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Transmission of urinary schistosomiasis in Sukumaland, Tanzania. 1. Snail infection rates and incidence of infection in school children

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ABSTRACT

Seasonal density fluctuations of *Bulinus nasutus* populations with accompanying *Schistosoma haematobium* infection rates in relation to rainfall and habitat water volumes were studied at Ukiriguru, Mwanza, Tanzania. Alongside the snail investigations, 50 school children initially negative for urinary schistosomiasis were examined regularly to determine seasonal incidence rates for the infection. Of the 17 646 *B. nasutus* collected in 2 years, 156 (0·88%) were found shedding cercariae. Snail populations fluctuated seasonally as influenced by rainfall through its effects on habitat water volume. Monthly snail infection rates ranged from 0·09% to 3·19% and were highest in February and March, at the time of the short dry period. Monthly incidence of *S. haematobium* in school children ranged between 2·6% and 12·5%, being highest in April and May. There was a significant linear association between monthly snail infection rates and *S. haematobium* incidence rates in school children (r_s^2=0·65 in 1982/83; r_s^2=0·87 in 1983/84) suggesting that the maximum transmission period for urinary schistosomiasis in the area occurs during the short dry period, sometime in February/March so that most of the infections in the community would be detected in April/May.

KEY WORDS: *Schistosoma haematobium, Bulinus nasutus,* Tanzania, epidemiology, incidence, infection rates

INTRODUCTION

Urinary schistosomiasis is known to be endemic in Sukumaland south and southeast of Lake Victoria, Tanzania. WEBBE (1962) showed that *Bulinus nasutus* was the principal intermediate host of *Schistosoma haematobium* in the area. According to WEBBE (1962), *B. nasutus* preferred temporary habitats ubiquitous in the rainy season and which dried up during the long dry season (June to September). Natural snail infection rates were found to be highest at the end of the rainy season and the period immediately afterwards (WEBBE, 1962; BAALAWY & MOYO, 1970). The transmission of *S. haematobium* was, therefore, considered to occur during this period (July to September).

However, MCCULLOUGH *et al.* (1968) in the WHO/Tanzania pilot control project hardly found any infected snails during this expected period of peak transmission in Sukumaland. Therefore, further investigation of the dynamics of transmission of *S. haematobium* was found desirable in order to clarify the situation.

This paper presents results of a 2 year study on the transmission of *S. haematobium* in the same endemic area at Ukiriguru, Mwanza, Tanzania.

MATERIALS AND METHODS

Ukiriguru is located about 35 km south of Mwanza town along the main road to Shinyanga. It is topographically and climatically typical of Sukumaland as described by WEBBE (1962). This investigation was conducted from September, 1982 to August, 1984.

Temporary habitats consisting of 8 ponds were selected for snail host studies before the onset of the rainfall season. The ponds were chosen for investigation on the basis of having shells of *B. nasutus*, closeness to human houses and having been identified by the local community as favoured bathing and swimming places, particularly for children. Soon after rainfall commenced, the study ponds were sampled for snails monthly using a standard scoop as recommended by OLIVER & SCHNEIDERMAN (1956). Water volume in the ponds was estimated as described by OLIVER & UEMURA (1973). In the laboratory *B. nasutus* from the field were screened for cercariae individually and their shell height measured. The cercariae were pooled for each pond and used in infecting hamsters for identification of the schistosome. Snails were then returned to the field within 48 hours. Rainfall and temperature records were obtained from the Tanzania Agricultural Research Organization at Ukiriguru.

Alongside the snail investigations, mid-day urine specimens were collected from 186 school children aged 8 to 12 years at Ukiriguru and Ng'ombe primary schools. Single 10 ml aliquots were examined for *S. haematobium* egg counts by the centrifugation method. Negative cases on the first examination were re-examined on 2 consecutive days in order to detect light infections otherwise easily missed by a single urine test. Finally 50 negative children were selected for the study and thereafter examined monthly for *S. haematobium* egg excretion. At the end of the first 12 months all children who became positive were dropped from the study and fresh negative ones were recruited to keep the number at 50.

RESULTS

Monthly *B. nasutus* population numbers and accompanying cercarial infection rates are shown in Table I. Rainfall and temperature figures are shown in Table II.

Of the 186 school children examined at baseline, 136 (73%) passed *S. haematobium* eggs in urine while 50 were negative. Table III shows the monthly incidence of *S. haematobium* infections in the 50 initially negative cases studied.

