THE EFFECT OF WATER TEMPERATURE ON THE PENETRATION AND DEVELOPMENT OF ST. LUCIAN *SCHISTOSOMA MANSONI* MIRACIDIA IN LOCAL *BIOMPHALARIA GLABRATA*

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INTRODUCTION

There have been many reports in the literature concerning the effect of water temperature on the development within the intermediate host snails of human schistosome parasites (Gordon *et al.*, 1934; Standen, 1952; Stirewalt, 1954; Edwards and McCullough, 1954; and Foster, 1964). On the other hand, there have been a very few reports concerning the effect of water temperature on the initial penetration of the intermediate host snails by human schistosome miracidia (DeWitt, 1955; Purnell, 1966; and Chu *et al.*, 1966). Seasonal variations in water temperature ranging from 22°C-30°C occur in four valleys under routine observation on the island of St. Lucia. Nevertheless, direct sunshine on shallow water habitats can produce temperatures in excess of 30°C at almost any time of the year. The purpose of this investigation was to study the effect of water temperature on the initial penetration of St. Lucian *Biomphalaria glabrata* by local *Schistosoma mansoni* miracidia and on the subsequent development of the parasite in the snails.

MATERIALS AND METHODS

The laboratory-bred *B. glabrata* used were the offspring of field snails and ranged from 7-10 mm in diameter. Miracidia of *S. mansoni* were obtained by hatching eggs from faeces of infected St. Lucian patients.

360 snails were used in 12 groups of 30. One group served as a control, the other eleven groups were exposed to miracidia in water temperatures ranging from 10°C to 40°C at 3°C intervals. Refrigerators were used for exposures at 10°C, 13°C, and 16°C; air-conditioned rooms for exposures at 19°C and 22°C; and water-baths for exposures at higher temperatures.

Snails were exposed individually for one hour to 4 miracidia each in tubes containing about 5.0 ml of filtered well water. The snails and the tubes containing the miracidia were kept separately at the experimental temperature for 30 minutes prior to exposure.

After exposure, the snails were taken out of the tubes, washed several times in filtered well water, and then maintained in glass jars at room temperatures (25°C-27°C). The snails were fed with boiled dasheen *(Colocasia esculenta)* leaves. Twelve days after exposure, each snail was examined for *S. mansoni* daughter sporocysts by crushing (Chernin and Dunavan, 1962). The method of estimating the number of miracidia penetrating a snail has been described elsewhere (Upatham, 1973a).

RESULTS

The results are shown in Fig 1. No infection occurred below 16°C. Snail infection rates rose with increasing water temperatures, from 14.3% at 16°C to a peak of 71.4% at 34°C, and then decreased to 10% at 40°C. Maximum infection rates were obtained between 25°C and 34°C.

