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SOME MICRO-ECOLOGICAL FACTORS INFLUENCING THE POPULATION DYNAMICS OF SCHISTOSOMIASIS INTERMEDIATE HOST SNAILS IN KHARTOUM STATE, SUDAN

Mohamed A. Zakaria [1], Azzam Afifi [2], Yassir Sulieman [*3], Theerakamol Pengsakul [4]
[1] Department of Biology, Faculty of Education, University of Nyala, SUDAN
[2] Department of Zoology, Faculty of Science and Technology, Omdurman Islamic University, SUDAN
[*3] Department of Zoology, Faculty of Science and Technology, University of Shendi, SUDAN
[4] Faculty of Medical Technology, Prince of Songkla University, Hat Yai, Songkhla 90110, THAILAND

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ABSTRACT

This study was conducted to determine the role of some micro-ecological factors influencing the population dynamics of schistosomiasis intermediate host snails in the water bodies of Khartoum State, Sudan. The results show that the air and water temperature play a significant role in the determination of snail growth, a gradual increase of air and water temperate causing an increase in the snail population growth rate with the peak in summer. Water of high turbidity and high current speed caused a drop in the snail population. Vegetation cover in water bodies showed a significant effect on the snail population, the denser the cover the higher the snail population growth rate.

Keywords:
Snail; Ecology; Sudan.

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1. INTRODUCTION

Schistosomiasis is one of the major water-borne diseases in tropical and subtropical zones of the world affecting approximately 240 million people in both rural and peri-urban areas and causing at least one million deaths every year (Bruun et al., 2008). People become infected with schistosomiasis through direct contact with water bodies that are infested with the infective stage of the parasite which is liberated by different species of intermediate snail hosts (Colley et al., 2014).

Sudan is a sub-Saharan country in Africa with many water bodies which provide a favorable environment for schistosomiasis transmission (Ahmed, 1998). Among these water bodies, is the River Nile, which extends from the equatorial boundary and passes through the country from the southern region to the deep desert in the northern region, and its tributaries extend to many states of the country. Around these huge water courses, many irrigation schemes have been constructed, which provide ideal habitats for snails to breed and increase their population density. These snail species include both species of schistosoma intermediate hosts, *Bulinus* spp. And *Biomphelaria* spp. which cause dramatic levels of infection of schistosomiasis in a very wide area (Khairala, 2006).

The favorable ecological factors that enhance snail population growth are either direct factors such as temperature, rainfall, light, water current speed and turbidity, and fluctuations in desiccation, and the geology of the watercourse, or indirect factors which include abundance, feeding pattern and migratory and swimming behaviors (Madsen, 1990; Sturrock, 1993; Storey, 2002). Because of the epidemiological aspects of the transmission and control of schistosomiasis, information about the distribution and population dynamics of the intermediate hosts is very important. This information relates to the interrelationship between the disease and its intermediate host, and provides crucial key factors for any serious implementation of the disease control programs (Engels et al., 2002).

Therefore, this investigation was designed to focus on some elements of the freshwater bodies (air and water temperature, water turbidity, current speed and vegetation cover) in Khartoum State, Sudan, which may play an important role in snail population dynamics.

2. MATERIALS AND METHODS

Ninety one water contact sites which were either canalized systems or River Nile shores were randomly selected survey in 2010, from the localities of Khartoum State, Sudan, for malacological. The selected water contact sites were subjected to monthly snail collection by using the scooping technique (Amin, 1972; Ahmed, 1998). The snails collected were transferred to the Schistosomiasis Research Laboratory, University of Khartoum for classification. The snail species classified were counted separately and their population density was recorded. Air and water temperature at the selected sites were measured monthly using a normal thermometer at midday. The water current speed was measured by placing a very light floating disc at the head of the canal and allowing it to move with the water current. The time and distance moved by the disc were measured and recorded as cm/second. The water turbidity was recorded by observation of its transparency levels with the naked eye. The density of vegetation was monitored monthly and its distribution was recorded as a percentage. The depth of the water at the contact sites was measured using a long ruler. The data obtained on all the factors were statistically analyzed using the statistical software package, STATISTIX (version 4, USA).

