Potential of the leech *Glossiphonia weberi* (Blanchard) in controlling the sewage snail *Physa acuta* Draparnaud

The North American sewage snails *Physa acuta* are nowadays common/abundant in many parts of Europe, Australia, Asia and Africa[1–8]. As they are prolific breeders even in polluted waters and are able to spend a good length of time outside the water, they have become a serious threat to purification plants of sewage works by rendering the biofilters ineffective[1], and to the garden vegetations because of feeding on the same[3] in the introduced areas concerned. In this context, it is to be mentioned here that these snails have spread from the site of first occurrence in 1994 in a domestic sewage drain at Dunlop, Kolkata[8]. At present, they are not only common but also enormous in number in most of the sewage drains of Kolkata and Howrah, India. Therefore, there exists every possibility that these snails would become a serious threat to our agrihorticulture and sewage purification plants in the near future. Since our continued observations on the bioecology of these snails revealed that leeches *Glossiphonia weberi* were feeding on these snails in the sewage drains in Kolkata, we took the liberty to study the potential of *G. weberi* in regulating the density of *P. acuta* experimentally, in the laboratory. The results are presented with a hope to prove helpful in the biological control of *P. acuta* in the coming years.

Both *G. weberi* and *P. acuta* were collected from their common natural habitat from time to time, according to requirement, during the study period. To study the impact of the size of the predator and prey on the rate of predation, *G. weberi* were grouped into five size-classes, viz. 2–3, 4–5, 6–7, 8–9 and 10–11 mm in body length (at rest), and *P. acuta* were grouped into seven size-classes, viz. ≤ 2, 2.1–3, 3.1–4, 4.1–5, 5.1–6, 6.1–7 and 7.1–8 in shell height, and the following experiments were performed.

Experiment I: An individual of *G. weberi* belonging to a particular size class was exposed to 15 *P. acuta* belonging to one size class.

Experiment II: An individual of *G. weberi* belonging to a particular size class was exposed to 15 *P. acuta* belonging to all the size classes in different combinations, taking at least one, but never more than eight individuals from a size class, together.

The experiments were carried out in plastic containers each measuring 8 cm in diameter and 6 cm in depth, containing 200 ml pond water. The mouth of the container was closed with a piece of muslin. The snail individuals, according to specifications, were exposed to *G. weberi* belonging to a specific size class for a period of 24 h. Then, the number of *P. acuta* destroyed by *G. weberi* was counted and noted. For each individual of *G. weberi* of a size class, six trials were made with each size class of prey individuals. In the case of mixed size classes of *P. acuta*, 32 trials were performed by using *G. weberi* belonging to a size class. Control trials were carried out simultaneously in all cases by keeping the snails according to specifications, to note the normal mortality rate, daily. Mean and standard error (SE) were calculated to present the data. Randomized block design analysis of variance (ANOVA) was applied[9] to justify the effects of size of the predator (except the size class 2–3 mm) and prey on the rate of predation, and one-way ANOVA[10] was applied to justify (i) the frequency of attack by the predator to the prey individuals from among the mixed size classes of *P. acuta*, and (ii) the average rate of predation by a leech on different size classes of *P. acuta* supplied separately, as regards to size class, and together, in mixed size classes. Regression analysis was done to determine whether the maximum size of prey taken by the predator is a function of its own size or not. The method of Rapport

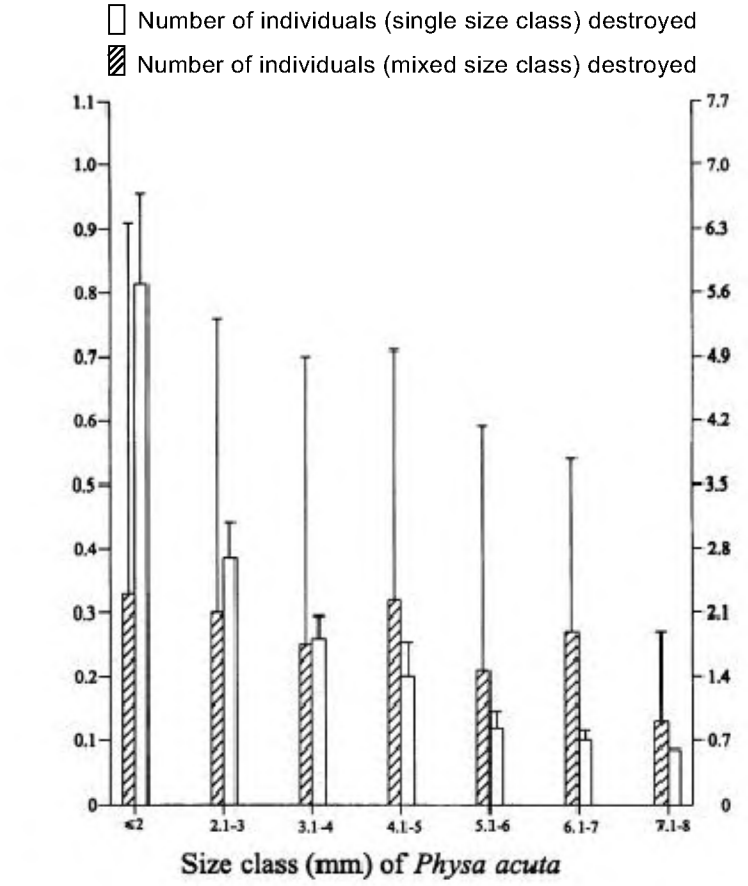

Figure 1. Daily rate (mean ± SE) of predation by a single *Glossiphonia weberi* irrespective of sizes when offered 15 *Phys acuta* individuals belonging to a single size class and mixed size classes experimentally, in laboratory. SE bar is omitted where value is zero.

