

SUSCEPTIBILITY OF THE SNAIL INTERMEDIATE HOSTS OF SCHISTOSOMIASIS FROM NORTHEASTERN BRAZIL TO THE INFECTION WITH *SCHISTOSOMA MANSONI*

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SUMMARY

Snail host strains of schistosomiasis collected in Northeastern Brazil were submitted to infection experiments with *Schistosoma mansoni*. For these studies, 16 strains of *Biomphalaria glabrata* and 223 strains of *B. straminea* were utilized. Results showed that *B. straminea* was consistently a poor vector. Adaptations between *B. glabrata* and local strains of *S. mansoni* were demonstrated.

INTRODUCTION

It has been shown by BARBOSA and coworkers^{3, 4, 7} that the well known snail intermediate hosts of schistosomiasis in Northeastern Brazil differ a great deal in their susceptibility to the infection with *Schistosoma mansoni*. It was demonstrated that *Biomphalaria glabrata* under laboratory conditions was much more susceptible to the infection than *B. straminea*. In the field *B. glabrata* was also proved to be a more efficient vector.

However, susceptibility to the infection in the snails is not only a condition of intra-specific character. BARBOSA & BARRETO² demonstrated that the strain of *B. glabrata* from Salvador (Bahia, Brazil) was much less susceptible to the infection with *S. mansoni* than the strain of the same species from Pernambuco. It should also be pointed out that susceptibility to the infection depends on conditions related to the snail as well as to the parasite.

The present study was designed to make known in as much detail as possible the comparative susceptibility of the strains of

the snail hosts of schistosomiasis mansoni living in extensive areas of Northeastern Brazil. In a previous paper by BARBOSA & FIGUEIREDO⁵ the geographical distribution of those snails was presented.

MATERIAL AND METHODS

Part of the material used in a previous paper by BARBOSA & FIGUEIREDO⁵ was utilized in the present work for the infection experiments: 16 strains of *B. glabrata* and 223 strains of *B. straminea*. Snails were collected in the whole Northeastern region during three years (September 1964 to August 1967) and sent alive to the laboratory.

Variable number of snails were exposed to ten miracidia each of a strain of *S. mansoni* from Pernambuco. A limited number of infection experiments were made utilizing other *S. mansoni* strains.

Snails exposed to the infection were kept in aerated tanks and examined for cercariae

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by exposition to light beginning the 20th day after the infection. Negative snails were crushed after the 50th day of the infection and examined for sporocysts.

In all the infection experiments a highly susceptible strain of *B. glabrata* (from Paulista, Pernambuco) was used as control for testing the efficiency of the miracidia. When the infection in the control snails was lower than 90 per cent the experiment was repeated or discarded.

RESULTS

Infection rates obtained in *B. glabrata* exposed to the miracidia of *S. mansoni* from

Pernambuco are shown in Table I for four Brazilian states. This snail species was not found in the State of Ceará.

Tables II to VI show the infection rates of *B. straminea* exposed to *S. mansoni* for five states, respectively, Ceará, Rio Grande do Norte, Paraíba, Pernambuco and Alagoas.

Results of the exposition of *B. glabrata* and *B. straminea* to local strains of *S. mansoni* in comparison to the infection with the strain of the same parasite from the state of Pernambuco can be seen in Tables VII and VIII.

TABLE I
Results of the exposition of *Biomphalaria glabrata* to miracidia of a strain of *S. mansoni* from the State of Pernambuco

State	County	Snails exposed			
		no.	no. alive after 20 days	infected	
				no.	per cent
Rio Grande do Norte	Pureza	100	90	63	70.0
Paraíba	Alhandra	50	21	20	95.2
	João Pessoa (Varadouro)	93	90	4	4.4
	João Pessoa (Graças)	100	66	3	4.5
Pernambuco	Correntes	86	64	0	0.0
	Garanhuns	100	78	15	19.2
	Paulista	100	88	88	100.0
Alagoas	Anadia	30	27	0	0.0
	Capela	62	19	0	0.0
	Coruripe	60	57	19	33.3
	Junqueiro	30	27	12	44.4
	Maragogi	40	38	23	44.4
	Piaçabuçu	100	93	37	39.8
	Quebrangulo	100	72	20	27.8
	São José da Lage	40	36	4	11.1
Viçosa	50	47	0	0.0	

