THE ACQUISITION OF DISEASE IN A RESETTLEMENT AREA IN THE SUDAN AND THE MEANS WHEREBY SUCH DISEASES MAY BE CONTROLLED

THESIS

Submitted to the

UNIVERSITY OF LONDON

for the degree of

DOCTOR OF PHILOSOPHY

in the

FACULTY OF MEDICINE

by

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From the Department of Clinical Tropical Medicine
London School of Hygiene and Tropical Medicine

October, 1973

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ABSTRACT

The construction of the Aswan High Dam resulted in flooding and submerging the land behind it. By 1964 a large and deep lake was formed and about 150 kilometres of it was inside the northern borders of the Sudan. It covered the Wadi Halfa district where 60,000 Sudanese Nubians had been living and the Republic of the Sudan had obligations, as stated in the 1959 Nile Waters agreement, to resettle these people. Over 50,000 of these Nubians were transferred and resettled in Khashm el Girba, 600 miles away in Eastern Sudan. They had been deeply rooted in their homes for thousands of years and had there been part of an ancient civilisation as evidenced by relics in Bohen and Abu Simbil.

This mass resettlement was completed in about 3 years. The magnitude of the problem surpassed any past experience of the kind in Sudan and was perhaps unique in the world. The Nubians in the new area faced completely different social, ecological and environmental conditions from what they had known. This it was thought would expose them to new diseases, a situation which needs to be studied with as objectives first the information of the public health

authorities about the health problems detected and thus helping in establishing control measures and secondly the determination of principles for preservation of health that ought to be applicable to other situations.

The present study included clinical examinations and investigations in both areas in an attempt to find the evidence of acquisition of disease resulting from the uprooting and resettlement of the Nubians in the new area. This study had shown that the Nubians are acquiring Schistosoma mansoni infection for the first time and that this infection is gaining predominance over S. haematobium infection. This study also provides evidence that the reaction of the Nubians to the leishmanin test is changing. This may suggest that the new settlers are being exposed to leishmaniasis. The Nubians came from a malaria free district and are now also faced with the problem of malaria in Khashm el Girba. The results of the malaria survey are therefore reported. The pattern of other diseases in the two districts, as well as G-6-P D deficiency and abnormal haemoglobins in the Nubians are also reported. An ecological study of the resettlement area was made and a survey for the vectors of disease and for snails was performed.

Thus the medical problems of immediate importance to the new settlers were found to be schistosomiasis and malaria and the findings of this study suggest that leishmaniasis and onchocerciasis are possible future problems. Careful surveillance of these medical problems is needed and the possible control measures for these diseases are discussed in this study. Similar surveys are needed in resettlement areas, and newly established agricultural schemes as this will enable the health authorities to take the necessary control measures. It is suggested that this study ought to be applicable in the proposed Rahad scheme in the Sudan where it is planned to resettle Nomadic tribes. It might also be applicable to similar schemes elsewhere.

ACKNOWLEDGEMENTS

I am greatly indebted to Professor A. W. Woodruff, Professor of Clinical Tropical Medicine, London School of Hygiene and Tropical Medicine for his supervision, guidance encouragement and valuable suggestions throughout the work.

I wish to extend my sincere thanks to Mr. L. E. Pettitt, Senior Technical Officer, Department of Clinical Tropical Medicine for his technical assistance and also to the technicians, laboratory assistants and all those who worked for late hours in the field studies and travelled long and sometimes rough journeys.

My gratitude is due to my colleagues in Khashm el Girba District, Old Halfa, and El Gedarif for allowing me to use their hospital facilities, their help with the transport and their generous hospitality. Special thanks are extended to Dr. M. A. Amin for helping in the snail studies and to Mr. S. M. Hussein for his help in the entomological survey.

I am very grateful for the financial support and help of the

Ministry of Health in Sudan, Sudan National Research Council, Khartoum Institute of Tropical Medicine and the World Health Organisation.

I am also grateful to Miss L. Chapman for typing the thesis.

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PART I

INTRODUCTORY CHAPTERS

CHAPTER 1

DEFINITION OF THE PROBLEM

The theme of this study is the acquisition of disease in the Nubians uprooted from Old Halfa and resettled 600 miles away in Khashm el Girba area. This mass resettlement posed many questions. It was evident that the Nubians being transferred from the northern boundary of the country to Eastern Sudan are facing different social, ecological and environmental conditions from what they had previously known. The impact of these factors on their health may be great. An attempt was therefore made in this work to study these factors and to see if there is a great variation in the two areas.

When this study was started there were still some Nubians living in the old area and it was of value to find the prevalence of diseases in this population as a base line for the comparison. The study of this population included a clinical examination and various investigations in an attempt to find the aetiology of diseases in Old Halfa.

When this survey was started in the resettlement area in February, 1969 there were over 50, 000 Nubians who had been in the Khashm el Girba district for about 3 years. To find the diseases that these people

had acquired in this area, certain questions had to be answered. It was important to find out the prevalence of disease in the indigenous population of Khashm el Girba district, this may suggest that the Nubians are likely to acquire the same diseases as they are going to live in the same district as these indigenous inhabitants. The situation has however changed in the area for both the indigenous population and the new settlers. A Dam has been built and a new irrigation scheme has led to an increased risk of transmission for schistosomiasis. A sugar factory was also built and sugar plantation started with resulting stagnant water. There is thus possibly a risk of more favourable conditions for mosquito breeding. Labour has been imported to the district, thus importing disease. The pattern of disease in the Nubians may not necessarily therefore be the same as that of the indigenous nomadic tribes of the area. So a follow up study in the Nubians was needed to find exactly what a selected number would acquire in a limited time. An interesting group of people was the Nubians born in the area. As these children have lived in the area and have not been to Old Halfa or other parts of the country, their examination and investigations would reveal the diseases actually acquired by the Nubians in New Halfa. A comparison with a similar age group in

Old Halfa would suggest a changing pattern of diseases among the Nubians. As mentioned the imported labour created new medical problems to the area and therefore I was interested to find the pattern of diseases in these labourers. They mostly came from southern and western Sudan where some tropical diseases like schistosomiasis, leishmaniasis, malaria and filariasis are endemic, special attention was given to these diseases in investigating this group. It is known that the treatment of malaria is hazardous in patients deficient in the enzyme G-6-P D and that those with sickle cell anaemia are at a risk when exposed to infections in general, so I felt that the estimation of the incidence of G-6-P D deficiency and abnormal haemoglobins in the Nubians is important.

An important theme of this study was to suggest some means of controlling the major diseases of the area. To achieve this objective after investigating these diseases, it was essential to find the vectors of disease in the area. As the ecological and environmental conditions were different in the two areas, the presence of different vectors was expected. So a survey for the various vectors in different parts of the scheme was made, e.g. the resettlement villages, the sugar

factory and the Dam. As schistosomiasis is the major medical problem of the area and probably its incidence is going to increase in the future expansions of the scheme, I thought that a study of the snail intermediate host is necessary. This entailed inspection of various water courses and a study of the infection rates of the snails.

Thus to complete this study a survey of both areas was needed. The examination of various age groups in different populations was essential and to look for the different social, ecological, environmental and other contributing factors was also important.

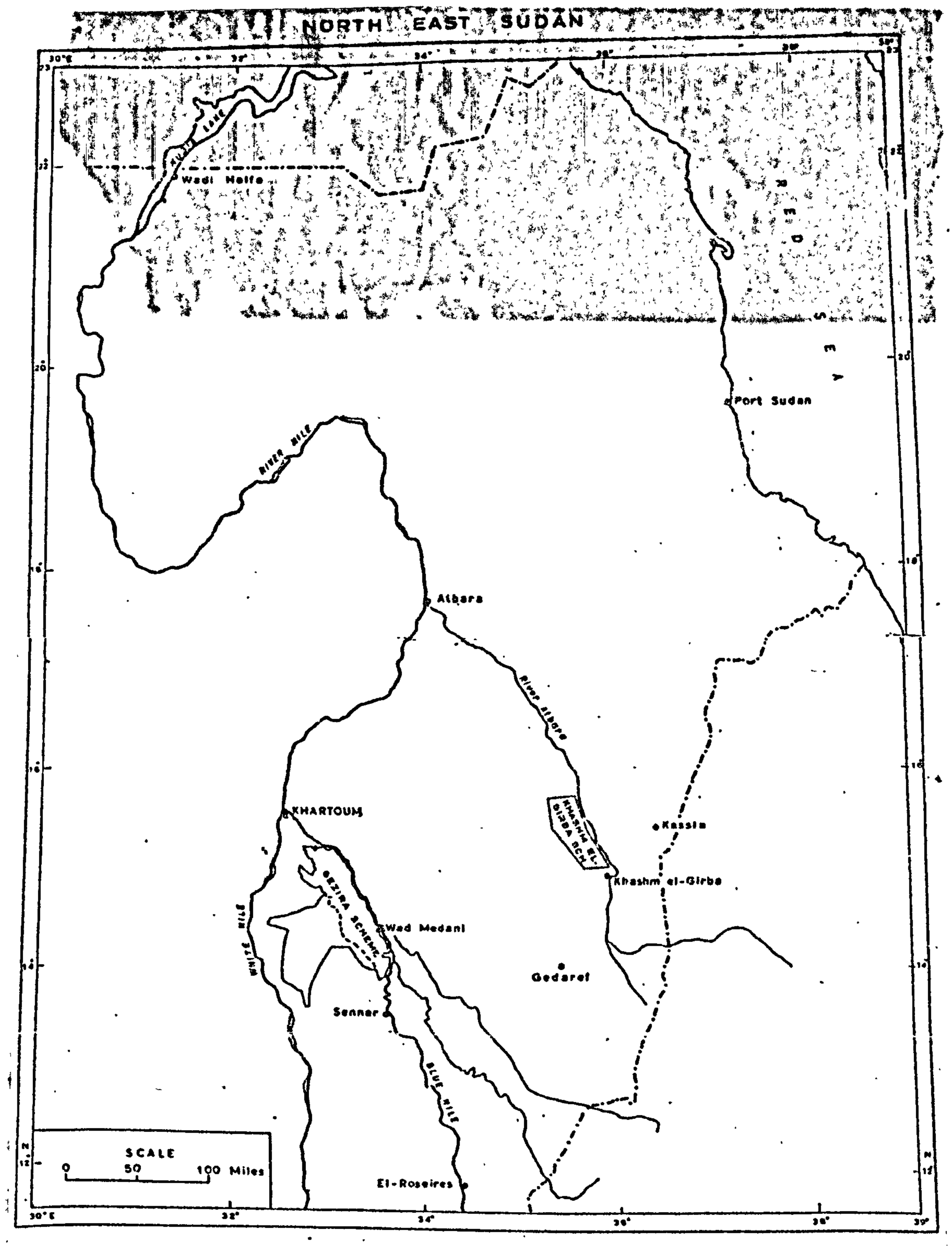
CHAPTER 2

HISTORICAL BACKGROUND AND DESCRIPTION OF OLD HALFA

The Nubians lived in Wadi Halfa district for centuries (Fig 1. map of the Sudan). Hundreds of years before Christ a Sudanese Empire existed there. The Nubian King Turhakah (7th century B. C.) and the Nubian King Piankhy of Nepata who ruled also upper Egypt (8th century B. C.), (Wallis-Budge, 1967).

The Nubian culture although influenced by the Roman, Greek and ancient Egyptian cultures from the north and also by the Ethiopian and African cultures from the south can still claim some originality. The area was described as the medium through which the past civilisations from Asia and the Mediterranean found their way to true Africa.

The Nubians are known to have their own traditions and individualism and are deeply attached to their past culture. This background is responsible for the character of the Nubian, his deep sense of belonging to the Nubian society and his attachment to the Nile. These features of the Nubian created some difficulties during their transfer to Khashm el Girba.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River Nile
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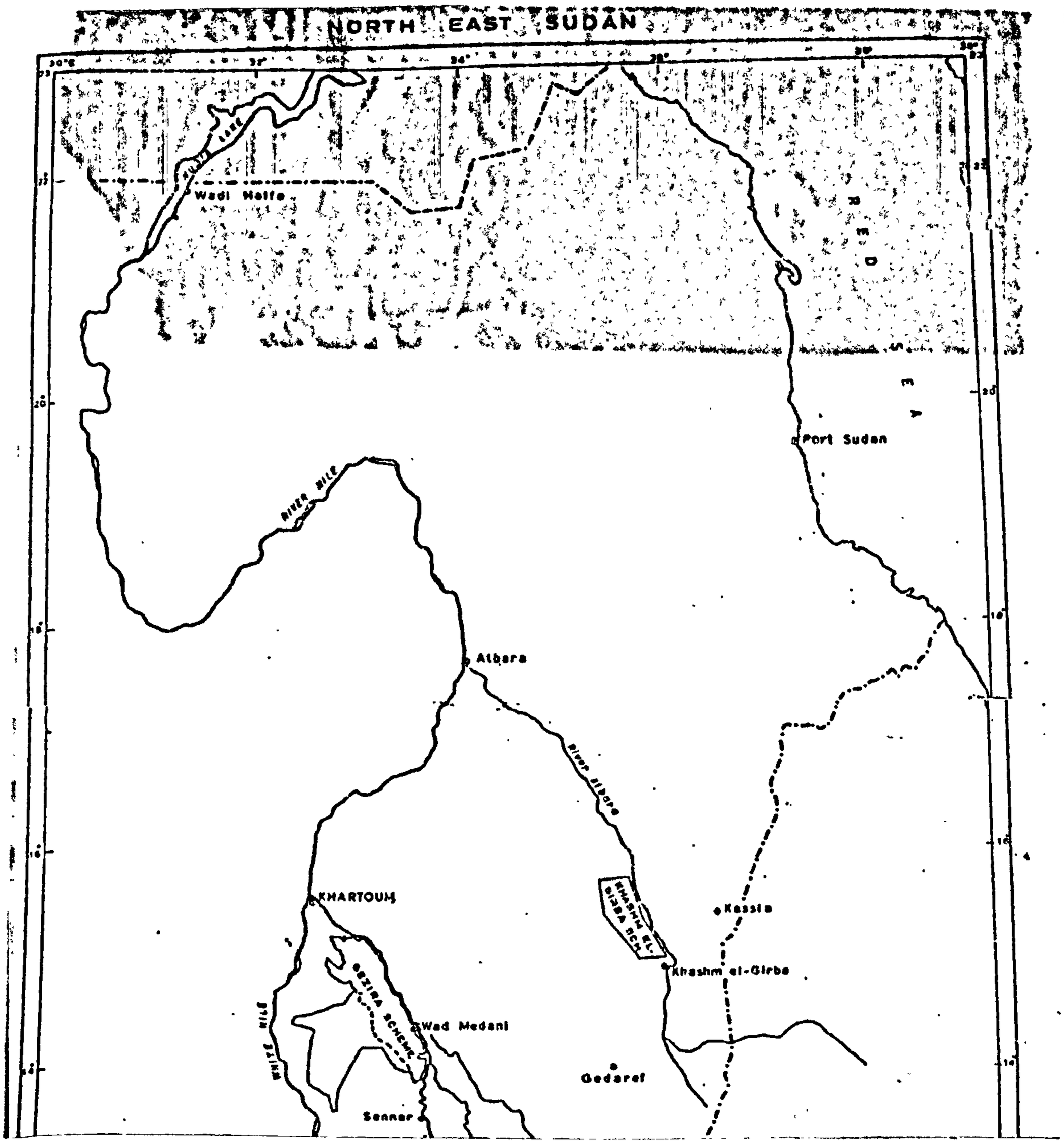


Figure 1.

Map of the Sudan showing the submerged Nubian area in the north and the resettlement area in Khashm el Girba.

Description of the Old Halfa area

The area is part of the Wadi Halfa district which was submerged by the High Dam waters extends from Faras (a border village) in the north of the Sudan to Dal Cataract in the south. It includes Old Halfa, the most northerly town in Sudan and about 14 other groups of villages. The most important ones from north to south are:- Faras, east and west, Sara, Dobiera, Ashkeit, Argin, Defhein, Saras and Akasha.

The length of the area submerged by the high dam waters is 170 kilometres. It is a narrow strip along the Nile bordered by the desert. Wadi Halfa town was the second port in the Sudan handling most of the trade between the Sudan and Egypt. It was the terminus for railways from Sudan and the steamer services from Egypt. It used to have an important airport for aeroplanes operating from U.K., Egypt and Middle East countries.

Out of the 60, 000 people who lived in that area 11, 000 lived in Wadi Halfa town, the rest lived in the scattered villages.

The Nubians are known to be law abiding and compared with other parts of the country the percentage of literacy was high. They are also known to have a high degree of political and social consciousness, to be honest, intelligent, hospitable and with high

moral standards. A high percentage (50%) of adult emigrants because of shortage of jobs kept an intimate connection with their families and used to send much financial help to their homes and so the standard of living in the area was fair compared with other parts of the country. Statistics have shown that the Nubian percentage of room and furniture exceeds other parts of the country.

Halfa town population is different from the other scattered villages, it is of a mixed structure as follows:-

1. The Nubians who constitute the majority are usually traders. Like the other Nubians who live in the scattered villages, many of working age earn their living outside this area especially in Egypt thus females exceed males in number.

2. Muhagreen who emigrated to the town mainly from the northern province (Dangola area) and they work in dockyards and follow other specialities like carpentry.

3. Asswalias who came originally from the adjacent area of southern Egypt (Aswan) and settled in Halfa mainly working as traders.

4. Bassalwas who came originally from rural Egypt.

5. Kunuz who came originally from the Shellal area (southern Egypt).

6. Eleigat who are Egyptians.

7. Shawam who are Syrians and are traders.

8. There are also the Government officials who came from different parts of the Sudan.

The River Nile transverses the Wadi Halfa district running through the desert with only a fringe of fertile land in a narrow strip on both sides. The Sahara desert lies on the west of the Nile and the Nubian desert on the east. The desert reaches the water edges in some areas, while in others there are flood plains hundreds of metres in width.

The fertile land in all the district does not exceed 20,000 acres. The main source of irrigation is by Sakias, Shadoofs and in very few areas by water pumps (Figure 2), and basins which are filled with water when the Nile is high during the flood season. The Nile runs in the southern region through rocks with a very small area available for cultivation. This limited area for cultivation resulted in much emigration, the percentage of emigrants exceeding 50% of the working age group, (Wadi Halfa Resettlement Commission, First Interim Report, 1960).

Figure 2.

A water pump scheme in Old Halfa, regarded as the most modern type of irrigation there.

Cultivation

The most important type of cultivation is the palm tree (date tree) and the area was famous in producing large quantities of all kinds of dates.

Other important crops of the area were wheat, vegetables and citrus fruit in small scale in the northern parts of the area.

Conservancy

The double bucket system of conservancy was predominant in Old Halfa town and was operating efficiently. In the villages it was mostly open defaecation as the majority did not have any type of conservancy except in the schools where they had bucket systems. Some of the houses had shallow pit latrines.

Water supply

Halfa town had an efficient chlorinated piped water supply. In the villages people either drink from the Nile or depend on wells or the small irrigation canals.

Climate of Wadi Halfa District

It is of the desert type rainless, hot during summer and cold in winter. There are very occasional showers in winter time. The temperature shows marked variation during the year. The highest maximum temperature occurs during May-June reaching 120°F

Figure 3.

Palm tree (date palm). The area was famous for producing large quantities of good dates. It was thought that dates have contributed in the bad state of the teeth of the Nubians.

(48.5°C) and the lowest in January-February when it goes down to 34°F (1.1°C).

The Style of Building

The houses are built with either stone or burnt red bricks in the town and sun baked mud bricks in the villages. Sometimes they were built mainly with mud instead of the mud being used only to plaster the bricks. On some islands they were built mainly with grass. The ceilings were usually made of palm tree branches (knitted together) and the rainless climate has helped to foster this design, however the Egyptian and Turkish styles of architechture have influenced the type of building and the street layout.

Communications in the area

The roads were very bad in the area, indeed the Halfa-Dongola road was described as being the worst motor road in the Sudan due to its roughness.

Sailing boats were commonly used for transport. Donkeys and camels were used in areas where the presence of scattered cataract rocks was a hazard for navigation.

Dietary surveys

Dietary surveys were carried out in Old Halfa before the transfer to the New resettlement area. Wadi Halfa Resettlement

Figure 4.

