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COMPETITIVE INTERACTIONS BETWEEN SPECIES OF FRESHWATER SNAILS. I. LABORATORY STUDIES: Ib. COMPARATIVE STUDIES OF THE DISPERSAL AND THE VAGILITY CAPABILITIES OF *BIOMPHALARIA GLABRATA* AND *BIOMPHALARIA STRAMINEA*

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Experiments reported in the current paper, carried out under semi-field conditions created in the laboratory, have shown that B. straminea *has competitive superiority when compared with* B. glabrata. *The former species has shown higher capabilities of both dispersal and vagility. In addition,* B. straminea *was able to compete sucessfully with* B. glabrata.

The interactions between populations of *Biomphalaria* spp were first quantitatively evaluated by Barbosa (1973) in an area near Recife, state of Pernambuco, Brazil. The phenomenon was tentatively interpreted as a case of natural competitive displacement of *B. glabrata* by *B. straminea.*

More recently, Michelson & Dubois (1979) have confirmed Barbosa's field observations showing that in the laboratory *B. straminea* ". . . appears to be the dominant species and, under certain circunstances may replace *B. glabrata*".

The word dispersal is accepted in the current paper in its restrictive sense as the means by which the components (individuals or their propagules) of a population migrate to an unoccupied territory. This type of movement is an active one and should not be obviously confounded with passive dispersal.

Vagility is here understood as an inherent movement power of a migratory species toward a territory already occupied by a different species. Thus, this migratory movement is linked to the aggressive component of a determined species.

Among others, three conditions are known to have decisive influence in the migratory animal movements: amount of resources, status of the population growth, and presence or absense of barriers. This explains the conditions that were offered to the snails during the current laboratory experiments.

The current paper deals with experiments on the interactions between populations of *B. glabrata* and *B. straminea.* Competitive studies were made on the dispersal and the vagility capabilities of the above snail species. The study on vagility was extended with the aim of testing the competitive interactions between the two populations.

METHODS

The general methodology used in this paper is the same already published (Barbosa et al., 1982).

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For all experiments a 3 m long channel was prepared in the usual way.

During the experiments of dispersal and vagility the snails were left without food. An obstacle made of small rolling stones was placed at the middle part of the channel, occupying 1/3 of its total length. The stones were disposed in a cluster, acting as an obstacle to be overcome by the spontaneous migrating movements of the snails. To favor this movement a water layer was left above the stones to assure that the diameter of both snail species was not a constraint in crossing the obstacle.

Both snail species utilized in the experiments belong to our laboratory bred stocks. *B. glabrata* was originated from the county of Paulista while *B. straminea* (PT, albino strain) was native of the county of Petrolandia, both in the state of Pernambuco, northeast of Brazil.

The number of the snail specimens in both experiments was proportionally calculated a little above the crowding level. This, at least theoretically, would stimulate the movements of the snail populations toward the occupation of a new territory.

The snails were counted at both ends of the channel during the period that dispersal and vagility experiments lasted, at intervals shown in Tables I and II. The *B. straminea* albino specimens were easily distinguished from the black skinned *B. glabrata* specimens.

TABLE I

Comparative dispersion capability of ***Biomphalaria straminea*** and ***Biomphalaria glabrata***

Hours after seeding	*B. straminea*: specimens passing the obstacle		*B. glabrata*: specimens passing the obstacle	
	No.	Per cent	No.	Per cent
7	6	1.47	2	0.67
24	23	5.65	8	2.70
31	37	9.09	8	2.70
48	56	13.76	12	4.05
55	62	15.23	12	4.05
72	73	17.94	16	5.40
79*	96*	23.59	17*	5.74
Total No. of snails	407	–	296	–

* $P < 0.0001$. ($z = 6.36$).

