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COMPARATIVE STUDY OF THE FECUNDITY AND FERTILITY OF *Biomphalaria glabrata* (Say, 1818) AND *Biomphalaria straminea* (Dunker, 1848) IN A LABORATORY THROUGH SELF-FERTILIZATION AND CROSS-FERTILIZATION

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SUMMARY

The aim of this study was to compare the fecundity and fertility of *B. glabrata* and *B. straminea* by cross- and self-fertilization. To attain this objective, laboratory-raised strains of *B. glabrata* and *B. straminea* were used. The former originated from natural breeding grounds in the municipality Paulista, state of Pernambuco, Brazil. The latter originated from irrigation ditches in the municipality of Petrolândia, in the same state. Snail populations of *B. glabrata* and *B. straminea* were maintained for 240 days in laboratory. Their fecundity was evaluated by noting the number of egg-masses, eggs and eggs per mass. Their fertility was evaluated by the number of viable eggs and the hatching rate.

B. straminea was markedly more fecund than *B. glabrata* through cross- and self-fertilization, namely: greater egg-mass; higher egg production and more eggs per mass. Regarding fertility, there seemed to be no preferential period for occlusion to occur or a trend in the rhythm of producing viable eggs.

KEYWORDS: *Biomphalaria straminea*; *Biomphalaria glabrata*; Cross-fertilization; Self-fertilization.

INTRODUCTION

Studies under semi-natural and field conditions have revealed the competitive superiority of *B. straminea* over *B. glabrata*[3,4,5,6,8,9]. Among the factors involved, in addition to low susceptibility to infection by *S. mansoni* and greater resistance to desiccation, better dispersal capacity and higher vagility were noted for the former species[6,7,14,27]. However, the few existing studies comparing the reproducibility of these two species invariably attribute a higher fecundity rate to *B. glabrata*[1,2,15,19]. More recent observations of the fecundity of *B. straminea* compared to *B. glabrata* found a higher fecundity rate in *B. straminea*[26].

Studies comparing the fecundity of *B. glabrata* and *B. straminea* are rare, with that by PENIDO *et al*.[22] being particularly noteworthy. There is also a dearth of studies of self-fertilization, and those that exist mostly cover *B. glabrata,* attributing preference to self-fertilization[11,23]. Other authors attribute the preference of this species to cross-reproduction[10,20,25]. Despite studies indicating the competitive superiority of *B. straminea* over *B. glabrata*, little is known about the factors favoring the species. Among these factors, reproduction is one of the most important elements in the dynamics of this process. Consequently, the main purpose of this work is to compare the fecundity and fertility of *B. glabrata* and *B. straminea* under laboratory conditions, based on self-fertilization and cross-fertilization.

MATERIAL AND METHODS

The study was carried out comparing two snail species, *B. glabrata* from natural breeding places in Paulista and *B. straminea* from irrigation ditches in Petrolândia, both rural municipalities in the state of Pernambuco in Northeast Brazil.

Thirty adult snails belonging to each species were placed in separate aquariums, each containing ten liters of water, and were left for 48 hours to lay the egg-masses. After this period, the adult snails were removed and the egg-masses in the aquariums were left for the eggs to hatch. After 15 days, 30 young snails were separated of each species and placed in smaller aquariums or beakers as follows:

30 snails (*B. glabrata*) - 20 in Aquarium 1 and 10 in 10 individual beakers; 30 snails (*B. straminea*) - 20 in Aquarium 2 and 10 in 10 individual beakers. Each aquarium and beaker contained 2 and 0.2 liters of water respectively, in addition to a layer of clay blended with calcium carbonate in proportions of 10:1 and 5:2 respectively, according to PARAENSE & CORRÊA[21].

In order to check fecundity, the number of eggs per egg-mass, eggs per snail and egg-masses per snail were counted on a weekly basis. Fresh lettuce was given as food. The fertility of the eggs was assessed through the snail hatch rate and the percentage of fertile eggs. Variance analysis

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and the Student "t" test were applied to compare fecundity, while the Z Coefficient was used to compare fertility through two proportions between the species and different age groups[13].

