

An Ecological Study on Some Aspects of Schistosomiasis in the Mid-Western Region of Saudi Arabia

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ABSTRACT. This ecological study on some aspects of schistosomiasis was conducted in the Mid-Western Region of Saudi Arabia during a six months' period (September 1984 - February 1985). The snail intermediate-hosts of schistosomiasis that were collected were *Biomphalaria arabica arabica* (Melvill and Ponsonby 1896) *Bulinus (Bulinus) truncatus* (Audouin 1827) and *Bulinus (Bulinus) beccarii* (Paladilhe 1872) the first being the most predominant. Snail habitats vary from perennial streams, intermittent streams, cisterns, dams and their reservoirs. The permanent perennial streams and dams' reservoirs support the greatest abundance of snails. Baboons, *Papio hamadryas*, were found naturally infected with *Schistosoma mansoni* (Sambon 1907).

Schistosomiasis is considered to be one of the most important public health problems in the world affecting almost 300 million people (Jordan and Webbe 1982). Azim and Gismann (1956) were the first to record infection with *Schistosoma mansoni* (Sambon 1907) in children in the Kingdom of Saudi Arabia. Later, Farooq (1961) conducted a comprehensive survey of schistosomiasis in the Kingdom of Saudi Arabia and recorded infections with *Schistosoma mansoni* and *Schistosoma haematobium* (Bilharz 1852) in various regions. Alio (1967) produced a comprehensive report on the epidemiology of schistosomiasis in the Kingdom of Saudi Arabia with emphasis on geographical distribution patterns of snail intermediate-hosts. Arfaa (1976) made a survey of schistosomiasis in Saudi Arabia. He commented on the focal nature of transmission and suggested that this offers a good opportunity to reduce the transmission of schistosomiasis by snail control operations. However, recent developmental schemes involving agriculture have resulted in an increase in surface water and the creation of new habitats suitable for

the survival of snail intermediate-hosts of schistosomiasis. This may result in an all-year transmission of schistosomiasis in large foci instead of seasonal transmission in small foci (Jordan and Webbe 1982). Despite extensive control measures, baboons, (*Papio hamadryas*) occur freely in some parts of Saudi Arabia, Western and Southern Regions of Saudi Arabia. (Kummer *et al.*, 1981). As they live in close association with man they may help to maintain transmission to humans by acting as reservoir hosts.

The present study is an ecological survey of the distribution and some biogeographical aspects of snail intermediate hosts of schistosomiasis in the Mid-Western Region of Saudi Arabia. The role of baboons, *Papio hamadryas*, as reservoir hosts of schistosomiasis was also investigated.

Material and Methods

The present study is of a qualitative nature conducted during a six months' period, September 1984 - February 1985, corresponding with high level of precipitation and rainfall. The conditions allow the establishment of snail habitats and enhance their survival thus facilitating their location.

Description of Area of Study and its Water Resources :

The Mid-Western Region extends from the Red Sea including the Tihamah Plateau and the Sarawat Mountains. The central portion of the Sarawat Mountains may be divided into two areas: the Highlands of Central Hijaz (Taif) and Southern Hijaz (Ghamid and Zahran) with mountain peaks reaching 2500 meters above sea level. The areas visited and surveyed in the Mid-Western Region were Khulays oasis, Wadi Fatimah, Jeddah-Mecca area, Taif Highlands, Turabah oasis, Aqiq Oasis, Bahah and Makwah.

The Khulays oasis lies near the highway directly connecting Jeddah/Medina. It has many dug wells and a running stream (Wadi Khulays) emerging from an underground canal arriving from springs in the Khawar area.

Wadi Fatimah is the garden area for Jeddah and Mecca and the Wadi's water comes from a watershed north of Mecca. There are also many drilled wells and some small springs.

Jeddah-Mecca area includes two of the largest cities of Saudi Arabia, the Holy city of Mecca and the Red Sea port of Jeddah. Many wells, such as the big Aziziyah well, supply water to humans and for other purposes.

Taif Highland, in Central Hijaz, derives its water from wells and from Turabah oases and there are also many perennial streams in the surrounding area.

Turabah oasis, 180 kilometers East of Taif at an elevation of 1100 meters above sea level, derives its water from the large "Wadi Turabah" collecting flood water from the surrounding Highlands.

