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The mouse as a suitable host for an isolate of *Schistosoma haematobium* from Niger

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ABSTRACT

The host-parasite relationships of a *Schistosoma haematobium* isolate, originating from Niger, and the white mouse are described. Swiss OF1 albino mice were exposed individually to 200 cercariae and worms were recovered 9, 12, 16 and 20 weeks post infection. The mean worm returns ranged between 10·54 and 13·05% and did not alter significantly between 9 and 20 weeks post infection. The sex ratio of worms was always in favour of males; from 7·09:1 at 9 weeks after infection it decreased regularly to 3·28:1 at 20 weeks. Male worms reached a mean length of 8·72 mm at 20 weeks. From the 12th week post infection, a high number of eggs was found in the liver and gut. At 20 weeks, eggs were also found in the bladder. Viable eggs and infective miracidia were obtained. The infection of *Bulinus truncatus* from Niger succeeded with a mean rate of 61% after the first passage through mice. The isolate of *S. haematobium* was maintained in the laboratory during 3 successive passages through mice. These entirely new results are very probably linked to genetic characteristics peculiar to the *S. haematobium* populations from Niger.

KEY WORDS: *Schistosoma haematobium,* mouse, miracidium infectivity, Niger, host-parasite relationships, Trematoda

INTRODUCTION

Very little experimental research has been carried out on *Schistosoma haematobium,* mainly because its cycle is difficult to maintain under laboratory conditions. The only hosts, with the exception of a few species of primates, on which several generations of the parasite can be maintained are the hamster and the jird (*Meriones unguiculatus*). It has to be underlined that *S. haematobium* cannot be maintained indefinitely in these rodents since the strain inevitably becomes sterile after the fourth or fifth passage through these hosts. The mouse, a choice host for experimental research and for the maintenance of cycles for most species of *Schistosoma*, has responded in a very variable way to infections by *S. haematobium*. Most research carried out on this rodent, in particular the studies of MOORE & MELENEY (1954) with CFW albino mice, and CHEEVER *et al.* (1983) with Swiss albino mice, conclude that this host is non-permissive because of the low percentage of adult development. More recently however, AGNEW *et al.* (1988), obtained different results with two isolates of *S. haematobium* from West and East Africa, showing the CBA mouse to be a permissive host in regard to worm recovery, sexual maturation and fecundity of the adults. Nevertheless, in all studies, attempts to infect snails with miracidia hatched from eggs produced in mice always failed.

In this study, we have re-evaluated the compatibility of the mouse-*S. haematobium* system using an isolate of *S. haematobium* from Niger. Our results show better host-parasite relationships than those described by AGNEW *et al.* (1988), and in particular the ability of miracidia hatched from eggs from mice to infect snail hosts.

MATERIALS AND METHODS

The Niger *S. haematobium* isolate was obtained from human urine in the Liboré area. It was cycled through *Bulinus truncatus,* also originating from Niger.

The cercariae used to infect Swiss OF1 white mice were pooled from 16 infected *B. truncatus.*

Forty five mice in total were individually infected with 200 cercariae, percutaneously through the abdomen, for 30 min whilst anaesthetized. Four groups of 8 to 13 mice were perfused at 9, 12, 16 and 20 weeks after infection. The worms were collected by perfusion of the hepatoportal system and intestinal veins using the technique of DUWALL & DEWITT (1967). Male worms were measured alive after 30 min relaxation in sodium pentobarbital (0·1 ml of 5% Nembutal in 10 ml of isotonic saline solution). Following perfusion, the entire intestine, liver, lungs and bladder were removed. The number of eggs in these tissues was estimated by counting after digestion in 2·5% KOH.

The egg excretion was determined after dissolution of 1 g of faeces in 5 ml water.

In order to determine the infectivity of miracidia originating from liver eggs, three batches of 84, 72 and 71 *B. truncatus* from Niger were exposed to miracidia respectively after 1, 2 and 3 passages through mouse. The snails were individually exposed to 5 miracidia and checked for cercarial shedding 45 days after exposure.

Kruskal-Wallis test was used to compare means of adult recovery percentages.

RESULTS

The parasite

Parasitological information indicating the worm recoveries in the four groups of mice, perfused from 9 to 20 weeks after infection, are presented in Table I. The mean worm return ranges from 10·54% at 20 weeks to 13·05% at 12 weeks post-infection. The mean percentage of recoveries from each group does not differ significantly between 9 and 20 weeks post-infection ($p>0·05$).

The sex ratio of adult worms in mice

The mean sex ratios of adult worms recovered in each group are given in Table I. Within each group of experiments, the sex ratio appears to be in favour of males. The highest sex ratio, 7·09:1, was noted at 9 weeks after infection. It decreased regularly from 12 weeks, reaching 3·28:1 at 20 weeks.

TABLE I. The number, length and sex ratio (males in relation to females) of *Schistosoma haematobium* adults from Niger developed in OF1 Swiss mice.

	Number of worms recovered			
	9 weeks after infection	12 weeks after infection	16 weeks after infection	20 weeks after infection
Number of mice	8	10	10	13
Worms recovered (males, females, total)	149 21 170	219 42 261	186 46 232	210 64 274
Mean worm return (%) ±S.E.	10·62±1·43	13·05±1·65	11·60±1·83	10·54±1·14
Mean male worm length (mm) ±S.E.	6·81±1·87	7·45±2·08	8·18±2·42	8·72±2·49
Sex ratio (males/females)	7·09/1	5·21/1	4·04/1	3·28/1

The development of adults in the mouse

Table I shows the growth of male adult paired worms in the mouse. The male worms did not reach their final size (8·72 mm long) until 20 weeks after infection, although they were reproductive before 12 weeks.