RESULTS

FECUNDITY

Comparison of the number of egg-masses, eggs per snail and eggs per mass of *B. glabrata* and *B. straminea* raised in groups and individually: Table 1 gives the findings for the average of egg-masses and eggs per snail for two species raised in group. An average of 2.8 egg-masses per snail and 54.3 eggs per snail was obtained for *B. glabrata,* while *B. straminea* presented an average of 3.8 egg-masses per snail and 71.7 eggs per snail. The comparison of these two species indicates a significant difference ($p < 0.05$) in almost all age groups, with an exception of the 206 - 221 day group for egg-mass capsules per snail.

When the species were raised individually, an average of 1.0 egg-mass per snail and 8.1 eggs per snail was observed for *B. glabrata,* while *B. straminea* presented an average of 4.1 egg-masses per snail and 64.4 eggs per snail. The comparison between the averages for the number of egg-masses and eggs per snail in both species showed a significant difference ($p < 0.05$) in almost all age groups, with *B. straminea* superior to *B. glabrata.* (Table 1)

Table 1
Number of egg-masses per snail and eggs per snail (mean) laid by *Biomphalaria glabrata* and *Biomphalaria straminea* raised in groups and individually, by age group

Age group (days)	Egg-masses/snail *B. glabrata*		Egg-masses/snail *B. straminea*		Eggs/snail *B. glabrata*		Eggs/snail *B. straminea*	
	Group	Individual	Group	Individual	Group	Individual	Group	Individual
0-83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84-98	0.0	0.0	0.4	0.8	0.0	0.0	2.9	2.9
99-113	0.7	0.4	1.5	2.1	7.5	3.0	18.5	30.0
114-129	1.4	3.3	2.8	5.4	21.4	36.0	38.2	88.4
130-144	3.7	1.3	2.0	7.9	60.4	9.1	113.0	126.8
145-159	4.3	2.0	5.3	6.2	62.4	18.0	98.6	94.9
160-174	5.5	2.4	12.3	8.2	87.0	18.2	243.7	155.3
175-190	2.6	1.2	5.8	6.4	48.6	5.0	102.4	109.8
191-205	4.2	0.0	10.6	3.3	77.0	0.0	140.6	37.8
206-221	3.3	0.5	2.4	2.2	71.6	1.5	46.0	13.1
222-236	5.8	1.0	3.5	3.5	162.0	3.0	57.5	71.4
237-240	3.1	1.0	0.0	4.2	54.8	4.1	0.0	43.4
Overall means	2.8	1.0	3.8	4.1	54.3	8.1	71.7	64.4

Age group (days)	Egg-masses/ snail Test "t" *B. glabrata X B. straminea* (Group)	Eggs/ snail Test "t" *B. glabrata X B. straminea* (Group)	Egg-masses/ snail Test "t" *B. glabrata X B. straminea* (Individual)	Eggs/ snail Test "t" *B. glabrata X B. straminea* (Individual)	Egg-masses/ snail Test "t" *B. glabrata* Group X Individual	Eggs/ snail Test "t" *B. glabrata* Group X Individual	Egg-masses/ snail Test "t" *B. straminea* Group X Individual	Eggs/ snail Test "t" *B. straminea* Group X Individual
0-83	-	-	-	-	-	-	-	-
84-98	-2.83*	7.61*	2.83*	5.38*	-	-	-1.42	0.0
99-113	-2.36*	-9.59*	3.40*	14.86*	1.14	4.78*	-1.08	-6.28*
114-129	-3.05*	-9.76*	2.25*	14.86*	-3.44*	-7.36*	-3.50*	-17.46*
130-144	-3.22*	-17.72*	6.88*	31.93*	3.69*	20.22*	-1.90	-3.27*
145-159	-1.34*	-12.33*	4.64*	22.89*	3.54*	16.51*	-0.92	0.97
160-174	-6.89*	-37.03*	5.55*	32.72*	3.15*	22.09*	-3.07*	14.97*
175-190	-4.85*	-19.91*	5.90*	30.84*	2.55*	19.24*	-0.60	-1.81
191-205	-6.43	-18.10*	5.68*	19.42*	6.49*	27.76*	-5.29*	12.00*
206-221	1.60	9.84*	3.11*	9.38*	4.71*	26.06*	-0.19	-12.15*
222-236	2.61*	23.61*	3.53*	24.86*	6.02*	39.29*	-0.07	-3.55*
237-240	5.64*	23.43*	4.23*	17.70*	7.55*	-21.21*	-6.54*	-20.84*
Overall means	-	-	-	-	-	-	-	-

* Refers to the age groups showing significant differences ($p < 0.05$)

The average number of eggs per egg-mass in both species raised in groups was 14.5 for *B. glabrata* and 12.9 for *B. straminea*. There was a significant difference ($p < 0.05$) between the species in almost all age groups. *B. straminea* had average number of eggs per egg-mass equal to or higher than *B. glabrata,* and from the 191 - 205 age group onwards, this behavior was reversed (Table 2).