The style of buildings in Old Halfa and the street layout. (The mosque shown in this photograph will be shown in later photographs to be deep under water).

Commission, Third Interim Report (1960), showed that the feeding situation was better in the northern part of the area than the south. The same reports have shown that although the level of feeding is good in Old Halfa there was a shortage of calcium and vitamins, especially riboflavin. When comparing Old Halfa to Khartoum north in the centre of Sudan, the food intake was regarded as being higher in Old Halfa than Khartoum north for calories, fat and vitamin A, (Wadi Halfa Resettlement Commission, 7th Interim Report, 1960)

Health services in Wadi Halfa District

There was only one hospital in Wadi Halfa town; it had 202 beds and was run by 3 doctors. The scattered villages had 6 dispensaries and 9 dressing stations. There were 2 maternity and child welfare centres in the area. There was one human quarantine station at the northern border of the area and it conducted all the preventive measures. These included treating schistosomiasis and ancylostomiasis, dealing with the Saide labourers recruited from Egypt and carrying out delousing measures against typhus. Wadi Halfa area had also a veterinary quarantine station run by Sudanese and Egyptian doctors and at this station all animals going from Sudan to Egypt were examined (Shamy, 1960).

Vectors of the Disease

Mosquitoes in general

The mosquitoes reported in Wadi Halfa district (Lewis, 1949) were:-

Anopheles gambiae

Culeseta longiareolata Macqu

Aedes arabiensis patton

Culex tigripes grp

Culex univiattatus theo

C. pipiens ssp. Mallestus forsk

Lewis added that the common ones were only A. gambiae and C. univiattatus.

In 1942 and 1943 a very serious epidemic of malaria occurred in southern Egypt and the authorities in Egypt undertook a campaign to exterminate A. gambiae in that area. Many authors referred to this serious epidemic (Farid, 1943; Lewis, 1944 and Sousha, 1949). The outbreak spread northwards after starting in Abu Simbil, where the famous Abu Simbil temple exhisted. It was evident that the outbreak was due to A. gambiae which was present in large numbers in the epidemic area. Shousha (1949) illustrated the dramatic effect of that epidemic by the following table.

Village	Population	No. of blood films examined	Positive for P. falciparum	% positive
Abu Simbil	3481	972	842	86.6
Ballena	2577	1008	549	54.5
Qustul	412	412	334	81.1
Adindan	1938	422	302	68.3

Shousha postulated in this report that the Egyptian invasion by A. gambiae occurred from Wadi Halfa by wind and boat transport and added that the volume of transport between Wadi Halfa and Egypt increased tremendously during the second world war. However Worthington (1946) held a different point of view and suggested that the northward spread of A. gambiae was possibly due to air transport from west and central Africa. An entomological survey was needed in the area as a result of the identification of A. gambiae in the region and the following mosquito fauna was described in the area by Lewis (1944).

- Anopheles (Myzomia) gambiae Giles
- Anopheles (Myzomia) multicolor Cambouliu
- Anopheles (Myzomia) pharoensis Theobald
- Theobaldia (Allotheobaldia) longiareolala Macquart
- Aedes (Ochlerotatus) caspius Pallas

- Culex (Cullex) univittatis Theo
- Culex (cullex) pipiens s. sp. molestus Forskal.

In 1944-46 control measures against A. gambiae were intensified in the Wadi Halfa area to minimise the chance of A. gambiae spreading to Egypt, thus hindering the extermination campaign, and to prepare the way for extermination in the Wadi Halfa area should the campaign in Egypt prove successful. A. gambiae was thus exterminated in Egypt in 1945 and plans for extermination in Wadi Halfa were started in 1945-46 (Lewis, 1949). Lewis also added that these plans were successful at that time, they were the first of their kind in the Ethiopian zoogeographical region and required few staff.

The method used by Lewis was to treat all breeding places with Paris green dust once a week from November to March irrespective of whether larvae were found or not. The mosquito men were trained to recognise mosquito larvae and apply larvicides. No control of adults was carried out apart from the spraying of vehicles.

The Wadi Halfa district became free of Anopheles gambiae in 1945 and remained so even after the great Nile flood of 1946. This was the highest recorded for over a century and following it large numbers of mosquitoes other than Anopheles gambiae appeared. Thus Lewis (1949) reported that 30 months have elapsed since A. gambiae

was last found in that area. Due to the high flooding of the River Nile in 1954 an antimalarial campaign was carried out in Wadi Halfa district in 1954-55 under the supervision of Dr. Shamy. This campaign was a combined effort of both the Sudanese and Egyptian Governments. It followed the following lines, (Shamy, 1958):-

1. Adult mosquito control
2. Larva control
3. Use of prophylactic antimalarials.

The anti-larval methods used

The larvicide was prepared by the method described by Soper and Wilson (1943) using 1% Paris green. This was mixed at the breeding places using local dust in a pail. It is of interest that the Gambusea fish was bred and proved successful at Faras basin.

Methods used in the adult control

a. The vehicles entering the area from the southern uncontrolled areas were sprayed with pyrethrum at Ashkeit port.

b. The trains coming from the south into the area were stopped 13 kilometres before Halfa town and sprayed with pyrethrum. The trains were also sprayed with DDT at 4 monthly intervals.

c. Boats and steamers were sprayed at Wadi Halfa port on arriving and departure.

d. The aeroplanes landing at Halfa airport were sprayed.

This area was kept continously under very thorough observation for the presence of Anopheles gambiae to keep the district free and protect the inhabitants. The least team that went to the area (in 1973) was from the Sudan Ministry of Health and was accompanied by W.H.O. Consultants. It was revealed that the area is free from Anopheles gambiae. (Abd el Nur, 1973 personal communication).

Schistosomiasis in old Halfa

Schistosoma haematobium was known to exist in the area, the incidence varied in different parts of the district but an overall incidence of 15% was given among children (Shamy, 1961).

Schistosoma mansoni infection

No case of intestinal schistosomiasis was ever recorded in the area and transmission of this infection did not exist.

Filarial infections

Onchocerciasis and other filarial infections are not known in this area.

Visceral and cutaneous leishmaniasis are not also known in this district.

Communicable eye diseases and visual defects in Old Halfa District

Communicable eye diseases and visual defects especially unilateral or bilateral squint are known to be common in Wadi Halfa district.

Delon (1962) reported that the prevalence of trachoma and other communicable eye diseases in the area was 78% and 60% for boys and girls respectively. Conjunctivitis was also reported to be very common occurring mainly in the age group 0-14 years, its prevalence was 68%.

In view of the above findings Delon recommended that all the population near Wadi Halfa should be treated without preliminary screening. The objectives of the treatment programme were stated as to achieve a reduction of the prevalence of trachoma in the area to a level where it is no longer a problem of public health importance. The treatment programme was also intended to provide training for personnel and to evaluate new drugs and new treatment schedules.

The treatment programme was carried out during 1962-63 starting at the northern part of the flooded region and moving southwards. Wide spectrum antibiotics mainly aureomycin and oxytetracycline ointments and oily suspensions were used in this mass treatment programme.

Due to the shortage of time before the transfer and the expected flooding of the region, the treatment of Wadi Halfa town people was not done in Wadi Halfa as they were expected to have a better standard of hygiene after they had moved. The inhabitants of the villages of the southern region were not treated due to difficulties in transport.

It was planned that all the untreated people would have their treatment when they settled in the new area (Khashm el Girba area). Out of the 13, 523 people registered 8, 523 (64%) received 100% treatment and finished the prescribed course.

Maitchouck and Sherif (1963) evaluated the treatment programme at Wadi Halfa. They concluded that a reliable evaluation was not possible as a preliminary evaluation of their same group had not been carried out. However they found that the prevalence of communicable eye diseases in the treated people was generally lower than in the untreated people. The treatment done in Wadi Halfa was regarded as the first phase, a second phase was carried out in the resettlement area.

Tuberculosis survey

Due to difficulties of transport, shortage of doctors and lack of co-operation of people, the attempt to carry a prevalence survey of pulmonary tuberculosis at Wadi Halfa was abandoned. The Ministry of Health then decided to conduct a case finding survey. 15, 000 people in the northern part of the area were examined. Skin tests were done and those above 7 had chest x-rays (Mahadi and Masri, 1972). The percentage of reactors was 3.7% in age group 0-6 years and 12% in the age group 7-14 years.

Mental health

The psychological factors involved in the uprooting and resettling of the population of Wadi Halfa were well appreciated by the Ministry of Health in Sudan and the senior psychiatrist at the time Dr. Baasher took part in the surveys there.

Baasher (1960) reported on some characteristics of the Nubian people. He described them as having individual social relations and sense of belonging to the community. He noticed that they had strong family ties and that the mentally ill received attention and kindness.

Baasher (1967) after carrying a preliminary survey of the mental health of one village followed that by 10% random sampling from the area to be flooded. He found that the future housing and working conditions in the resettlement area of Khashm el Girba presented new stresses to the Nubians.

He found that the houses in the old area being built of local material were cheap and spacious with adequate rooms. The villages were situated near to the agricultural area and they had no problems of transport. Although the chances for finding a job for the young working age group were few, yet they used to immigrate and send money to their dependants. This immigration of the young had some psychological ill effects on the remaining female population and the children.

Baasher added that the mental health survey revealed a lower prevalence rate of psychotic states than that in the rest of the country. A rate of 7 per thousand for schizophrenia compared favourably with international figures. He also found that the incidence of neurosis was low in Wadi Halfa rural districts.

CHAPTER 3

EVENTS PRECEEDING THE UPROOTING AND THE RESETTLEMENT OF THE NUBIANS

The Aswan High Dam

The transfer of the Nubians to the resettlement area followed the construction of the Aswan High Dam. It was linked with political agreements and was met with various reactions from the Nubians: the Sudan Government formed various committees to study the situation, carry out surveys of the area and submit recommendations. An attempt is made in this chapter to review these events that preceeded the uprooting and resettlement of the Nubians.

Although the idea of erecting the Aswan High Dam was an old one dating from 1943 yet it only become widely known in 1952-53 that the Egyptian Government intended to construct this Dam. The Aswan High Dam would result in flooding and submerging the Sudanese territory and an agreement between the two countries had to be worked out before construction began (Wadi Halfa Resettlement Commission first Interim Report).

The High Dam Committee

When it was known that the Egyptian Government intended to construct the Aswan High Dam, the Sudan by the Council of Ministers discussion No. 844 in 1956 formed a High Dam Committee with the

following terms of reference. To study and investigate all the problems which may ensue due to the wish of the Egyptian Government to erect the High Dam so that the Sudan Government would be able to express her views.

The interpretation of these terms of reference are briefly as follows:-

1. To estimate the losses due to the erection of the High Dam.

2. To investigate and study the places which shall be submerged by the High Dam waters and the consequences which will follow in the economic, social and health sides.

3. Investigation of the necessary procedures etc., measures and precautions to meet the situation and resettle the population of the area.

4. To carry out geological investigations and estimate the value of the antiquities and existing establishments.

5. Collection of statistics about the number of population and their economic, social and agricultural conditions.

6. Collection and study of all suggestions concerning resettlement of the inhabitants and to know the wish of the inhabitants in this matter.

7. They were asked to submit their reports and recommendations from time to time.

The Nile Water Agreement

This agreement was concluded between the two Governments in 1959 (Wadi Halfa Resettlement Commission, Final Report, 1969). The relevant points of this agreement were that.

1. To regulate the Nile waters and control it preventing its flow into the sea, both countries agreed that the United Arab Republic would construct the Dam at Aswan.

2. The United Arab Republic would pay to the Sudan a comprehensive compensation for the damage caused to the Sudanese present properties.

3. The Sudan Government would undertake to arrange the transfer of the population of Halfa district which shall be submerged by the newly formed Lake Nasir from the stored water. It was agreed that the population would leave Halfa before July, 1963 (but it moved later).

The construction of the High Dam would allow Sudan to increase its share of Nile water from 4 to 18.4 milliards.

The Egyptians would benefit greatly from the scheme as it would fulfil for them the following:-

1. Complete use of the Nile water and its control.

2. It will enable them to enlarge the agricultural land.

3. Would protect the country from floods.

4. Harnessing electricity.

Figure 5.

Flooding and submerging of Wadi Halfa Town, shown here by the mosque, the highest building in the Town, surrounded by the new lake water. This mosque was shown in Figure 4 in the town prior to the High Dam construction.

Figure 6.

Further stage of Lake Nasir formation when more than $\frac{2}{3}$ of the mosque is well under water. The town is now almost disappearing, few months later the mosque disappeared.

5. Navigation would be possible throughout the year in the Nile.

Following the Nile water agreement in 1959 the Sudan Government started to face its obligations. The reaction to the transfer among the people of Wadi Halfa was variable. The following points were summarised by Baasher (1960 and 1967).

The people of Wadi Halfa are deeply committed with their land and adapted themselves to the prevailing conditions. In some places like Halfa Town and few village modern agricultural schemes made living regular and pleasant. While in other places like Saras where nature is harsh the people were not in agreement about their reaction to the transfer.

However on the 6th December, 1959 the President of the Sudan told them "We are responsible to arrange for you a decent living and your future is in honest hands. Those of you who have rights will have their worth."

Wadi Halfa resettlement Commission

Decision of the Council of Ministers on 7-2-1960

The Sudan Council of Ministers decided on 7-2-1960 to establish a commission for the compensation and emigration of the inhabitants of Halfa area.

This Commission started to work in March, 1960.

Results of population census and socio economic studies done in Old Halfa prior to the transfer.

A population census was carried out in the area to be flooded revealed the following data (Statistics Department, 1960).

A, Total numbers of Population.

	Males	Females	Total
Residents	17,451	21,027	38,478
Absent			14,796
			53,274.

The absentees were those who lived less than 6 months in the last year in the area.

B. The classification of sex.

$\frac{\text{Men}}{\text{Women}}$ Ratio in age group 0-15 = 1.02

$\frac{\text{Men}}{\text{Women}}$ Ratio in age group 16 and over = 0.58.

The high rate of the absentees was due to the immigration of men to other parts of Sudan and to U.A.R. looking for jobs. The Nubians are known to have a high rate of literacy compared to the other tribes in Sudan, so they can easily get jobs elsewhere. This fact is shown more by the ratio in the age group 16 and over.

The Occupation of Residents over 16 years.

	Males	Females	Total
Agriculture	3199	1476	4675
Other occupations	1196	99	1295
No occupation	806	10248	11054
The classification of cultivators			
Cultivation in pump schemes	1387	637	2024
Cultivation by water lifting methods	1014	281	1295
Cultivation in flood lands	531	537	1068

This shows that the occupation of the majority is agriculture but the system is different from the canal irrigation scheme of New Halfa.

The average family income was in the range of LS 12, 67 to 14. 69 Sudanese pounds per month and the average family size was 5 persons.

The most common type of trees in the area was the date palm which was found to be the best investment for the scarcity of land and labour, the productive date palms were 372, 749 while the non productive 256, 104.

Wadi Halfa Resettlement Commission Advisory Committee

This Commission formed an advisory Committee of 24 members, 16 of these were elected by the Nubians of Wadi Halfa district representing

the different parts of the area to be flooded. The main job of this Committee was to advise the Government on the areas to be chosen for the resettlement scheme. Six proposed sites were suggested and given the top priority to be considered.

The proposed sites for the alternative resettlement area

1. Wadi El Khaw, this site is near Dongola in the northern province.
2. Kadaru which is north of Khartoum.
3. South of Khartoum in the northern extension of Gezira (main cotton area of Sudan).
4. Managil, southern extension of the Gezira.
5. Wad el Hadad (near Sennar where the Sennar Dam which irrigates all the Gezira scheme). It is in the Blue Nile province.
6. Khashm el Girba (on the Atbara river which came to be known as New Halfa area. It is in Kasala province, eastern Sudan.

The Wadi Halfa resettlement commission studied various aspects of these areas e.g., the agricultural land, the soil, climate, irrigation, transport, health and feasibility of industrial processing. The Committee visited the various areas. The Committee then held a series of meetings with the Nubians who did not agree to any one suggested area influenced by their feel ings and emotions.

Another important development occurred at that time, when the Sudan Government decided to build the Khashm el Girba Dam on the Atbara river to irrigate a big agricultural area. It was therefore thought at that time to make use of this scheme in the resettlement of the Nubians.

The Minister of the Interior at that time visited Wadi Halfa and in a public meeting on 22nd October, 1960 thanked all the committees and told the Nubians the choice for their new home is Khashm el Girba.

He told them that there are various reasons for this choice e.g.

1. The scanty population of Khashm el Girba area.
2. The soil there is fertile.
3. Good prospects of agricultural expansion in Khashm el Girba.
4. There is a nearby railway line.
5. The Khashm el Girba Dam would irrigate all the area.

The Wadi Halfa Resettlement Commission reported that the Nubians reacted differently to this choice of Khashm el Girba as their resettlement area.

1. A group agreed with the emigration to Khashm el Girba.
2. Others suggested different places, the majority of this group favoured El Kadaru (north of Khartoum).

3. A small group decided to stay at Wadi Halfa and to move to higher places later when the lake was formed.

The unsettled situation of the selection of the resettlement area from the various sites mentioned, together with different reactions of the Nubians to those sites created a situation of unrest among the Nubians which undoubtedly contributed to their reaction to the transfer and perhaps to the incidence of psychological states.

Compensation of the Nubians for the submerged land and properties

The compensation was decided on the following basis:-

1. Those possessing land or houses were given the choice of either having a house at Khashm el Girba or the cost value of their house.

Three categories of houses were built at Khashm el Girba and each family was to get a house approximately of the category of their old one.

2. For the other unmovable property e.g., palm and fruit trees etc., they were compensated in cash. The Government worked out new regulations for the property ownership of the new houses and restricted their sale.

The agricultural land compensation was avoided but they were given at the new scheme where there is no shortage of land

at least twice the original freehold land (Wadi Halfa Resettlement Commission, Final Report, 1969). This had improved their incomes and nutrition.

The historical movement of the Nubians to Khashm el Girba

The deeply rooted Nubians with their affection to the Nile and their sentimental ties reflected in famous folk songs about the Nile, the date palms and the peaceful shores seeing that the construction of the High Dam is already in progress had to face reality and pack to move yet there were troubles and demonstrations at that time.

The journey to the resettlement area was made by train. The Government was responsible to provide passenger trains at the rate of 2 trains per week and to arrange the transfer of furniture, luggage and animals with good trains and trains for livestock.

The number of Nubians who actually moved

Northern region of Wadi Halfa District	33,664 (19,638 adults, 14,026 children).
Southern region of Wadi Halfa District	8,720 (5,160 adults and 3,500 children).
Grand total	42,384

It is worth mentioning that this number did not include the emigrant working male Nubians who later joined their families. The Wadi Halfa Resettlement Commission provided the Nubians with enough guidance for the packing and the journey and equipped their trains with medical teams. They provided them with photographs of the resettlement area and guidance for the new agricultural scheme.

Animals are known to transmit bacterial diseases like brucellosis and cows can play a role in the transmission of schistosomiasis. Thus it is important to report on the records of the transfer of animals to the new area. These records have shown that the following numbers were taken by the Nubians to the new area (Wadi Halfa Resettlement Commission, Final Report, 1969).

Cattle	1,481
Sheep	14,990
Goats	25,696
Horses	33
Donkeys	2,894

The Nubians were given $\frac{1}{3}$ of their cash compensation before they moved and some extra money of LS 2.5 ($2\frac{1}{2}$ Sudanese pounds per family for packing and food expenses during the journey.

The journey to Khashm el Girba was about 600 miles and was scheduled to take about 40 hours with several stops. The route was south through the Nubian desert to Abu Hamad then to Atbara and east to Haya, Kassala and Khashm el Girba which is one hour by train from the centre of the scheme New Halfa town, their terminal for the journey.

No major problems were met in these train journeys and as it was a historical journey the people living along the railway route were very helpful to the Nubians and gave them a warm welcome.

At the other end in Khashm el Girba all the necessary preparations were made to meet the Nubians.

Provisions of food were ensured, grain supplies and fresh vegetables were prepared from Government agricultural farms. Water was supplied to the houses. The necessary motor transport was prepared to take the new settlers from the railway station to their villages.

Figure 7.

The Nubians had to pack up and move. A lot policemen were present during these train journeys to prevent trouble and the feelings of the Nubians are shown by the sad look on their faces. These feelings have contributed to the worsening of the psychological states of the Nubians.