3. RESULTS AND DISCUSSION

In this study, the lowest air temperatures were recorded in the winter, while the highest were in summer. Similarly, the lowest water temperatures were in winter and the highest in the summer (Table 1). According to the results obtained, the snail population density increased gradually with increases in the temperature of both the air and water and reached a peak in late summer. The growth in the snail population accelerates at the optimum range of temperatures, 20-27°C, as stated previously by Appleton (1978). However, higher temperatures increase the mortality rate of the snails particularly when the thermal death point of 35-40°C is reached (Pfluger, 1980). The analysis of the dynamics of the snail population studied in related to temperature variations was statistically significant at $P < 0.05$.

Table 1: Seasonal variations in temperature of air and water and their role in distribution of snail population, Khartoum State, Sudan, 2010.

Season/month		Average air temperature (C°)	Average water temperature (C°)	Snail species number		Snail total number
				Bulinus sp.	*Biomphalaria* sp.	
Winter	January	25	15	70	103	173
	February	22	16	106	183	289
	March	29	17	145	259	404
Summer	April	35	23	204	487	691
	May	36	24	272	568	840
	June	39	25	311	643	954
	July	37	23	139	477	616
Autumn	August	33	22	66	123	189
	September	32	20	21	24	45
	October	31	19	36	41	77
	November	30	19	33	53	86
	December	27	17	48	92	140
Total				1451	3053	4504

In this study, the water current speed and turbidity in the canal system were found to fluctuate throughout the year (Table 2). In winter, the water turbidity level was low and the current speed in the canals was only moderate. This situation probably creates unfavorable conditions in the snail's habitat that reduce the growth level of their population density (Fenwick, 1988). In summer, the water became almost transparent, and its current speed reduced gradually to a stagnant state. Within this period, the snail population density started to increase to reach a peak in June. This finding is similar to the results of a previous study conducted by Babiker (1987). In tropical regions, rainfall is probably the most important climatic factor affecting snail population density, and rain is associated with abnormal bursts of egg-laying in field sites (Madsen, 1982; O'Keeffe, 1985). However, in autumn, the amount of water in the canal systems increases and leads to high turbidity levels as well as a high current speed. This situation is usually followed by a reduction in the snail population density due to changes in several habitat factors, such as temperature, nutrient availability or other physicochemical factors (Mahmoud et al., 2001).

In winter, the water depth was recorded as being between 30.5 and 36.4 cm, whereas the vegetation covered less than 50% of the water bodies, causing a reduction in snail species density. In summer, the water depth ranged between 30.6 and 36.3 cm and the vegetation became progressively denser to reach 80% coverage in June. Because of this, the snail population density increased dramatically and reached its peak (Table 2). In autumn, both the water depth and vegetation cover showed the lowest levels and the density of snails was consequently highly reduced, especially in October when it reached its lowest level. Webbe (1962) stated that one of the most important factors determining the distribution of snail populations is the availability of food. Differences in snail population density according to water depth and vegetation cover at contact sites were statistically significant at $P < 0.05$.

In conclusion, the information provided on ecological factors that influence the distribution of the snail host of schistosomes will allow decision makers to adopt effective control measures.

Table 2: Seasonal variation of some ecological factors associated with snail population, Khartoum State, Sudan, 2010.

Season/month		Water turbidity	Water current speed (cm/s)	Water depth (cm)	Vegetation cover (%)
Winter	January	Low	Moderate (2≤10cm/s)	36.4	35
	February	Low	Slow (>2cm/s)	34.7	48
	March	Low	Slow (>2cm/s)	30.5	50
Summer	April	Very low	Stagnant (no current)	32.6	70
	May	Very low	Stagnant (no current)	36.3	73
	June	Very low	Slow (>2cm/s)	33.8	80
	July	Low	Slow (>2cm/s)	35.1	76
Autumn	August	Turbid	Moderate (2≤10cm/s)	21.4	46
	September	High	Fast (<10cm/s)	22.9	15
	October	Moderate	Fast (<10cm/s)	19.7	20
	November	Moderate	Moderate (2≤10cm/s)	20.5	30
	December	Low	Stagnant (no current)	18.3	50

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