

EXPERIMENTAL INFECTION WITH SCHISTOSOMA MANSONI  
OF BIOMPHALARIA STRAMINEA FROM DIFFERENT  
PARTS OF THE NORTHEAST OF BRAZIL

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S U M M A R Y

In the western part of the State of Bahia *Biomphalaria straminea* and *B. glabrata* both occur, but in the majority of cases they do not share the same habitat. In the State of Ceará, however, *B. straminea* is the sole snail host of *Schistosoma mansoni*. In this survey, no naturally infected *B. straminea* was found among snails collected from Bahia and Ceará, evidently because of the very low infection rates. The susceptibility of laboratory-reared specimens to infection with a Puerto Rican strain of *S. mansoni* was then tested experimentally. In general, the snails showed very low susceptibility. The infection rates were 1.1% among snails from Redenção (Ceará); 2.3% in those from Pentecoste (Ceará); 2.9% in snails from São Desidério (Bahia), while they were very high among an albino strain (NIH) of *B. glabrata* used as control. Another group of *B. straminea* from São Desidério was exposed to a Bahian strain of *S. mansoni* and the infection rate was still very low (3.6%). Apparently, the very low susceptibility of *B. straminea*, despite high snail density, is correlated with moderate infection rates with *S. mansoni* among humans, as shown by the results of stool examinations conducted by SUCAM in the municipalities of Redenção and Pentecoste, in Ceará.

**KEY WORDS:** *Schistosoma mansoni*: Experimental infection — Snails  
*Biomphalaria straminea* — Northeast of Brazil

I N T R O D U C T I O N

In the northeast of Brazil two species of *Biomphalaria*, viz. *B. glabrata* and *B. straminea* are intermediate hosts of *Schistosoma mansoni*. *B. glabrata* is present in the coastal area and the adjacent regions of the interior. It is found in several localities in the states of Pernambuco, Alagoas, Bahia, Rio Grande do Norte, Paraíba and Sergipe. *B. straminea* has a wider distribution, and there are numerous habitats in Ceará. Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Bahia, and a few scattered habitats in Piauí and Sergipe. In the State of

Ceará, *B. straminea* is the only biomphalarid species present and is, accordingly, the sole intermediate host of *S. mansoni*.

It has been shown that in the State of Pernambuco *B. glabrata* is a more efficient snail host in the field than *B. straminea*, and that under laboratory conditions *B. glabrata* is much more susceptible to infection with *S. mansoni* than is *B. straminea* (BARBOSA et al.<sup>5</sup>; BARBOSA & COELHO<sup>3</sup>; COELHO & BARBOSA<sup>10</sup>). In the State of Ceará, BEZERRA<sup>8</sup> showed that natural infection with *S. mansoni* in *B. straminea*

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nea was very low. He found that one snail out of 1,228 (0.08%) was naturally infected in the municipality of Pacoti. On the other hand, ALENCAR<sup>1</sup> stated that in one locality, also in Ceará, there was 0 to 27.2% infection among 307 *B. straminea* examined. Other data on natural infection of *B. straminea* with *S. mansonii* are: in the State of Pernambuco, 0 to 0.57% among 4,220 snails (COUTINHO et al.<sup>11</sup>); 0 to 0.64% among 4,345 snails from four localities (BARBOSA et al.<sup>5</sup>); 0.05% among 33,461 snails from 10 localities (BARBOSA & COELHO<sup>3</sup>); 0.02% among 185,039 snails from 17 localities (BARBOSA & COELHO<sup>4</sup>); and 0.57% among 1,938 snails from one locality (LUCENA<sup>14</sup>). In the State of Pará, PARAENSE<sup>18</sup> found no infected snail among about 5,000 specimens examined. BARBOSA et al.<sup>7</sup> found 0 to 0.055% infected among 51,435 snails examined in the State of Goiás, and SOUZA et al.<sup>22</sup> found no infected snail among 640 specimens collected in Minas Gerais.

