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# OBSERVATIONS ON SCHISTOSOME INFECTIONS OF BIOMPHALARIA GLABRATA AND AN INVADING POPULATION OF TAREBIA GRANIFERA IN A SMALL STREAM IN PUERTO RICO

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# OBSERVATIONS ON SCHISTOSOME INFECTIONS OF *BIOMPHALARIA GLABRATA* AND AN INVADING POPULATION OF *TAREBIA GRANIFERA* IN A SMALL STREAM IN PUERTO RICO[1]

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## Abstract

The purpose of this study was to monitor the presence of cercariae of *Schistosoma mansoni* in a small stream in Puerto Rico and to determine the distribution of the intermediate snail host, *Biomphalaria glabrata* as well as a thiarid snail, *Tarebia granifera*. The second snail expanded from its original limited distribution soon after the project started in February 1964. Within five years, the *T. granifera* had occupied the central portion of the stream and the *Biomphalaria glabrata* population remained only in the upper and lower reaches which were not occupied by *T. granifera*, suggesting some form of competition.

These observations suggest that the thiarid snail may have some value in a schistosomiasis control program. However the risk of transmitting the oriental lung fluke must be evaluated first since *T. granifera* does transmit this parasite in the Orient.

The occurrence of cercariae at two stations along the stream showed no seasonal pattern but appeared to follow a random distribution.

Tarebia granifera, a small thiarid snail recently introduced to Puerto Rico from Hawaii, now occurs in almost every freshwater body in Puerto Rico, often in enormous numbers.

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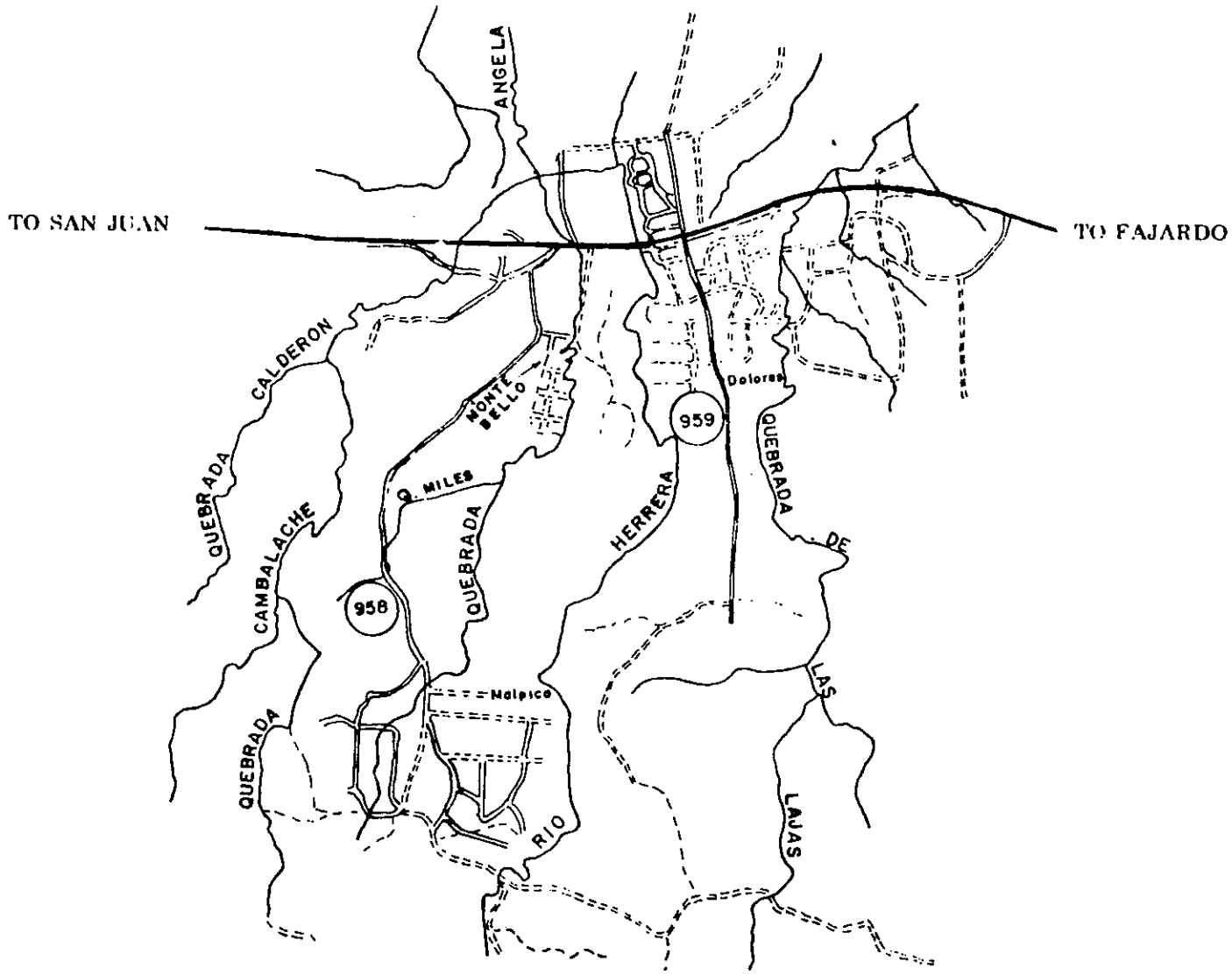
## INTRODUCTION

