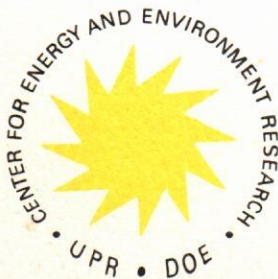


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**BIOLOGICAL CONTROL OF SCHISTOSOME TRANSMISSION
IN FLOWING WATER HABITATS OF RIO GRANDE, PUERTO RICO**

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Abstract

Little attention has been given to the effectiveness of Marisa cornuarietis for controlling Biomphalaria glabrata in flowing water. Furthermore the impact of this ampullarid snail in interrupting schistosome transmission has not been evaluated previously in an endemic community. Thus it was the purpose of this study to evaluate the role of M. cornuarietis as the sole agent for schistosomiasis control in an endemic community in Puerto Rico where transmission was occurring in flowing water. Two similar endemic communities on the northeastern coast of Puerto Rico were studied for 4 years. Populations of B. glabrata and their schistosome infections were monitored before and after introduction of 20,000 M. cornuarietis into the downstream community. After treatment (addition of the ampullarid snail) very few B. glabrata were found and none were infected. In the untreated community the B. glabrata population remained stable and the mean schistosome infection rate increased. The entire control effort for the community of 3000 people cost \$260 for over a year of protection, considerably less expensive than any other known method of control.

Introduction

Although there are several reports on the successful control of Biomphalaria glabrata by Marisa cornuarietis in ponds and reservoirs, little attention has been given to the efficiency of this biological control agent in flowing waters such as streams or irrigation canals. Studies in ponds and reservoirs are easier to organize in similar replicates, thus the initial scientific evaluations of M. cornuarietis were in various sets of ponds, leaving the impression that this ampullarid snail was not effective in flowing water. Furthermore the replicate ponds and reservoirs were chosen on the basis of similar ecology, not because they were important in schistosome transmission. Thus no information was published on the impact of M. cornuarietis in interrupting transmission of the parasite. Some have taken this to mean that M. cornuarietis is not effective in controlling transmission.

As it appeared to us that the ampullarid was effective in many flowing water habitats and that evidence has accumulated showing an additional "decoy" effect in which M. cornuarietis protects B. glabrata from schistosome infections, it was the purpose of this study to evaluate M. cornuarietis as the sole agent for control of schistosome transmission, in a representative endemic community in Puerto Rico. This simple 4-year study was designed to evaluate the effectiveness of biological control by monitoring the direct biological changes in the snail populations and their schistosome infections.

Materials and Methods

Two similar endemic communities on the northeastern coast of Puerto Rico were studied for 4 years. In addition to monitoring the snail populations, the schistosome infections in B. glabrata were also determined. The two communities were in the watershed of the Herrera River, along a system of small streams which flow all year. The streams are subject to flooding and rapid flows, due to the steep slope of the watershed and the high rates of rainfall, especially from July to December. A second shorter rainy season usually occurs in April and May.

The untreated community, Malpica, was located along Angela Creek upstream of Montebello, the community where the Marisa cornuarietis were placed, in the municipality of Río Grande (Figures 1 and 2). Housing in Malpica was slightly better than Montebello, but both communities were relatively poor by present standards in Puerto Rico. About 3000 people lived in each community and most children attended nearby public schools. The streams in Montebello were rocky but bordered with heavy vegetation. The rocks formed many deep pools which sheltered snails and offered attractive bathing sites for children who were often seen in the relatively clean water (Figure 3). In Malpica the streambeds were mostly clay with heavy vegetation. The water was turbid and filthy but children played in it (Figure 4). In both communities the streams were contaminated by direct sewage discharges from latrines and septic tanks.

