Impact of the age of *Biomphalaria alexandrina* snails on *Schistosoma mansoni* transmission: modulation of the genetic outcome and the internal defense system of the snail

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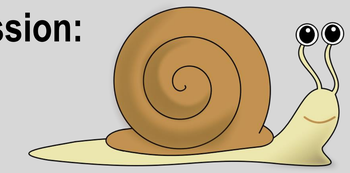
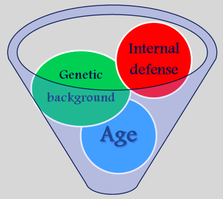




ABSTRACT

Of the approximately 34 identified *Biomphalaria* species, *Biomphalaria alexandrina* represents the intermediate host of *Schistosoma mansoni* in Egypt. Using parasitological and SOD1 enzyme assay, this study aimed to elucidate the impact of the age of *B. alexandrina* snails on their genetic variability and internal defense against *S. mansoni* infection.

Susceptible and resistant snails were reared individually for self-reproduction; four subgroups of their progeny were used in experiment. The young susceptible subgroup showed the highest infection rate, the shortest pre-patent period, the highest total cercarial production, the highest mortality rate and the lowest SOD1 activity. Among the young and adult susceptible subgroups, 8% and 26% were found to be resistant, indicating the inheritance of resistance alleles from parents. The adult resistant subgroup, however, contained only resistant snails and showed the highest enzyme activity. The complex interaction between snail age, genetic background and internal defense resulted in great variability in compatibility patterns, with the highest significant difference between young susceptible and adult resistant snails. The results demonstrate that resistance alleles function to a greater degree in adults, with higher SOD1 activity and provide potential implications for *Biomphalaria* control. The identification of the most susceptible snail age enables determination of the best timing for applying molluscicides. Moreover, adult resistant snails could be beneficial in biological snail control.

INTRODUCTION

Schistosomiasis is recognized as a major neglected tropical disease. The world-wide distribution of *S. mansoni* is permitted by the broad geographic range of the susceptible species of its intermediate host, *Biomphalaria* snail.

B. alexandrina represents the intermediate host of *S. mansoni* in Egypt (Abou-El-Naga et al. 2011). *Biomphalaria* snails are known to display a wide range of susceptibility phenotypes to *S. mansoni* infection (Negrão-Corrêa et al. 2007, Abou-El-Naga et al. 2010).

Snail's age, genetic background and internal defense system are among the snail related factors that affect snail's compatibility to *S. mansoni* (Richards et al. 1992, Abou-El-Naga & Radwan 2012). Resistance of *B. glabrata* to *S. mansoni* infection was found to vary with age while little is known about the effect of age on genetic modulation and *S. mansoni* infection compatibility in *B. alexandrina*. Internal defense system is mainly composed of circulating hemocytes which can inflict significant damage to invading parasites by generating reactive oxygen species (ROS).

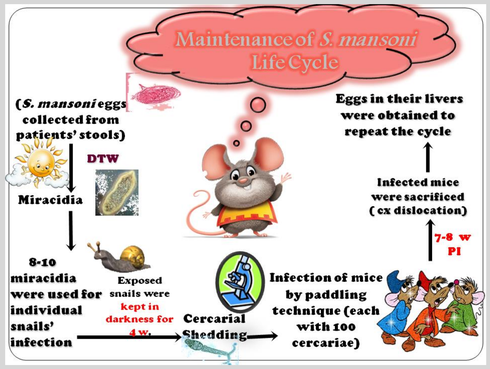
The cytosolic enzyme Cu/Zn superoxide dismutase (SOD1) which is produced by the snail hemocytes plays an important role in the oxidative damage and hence affects the susceptibility of the snails (Bayne 2009). Studying the physiological and biochemical criteria that modulate *Biomphalaria* susceptibility to *S. mansoni* is pivotal to provide new insights into the control of the targeted mollusc (Oliveira et al. 2010).

AIM OF THE WORK

The current work aimed at studying the impact of the age of *B. alexandrina* snails on alterations in their genetic outcome and internal defense. This was achieved by using different parasitological parameters and SOD1 enzyme assay.

MATERIAL & METHODS

Breeding of the snails was done in standard lab conditions for maintenance of *S. mansoni* cycle and for experimental study.



The experimental design used is illustrated in Figs 1, 2.