Aqiq Oasis, 300 kilometers East of Taif, at an elevation of 1300 meters above sea level, has an extensive perennial stream supplying water for agriculture and human use.

Bahah, 250 kilometers East of Taif, at an elevation of 2200 meters above sea level, is the central town of the Mid-Western Region and has many perennial streams nearby.

Makwah, 350 kilometers East of Taif at an altitude of almost 2000 meters above sea levels has many perennial streams.

In Taif Highlands and Ghamid and Zahran Area almost more than 18 dams have been constructed. The reservoirs of these dams are full of water throughout the year.

Snail Survey: Visits were made to the above-mentioned sites and three factors were investigated: the species of snail intermediate-hosts (and other aquatic snails) present, the geographical distribution of snails, and the ecological parameters at snail habitats. Snails were identified by the late Dr. C. Wright (Natural History Museum, London). In the laboratory snails were individually placed in "3×1" glass tubes under an electric lamp to detect any shed cercariae.

Baboon survey: Stool samples were collected from a troop of 40 baboons in Bahah area. These were examined in the laboratory, after concentration by standard parasitological techniques, for schistosome eggs. (Jordan and Webbe 1982).

Results

A. *Snail Survey*

1) *Snail species collected:* The snail intermediate-hosts of *S. haematobium* collected in this study were *Bulinus (Bulinus) truncatus* (Audouin 1827, Egypt) and *Bulinus (Bulinus) beccarii* (Paladilhe 1872, Aden). *Bulinus (Bulinus) wrighti* (Mandahl-Barth 1965, South Yemen) was not found in the present study but was recorded by Alio (1967).

The snail intermediate-host of *S. mansoni* collected in this study was *Biomphalaria arabica arabica* (Melvill and Ponsonby 1896, Dhofar).

