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HOLOCHILUS BRASILIENSIS AND *NECTOMYS SQUAMIPES* (RODENTIA-CRICETIDAE) NATURAL HOSTS OF *SCHISTOSOMA MANSONI*

H. PICOT

Laboratoire de Parasitologie, Faculté de Médicine Broussais, Université Paris VI, 15, Rue de L'Ecole de Médicine, 75270 Paris Cedex 06, France

After several Brazilian researchers, the author examines the capacity of two species of rodents Cricetidae, Holochilus brasiliensis *and* Nectomys squamipes, *to maintain the biological cycle of* Schistosoma mansoni *in the field and to be parasite reservoir: (a) the role they are able to play in human endemy; (b) the methods necessary to characterize the population of* Schistosoma mansoni *related either to man, either to rodents, either to both.*

Key words: *Schistosoma mansoni* – Brazil – *Holochilus* – *Nectomys* Cricetidae – epidemiology – reservoir

In his talk, Rey (1992) summarized the amount of informations that have been published about wild animals infected by *Schistosoma mansoni* in Brazil. So I will concentrate here on a few aspects of which study might make progress in our knowledge at a time when new epidemiological situations occuring after mass treatment, reveal the role played by the rodents as potential reservoir.

FREQUENCIES OF PARASITISM OF RODENTS

Among numerous species of marsupials or rodents parasited, *Holochilus brasiliensis* and *Nectomys squamipes** are the most frequently infected, in most of the endemic regions of Brazil (Table I).

In the marsh around São Bento (Maranhão), the positivity rate rose to 92% of the *Holochilus* studied by Veiga-Borgeaud in November 1985 just before the season of multiplication of *Biomphalaria glabrata* (Veiga-Borgeaud, 1986, 1987). In the same municipality, in September 1991, 34 parasited *Holochilus* (31%) excreted on average 222 eggs for one gram a day. According to SUCAM, in 1989, the prevalence of human disease was inferior to 4%. So, since the discovery by Amorim et al (1954), epidemiologists have be raising questions in relation to the role of these rodents in the transmission of *S. mansoni* to man (Antunes et al., 1973; Barbosa et al., 1953, 1958; Carneiro, 1990; Carvalho, 1975; Dias, et al., 1978; Kawazoe & Pinto, 1983).

TABLE I

Some percentages of naturally infected animals by *Schistosoma mansoni* in Brazil

	%	Author	Year	State
Didelphis paraguayensis	23	Piva	1966	Sergipe
Cavia aperea	60	Barreto	1964	Bahia
Rattus norvegicus	46	Martins	1955	Minas Gerais
Rattus R. frugivorus	59	Barbosa	1953	Pernambuco
Holochilus brasiliensis	92	Veiga	1986	Maranhão
	75	Dias	1978	São Paulo
Nectimys squamipes	75	Amorim	1953	Alagoas
	57	Martins	1955	Minas Gerais

But if there are many papers about rates of positivity, few authors indicate in which conditions rodents have been captured: superficy of the fields, distance from the water, estimate total population, type of environnement. . . It is therefore difficult to establish the reality of the prevalence, to compare the human and murine prevalences in time and space, and to know something about the ways of contamination.

Nobody has suggested that, in Brazil, the parasite of rodents should be of species differ-

*We have use here the names currently used. A revision might be necessary to avoid synonymies.

ent from human species, as Schwetz (1952) did in Africa in putting forward the idea of the existence of one variety *S. rodentarum*. Several authors, using various methods, have tried to set up differencies between human and murine strains: pathogenicity for white mice (Bastos et al., 1982, 1984; Silva & Andrade, 1989) compatibility for snails (Antunes et al., 1973; Dias et al., 1978; Bastos et al., 1984), sensibility to oxamniquine (Souza et al., 1991), etc. Very recently, neither Carneiro (1990, 1991) through precipiting antigenic fractions in western-blot, nor Rodriguez (1991) through allelics forms of the G6PD have established characteristics differences between two strains of Maranhão.