It has been observed for some time in Puerto Rico that the thiarid snail, Tarebia granifera was spreading throughout the island, especially in flowing water. Furthermore it often appeared to displace existing populations of Biomphalaria glabrata, the intermediate snail host of schistosomiasis. During a field study on fluctuations in the numbers of schistosome cercaria produced by a colony of B. glabrata in a small stream, it was noted that a limited population of T. granifera was gradually expanding into the area occupied by the B. glabrata colony. It was the purpose of this study to record the ensuing distribution of these two snail species, as well as the fluctuations in the number of cercariae proceeding from the B. glabrata.

The study was conducted on a small stream on the northeastern coast of Puerto Rico. The stream, called Quebrada Miles, is a tributary of the Quebrada Angela in the watershed of the Río Herrera. It drains a small part of a community called Malpica in the Cienaga Baja area of Río Grande, Puerto Rico (Figure 1).

FIGURE 1. LOCATION OF QUEBRADA MILES IN RIO GRANDE, PUERTO RICO



## MATERIALS AND METHODS

After a reconnaissance survey in February 1964, permanent sampling stations were established along Quebrada Miles, beginning with station 1 at the upstream origin and continuing downstream at 100 foot intervals for 10,000 feet. These stations were inspected about twice a year for snails, making 10 sweeps with a wire screen dipper at each station.

Because of the continuous presence of human feces and B. glabrata at Stations 16 and 23 they were monitored two days a week for over two years to measure the number of schistosome cercariae in the water. At Station 16 a centrifuge was used to concentrate cercariae from 20 liter samples of stream water beginning in February 1965 (Butler et al, 1971). The samples were taken hourly from 10 AM to 2 PM on Tuesdays and Thursdays. The cercariae recovered were fixed with picric acid and formalin and examined with a low power microscope to determine the species.

At Station 23 a filter of 11 centimeter diameter was used, recovering the cercaria on S and S 404 filter paper (Rowan, 1965). After staining with ninhydrin and heat fixation the cercaria were examined microscopically to assure correct identification. The same sampling schedule was followed as at Station 16, beginning in September 1964. Local rainfall and stream flow records were obtained from the U.S. Weather Bureau and the U.S. geological Survey.