The average number of eggs per egg-mass was 4.6 and 12.3 for *B. glabrata* and *B. straminea,* respectively, in both species raised individually (Table 2). The average number of eggs per egg-mass for *B. straminea* was always higher than that for *B. glabrata* all age groups. Comparing the average figures for the number of eggs per egg-mass between the species shows a significant difference ($p < 0.05$) in all age groups.

The comparison of *B. glabrata* between both types of breeding conditions showed a significant difference ($p < 0.05$) for almost all age groups, with an average number of egg-masses per snail of 2.8 for the groups and 1.0 for those raised individually. We also found an average number of eggs per snail of 54.3 in the groups and 8.1 for the individually raised (Table 1).

The average number of eggs per egg-mass was always higher for *B. glabrata* in groups than for the individuals at all age groups studied. We found an average number of eggs per egg-mass of 14.5 and 4.6 for *B. glabrata* raised in groups and individually, respectively. With the exception of the 99-113 day age group under both breeding conditions, significant differences were noted ($p < 0.05$) in all the other age groups, favoring *B. glabrata* in groups (Table 2).

A comparison of the results for *B. straminea* given in Table 1 by age group shows that there was little difference in the average number of egg-masses per snail between *B. straminea* raised in groups and individually, at 3.8 and 4.1 respectively. A significant difference ($p < 0.05$) in the 114 - 129, 160 - 174, 191 - 205 and 237 - 240 day age groups. No significant difference was noted for the other age groups. The average number of eggs per snail of 71.7 and 64.4 raised in groups and individually showed a significant difference ($p < 0.05$) in almost all age groups.

The average number of eggs per egg-mass was 12.9 for *B. straminea* raised in groups and 12.3 when raised individually. In general, there was little difference between the two breeding conditions at the different age groups. A significant difference ($p < 0.05$) was noted between *B. straminea* raised in groups and individually in the 130 - 144, 145 - 159, 206 - 221 and 237 - 240 day age groups (Table 2).

FERTILITY

Hatch rate comparison: The average hatch rates obtained were 64.6% and 63.1% for *B. glabrata* and *B. straminea* respectively in groups, with a significant difference ($p < 0.05$) noted for *B. straminea* in all age groups except the 99 - 113 and 114-129 day groups (Table 3).

A hatch rate of 57.2% was observed for *B. glabrata* and 70.7% for *B. straminea* raised individually. The comparison of the hatch rate between the species by age group indicated a significant difference ($p < 0.05$) in almost all age groups, the exceptions being 114 - 129, 130 - 144, 206 - 240 and 237 - 240 days (Table 3).

A hatch rate of 64.6% for *B. glabrata* raised in groups and 57.2% for those raised individually was noted, with significant differences in almost all age groups (Table 3).

Table 2

Number of eggs per egg-mass (mean) laid by *Biomphalaria glabrata* and *Biomphalaria straminea* raised in groups and individually, by age group

Age group (days)	Eggs/egg-masses *B. glabrata*		Eggs/egg-masses *B. straminea*		Eggs/egg-masses			
					Test "t" *B. glabrata* X *B. straminea* (Group)	Test "t" *B. glabrata* X *B. straminea* (Individual)	Test "t" *B. glabrata* Group X Individual	Test "t" *B. straminea* Group X Individual
	Group	Individual	Group	Individual				
0-83	0.0	0.0	0.0	0.0	-	-	-	-
84-98	0.0	0.0	7.2	3.6	-4.17*	-11.54*	-	2.00
99-113	10.0	7.5	11.9	14.2	-0.92	-1.83	1.00	-1.77
114-129	15.2	10.9	13.6	16.3	1.01	-3.42*	2.52*	-1.96
130-144	16.2	7.0	18.8	16.0	-2.25*	-4.07*	4.56*	2.35*
145-159	14.2	9.0	18.4	15.3	-4.09*	-3.86*	3.73*	2.67*
160-174	15.6	7.5	19.8	18.8	-3.63*	-7.19*	4.05*	0.76
175-190	18.2	4.1	17.5	17.0	0.43	-5.21*	4.97*	0.31
191-205	18.2	0.0	13.2	11.2	5.36*	-8.73*	10.10*	1.45
206-221	21.5	3.0	19.0	5.7	1.09	-1.17*	3.79*	4.76*
222-236	27.8	2.0	16.4	20.0	6.05*	-6.76*	7.80*	-1.70
237-240	17.2	4.1	0.0	10.1	10.71*	-3.51*	5.76*	-8.45*
Overall mean	14.5	4.6	12.9	12.3	-	-	-	-