Only a few studies have been carried out on the experimental infection of *B. straminea*, mainly in the states of Pernambuco and Minas Gerais. In the present study no naturally infected *B. straminea* were found among snails collected from Bahia and Ceará. Experimental infection of laboratory-reared snails from both states was then carried out to test their susceptibility to infection with two strains of *S. mansonii*.

#### MATERIALS AND METHODS

Field collections of *B. straminea* were made from the reservoir at São Desidério, an artificial pond near Barreiras in western Bahia, and from irrigation canals at Pentecoste, and a stream at Redenção, both in Ceará. *B. glabrata* was collected in Bahia from a small stream above the reservoir at São Desidério and from banana plantation canals in Catolandia. The snails were maintained separately in the laboratory in New Orleans, and several generations were obtained. Among *B. glabrata* collected in Catolandia there was a 24.5% infection rate with *S. mansonii*. This strain of schistosome was maintained in white mice and was used in the experiments, in addition to a previously

established strain from Puerto Rico, also maintained in white mice.

All *B. straminea* and *B. glabrata* snails used in the exposure experiments were laboratory-reared progenies of the field-collected snails. The snails, of all sizes (ages), were each exposed to 5 to 10 miracidia of the schistosome. Shell vials 13 to 16 mm in diameter were used in the trials. Exposure was carried out at room temperature (23-25°C), and afterwards the snails were maintained in pans and plastic boxes. Various numbers of an albino NIH strain of *B. glabrata*, or a pigmented *B. glabrata* from a stream above the reservoir at São Desidério, were exposed under the same conditions as *B. straminea* and from the same miracidial pool. Before exposure the snails were washed several times to remove oligochaetes and other microorganisms which might influence the results of the susceptibility tests.

#### RESULTS

Examination of *B. straminea* collected in the field in Bahia and Ceará proved that they were all negative for cercariae of *S. mansonii*. There were 584 snails in 1974, and 415 in 1975, collected from the reservoir at São Desidério, and 172 from an artificial pond near Barreiras, in Bahia. There were also 462 collected at Redenção and 288 at Pentecoste in Ceará in 1979. Among the snails from Redenção there were six infected with a strigeid trematode, probably a parasite of birds in the area; such fork-tailed cercariae emerging from some snails might be confused with those of *S. mansonii* by an inexperienced laboratory technician.

In the experimental tests for the susceptibility of *B. straminea* the snails showed, in general, very low infection rates. Table 1 shows that the infection rates were 2.9% and 3.6% for snails from São Desidério using Puerto Rican and Bahian strains of *S. mansonii*, respectively. The infection rate was only 2.0% for the snails from a pond near Barreiras, using a Bahian strain of *S. mansonii* and 2.3% and 1.1% for snails from Ceará, using a Puerto Rican strain. On the other hand, for the five experiments *B. glabrata*, the control species, showed an infection rate which varied from 78.5% to 92.1%.