## RESULTS

The results of the cercarial sampling showed no definite seasonal trends (Table I). The number of cercaria recovered each day varied from 0 to 580 in the 20 liter samples. Comparisons of cercarial populations with rainfall or water temperature failed to show significant trends, either with the number of cercariae recovered on a given day or with the number of days per month when cercariae were recovered. Most of the cercariae were recovered at 12 noon and 1 PM but significant numbers were also recovered at 10 AM, 11 AM and 2 PM. The results indicated sporadic transmission, probably related more to occasional defecation upstream than to changes in seasonal conditions. The centrifuge was easier to operate than the filter when the water contained a turbidity above 50 standard units since the filter process required additional filter papers or pre-flocculation of the sample.

The results from the bi-annual snail surveys showed a marked interaction between the populations of Tarebia granifera and Biomphalaria glabrata. In addition scattered populations of Physa cubensis, Drepanotrema hoffmani, Lymnaea cubensis and Ferrissia beaui were observed but showed no relation to the other snail population except that Physa cubensis often occurred at the same stations as Biomphalaria glabrata.

TABLE 1

Ratios of numbers of days when cercaria of Schistosoma mansoni were recovered from 20 liters of sample versus number of days sampled each month at two stations along a small stream, Quebrada Miles, in Cienaga Baja, Puerto Rico.

| MONTH | 1964 | 1965 | | 1966 | |
|---|---|---|---|---|---|
| | Sta. 23 | Sta. 16 | Sta. 23 | Sta. 16 | Sta. 23 |
| J | | | 1/8 | 2/8 | 1/8 |
| F | | 4/7 | 1/8 | 2/8 | 2/8 |
| M | | 1/9 | 1/9 | 2/10 | 4/10 |
| A | | 1/9 | 0/9 | 0/8 | 2/8 |
| M | | 2/8 | 0/8 | 0/9 | 0/9 |
| J | | 8/9 | 3/9 | 0/9 | 0/9 |
| J | | 6/9 | 8/9 | 0/8 | 0/8 |
| A | | 0/9 | 2/9 | 0/9 | 1/9 |
| S | 2/4 | 2/9 | 1/9 | 0/9 | 1/9 |
| O | 4/9 | 1/8 | 5/8 | 0/8 | 0/8 |
| N | 0/8 | 1/9 | 5/9 | 0/8 | 0/8 |
| D | 0/10 | 2/9 | 2/9 | 0/9 | 0/9 |

During the first snail survey of June 1964, B. glabrata was present at 53 of the 100 stations, from station 4 to 93 (Figure 2). I. granifera was found from station 30 to 47 and at station 70, a total of 17 out of 100 stations. Gradually the I. granifera population extended downstream, reaching station 84 by April 1965 and station 88 by January 1968. Finally at the end of the study in October 1969 the thiarid population had reached station 92.

In contrast, the colony of B. glabrata began decreasing in extent by April 1965, showing a marked withdrawal in March 1966 to the reach between stations 11 and 44. In 1967 B. glabrata was re-established in the lower reaches below station 85. During 1968 until the end of the study in 1969, B. glabrata appeared sporadically in the intermediate reaches.

The changes in extent of B. glabrata and I. granifera showed a strong relationship. As the thiarid snail covered the middle reaches of the stream, the planorbid snail population remained only in the upper and lower reaches, retreating from its original widespread distribution. This was seen most dramatically during October 1967 when B. glabrata did not occur at any of the stations from 29 to 85 where I. granifera was present (Figure 2).