CHAPTER 4

REVIEW OF THE LITERATURE

This mass resettlement in Khashm el Girba has been linked with the development of a large scale agricultural scheme. The analysis of such a scheme should have included the impact of the project on transmission and severity of schistosomiasis. The effect of schistosomiasis in the work and productivity of the workers in this scheme is important to the yield of the project, thus it is important to review the literature on this problem.

Although the effect of schistosomiasis on work and productivity is not yet determined in Sudan yet many attempts to solve this question have been made in other endemic areas. Foster (1967) made a study in a sugar estate in Tanganyika. He found a statistically and substantial (approximately 30%) increase in absence from work attributable to schistosomiasis and not associated with medical treatment. In this sugar estate workers were screened for health deficiencies before they were offered the job. Another attempt to investigate the effect of schistosomiasis on productivity was made by Gateff et al (1971) in the sugar estate in the Cameroon. These workers found no significant differences between infected and

uninfected workers and nor among initially infected workers before and after treatment.

Workers from St. Lucia (Weisbord et al, unpublished) studied the effects of schistosomiasis as measured by presence of eggs on mortality, fertility, educational achievement and several measures of productivity among several groups of workers. Allowing for the effect of other infections, other work, education and age, they found no constant pattern of statistically significant negative effects of schistosomiasis. They thought because of the number of independent bodies of data they used and the number of economic variables examined, schistosomiasis has no effects on productivity.

Farook (1963) estimated the economic loss to the Philippines resulting from incapacity due to schistosomiasis and the costs of treating the patients is estimated at 13 million pesos annually calculated as 52 persos per infected person. He regarded the loss due to S. japonicum there as greater than the economic loss due to malaria.

Omer and Mahmoud (1973) attempted to assess the physical performance and lung function of 31 nurses infected with Schistosoma mansoni and working in Khartoum Hospital. The standard bicycle physiological test was used before and after

treatment compared with a control group of 10 nurses of the same age group. The oxygen consumption per heart beat at rest in the bilharzial patients before treatment ranged 2.6-6.5 ml. (mean 3.95 ml; S.D. $\pm$ 0.8). The mean oxygen consumption per heart beat at rest in the control group was 3.58 ml, S.D. $\pm$ 0.7. The mean oxygen consumption per square metre of surface area in the 31 bilharzial cases was 183 ml (S.D. $\pm$ 30.4 compared with 152 ml S.D. $\pm$ 20.7) in the 10 control patients. The mean pulse rate at rest in the bilharzial cases was 78/minute (S.D. $\pm$ 12.4) compared with a mean of 73 (S.D. $\pm$ 6.9) in the control group.

The previous studies show some differences in findings of different workers. This may be due to the different approaches of the different workers. Thus while the health specialists would be interested in differences in the severity of disease, the economists would look for other influences. It is expected perhaps that the effect of schistosomiasis control on productivity would be greatest where workers are more responsive to changes in wage rates. This variation in responsiveness to wage rates in different areas alone may vary the effect of schistosomiasis.

Mincer (1962) found that a decrease in total disability of family heads would lead to some compensatory reduction in the earnings of other family earnings; another factor in complicating the assessment. However in Sudan Gordon (1953) states that he and Professor T.J. Davey were unable to obtain reliable evidence for or against any marked loss of manpower attributable to schistosomiasis in Sudan and suggested a clearer basis for determining estimated losses would be of value. This review has shown that the various studies are not in agreement about the effect of schistosomiasis on work and productivity and therefore an attempt was made in this study to find the effect of schistosomiasis on the performance of school children in their studies and games. It is thought that this may show whether the infected children are worse than their colleagues in these aspects or not.

The prevalence of schistosomiasis in Sudan has been studied by some workers. Ayad (1956) collected the stool and urine examinations done in the country in 1949 and he found that out of 163, 140 faecal examinations, 8, 861 were positive i.e. 5.4% and in 270, 638 urine specimens which were examined 22, 031 positive cases were detected i.e. 8.1%. On these figures which

which do not seem to reveal the present situation, McMullen and Buzo (1959) estimated that in Sudan 830,000 persons were infected with Schistosoma haematobium and 554,000 with S. mansoni. These figures are of great interest to the present work where the pattern of the predominance of the two infections is being studied and seems to be changing in the resettlement area.

In Sudan there is much migratory labour and seasonal tribal movements between the various parts of the country. These may affect the accuracy of the prevalence rates and the accurate distribution which is available in a few areas. The new resettlement area employs many immigrant labourers who import disease to the area. The arid northern and Red Sea deserts are apparently free from schistosomiasis. In this non endemic belt schistosomiasis is rare except along the Nile and the small fringe of fertile land on both sides. This is the situation which exists in old Wadi Halfa where it is only S. haematobium infection.

It is unfortunate that the annual report of the medical services does not enumerate the two species of the schistosomiasis separately. In the 1961-62 report it stated that the largest number of reported cases came from the Blue Nile province (Gezira irrigation

irrigation scheme) followed by Darfur province (western Sudan), (Republic of the Sudan, 1964).

The reported total numbers of cases in the years 1952-53 to 1961-62 rose from 29,286 to 57,218. It is not known whether this increase is real or due to better reporting. However accurate surveys are now done in both areas and the prevalence is reported to be in El Gezira varying from 60-80% (Omer, 1973), and is very sporadic in western Sudan varying from 0-100% (Eltom, 1973).

Ayad (1956) cited the figures of 1949 and said that the highest prevalence rates were recorded along the Blue and White Niles below Khartoum. Farooq (1961) showed that the largest numbers of cases of schistosomiasis for the 1956-57 were reported from the Blue Nile province followed by Kardofan province.

Farooq (1961) gives the following data concerning infections among 7 year old new entrants to 19 schools in the area for 1957-60.

	1957	1958	1959	1960
Number examined	902	936	979	897
Number infected	256	132	45	30
Percentage infected	28.3	14.1	4.6	3.3

Farooq noted however that no separate figures were given for S. haematobium and S. mansoni and that children in 8 of the schools examined had had treatment previously

Records of the urine examinations in the Gezira area over the period 1951-1960 indicate a reduction of the infection rate of S. haematobium from 4.1 to 1.0‰ in children and a reduction in all age groups from 2.5% to 0.9‰. This finding of reduction of S. haematobium in the Gazira is consistent with the present findings in El Galgala village in the Gazira where in the present survey of London-Khartoum project, Omer (1973 unpublished) out of the total village population of 2, 200 examined 1, 980 and has found a 65% prevalence rate of S. mansoni infection and only 4 cases of S. haematobium (0.2%)

During the year 1959-1960 the number of new cases treated in 6 districts of the northern province were as follows:-

Halfa	2536
Dongola	45
Murowe	769
Berber	79
Atbara	1395
Shendi	106

No distinction was made for the two types of schistosomiasis.

The Sudan Annual Report of the medical services for the year 1961-62 dealing with the medical examination of school children shows that 2.9% of 137, 870 from the 9 provinces at the time were positive for schistosomiasis (without differentiating the two types), (Republic of the Sudan, 1964).

The highest infection rate was 12% in Darfur province, followed by Kordofan province 7.5% and Northern province 4.5%. Malek (1960) found that urinary schistosomiasis has increased in Khartoum and attributes the increase to pump irrigation. He found that 23.2% of 439 school boys 6-12 years of age infected at Shambat 9.46 kilometres north of Khartoum and only 3 of 395 girls were positive. Amin and Omer (1972) found that the prevalence of S. haematobium among school children in Kober area (about 8 kilometres north east of Khartoum) is 30%, and this is also due to a pump scheme. In southern Sudan in Equatoria province Ayad (1956) recorded a rate of 51% in 39 school children at Juba. A severe form of S. mansoni infection with extensive visceral involvement has been reported from Bor district in the Upper Nile province by Abdalla et al.

Having reviewed the reported number of cases in the different parts of the country it is concluded that the distribution of schistosomiasis in Sudan is not accurately worked out and few surveys have been

made. In this study a special attention was given to the prevalence of both types of schistosomiasis in Old Halfa and the resettlement area.

The intermediate host in Sudan

Malek (1959) reported on natural and experimental infection of various species of snails with S. haematobium. He also reviewed the role of several species in the transmission of disease in the Sudan (Malek, 1958). He stated that the main snails involved in the transmission of urinary schistosomiasis are B (B) truncatus (truncatus) which is found in northern, central Sudan, Kordofan, Darfur, Bahr ElGazal province (rare) and B. (ph) globosus which occurs in southern Equatoria province.

B. pfeifferi and B. sudanica serve as intermediate hosts of S. mansoni. B. pfeifferi is found mainly on the Blue and White Nile provinces but is also found in Bahr El Gazal and Upper Nile provinces in southern Sudan and in some agricultural schemes in the northern and Khartoum provinces. B. sudanica was reported by Malek to be common in Bahr el Gazal and upper Nile provinces and also in some islands in the White Nile (Malek, 1966). Mandahl-Barth (1957) reported B (B) truncatus rohlfsi from Jebel Marra in western Sudan transmitting S. haematobium.

The snails intermediate hosts of schistosomiasis have not been reported in New Halfa Resettlement area being a new agricultural scheme. However we inspected various water courses and we found that B. truncatus and B. pfeifferi are the intermediate hosts of S. haematobium and S. mansoni respectively as reported by the various workers in other parts of the country.

It is known that the snails will thrive in a wide range of environmental conditions. They breed in different sites provided that the essential conditions of the presence of water, relatively solid surfaces for their eggs and some source of food are found. There are certain chemical, physical and biological factors which make a habitat suitable or unsuitable for the snails (WHO, 1965). The principal conditioning factors were cited by Malek and Hupendiek (1958) to be the amount of food available, the extent of growth of aquatic weeds, the oxygen content of the water and the strength of the water current. These seem to be available for conditions for the snails in the new resettlement area in the irrigation canals.

It is believed that snail intermediate host of schistosomiasis vary in their tolerance to strong currents, the deciding factor being their ability to cling to the surface. Jobin and Ippen (1964) showed that a flow of 33 cm per second causes immobilisation and 65 cm per second

causes dislodgement of Biomphalaria glabrata attached to a smooth surface.

The flow of water however in the northern end of the Khashm el Girba scheme is much slower than the southern end. Gordon et al (1934) found that in general, the snails are abundant near human habitations which pollute the water directly or indirectly and this gave the name of "mess-mates" of man. This sort of environment is found in some places in New Halfa resettlement area.

Irrigation

The importance of man made irrigation in intensifying schistosomiasis is well known and the experience of Sudan is a classical example. McMullen et al (1962) stated that 6 countries in Middle East and Africa expected to convert in the next 10 to 15 years a total of 8.9 million acres from partial to perennial irrigation. Conversion from rain irrigation to perennial canal irrigation had already been accomplished in the area covered by the scheme.

Desiccation

Many of the fresh water snails have remarkable powers of tolerating desiccation of the habitat. Greany (1952) reporting on snail intermediate hosts in irrigation canals of the Gezira in the Sudan said that a proportion of both Bulinus and Biomphalaria snails may

survive desiccation for up to $3\frac{1}{2}$ months. He reported that after one month of drought 16.4% of Bulinus (Bulinus) truncatus tested revived and after $3\frac{1}{2}$ months 10% of Bulinus and 7% of Biomphalaria in different canals revived. Webbe (1962) reported similar observations in the capacity of the snail vectors to withstand desiccation. However in New Halfa only water courses that are dry for some days are the Gadwals (Abu Sitta).

The clinical and public health importance of schistosomiasis

The literature on the clinical and public health importance of schistosomiasis is conflicting about the severity of the disease and as this study will be dealing with both S. mansoni and S. haematobium infections the reports of the disease patterns of these species will be reviewed.

Forsyth and Bradley (1966) in Tanzania reported on the abnormalities in the urinary tract and the frequent occurrence in young people of calcified bladders, hydronephrosis and non functioning kidneys. Gilles et al (1965) reported similar findings in Nigeria where half of the children investigated at one school had abnormal pyelograms. However Forsyth (1969) in East Africa failed to demonstrate an association between urinary schistosomiasis and impaired growth of children, protein deficiency, disease of liver or spleen, systemic or significant pulmonary hypertension, school

absenteeism or even secondary urinary bacterial infection.

In South Africa two different conclusions were reached by various workers. Powell et al (1968 a & b) demonstrated by excretion urography urinary tract disease in about 40% of school children while in a retrospective study they found that schistosomiasis of the bladder did not produce or cause early death. On the other hand King (1965) made a clinical study of genito urinary complications in 2 groups of South African miners. One group was infected with S. haematobium infection and in the second, a control group, it was found that renal failure was 21 times more common and other urinary tract diseases 9 times more common in the infected group than in the uninfected group. The impact of schistosomiasis on the Bantu children in South Africa was studied by Walker et al (1970). Their findings revealed that frank haematuria occurred in 7.5% severe albuminuria in 13.3% and bladder calcification in 9% of those infected. However they could find no significant differences between infected and non-infected children in running performance, in their examination results and their growth. They concluded that this infection is not a cause of disability but emphasised the need for longitudinal study. In Egypt, Farid et al (1970) studied 75 farmers infected with

S. haematobium. They found that all patients had urographic abnormalities and nearly half had bilateral obstructive uropathy. Salmonella bacterial infection was found in $\frac{1}{3}$ of the patients. 49 showed significant impairment of maximal urinary concentrating ability. Forsyth (1969) reported that 2 deaths per 1000 people occur annually in Zanzibar where the prevalence of infection was over 90% in the 11- 14 year old children.

Thus different conclusions were reached by various workers on the clinical significance and complications of urinary schistosomiasis. It was not possible in this field study to perform detailed urinary investigations and the approach was a clinical examination and the examination of the urine. These have shown that the infection can cause disability. The performance of infected and non-infected children was also investigated in this study.

In tropical countries when schistosomiasis and anaemia are both found to be the problem of a patient schistosomiasis is usually blamed to be the cause of the anaemia. This led various workers to study the anaemia of schistosomiasis and study the possible aetiological factors. Woodruff et al (1966) and Sabour et al (1967) suggested haemolysis as a possible aetiological factor. Another theory of haemodilution was suggested by Saif (1966). Other concomitant diseases in the endemic areas sometimes make it difficult to identify the main aetiological factor. No detailed investigations were done for the anaemia in this study and we only carried out a survey to see if there is any difference

in the haemoglobins of bilharzial and non bilharzial cases.

The development of malignant growths appears to be of considerable importance in some countries e.g. the association between urinary schistosomiasis and bladder cancer in Egypt. (Edington, 1967; Isahk et al, 1967). However there were no reliable records in Sudan to show whether there is a link between urinary schistosomiasis and urinary cancer.

Schistosoma mansoni infections

S. mansoni infection is emerging as a problem in the new resettlement area, the Nubians were not exposed to this infection before and it is interesting to follow the course of this disease in them. The experiences of various workers from the different parts of the world are not uniform. There is however increasing evidence that the most important factor in the development of severe disease is a high intensity of infection. Cheever (1969) did a post mortem study of S. mansoni in man and postulated that light infections are of little consequence and that heavy infection is a prerequisite for the development of Symmer's fibrosis. He also found that the number of eggs per gram of faeces reflected the worm burden in a nearly linear relation and that there was no change in the number of

eggs per gram of faeces per worm pair with increasing age.

In Brazil Kloetzel (1963) found that splenomegaly due to S. mansoni was closely related to the intensity of infection. He gave two examples of two areas where the highest arithmetic mean egg output was 242 eggs per gram and over 800 eggs/gram and the spleen rates were respectively 2.2% and 12.3%. These findings were even detected earlier when Scott (1942) found a general relationship between prevalence and intensity of infection in Egypt and Venezuela. As prevalence increases so does the intensity of infection in both countries. Scott reported that the egg count data seem usable for comparisons between different populations as well as for comparisons including groups within the same population. Areas in Egypt and Venezuela where the prevalence was the same, 75%, the corresponding mean output was 170 and 174 eggs/ml of faeces.

Comparable clinical data are not available from many parts of the endemic areas but incidence in Tanzania and St. Lucia (Webbe and Jordan, 1966) suggest that the frequency of liver enlargement is similar in both countries for a given prevalence of infection. Pitchford (1952) had found a similar relationship in South Africa.

It is known that splenomegaly is more important than hepatomegaly

as a sign of severe disease but the difficulty is that splenomegaly due to malaria is common also in Africa. However Nelson (1958) and Pitchford (1952) found that splenomegaly was more common in areas where S. mansoni is endemic and also when there is a high prevalence of S. mansoni. Gelfand (1967) found a village in Rhodesia where 61% of people of less than 20 years of age had enlarged hard livers and a large number of them had enlarged spleens.

Barbosa and Voss (1969) studied the clinical evaluation of S. mansoni in children in Brazil and classified them as belonging to one of the following groups.

I Symptoms and signs absent or mild and referable to the intestinal tract.

II Liver involvement.

III Liver involvement, splenomegaly or other advanced signs.

Six years later he examined 600 of them and found the following:- 398 initially in stage I, 175 of them 41% progressed to stage II and 81 (20%) progressed to stage III.

Three deaths occurred, two from children in stage III and I from stage I. Other longitudiml studies were done by Kloetzel (1964) who followed 109 S. mansoni cases with splenomegaly in Brazil for an

average of 3.6 years. During this period liver failure occurred in 8, haematemesis in 11. A total of 15 died, 5 died of massive haematemesis and 6 of liver failure.

However the study of Katz and Brener (1966) on infected subjects demonstrated a lower morbidity. They followed the clinical course of 112 for a 10 year period. Initially 91 cases were either in group 1 or 11 and only 7 of these progressed to stage 111 in the 10 year period. In the 21 cases of the initial stage 111, 6 developed haematemesis while in 8 the spleen regressed. However Schistosoma mansoni infection is recent in the Nubians as shown by this study and the prevalence is still low except in few foci in the resettlement area. But an attempt had been made to establish the incidence of hepatic and splenic enlargements in various age groups and to carry out a follow up study and to look for other complications.

Control of schistosomiasis

The control of schistosomiasis is one of the objectives of this study and as different conclusions have been reached by various workers on the value of therapy and molluscicides, it is thought of reviewing the literature on the experience of various workers on this problem.

Plans for the control of schistosomiasis should include the

costs and the beneficial effects of the control scheme to the country. The costs for these programmes are usually the main difficulty to the developing countries in adopting the control measures or continuing them and this is the situation in New Halfa. At present control of schistosomiasis everywhere depends principally on chemical molluscicides, mass therapy, sanitation and reduced contact with contaminated water possibly with health education.

In Japan transmission control has been achieved in all endemic areas and their clinical cases are relatively few, (Yokogawa, 1970). In addition to the molluscicides they used other methods like lining the irrigation ditches with concrete. Ayad (1962) and also Clarke et al (1961) reported good results with molluscicides in Egypt and southern Rhodesia respectively.

In selected water sheds in Puerto Rico, Jobin et al(1970) showed that transmission was greatly reduced.

Therapy combined with molluscicides was tried in a 7 year programme in Vieques and success was achieved in greatly reducing the transmission of S. mansoni infections.

The problem in the molluscicides application are many. Apart from being costly their use must be maintained for a long time. The choice of the molluscicide for the scheme may also be difficult.

Jobin (1968) developed a mathematical model for an objective discussion of the molluscicides. This model incorporates data on toxicity, stability, labour costs and hydraulic characteristics of the waterway. In the Gezira irrigation scheme of the Sudan it is now evident that there are some problems of the molluscicide which is on trial (Frescon) especially in the question of penetration in the small canals and also has hydraulic problems (Amin, 1973).

A large scale assessment of the molluscicides copper sulphate and N. tritylmorpholine (Frescon) was carried out in the northern Gezira, Sudan (Amin, 1972). He concluded that his results show that copper sulphate is far from being an ideal molluscicide in the Gezira and that the application of Frescon for 30 days in a dose of 0.075 p.p.m. kept the snail population at a very low level for approximately 3 months. He suggested that Frescon may play an important part in the control of schistosomiasis if the timing, dosage, duration and frequency of application are determined.

The other methods for changing the snail environment like cement lining of irrigation channels, mechanization, changing methods of agriculture, can be tried but are expensive. However like the situation in western and southern Sudan, some large swamps

can be drained with relatively minimal costs as the drained area can be used for agriculture.