FIGURE I. LOCATION OF MONTEBELLO AND MALPICA ON NORTHEAST COST OF PUERTO RICO

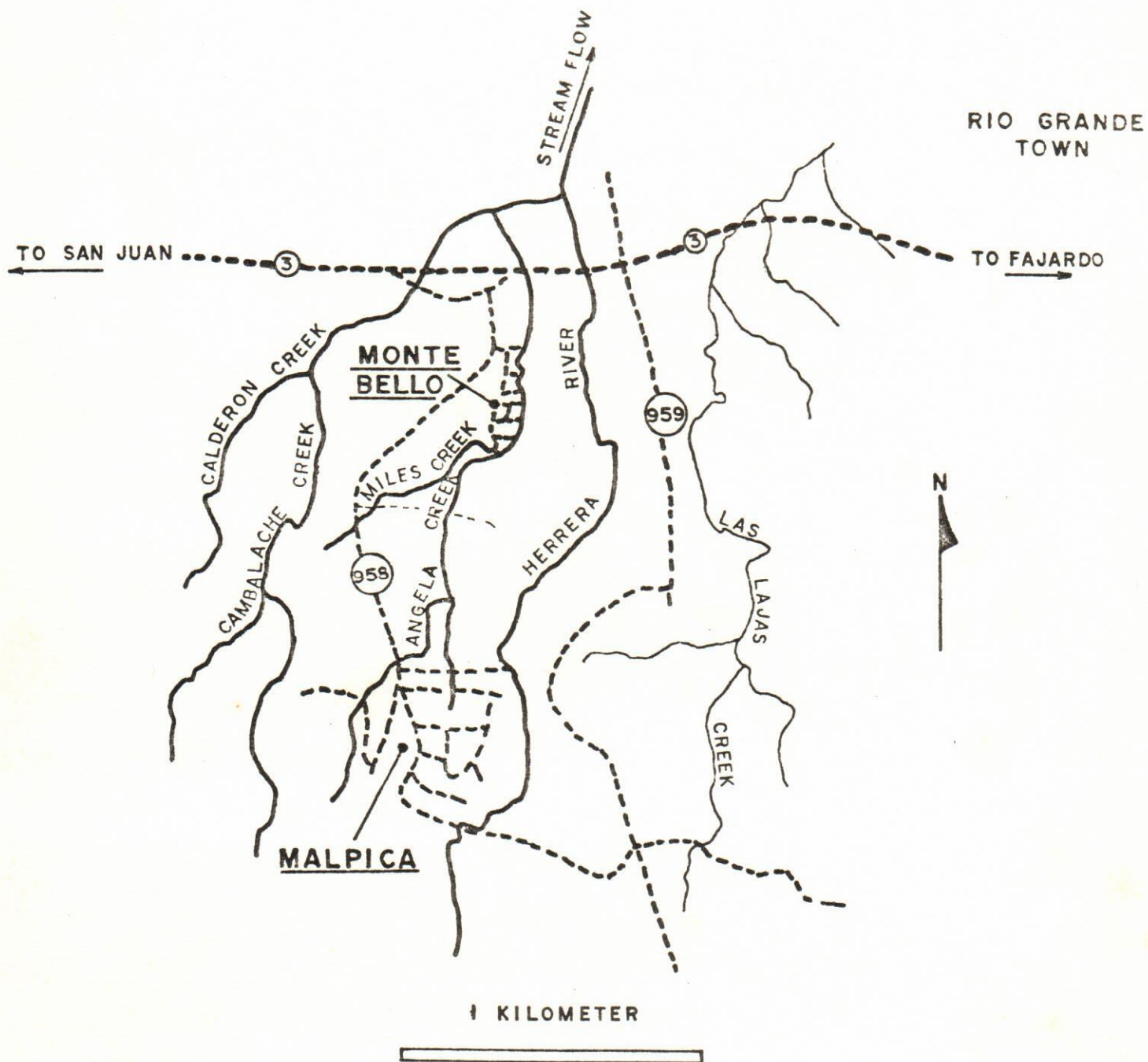




Figure 2. Montebello consists of a compact community of single-family houses constructed in the flood plain of Angela Creek. The creek is delineated by the row of trees in the foreground and right-hand side of the photo.



Figure 3. Angela Creek near Montebello contains many pools formed by large rocks and surrounded by heavy vegetation.

Very simple techniques were used in the biological control effort; M. cornuarietis were collected from Lake Guayo in central Puerto Rico by walking the lake shore, collecting the snails with wire dippers and placing them in plastic buckets (Figure 5). Four men each collected about 1000 snails per hour. The snails were transported the same day and placed in the streams at 10 different sites in the treated community of Montebello. About 13,000 ampullarids were placed in October 1977 and 7,300 in February 1978.

Monitoring of schistosome infections in the planorbid snails from both communities began in May 1975, over 2 years prior to treatment, and continued after treatment until March 1979. Snails were collected quarterly by 2 man-days of inspection in all water-bodies of the two communities, and examined for parasitic infections. The individual snails were crushed in a press-slide preparation and examined under low power microscope for presence of schistosome sporocysts and cercariae, as well as other cercaria which occasionally occur in Puerto Rico.



Figure 4. Angela Creek in Malpica contained high levels of human and animal wastes and heavy vegetation.

Table 1

Number of Biomphalaria glabrata collected and number infected with Schistosoma mansoni in Malpica and Montebello of Río Grande, Puerto Rico from 1975 to 1979.

Date	Malpica-Untreated		Montebello-Treated	
	<u>B. glabrata</u>	Number Infected Snails	<u>B. glabrata</u>	Number Infected Snails
<u>1975</u>				
May	53	0	29	0
June	--		50	3
<u>1976</u>				
August	33	0	25	5
September	19	2	6	1
<u>1977</u>				
March	37	14	21	2
June	5	0	3	2
September	15	0	28	1
			* * * * *	
December	37	1	0	0
			* * * * *	
<u>1978</u>				
April	25	1	0	0
May	0	0	0	0
July	6	1	0	0
September	126	52	1	0
October	37	6	0	0
December	--	--	6	0
<u>1979</u>				
January	52	7	0	0
March	44	4	1	0
April				

*Marisa cornuarietis added (a total of 20,000).