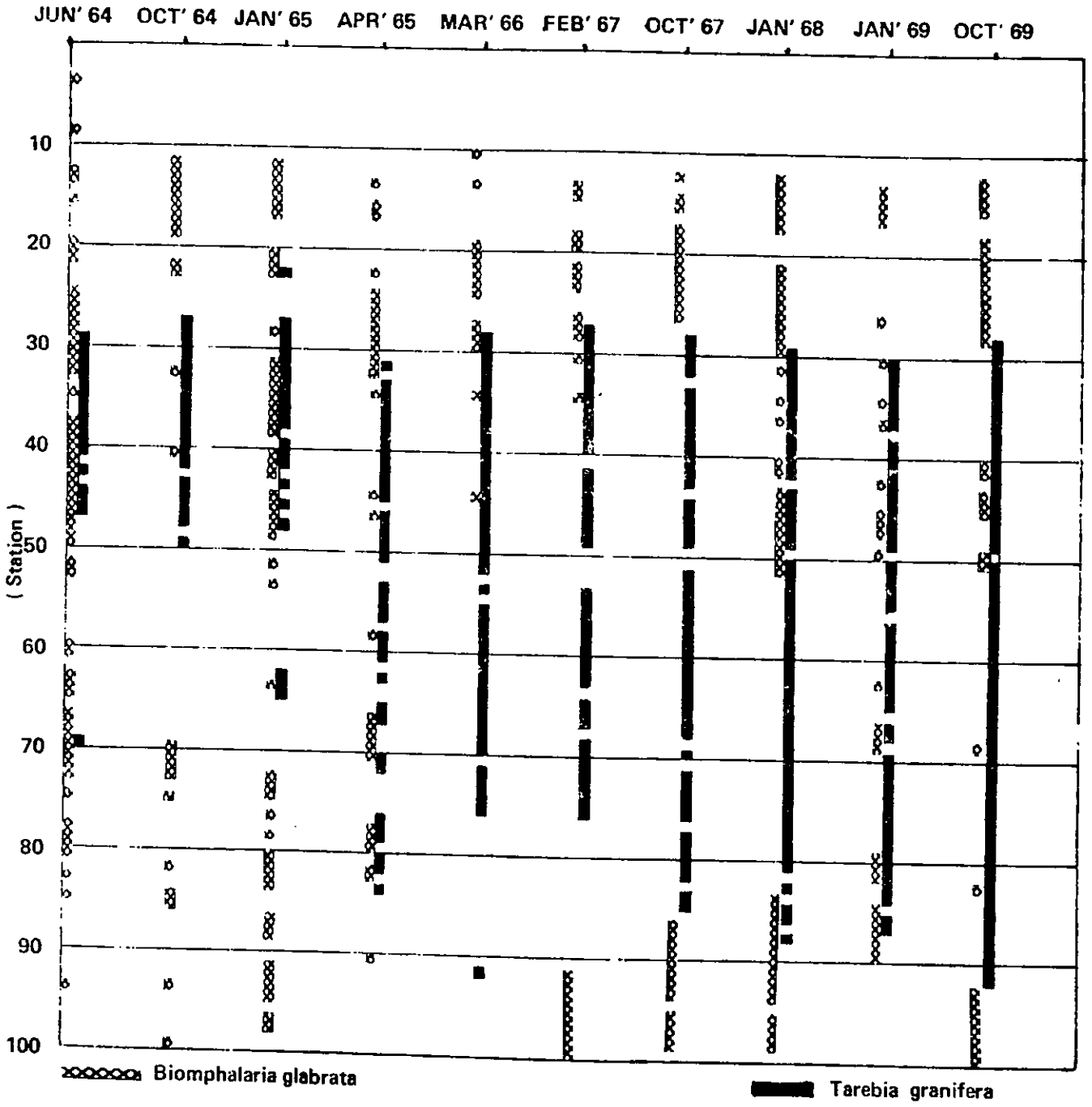



Figure 2 Presence of *Biomphalaria glabrata* and *Tarebia granifera* along a small stream, Quebrada Miles, in Ciénaga Baja, Puerto Rico.

This exclusion was not complete during other surveys but the relationship was marked during the last 4 years of the study. Due to the sporadic transport of snails by flow and their continual up-stream migration against the current, the populations were developing in a dynamic situation. Thus both species are being continuously reintroduced by this process throughout the stream's length. Because of this, long-term absence of the planorbid from the middle reaches must have been due to a significant force existing in those reaches which prevented normal development of the planorbid colony, probably the presence of T. granifera. A second more complicated explanation is also possible. Since T. granifera does not have exactly the same habitat preferences as B. glabrata, changes in the ecology of the middle reaches could have favored the thiarid snail and suppressed the other. Although no obvious physical changes occurred during the study, there may have been changes in flow of the stream, flood frequency and other factors which were not monitored.