These problems about the molluscicides might invite the use of mass treatment in combination with molluscicides or alone if an effective cheap drug with minimal toxicity is available.

Mass chemotherapy

The presence of both species of schistosomiasis in New Halfa resettlement area creates problems regarding the choice of anti-bilharzial drugs for mass chemotherapy in the district. Thus metrifonate which is highly effective against S. haematobium and not effective against S. mansoni is of no value in mass chemotherapy in the area. Other factors that influence the choice of a specific drug for mass chemotherapy in the new area include, the cost of the drug, its cure rate, re-infection and its side effects and the experience of previous workers in this field is thus needed.

There are various results reported in the literature from mass treatment. The main disadvantage of mass treatment is re-infection. Jordan (1968) followed Tanzanian children with S. haematobium infection after stibocaptate treatment. On 5 occasions in the first 2 years he found that about $\frac{1}{4}$ were re-infected, mostly between 12 and 24 months after treatment. When he considered the whole group,

the group egg output after 2 years was 62%, lower than before therapy. Davis (1968) found a re-infection rate of 16% at 1 year after treatment of Tanzanian adults infected with S. haematobium and treated with a course of antimonial drug. Davis and Bailey (1969) found re-infection rates varying between 3% and 14% in school children followed over one year. The figures given by Kloetzel (1967) had emphasised the need for treatment of children in endemic areas as molluscicides cannot help much in this situation. He followed 105 patients with splenomegaly due to S. mansoni for 7 years. Three deaths occurred in those under 20 years giving a standardized death rate of 8.8/1000 man years. While in those over 20, 16 died giving a standardized death rate of 47.7/1000. Considering the total number of deaths, haematemesis was the cause of death in 7/19 and liver failure in 4/19.

Suppressive management with the aim of producing a reduction of egg output by periodic administration of subcurative doses of a schistosomicide may help also in control measures and reducing the intensity of infection.

In Iran Arfaa et al (1967a, 1967b, 1970a, 1907b) having favourable epidemiological characteristics in their area, used niridazole against S. haematobium in doses of 120 mg/kg body weight

given in divided doses for 4 days instead of the recommended dose of 175 mg/kg body weight over 7 days. In their first chemotherapeutic trial in one village with a prevalence of 53% the short term cure rate was 100% and one year after treatment prevalence was 4.2%. Then mass chemotherapy was given to 6,488 people in 132 villages with a prevalence over 10% in each. A follow up at 3 and 6 months in a small sample revealed a cure of 97 and 98% of treated people. The prevalence rates fell in the next year and after considering the various factors e.g. defaulters, exclusion from treatment etc., the cure rate was 80%.

Schistosomicidal drugs

The experience which is usually gained by carrying out field surveys and using schistosomicidal drugs is that apart from the usual requirements in such drugs like the high efficiency, acceptable toxicity etc., other requirements like fewer doses per treatment regime and low costs are highly required in most of the endemic areas.

Davis (1968) carried out a comparative trial of the antimony drugs in urinary schistosomiasis, reported that retention of metal in the tissues was directly related to cure rate and side effects.

He concluded that none of the antimony drugs are suitable for mass chemotherapy but that antimony dimercaptosuccinate could be accepted as a reference standard for comparative trials of other drugs. The problem about the trivalent antimonials is that their toxicity would not confidently permit their use without direct medical supervision. Although niridazole has been mentioned as being useful in mass treatment (Arfaa et al, 1967a, 1967b, 1970a, 1970b) when used in endemic areas of S. mansoni where liver enlargement is common serious side effects may occur. It is reported by Yokogawa et al (1969) that it is less effective in S. japonicum than against the other species.

Metrifonate - This is a new organophosphorous compound which proved to be effective in S. haematobium infections (Davis and Bailey, 1969). Being an oral schistosomicidal drug, it is very useful for field treatment but reservations concerning its general use rests on the understanding of erythrocyte cholinesterase. It is better to avoid using the drug in situations where the enzyme cholinesterase levels are depleted through contact with organophosphorous compounds which are commonly used in agriculture as pesticides. This situation does exist in New Halfa area where pesticides are used.

Hycanthone "Etrenol" - This is effective against S. haematobium

and S. mansoni infections. The cure rate from a single intramuscular injection is good. There are usually common transient effects but they are infrequent yet unpredictable hepatoxocity can occur. In a clinical trial conducted in the Sudan (Omer, 1972) in which 95 patients were treated with a single intramuscular injection of hycanthone (Etrenol) the drug was found to be very effective, and provided a cure rate of 95.3% at one month and 98% at 3 months after treatment. 40 patients (42.1%) tolerated the drug well. The remaining (47.9%) had various side effects which were generally mild and occurred in the first 24 hours. The commonest side effects were nausea and vomiting which occurred in 51 (53.7%) and 46 (48.4%) patients respectively. A significant improvement was seen in this trial in the haematological and biochemical indices. An important finding was also the regression which occurred in the liver and spleen after treatment. This regression of liver and spleen was also reported by Kloetzel (1963) and Cook and Jordan (1971). The advantage of such a drug like hycanthone that can be given over a short period are several e.g. it is more likely that patients will finish treatment as it will be more acceptable to them than the treatment which extends over longer periods of time. It is economical for the number of personnel needed. This may make this drug a useful one for mass chemotherapy. Mass chemotherapy alone or in combination with molluscicides can be tried in New Halfa to control

schistosomiasis. Both species of schistosomiasis are present in the area which have to be taken in consideration in the choice of the drug. Another important factor is the safety of the drug in the existing field conditions in the area.

Malaria

Malaria represents an important medical problem in New Halfa resettlement area as the Nubians came from an area where malaria has been eradicated by the measures taken against Anopheles gambiae in southern Egypt and northern Sudan in 1948, (Lewis, 1949). The report presented by the Director General of the World Health Organisation to the 25th World Health Assembly (W.H.O. Chronicle, 1972) indicated that by the end of 1971 out of the estimated 1827 millions who live in areas known to be malarious 74% i.e. 1346 millions of them now live in areas where malaria eradication has been complete or where it is in progress. The rest, 480 million people, live in areas where no eradication programmes are in operation. The application of this report to the Sudan would put the Nubians as being originally in the 1346 million group that shifted by their transfer to New Halfa to the second 480 million group.

Gramicia and Hempel (1972) stressed the importance of malaria

in discussing the death rate and malaria mortality rates gathered over the period 1955-1968 from 20 countries that leads to important conclusions. In 7 countries where malaria eradication is satisfactory, the actual decrease of malaria mortality was from 53 per 100, 000 population to 2. 5 per 100, 000 while in the 13 countries where malaria eradication was not satisfactory, the mortality figures went down from 10/100, 000 to 0. 2/100, 000. The proportional decrease of deaths ascribed to malaria was thus between 95% and 98% in the 2 groups of countries.

The crude death rate, decreased much less from 12 to 9/1000 in the first group and from 10 to 7/1000 in the second group. Therefore the authors concluded that the impact of antimalarial activities on death rate attributed to malaria alone is very considerable irrespective of the progress of malaria eradication and they emphasised that even when malaria eradication programmes do not reach their objectives, they are of great help in lowering the mortality.

The role of malaria as a major disease in the world, has given it a great importance in the World Health Organisation and in malaria eradication the terminology surveillance (the study of disappearing disease) is defined as "that part of the programme

aimed at the discovery, investigation and elimination of continuing transmission, the prevention and cure of infection and final substantiation of claimed eradication", (W.H.O. 1963). The W.H.O. Expert Committee on Malaria in its 6th Report (1957) identified the surveillance as a combination of various activities that includes screening all persons with fever for malaria (case detection), epidemiological investigations and antimalarial drug treatment.

Case detection is either done by passive case detection (P.C.D.) which covers a proportion of the population e.g. collection in rural health centres or dispensaries, or active case detection (A.C.D.) is where collection is by domiciliary visits at periodic intervals. In a proper surveillance both methods are adopted together. In this study the survey for malaria included screening hospital cases with fever (P.C.D.) and also village surveys (A.C.D)

In surveillance the epidemiological investigations aim at the discovery of the origin of cases. Yekutiel (1960) noted that as residual malarial infection expressed as annual parasite incidence (A.P.I.) decreases as a result of attack operations, the portion of asymptomatic malaria carriers to the total number of malaria cases also decreases. So it appears that fever is a good screening device for case detection but when favourable conditions (low parasite reserve) exists and even then it will not reveal all cases of malaria.

It is accepted that the confirmation of malaria is based on the presence of malaria parasites in the blood. Raghavan (1966) basing his argument on statistical grounds reported that when the techniques of preparing blood films are accurate a parasite count of 44 in a total of 1000 thick film fields is about the lowest that gives a reasonable certainty of positive diagnosis when only 100 fields are examined (100 being considered as the usual standard). Therefore when the parasite densities are below that level, more parasitological examinations must be carried out. However the examination of thick and thin blood films was the only practical test for this survey and a total number of 961 and 5576 individuals were examined in old and New Halfa respectively.

The malaria incidence and species prevalence has been studied in Kenya by Rickman et al (1972). They found that slightly less than half of the population of the Lambwe valley in Kenya had patent malaria infections. Malaria transmission is thought to be perennial as the crude parasite rate for malaria was found to vary only a little during the year.

The clinical significance of malaria

While investigating the children in New Halfa district, it was

evident that malaria was a very important cause of febrile illness in them. This is indeed the experience in many other parts of the tropics (Gilled, 1966; Viswanathan, 1936). In a recent survey in Dar-es-Salaam for the clinical significance of malaria it was found that fever was a common presenting symptom in children who showed positive blood films for malaria (Okeahialam et al, 1972) fever occurred in 62 children (72%) and was the only presenting symptom in 37 children (43%) in this study. Other common symptoms in this study was cough, in 28%, and vomiting in 21% of the children.

It was observed that in New Halfa area some children presented with albuminuria (without obvious renal aetiology) and it is interesting that there are some reports in the literature of nephrotic syndrome in cases of malaria and schistosomiasis. Berger et al (1967) reported 3 cases of nephrotic syndrome as secondary to acute glomerulonephritis caused by or occuring in falciparum malaria (total number of cases examined, were 150). The characteristic laboratory findings present in all the cases included haematuria, marked proteinuria, casts and azotaemia with marked impairment of creatinine clearance. All had features of the nephrotic syndrome with hypoalbuminaemia and with protein excretion in excess of 3.5 grams per 24 hours. Renal biopsy in his cases showed hypercellularity, adhesions

of the glomerular tuft to Bowman's capsule, polymorphonuclear leucocyte infiltration and minimal focal thickening of the basement membrane. All his cases showed progressive improvement. Wolthuis (1968) reported also a malaria case that suffered from a severe functional renal disturbance. He thought that the pathogenesis of the serious renal changes in malaria and blackwater fever is fundamentally identical with that of other syndromes caused by a disturbed vascularisation of the kidney and known as "Nephron nephrosis" or acute intrinsic renal failure. His reported case responded to the administration of Nivaquine and conservative treatment of the uraemia, the creatinine clearance improved rapidly.

The red cell damage by Plasmodium falciparum

Plasmodium falciparum was found to be the commonest species in the resettlement area. The active case detection revealed 97 cases of falciparum malaria compared with 32 vivax and 15 malariae in 2178 Nubians. It was also found that there were 151 falciparum cases in 1789 hospital collection slides compared with 54 vivax and 79 malariae. Haemolysis is an important complication of falciparum malaria. Although there is an impression that the non-immune Nubians are experiencing severe complications of this disease, it was not possible to obtain accurate

figures of the incidence of these complications. However the experience of various workers on the ultrastructure, mechanism of invasion and destruction of red cells in this infection explained the haemolytic mechanism.

Blacerzak et al (1972) reported the mechanisms of invasion and destruction of erythrocytes by malaria parasites by using scanning electron microscopy of the suface of cells infected with Plasmodium falciparum. He found defects in the surface of infected erythrocytes, some parts of the defective cells have smooth surface while others contrasted sharply with the smooth contour of the rest of the red cell. The bulk of the parasite was under the smooth membrane of the red cell but part of it was usually associated with the surface defect. By examining serial sections of cells by transmission electron microscopy they found that there were small portionsof the parasite which projected well beyond the normal surface contour of the red blood cell.

They also discovered that some uninfected R.B. cells contained depressions or cavities and the authors suggested that these are scars from a pitting process in which the spleen removes the parasites without destroying the erythrocytes.

This pitting function of the spleen in malaria was studied by

Schnitzer et al (1972). The authors concluded that the spleen is capable of pitting (or removing) parasites from the erythrocytes, by using transmission electron micrographs prepared from splenic tissue of rhesus monkeys infected with Plasmodium knowlesi. They suggested that although normal red cells are very deformable red blood cells containing rigid inclusions like parasites may not be able to pass into the sinuses, hence the portion of the red cell containing the inclusion is trapped and is severed from the rest of the red cell which is able to pass into the sinus and then to the circulation.

Miller (1972) studied the ultrastructure of red cells infected by Plasmodium falciparum in man. He studied infected R.B. cells by transmission and scanning electron microscopy. He found that erythrocytes infected with young ring trophozoites were only slightly distorted, the membrane being elevated in the region of the parasite. The cells which were infected with mature trophozoites were grossly distorted and never within rouleaux or in close opposition to other cells. They had also long cytoplasmic projections. He found no protrusions in the cells infected with gametocytes only, apart from the characteristic apron deformity.

Conrad et al (1968) studied the splenic function in experimental

malaria using normal and splenectomized rhesus monkeys. He found that the radiochromium disappeared from the blood of both normal and splenectomized recipient animals at a rapid and similar rate. Parasites disappeared from the blood of normal but not splenectomized monkeys faster than the radiochromium. He concluded that the spleen removed malaria parasites from the transfused cells without destroying the erythrocytes.

The present survey had shown that the incidence of G-6-P D deficiencies and abnormal haemoglobins is higher in the Nubians than the mixed population of central Sudan (3% and 1% in the Nubians compared with 0% and 0% in El Kalakla village). It is expected that the Nubians will continue to take various antimalarial drugs including primaquine until efficient control measures are applied in the area. This could result in haemolytic anaemia for which therefore a watch has been kept in the survey.

Ander et al (1968) reported Coomb's positive haemolytic disease in malaria which occurred after treatment in 4 out of 131 soldiers from Vietnam with drug resistant falciparum malaria. As quinine is administered to many patients with malaria and yet quinine induced haemolysis (blackwater fever) is rare, the authors considered that it is, therefore unlikely that the haemolysis of blackwater fever is caused only by the effect of quinine on the erythrocytes.

Barrett-Connor (1967) reported on Plasmodium vivax and Coomb's positive anaemia. She began by citing the previous concepts that phagocytosis extends beyond that of the parasitised cells to include normal red cells and the concept of autoimmune haemolysis to explain the excessive anaemia of chronic malaria and the effects of antimalarial drugs. Her reported case was infected with Plasmodium vivax at least 8 months before examination. The patient was severely anaemic and the direct Coomb's test was positive and also the venereal disease research laboratory (VDRL) and the rheumatoid arthritis latex fixation test. When the patient was treated with chloroquine she recovered fully and the Coomb's test and the rheumatoid arthritis latex fixation test became negative.

Brewer and Zarafonetis (1967) reported on the haemolytic effect of various regimens of primaquine with chloroquine in American negroes with G-6-P D deficiency and the lack of an effect of various antimalarial suppressive agents on erythrocyte metabolism. The experimental observations in their work define the lesser known effect of larger doses given at longer intervals. The combined treatment was chloroquine and primaquine and their findings were:-

1. No haemolysis occurred in control subjects with no G-6-P D

deficiency.

2. Haemolytic crises were milder in group 1 with the 45 mg of primaquine and 300 mg chloroquine once a week.

3. Intermediate in severity in group 111 where the above drugs were given once a week for 4 weeks and then twice a week for 6 weeks.

4. The haemolytic crises were more severe but still mild in group 11 where the 2 drugs were given twice a week from the start to 8-10 weeks.

The relationship of blood groups to malarial infection has been studied and reviewed by Athreya and Coriell (1967). They cited that all species of malaria possess both the A and B antigens found indirectly by the rising titre of the corresponding antibodies. The authors noticed that there is little work in the subject to be reviewed except the work of Oliver-Gonzalez (1944) in which he found that group O subjects infected repeatedly with either P. vivax or P. falciparum had shown a great increase in anti A in the serum and a lesser increase of anti B. Therefore he assumed that persons who are unable to manufacture anti A i.e. (group A subjects) would be at a disadvantage in malarious regions and thus the A group would be uncommon there. In the analysis of the authors they found that O, M, N and P bear no relation to malarial endemicity and they doubted whether group O frequencies are greater in malarial regions than elsewhere and they thought that as the genes

are widely distributed throughout pathogenic species it would seem that the natural relation by these factors would be complex.

Drug resistance

The Nubians having come from a non endemic area of malaria and many of them being faced with malaria for the first time in the new resettlement area, would obviously try to get hold of antimalarial drugs when they feel feverish. Antimalarial drugs are easily available in the pharmacies and even in some shops without any prescription there. Although drug resistance is not yet proved in Sudan, this is perhaps a situation which may create suitable conditions for its development as the resistant strains may arise from the survival (under drug pressure) of small numbers of mutants in a very large population of susceptible parasites.

Recently the problem of drug resistance in malaria in certain parts of the world stimulated many workers. Clyde (1972) examined the response of several South East Asian chloroquine resistant strains of P. falciparum in non immune volunterrs. A Thau strain infection was sub-inoculated from a man in whom 1 gram sulphone failed to produce radical cure into a new volunteer. He noticed that in this new volunteer the same dose of sulfalene was curative. Therefore from this and other experiences, the author suggested that

the cases of supposed resistance to these sulphonamides may in fact be examples of drug failure due to a pecularity in the manner in which the drugs are metabolised in certain individuals. He suggested the terms Fl, Fll, Flll (drug failure) in place of Rl, Rll, Rlll drug resistance classification.

Drug failure may however imitate resistance and thus complicate the choice of eradication or control.

Resistance is defined by the W.H.O. Document as the ability of a parasite to multiply or to survive in the presence of a drug that normally destroys parasites of the same species or prevent their multiplication (WHO, 1963). Drug failure is defined as the absence or insufficiency of drug action after administration of a normally effective dose caused by improper ingestion or deficient absorption or unusual rate of degradation, or rapid excretion of metabolic abnormality of the host not produced by subinoculation of parasite into other individuals. It is still early to tell whether chloroquine resistance can become a problem in New Halfa resettlement area where the Nubians are sometimes taking the drug without prescriptions but various workers reported on resistance to the antimalarial drugs in different parts of the world. Colwell (1972) reviewed the historical

aspects of chloroquine resistance malaria in Thailand with reference to geographic distribution, prevalence and alternative treatments. He concluded that chloroquine resistant strains of P. falciparum are distributed throughout all of Thailand and where extensive study was carried out the majority of strains are resistant to conventional doses of chloroquine. He added that a single dose administration of sulphormethoxine - pyrimethamine and a multiple dose of quinine-tetracycline are promising alternatives to chloroquine resistant cases. He suggested that the first combination is suitable for control programmes and the second for hospital cases.

In South America, like South East Asia, strains of P. falciparum are found resistant to chloroquine.

Many of these strains are also found to be resistant to folic reductase inhibitors, pyrimethamine and chlorguanide (prograunil). The resistance to sulfones may be attributable to host factors rather than to extension of parasite resistance to these drugs.

Walker (1968) in South America reported on the resistance by P. falciparum to folic reductase antagonists, an exception being the finding of chlorguanide (proguanil) in chloroquine resistant strains from Rondenia in Brazil.

More recently in South and Central America combination of drugs has been used for mass chemotherapy. Babione (1966) reported on the use of chloroquine with pyrimethamine. Coricha-Y-Venegas (1963) reported on the use of chloroquine with primaquine and pyrimethamine.

The drug combinations may have their problems against certain strains e.g. sulfadiazine and pyrimethamine did not prove rapidly effective against a strain in non immune persons.

While trimethoprim and sulpalone appeared highly and rapidly effective against strains of P. falciparum from Uganda and against a strain of chloroquine resistant P. falciparum from Malaysia (Martin et al, 1968).

