Fecundity Changes Induced by Low-Doses of Gamma Radiation on *Biomphalaria straminea* (Dunker, 1848)

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A population of 420 snails Biomphalaria straminea, *an intermediate host of* Schistosoma mansoni, *received gamma-rays obtained from a* ^{60}*Co source in low-doses (0/2,5/5/7,5/10/15/20 and 25 Gy); half population was kept in colonies (allowing cross fertilization) and the other half was mantained in sexual isolation (allowing self fertilization). Results showed that 15 Gy stimulates the fertility of both groups but the colonies were more sensitive and at this dose its fertility overpasses the control group dose. The possible hormonal role played in the observed phenomena is under investigation.*

Key words: fecundity - gamma radiation - *Biomphalaria straminea*

Biomphalaria straminea, intermediate host of *Schistosoma mansoni*, are hermaphrodite snails (Paraense & Deslandes1955, Leal 1976). Widespread in northeast Brazil, and existing in other regions, it contributes to the endemic schistosomiasis occurring in some regions of this country (Paraense & Deslandes1955). The research on this snail has a social and epidemiological interest for public health (Pessoa & Martins 1982). Previous reports state that the reproductive activity of snails is particularly affected by ionizing radiation (Liard 1968). Aiming to examine more closely some aspects of this subject, this study was performed in order to observe the fecundity behavior of this epidemiological vector of schistosomiasis after its exposure to low intensity gamma-rays, in cross and self fertilization.

MATERIALS AND METHODS

Gamma-rays obtained from a ^{60}Co source in low-doses (0/2,5/5/7,5/10/15/20 and 25 Gy) were applied upon 420 snails *B. straminea*, BH breed, obtained from Centro de Pesquisas Aggeu Magalhães. Maintained in our laboratory, the snails had the same age (7 weeks), were bred from the parent's eggs laid with a maximal difference of two days and, divided into groups of 30 snails per dose. The population of snails observed had already attained its reproductive development. One half of the snail population was kept in colonies allowing cross fertilization and the other half was maintained isolated (allowing self fertilization). Fecundity, estimated by the amount of egg mass as by the number of eggs, was observed during 30 days. All the groups/dose were maintained in individual (isolated) and collective (colony) aquariums with water temperature (27°C ± 2°C) and pH (6.6-6.8) controlled. The ratio water volume/snail (50 ml) was kept constant, during the whole period of observation. During the irradiation of the snails by gamma-rays, groups of 30 snails were placed into a glass tube by time and then placed in a Gammacell Irradiator, model RL-60, from Radionics Laboratory, emitting gamma-rays in a rate of 0.97 Gy per minute. The snails remained in the irradiating device during a period of time enough to reach the programmed dose. In order to avoid copulation during the exposure, each isolated group had the snails separated by a thin cotton cushion between them. To facilitate egg laying, some pieces of solid floating material (ISOPOR™) was distributed over the water surface of each aquarium, in order to support the offspring, where the eggs were agglutinated in a mucoproteic jelly. In order to count the egg masses each offspring was placed in a Petri dish with distilled water to prevent the egg mass dehydration. Finally the eggs were counted, with a stereo microscope.

RESULTS

The resulting data were averaged for each group/dose and the standard deviation of each value are seen in Table I.

The above data reflect a reduction of fecundity after irradiation in both the colonized and isolated groups, as measured by the number of egg masses and eggs, except at the 15 Gy dose group, when the snails from the colonized groups showed a greater fecundity as compared with the control

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TABLE I

Mean values of egg masses and eggs in each offspring of *Biomphalaria straminea* following a low-dose radiation with gamma ray from a ^{60}Co source, in sexual isolation or in colonized groups

	Egg mass				Eggs			
	Colonized		Isolated		Colonized		Isolated	
Dose (Gy)	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	36.8[a]	13.1	25.2[a]	11.2	485.5	204.2	204.9	107.1
2.5	14.3[a]	8.9	13.3[a]	9.9	219.8	137.3	158.1	121.2
5.0	21.5[a]	12.8	14.5[a]	7.6	285.7	187.0	167.7	90.9
7.5	21.4[a]	12.7	9.7[a]	7.6	341.0	216.9	74.9	61.0
10.0	15.9[a]	12.6	8.9[a]	4.0	159.9	153.6	43.7	25.7
15.0	24.6	2.5	27.8	2.0	253.0	102.0	278.9	14.0
20.0	20.8[a]	15.4	15.0[a]	8.7	213.0	194.1	70.0	55.7
25.0	28.1	12.3	17.0	9.4	250.3	132.0	162.6	98.7

a: significant irradiated-control egg mass difference at $p<0.001$ (by the chi-square test); SD: standard deviation

group (0 Gy), concerning the number of egg masses and eggs. At this dose, moreover, it was observed the less disperse response of the egg mass produced by the irradiated snails, with a standard deviation nearly 5.5 times lower than the control group. When the data from eggs and egg mass were compared conjointly with the controls' results, through the chi-square test, only the doses 15 and 25 Gy did not show statistical significance to $p<0.001$.

