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Population dynamics of *Lymnaea columella* and its natural infection by *Fasciola hepatica* in the State of Minas Gerais, Brazil

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Abstract

Studies on the population dynamics and natural infection of *Lymnaea columella* by *Fasciola hepatica* were carried out from September 1999 to December 2000 in a low-lying area near Itajubá in the Brazilian State of Minas Gerais. A total of 626 snails were collected monthly at nine different sites, counted, and dissected to search for larvae of *F. hepatica*. The highest populations of *L. columella* were reached in October of 1999 and August of 2000, and the highest natural infection rates of snails by *F. hepatica* were reached in September 1999 (5.2%) and July 2000 (3.9%). The removal by farmers of aquatic plants from the drainage furrows caused a drastic reduction in this snail population.

Introduction

Fasciola hepatica (Digenea: Fasciolidae) is a digenetic fluke from the bile ducts and liver of cattle, sheep, rabbits, pigs, rodents and man (Gordon, 1955; Ueno *et al.*, 1975; Oakley *et al.*, 1979; Alcaino *et al.*, 1983). Fascioliasis is a serious problem in sheep and cattle rearing, lowering the productivity of herds by inhibiting growth, reducing milk and meat production, damaging livers so that they are unsuitable for human consumption, causing abortions, killing livestock, and requiring expenditure on parasite control measures (Oakley *et al.*, 1979; Daemon & Serra-Freire, 1992). Lymnaeid snails, the intermediate hosts of *F. hepatica*, play a very important role in the epidemiology of fascioliasis, which has been investigated in several countries (Ueno *et al.*, 1975; Rondelaud, 1977; Gaasenbeek *et al.*, 1992). In Brazil, the main enzootic area of *F. hepatica* lies in the south of the country, and *Lymnaea columella* is the snail species which acts as the intermediate host (Amato *et al.*, 1986). Several authors have studied the epidemiology of fascioliasis in different locations in Brazil, but population dynamics and natural infection rates in *L. columella* are still poorly understood. The objectives of the present study were to investigate seasonal changes of *L. columella* populations and their *F. hepatica* infection rates.

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Materials and methods

Study site

This work was carried out in a farm near the city of Itajubá (22°25′33″S; 45°27′09″W) situated at 844 m above sea level in the Brazilian State of Minas Gerais. The farm is typical of the region, where cattle rearing is the main economic activity. The topography consists of low-lying areas with *Brachiara decumbens* pastures, surrounded by mountains. The study area was crossed by a 2 m wide stream and several drainage ditches, in which lymnaeid snails were found on the aquatic plants *Eichornea azurea* and *Heteranthera reniformis*.

The drainage ditches were cleaned by farmers in March and September 2000, i.e. at the end and the beginning of the rainy season, in order to remove aquatic plants and facilitate the flow of water. In the drier months, aquatic plants were allowed to grow and cover the ditches in order to prevent them from drying up completely. Other ditches were randomly cleaned during the study.

Snail sampling and examination

A 1 km transect was run monthly from September 1999 to December 2000 to search for potential habitats of *Lymnaea columella*. Snails with a shell height larger than 2 mm were collected from nine different plots, in 4–90 cm deep ditches. Monthly sampling was performed using the quadrat method (Amato *et al.*, 1986) in which a 1 m^2 area was randomly selected for each plot, and snails were either collected from the water with a steel sieve (1 mm mesh) or picked off aquatic plants, during a period of 20–30 min of investigation. They were then placed in wet gauze strips and transported to the laboratory.

Snails were counted, measured, and dissected under a stereomicroscope at a magnification of 40 × to search for larval stages of *F. hepatica*.

Statistical analysis

Spearman correlation tests were performed between snail population densities and factors such as precipitation, habitat area, and shell size. Correlation coefficients tests were performed using SYSTAT for Windows ®

Results

Lymnaea columella populations

A total of 626 *L. columella* were collected during the study. No lymnaeid snails were found in the stream nor in ditches where aquatic plant species *Eichornea azurea* and *Heteranthera reniformis* were absent.