Intestinal helminths and protozoa

To determine the incidence of intestinal helminths and protozoa is one of the problems which it was attempted to solve in this study. Sanitation and probably many other factors play a part in determining the prevalence of the various intestinal helminths and protozoa. The Nubians were transferred to a completely different environment where the type of soil, humidity, rainfall and sanitation is different. Thus had resulted changes in the prevalence of certain intestinal helminths and protozoal infections and perhaps the picture may further changae in the future when they have been in Khashm el Girba longer. The

experience in different parts of the world of various workers had shown disparity in the prevalence of these infections in the different environmental conditions within the tropics. In a recent study in Nairobi (Wijers et al, 1972) it was found that 64.8% of school children harbour different worms and 75.6% harbour intestinal protozoa. In their study only 11.3% had neither worm eggs or cysts in their stools. Ascaris lumbricoides was the most common helminth found in 46% and Entamoeba coli was the most common protozoa found in 39% of the schoolchildren.

In Iran a stratified random sampling technique was used to investigate the incidence of certain intestinal helminths in families from villages in 2 areas using a thick smear of stools and brine flotation method (Sabbaghian and Arfaa, 1970). They examined the stools of 1017 and 1812 of the 2 villages.

Ascaris was the commonest intestinal helminth being present in 81% of the stool specimens in village 1 and in 74% in village 2, the second commonest was Trichuris present in 37 and 12% respectively, and Hymenolepis in 4 and 8% respectively in the two villages.

They found that the children aged 6-10 years showed the highest rate of infection for Ascaris.

In Malay Bisseru and Ahmed (1970) studied the intestinal parasites in a Chinese and Indian school using a single stool examination with formol ether concentration technique for the school children.

In a total of 678 children aged 7-12 years in 5 schools, the prevalence of intestinal helminths and protozoa was as follows:-

Ascaris 69%

Trichuris 80%

Hookworm 51%

Giardia intestinalis 25%.

Enterobius was not often found by them and they attributed that to their stools method of examination.

Cells and Viloria (1970) did a parasitological survey in Manila (Philippine's capital) where they stated that the sanitation is very poor in their area of survey and 68% of the houses classified as slums. They found that the commonest helminths were Ascaris and Trichuris. The intestinal protozoa E. histolytica and Giardia were rare in this area.

In Liberia the first country wide survey to study the distribution of Necator americanus and Ancylostoma duodenale was done by Hsieh et al (1972). They used the filter paper cultivation technique which revealed a prevalence rate of hookworm disease of more than 90% and commented that this is a very sensitive technique. This filter paper culture for hookworm was used also in a study in a rural area in Formosa to determine the prevalence of intestinal helminths by Chen and Hsieh (1969), where they found 27 out of 1525 children infected with hookworm

mainly Ancylostoma. Using Stoll's method for the examination of the other helminths in the same number of children, revealed a prevalence of 75% Ascaris, 79.7% Trichuris and 53% with Enterobius using the adhesive tape method. They added that there is an annual rise of Ascaris following rainfall.

The epidemiology of Hymenolepis nana infections was studied in the Punjabi villagers in West Pakistan by Buscher and Haley, (1972), they found that the infection rates were highest in the age group 2-19 years and the transmission appeared to be hand to mouth.

A hospital analysis of 13055 patients was done at the Gandhi Memorial and associated hospitals in India during 1958-1960 (Vedyarthi, 1969). The examinations of 1692 unselected stool specimens from the above number with saline and M.I.F. concentration revealed a total parasitic rate of 57.27%. In this series he found that the symptoms of pain in the abdomen correlated with Ascaris more than any other parasitic infection. Ascaris and Giardia were more prevalent in females than in males.

An interesting case was reported from Ceylon by Aluwihare et al (1972) referring to abdominal pain and peritonitis in Ascaris. They reported a case of subacute peritonitis due to Ascaris ova mimicking tuberculous peritonitis. They suggested therefore that a biopsy in all cases of tuberculous peritonitis is needed as the diagnosis

can be established only histologically.

Onchocerciasis

One of the major problems that was thought might face the Nubians in the new resettlement area is onchocerciasis. Onchocerciasis is unknown in Old Halfa area but the neighbouring area in New Halfa is a known endemic focus for it. Lewis (1953) has found the vector on the upper Atbara River and also some species in Kassala province. The study by Lewis was done 10 years before the construction of Khashm el Girba Dam which is expected to modify the situation and I am reporting on this in my findings. Ovazza (1970) in a report that he submitted on a visit to the area thought that probably all the area along the Ethiopian border from Southern Fung to Kossala presents foci of onchocerciasis, and the development projects in the area entail the risks of creating a dangerous focus. He added that until 1969 there is no evidence of an important incidence of human onchocerciasis along the main Nile (which includes old Wadi Halfa area) and he found that in the area from the fifth cataract to the third cataract in the River Nile, Simulium damnosum and Simulium griseicolle are a nuisance and interfere with the economic development of important provinces. He suggested that the future movement of the population may lead to the creation of a focus of onchocerciasis. Morgan (1957) was the first to prove the presence of onchocercal infection in the northern

Sudan. He discovered in Khartoum Civil Hospital skin clinic, 3 proved cases of onchocerciasis, none of them had visited southern Sudan and all lived along the river Nile between Abu Hamed and Shereik. He later surveyed that area (Morgan, 1958) and proved that onchocerciasis was endemic there.

Lewis (1948) noticed that although Simulium damnosum in Sudan breeds mainly in waterfalls, rocky gorges and cataracts with well aerated rapidly flowing water, yet it was found to breed in mud and relatively slow flowing water (approximately two kilometres per hour). The canals in the resettlement area may thus be a favourable site for the breeding of Simulium. Kirk et al (1959) reported that the principal clinical features of onchocerciasis in Sudan are the onchocercal nodules, eye lesions, including blindness, various skin manifestations, lymphadenopathy and genital elephantiasis. Bryant (1935) reported on ocular onchocerciasis and endemic retinochoroiditis.

Woodruff et al (1966a) found in a focus of onchocercal infection in Zigi valley and Amani in East Africa that the incidence of infection appears to increase with age. They found that among 84 patients with microfilariae in their skin, corneal lesions were present in 23.8%, iritis in 7.14%, fundal

lesions similar to senile choroidal sclerosis in 10.85% and in only 16.5% of their patients they detected microfilariae in the anterior chamber of the eye. The commonest symptom in their patients was pruritus present in 83.3% of patients and thickening of the skin was present in 28.6%.

Woodruff et al (1966) found major differences between the East African onchocerciasis and that of Guatemala. They found that there was a greater frequency of iritis and keratitis in Guatemala and a lower frequency of skin lesions especially those of the legs. They found that in the endemic regions of Guatemala the infection in the early age groups was higher than in East Africa, I tried however in this study to survey both age groups.

Kirk (1957) has discussed the tendency to regard all eye conditions in an area of onchocerciasis to be due directly to the worm infestation and to ignore the effects of nutritional deficiency, trachoma infections etc., but later Kirk et al (1959) pointed out that onchocerciasis in northern Sudan may have been missed "due to an error in the opposite direction" which lead to all cases of eye lesions, defective vision and blindness being regarded as due to trachoma which is common in that area.

Leishmaniasis

Leishmaniasis is considered to be a major medical problem in Sudan (Archibald et al 1923). It is now felt that more study is needed for the various aspects of this disease in Sudan and the newly formed Institute of Tropical Medicine in Khartoum is giving this disease a top priority in its research. The hyperendemic provinces of visceral leishmaniasis in Sudan are the:-

1. Upper Nile Province
2. Blue Nile Province
3. Kassala Province.

Few sporadic cases are seen in Darfur province (Republic of the Sudan, 1964).

A leishmanin study done by us in patients in Omdurman Hospital (Cahil et al, 1965) have shown that 42% of the patients from endemic zones, in contrast to only 3.5% of patients from Khartoum were positive reactors and the great majority of reactors came from the hyperendemic provinces mentioned above.

The Nubians came from a kala azar free area and they were resettled in a known endemic province and this I thought was an interesting situation where the leishmanin skin test can really be evaluated. It is important to study the epidemiology of this disease

in the new resettlement area. This disease has occurred sporadically in East Africa except for a few outbreaks in troops in the northern province of Kenya during the second world war and then appeared in epidemic form in Kenya in 1952 (Manson-Bahr and Southgate, 1964) and very little was known about the disease before that outbreak, a situation which we would like to avoid.

It was attempted in the present survey to study the epidemiology of leishmaniasis among the Nubians by searching for the vector, using the leishmanin test and looking for cases.

Difficulties may arise sometimes in collecting the sandflies or knowing their breeding places, (Heisch, 1954). Heisch (1955) discovered a new species of sandfly in East Africa which is naturally infected with leptomonads and which can become infected with human leishmania skin lesions and he naturally thought that was the vector of the disease. However, epidemiological studies later in Africa by Wijers and Minter (1962) ruled out this possibility. In East Africa (and New Halfa is near this region) human patients form a good reservoir for sandflies, 4 months after infection until the case is diagnosed which is an average period of 7 months. This differs from the Mediterranean type of kala azar which is not infective for sandflies (Manson-Bahr and Southgate, 1964). When

the movements of the population in the new resettlement area is considered this observation represents a real hazard for the spread of the disease.

The leishmanin test if used properly has great specificity and the false positive rate in areas where kala azar was absent was under 0.75% (Manson-Bahr and Southgate, 1964). The results of inoculating immune individuals with the leishmanin test vary from a large arthurs reaction to temporary skin nodules (Manson-Bahr, 1961; Manson-Bahr et al, 1963).

Had the vaccination trials been successful, prophylactic vaccination against kala azar would have been necessary for the Nubians who were not exposed to leishmaniasis in their Old Halfa district. However field trials done in northern Kenya failed to show any protection in nature by vaccination against leishmaniasis. (Manson-Bahr and Southgate, 1964). They carried out the field trial of vaccination in the principal epidemic area in Kenya in 2946 people out of a total population of 8,200. They concluded that although immunity to infection with L. donovani could be induced in volunteers experimentally their field trial failed to show any protection in nature and they added that this may be due to loss of virulence on the part of the culture used in the vaccine.

PART II

MATERIALS AND METHODS

CHAPTER 5

POPULATION SELECTION

A. In Old Halfa

Old Halfa was visited for this study in December, 1969. At this time most of the town was submerged but there were about 4000 Nubians living in temporary wood houses in the town and the few neighbouring villages (Fig. 8). It was thought that a survey of a sample of the remaining population would provide a suitable base line in the study of the changing pattern of diseases in the Nubians who were uprooted from this area and resettled in Khashm el Girba.

Our base in Old Halfa was the small hospital and the wards were temporary buildings. A wide range of age groups was selected for this survey but particular emphasis was placed on the age group 6-15 from which a larger number was selected, this is the school age range and the schools in Old Halfa also drained schoolboys from the few small surrounding villages of the Nubians. Thus they represent the population in the district.

As the one mixed elementary school in old Halfa and the intermediate school were the only available schools in Old Halfa at that time these were the choice for the school range age group

Figure 8.

The temporary wood houses in Old Halfa after the Old Town was submerged under water.

6-15 years. The aim was to examine more than 25% of the children.

The selection of the adults and the pre-school age groups presented a problem. It was difficult to map and number the temporary houses distributed in a very wide area and of variable sizes and structure and it was decided to take a 20% random sample of all houses in New Halfa and all persons in the selected houses were eligible for examination.

In addition all the patients in old Halfa Hospital were examined and investigated but knowing that they are a selected group their data was separately analysed.

B. Population Selection in New Halfa

The Nubians were resettled in Khashm el Girba area in New Halfa town and 25 other villages during 1964-1967. The first Nubians arriving were resettled in village 1 and the resettlement continued during the years in the remaining villages according to their numerical order.

Village 1 is at the southern end of the Scheme (the nearest end of the scheme to Khashm el Girba Dam). Village 26 lies at the northern end of the scheme and its population consist of the late arrivals. Villages 14 and 16 are in the middle of the scheme and their population arrived during 1965-1966.

The above villages plus New Halfa town were the areas which were investigated by us extensively. The village total population is generally 1200-1500 and it was aimed at examining more than 25% of the population of these villages and the largest group would usually be the young age group. The main interest in New Halfa town was the large number of the children born and living in the area.

The follow up study was mainly in villages 13 and 16. Although the main study was in the above villages, some other villages were also studied but a smaller sample was taken as it was of interest to see if there was a different pattern of diseases in the other villages.

The sugar factory represented a different environment in this study where there is a large group of immigrant labourers importing diseases to the area (Fig. 9). In the sugar factory we examined school children, young children of Nubians and other tribes, to see the type of acquired diseases and also the labourers who came mainly from southern and western Sudan importing diseases to the area. The labourers who are employed to clean the canals (canal cleaners) were also selected as they represent a group with a very high risk of exposure to schistosomiasis and if infected they would increase the risk of transmission of the disease.

C. Population selection of the Nomadic Tribes and the Population of Khashm el Girba

The nomadic tribes live in small groups and El Gafala is one of the relatively large villages of those tribes. It was therefore chosen for this study and over 20% of the population there were examined. The main interest here is to find the pattern of diseases in the indigenous population of the area.

Khashma el Girba, the site of the Dam, was the largest town of the area, but New Halfa town is now the largest and is the important town in the district. A relatively small number of people in Khashm el Girba was examined and the records of the health centre there were studied.

Apart from the population of New Halfa district it was necessary to use the leishmanin test for comparison in a neighbouring endemic area of kala azar. El Gadarif town which is about 100 kilometres from Khashm el Girba was chosen for this purpose. The test was performed in the Hospital non kala azar cases from both the surgical and medical wards in various age groups. The patients selected for the tests were those coming from the town itself or the neighbouring area. Patients coming from other far districts were not tested. The hospital cases were selected for the

study as they would be available for the reading after 48 and 72 hours.

Children born in New Halfa

These form a very important group in this study. They were born in the area and the majority have not left the area even for very brief visits. A note was made about any visit they made to other parts of the country if there were positive findings. The resettlement in New Halfa district started in 1964 and a sufficient number of children aged 0-8 years who were born in the resettlement area were found in the visits in 1971 and January, 1973. These children born in the area were selected from New Halfa town and the other villages.

The first visit to the area was made in February, 1969 and 6 more visits were made during the period April, 1969 to December-January, 1973. Each time more patients were examined, a follow up done and children born in New Halfa were examined in the last two visits.

The team helping in the investigations and the organisation of the work in the field consisted of:- 2 technicians, 2 laboratory assistants and a driver. In addition in New Halfa another laboratory assistant, a number of bilharzia men and malaria men and another driver were usually provided. The medical assistants and the senior nurses in charge of the health centres and the dressing stations provided any help needed.

The team was provided with 2 cars for the transport of personnel and the equipment in New Halfa area.

CHAPTER 5

QUESTIONNAIRE AND CLINICAL SHEETS

Old Halfa

The selected group of the school children of both the elementary school and the intermediate school (age group 6-19 years) and the random sample of adults and preschool age from Halfa town were subjected to the questionnaire shown in pages 113-117. For those who did not move to New Halfa the clinical sheet was as shown in page

As stated before the questionnaire was completed and clinical examinations were done in Old Halfa in December, 1969 and at that time the original town was submerged under water and the Nubians were living in temporary wood houses.

Questionnaire

The main purpose of the questionnaire in Old Halfa was to elicit the difference in symptomatology between the two areas (old Halfa and the resettlement area in Khashm el Girba), and therefore question 11 was the same in both sheets.

As schistosomiasis was the major disease in this study, haematuria, burning micturition, frequency of urine (were given importance and included for the haematobium infection) and diarrhoea, blood and mucus in stools included for the mansoni infection.

Enterobius infection and Taenia saginata infection are common in Sudan and the method of stool examination may miss these helminths or the specimens taken in the survey may not show the infection on that particular day. It is for this reason that the Nubians were asked in question II, parts vi, vii, viii if they passed worms in the stools. Many patients would notice the small thread-like worm in their stools or around the anal region if they have Enterobius infection and the mothers would notice that if the child had this infection and therefore they were asked in part vii to describe the worm. Segments of Taenia saginata were often noticed in the stools and many patients could also describe them. Pruritus ani is also a common symptom in Enterobius infection and has been emphasised in part viii because it was thought that the methods of stool examination used in the survey was not a good method for detecting Enterobius infection but nevertheless, the most practical method for such an extensive survey.

While malaria is an important medical problem in the resettlement area Anopheles gambiae was exterminated in Old Halfa, therefore, the Nubians who did not move to New Halfa were asked about fever in the questionnaire for comparison.

Itching is an important complaint in onchocerciasis and although onchocerciasis is not a problem in New Halfa, it was essential to ask about this symptom for the purpose of comparison in the follow up study in the

resettlement area.

Eye troubles are a major problem in the Nubians as shown in the Introductory Chapters and so it was important to enquire about eye diseases in the questionnaire.

It was tried also to divide the population into 4 age groups and as particular stress in this study was on the young age group, those below 15 were divided into 0-5, 6-10 and 11-15.years.

The sex and occupation were also important for the epidemiological study.

Questionnaire for those in the resettlement area

The main difference between this questionnaire and the one for those who did not move which has been discussed before, is the additional questions 15-21. The aim of these questions was to reveal more evidence of diseases acquired in the new resettlement area.

The patient was asked in question 15 if he had treatment for the important diseases previously mentioned or if he had been told that he had any of them.

Diarrhoea and fever are important symptoms in the tropics and the patient was asked directly if he had more of them or not in the new resettlement area.

Ill health as noticed by the patient or evidenced by admission to hospital in the two areas was stressed in questions 19-21.

Clinical examination

The clinical examination sheet shown in pages 118-119 is the same for both Old Halfa and the resettlement area.

The points stressed in the general examination is the physique of the patient to see whether the new environment will result in a change and also the eye evidence of trachoma and the evidence of itching. Trachoma as stated before is common in Old Halfa and the Nubians were given treatment before they left so it was important to see if there is evidence so far of a change. A question was asked about itching and in the general examination it was of interest to see if there was evidence of itching suggestive of onchocerciasis.

In item 12 when examining the systems, special attention was given to the abdomen and it was attempted to palpate accurately the size of the liver and spleen as their enlargement is common in both the malarial and schistosomal cases, the major medical problems in this study.

Fluid in the abdomen was looked for carefully to find out the evidence

of schistosomiasis if any or possibly some other aetiological causes.

Examination of the chest and heart was mainly to look for other concomitant diseases and it was possible to detect some congenital and rheumatic heart diseases and help the patients and also treat some respiratory tract infections. This is very helpful in field surveys as it will encourage the people to co-operate with us in the survey.

THE QUESTIONNAIRE

AND CLINICAL EXAMINATION SHEETS

A study of tropical diseases in Old Halfa

(for those who did not move to New Halfa).

1. Date

2. Serial No

3. Name

4. Age (i) 0-5 (ii) 6-10 (iii) 11-15 (iv) 16 and above

5. Sex Male Female

6. Name of Village

7. Name of School

8. Occupation

(i) Preschool (ii) school child

(iii) Farmer (iv) labourer

(v) Others

9. How long have you lived here?

10. Did you ever leave Old Halfa and if so to where and when

11. Have you ever been troubled by any of the following symptoms in Old Halfa?

(i) Haematuria (ii) Burning micturition

(iii) Frequency of urine (iv) Diarrhoea

(v) Blood and mucus in stools

(vi) Passed or noticed worms in stools

(vii) If so can you describe them.