Experiment 1: Dispersal

In this experiment only one end of the channel was seeded with a snail species at each time. The channel opposite side was left free of snails, representing a territory under negative pressure to be occupied by the migrating snail population that had overcome the stones' obstacle. 296 specimens of *B. glabrata* were first seeded. *B. straminea* (407 specimens) were seeded after a period of few days during which the channel was emptied, washed and recovered in the ordinary way (Barbosa et al., 1982).

Experiment 2: Vagility and Competition

In this experiment both species were simultaneously introduced in the channel: 296 specimens of *B. glabrata* were placed in one end while 407 specimens of *B. straminea* occupied the opposite end of the channel.

TABLE II

Comparative vagility capability of *Biomphalaria straminea* and *Biomphalaria glabrata*

Hours after seeding	Snails invading other territory			
	S. straminea		*S. glabrata*	
	No.	%	No.	%
7	7	1.72	2	0.68
24	15	3.69	3	1.01
31	18	4.42	3	1.01
48	31	7.62	4	1.35
55	34	8.35	4	1.35
78*	59*	14.50	7*	2.36
Total No. of snails	407	–	296	–

* $P < 0.0001$. ($z = 5.44$).

After 78 hours period, at the end of the experiment on vagility, only few stones were left at the bottom of the middle part of the channel. At that moment, two snail collecting fixed stations were introduced and since then the channel was followed according to the method already described (Barbosa et al., 1982). Snail countings were made at ten weeks intervals. The sample size of the collecting stations represented 13.3 per cent of the total channel content. After the last snail counting (100 weeks) *B. glabrata* specimens were not seen at the regular channel inspections made during the following 10 days. Then, it was decided to empty the channel and examine its whole content for snails.

RESULTS

Clear-cut results were obtained in both experiments. Under population pressure, *B. straminea* has shown a much higher capability to migrate towards a new unoccupied territory than *B. glabrata* (Table I). 79 hours after the seeding of the snails the difference between the rates (17.8%) was greater than twice the standard-error of the difference (2.5 x 2).

In addition, *B. straminea* is a more vagile species than *B. glabrata* (Table II). At the end of experiment (78 hours) the difference between the rates (12.13%) was greater than twice the standard-error of the difference (2.8 x 2). Not only *B. straminea* had invaded more rapidly the territory occupied by *B. glabrata* but was also able to exclude this species from the whole channel at the period of 100 weeks (Table III and Fig. 1). At this time the thorough examination of the whole content of the channel has not shown any alive specimen of *B. glabrata*.

During the experiments snails of both species were seen passing over the stones. After the removal of the stones, specimens of both snail species were also found making their move through the empty small spaces left among the rolling stones.

COMMENTS

The competitive superiority of *B. straminea* over *B. glabrata* has been described in recent papers (Michelson & Dubois, 1979; Guyard & Pointier, 1979; Barbosa et al., 1981).

TABLE III

Competitive interactions between *Biomphalaria straminea* and *Biomphalaria glabrata*

Snail countings made at ten week intervals

Week	Number of snails in the sample	
	B. glabrata	*B. straminea*
10	33	33
20	35	25
30	13	27
40	19	95
50	11	117
60	7	108
70	5	119
80	1	120
90	3	97
100	0	112