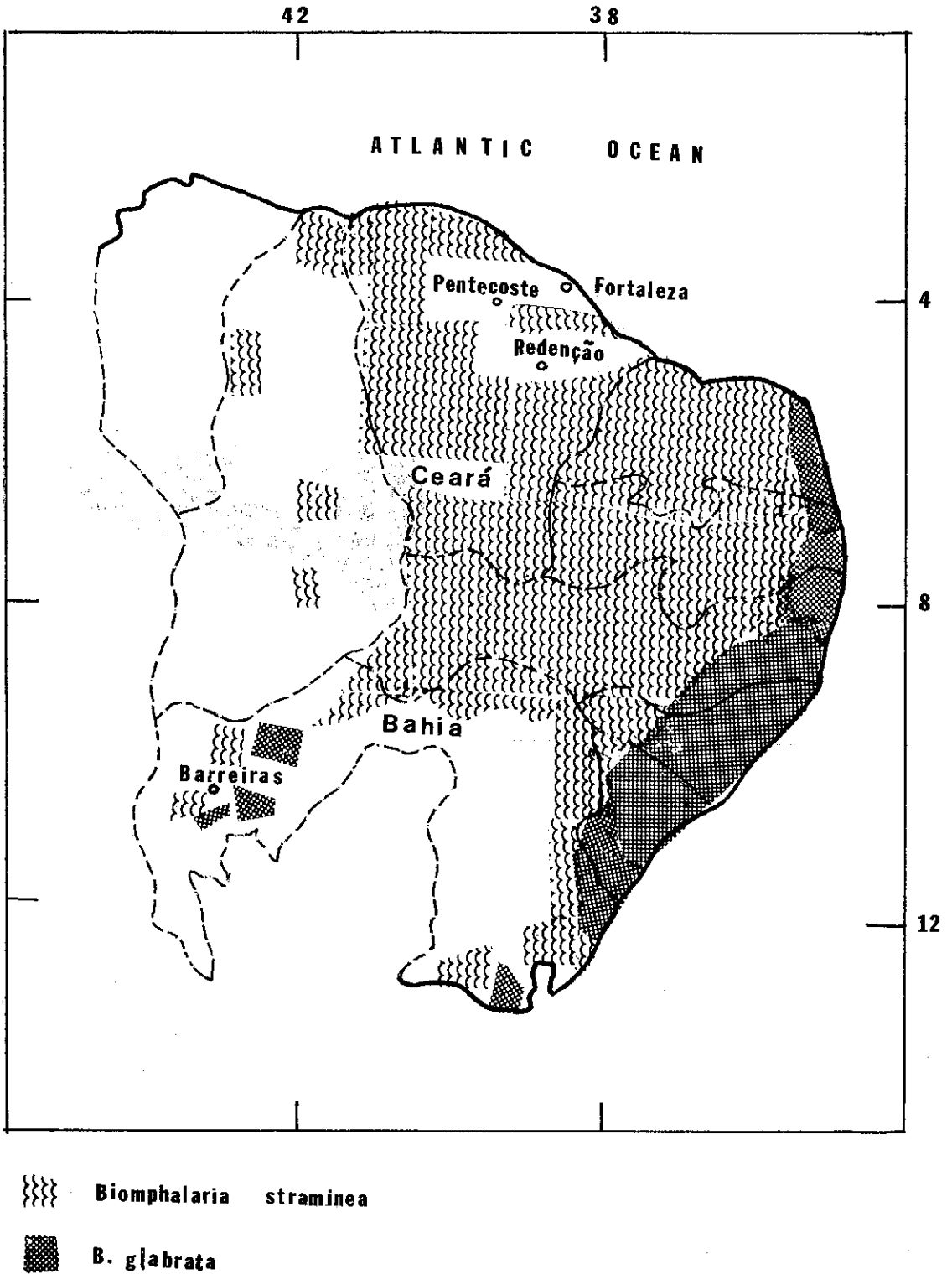


Fig. 1 — Map of the Northeast of Brazil, showing distribution of *Biomphalaria straminea* and *B. glabrata*, and the localities in Ceará and Bahia where collections of snails were made.

T A B L E I

Results of exposure of progenies of *Biomphalaria straminea*<sup>a</sup> from Bahia and Ceará, Brazil to miracidia of *Schistosoma mansoni*<sup>b</sup>

| Locality <sup>c</sup> | <i>Biomphalaria straminea</i> |          |          |            | <i>B. glabrata</i> (control) |          |          |            | Strain of <i>S. mansoni</i> <sup>d</sup> |
|-----------------------|-------------------------------|----------|----------|------------|------------------------------|----------|----------|------------|--|
|                       | No. snails                    |          | Infected | % infected | No. snails                   |          | Infected | % infected |  |
|                       | Exposed                       | Survived |          |            | Exposed                      | Survived |          |            |  |
| Bahia                 |                               |          |          |            |                              |          |          |            |  |
| SD                    | 337                           | 309      | 9        | 2.9        | 30 <sup>e</sup>              | 30       | 27       | 89.9       | PR                                       |
| SD                    | 461                           | 420      | 15       | 3.6        | 25 <sup>f</sup>              | 24       | 20       | 83.3       | BA                                       |
| NB                    | 305                           | 296      | 6        | 2.0        | 40 <sup>f</sup>              | 38       | 35       | 92.1       | BA                                       |
| Ceará                 |                               |          |          |            |                              |          |          |            |  |
| P                     | 233                           | 217      | 5        | 2.3        | 30 <sup>e</sup>              | 28       | 24       | 85.7       | PR                                       |
| R                     | 385                           | 352      | 4        | 1.1        | 45 <sup>e</sup>              | 42       | 33       | 78.5       | PR                                       |