Figure 1 illustrates the relationships between rainfall pattern, snail habitat water volume and *B. nasutus* population fluctuations with accompanying cercarial infection rates on the one hand, and monthly incidence of *S. haematobium*

TABLE I. Monthly snail numbers and their *S. haematobium* infection rates collected from 8 ponds at Ukiriguru village.

	1982/83		1983/84	
Month	No. of snails collected/80 min	No. (%) infected snails	No. of snails collected/80 min	No. (%) infected snails
October	234	—	36	—
November	2150	2 (0·09)	357	2 (0·56)
December	3205	12 (0·38)	471	2 (0·42)
January	2234	11 (0·49)	1116	—
February	2206	42 (1·90)	345	3 (0·87)
March	2135	67 (3·19)	249	3 (1·21)
April	1276	8 (0·63)	30	—
May	907	1 (0·11)	44	—
June	449	3 (0·67)	—	—
July	136	—	—	—
August	59	—	—	—
September	7	—	—	—
Total	14 998	146 (0·97)	2648	10 (0·38)

infections in school children on the other. The Spearman rank correlation test between monthly cercarial infection rates in snails and monthly incidence of *S. haematobium* in school children, arranged such that the former corresponded with the latter in the third month, gave a highly significant linear association in both years (r_s^2=0·65 in 1982/83 and r_s^2=0·87 in 1983/84). Such an arrangement was necessary to allow for the prepatent period before an infected person began passing *S. haematobium* eggs in urine (SMITH *et al.*, 1976).

DISCUSSION

Findings in the present study indicated that the rainfall pattern influenced snail population fluctuations by filling and drying of snail habitats as also shown by BAALAWY & MOYO (1970). Maximum population density of *B. nasutus* occurred in December or January, lagging 1 to 3 months behind rainfall peaks (Fig. 1). Unlike

TABLE II. Rainfall and temperature data at Ukiriguru village†.

Month	Total monthly rainfall (mm)		Mean monthly temperature (°C)	
	1982/83	1983/84	1982/83	1983/84
October	75 (9)	145 (17)*	24	23
November	256 (21)	77 (11)	23	24
December	146 (11)	71 (9)	23	23
January	62 (7)	52 (5)	24	22
February	75 (5)	68 (10)	25	24
March	140 (13)	97 (10)	25	24
April	242 (18)	160 (17)	23	23
May	42 (5)	6 (2)	24	23
June	0	4 (1)	24	22
July	21 (1)	23 (3)	23	23
August	2 (1)	0	24	23
September	34 (3)	0	23	22
Total	1095 (94)	700 (85)		

*Number of days of rainfall in parentheses.
†Data provided by the Tanzania Agricultural Research Institute, Ukiriguru.

TABLE III. Monthly incidence of infection in school children by *S. haematobium* at Ukiriguru village.

Month	1982/83 No. of children examined	1982/83 No. (%) new infections	1983/84 No. of children examined	1983/84 No. (%) new infections
October	50	—	50	—
November	50	—	50	—
December	50	—	50	—
January	50	—	50	2 (4)
February	50	3 (6)	48	2 (4·2)
March	47	3 (6·4)	46	—
April	44	4 (9·1)	46	3 (6·5)
May	40	5 (12·5)	43	5 (11·6)
June	35	1 (2·9)	38	—
July	34	2 (5·9)	38	—
August	32	1 (3·1)	38	1 (2·6)
September	31	—	37	—
Overall (Annual)	50	19 (38)	50	13 (26)