TABLE II

Results of exposition of *Biomphalaria straminea* from the State of Ceará to miracidia of a strain of *S. mansoni* from the State of Pernambuco

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Aracaú	60	38	0	0.0
Acopiara	50	26	0	0.0
Antonina do Norte	100	85	0	0.0
Aquiraz	63	50	0	0.0
Aracati	45	42	0	0.0
Araçoiaba	100	62	0	0.0
Araripe	50	37	0	0.0
Arneiroz	45	25	1	4.0
Assaré	43	39	0	0.0
Baixio	41	35	0	0.0
Barbalha	81	81	11	13.6
Baturité	201	144	10	6.9
Bôa Viagem	48	43	0	0.0
Brejo Santo	50	46	3	6.5
Campos Sales	100	87	0	0.0
Cariré	100	87	0	0.0
Cascavel	51	47	0	0.0
Caucaia	100	89	0	0.0
Cedro	100	72	8	11.1
Coreaú	40	29	0	0.0
Crato	100	82	0	0.0
Fortaleza	50	46	9	19.6
General Sampaio	40	33	1	3.0
Granja	39	30	0	0.0
Iguatu	100	87	4	4.6
Ipu	40	32	0	0.0
Itaiçaba	70	63	0	0.0
Itapagé	60	56	0	0.0
Itapipoca	78	67	4	5.9
Itapiuna	78	67	0	0.0
Jardim	90	72	0	0.0
Jati	120	100	0	0.0
Juazeiro do Norte	110	89	0	0.0
Jucás	100	70	1	1.4
Lavras da Mangueira	100	58	0	0.0
Maranguape	54	48	10	20.8
Massapê	40	30	0	0.0
Mauriti	100	97	0	0.0
Milagres	62	43	0	0.0
Missão Velha	94	60	0	0.0
Mombaça	35	32	1	3.1
Morada Nova	87	77	0	0.0
Morrinhos	123	105	0	0.0
Nova Russas	100	70	0	0.0
Orós	40	32	0	0.0
Pacatuba	100	79	0	0.0
Parambu	100	100	1	1.0
Penaforte	100	87	0	0.0
Piquet Carneiro	100	70	5	7.1
Porteiras	150	147	2	1.4
Quixadá	100	85	6	7.0
Quixeramobim	100	74	0	0.0
Quixeré	100	100	0	0.0
Redenção	183	139	5	3.6
Santana do Cariri	100	88	1	1.1
São Benedito	100	92	1	1.1
São Gonçalo do Amarante	61	59	0	0.0
Senador Pompeu	117	87	1	1.1
Sobral	100	54	0	0.0
Solonópole	40	34	0	0.0
Tabuleiro do Norte	60	57	0	0.0
Uruburetama	60	57	0	0.0
Uruoca	50	35	1	2.9
Várzea Alegre	55	55	0	0.0

TABLE III

Results of the exposition of *Biomphalaria straminea* from the State of Rio Grande do Norte to miracidia of a strain of *S. mansoni* from the State of Pernambuco

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Acari	43	32	0	0.0
Açu	55	51	0	0.0
Alexandria	45	35	1	2.9
Angicos	100	89	0	0.0
Apodi	20	20	0	0.0
Augusto Severo	15	11	0	0.0
Caçara do Rio do Vento	50	37	0	0.0
Caraúbas	50	44	0	0.0
Cerro Corá	32	32	0	0.0
Currais Novos	45	33	3	9.0
Goianinha	100	78	0	0.0
Ipueira	57	57	1	1.8
Itaú	83	78	0	0.0
Jardim do Seridó	50	26	2	7.7
Luiz Gomes	40	38	0	0.0
Macaíba	10	6	1	16.7
Macau	85	67	1	1.5
Martins	100	96	1	1.0
Nova Cruz	40	34	0	0.0
Parelhas	60	53	0	0.0
Patu	86	76	0	0.0
Pau dos Ferros	26	25	0	0.0
Portalegre	10	9	1	11.1
Pureza	100	82	4	4.9
Santa Cruz	55	52	3	5.8
São José de Mipibu	100	84	3	3.6
São José do Campestre	50	36	0	0.0
São Miguel	138	103	4	3.9
São Tomé	38	30	0	0.0
Sítio Nôvo	100	76	1	1.3