* Refers to the age groups showing significant differences ($p < 0.05$)

Table 3
Hatch rate (%): ratio between the number of snails hatched and number of fertile eggs and percentage of fertile eggs studied individually and in groups for *B. glabrata and B. straminea*, according to age group

Age group (days)	Hatch rate (%) Group	*B. glabrata* Individual	Hatch rate (%) Group	*B. straminea* Individual	% of fertile eggs Group	*B. glabrata* Individual	% of fertile eggs Group	*B. straminea* Individual
0-83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84-98	0.0	0.0	87.1	96.6	-	0.0	53.4	100.0
99-113	87.8	93.3	82.8	71.8	92.1	100.0	91.4	95.7
114-129	75.4	82.3	79.8	86.7	94.9	98.9	95.6	98.5
130-144	76.9	65.2	73.0	68.6	94.1	97.8	98.0	98.1
145-159	88.9	89.9	69.3	83.2	98.2	93.3	96.6	98.1
160-174	83.7	94.6	79.8	76.5	97.4	91.8	98.4	98.9
175-190	75.6	48.9	77.9	87.9	97.7	94.0	97.7	98.7
191-205	78.5	0.0	64.4	80.2	97.1	0.0	98.3	96.7
206-221	79.5	83.3	60.6	97.3	97.4	80.0	96.2	81.5
222-236	76.6	59.3	83.4	92.6	97.6	90.0	95.5	97.2
237-240	53.4	70.3	0.0	70.6	95.0	90.2	0.0	95.1
Overall means	64.6	57.2	63.1	70.7	80.1	70.0	76.7	88.2

Age group (days)	Hatch rate (%) Test "t" *B. glabrata X B. straminea* (Group)	Hatch rate (%) Test "t" *B. glabrata X B. straminea* (Individual)	Hatch rate (%) Test "t" *B. glabrata* Group X Individual	Hatch rate (%) Test "t" *B. straminea* Group X Individual	% of fertile eggs Test "t" *B. glabrata X B. straminea* (Group)	% of fertile eggs Test "t" *B. glabrata X B. straminea* (Individual)
0-83	-	-	-	-	-	-
84-98	-	-	-	-1.09	-	-
99-113	-1.45	4.07*	-1.03	3.28*	0.27	3.67*
114-129	-1.69	-1.89	-2.34*	-3.67*	-0.54	0.58
130-144	2.52*	-0.65	2.25*	2.38*	-5.29*	-0.19
145-159	13.63*	2.99*	-0.48	-8.59*	2.81	-2.91*
160-174	3.61*	8.67*	-5.44*	2.58*	-2.27	-3.46*
175-190	-2.93*	-9.29*	3.61*	-7.16*	0.0	-1.39
191-205	9.45*	-34.45*	-	-6.25*	-2.30*	-
206-221	8.94*	-1.28	-0.39	-14.20*	1.47	-0.14
222-236	-3.81*	-3.49*	1.82	-4.64*	2.30*	-1.30
237-240	0.0	-0.04	2.20*	-	-	-1.02
Overall means	-	-	-	-	-	-

* Refers to age groups showing significant differences ($p < 0.05$)

B. straminea had a mean hatch rate of 63.1% for the snails raised in groups and 70.7% for the individuals, a significant difference ($p < 0.05$) in all age groups with the exception of 84 - 98 days (Table 3).