## DISCUSSION

Over 3,500 T. granifera from eastern Puerto Rico were examined for trematode infections and found negative (Lee and Berrios, 1973). However, Tarebia granifera is the intermediate host for Paragonimus and theoretically could cause human disease in Puerto Rico, if un-cooked crustacea were eaten locally. This does not occur in Puerto Rico but its possibility should be evaluated. If it were proven that Tarebia granifera could be used to prevent schistosomiasis however, the extremely small risk that it might some day transmit Paragonimus would seem acceptable. Furthermore the snail is present in many parts of the island already and its introduction into schistosomiasis foci would not dramatically change the remote possibility of Paragonimus transmission in the future.

Carefully designed field trials are needed to determine if T. granifera can regularly control B. glabrata and to determine the habitat characteristics in which this method would succeed. Assuming that Tarebia granifera would be most effective in flowing water, it would complement the use of Marisa cornuarietis in standing water (Jobin, et al, 1973).

The data on cercarial populations did not show any particular seasonal distribution. Previous reports on monthly variations in infection rates of snails have also shown a fairly uniform seasonal pattern. For four years the Puerto Rico Health Department collected snails from their pilot control projects and checked them for a week for shedding of cercariae, in the U.S. Public

Health Service Laboratory. The Annual Reports of the USPHS Laboratory showed a mean infection rate of 1.5% for the snails, varying between 0% and 5.6% but no consistent annual pattern was found (Table II).

TABLE II

SUMMARY OF PUERTO RICAN SNAIL - INFECTIVITY DATA TAKEN FROM RANDOM COLLECTIONS OF BIOMPHALARIA GLABRATA - FROM JANUARY 1954 THROUGH JUNE 1956.

| Year | January | February | March | April | May | June | July | August | Sept. | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1954 | 1/664* | 2/540 | 30/923 | 0/783 | 0/761 | 1/565 | 15/849 | 8/1063 | 16/1020 | 53/1455 | 25/668 | 42/1820 |
| | 0.15% | 0.37% | 3.25% | 0% | 0% | 0.18% | 1.77% | 0.75% | 1.57% | 3.64% | 3.64% | 2.31% |
| 1955 | 74/3530 | 18/2089 | 43/2396 | 9/1292 | 33/2575 | 5/973 | 19/1488 | 23/1282 | 3/1255 | 19/300 | 10/545 | 11/1202 |
| | 2.10 | 0.86 | 1.80 | 0.70 | 1.28 | 0.51 | 1.28 | 1.79 | 0.24 | 6.33 | 1.84 | 0.92 |
| 1956 | 14/875 | 10/1573 | 51/1986 | 65/2560 | 22/2506 | 6/1638 | 3/1197 | 4/1239 | 60/1064 | 11/858 | 17/951 | 26/435 |
| | 1.60 | 0.64 | 2.57 | 2.50 | 0.88 | 0.37 | 0.25 | 3.23 | 5.64 | 1.28 | 1.79 | 0.60 |
| 1957 | 13/1290 | 27/959 | 3/991 | 46/1567 | 7/866 | | | | | | | |
| | 1.01 | 2.82 | 0.30 | 2.94 | 0.81 | 0 | | | | | | |
| TOTAL | 102/6359 | 57/5161 | 127/6296 | 119/6202 | 62/6708 | 12/3723 | 37/3534 | 35/3584 | 79/3339 | 83/2613 | 52/2164 | 79/3457 |
| | 1.60 | 1.10 | 2.02 | 1.92 | 0.92 | 0.32 | 1.05 | 0.98 | 2.36 | 3.18 | 2.40 | 2.28 |

*Number of infected snails/number of snails collected.

## Acknowledgments

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