and Turner[11] was followed to determine the preference coefficients in respect to the prey individuals supplied to the predators.

In Experiment I, *G. weberi* belonging to the size classes 2–3 and 4–5 mm failed to attack *P. acuta* larger than 2 and 5 mm in shell height respectively. In the remaining trials, the number of *P. acuta* destroyed by a *G. weberi* ranged from 0 to 11. Irrespective of size class, a *G. weberi* destroyed on an average, a maximum of 5.7 and a minimum of 0.6 *P. acuta* individuals belonging to the lowest and highest size classes respectively, daily. The mean rate of daily predation on prey individuals belonging to a size class by a *G. weberi* has been shown in Figure 1. Results of ANOVA test indicate that the size of the snails and leeches has significant effect on the rate of predation, though the size of *P. acuta* has bigger effect ($P < 0.001$, $F = 27.88$, df = 6) than that of *G. weberi* ($P < 0.001$, $F = 15.39$, df = 3).

In Experiment II, leeches belonging to the size classes 2–3, 4–5, 6–7 and 8–9 mm did not attack *P. acuta* larger than 2, 4, 7 and 7 mm respectively. In the remaining cases, marked variations in the rate of predation have been noted in respect to the size classes of predator and prey concerned (Figure 1). A *G. weberi*, irrespective of size, destroyed on an average 0.13–0.33 individuals belonging to seven size classes with a total of 1.81 *P. acuta* per day (Figure 1). In 32 trials, the frequency of attack by *G. weberi* to *P. acuta* belonging to different size classes varied to a great extent (Table 1), and such variations are statistically significant as is evident from the results of ANOVA tests ($P < 0.001$, $F = 7.46$, df = 4).

The rate of predation by a single *G. weberi*, irrespective of size, on individuals belonging to different size classes of *P. acuta* (Figure 1) differs significantly ($P < 0.05$, $F = 6.07$, df = 1) with treatment. Results of regression analysis (the equation $y = a + bx$) of the data presented in Table 1 indicate that the leeches belonging to 4–5 mm ($y = 10.34–1.78x$) and 6–7 mm ($y = 8.75–1.04x$) size classes preferred prey individuals belonging to the lower size classes, while those belonging to 8–9 mm ($y = 0.99 + 0.63x$) and 10–11 mm ($y = 1.15 + 0.72x$) size classes preferred *P. acuta* of larger size classes. However, the relative preference for *P. acuta* belonging to different size classes by a *G. weberi* varied to a great extent in respect to its own size (Table 2). Since relative preference coefficients[11] can range from 0 to – 2 for negative preference and from 0 to + 2 for positive preference, it is evident that the 4–5 mm *G. weberi* preferred 3.1–4 mm

Table 1. Frequency of predation by *Glossiphonia weberi* belonging to a definite size class on *Physa acuta* of a definite shell height. ($n = 32$ replicates, 15 *P. acuta* with different shell heights were exposed to *G. weberi* for 24 h in each trial)

Shell height (mm) of *P. acuta*	Size-class (mm) of *G. weberi*				
	2–3	4–5	6–7	8–9	10–11
1.1	3	9	15	1	0
1.5	0	7	3	0	0
1.9	0	4	5	1	4
2.1	0	6	8	1	2
2.5	0	13	3	1	1
2.9	0	2	4	2	4
3.1	0	6	5	6	6
3.5	0	2	4	1	1
3.9	0	4	2	0	3
4.1	0	0	8	8	2
4.5	0	0	3	4	6
4.9	0	0	7	10	3
5.1	0	0	5	4	9
5.5	0	0	3	4	5
5.9	0	0	0	2	5
6.1	0	0	0	7	8
6.5	0	0	1	5	8
6.9	0	0	0	1	3
7.1	0	0	0	0	7
7.5	0	0	0	0	6
7.9	0	0	0	0	7