(viii) Pruritus ani) (ix) Itching

(x) Rash (xi) Abdominal pain and colic

(xii) Fevers (xiii) Pain right hypochondrium

(xiv) Pain left hypochomdrium

(xv) Central abdominal pain

(xvi) Pain in loins (xvii) Pain lateral quadrants of abdomen

(xviii) Eye troubles (xiv) Others

(xx) Don't know

12. Have you had treatment for any of the following since you were born (write no.).

(i) Schistosomiasis (ii) Malaria (iii) Kala azar

(iv) Worms (v) Anaemia (vi) Trachoma

(vii) T.B. (viii) Diarrhoea (ix) Fevers

(x) Others (xi) Don't know

13 Have you been admitted to hospital in Old Halfa

14. Have you got relatives in New Halfa.

A study in tropical diseases
in New Halfa Resettlement area

1. Date 2. Serial No.

3. Name

4. Age (i) 0-5 (ii) 6-10

(iii) 11-15 (iv) 15 and over

5. Sex Male Female

6. Name of Village

7. Name of School

8. Occupation

(i) School child (ii) Farmer

(iii) Labourer (iv) Others

9. Where did you live before? (Previous village)

10. How long have you lived here?

11. Have you ever been troubled by any of the following symptoms before coming to New Halfa?

(i) Haematuria (ii) Burning micturition

(iii) Frequency of Urine

(iv) Diarrhoea (v) Blood and mucus in stools

(vi) Passed or noticed worms in stools

(vii) If so can you describe them

(viii) Pruritus ani) (ix) Itching (x) Rash

(xi) Abdominal pain and colic (xii) Fevers

(xiii) Pain right hypochondrium

(xiv) Pain left hypochondrium

(xv) Central abdominal pain

(xvi) Pain in loins

(xvii) Pain lateral quadrants of abdomen

(xviii) Eye troubles

(xiv) Others (x) Don't know

12 Have you been troubled by any of the above since you arrived here?

(i) Yes (write no.) (ii) No (iii) Don't know

13. Gave you had treatment for any of the following before coming (write no.)

(i) Schistosomiasis (ii) Malaria (iii) Kala azar

(iv) Worms (v) Anaemia (vi) Trachoma

(vii) T.B. (viii) Others (ix) Don't know

14. Have you been told that you have any of the above before coming? (write no.)

15. Have you had treatment for any of the above since you came to New Halfa?

16. Have you been told that you had any of the above since you came to New Halfa?

17. Did you have more diarrhoea in

(i) Old Halfa (ii) New Halfa (iii) Don't Know

18. Are you having

(i) More fevers (ii) less fevers now than in Old Halfa

19. Have you been admitted to hospital in Old Halfa?

20. Have you been admitted to hospital in New Halfa?

21. Is your physical health (more illness)

(i) better in Old Halfa (ii) better in New Halfa

(iii) Don't know

1. Date
2. Serial No.
3. Name
4. Age
5. Sex
6. Name of Village
7. Name of School
8. Occupation
9. When did you come to New Halfa?
10. Any complaint?
11. General examination

(a) Physique

(i) Lean and underweight (ii) Fat (iii) Fair

(b) Appearance of illness

(c) Temperature (d) Pulse rate

(e) Skin colour

(f) Cyanosis Anaemia

Jaundice Pigmentation

Skin eruptions Oedema

Mucous membranes Eye evidence of trachoma

Lymph glands Evidence of itching

12. Systems

(a) Chest

(b) Heart

(c) Abdomen

(l) Liver:

(i) Not palpable (ii) Just palpable

(iii) 2-4 cms (iv) more than 4 cms

(2) Spleen

(i) Not palpable (ii) Just palpable

(iii) 2-4 cms (iv) more than 4 cms.

(3) Fluid in abdomen

(d) C.N.S.

13. Is he given treatment now and if so what?

14. Investigations done by us

CHAPTER 6

Basic Investigations.

A. Stool examinations

The majority of the persons in this study had their stools examined by either the direct smear method or the concentration digestion method and the method of examination for any group is shown in the results.

Cardboard containers were distributed to those selected to bring their stools for examination the following morning on the previous night. The persons were asked to pass fresh specimens in the containers in the early morning and to bring the specimen directly to the laboratory in their village. The health visitors and the assi stants stressed to the head of the family that the container which was marked was to be used by that specific person and covered by the special cover. As soon as the container was received by the team in the laboratory it was marked clearly by a serial number and the name, the serial number, age and sex entered in the register of that day.

Every specimen was examined in the field by the direct smear. method and the remainder of the specimens sent to the nearby central laboratory of the team for the digestion concentration method.

In some places only the direct smear method was performed.

Direct smear method

Sterile wide mouthed disposable containers were used for the collection of the stool samples. A first naked-eye inspection was made for the presence of any abnormal constituents and then the direct method is done as follows:-

1. A few drops of 1% eosin-saline were added to a clean slide
2. Using a wooden applicator a small piece of stool was taken from the specimen especially from the area of mucus or blood if any and emulsified with the eosin-saline solution.
3. This was mounted with a thin cover slip and using the 16 mm. objective and the high power eye piece, the smear was examined for eggs, larvae, vegetative amoebae or flagellates
4. For the examination of cysts one or two slides are prepared as described above, but Lugols iodine was used instead.

Two well trained and experienced technicians examined at least two slides of the same specimen and the author checked the examination of the samples.

2. The concentration method for ova and cysts

Digestion method using 2% NaOH

These persons were asked to bring large amounts of the stools for this examination and this point was stressed by the team the night before the examination.

1. 5 grams were usually taken from the stools but sometimes in spite of the efforts small samples were supplied by the patients.
2. The specimen was subjected to grinding in a mortar and pestle.
3. 10 ml of 2% NaOH were poured for each gram of stool.
4. This was left to digest at room temperature for about 3 hours
5. The suspension was then mixed.
6. Using especially calibrated pipettes (0.1 ml) was taken and mounted with a thin cover slip in each of 3 slides and examined.

Then the mean of the 3 slides is taken and eggs/gram =

$$\frac{X \times 10 \times 50}{5 \text{ grams}}$$

This is needed for the egg count in cases of S. mansoni infection but for the other eggs and protozoa, any helminth eggs or segments, or protozoa present in the 3 slides is reported as positive.

Two experienced technicians examined any sample and the examination was supervised and checked by the author.

If the patient was going to be subjected to the questionnaire and clinical examination, these were done first and then he was given a card with his serial number, full name, age, sex, occupation and asked to go to a second room for the other procedures. If he was just coming for the investigations alone, the above information was also needed and he was asked to hand in his stool and urine specimens and the other investigations done.

Procedures for the urine examination

The patients were asked by our team to pass enough urine sample into the glass or plastic urine bottles and cover them and bring them with the stool specimens early in the morning. The head of the family was given instructions by our team to observe this procedure and not to allow his children to mix their specimens. If there was any doubt about the observation of these precautions or if the family was a large one or mistakes in the specimens were likely the patient would be asked to pass urine under supervision in a new container and the other one was discarded.

The same procedure was observed if the sample was a small one or not satisfactory.

After the urines were received in the laboratory they were emptied by a trained technician into urine glasses numbered according to the

serial numbers adopted and against that serial number full name, age, sex and occupation was written in the records.

The urines were then centrifuged, and the supernatant fluid sucked off. The remaining sediment (about 1-2 ml) was shaken slowly and few drops only removed by a pipette for examination. The remaining urine sample with the serial number on it was kept for checking on the same morning or afternoon.

The pipettes were thoroughly washed before being used again for another sample.

The glass slides used for the examination of the sediment had the same serial number on it.

Schistosoma eggs were looked for and also the other deposits were reported.

In limited numbers the urine was tested for proteinuria and also egg counts were done.

The technicians at the end of the day with the help of a clerk or an assistant would transfer the results of the urine and stool to the investigation sheet of results with the name of the village and date on the top.

The examination of the urine samples performed by well trained technicians was supervised and checked by the author, a number of the remaining samples were also checked. The results sheet was also checked at the end of the day.

HAEMATOLOGICAL STUDIES

Haemoglobin estimation

A limited number of patients in village 16 were chosen for this haemoglobin estimation. The main interest was to compare the bilharzial cases with the non bilharzial ones.

The Sahli haemoglobinometer method was used and although this method is not an accurate procedure for haemoglobin estimation, in my opinion it was the most practical for such a field survey, which was at a distance from adequate laboratories.

The comparison tube was the standard acid-haematin tube and the haemoglobin in the diluting tube is converted to the same substrate by the addition of 0.1 normal HCl.

Method

The diluting tube is filled to the 20 mark with 0.1 NHCl.

20 cu mm. of blood obtained by a finger prick is taken by a pipette, blown gently into the tube, and allowed to stand exactly for

5 minutes. Then adding water and matching using a small glass rod for stirring each addition of water.

The instrument is calibrated so that 100% = 14 grams of haemoglobin.

The results of the haemoglobin of each patient is recorded immediately with the serial number, full name and other details.

White blood cell count, total and differential

A limited number was done, the main interest was the eosinophilia.

The blood obtained by the finger prick is mixed and then sucked with the standard white cell pipette to the mark 0.5. Then the diluting fluid is sucked by the same pipette to the mark II (2% acetic acid and a drop of gentian violet.). The pipette is then shaken. The Neubauer counting chamber was fill by means of a stout glass or Pasteur pipette by the diluted blood, a thick coverslip put on top and examined with 16mm objective.

Differential count

Leishman's stain was used for the differential count.

A thin blood film was dried in the air and then flooded with the stain.

After 2 minutes we double the volume by distilled water on the slide and the film was allowed to stand for 8 minutes. The slides are then washed in a stream of buffered distilled water and set up to dry.

Using oil immersion lens we calculate the differential on 200 cells. A note was also made of any parasites present in the film. The slides were carefully marked.

Blood films for malaria:-

Blood films for malaria were taken from the following groups of the population:-

In Old Halfa

1. From persons who were selected by the team for the survey
2. From a random house-to-house survey
3. From some hospital outpatients reporting on certain days

In New Halfa

1. From a number of people (asymptomatic) that are called to the survey by the team.
2. House-to-house survey (random sample)
3. From the Nubians and other tribes who reported to New Halfa hospital on certain days
4. From the sugar factory area
5. From the nomadic tribes living around the resettlement area.
6. From children born in New Halfa

Method

Two thick and thin films were prepared from finger prick blood samples. In some cases one thick and one thin blood sample were taken.

The films were stained with Giemsa stain by the method of Shute and Maryon. The films were carefully labelled.

The films were examined by two expert technicians and the author supervised and checked the findings.

The films taken in Old Halfa were also checked in the malaria section in Khartoum and those taken in New Halfa were also checked by the malaria centre in the resettlement area.

Blood films for filaria

Apart from looking for filarial infections in the blood films taken for malaria and the differential white cell count a special survey for filarial infections was done in the sugar factory area with large immigrant labour community. The thick and thin blood films taken from this community were stained with Leishman stain (the method previously described).

Skin snips for onchocerciasis

The population selected for the skin snips was from the following:-

New Halfa

1. Village 1 in the southern end of the scheme which is the nearest village to the Dam where we have found Simulium larvae and pupa

2. Village 26 near the sugar factory where there are immigrant labourers

3. In the sugar factory for both the Nubians and immigrant labour

4. From the nomadic tribes

5. In the suspicious thick itchy skins that are seen during the examination.

Old Halfa

From both adults and children (a limited number).

Method

Under supervision, thin skin snips were taken from both legs and in some cases from both the legs and shoulders. In a few cases where the clinical picture is suggestive (thick itchy skin) more snips are taken.

The snips after being transferred to a carefully labelled slide and with a drop of saline and cover slip were left for about 20 minutes and then examined for microfilariae.

CHAPTER 8

The Intradermal tests

A. The leishmanin skin test

This test was done in the following groups.

1. In old Halfa

In both children and adults from the town and in all the hospital cases. The cases that moved outside Old Halfa to possible endemic areas were excluded.

2. In the Resettlement area

    1. In the Nubians visited in 1969
    2. In the Nubians visited in 1971 and January 1973
    3. In the Nomadic tribes
    4. In the hospital in-patients in New Halfa town.
    5. In the neighbouring endemic area of El Gedarif (hospital non kala azar in-patients).

Methods

The antigen used in this study was commercially prepared (Wellcome Laboratories of Tropical Medicine), the solution containing 5-8 million phenol-killed leptomonads of L. donovani (Kenya strain) per cubic cm.

1ml. widely calibrated disposable syringes were used and 0.2ml of the antigen was injected intradermally on the forearm and the area was

examined 48 hours and 72 hours later.

All those having an indurated area greater than 5 mm in diameter 48 or 72 hours after the injection were considered by the author as having positive leishmanin skin tests.

B. Schistosomal skin test

This skin test was done in a limited number of cases.

1. In village 13 in a group of people

2. In village 16 in a number of bilharzial and non bilharzial cases.

The antigen used in this study was the World Health Organisation prepared antigen (from the adult worms). The control used was the W.H.O. buffer supplied with that antigen.

(The W.H.O. Parasitic section in Geneva had kindly supplied this antigen and the buffer).

CHAPTER 9

G-6P D deficiency and abnormal haemoglobins

Venepuncture is not easily acceptable in medical surveys and sometimes it discourages people from coming to these surveys. The author therefore avoided this procedure whenever finger pricks could do the job. But for the estimation of G-6 PD and abnormal haemoglobins where venepuncture is essential, it was tried to take samples from a relatively small number of people from areas not under the other procedures of the present survey. The blood samples were taken from unrelated Nubian males. The blood relationship was avoided in each group and even distant relatives were excluded.

The blood samples were collected in Sterile A.C.D. solution in the special small covered tubes and then the blood samples were immediately stored in ice in vacuum flasks and delivered by car to the central laboratory in Khartoum within 24 hour s.

Screening for the deficiency of G-6-P D was done by the methaemoglobin reduction test (Brewer et al., 1962) and by the kit method (Dades reagents, Dades Dev. Amer. Hosp. Supp. Corp. Florida).

The sickle cell test and haemoglobin paper electrophoresis were done by the standard methods (Dacie and Lewis, 1968).

This study was combined with a wide country study in Sudan for the indigenous and immigrant tribes and published in the Journal of Tropical and Geographical Medicine, 1972, volume 24, no. 4.

CHAPTER 9

The snail collection and entomological study

Snail collection

The main purpose of this part of the study was to try to find out whether the snail intermediate hosts of schistosomiasis are present in the irrigation system and in various canals in this area or not. It was therefore decided to survey many canals in the scheme. Most of the collections were not done according to a statistically standardised technique as this was not needed for the objective stated above. Snails were collected by means of a flat wire mesh net, and many dips were taken from the chosen area of the canal. Vegetation pulled out of the water was also inspected. The method of snail sampling adopted by Malek (1962) was found to be satisfactory under local conditions and thus several different water courses were inspected.

Any snails collected would be brought to the laboratory in wet cotton pieces. The snails were then identified and put in a wide glass tube. The tubes were then exposed to light and observed with a hand lens to see if they were shedding cercariae. The cercariae were identified whether they are of the human pathogenic type or not.

Entomological study

The author consulted and was helped by Dr. S.M. Hussein and Dr. O. Abdel Nur in this entomological study and the identification of the specimens.

Special sites were selected for this study and these were:-

1. Khashm el Girba Dam area
2. The sugar factory area
3. A riverain village, inhabited by the nomadic tribes
4. Villages 1, 16 and 24 in the resettlement area.

The Khashm el Girba Dam site was specially searched for Simulium as it was expected to be the most favourable site with rocks and fast running water.

The sugar factory with a lot of stagnant water was expected to be a favourable site for the mosquitoes.

It was also necessary to survey a representative nomadic tribe area (the riverain area) and Nubian villages, villages 1, 16 and 24 in different areas of the scheme.

Outdoor traps were set for adult mosquitoes and Simulium and also outdoor searches by hand capture were also carried out by trained mosquito men.

The rocky area under the Khashm el Girba Dam was carefully

searched by a trained labourer from our team for Simulium larvae and pupa.

Several water courses were also carefully searched for mosquito larvae.

PART III

RESULTS

CHAPTER 10

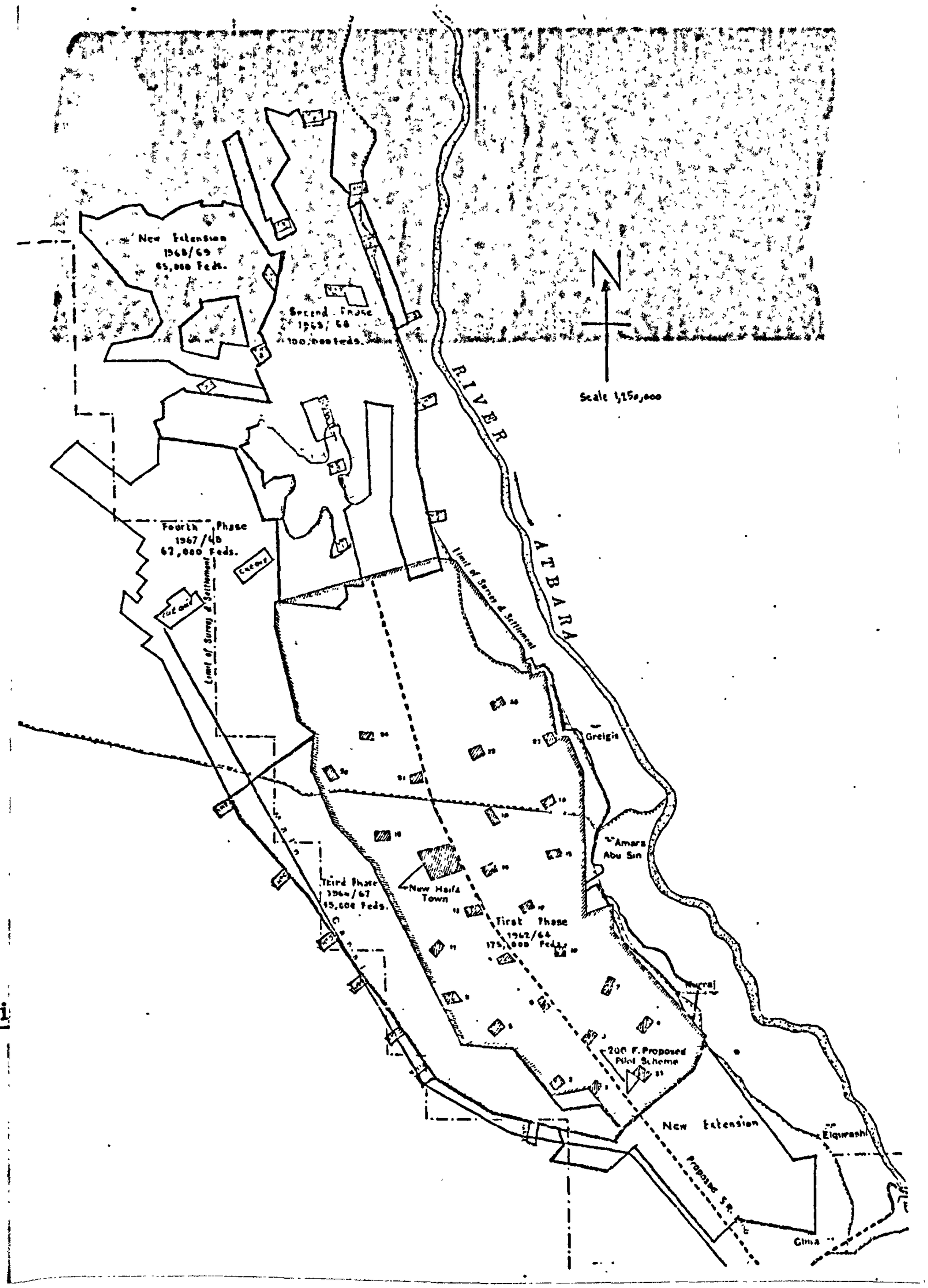
Personal observations on the social, environmental and ecological factors in Khashm el Girba scheme. The New Resettlement area.

Observations were made of the social impact upon the Nubians of moving, and though this impact is not part of the results of the medical survey which forms the main part of this thesis the observations have important bearings on the medical survey and are therefore included here.

The scheme was designed to resettle about 60,000 Nubians uprooted from Old Halfa in phase 1 of the scheme and the neighbouring nomadic tribes in the other 4 phases of the scheme (phase 2-5) if the settlement of these went according to the plan (Fig. 9).

Location of the scheme

In 1954 a study of the River Atbara at Khashm el Girba where the river passes through rocks and changes its width sharply demonstrated the feasibility of constructing a Dam there. The Dam in this place can command by gravity the irrigation of about half a million feddan of very fertile land (1 feddan = 1.038 acres). But it was only in 1959 when the Nile agreement between Sudan and Egypt was concluded, that it was then decided that an irrigation scheme


New Extension
1968/69
65,000 Feds.
Second Phase
1963/68
100,000 feds.
N
Scale 1,250,000
RIVER ATBARA
Fourth Phase
1967/68
62,000 Feds.
Cacong
Limit of Survey & Settlement
Greigis
Amara Abu Sin
Third Phase
1966/67
15,000 Feds.
New Haifa Town
First Phase
1962/64
175,000 Feds.
Nurai
200 F. Proposed Pilot Scheme
New Extension
Elquraishi
Proposed S.R.
Gima

Fi

would increase the agricultural production of the country and resettle the Nubians displaced from Wadi Halfa by the construction of the high Dam. This area is a large plain of the Butana on the west side of the River Atbara, about 400 kilometres east of Khartoum. It is between latitude 15° 8" - 15° 30" and longitude 35° 40"- 35° 55" E. It is separated from the Atbara river by 3-8 kilometres.