COMMENTS

Data presented in this paper confirm that *B. straminea* as first shown by BARBOSA and coworkers^{3,7} for limited areas in Pernambuco State, is consistently a poor vector of schistosomiasis mansoni in the whole Northeastern region. When the strains of *B. straminea* were exposed to miracidia of the strain of *S. mansoni* from Pernambuco near 58 per cent of them did not take the infection. Only in 15 cases the infection rates were 10 per cent or over, reaching 34.5 in Pilar (State of Paraíba) and 35.3 per cent in Girau do Ponciano (State of Alagoas), which are unusual figures for *B. straminea*. Other "high" infection rates were recorded

for Maranguape, 20.8 (State of Ceará), followed by Fortaleza, 19.6 (Ceará), Rio Tinto, 18.7 (State of Paraíba) and so on.

The exposition of limited number of strains of *B. straminea* to the local strain of *S. mansoni* gave similar results to those obtained with the Pernambuco strain of the parasite.

Susceptibility of *B. glabrata* to the miracidia of *S. mansoni* from Pernambuco varied a great deal. About 27 per cent of the snail strains did not take the infection. Infection rates ranged from 4.4 to 100 per cent.

PARAENSE & CORRÊA⁸ observed no relationship between the degree of susceptibility of *B. glabrata* to *S. mansoni* and the distance separating the snail populations. The

TABLE IV

Results of the exposition of *Biomphalaria straminea* from the State of Paraíba to miracidia of a strain of *S. mansoni* from the State of Pernambuco

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Alagoa Grande	100	64	6	9.4
Alagoa Nova	22	22	1	4.5
Araçagi	100	66	0	0.0
Boqueirão	80	75	0	0.0
Brejo do Cruz	8	8	0	0.0
Cabaceiras	100	76	0	0.0
Cajazeiras	30	29	0	0.0
Campina Grande	100	96	0	0.0
Catolé da Rocha	15	11	2	18.2
Coremas	100	55	1	1.8
Cruz do Espírito Santo	92	87	0	0.0
Esperança	75	52	0	0.0
Guarabira	156	138	0	0.0
Ingá	60	57	0	0.0
Itabaiana	61	47	4	8.5
Itaporanga	61	46	2	4.3
João Pessoa	200	153	0	0.0
Juazeirinho	50	46	0	0.0
Mamanguape	100	74	0	0.0
Monteiro	100	76	0	0.0
Patos	100	35	0	0.0
Pedra Lavrada	80	70	0	0.0
Piancó	65	60	0	0.0
Picuí	70	50	0	0.0
Pilar	50	29	10	34.5
Pilões	100	50	4	8.0
Pirpirituba	100	68	6	8.8
Pombal	100	48	0	0.0
Rio Tinto	230	48	9	18.7
Santa Luzia	60	46	8	17.4
São João do Cariri	50	29	0	0.0
São José de Piranhas	140	120	5	0.0
Sapé	100	82	13	15.9
Solânea	120	110	0	0.0
Sousa	65	45	0	0.0
Taperoá	40	24	4	16.7
Teixeira	100	65	0	0.0
Umbuzeiro	101	29	1	3.5

same conclusion can be drawn from the data presented in this paper.

However, when *B. glabrata* was exposed to the local strains of *S. mansoni* higher infection rates were obtained. This was particularly evident in the case of the snails from Viçosa (State of Alagoas).

Differences in susceptibility must be related to the genotypes of the snail populations or of the schistosome strains. The phenome-

non can be explained by and adaptation between the snail and a local strain of *S. mansoni*, as it was first suggested by COELHO⁶ and confirmed by PARAENSE & CORRÊA⁹ in regard to *B. tenagophila* from Southern Brazil.