Table 2. Relative preference coefficient for the size groups of *P. acuta* ($p_1 = \leq 2$ mm, $p_2 = 2.1–3$ mm, $p_3 = 3.1–4$ mm, $p_4 = 4.1–5$ mm, $p_5 = 5.1–6$ mm, $p_6 = 6.1–7$ mm, $p_7 = 7.1–8$ mm) by *G. weberi*

	p_1	p_2	p_3	p_4	p_5	p_6	p_7
For 4–5 mm *G. weberi*							
p_1		– 1.88	– 1.46	+ 1.2	+ 1.2	+ 1.2	+ 1.2
p_2			+ 0.42	+ 3.08	+ 3.08	+ 3.08	+ 3.08
p_3				+ 2.66	+ 2.66	+ 2.66	+ 2.66
p_4					0	0	0
p_5						0	0
p_6							0
For 6–7 mm *G. weberi*							
p_1		– 0.51	– 0.49	– 2.14	– 0.73	– 1.36	+ 0.81
p_2			+ 0.02	– 1.63	– 0.22	– 0.85	+ 1.32
p_3				– 1.65	– 0.24	– 0.87	+ 1.30
p_4					+ 1.41	+ 0.78	+ 2.95
p_5						– 0.63	+ 1.54
p_6							+ 2.17
For 8–9 mm *G. weberi*							
p_1		+ 0.29	– 0.08	– 1.84	– 1.05	– 2.29	+ 0.58
p_2			– 0.37	– 2.13	– 1.37	– 2.58	+ 0.29
p_3				– 1.76	– 0.97	– 2.21	+ 0.66
p_4					+ 0.79	– 0.47	+ 2.42
p_5						– 1.24	+ 2.63
p_6							+ 2.87
For 10–11 mm *G. weberi*							
p_1		– 0.16	– 0.45	– 0.63	– 1.94	– 2.85	– 4.32
p_2			– 0.29	– 0.47	– 1.78	– 2.69	– 4.16
p_3				– 0.18	– 1.49	– 2.4	– 3.87
p_4					– 1.31	– 2.22	– 3.69
p_5						– 0.91	– 2.38
p_6							– 1.47

P. acuta the most and 2.1–3 mm *P. acuta* the least. Likewise, a 6–7 mm *G. weberi* has almost equal preference for *P. acuta*, except the smallest and largest size classes. *G. weberi* belonging to 8–9 mm class though preferred ≤ 2 mm *P. acuta* over 2.1–3 mm individuals, snails of 7.1–8 mm were usually avoided by the leech in the presence of smaller ones. The leeches belonging to the largest size class preferred large-sized prey individuals most. Not a single *P. acuta* died in the control experiments.

From the results, it is evident that *G. weberi* is effective in destroying the *P. acuta*, though the effectiveness is dependent on the size of the prey individuals concerned. It seems that the predation interaction process is governed primarily by the ability of a leech to capture the snail for sucking body fluid and secondarily, on the possibility of getting sufficient number of capturable prey individuals amongst the so-called non-capturable individuals. A single leech individual, belonging to the size-classes 2–3, 4–5, 6–7, 8–9 and 10–11 mm, killed on an average 0.09, 1.66, 2.38, 2.61 and 2.81 *P. acuta* individuals respectively, daily. It is thus clear that the rate of predation also increases with the increasing size of the predator concerned. On the contrary, a *G. weberi* though consumed on an average almost equal number of *P. acuta* when exposed either to size class separately (killed 1.96 individuals) or to mixed size class populations (killed 1.81 individuals), attacked gradually less number of *P. acuta* with increasing shell height. This phenomenon is most probably related to the ability of the leeches to capture the prey individuals with respect to the avoidance responses developed by the prey snails against the predatory leeches[12].

G. weberi is efficient in searching the preferred size prey individuals from amongst the mixed population of *P. acuta*, as is evident from the fact that no predation was present on the snails belonging to certain specific size classes, offered separately. Though predation is expected to be confined within the preferred sizes of prey individuals, the said principle is flexible in cases of scarcity of prey individuals. Under such a situation, the predator would go on capturing individuals belonging to the less preferred size classes to ensure survival. This fact is evident from the data recorded on the frequency of attack on *P. acuta* with various shell heights by *G. weberi* in the 32 trials performed. This sort of prey selection further strengthen the idea that the leeches *G. weberi* are effective in killing a good number of *P. acuta* daily. But, in reality, with respect to the data recorded in this study, the number of *P. acuta* to be killed by *G. weberi* would be much more if group predation was allowed by releasing a number of leech individuals together in the container. Such predation has already been noted by Raut and Nandi[13] by this leech species on the snails *Lymnaea luteola*.

That glossiphoniid leeches prey upon the small oligochaetes, chironomid larvae and molluscs is a well-established fact[12–22]. Also, the effectiveness of the leeches *Helobdella punctato lineata* and *H. fusca* in controlling the vector snails *Biomphalaria alexandrina* and *Australorbis glabratus* is evident from the studies of Abdallah and Tawfik[23] and Chernin and co-workers[15]. The field trials of these leeches in connection with control of the vector snail populations of the species concerned, are yet to perform to ensure possibility of their use in the biological control programme. As the potential of *G. weberi* to destroy *P. acuta* is well established, they may be considered to be of use in the biological control programme of the sewage snails, *P. acuta*. However, in view of determining the ratio of predator and prey to ensure success in the control measure, a detailed account on the bioecology of *G. weberi* and *P. acuta* in nature is needed.

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