<sup>a</sup> Snails of all sizes (ages)

<sup>b</sup> Exposure and maintenance temperature, 23-25°C

<sup>c</sup> SD, Sao Desiderio; NB, near Barreiras; P, Pentecoste; R, Redenção

<sup>d</sup> PR, Puerto Rican, BA, Bahian

<sup>e</sup> Albino NIH strain

<sup>f</sup> From stream above reservoir, São Desidério, Bahia

## DISCUSSION

Studies on the natural and experimental infection of *B. straminea* in Ceará are of interest because this biomphalarid species is the only intermediate host of *S. mansoni* in this part of Brazil. No natural infection with *S. mansoni* was encountered in the snails collected from Ceará and Bahia, evidently because of the low or moderate human infection rates.

The western area of Bahia (centered around the city of Barreiras, where *B. straminea* and *B. glabrata* were collected in this study) is a new distribution record for this part of Brazil. Previously, the two biomphalarid species have been reported only for the eastern (coastal and near-coastal) area of Bahia, along the Atlantic Ocean (PARAENSE<sup>19,20</sup>).

In the present study experimental exposure of *B. straminea* from Bahia and Ceará to miracidia of a Puerto Rican strain of *S. mansoni* to test its susceptibility to this schistosome showed very low infection rates (1.1% to 2.9%). The susceptibility was still low when the snails from Bahia were exposed to a Bahian (Cato-

landia) strain of the schistosome. A few susceptibility tests by other investigators also yielded low infection rates. BARBOSA & COELHO<sup>3</sup> obtained 22 positive snails out of 344 survivors (3.6%) from Pernambuco; COELHO<sup>9</sup> found two positive snails among 36 survivors (5.5%) from Pernambuco; BARBOSA & FIGUEIREDO<sup>6</sup> found 86 out of 4,206 survivors positive (1.7%) from Ceará, none from Pentecoste or Redenção; 26/1,490 (1.5%) from Rio Grande do Norte, and 42/1,527 (2.2%) from Alagoas; FREITAS et al.<sup>12</sup> found 3/500 (0.6%) from Minas Gerais positive; GERKEN et al.<sup>13</sup> obtained infections in 11/1,394 (0.79%) of snails from Lagoa Santa and Lagoa dos Mares, Minas Gerais; and PARAENSE<sup>18</sup> obtained infections in 3/28 (10.7%) snails from Amazonas. The above Authors used *S. mansoni* strains from Pernambuco, Minas Gerais, Pernambuco and Minas Gerais, respectively. Later, SOUZA et al.<sup>22,23</sup> obtained up to 11% infection when they exposed *B. straminea* from Minas Gerais to one or more of three strains of *S. mansoni* from Minas Gerais or São Paulo.

Apparently, the very low susceptibility of *B. straminea* is correlated with moderate in-

fection rates with *S. mansoni* among humans. The prevalence of human schistosomiasis in 1978 was up to 40.1% in the municipality of Redenção and up to 20.76% in the municipality of Pentecoste. These infection rates are based on the results of stool examinations conducted by SUCAM (Superintendencia de Campanhas de Saúde Pública) of the Brazilian Ministry of Health, of a moderate or a large sample of the residents in several infected localities in each of the two municipalities in Ceará. For example in the town of Redenção with a population of 3,002 inhabitants, 249 were positive out of 755 examined (32.9%); in Canta Galo with a population of 601, 26 were positive out of 66 examined (39.4%), and in Barra Nova de Fora with a population of 270, 26 were positive out of 53 examined (6.17%); in Bairro Ipase with a population of 1,542, 115 were positive out of 554 examined (20.76%).