The soil of the area is a very fertile first class land, it deteriorates slightly when going north. It is a dark coloured heavy plain. There is a slight north west slope of 45 cm/kilometre which makes gravity irrigation possible.

The Butana plain before the resettlement scheme used to be sparsely populated by nomadic and semi-nomadic tribes mainly the Shukriya for grazing cattle, sheep and camels. Those tribes used some of the land for cultivating dura and dukhn which are their main cereals.

Climate

The area is semi-arid with an annual rainfall of 300-500 mm varying considerably from year to year.

The rain is maximum in the town of Khashm el Girba (site of the Dam) reaching 390 mm in some years and gradually decreasing northwards reaching 300 mm only 40 kilometres north. There is

usually a period of 2 weeks of heavy rain in July-August.

Temperature

The temperature is usually high with an average of about 29°C. The hottest month is May when the temperature can go up to 41°C, while in the coolest month, January, the mean temperature is usually about 15°C. However generally in this area there is a small difference between the maximum and minimum temperatures. There are usually 3 seasons.

a. Winter - From the 15th November to 15th March

b. Rainy season - June to September when the weather becomes cool and humid (rain is confined to this season).

c. Summer - very hot with very little or usually no rain at all.

Humidity

The relative humidity is very variable during the year. It is highest during the rainy season (45%) and is lowest in April with a mean of 10%

The Khashm el Girba Dam

The design of this Dam and the associated structure of canals was made by foreign contractors. Other contractors undertook the actual construction of the Dam which was completed in June, 1963 (Wyne, 1963).

The cost of constructing the Dam was estimated at 7.7 million Sudanese pounds while the cost of the preparation of 150, 000 feddans of land for the resettlement of the Nubians of Wadi Halfa was estimated at 6.4 million Sudanese pounds.

The overall length of the dam is 3850 metres and its height is 55 metres. The reservoirs total capacity is 1.3 million cu. metres and extends for about 80 kilometres upstream. It is important to note that this water is enough to irrigate ½ million feddan.

Hydroelectric power

The turbines on the Dam and the major canals generate about 14000 K.W.. This electricity supply is used both for the domestic and industrial purposes.

It was planned that in future the neighbouring towns of El Gedarif and Kassala would receive their electricity from this project.

The system of the scheme

The five phases of the scheme are now fully operational.

The Nubians were settled in phase 1 of the scheme which includes also the sugar plantation of 45, 000 feddans and refineries.

The agricultural area for the Nubians resettlement is 80, 000 feddans while their housing area is approximately 90, 000 feddans.

The total surface area of this phase is 36 square kilometres. This is compared to scattered villages in an area of 150 square kilometres in the old submerged area.

In addition the Nubians were allotted 25, 000 feddans as freehold. This allocation of freehold ended in 1969. Local tribes were allotted 25, 000 feddans of agricultural land. They were mainly from the Shukrya tribe.

Miscellaneous agricultural land in phase 1

18900 feddans rented to contractors for wheat cultivation, 2250 feddans for forestry, 800 feddans for the agricultural substation. The total resettlement costs were estimated to be 23 million Sudanese pounds (The Egyptian Government contributed by 15 million pounds as a compensation for the lost submerged properties).

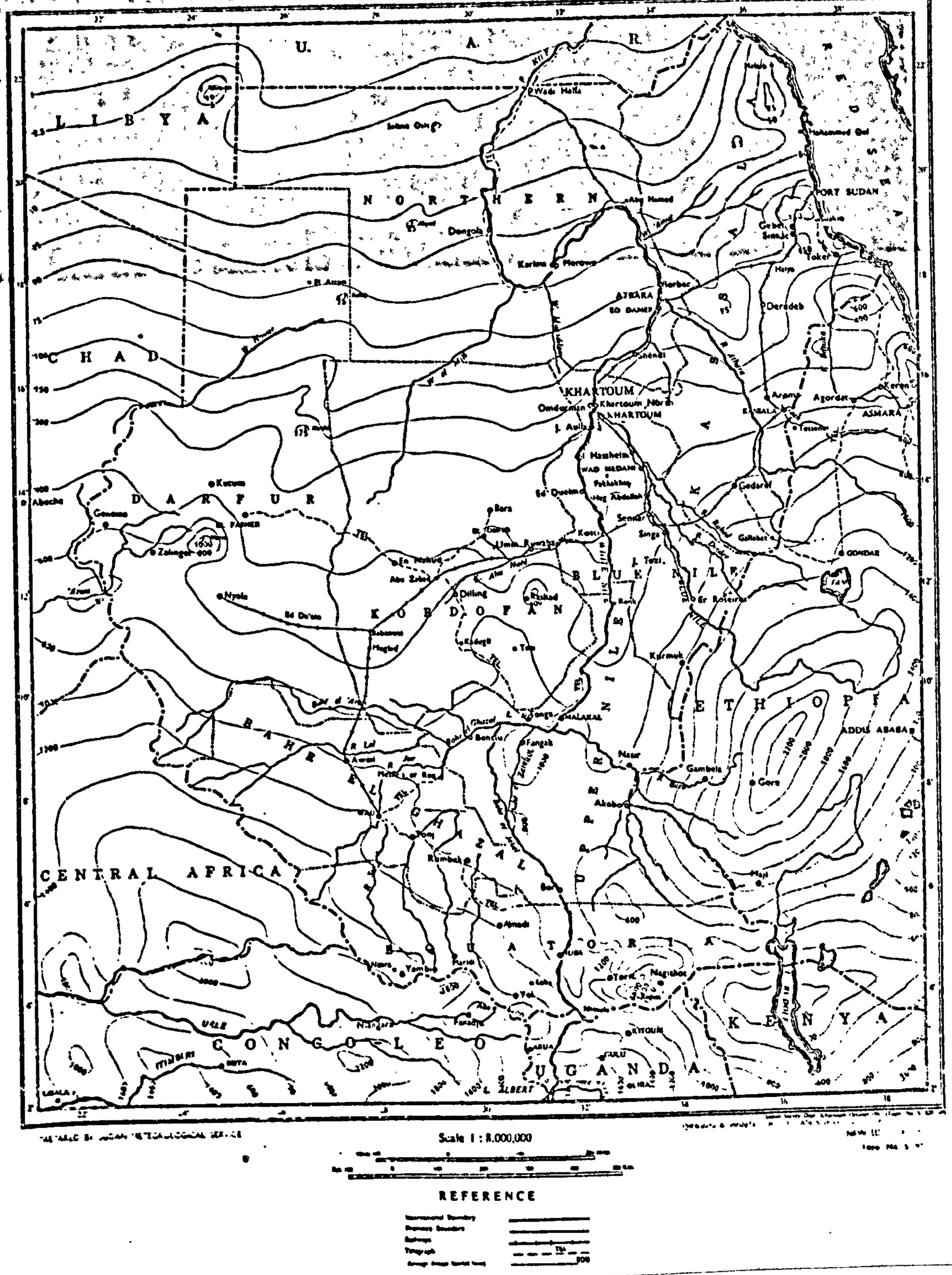
The Dam and the canalisation system were estimated to be 26 million pounds.

The cost of the sugar factory in phase 1 was 5 million pounds and started functioning in 1965.

Design of the villages in the scheme

25 villages were planned in the northern and central areas of phase 1. New Halfa town is in the centre of the villages. Its size

AVERAGE ANNUAL RAINFALL 1931-1960 (MM)
SUDAN



Fi

... 100 millimetres per year.

is approximately equivalent to 6 villages. The agricultural land is sited as near as possible to these villages.

The optimum village size which would enable the services to be provided economically was strictly observed in their design.

The village had usually between 250-300 houses built in a modern style with cement blocks and corrugated iron roofs. The houses allocated to the Nubians according to their previous holdings in Old Halfa. The average house cost was approximately 2000 to 2500 Sudanese pounds.

The style of the streets is usually straight, and sometimes monotonous but the Nubians have now changed this monotony by their inherited love for planting trees and decorations. The villages were sited at intervals of 5 km. from each other.

Every effort was made so that the original Wadi Halfa people retained their population groups in these villages and that the original communities retained their neighbourhood in the allocation of dwellings and villages.

Organising bodies responsible for running the scheme

1. Khashm el Girba agricultural scheme

Responsible for allocation of tenancies, initiating crop production and land clearance.

2. Ministry of irrigation

This is responsible for the Dam, canals and system of irrigation.

3. Industrial development corporation

This is responsible for sugar plantation and its refineries.

Phases 2-5

Work in these neighbouring phases which are inhabited by the nomadic and semi-nomadic tribes started in 1966 and has now finished.

It is important to note that the Khashm el Girba scheme was established in an area claimed by the camel owning nomadic Shukriya tribe. This land was used by them for grazing and for cultivation irrigated by rain.

Those Shukriya with established claims of ownership were given priority in tenancy allocation after the resettlement of the Nubians.

The remaining tenancies have been allotted to the following tribes:-

KHASHM.ELGIRBA.

Scale 1:10,000

Village. 26

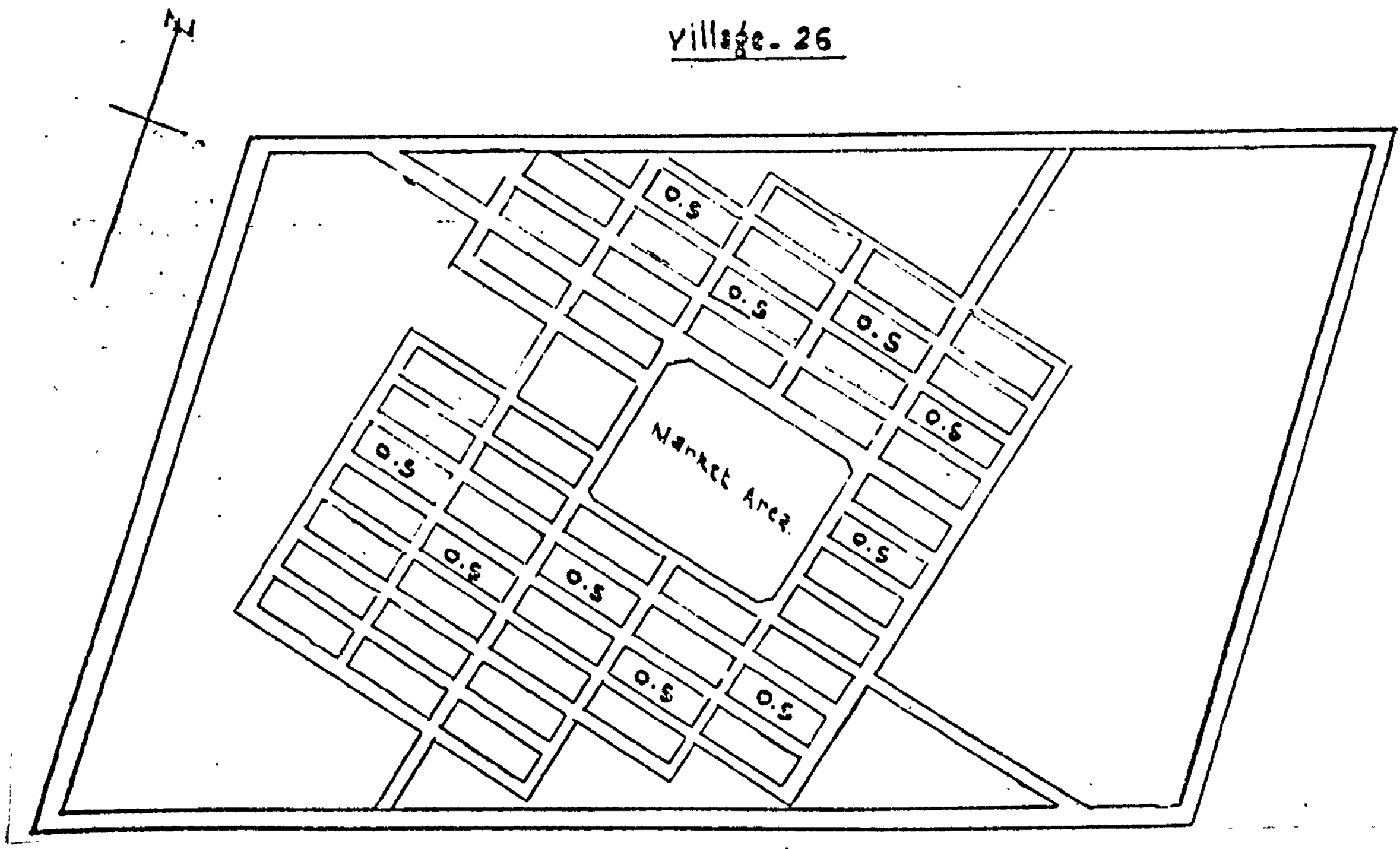


Figure 11.

Map of the largest village. Village 26
to show the houses layout and style of the streets.

1. The rest of the Shukriya

2. Rashaida

3. Beja tribes having the following groups:-

   a. Hadendowa

   b. Burharin

   c. Amara

   d. Beni amer

All of them are camel and cattle owning tribes. No resettlement aid was given to these nomads.

Size of phase 2-5

Phase 2 - 101, 000 feddans and has 15 villages.

Phase 3 - 45, 000 feddans and 7 villages

Phase 4 - 61, 000 feddans and 5 villages

Phase 5 - 44, 000 feddans. The villages are still growing.

N.B. The total size of phase 1 is 175, 000 feddans.

Allocation of tenancies in Phase 1 (The Nubian resettlement phase)

The first group of Nubians left their original home (Old Halfa) in 4-1-1964 to Khashm el Girba and the last group of Nubians arriving in New Halfa area arrived in June, 1967. There was estimated on this site to be 53, 000 Nubians arriving on 131 special trains.

The agricultural land was allocated as leasehold lands on an annually renewable basis. Each tenancy was 15 feddans. The tenancies were distributed according to priority systems taking into consideration the following criteria:-

1. Ability to farm
2. Reliance on agriculture as a means of living
3. Residence in the scheme
4. The dependent family

The leasehold is given to the head of the family if he wants it. The system of cultivation adopted in phase 1 was a rotation system to rest the soil.

Each rotation consisted of a cash crop, a cereal and a fodder crop including at least one leguminous crop to replenish the soil. The 3 crops had to be grown on 3 equal areas of 5 feddans each. The rotating schedule is according to the following programme.

Crop	Planting time	Harvesting
Ground nuts	July	December
Cotton	August	January-March
Wheat	October	March

The planting, harvesting and the sale of cotton is controlled by

the corporation. The tenants receive a proportion of the profit.

Wheat and ground nuts are the responsibility of the tenants who are organised into co-operatives to allow full mechanisation of the wheat which is the stable food of the Nubians.

In the freehold land vegetables and fruit are now growing well.

Sugar plantation

In the sugar plantation, the crop rotation is every 5 years. Planting of cane is from mid-September to end of January. Harvesting is from end of October to mid-July.

The Khashm el Girba scheme has proved to be a very successful scheme which is shown by the following 2 tables.

Scheme	Gross return per feddan L.S. (Sudanese pound)
Khashm el Girba	38.3
Gezira	25.3
Managil	26.4
Roseries	34.8

The above 3 other schemes are the only schemes comparable to Khashm el Girba is size.

In the year. 1970/1971 all the 5 phases of this scheme became operational and the yield expressed/feddan was as follows:-

	Cotton yield kentar/feddan	Wheat yield tons/feddan	Ground nut yield ton/feddan
Year 1970/71	4.52	0.55	0.50

In this scheme the middle staple cotton is grown as compared with the long staple cotton grown in the Gezira which yields 4.5 kentar/feddan. Kentar = 315 lbs.

Irrigation system and canalisatinn

Out of the reservoir of Khashm el Girba which has a capacity of 1.3 milliard per cu. metre, a main canal arises; this has a total length of 20 kilometres and runs northwards to the station named kilo 26. The water runs in this canal by gravity till the reservoir level falls below canal level when the pumps are brought into action to maintain the supply.

At kilo 26 the first regulator divides the main canal into the west and east branches and in 1967 a third branch (Sabir) was added to irrigate phases 3, 4 and 5. Minor canals lead off via regulators at intervals from each of the 3 branches.

Lateral field channels (Abu Ushreens) take off their water from the minors into the fields.

The Ministry of Irrigation is responsible for regulation of the water flow and the maintenance of the dam, reservoir and the canals up to Abu Ushreen. The agricultural corporation takes over the regulation of the water supply at the beginning of Abu Ushreens. Each Abu Ushreen commands 180 feddans of one crop made up of 36 tenancies of 5 feddans each. The watering is carried out every 15 days at the rate of 400 cu metre water per feddan.

The period of 1st April to 1st July is the dead season when the water is maintained only in the minors and Abu Ushreens carrying the water to the villages and to the sugar plantation where irrigation is perennial.

In the sugar plantation each Abu Ushreen supplies 90 feddans and watering takes place every 8-12 days for 24 hours.

The agricultural management

As mentioned previously the Agricultural Production Corporation took charge of this scheme from 1967. The sugar factory however is run by the Industrial Development Corporation. Each phase of the scheme is headed by one or two senior agricultural inspectors being in charge of all the work related to that scheme. The phase (like phase 1 of the Nubians) is divided into blocks of 17500 feddans each which are supervised by an agricultural inspector with a variable number of agriculturalists (assistant inspectors) and extensionists working with the tenant farmers. Two or 3 junior officers are also included in this

team. This ratio of agricultural staff to the number of tenants is the highest of the whole of the Sudan. The agricultural staff besides their a dministrative responsibilities also supervise and guide the tenants.

The corporation is also in charge of a ginning factory and seed propagation centre.

Labour

The family labour contribution in agricultural operations is very low. Although no reliable figures are available for this yet many authorities estimate that the family labour contribution does not exceed one third of the total manual operations. The contribution of the family labour is restrictd to watering of the tenancies and supplementing hired labour for cotton picking.

The scheme had difficulties in its early years in finding the required seasonal labour, but now the labourers are coming to the scheme from the Gash Delta, Butana and Gedarif. In the sugar factory most of the labourers come from the west of Sudan. This influx of labourers add to the dangers of importation of diseases to the area (Fig. 13).

Public services

Public health services were lavish in transport and personnel compared with other parts of the country when the scheme started but is deteriorating now.

Figure 12.

Khashm el Girba where the main canal irrigating the resettlement area arises from the reservoir of the dam.

Figure 13.

The sugar factory workers. They usually come from western and southern Sudan importing diseases to the area.

Staff

There is a public health inspector who directs 3 sanitary overseers (1 per district), 62 bilharzia men, 5 drivers (3 small lorries and 2 land-r overs) and 3 conservancy men. The estimated cost per resident is L.S. 0.323.

Health Services

Intensive medical care and the environmental sanitation services are confined at present to phase 1, the area of the permanent dwellings of the Nubians.

The 250 bed hospital is situated in New Halfa Town. In addition to this hospital in New Halfa the sugar plantation and the 25 Nubian villages have the following health services:- 7 health centres, 14 dispensaries, 6 dressing stations and 27 health offices.

The sugar factory area in addition has a small hospital with few beds and staffed with one medical officer who deals with the outpatient and emergency cases and refer some cases to the main hospital in New Halfa Town.

The nomadic tribes area of the other phases of the scheme (phase 2-5) have few dressing stations and dispensaries.

The health offices are staffed with the following

4 public health officers

15 medical assistants

3 laboratory assistants

7 health visitors

31 midwives

33 dressers

28 sanitary overseers

41 assistant sanitary overseers

20 social workers

65 mosquito men

62 bilharzia men

248 refuse collectors

63 conservancy men

29 drivers.

The malarial control service has 36 additional public health staff.

Latrines

The houses are fitted with water privy latrines. Many of the

latrines were not adequately constructed and sometimes not well maintained. However little contamination of the environment occurred.

Water supply

New Halfa Town is provided with a Ministry of Works maintained rapid sand filtration system. This plant is also chlorinated.