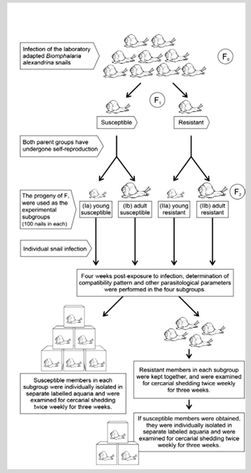


Fig. 1: a scheme showing the followed experimental design with regards to the parasitological parameters

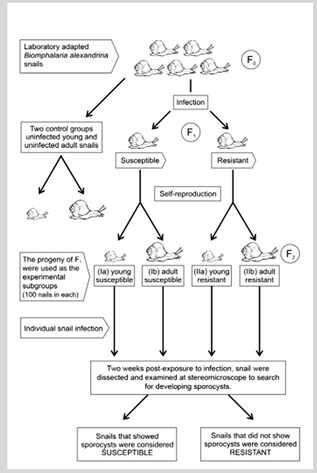
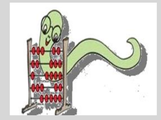


Fig. 2: a scheme showing the followed experimental design with regards to cytosolic superoxide dismutase enzyme assay

Each shedding snail in all experimental subgroups was investigated for parasitological parameters [the pre-patent period (PPP), infection rate (IR), mean cercarial output (MCO), mortality rate (MR)] (Yousif et al. 1998) and for biochemical study using SOD1 enzyme assay (Todd and Gomez 2001).

PPP= the period from the day of snail exposure to miracidia to the day immediately before its first shedding of cercarie starting from the 28th day post exposure till the 49th day post exposure

$$IR = \frac{\text{Number of shedding and positive crushed snails in each subgroup}}{\text{Number of exposed snails in each subgroup}}$$



$$MCO = \frac{\text{Sum of shed cercariae in all shedding times}}{\text{Number of shedding times}}$$

$$MR = \frac{\text{the number of dead snails in each subgroup}}{\text{the total number of exposed snails in each subgroup}}$$

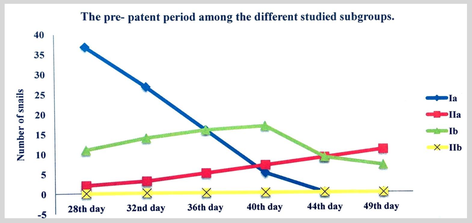
RESULTS

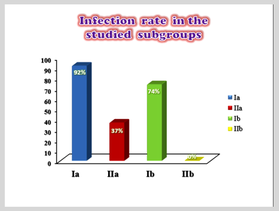
Our results showed that, young susceptible subgroup showed the highest infection rate, the shortest pre-patent period, the highest total cercarial production, the highest mortality rate and the least SOD1 enzyme activity.

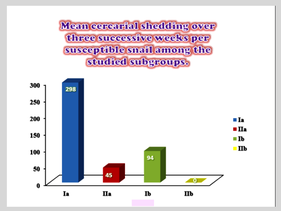
8%, 26% resistant members were obtained among young and adult susceptible subgroups respectively, indicating inheritance of resistance alleles from their parents.

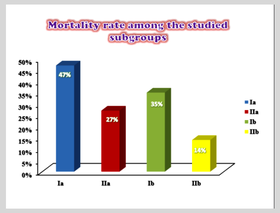
Adult resistant subgroup contained only resistant members and showed the highest enzyme activity while 37% of young resistant subgroup was susceptible.

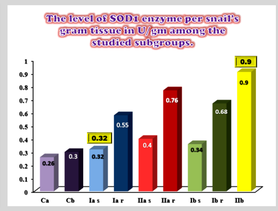
When young and adult snails obtained from the same (F1) parent were examined, higher enzyme activity was produced in adult age indicating that, *B. alexandrina* snails' age affects SOD1 enzyme activity levels.











CONCLUSION

The significant differences in all parasitological and biochemical parameters between young and adult snails in the same group were attributed to the age effect, which made resistance alleles more functional in adults, with higher SOD1 enzyme activity. Moreover, the complex interaction between age, genetic background and IDS between the susceptible and resistant subgroups results in great variability in compatibility patterns.

The results presented herein can have potential epidaemiological implications in *Biomphalaria* control. By determining the age at which a snail is most susceptible to *S. mansoni* infection, the optimal timing for the application of molluscicides could be identified. This in turn would increase the efficacy of the applied control method. Moreover, identification of the most resistant snails is important for use in biological snail control, after studying the compatibility of successive generations.

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