Location of adults in the mouse

The majority of worms resided in the upper mesenteric veins. No parasites were found in the lungs. In one mouse, perfused at 20 weeks post-infection, two worm pairs were encountered in the venous bladder circulation and high egg numbers were found in both the lungs and the bladder.

The distribution of parasite eggs in tissues

The search for eggs in tissues was done in 3 groups of 3 mice killed at 9, 12 and 20 weeks after infection. The results are presented in Table II. At 12 weeks, all mice had eggs in the liver. One of the 3 mice also had eggs in the gut. At 20 weeks, all mice showed high numbers of eggs in both the liver and the gut. As mentioned above, one of the 3 mice of this group was found to have eggs in the bladder.

Infectivity of miracidia

Attempts were made to infect *B. truncatus* from Niger with miracidia from *S. haematobium* infected mice. Eggs were extracted from livers of mice infected for 20 weeks. The infectivity of the miracidia was checked after 1, 2 and 3 passages of *S. haematobium* in mice. A summary of the results of infections is given in Table III. Snails were infected in all 3 experiments, with a rate of infection ranging from 25% to 61%.

TABLE II. Worm pairs and eggs recoveries in OF1 Swiss mice infected with *Schistosoma haematobium* from Niger.

Weeks after exposure		Worm pairs (WP)	Eggs/WP in liver	Eggs/WP in gut	Eggs in lungs (total)	Eggs in bladder (total)	Eggs/g. of faeces
9	1st mouse	6	0	0	0	0	0
9	2nd mouse	3	0	0	0	0	0
9	3rd mouse	3	0	0	0	0	0
12	1st mouse	5	478	·0	0	0	0
12	2nd mouse	6	373	30	0	0	0
12	3rd mouse	1	230	0	0	0	0
20	1st mouse	9	370	632	0	0	11
20	2nd mouse	4	2464	35	0	0	3
20	3rd mouse	5	2062	1150	163	2873	5

TABLE III. Snail infection experiments: infectivity of miracidia after 1, 2 and 3 passages of *Schistosoma haematobium* from Niger in mice.

Passage through mouse	No of snails exposed	No surviving prepatent period	No surviving infected	% surviving infected
1st passage	84	78	42	53·84
2nd passage	72	51	24	47·06
3rd passage	71	38	8	21·05

DISCUSSION

The mouse has generally been regarded as a non-permissive, or at best slightly permissive, host for *S. haematobium*, based on the criterion of susceptibility to infection. The mean worm return generally found in the mouse is close to or below 10% (TAYLOR & ANDREWS, 1973 with TO strain albino mice; CHEEVER *et al.*, 1983 with Swiss albino mice), whereas infection rates over 15% have been found regularly in hamsters (CAPRON *et al.*, 1965; WRIGHT & KNOWLES, 1972). The infection levels found in this study, between 10·54 and 13·05%, are close to those usually found in the mouse. It should be noted that results for infection levels are not always comparable since the infection technique of the rodents often differs with the authors.

The ratio of male to female worms was always biased towards males. In the literature, the sex ratio in a mature infection by *S. haematobium* is often unbalanced in this way. The sex ratio of schistosomes in the vertebrate host can vary for a number of reasons (MITCHELL *et al.*, 1990). Our results show a decrease in the ratio of male to female during parasitosis; this decrease seems to be due to the short survival time of the male worms, for which we have so far no explanation.

As far as the development of *S. haematobium* is concerned, the adults were fully grown at 20 weeks in this study. The males reached an average length of 8·72 mm, which is longer than that usually noted in the mouse. In their study, in CBA mice AGNEW *et al.* (1988) recorded an average length of 4·8 mm for the male. In our model, the first eggs appear in the tissues at 12 weeks post infection, mainly in the liver. Eggs were found in the lungs and bladder of one mouse infected for 20 weeks. These figures confirm AGNEW *et al.'s* (1988) results. Eggs were found in the bladder wall, thus confirming the existence in the mouse of a pelvic localization of worms, more frequent when the animals have been heavily infected for a long time. AGNEW *et al.* (1988) think that "the association between duration of infection and the ability of worms to migrate to the bladder could be the result of increasingly severe pathological changes in the host". In our study, eggs were not found in the faeces until the 20th week, whereas AGNEW *et al.* (1988) found eggs from the middle of the 12th week. Like them, we never found eggs in the urine. The density of eggs in the tissues is very similar to that reported by AGNEW *et al.* (1988).

As for the fertility of *S. haematobium* eggs, the results we obtained are entirely new (Table III). This is the first time that *S. haematobium* miracidia hatched from eggs produced in mice have succeeded in infecting snail hosts. The infection percentages obtained show a good snail—schistosome compatibility for the system used. The infecting character of *S. haematobium* miracidia from Niger is probably a genetic character peculiar to the populations from Niger of this parasite, whose genetic originality has already been pointed out for other characters (VERA *et al.*, 1990). An effect of the mouse strain cannot be rejected although most previous results were also obtained with albino mice.

Judging from our results, the mouse-*S. haematobium* Niger couple appears to be an interesting host-parasite combination, which may be useful for studying host-parasite relationships. The development and maturation of the parasite in the mouse are very similar to those in the hamster. The pelvic localization of a part of adult worms in chronically infected mice allows interesting comparisons to be made with the parasitosis of man, in which the bladder pathology dominates. Finally, the retention of the infecting capacity of the miracidia, even after several passages through the mouse, means that *S. haematobium* could be kept in the laboratory exclusively in the mouse. Experiments are in progress in order to verify that sterility of infection does not occur after numerous passages.

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