Percentage of fertile eggs: We observed mean percentages of fertile eggs of 80.1% and 76.7% for *B. glabrata* and *B. straminea* raised in groups, respectively (Table 3). When the snails were raised individually, we found mean percentages of fertile eggs of 70.0% for *B. glabrata* and 88.2% for *B. straminea*. The comparison between the two species raised as groups and individuals indicated significant differences only in some age groups. The same occurred when intra-specific comparisons were carried out, implying that there would be no marked differences between them when raised in groups or individually. Although there were significant differences in the percentages of fertile eggs between the two species in the 130 -144, 145 - 159, 160 - 174, 191 - 205 and 222 - 236 day ages raised in groups and 99 - 113, 145 -159 and 160 - 174 days raised individually Table 3 shows that the percentage of fertile eggs for these two species was very similar.

DISCUSSION

FECUNDITY

Number of egg-capsules per snail: Laboratory studies of the fecundity of the *B. glabrata* present highly variable figures for the average number of egg-masses per snail. Studying this same species, BRUMPT[11] found 0.89 for individuals and 0.76 for paired snails, while REY[24] obtained 5.2 and 3.1 egg-masses per snail for individuals and 6.4 and 4.8 for grouped snails, assigning higher rates to snails with larger

diameters. SZUMLEWICZ[23] obtained an average of 0.47 and 0.67 egg-masses per snail for the pairs and individual snails respectively, while RITCHIE *et al.*[25] obtained different results, observing a higher number of egg-masses per snail when raised in pairs (1.7 egg-masses per snail) instead of keeping them separate (0.6 egg-masses per snail) or raised in groups (1.4 egg-masses per snail). BARRETO[10] observed 2.6 and 2.9 for the groups and 1.0 and 2.2 for the individuals. MAGALHÃES & CARVALHO[17] observed an average of 9.6 egg-masses per snail for the pairs over a period of 30 days, while KAWAZOE[16] noted an average of 12.8 over 20 days, also for the pairs.

In the course of this study, we noted through weekly observations that *B. glabrata* raised separately showed a drop in egg-mass production as the sample aged. The significant difference in the number of egg-masses per snail for cross-fertilization, compared to self-fertilization suggests that for *B. glabrata*, cross-fertilization remains preferential, confirming most of the data in the literature[10,24,25] .

For *B. straminea*, the average observed was 3.8 egg-masses per snail for the groups and 4.1 for the individuals. These findings indicate that the reproductive capacity of *B. straminea* does not drop either in groups or individually, although mention is made in the literature of the preference for cross-fertilization among the planorbids[20] .

Comparing *B. glabrata* with *B. straminea* individually, we also found a higher average for *B. straminea*, with 4.1 egg-masses per snail and 1.0 for *B. glabrata*. *B. straminea* was more fecund than *B. glabrata* throughout the entire period under study, favoring this species.

ROZEMBERG *et al.*[26] studied cross-fertilization over a 12-month period, finding an average of 0.9 egg-masses per snail for *B. straminea* and 0.69 for *B. glabrata*. In this study, larger numbers of egg-masses per snail were also noted for *B. straminea.* In general, *B. straminea* produced a larger number of egg-masses than *B. glabrata*, with its reproduction peaking during the 160-174 age group (Table 1).

Number of eggs per egg–mass: The earliest laboratory studies on the number of eggs per egg-mass were carried out by BRUMPT[11], obtaining 23.3 eggs per egg-mass for self-fertilization. REY[24] compared *B. glabrata* raised in groups and individually, finding 10.2 and 16.9 eggs per egg-mass and 10.9 and 18.2 eggs per egg-mass respectively. In this study, an average of 14.5 eggs per egg-mass was found for the groups and 4.6 eggs per egg-mass for the individuals, indicating the advantage of *B. glabrata* in cross-fertilization. The results found in this study for the individuals are close to those of BARRETO[10], who obtained an average of 5.3 and 4.7 eggs per egg-mass for the individuals and far higher averages for the group, at 7.4 and 7.5 eggs per egg-mass. In this study, the superiority of *B. glabrata* raised in groups is easily noted. The phenomenon of self-fertilization was found more widely in younger animals when compared to *B. glabrata* raised in groups.

We obtained averages for *B. straminea* of 12.9 and 12.3 eggs per egg-mass for both the groups and the individuals. The analysis in Table 2 shows that in general, *B. straminea* raised in groups and individually behaved similarly, with the exception of the 237 - 240 day age group, when no egg-masses where laid. As also noted in the eggs per snail ratio, *B. straminea* seems to undergo no alterations in terms of the production of egg-masses or eggs, indicating the high reproductive efficiency of this species.