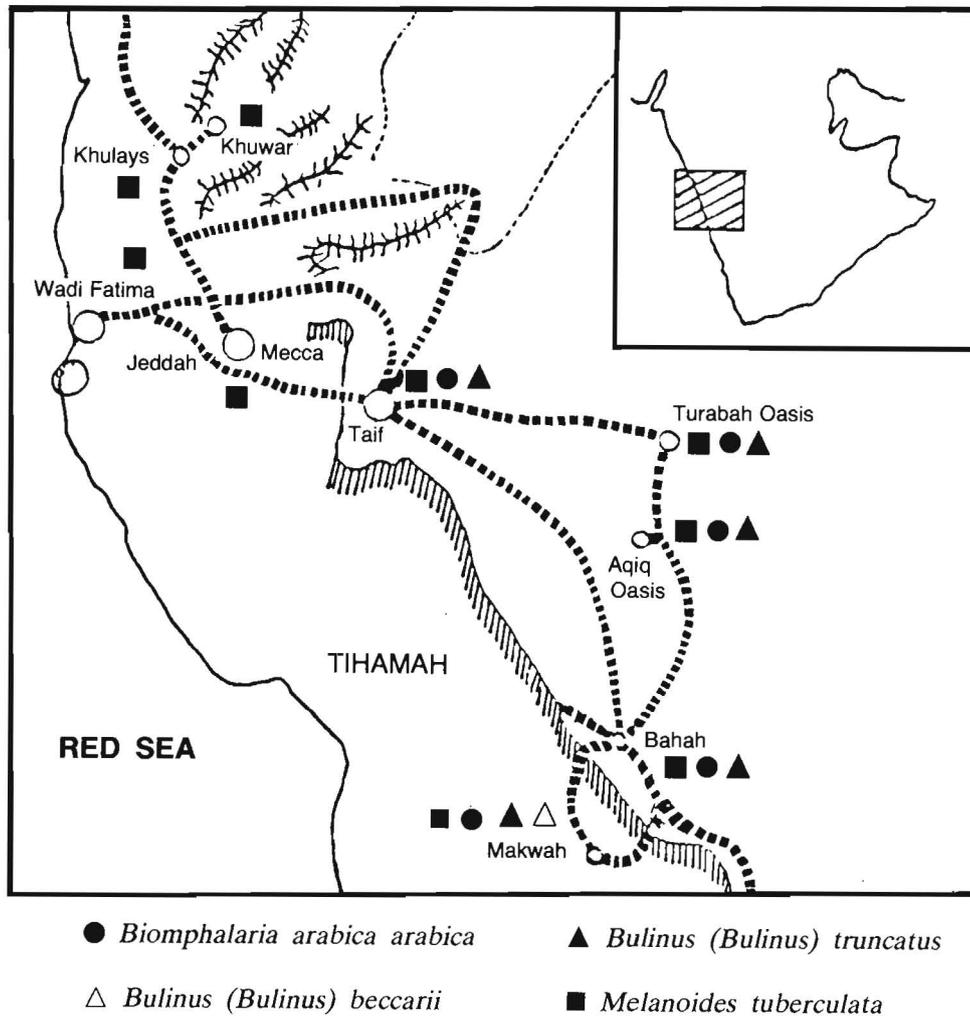


Fig. 1. Map of the Mid-Western Area of Saudi Arabia showing the geographical distribution of snails.

The snail, *Melanoides tuberculata* (Müller 1774, India) which is not an intermediate-host for *S. haematobium* or *S. mansoni* was the only other snail collected in this study.

2) *Geographical distribution of snails*: The present study shows the absence of snail intermediate hosts of schistosomiasis, during the period of investigation, in Khulays, Wadi Fatimah and the Jeddah-Mecca area. In the other five areas (Taif, Turabah, Aqiq, Bahah and Makwah) *Biomphalaria arabica arabica* (Melvill and Ponsonby 1896, Dhofar) and *Bulinus (Bulinus) truncatus* (Audouin 1827, Egypt)

have been found. At Makwah, in addition to these snail intermediate-hosts *Bulinus* (*Bulinus*) *beccarii* (Paladilhe 1872 Aden) was also recorded. The aquatic snail *Melanooides tuberculata* (Müller 1774, India), which is not an intermediate-host for schistosomiasis, was found in all the eight areas surveyed in the present study in greater abundance than other snails. This may be due to its parthenogenetic and viviparous mode of reproduction (Brown and Wright 1980).

3) *Ecological Parameters of Snail Habitats and Relative Abundance of Snails:* The snail habitats studied in this survey can be grouped into four categories: perennial water courses (Figs. 2,3,4), intermittent water courses (Figs. 5,6,7), cisterns (Figs. 8,9,10) dams and their reservoirs (Figs. 11,12,13). Tables (1,2,3 and 4) show the ecological parameters at these water courses. Natural infection with *S. mansoni* was recorded in *Biomphalaria arabica* from Bahah at the rate of 1%.

B. Baboon Survey

Examination of baboon stools revealed the presence of natural infection with *Schistosoma mansoni* in two (out of 40) of the samples examined. The number of eggs was very scanty (5 eggs/gm. faeces). Baboons were seen at Taif, Bahah, Aqiq and Makwah.



Fig. 2. (Wadi Turabah)



Fig. 3. (Makwah area)



Fig. 4. (Taif area)

Figs. (2,3,4): Perennial Water Courses in the Mid-Western Region of Saudi Arabia.



Fig. 5. (Wadi Fatimah Area)



Fig. 6. (Khulays Area)



Fig. 7. (Jeddah-Mecca Area)

Figs. (5,6,7): Intermittent Water Courses in the Mid-Western Region of Saudi Arabia.

