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Phenotypic characterization of *Schistosoma mansoni* adult worms recovered from undernourished mice: a morphometric study focusing on the reproductive system

Caracterização fenotípica de vermes adultos de *Schistosoma mansoni* recuperados de camundongos desnutridos: estudo morfométrico do sistema reprodutor

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Abstract *A morphometric study focusing on some features of the reproductive system of* Schistosoma mansoni *adult worms was performed, aiming to complete previously reported data concerning the effects of undernourishment of the host on the parasites. Male worms were significantly affected (p<0.05) regarding the testicular lobes.*

Key-words: Schistosoma mansoni. *Nutritional status. Morphometric study. Phenotypic plasticity.*

Resumo *Foi realizado um estudo morfométrico de alguns elementos do sistema reprodutor de machos e fêmeas de* Schistosoma mansoni*, objetivando complementar estudo anterior sobre os efeitos da desnutrição do hospedeiro sobre os parasitos. Alterações significativas ocorreram em parasitos machos (p<0,05), em relação aos lobos testiculares.*

Palavras-chaves: Schistosoma mansoni. *Estado nutricional. Estudo morfométrico. Plasticidade fenotípica.*

Schistosomiasis mansoni and malnutrition are pathologies that can simultaneously occur in developing areas such as Northeastern Brazil[4]. The difficulty in undertaking longitudinal studies in human populations has justified the development of experimental models[8]. Malnutrition has been considered as a factor able to modify the host-parasite-environment system, aggravating the course of schistosomiasis by breaking the equilibrium in the relationships among the components of this system[3].

Brightfield, scanning electron microscopy and confocal laser scanning microscopy (CLSM) have been used in morphological studies of *Schistosoma mansoni* adult worms[9 11 12 13 14 15 20]. Besides the known effects on the course of the infection, malnutrition of the host leads to a reduction in the worm body length and in the distance between the suckers in males, as well as changes in the reproductive system of male and female worms[21]. These findings were also confirmed by confocal laser scanning microscopy (CLSM)[19].

This paper aims to bring some additional information concerning the effects of the undernourishment of the host on male and female adult *Schistosoma mansoni*.

Swiss Webster mice were percutaneously infected with 80 cercariae (BH strain). Undernourished animals were fed a multideficient and essentially low protein diet (Regional Basic Diet – RBD)[5]. Well-fed control mice ingested a standard commercial diet (Nuvilab CR-1). Mice were sacrificed 75 days post-infection and worms were recovered by perfusion technique[7]. All specimens were fixed in 10% formalin, stained with carmine chloride, clarified in methyl salicylate and preserved as whole-mounts.

A brightfield microscope linked to software for image analysis (Image Pro Plus – Media Cybernetics) was

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utilized. The following morphological parameters were studied for male worms: larger and smaller diameter, longer and shorter axis and perimeter for the testicular lobes. Female worms were studied according to the following parameters: area and perimeter of uterine eggs; area, larger and smaller diameter and perimeter of egg spine[19]. Student's *t* test was performed, values of $p<0.05$ were considered as significant for differences between the undernourished and control groups.

Morphometric data of male and female worms are given in Table 1. Specimens from undernourished mice showed lower values for all variables, when compared to those from well-fed mice. However, significant differences were only detected in males.

Morphological changes in the tegument and the reproductive system had been previously described in worms recovered from underfed animals[6 21]. Reported data based upon morphometric studies now show that some components of the reproductive system may also be injured in undernourished hosts. These effects seem to relate to unavailability of nutrients in the blood of the vertebrate host[21].

Table 1 - Morphometric data of male and female adult worms of Schistosoma mansoni *recovered from undernourished and control mice.*

	Mice	
	undernourished	control
Morphological parameters	(X±Sd)	(X±Sd)
Males (testes lobes)	(n=35)	(n=35)
larger diameter (μm)*	278±55	316±50
smaller diameter (μm)*	89±16	106±23
longer axis (μm)*	296±62	333±51
shorter axis (μm)*	106±20	129±20
perimeter (μm)*	696±147	814±118
Female (eggs)	(n=20)	(n=20)
area (μm^2)	3470±556	3756±636
perimeter (μm)	274±22	281±19
spine area (μm^2)	162±66	170±74
spine larger diameter (μm)	20±5	21±7
spine smaller diameter (μm)	9±2	10±3
spine perimeter (μm)	57±12	58±18

* significant difference ($p \leq 0.5$).

It is known that, besides the host's nutritional status, several other factors can affect the host-parasite relationships, which may lead to several pathological manifestations. Any disturbances, therefore, in the microenvironment of the parasite can impair its biological behavior[8]. Thus, supplementary food programs are recommended for those who inhabit endemic areas in order to improve their nutritional status[8].

The nutritional status of the host can induce alterations in adult worms[19]. Worms recovered from underfed animals showed changes in the tegument and the reproductive system[16]. The data presented herein confirm such alterations and show that other characteristics (area, perimeter and spine size of uterine eggs and size of testicular lobes) are affected by the nutritional status of the host. This is probably due to changes in availability of nutrients within the host[19].

As the surface architecture of the tegument allows the adult worm to ingest its nutrition[1] and enhances migration of the worms against the bloodstream towards the site of oviposition, one can speculate that these alterations could impair the parasite behavior regarding several points. Since the effects of undernourishment are more severe in male worms and being well established that male worms supply nutrients for females[10], these interactions may be disturbed. Furthermore, as males have a well-developed musculature, they are responsible for carrying females to the site of oviposition[17 18]. Obviously, if this does not occur, egg-laying and fecal egg-count can be altered. It must also be pointed out that nutrients can be ingested through the oral sucker or across their tegument[22]. Fatty acids for example are metabolized into complex lipids[2] and absorbed glucose is used in the synthesis of glycogen[22] stored by the schistosomes as their main energy source.

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