Regarding comparison between eggs per egg-mass, JANSEN[15] carried out the first studies in populations of *B. glabrata* and *B. straminea*. He found an average of 12.0 eggs per egg-mass for *B. straminea* and 45.0 for *B. glabrata*. PENIDO *et al.*[22] studied the same species and noted averages of 13.2 and 24.5 eggs per egg-mass respectively. ROZEMBERG *et al.*[26] noted an average of 22.4 eggs per egg-mass for *B. straminea* and 13.08 eggs per egg-mass for *B. glabrata*. We found 14.5 eggs per egg-mass for *B. glabrata* and 12.9 eggs per egg-mass for *B. straminea,* in keeping with the first two authors.

According to ROZEMBERG *et al*.[26], her results may be due to the fact that the population of *B. straminea* at Picos (Piauí State) used in her experiment was more fertile than those in other *B. straminea* species raised in the laboratory under the same conditions. There were significant differences between *B. glabrata* and *B. straminea* raised individually, for almost all age groups, with an average of 4.6 for *B. glabrata* and 12.3 for *B. straminea* eggs per egg-mass, favoring *B. straminea* considerably with regard to self-fertilization. The production of egg-masses is not necessarily related to the production of eggs, and the reproductive superiority of *B. straminea* is largely due to a high production of eggs in a relatively small number of egg-masses, meaning that egg-laying activity is more efficiently exploited by this species for effective production of descendants.

Number of eggs per snail: Using a group of *B. glabrata* and varying the water volume, REY[24] found an average of 326.3 and 168.1 for the groups, and 24.6 and 87.6 for the individuals, which are relatively high averages. Raising snails in groups and individually, BARRETO[10] obtained an average of 47.0 and 42.0 eggs per snail for the groups and 18.1 and 33.0 eggs per snail for the individuals. Under individual conditions, RITCHIE *et al.*[25] obtained 23.0 eggs per snail for individuals and 66.0 eggs per snail for the groups over a period of eight months. The findings in this paper are quite consistent with those noted above.

Few data are available in the literature on *B. straminea* egg production. Table 1 presents the variation in the number of eggs per snail for *B. straminea* in groups and individually, showing that there was little variation in the number of eggs per snail, while in some age groups, *B. straminea* performed better as individuals than in groups. It seems that self-fertilization is not a limiting factor for this species, in terms of reproductive capacity.

Comparing the number of eggs per snail, between the *B. glabrata* and *B. straminea* species raised in groups, ROZEMBERG *et al.*[26] observed an average of 10.1 eggs per snail for *B. glabrata* and 23.9 eggs per snail for *B. straminea* over a period of one year. We found averages of 71.7 and 54.3 eggs per snail for *B. straminea* and *B. glabrata* respectively, in keeping with the observations of the above author (Table 1).

Looking at the two species raised individually, the superiority of *B. straminea* was quite clear compared to *B. glabrata*, for all age groups studied (Table 1).

These results confirm previous studies in laboratories by MICHELSON & DUBOIS[19], where *B. straminea* was found to be more fecund than *B. glabrata. B. straminea* has some specific characteristics, such as vagility, aggressiveness, resistance to desiccation, high rate of

locomotion and power of exploration, and great adaptability to environmental conditions[4,5,6]. Hence, all these characteristics are important if we relate them with the greater fecundity of *B. straminea*, explaining its greater success in the face of adverse factors. This being the case, self-fertilization is extremely favorable for the transmission of schistosomiasis, since it only takes a single individual in different types of biotopes to ensure the population density and prevalence, particularly in Northeast Brazil.

FERTILITY

Hatch rate: Looking at the hatch rate for planorbids belonging to the *Biomphalaria* genus raised in groups, BRUMPT[11] noted rates of 85-100%. In this paper, a hatch rate of 64.6% for *B. glabrata* in groups and 57.2% for the individuals was observed. Table 3 shows that significant differences were observed only for some age groups, without preference for individual or group. On the other hand, PARAENSE[20] found a hatch rate of 78.3% for *B. glabrata* in egg-masses obtained through self-fertilization. BARRETO[10] found hatch rates of 64% and 43% for individuals and 78.8% and 83.0% for the groups. The results obtained by that author are close to those found for the individual *B. glabrata*. The lowest hatch rate found in our project was 53.4% for the groups. These results are in accordance with those of REY[24], who noted a wide variation in egg fertility, depending on the batches used and the time of year. He observed a hatch rate for *B. glabrata* that ranged from 37.7% to 56.0%.

