IVd : A *S. rusticum* consumed 95 to 108 (average 102.0 ± 1.3) fourth instar *Ch. stratipenis* daily.

In all cases the predator consumed chironomids (prey) more in number than the mosquito larvae. But such differences were not statistically significant as could be revealed from the results of ANOVA tests (Predator : *S. annulatum*, for third instar mosquito and chironomid larvae (prey) $F = 2.34$, df = 1, for fourth instar mosquito and chironomid larvae $F = 8.85$, df = 1, predator *S. rusticum*, for third instar mosquito and chironomid larvae $F = 2.67$, df = 1, for fourth instar mosquito and chironomid larvae $F = 0.71$, df = 1, table value of F at 5% level is 5.99.

Discussion

Larval mosquito population density is regulated by a number of biological agents (1, 11—16) on way of predation. Of the recorded effective predators guppies (*Poecilia reticulata* (3, 16, 17), mosquitoes *(Toxorhynchites splendens)* (7, 18, 19) and the water-bugs *(S. annulatum, S. rusticum)* as is evident from the present study, prefer chironomid larvae more than those of mosquito larvae when they are available at large for predation.

Inspite of higher consumption rate if we accept the statistical result, then it is an established fact that the predators of vector mosquito larvae prefer chironomid larvae almost equally. Therefore, in their natural habitats especially in the municipality drains, the introduced biocontrol agents would prove only 50% effectiveness to reduce the larval mosquito population in presence of the chironomid larvae. Thus, to get the 100% effective results, the number of biocontrol agents to be released, in respect to the density of target mosquito species larvae and the chironomid larvae of the habitat, is to be determined first.

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