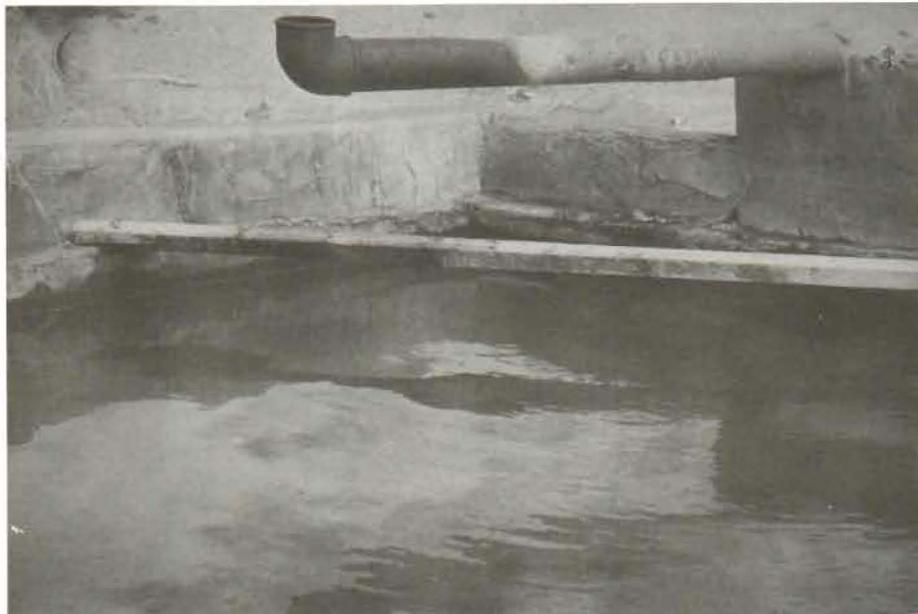


Fig. 8. (Wadi Fatimah Area)



Fig. 9. (Jeddah-Mecca Area)

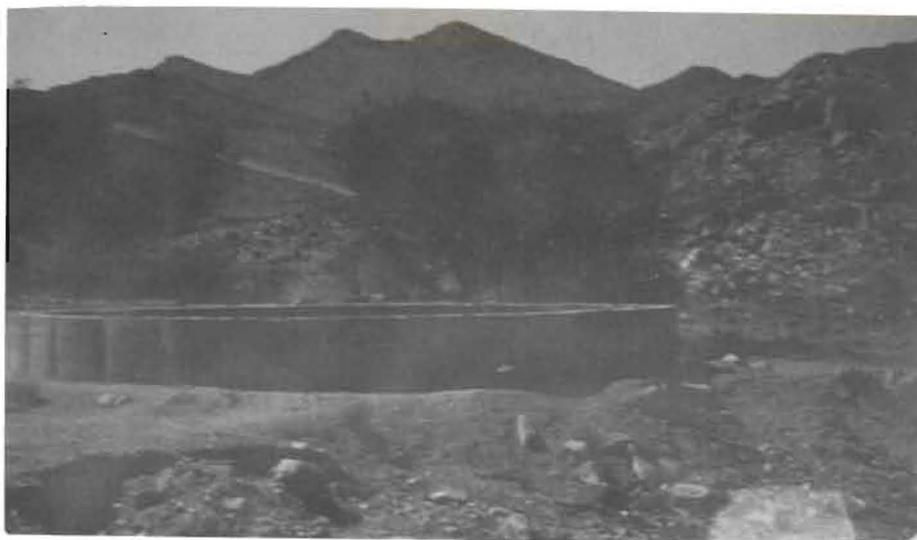


Fig. 10. (Khulays Area)

Figs. (8,9,10): Cisterns Supplied with Water from Dug Wells, in the Mid-Western Region of Saudi Arabia.



Fig. 11. (Dam near Bahah Area)

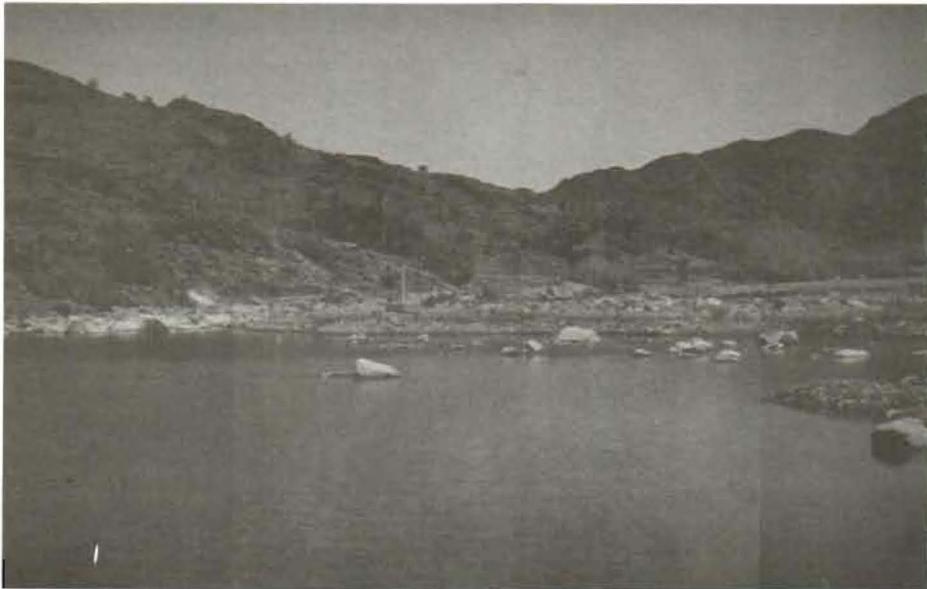


Fig. 12. (Reservoir of Dam near Baha Area).