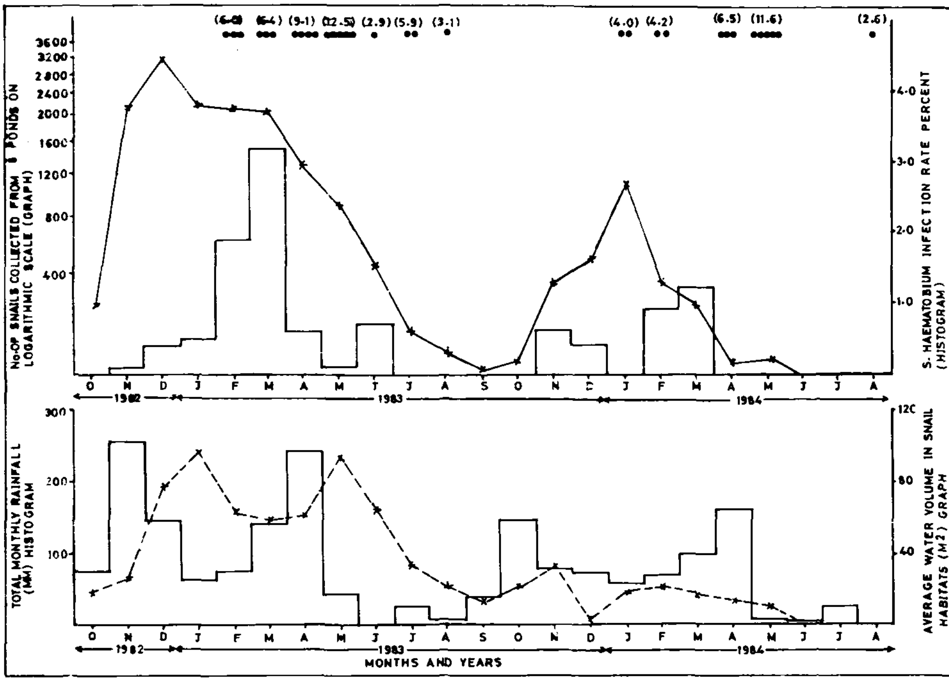

FIG. 1. Relationship between rainfall pattern, habitats water volume, snail population pattern, cercarial infection rates and monthly incidence of *S. haematobium* infection in school children. (● represents 1 positive case, while the numbers in parentheses show the incidence rate).

the findings of WEBBE (1962), there was a definite decline in snail population density at the end of the rainfall season as water volume in ponds decreased to a lowest level in July to September of 1982/83 as also observed by BAALAWY & MOYO (1970). In 1983/84 rainfall was less than in the previous season and snail populations died out in June, earlier than in the preceding year. Fluctuations in mean monthly temperatures were minimal throughout the study period and according to APPLETON (1978), were of the range favourable to aquatic pulmonate snails. Therefore, temperature was considered to have no adverse effects on *B. nasutus* population growth.

Despite the differences in the amount of rainfall and snail population sizes in the two years of study, the occurrence of infected snails during the rainy season was remarkably similar. Snail infection rates were highest in February and March of both years, at the time of the short dry period (Fig. 1). Cercarial shedding in *B. nasutus* might have been influenced by temperature, because the maximum snail infection rates were recorded when mean monthly temperatures were highest. These observations are, however, at variance with those of WEBBE (1962) and BAALAWY & MOYO (1970) who recorded the highest cercarial infection rates in *B. nasutus* between July and September, i.e., at the end of the rainy season and the period immediately afterwards.

In the present study there was either very little rainfall (1982/83) or none at all (1983/84) between June and September and snail habitats either contained small volumes of turbid water or were completely dry. Casual observations and interviews indicated that at this period swimming and bathing in the ponds lessened probably due to the unattractiveness of small volumes of turbid water as also found by LWIHULA (1985) in Ifakara, Tanzania. These findings are in close agreement with those of McCULLOUGH *et al.* (1968) who found either no infected *B. nasutus* or very few at Misungwi between July and September 1967, at the time when highest snail infection rates were expected. It would appear, therefore, quite unlikely that the peak transmission period of *S. haematobium* occurred between July and September when snail habitats were unfit for human contact and contained very few snail hosts.

Furthermore, observations on the temporal pattern of infection rates in snails are supported by those of the monthly incidence of *S. haematobium* infections in school children. By allowing an appropriate time (SMITH *et al.* 1976) for infected individuals to begin excreting *S. haematobium* eggs in urine, the monthly incidence rates in school children gave a highly significant linear association with snail infection rates.

Considering all basic factors of the transmission of urinary schistosomiasis, at least under the conditions in the present study, the maximum transmission at Ukiriguru, and probably in most of Sukumaland occurs during the short dry period, sometime in February/March so that most new cases of infection are detected in April/May.

Should control of urinary schistosomiasis in Sukumaland be contemplated, chemotherapy would best be administered in September and October, a period just before transmission begins. Apart from reducing morbidity, it will lower egg output and therefore fewer miracidia will be available to infect snail hosts during the main transmission period, hence, minimising re-infection of treated cases. Molluscicides may be applied in focal areas of intense transmission in December/January to reduce snail populations before the peak transmission period occurs.

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