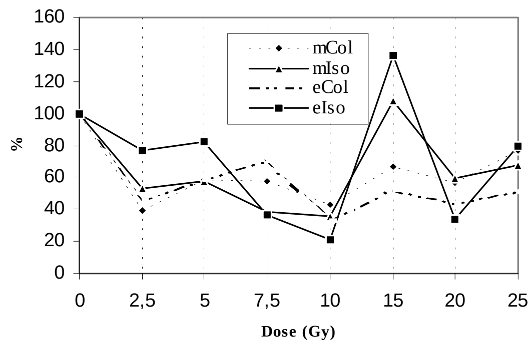
The number of eggs per egg mass is seen in Table II, as result of the division of eggs by the number of egg masses observed.

The 15 Gy dose-group induced the greater fecundity among the snails of the irradiated isolated group. Concerning the egg count (Fig.), its standard deviation was about 50% less than the control group and caused the same ratio egg/egg mass in both the isolated and colony groups (see Table II).

TABLE II

Ratio egg/egg mass values observed on both groups from egg mass and eggs in each offspring of *Biomphalaria straminea* after a low-dose radiation with gamma ray from a ^{60}Co source, in sexual isolation or in colonized groups

Dose(Gy)	Colonized	Isolated
Control	13.2	8.1
2.5	15.3	11.9
5.0	13.3	11.5
7.5	15.9	7.7
10.0	10.0	4.9
15.0	10.3	10.7
20.0	10.2	4.7
25.0	8.9	9.6



Graphic representation of the percent of egg masses and eggs per group doses of *Biomphalaria straminea* snails in colonies and isolated, irradiated with low doses of gamma rays (mCol = egg mass of colonized groups; mIso = egg mass in isolated groups; eCol = eggs of colonized groups; eIso = eggs in isolated groups).

Here, the colonized control group values appeared 61.64% greater than those seen in the isolated control group. The 2.5 Gy and 5 Gy dose-group values overpassed the amount of eggs per egg mass observed in the control group, but the number of eggs per egg mass diminished as the gamma-rays dose augmented, except for the isolated 15 Gy and 25 Gy dose-group, as stated before.

DISCUSSION

The fecundity of *B. straminea* in colonies is reportedly greater than when they are isolated (Paraense 1986, Pessoa & Martins 1982). The results showed in Table I revealed that fecundity of the snails irradiated with low doses was depressed, except after the irradiation with 15 and 25 Gy. Results were not different from those observed in the control groups. Table II shows that the ratio egg/egg mass increased after gamma-irradiation with 2.5 and 5 Gy, among isolated and colonized groups. This effect is presumably a normal reaction of the reproductive system to ionizing radiation, but from 7.5 Gy to 25 Gy the fertility trends to lower values, thus indicating a depression of egg production. The dose of 15 Gy raised the ratio egg/egg mass in the isolated groups about 200% as compared to the nearby doses and, in addition, the weak dispersion observed after this dose (Table I) enhances our supposition of some hypothetical resonance inducing a more homogeneous biological effect as suggested by Lorenz (1950). Fig. shows that gamma-rays doses depressed the *B. straminea* reproductive processes progressively until the dose of 10 Gy, and then started the reversion of this effect. The dose 15 Gy, however, stimulated the sexually segregated group fecundity, producing a burst of growth in the amount of eggs among the isolated snails, probably due to an increase in sexual hormones or by any excitatory mechanism associated to the reproductive activity.

This effect could be linked to a presumed self protective effect in this species, enhancing the hermaphroditic reproductive activity when the animal is suffering a radio-ionizing aggression occurring by some hypothetical hormonal molecular resonance in the dose of 15 Gy. Moreover, it is curious that the reproductive behavior of another *S. mansoni* vector, *B. glabrata*, has a similar reproductive profile, but without ionizing radiation (Brumpt 1941, Carvalho 1992). This fact could be due to the wilder character of *B. straminea* and its predominance over the rival species (Perlawagora & Berry 1964, Rozemberg 1989, Carvalho 1992) in the competition for the supremacy of an area where both the species exist. Another particular aspect can be observed in both reproductive form groups studied, as shown in Table I and Fig.: the doses applied immediately under and above 15 Gy caused reduction on the fecundity and 10 Gy induced the most reducing response. This fact can suggest an excitatory reaction of the reproductive processes, occurring among the 15 Gy irradiated snails. Finally the ratio eggs/egg mass in the isolated group was found at its lower level at 10 and 20 Gy whereas its greater level occurred at the doses 2.5, 5 (as expected) and at 15 Gy, emphasizing the excitatory effect of the 15 Gy dose.

This evidence led us to suppose a marked enhancing effect of the 15 Gy gamma-rays doses on the fecundity of the sexually segregated *B. straminea* when compared with the control group. Ongoing studies are in progress to investigate the observed difference among the groups analyzed here, mainly on the question of sexual isolation and self fertilization after 15 Gy gamma-rays irradiation, which presented many ambiguous aspects. RIA techniques will be tested to attempt defining the hormonal role played in this phenomenon, envisaging a future application in the epidemiological control of schistosomiasis.

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