-- No survey.

Results

Previous to addition of the ampullarid snails, both communities had stable populations of B. glabrata, with low rates of schistosome infections occurring in the snails in all months of the year (Table 1). The mean infection rate with S. mansoni was 9% in Montebello and 10% in Malpica, before treatment. Occasional infections with Cercaria marini were found, but the large majority were S. mansoni.

In the year and a half after the first group of M. cornuarietis were placed in Montebello very few planorbid snails were found despite intensive searching. None were infected. The ampullarid population declined somewhat but continued to reproduce. Since the small streams were frequently scoured by floods, the smaller B. glabrata was expected to survive better than M. cornuarietis, but apparently the ampullarid reduced B. glabrata to minimal levels.

In the untreated community of Malpica the B. glabrata population remained stable at pretreatment levels and the mean schistosome infection rate increased to about 28% during 1978, demonstrating that the decreases in snails and schistosome infections in Montebello were not due to general ecological trends in the area. Since Malpica is directly upstream of Montebello, planorbid snails were probably being continually washed down to Montebello but were not establishing colonies, apparently due to the effect of M. cornuarietis.

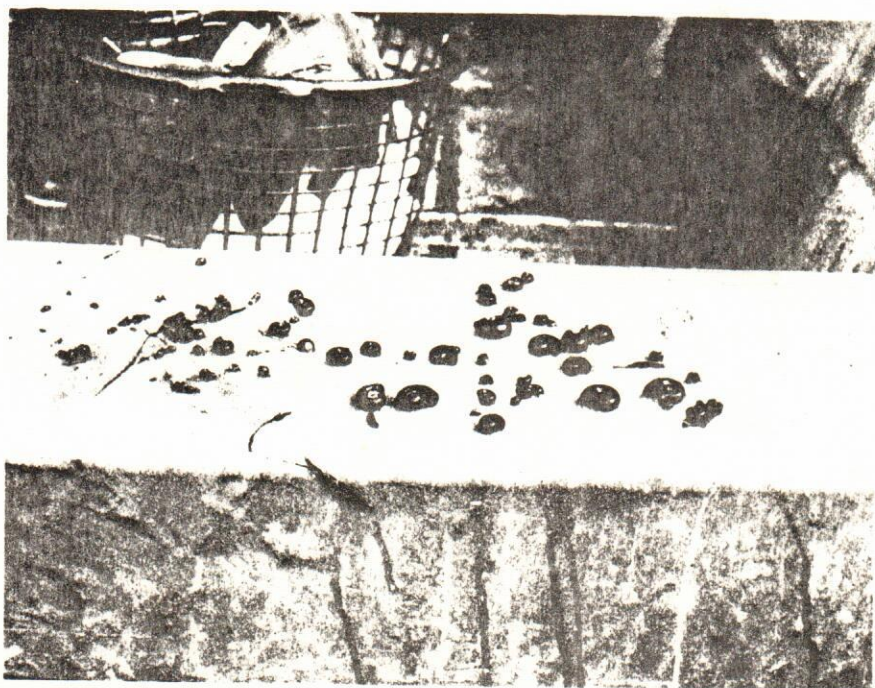


Figure 5. Large numbers of Marisa cornuarietis were collected in a single scoop from Lake Guayo, including all ages and sizes.

Discussion

Previous field surveys showed that schistosome transmission had been occurring in this area for over 15 years^{1,2}. In addition studies in 1963, 1964 and 1965 showed that cercariae could be recovered from the water entering Montebello during every month of the year³. Continuation of transmission was further documented in 1976 when this municipality was found to have the second highest skin test positivity on the island⁴. There is thus no doubt that this was an endemic zone for some time and provided a representative site for testing the ampullarid snail.

Due to the large decrease in the planorbid population it was not possible to measure the decoy effect of M. cornuarietis, but this may have been protecting the planorbids from infection. Previous pond studies showed that this ratio should be 6:1 or greater to block schistosome infection⁵. The 20,000 M. cornuarietis may have been in excess of the number needed for the decoy effect. Although they were being continually washed out by floods, the large number of M. cornuarietis eggs laid in protected places seemed to replenish the population, keeping B. glabrata at a disadvantage.

The entire control effort for one year in this community of 3000 people involved 2 days of work for 4 men. The daily wages of these 4 averaged US \$30 and transportation of the snails involved 2 trips of 100 miles each, costing an additional \$20. The total control cost of \$260 protected 3000 people

for over a year, and is about 10% of the cost for chemical control of snails in Puerto Rico. In most endemic countries, wages for unskilled labor are closer to \$3 per day instead of \$30, thus use of this technique in the Dominican Republic or Brazil would be another order of magnitude cheaper. It is undoubtedly much cheaper than any other method of control available, and should be investigated on a larger scale.

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