Variation in mean population densities in the collection plots is shown in fig. 1, and fig. 2 shows the variation in the number of snails collected, together with records of precipitation and temperature. Snail population means were around 17 snails per m^2 in September and October of 1999, with the highest density of 20.6 snails per m^2 observed in November. The *L. columella* population decreased drastically in December 1999, and January and February 2000, due to the flooding of the study area during these months. In March, when the drainage ditches were cleaned for the first time a new snail population was discovered at a site where snails had not been found previously, in the only furrow that had not been cleaned. In April, this ditch was drained, eliminating the last remaining population of *L. columella* in the study area. In May and June, the aquatic plant communities resumed growth but no adult lymnaeid snails were collected. However, in June, *L. columella* eggs were found on the leaves of *H. reniformis*.

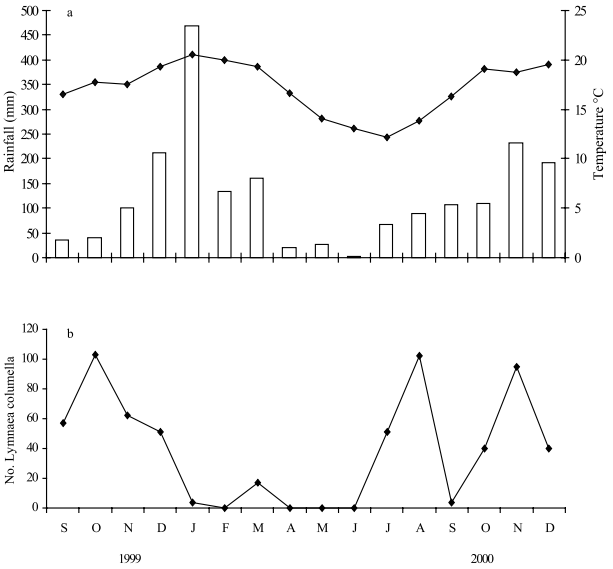

Fig. 2. (a) Mean monthly temperatures (-◆-) and rainfall (□) and (b) the number of *Lymnaea columella* collected in Minas Gerais State, Brazil, during September 1999 to December 2000.

In July, snail populations were again present at several sites. The number of snails collected increased during August but in September the ditches were cleaned for the second time, eliminating most of the snail populations. However, the populations recovered during the following months, reaching another peak in November. No correlation was found between temperature and snail populations (rs = −0.125) nor between precipitation and snail populations (rs = −0.249).

Figure 3 shows the mean of the shell height in *L. columella*. Shell height decreased monthly at the beginning of the research, and varied randomly in the later months. Larger snails were collected in September 1999 and July 2000, and smaller snails in November and December 2000.

Table 1 shows the number of infected snails collected, and monthly changes in the prevalence of infection. Natural infection rates of *L. columella* with *F. hepatica*

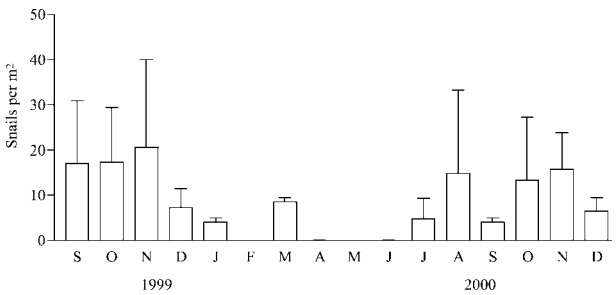

Fig. 1. Mean monthly variation in the *Lymnaea columella* populations in Minas Gerais State, Brazil, from September 1999 to December 2000.