Figs. (11,12,13): Dams and their Reservoirs in the Mid-Western Region of Saudi Arabia.



Fig. 13. (Dry Wadi Fatimah's Dam).

Table 1. Perennial Water Courses.

Date of Collection	Locality	Water Velocity	Aquatic Plants	Snails		
				<i>Biomphalaria arabica</i>	<i>B. truncatus</i>	<i>B. beccarii</i>
Sep. 1984 Oct. 1984	Taif (Gadir Al Banat)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	+++	+	-
Sep. 1984 Oct. 1984	Taif (Wadi Shafah)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	+++	+	-
Sep. 1984 Oct. 1984	Taif (Wadi Boau)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	+++	+	-
Nov. 1984 Jan. 1985*	Turabah (Wadi Turabah)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	++++ -	+	-
Jan. 1985	Aqiq (Wadi Aqiq)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	+	+	-
Jan. 1985	Bahah	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	++++	+	-
Feb. 1985	Makwah (Wadi Makwah)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	++	+	+

* Diversion of a small tributary of Wadi Turabah occurred.

++++ : 20 snails per collection for 15 minutes.

+++ : 10 snails per collection for 15 minutes.

++ : 5 snails per collection for 15 minutes.

+ : 1 snail per collection for 15 minutes.

Table 2. Intermittent Water Courses.

Date of Collection	Locality	Water Velocity	Aquatic Plants	Snails		
				<i>Biomphalaria arabica</i>	<i>B. truncatus</i>	<i>B. beccarii</i>
Oct. 1984 Dec. 1984	Wadi Fatimah	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Oct. 1984 Dec. 1984	Wadi Fatimah	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Dec. 1984	Khulays (Wadi Khulays)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Dec. 1984	Khulays (Wadi Khulays)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Jan. 1985 Feb. 1985	Jeddah-Mecca Road)	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Feb. 1985	*Makwah	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—

* Diversion of a tributary of Wadi Makwah occurred.

Table 3. Cisterns filled from wells.

Date of Collection	Locality	Water Velocity	Aquatic Plants	Snails		
				<i>Biomphalaria arabica</i>	<i>B. truncatus</i>	<i>B. beccarii</i>
Sep. 1984	Taif Area	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Oct. 1984 Dec. 1984	Wadi Fatimah	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Oct. 1984 Dec. 1984	Wadi Fatimah	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Dec. 1984	Khulays	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Dec. 1984	Khulays	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—
Jan. 1985	Jeddah-Mecca Road	Stagnant	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	—	—	—

Table 4. Dams and their reservoirs.

Date of Collection	Locality	Water Velocity	Aquatic Plants	Snails		
				<i>Biomphalaria arabica</i>	<i>B. truncatus</i>	<i>B. beccarii</i>
Sep. 1984	Taif	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	++	+	—
Oct. 1984	*Wadi Fatimah	—	—	—	—	—
Jan. 1985	Bahah	Slow	<i>Lippia Sp.</i> <i>Oedogonium Sp.</i> <i>Oscillatoria Sp.</i>	++ ++	+	—

* Dam is still dry since it is still under construction.

++ : 10 snails per collection for 15 minutes.

+ : 1 snail per collection for 15 minutes.