Attention should be called on the epidemiological importance of the data presented in this as well as in a previous paper⁵.

BARBOSA, F. S. & FIGUEIREDO, T. — Susceptibility of the snail intermediate hosts of schistosomiasis from Northeastern Brazil to the infection with *Schistosoma mansoni*. *Rev. Inst. Med. trop. São Paulo* 12:198-206, 1970.

TABLE V

Results of the exposition of *Biomphalaria straminea* from the State of Pernambuco to miracidia of a strain of *S. mansoni* from that same State

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Afogados de Ingazeira	150	54	0	0.0
Afrânio	33	33	0	0.0
Agrestina	220	176	3	1.7
Água Preta	100	88	1	1.1
Águas Belas	14	11	0	0.0
Aliança	100	70	2	2.8
Araripina	100	86	4	4.7
Arcoverde	100	92	0	0.0
Barreiros	50	45	1	2.2
Belém de Maria	130	61	0	0.0
Belém do São Francisco	74	51	0	0.0
Belo Jardim	150	112	0	0.0
Bezerros	100	96	0	0.0
Bodocó	100	91	0	0.0
Bom Conselho	310	227	10	4.4
Bom Jardim	100	100	0	0.0
Buíque	40	29	2	6.9
Cachoeirinha	100	54	1	1.9
Canhotinho	71	61	0	0.0
Carnaíba	100	88	0	0.0
Carpina	145	98	0	0.0
Caruaru	100	47	1	2.1
Catende	45	45	0	0.0
Escada	63	49	0	0.0
Exu	100	87	4	4.6
Fazenda Nova	100	90	9	10.0
Flôres	100	81	2	2.5
Floresta	73	43	0	0.0
Garanhuns	70	58	0	0.0
Gloria do Goitá	100	68	0	0.0
Goiana	40	35	6	17.1
Gravatá	100	62	0	0.0
Ibimirim	100	72	0	0.0
Inajá	90	48	0	0.0
Itapetim	40	39	0	0.0
Jaboatão	100	94	6	6.4
Lagoa dos Gatos	100	47	0	0.0
Lajedo	100	70	5	7.1
Mirandiba	29	29	0	0.0
Moreno	100	71	0	0.0
Orobó	100	81	0	0.0
Ouricuri	100	72	1	1.4
Parnamirim	77	72	0	0.0
Passira	200	86	8	9.3
Paudalho	60	51	0	0.0
Pedra	100	69	2	2.9
Pesqueira	100	70	4	5.7
Petrolândia	45	40	1	2.5
Petrolina	100	86	0	0.0
Ribeirão	80	41	1	2.4
Salgueiro	110	108	0	0.0

Continua

BARBOSA, F. S. & FIGUEIREDO, T. — Susceptibility of the snail intermediate hosts of schistosomiasis from Northeastern Brazil to the infection with *Schistosoma mansoni*. *Rev. Inst. Med. trop. São Paulo* 12:198-206, 1970.

Continuação

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Sanharó	100	91	1	1.1
Santa Cruz do Capibaribe	124	82	0	0.0
Santa Maria da Boa Vista	100	98	0	0.0
São Joaquim do Monte	100	70	4	5.7
São Caetano	100	65	0	0.0
São José do Egito	100	57	1	1.8
São Lourenço da Mata	210	160	1	0.6
Serra Talhada	95	89	0	0.0
Serrita	149	67	0	0.0
Surubim	40	37	0	0.0
Tabira	80	70	0	0.0
Taquaritinga do Norte	100	88	0	0.0
Timbaúba	34	21	1	4.8
Trindade	30	25	0	0.0
Triunfo	100	69	0	0.0
Venturosa	70	67	3	4.5
Verdejante	40	27	1	3.7
Vicência	100	48	2	4.2
Vitória de Santo Antão	100	69	4	5.8

TABLE VI

Results of the exposition of *Biomphalaria straminea* from the State of Alagoas to miracidia of a strain of *S. mansoni* from the State of Pernambuco