In the municipality of Pentecoste there is a reservoir behind a dam on the river Curu and an irrigation scheme with a complex system of irrigation canals which, together with the reservoir serve as ideal habitats for *B. straminea*. In 1964 ROUQUAYROL and CANTIDIO found only a 0.7% infection rate with *S. mansoni* in the valley of the river and called attention to the significance of development of agriculture under irrigation in aggravating the prevalence of schistosomiasis in the area, which has been found to be true on the basis of subsequent examinations (ALENCAR et al<sup>2</sup>).

During the senior Author's observations in western Bahia it was noticed that *B. straminea* competes in certain natural habitats with *B. glabrata* and usually eliminates the latter species, which shows a much higher natural and experimental susceptibility to infection with *S. mansoni*. As a result of this competition the two species, in the majority of cases, do not share the same habitat. MICHELSON & DU-BOIS<sup>17</sup> also showed this interspecific competition to occur under laboratory conditions. However, it is unwise to agree with some workers who advocate this competition by *B. straminea* as a biological means of controlling populations of the highly susceptible *B. glabrata*. This is because the poor natural and experimental susceptibility of *B. straminea*, as demonstrated in the present study, is usually correlated with moderate infection rates of schistosomiasis among the human population.

The suggested introduction into a certain waterbody of the competitor snail (*B. straminea*) would mean the replacement of a highly susceptible species (*B. glabrata*) by another species, *B. straminea*, which is still an effective transmitter of the disease, despite its very low susceptibility to infection with *S. mansoni*.

Among the snail hosts of other human species of schistosomes, *Bulinus (Bulinus) truncatus*, intermediate host of *S. haematobium*, always shows very low (less than 1%) natural infection rates in countries of the Middle East (MALEK<sup>16</sup>). Like *B. straminea*, these low infection rates are correlated with moderate or high infection rates with schistosomiasis among humans. However, *B. (B.) truncatus* differs from *B. straminea* in the fact that, in spite of very low natural infection rates, *B. (B.) truncatus* shows moderate susceptibility in the laboratory, for example between 21.4% and 39.6% in the case of a Sudanese strain of the snail when exposed to a Sudanese strain of *S. haematobium* (MALEK<sup>15</sup>).

## RESUMO

**Infecção experimental com cepas de *Schistosoma mansoni*, em amostras de *Biomphalaria straminea* de algumas localidades do Nordeste do Brasil**

Na região oeste do Estado da Bahia habitam caramujos das espécies *Biomphalaria glabrata* e *B. straminea* os quais, em geral, não coexistem no mesmo habitat. No Estado do Ceará os únicos hospedeiros intermediários de *Schistosoma mansoni* são da espécie *B. straminea*. Neste levantamento não foram detectados *B. straminea* naturalmente infectados, nem no Ceará e Bahia. Espécimes de *B. straminea*, tendo *B. glabrata* como controle, foram utilizados experimentalmente a fim de se determinar sua suscetibilidade frente a amostras portorriquenhas de *S. mansoni*. Os referidos *B. straminea* mostraram baixa suscetibilidade apresentando as seguintes taxas de infecção: 1,1% dentre os caramujos de Redenção-Ceará; 2,3% naqueles provenientes de Pentecoste-Ceará e 2,9% dentre os espécimes coletados em S. Desidério na Bahia. O lote controle, *B. glabrata* amostra NIH, apresentou elevadas taxas de in-

fecção frente àquela amostra de *S. mansoni*. Além desta cepa portorriquenha utilizou-se também uma cepa bahiana de *S. mansoni* cujo teste experimental com *B. straminea* de São Desidério também demonstrou baixas taxas de infecção, numa média de 3,6%. Aparentemente, a baixa suscetibilidade de *B. straminea* ao *S. mansoni*, a despeito da elevada densidade destes caramujos, está em correlação com a prevalência de esquistossomose nas muito elevada no Ceará como mostram os resultados de levantamentos coproscópicos realizados pela SU-CAM.

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