The numbers of *S. mansoni* daughter sporocysts produced at the various water

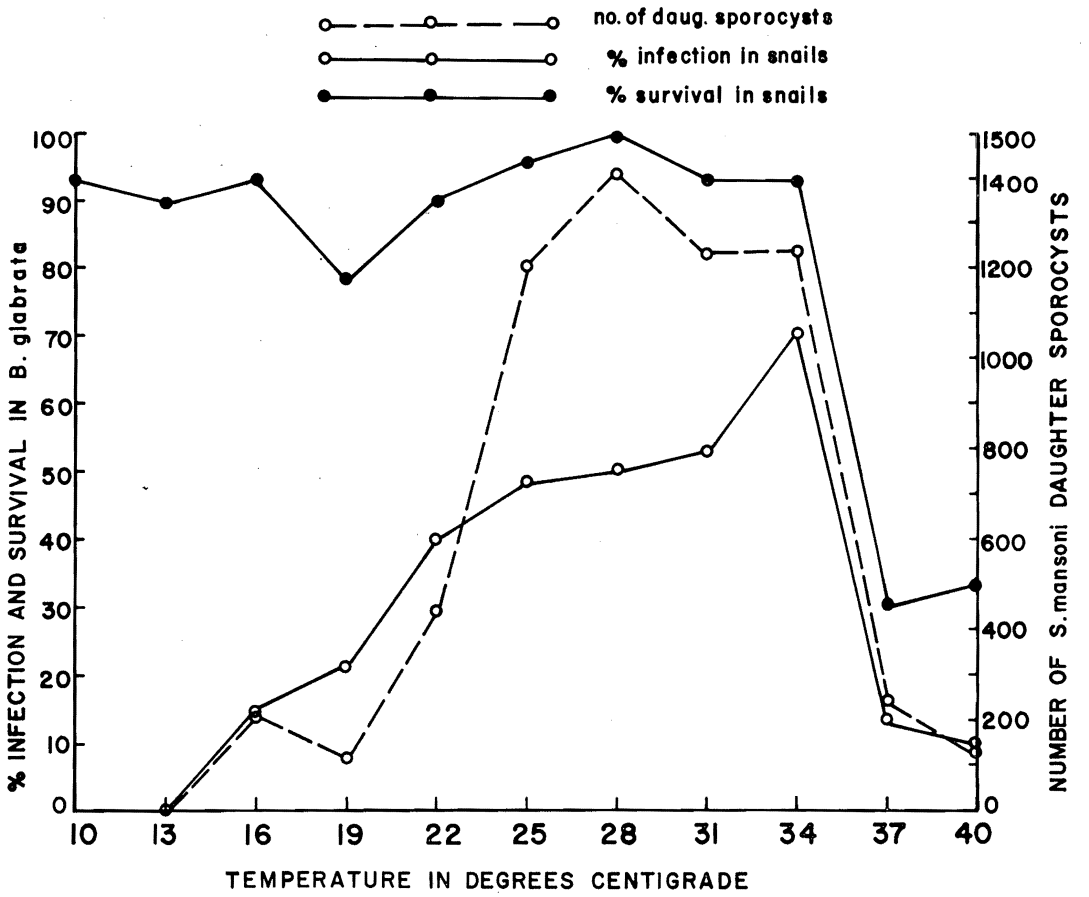

Fig. 1—Showing the effect of water temperature on the penetration and development of *S. mansoni* miracidia in *B. glabrata*, and on the survival of *B. glabrata*.

temperatures followed a pattern similar to the infection rates in snails; rising from 223 at 16°C to 1414 at 28°C, and then decreasing to 140 at 40°C. The optimum temperature for a high production of daughter sporocysts was also between 25°C and 34°C.

The snail survival rates were high in groups exposed at water temperatures between 10°C and 34°C, but were low in groups exposed at 37°C and 40°C.

DISCUSSION

The results of the present study indicated that both the penetration and the subsequent development of *S. mansoni* miracidia in *B. glabrata*, determined by snail infection rates and the development of daughter sporocysts, were directly related to the water temperature at the time of exposure. The optimum temperature range for maximum infection rates and sporocysts production was between 25°C and 34°C. Below this range, infection rates diminished to zero below 16°C. Above this range, poor survival by the snail to the 1.5-hour exposure reduced both the snail infection rate and sporocyst production.

DeWitt (1955), using *B. glabrata* from Dominican Republic, Puerto Rico and

Venezuela exposed to Puerto Rican *S. mansoni* miracidia at temperatures ranging from 10°C to 35°C at 5°C intervals, found no infection at 10°C but increasing infection rates up to 35°C. At 40°C most of the snails died during the exposure period. Purnell (1966), exposing Tanzanian *Biomphalaria sudanica tanganyicensis* to local *S. mansoni* miracidia at temperatures ranging from 9°C to 39°C at 6°C intervals, found that the snail infection rate rose linearly with temperature. Chu *et al.*, (1966), exposing Iranian *Bulinus truncatus* to local *S. haematobium* at 9 different temperatures ranging from 10°C to 38°C, found that infection rates rose with temperatures up to 30°C, but then declined.

The findings of DeWitt (1955) and those of the present study imply that water temperature of 10°C to 16°C either minimize the chance of *S. mansoni* miracidia penetrating *B. glabrata* or, if penetration does occur, affect the miracidia so adversely as to inhibit their development in the host. Judging from these data, Western Hemisphere strains of *S. mansoni* miracidia are less infective at cold temperatures (<15°C) than are the Tanzanian strain of *S. mansoni* and the Iranian strain of *S. haematobium* miracidia.

Since water temperatures of 22°C to 30°C are fairly common throughout the year on St. Lucia, infection of *B. glabrata* by *S. mansoni* should always be possible. However, infection rates could be reduced sharply owing to excessively high temperatures during the summer months of the year. Sturrock and Sturrock (1972) and Upatham (unpublished observations) observed, for example, that in a banana drain containing about 3 inches of water, midday temperatures reached 37°C in open sunlight but in contiguous shaded water a few feet away, the temperature was only 28°C. Nevertheless, it is unlikely that water temperatures sufficiently high to stop transmission will occur: if they do, they will almost certainly kill the snail (Brand *et al.*, 1957).

SUMMARY

Experiments were carried out to investigate the effect of water temperature on the initial penetration of *Biomphalaria glabrata* by *Schistosoma mansoni* miracidia and on the subsequent development of the penetrated miracidia into sporocysts in the snails.

Snails were exposed for one hour to miracidia at temperatures ranging from 10°C to 40°C at 3°C intervals. No infection occurred in snails exposed to miracidia at 10°C and 13°C. The snail infection rates rose with increasing temperatures, from 14.3% at 16°C to a peak of 71.4% at 34°C, and then decreased to 10% at 40°C.

The optimum range for a high snail infection rate and a high production of daughter sporocysts in snails was between 25°C and 34°C.

Snails exposed to miracidia at temperatures of 37°C and 40°C suffered high rates of mortality.

In general, extreme temperatures likely to interfere with the infection of *B. glabrata* by *S. mansoni* do not occur in habitats on St. Lucia where a year-round range of 22°C to 30°C is fairly common. Excessively high temperatures during the summer months of the year could reduce transmission in some habitats, but are unlikely to eliminate it entirely.

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