Before asserting the identity of the two parasites, we have to answer three questions: (a) Is a strain allegedly of human origin but maintened for many years on white mice, still "human"? (Loverde et al., 1985); (b) Can an isolated strain from one individual (man or rodent) represent faithully the population of parasite circulating in a focus? (C) Are the methods used in the past suitable to establish variability and intraspecific diversity which have been pointed out by Fletcher (1981), using several isoenzymatic systems and by Vieira using D.N.A. (1991).

CAN RODENTS BE RESERVOIRS OF PARASITE?

By definition, a reservoir excrete a large number of eggs capable to infect snails. This is not the case of *Didelphis* and *Cavia aperea* (Barreto et al., 1964), which, though frequently and heavily infected, have no viable eggs in the faeces.

After Piva & Barros (1969), Dias (1978), Souza (1991) and others authors, we experimentaly established that *Nectomys* and *Holochilus* excrete an average of over 1,000 eggs a day, eight months after being individualy infected by 500 cercariae, without apparent trouble (Table II).

TABLE II

Average eggs excretion at some moments of infection

Fortnight positivity	No. 2	No. 6	No. 11	No. 13
H. brasiliensis	1 705	1 030	2 694	1 588
N. squamipes	3 238	1 840	2 564	3 589

Because of the low density of cercariae in many water-contact sites, we are proceding at the moment to the same experiment with 100 cercariae.

Although the average number of eggs remains very high, it varies very much according to the sample of faeces, days and individual. This variability in the individual response to infection and the notion of agregation of parasite should be taken into account in epidemiological surveillance.

According to various protocoles (water volume, weight of stool, number of miracidium, number of eggs) we have succeded in infecting high percentage of *B. glabrata* with eggs excreted four months after the infection of rodents (Table III).

TABLE III

Rate of infected snails

	Nectomys	*Holochilus*
0,5g of faeces in 3 of water	100%	72%
300 miracidium in 100 of water	66%	46%

The rate of success is scarely smaller nine months later. This duration of excreting viable eggs can ensure the transmission when it is seasonal as it is often the case in Brazil as elsewhere.

Three experiments (Antunes et al., 1973; Carvalho, 1975; Kawazoe & Pinto, 1983) carried out in semi-natural conditions, have shown that rodents are able to ensure, on their own, the cycle of the parasite: the third paper is interesting because it prove the importance of ecological factors which favour the biological cycle: this one could not be completed in the experimental vivarium where infected and non-infected rodents had been settled, until *B. glabrata* have been introduced in the place of *B. tenagophila;* the latter, though local vectors of *S. mansoni*, did not find in the vivarium sufficient conditions to survive, to breed and to mature cercarie.

In the contrary, in October 1991, three *Nectomys*, out of nine that we found infected at São Lourenço de Mata (Pernambuco) had probably been infected in very small pond inhabited by *B. straminea* which is, wrongly considered to be poor intermediate host.

It is therefore certain that both species of rodents have the capacity to transmit *S. mansoni*, but none can tell so far in which proportion they play a role in the maintenance of human endemy, nor how the parasites circulate between men, rodents and snails.

RESEARCH ON THE ROLE OF *RATTUS RATTUS* IN GUADELOUPE

To answer these questions, the work carried out in Guadeloupe by Combes et al. (1975), since over 20 years on the black rat, could be the starting point for fruitful research to be carried out in Brazil.

In this small island of the Antilles, the schistosomiasis has pratically disappeared nowadays, due to standart of life and systematic treatment of each ill people, except for a few cases in a small focus, where the black rat is also infected. But in 1979, 4% of the 350,000 inhabitants excreted still eggs of *S. mansoni* (INSERM, 1980). Around 1975, in this small but very contrasted territory, very diverse epidemiological situations coexisted: (a) In crowdy, built-up valleys, the human prevalence was higher than murine prevalence. Nowadays, as all patients were cured, there is no infected rat: they were accidental hosts. (b) In a isolated mountain pond, with no human visitors, *Rattus* maintained alone the cycle for fifteen years until *Ampullarias* sp. accidentally introduced competed with *B. glabrata* and expelled them from the focus (Pointer et al., 1988). (c) The third type of focus is located at the back of a mangrove, on the border of a swampy forest, where a edible plants are grown. Rats and men are still found infected.