County	Snails exposed			
	no.	no. alive after 20 days	infected	
			no.	per cent
Arapiraca	50	29	0	0.0
Atalaia	198	163	2	1.2
Batalha	80	44	1	2.3
Delmiro Gouveia	100	95	5	5.3
Girau do Ponciano	25	17	6	35.3
Igreja Nova	70	36	0	0.0
Mata Grande	100	84	4	4.8
Murici	60	39	2	5.1
Olho d'Água das Flôres	80	67	0	0.0
Olho d'Água do Casado	100	91	4	4.4
Palmeira dos Índios	106	101	1	1.0
Pão de Açúcar	100	87	2	2.3
Passo de Camaragibe	64	61	0	0.0
Pilar	100	85	6	7.1
Piranhas	100	89	2	2.2
Pôrto Real do Colégio	100	91	0	0.0
Rio Largo	50	49	0	0.0
Santana do Ipanema	100	75	0	0.0
São José da Tapera	28	28	2	7.2
União dos Palmares	165	112	4	3.6
Viçosa	96	84	1	1.2

BARBOSA, F. S. & FIGUEIREDO, T. — Susceptibility of the snail intermediate hosts of schistosomiasis from Northeastern Brazil to the infection with *Schistosoma mansoni*. *Rev. Inst. Med. trop. São Paulo* 12:198-206, 1970.

TABLE VII

Results of the exposition of *Biomphalaria glabrata* to two different miracidia strain of *S. mansoni*

State	County	Snails exposed			
		strain of Pernambuco		local strain	
		no.	per cent infected	no.	per cent infected
Rio Grande do Norte	Pureza	90	70.0	42	100.0
	Viçosa	47	0.0	63	60.3

TABLE VIII

Results of the exposition of *Biomphalaria straminea* to two different miracidia strains of *S. mansoni*

State	County	Snails exposed			
		strain of Pernambuco		local strain	
		no.	per cent infected	no.	per cent infected
Rio Grande do Norte	Martins	96	1.0	98	0.0
	Pureza	82	4.9	94	6.4
Paraíba	Araçagi	66	0.0	62	0.0
	Guarabira	138	0.0	42	0.0
Alagôas	Viçosa	84	1.2	100	0.0

Most of the Northeastern Brazil is situated in a semiarid area — the *caatinga* — where schistosomiasis is not found. However, the snail hosts were collected in the entire region and some of the strains showed relatively high infection rates. *B. straminea* was the species found in the *caatinga*. Moreover, adaptations of the snails to local strains of the parasite are well known at present.

The above comments gain in importance when it is known that large irrigation projects are being developed in the São Francisco and Jaguaribe valleys.

The establishment of extensive irrigation systems will provide favorable snail habitats through a vast network of canals and drains. Lacking of sanitary facilities and poor education will result in pollution of the water-

courses with domestic sewage and in frequent contacts of the population with the water. Infected people will migrate from the coastal areas and then all effective conditions will be found in the irrigated areas to promote new, extensive, and important schistosome foci in Northeastern Brazil.

The past experience shows¹ that in developing countries schistosomiasis has been introduced or the existing problem has been extended after the establishment of open irrigation systems. As discussed before¹ this important problem has been overlooked in this country. The economic benefit brought by irrigation practices can be hindered by the great loss due to the disease unless effective sanitary and educational measures be taken.

R E S U M O

Suscetibilidade dos caramujos transmissores da esquistossomose no Nordeste do Brasil à infecção com Schistosoma mansoni

De extensas coletas de planorbídeos feitas no Nordeste do Brasil, foram utilizadas para o presente trabalho 16 cepas de *Biomphalaria glabrata* e 223 de *B. straminea*. Número variável de caramujos foi exposto a miracídios de uma cepa pernambucana de *S. mansoni*. Em número limitado, foram também realizadas infecções com cepas locais do parasita.

Os resultados mostraram que *B. straminea* se comportou consistentemente como mau vector de *S. mansoni*. As taxas de infecção foram muito variáveis para *B. glabrata*. Em relação a esta última espécie, verificaram-se adaptações de populações de caramujos a cepas locais de *S. mansoni*.

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