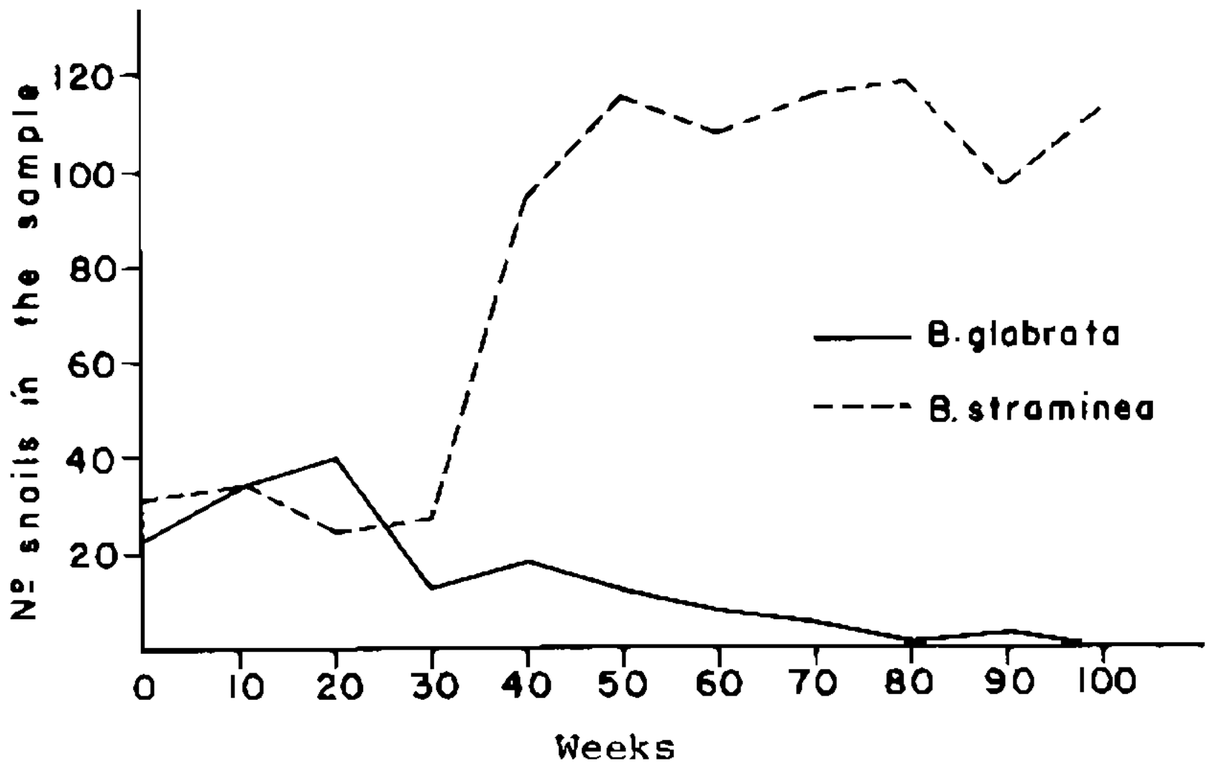

Fig. 1 – Interspecific competition between *Biomphalaria glabrata* and *B. straminea* under seminatural conditions. Recife, Brazil, 1981-1982.

The experiments presented in the current paper have clearly shown that *B. straminea* is the dominant species when confronts *B. glabrata*, being able to displace the later species after the period of 100 weeks. Fig. 1 shows a remarkable resemblance to the upper graph, figure 3, of Michelson & Dubois (1979). Dispersal and vagility experiments indicate that *B. straminea* is a more agressive species than *B. glabrata*, confirming the experiments reported by Michelson & Dubois (1979).

Field observations made very far apart, in northeastern Brazil (Barbosa, 1973; Barbosa et al., 1981) and in Martinique (Guyard & Pointier, 1979) completed by experiments carried out, under two different models, in U.S. laboratories (Michelson & Dubois, 1979) and in Brazil (current data), suggest that the competitive superiority of *B. straminea* over *B. glabrata* is a consistent phenomenon occurring between all the strains of both species that have so far being studied.

Data accumulated in the past few years show that more attention should be given to this subject. Barbosa et al. (1981) have already indicated ". . . the need for carrying out ecological and genetic studies in order to define the characteristics of the natural populations of the intermediate hosts of schistosomiasis".

RESUMO

Resultados do presente trabalho indicam a superioridade competitiva de *Biomphalaria straminea* sobre *Biomphalaria glabrata*. A primeira destas espécies, em experimentos conduzidos sob condições seminaturais desenvolvidas em laboratório, mostrou maior capacidade de dispersão e de vagilidade. Além disso, *B. straminea* foi capaz de eliminar *B. glabrata* em experiência de competição, no período de 100 semanas.

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