Of course, Imbert-Establet (1980, 1982) and Jourdan & Imbert-Establet (1980) have studied the compatibility of different populations of *S. mansoni* from Guadeloupe and other places with the black rat, using various tests such as adult worms recovery rate, migration and localization of worms, faecal eggs number. . .

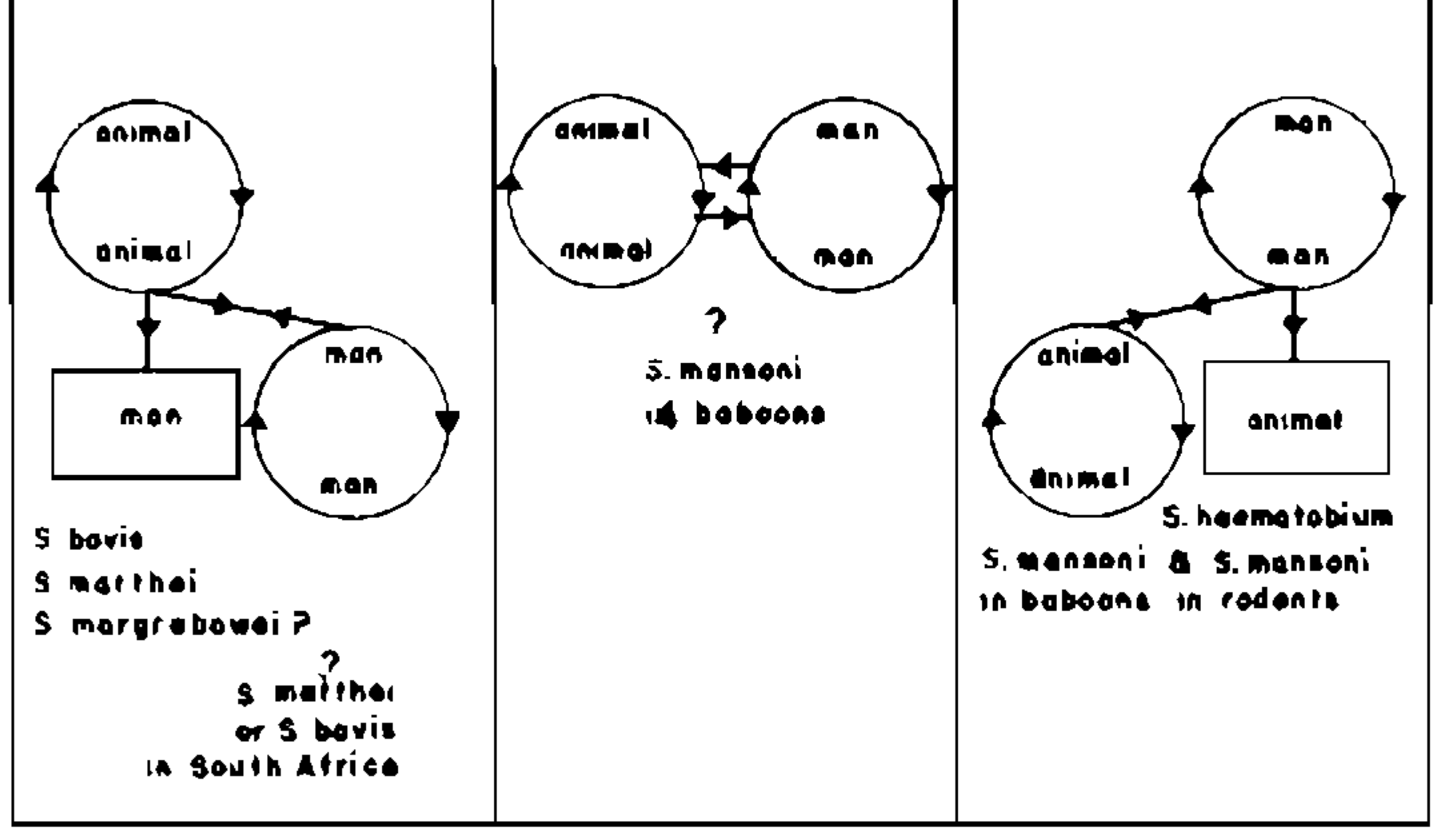
But, above all, Theron et al (1986) have discovered markers whose frequency allows to characterize populations of schistosomes related either to men, either to rats or in relation with both. These markers are: (a) The frequency of eggs of a particular shape which looks like the shape of eggs of *S. rodhaini* Rollinson et al., 1986; Theron, 1986; (b) The frequency of allelic forms of M.D.H.1 (Rollinson et al., 1986; Theron, 1986); (c) The time of maximum cercarial shedding by *B. glabrata* (Theron, 1984, 1985). This average peak of emergence occurs towards the end of the morning (i.e. 11h) where man is the main host, towards the evening (i.e. 16h) in area where rat is the main host; the intermediate patterns are observed with schistosomes originate from swamp where man and rat are involved. The adaptation character of this chronological phenomena in relation to the circadian rythm of host, is also to be found in other schistosomes in Africa (Bremont et al., 1990).