Discussion

The present study reveals three important ecological and epidemiological aspects: (i) the abundance of snail intermediate hosts in perennial water courses and reservoirs (and their absence in intermittent water courses), (ii) the positive role of baboons *Papio hamadryas* as reservoir hosts of schistosomiasis and (iii) the detrimental effect of diversion of existing habitat (and the creating of new water courses) on snails. The perennial water courses studied in this survey are supplied by water from reservoir: during the past 18 years almost 18 dams have been constructed in Taif Highlands and Ghamid and Zahran Areas. These dams have altered ecological conditions in the area and possibly enhance the transmission of schistosomiasis. Silt in flood water (pouring from mountains) is now retained behind these dams thus offering ideal conditions in water courses for snail survival. The reservoirs have reduced water current velocity thus increasing the probability of snails becoming infected by miracidia and of human hosts by the cercariae more than before dam construction. Alio (1967) and Arfaa (1976), Brown and Wright (1980) and Buttiker and Ferguson (1983), suggested that transmission of Schistosomiasis was seasonally focal in transmission in Saudi Arabia. However, the prevalence of infection with *S. mansoni* in the villages surrounding Bahah probably shows an all-year transmission pattern reaching high prevalence levels (9.35 - 26.2%) in 1983/1984 (Annual Report, Bahah, Schistosomiasis Control Division, 1984). In general, during the past 10 years public health problems associated with man-made lakes have become significant with the construction of large water impoundments in Africa such as Lake Kariba, Kainji Lake, Lake Nasser, Volta Lake, Cabora Bassa Dam in Mozambique and the Tafialet Dam in Morocco (Bradley and Webbe 1975). In Egypt, an increase in prevalence of schistosomiasis occurred due to the establishment of Aswan High Dam and the conversion of annual flooding (basin irrigation) into perennial irrigation. The Nile, previously devoid of snails, has now become a favourite habitat for breeding of snail intermediate-hosts of schistosomiasis and irrigation canals and drains harbour throughout the year undisturbed and stable populations of these snail hosts (Malek 1975). The present study clearly reveals the absence of snail intermediate hosts of schistosomiasis in the intermittent streams and their stability in perennial water courses. The risk to human health associated with man-made lakes and dams is to be borne in mind before the finalization of Wadi Fatimah Dam. At the present, snail intermediate-hosts (during the study period) are absent in the area. Storage of water in the dam's reservoir could create favourable conditions for snail intermediate-hosts and other vectors of disease. Proper control and water management should be implemented on completion of the dam.

The present finding of baboons as reservoir hosts of *S. mansoni* is of great epidemiological importance. These hosts could maintain the life cycle of the parasite and add strain on control measures. In addition, snail intermediate-hosts carried down by flood from non-inhabitable mountains, where baboons live could

disperse the disease over large areas. Similar cases of animal reservoirs of human schistosomes have been reported by Nelson (1960) and Fenwick (1969).

Diversion of tributaries of Wadi Turabah and Wadi Makwah and the creation of new water courses had a detrimental effect on snails. The dried water courses were full of dead snails while the newly created water courses were free of snails. The observations are limited but are similar to the "winter-closure" phenomenon in irrigation systems in the Sudan and Egypt whereby canals used to be closed and dried up for 40 days and the silt deposited on their beds was dredged out together with snails and vegetation (Malek 1975).

Barlow (1933) suggested, on basis of results obtained from an experimental area in the Nile Delta, that clearance of canals continuously over a period of years would not completely eradicate the snail hosts but would constitute the major factor in control of schistosomiasis. Bradley and Webbe (1975) recommended this environmental control measure of snail hosts.

The present study is a preliminary investigation on some ecological aspects of schistosomiasis in the Mid-Western Area of Saudi Arabia and is to be followed by a more extensive longitudinal study.

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دراسة بيئية عن بعض النواحي للبلهارسيا في المنطقة الغربية (الجزء الأوسط) بالمملكة العربية السعودية

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جدة - المملكة العربية السعودية

أجريت هذه الدراسة البيئية على بعض النواحي للبلهارسيا في المنطقة الغربية (الجزء الأوسط) في المملكة العربية السعودية خلال مدة ستة أشهر (سبتمبر ١٩٨٤ - فبراير ١٩٨٥ م). وقد جمعت قواقع العائل الثانوي للبلهارسيا مثل . .

Bulinus (Bulinus) truncatus, Biomphalaria arabica arabica

و *Bulinus (Bulinus) beccarii* ويغلب النوع الأول في العدد. وتتباين أماكن معيشة القواقع من مجارٍ دائمة إلى مجارٍ غير دائمة ومن خزانات المغيرة للماء إلى السدود وخزاناتها. وتكثر عادة هذه القواقع في المجاري الدائمة والسدود وخزاناتها. وقد وجدت نسبة إصابة طبيعية ببلهارسيا *Schistosoma mansoni* في قردة السعدان *Papio hamadryas*.