KAWAZOE[16] found an average of 95.8% for *B. glabrata* in pairs and MAGALHÃES & LUCCA[18] obtained a rate of 91.6% for *B. glabrata* in groups. In this paper, the hatch rates for *B. glabrata* in groups and individually show significant differences for some age groups, with a significant drop in the hatch rate for the groups is the last age group (Table 3). Whether raised in groups or individually, *B.straminea* showed variations in the average figures for all age groups studied. An overall average of 63.1% was obtained for the groups and 70.7% for the individuals, showing a significant difference for almost all age groups.

The overall average for the *B. glabrata* and *B. straminea* groups was 64.6% and 63.1% respectively. Table 3 shows certain variations in some age groups. Comparing *B. glabrata* with *B. straminea* raised individually, the same variations are noted. The overall average for the hatch rate was 57.2% for *B. glabrata* and 70.7% for *B. straminea*. The fertility rate for the two species seems to show that there are no age groups that are more successful at hatching.

Percentage of fertile eggs: BRUMPT[11] noted that certain egg-masses deposited by animals raised individually did not develop at all, retaining the same appearance several weeks later as when first laid. Otherwise, these sterile egg-masses seemed no different from the normal egg-capsules, and occurred at any time in the reproductive life of the snails, being interspersed with fertile laying activities. REY[24] found sterile eggs in fertile egg-capsules, although always at a very low rate, varying from zero to 2.7% for *B. glabrata*.

In this study, the percentage of fertile eggs recorded range from 92.1% to 98.2% for the *B. glabrata* groups, while the individuals varied from 80.0% to 100%. We found 53.4% to 98.4% for the *B. straminea* raised in groups and 81.5% to 100% for the individuals. The parameters studied for the two species presented little significant difference between the age groups. Consequently, there seems to be no trend for better periods to produce fertile eggs.

CONCLUSION

It was observed that *B. straminea* showed greater reproductive potential than *B. glabrata*, both when kept in groups and isolated. A comparison of the rates of intraspecific fecundity (average number of egg-masses/snail, eggs/snail and eggs/egg mass) suggests that self-fertilization as a reproductive strategy is more efficient in *B. straminea*, since the values found are very near those observed in the group snails. The fertility of the two species was relatively high, with no significant differences between them. This being the case, relating these observations with actions taken to control the intermediate hosts of *S. mansoni* points to the need for better follow-up of these measures not only based on seasonal climatic variations and transmission, but also fundamentally on studies of the population dynamics of each of the target species. Further studies are warranted, including with different samples of both species, to investigate other aspects of the fecundity and reproductive behavior that may be involved in competition for the space available and the occupation of new ecotopes.

RESUMO

Estudo comparativo da fecundidade e fertilidade de *Biomphalaria glabrata* (Say, 1818) e *Biomphalaria straminea* (Dunker, 1848) em laboratório por autofecundação e fecundação cruzada

O objetivo deste trabalho foi comparar a fecundidade e fertilidade de *Biomphalaria glabrata e Biomphalaria straminea* em condições de laboratório considerando a autofecundação e a fecundação cruzada. Durante oito meses, foram registrados em laboratório, o número de cápsulas ovíferas (desovas), ovos por cápsula ovífera, ovos totais, taxa de eclosão e percentual de ovos férteis dos moluscos criados individualmente e agrupados. Foram utilizados exemplares de *B. glabrata* de Paulista, PE e *B. straminea* oriunda de Petrolândia, PE. As observações foram divididas por faixa etária no periódo de 0 a 240 dias. Os resultados obtidos neste trabalho mostram que *B. straminea* apresenta um potencial reprodutivo maior do que *B. glabrata,* tanto para moluscos criados em grupo quanto para os criados individualmentes. A comparação dos valores encontrados para fecundidade dentro da mesma espécie sugere que a autofecundação como estratégia reprodutiva, é mais eficiente em *B. straminea*, já que as médias encontradas (número médio de capsúlas ovíferas e ovos por cápsula ovífera) são bem próximos aos valores observados nos moluscos mantidos em grupo. Com relação à fertilidade, parece não existir períodos favoráveis para a eclosão, não havendo também um ritmo e nenhuma tendência para a produção de ovos férteis.

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