The genetic background of this intraspecific polymorphism has been proven through crossbreeding of schistosomes from the various isolates (Theron & Combes, 1988; Theron et al., 1989). Thus, in relation to different environnement a population of parasite has evolved toward different local forms that can be identified. These forms share a common genetic pool but are still exchanging genes through genic flux of varying intensity according to the type of ecosystem. Rats related schistosome population benefit from selective pressure resulting from human treatment and changing pattern of water contacts.

SCHISTOSOMIASIS DUE AT *S. MANSONI*: A ZOONOSE?

The modalities of host-parasite relationship in Guadeloupe are in conformity to the patterns that Nelson suggested already in 1960, in his talk about the schistosomiase zoonose in Africa (Table IV).

TABLE IV



Nelson, G. S., 1960. Zoonoses in Africa. Schistosomiasis.

Although the research carried out were not as thorough as in Brazil, it does not seem that, in Africa, rodents play there an important role in transmitting *S. mansoni*. But baboons which are accidental hosts in Kenya, were able to maintain alone the cycle in a national park of Tanzany (Fenwick, 1969; Acha & Szyfres, 1987). After comments of Nelson about anthropozoonoses, we must add a new one: in Africa the animal schistosomes (*S. bovis; S. matthei; S. curassoni*), are able to infect man and to hybridize with *S. haematobium;* between this species and a fortiori between the populations which are component of these species circulate also genic flux (Bremont et al., 1990).

In Brazil exist certainly places where schistosomiase is a zooanthroponose: man is responsable for the contamination of rodents.

In other places, the situation is amphixenotic. Silva & Andrade (1989) point out that in the municipality of Planalta (Bahia) the human and murine prevalence are respectively 3.26% and 47%. In the Baixada in Maranhão, *Holochilus* are numerous, exclusively aquatic during at least nine months, and share the same biotope as fishers and hunters; today they are more frequently infected (31%) than men (3.9%). Epidemiological conditions may perhaps already have enable the selection of a population adapted to rodents, that could be identified through modern technics.

The eventuality of occurence of an anthropozoonose appears to be remote: genetic flux between human and murine schistosome still ocurrs, and the predictable increasing of human prevalence consecutive to the interruption of treatment that have been carried out for the last ten years, are found to increase the proportion of human schistosome.

CONCLUSION

Originating from various areas of Africa, *S. mansoni* when appearing in Brazil, must have been doted with capacities to invest new, vacant ecological niches. It adapted itself to intermediate hosts (*B. glabrata, B. straminea, B. tenagophila*) but also to definitive hosts, immunologicaly favorable which are nowadays turning into natural reservoir of parasite.

This adaptation and consequences demands a great epidemiological attention: the control of schistosomiasis in China is progressing slowly because of animals reservoirs.

So, in my opinion, should be undertaken, in endemic focus well defined: (a) epidemiological surveys taking into account not only the parasited rodents number but also time and space variations of prevalence, intensity, dispersion of the parasite among both host populations exposed to the risk; (b) ecological surveys about behaviour and dynamics of rodents populations and about abiotic and biotic factors which act upon these hosts; (c) research on the genetics of populations of schistosomes related either to man or to rodents or both.

This approach, integrating the various level of the system environment/host/parasite (individual population, focus, meta-population) carried out by multidisciplinary teams, including zoologists, ecologists, geneticians, would be a good method to analyse the way the system operates and to contribute to setting up strategies taking into account the existence of these infortunate animal reservoirs.

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