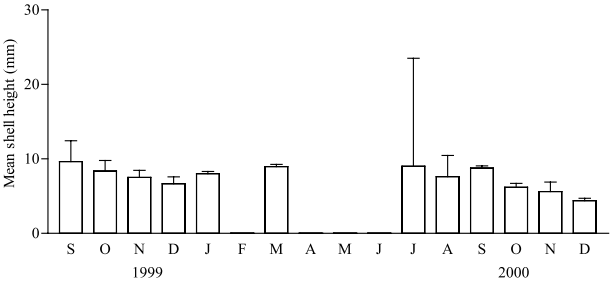

Fig. 3. Monthly variation in the shell height of *Lymnaea columella* in Minas Gerais State, Brazil, from September 1999 to December 2000.

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Table 1. The prevalence of natural infections of *Fasciola hepatica* in the snail *Lymnaea columella* in Minas Gerais State, Brazil during September 1999 to December 2000.

Year	Month	No. of snails examined	Prevalence (%)
1999	Sept	57	5.2
	Oct	103	1.9
	Nov	62	1.6
	Dec	51	1.9
2000	Jan	4	0
	Feb	0	0
	Mar	17	0
	Apr	0	0
	May	0	0
	Jun	0	0
	Jul	51	3.9
	Aug	102	0.9
	Sept	4	0
	Oct	40	0
	Nov	95	2.1
	Dec	40	0

ranged from 0.9% to 5.2% in the months when infected snails were found. The highest *F. hepatica* infection rates in *L. columella* were seen in September 1999 (5.2%), July 2000 (3.9%) and November 2000 (2.1%). The number of rediae and cercariae in infected snails varied from 1–5 and 6–25 respectively, except for one specimen in which 680 cercariae and 47 rediae were found. No correlation was found between temperature and infection rate ($rs = -0.272$) nor between precipitation and infection rate ($rs = -0.023$). A positive correlation was found between snail population densities and snail infection rates ($rs = 0.671$)

Discussion

The epidemiology of fascioliasis is related to the ecology of the intermediate host, the habitat in which it lives and climatic conditions (Mattos *et al.*, 1997). In the present study area, *L. columella* was found on the aquatic plants *H. reniformis* and *E. azurea*, which were shown to be important in supporting snail development. Other authors have reported similar associations of lymnaeid snails with aquatic plants. (Honer, 1979; Abílio & Watanabe, 1998). These findings challenge the assertion of Boray (1964) that snails preferentially occupy aquatic substrates with little or no plant coverage.

The first factor that affected the *L. columella* population during the study was a flood in January 2000. Water levels reached 7 m above normal and drastically reduced the *L. columella* population, the massive flow of water probably sweeping away most of the snails. The second factor was the cleaning of drainage ditches, which had a major influence on the population dynamics of *L. columella* in the study site. When ditches were cleaned in March for the first time, most populations were wiped out, while drainage of the last ditch in April eliminated snails from the habitat for three months. *Lymnaea columella* then returned to the study area, probably by migration from nearby areas or revival of aestivating individuals.

Population recovery showed different patterns between drainage ditches cleaned at different times. This lack of synchrony between snail populations suggests that the population dynamics in different ditches were not the same. In certain months the population of some ditches consisted entirely of young snails, whereas in others stable adult populations were already present. Shell height decreased at the beginning of this study due to an increase in the number of young snails, but no correlation was found between population density and shell size.

Natural infection rates of *L. columella* with *F. hepatica* ranged from 0.9% to 5.2%. These rates are lower than those found by Amato *et al.* (1986) in the Parnaíba valley, which reached 13.9% in the months of highest prevalence, as well as those found by Mattos *et al.* (1997) among snails on a farm in Rio Grande do Sul, southern Brazil.

Climate may influence infection dynamics of *L. columella* by *F. hepatica*. Gaasenbeek *et al.* (1992) discussed the importance of seasonality in infection rates of *Lymnaea* sp. in the Netherlands, where infected snails are able to hibernate. However, according to Amato *et al.* (1986), no seasonal pattern was found in the Parnaíba valley. Infection rates in the present study varied randomly, due in part to the small number of snails collected in some months.

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