Each village is however provided with a simple filtration system. The water is taken for this system from the irrigation canals, it passes through a settlement tank and slow sand filter and then is held in a tank with a simple drum chlorinator. A diesel pump takes the water up to a 10, 000 gallon reservoir tank from which the water is fed to stand pipes in the village. These village plants were observed by us to be overloaded and poorly maintained. Some of them were evidently contaminated.

Bathing

The villages are situated away from the irrigation system. Although the Nubians are not in the habit of bathing in public, however I have often observed children bathing in canals at various hours of the day (Fig. 14).

The agricultural seasonal labourers are usually housed in small

Figure 14.

Children swimming in the canals

settlements on the boundary of the village sited immediately adjacent to the canals. These labourers use the canals for drinking as well as bathing.

Similarly the sugar labourers site their houses or temporary dwellings near the canal (Fig. 15).

These temporary houses are sometimes mobile when the labourers follow the harvesting of cane.

The Nomads who graze their herds also use the canals for their drinking as well as for bathing.

Health education

Each village is provided with a social worker but is not linked officially with the malaria and schistosomiasis control projects and I found that this service is not well utilised.

Other public services

Table
Community services in the resettlement area compared with the Old Halfa area

Type of service	Resettlement	Old Halfa
Water filters	26	1
Mosques and worship houses	26	13
Illiteracy campaign centres	24	0
Elementary schools	27	23
Intermediate schools	5	3
Secondary schools	1	0

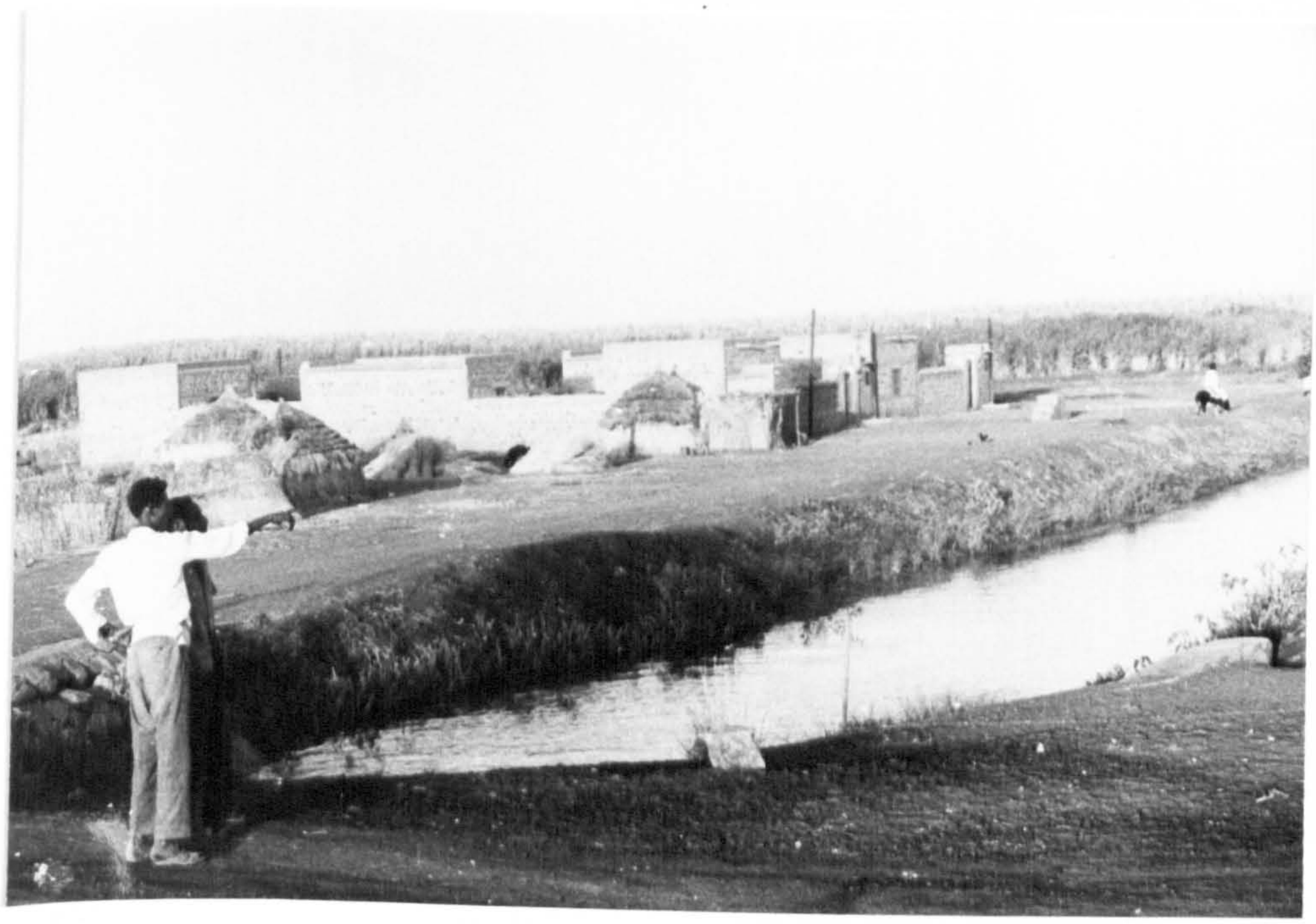


Figure 15.

Villages of the sugar factory labourers and temporary houses near the canals.

Animal production in the resettlement area

The agriculture rotation does not include a fodder crop and the rules there prevent the labourers from having any type of animal in their hawashas (tenancies). However the nomads who are living nearby (when the pasture is not available and this usually co-incides with cotton picking) allow their animals into the cotton fields for grazing which unfortunately reduces the cotton yield.

Due to the lack of mixed farming it was noticed that this scheme suffers from a shortage of meat, milk and eggs.

CHAPTER 11

Analysis of Old Halfa questionnaire

The questionnaire for those who did not move to New Halfa is shown on pages 113-114.

The population selected for this study was divided into the following age groups:-

i. 0-5 years

ii. 6-10 years

iii. 11-15 years

iv. 16 years and above.

The selection for the age group 0-5 and those over 16 years was done by the random sample selection described in part II. On the other hand the age groups 6-10 and 11-16 were selected from the elementary and intermediate schools present in Wadi Halfa Town and dranining the neighbouring scattered villages.

The number selected for each age group as well as the result of the answers to the important points in questions 11 and 12 are shown in Tables 1 and 2 but the following points need to be stressed.

Age groups 0-5 years

The children selected were 124 (65 males and 59 females). All the children lived in Wadi Halfa district since they were born except that 19 of the children have made brief visits to their relatives in New Halfa Town. They were all pre-school children. Their parents or close relatives answered the questions for them but it was felt that no reliable answers can be obtained about certain symptoms which as shown in the Table were deleted from this age group.

There was no marked difference between males and females in their c omplaints e.g. eye troubles in 28 children, 15 females and 13 males, fevers in 16 children, 9 males and 7 females. The fever was mostly due to respiratory tract infections.

Question 13

9 children were admitted to hospital (7%) due to various causes but mainly for respiratory tract infections

Question 14

113 children (91%) said they have relatives in New Halfa

The age group 6-10 years

The group selected from the mixed elementary school represents nearly 60% of this age group in the school.

Some of the children were helped by their relatives in answering the questions.

All the children had lived in Old Halfa since they were born.

16 children had made brief visits to their relatives in New Halfa and 4 other children had gone with their parents either to other parts of the Sudan or Egypt.

Question 11.

Although 27 children (16%) gave a history of abdominal pain, the majority could not localise the site of the pain exactly.

Eye troubles were again the most common problem in 40.5%, 38 females and 31 males.

The 3 children who had seen worms in the stools consisted of 2 females who described an Enterobius worm and one male who described Taenia like segments. One of the females had definite pruritus ani.

Question 12.

It was evident here that most of those who had eye trouble had sought medical treatment and all those who had seen worms in their stools consulted the doctor for treatment.

It was an important observation that no children had been treated for either malaria, kala azar and only one child had received treatment for schistosomiasis (Schistosoma haematobium) infection.

Question 13.

17 children (10%) were admitted to hospital and apart from the common causes (respiratory tract infections and gastroenteritis)

2 were admitted with jaundice and one with poliomyelitis.

Question 14.

118 children, (7%) said they have relatives in Old Halfa.

The age group 11-15 years

The 183 children interviewed in this age group were all school children. All of them had lived in Old Halfa since they were born but 15 children had made brief visits to their relatives in New Halfa and 12 children made short visits to other parts of the Sudan or Egypt.

Question 11.

Again the most common complaint in this age group was eye troubles in 45.9%, 45 males and 39 females. More children in this age group complained of haematuria 9.7% (12 males and 4 females). 13 children (7.1%) 8 females and 5 males had seen worms in their stools (12 were Enterobius and only one looked like Taenia segments). 9 of those that had seen Enterobius worms in their stools complained of pruritus ani.

Question 12.

8 children, 4.3% gave a history of past treatment of Schistosoma haematobium infections. It was evident also that 45.9%, 72 children (38 males and 34 females) had treatment for eye diseases.

Although 32 children gave a history of treatment for fever, none was suggestive to be malaria or kala azar or tuberculosis.

Question 13.

20 children (10.9%) were admitted to hospital in Old Halfa (13 were males and 7 females).

Question 14.

120 children (65.4%) said they have relatives in New Halfa.

The age group of those over 16 years

Only a few adults were seen by me were not Nubians and they were working in Old Halfa for variable periods. These were excluded from this survey as they could have acquired diseases from other areas. The number of the Nubian adults interviewed was 216, 114 males and 102 females.

22 adults had made brief visits to New Halfa and 10 adults visited other parts of the Sudan or Egypt.

The commonest problem in this age group was still the eye diseases, 142 adults 65.7%, 89 females and 53 males had been troubled by eye diseases.

The history of haematuria was given by 24 adults, 11.1%, 16 males and 8 females and 12 adults gave a history of treatment for Schistosoma haematobium. None gave a history of S. mansoni infection.

17 adults, 10 females and 7 males had seen worms in their stools, 14 descriptions resembled Enterobius and 3 Taenia segments. History of pruritus ani was given by 13 adults, 10 of whom had mentioned seeing the Enterobius worm in their stools.

Two of them only (.97%) gave a history of being treated for fever resembling malaria. One of them had been to other parts of the country.

Question 13.

32 adults (14.8%) 21 females and 11 males were admitted to hospital in Old Halfa.

Question 14.

87 adults (40.2%) said they had relatives in Old Halfa.

Some complaints and treatment not shown in Tables 1 and 2 for all age groups in Old Halfa.

It was possible to enquire about the localisation of the abdominal pain in the age groups 11-15 and in those above 16 years.

In the age group 11-15 years 38 (20.7%) gave the history of abdominal pain (21 females and 17 males). 28 children had central abdominal pain, 5 had pain in the loins, 6 in the lateral quadrants and 3 in the right hypochondrium. In the age group of those over 16 years abdominal pain and colic occurred in 93 adults, 43%, 59 females and 34 males. It was also central abdominal pain in the majority of them, 76 (35.1% of the total).

The history of a rash was given by 12 adults (5.5%), 3 could remember the history of measles and in 9 it was suggestive of chickenpox.

A rash occurred in 4 children (2.2%) in the age group 11-15, 3 earlier in childhood resembling measles and one suggestive of chickenpox.

9 children (5.3%) in the age group 6-10 gave a history of measles rash and none chickenpox.

In the age group 0-5, 6 children (4.8%) had measles.

It was evident that the commonest cause of fever in old Halfa for all age groups was respiratory tract infections.

Age group years	Number interviewed M	F	total	Percentage distribution of the complaints for the total number interviewed: Haematuria	Burning micturition	Frequency of micturition	Diarrhoea	Blood in stools	Passed or noticed worms	Abdominal pain	Fevers	Eye troubles
0-5	65	59	124	0%	-	-	11.2%	4%	1.6%	-	12.9%	22.5%
6-10	102	66	168	1.2%	-	-	14%	4.1%	1.8%	16%	21.4%	40.5%
11-15	98	85	183	8.7%	4.3%	1.1%	25.6%	6%	7.1%	20.7%	22.4%	45.9%
16 yrs and above	114	102	216	11.1%	9.7%	8.8%	31%	9.7%	7.8%	43%	34.2%	65.7%

Table 1

The distribution of complaints in the various age groups in Old Halfa (Question 11 of questionnaire).

Age group years	Number interviewed M	F	Total	Percentage distribution of treatment Schistosomiasis	Malaria	Kala azar	Worms	Eye diseases	Anaemia	T.B.	Fevers	Diarrhoea
0-5	65	59	124	0%	0%	0%	1.6%	22.5%	0%	0%	8.8%	10.4%
6-10	102	66	168	0.8%	0%	0%	2.3%	36.3%	0%	0%	16%	14%
10-15	98	85	183	4.3%	0%	0%	3.2%	39.3%	4.3%	0%	17.4%	17.5%
16 years and above	114	102	216	5.5%	1%	0%	7.3%	53.2%	13.4%	1.1%	20.3%	24.5%

Table 2

The percentage distribution in the various age groups in Old Halfa of the history of taking treatment for the common endemic diseases in Sudan (Question 12 of the questionnaire).

Analysis of New Halfa questionnaire

The questionnaire for the resettlement area is shown in pages 115 to 117.

The population selected for this study was divided into the following age groups:

i. 0-5 years

ii. 5-10 years

iii. 11-15 years

iv. 16 years and above

The Nubians in New Halfa district were resettled in various villages and New Halfa Town (shown in Fig. 9, page 139). Since the aim of this study is to study the acquisition of diseases in the resettlement area, the selection for the villages to be studied was done only according to the time of their arrival with no other bias in selection. This entails selection from the earlier arrivals (village 1) the late arrivals, village 26, and those that came in the intermediate period villages 10, 12, 13, 15 and 16. New Halfa Town itself was included in the selection. There was a random selection from the villages as described but a greater stress was on the younger age group.

The number selected for each age group and the results of the answers to the important points in questions 11, 12, 13, and 15 are shown in tables 3, 4, 5 and 6.

Comments on the questionnaire for the resettlement area

The age group 0-5 years

The children of this group are those born in Old Halfa but transferred to New Halfa at a young age which is in the majority less than 2 years. Children found to have been born in New Halfa were transferred to their special group.

The number of children interviewed were 812, 457 boys and 355 girls.

Question 11.

The results are shown in Table 3 and this represents the symptoms that they showed from diseases acquired in the old area. Haematuria was not noticed in any case in this young age group and it was not possible to enquire about some symptoms especially in relation to the abdominal pain in this age group.

Question 12.

The results are shown in Table 4 which are the symptoms that they noticed in New Halfa and the most important finding concerns the haematuria as 4.1% of the children had now seen blood in the urine. This finding together with the findings of children born in New Halfa suggests that the prevalence of Schistosoma haematobium is higher in the resettlement area and more children are acquiring this disease.

Question 13.

The results of question 13 are shown in Table 5 and it was evident that none of the children had treatment for schistosomiasis or malaria in Old Halfa.

Question 14.

It was found that all those who had been told that they had these diseases were given some treatment for them and so the answers of question 13 are applicable here. Therefore the answers for both questions are combined (told or given treatment) before coming.

Questions 15 and 16.

The children were asked here whether they were told or given treatment for the diseases stated in question 13 after their arrival in New Halfa.

The results are shown in Table 6. It is interesting to note that 28 children (3.4%) 19 boys and 9 girls had received treatment for schistosomiasis. 19 for S. haematobium infections which show that the prevalence was rising and 9 for S. mansoni which was not present in Old Halfa and was acquired in this area.

17 children (2%), 10 males and 7 females received treatment for malaria in New Halfa. The author did not come across any child up to the age of 16 who admitted receiving treatment for malaria in Old Halfa.

Question 17.

Of the 116 children who said they had diarrhoea after their arrival in New Halfa, 89 (76.7%) said they had more diarrhoea in New Halfa, 14 (21%) said they had more in Old Halfa and 13 (11.2%) said they did not know.

Question 18.

Of the 102 children who had fever in New Halfa 97 (83.7%) said they had more fevers in New Halfa, 7 (6.3%) said they had more fever in Old Halfa and 12 (10.3%) did not know.

Question 19.

29 children (3.5%) were admitted to Hospital in Old Halfa.

Question 20.

52 children (6.4%) were admitted to hospital in New Halfa.

N.B. The majority of these children had spent nearly equal periods in the two areas, having come to this area when they were 2-3 years old.

Question 21.

516 children (64%) said their health was better in Old Halfa. 184 children (22.6%) said better in New Halfa. 112 children (13.7%) did not know.

The age group 6-10 years

This age group was important for this study as they were all born in Old Halfa and transferred at a young age to New Halfa. They lived in this district for a period of 3-7 years depending on their age. 723 children were interviewed, 372 females and 351 males.

The results of questions 11, 12, 13, 14, 15 and 16 are shown in Tables 3, 4, 5 and 6.

Comments on the results of the questionnaire for this age group

Question 11.

The most common symptom among the children when they were in Old Halfa was eye trouble. 147 children, 79 boys and 68 girls (20.3%) had this problem. It was important also to note that in this age group none complained of haematuria when they were in Old Halfa.

Question 12.

While none had haematuria in Old Halfa 31 children (4.4%), 19 boys and 12 girls had haematuria in New Halfa. Fewer children had eye diseases in New Halfa. It was present in 98 children (13.5%) 51 boys and 47 girls. The commonest worm observed by the children in their stools was Enterobius vermicularis. Out of the 21 children who had seen worms in their stools in New Halfa, 19 were Enterobius like worms and in 2 it was a possible Taenia saginata segment (Taenia solium is not common

in Sudan).

Questions 13, 14, 15 and 16.

While none of the children had treatment for schistosomiasis and malaria in Old Halfa (q. 13) 47 children 6.5% (29 boys and 18 girls), 34 haematobium and 13 mansoni infections had treatment for schistosomiasis in New Halfa and 71 children (9.8%) 40 males and 31 females had treatment for malaria in New Halfa (questions 15 and 16).

Treatment for eye diseases was given to fewer children in New Halfa only 72 (9.9%).

Question 17.

Out of the 91 children who were troubled by the diarrhoea in Old Halfa, 62 (68.1%) said they were still troubled by the diarrhoea in New Halfa. For the 134 children who were troubled by the diarrhoea in New Halfa 105 (78.4%) said they were more troubled by the diarrhoea in New Halfa. This may suggest that diarrhoea is more of a problem in New Halfa.

Question 18.

In the 103 children who had fevers in New Halfa 85 (82.5%) said they were having more fevers in New Halfa. Out of the 69 children who had fever in Old Halfa 43 (62.3%) had more fevers in New Halfa. This also suggests that fever is probably a greater problem here.

Questions 19 and 20.

While 31 children (4.4%) were admitted to hospital in Old Halfa 13 boys and 18 girls more of them were admitted to hospital in New Halfa i.e. 54 (7.5%) 32 boys and 22 girls.

Question 21.

439 children (60.7%) had better health in Old Halfa. 197 (27.2%) had better health in New Halfa. 97 (12%) were not sure and did not know the answer.

The age group 11-15 years

The children selected in this age group for the interview were 714, 378 males and 336 females. All these children lived in Old Halfa, before and their duration of say in New Halfa was about 2-4 years. They were all school children.

The results of the questions of New Halfa questionnaire (questions 11-16) are shown in tables 3, 4, 5 and 6.

Comments on the results of the questionnaire for the resettlement area age group 11-15 years

Question 11.

The commonest complaint for this age group when they were in Old Halfa was eye trouble occurring in 242 children (36.7%), 139 males and

and 103 females. This age group was the first to complain in Old Halfa of haematuria occurring in 12 children (1.6%) 8 males and 4 females.

Question 12.

Here in New Halfa, the major problem for this age group was diarrhoea occurring in 292 children (40.9%) 163 males and 129 females. Haematuria occurred here in a larger number of children 92, (12.8%) 65 males and 12 females. 147 children complained of abdominal pain (20.5%) 83 males and 64 females. The majority, 129, had a central abdominal pain.

Questions 13, 14, 15 and 16.

While 22 children, 3% had either been told they had urinary schistosomiasis or received treatment for it in Old Halfa and none for mansoni infection, 105 children, 14.8% (74 males and 31 females) had received treatment for urinary schistosomiasis and 52 (7.2%), 31 males and 21 females received treatment for mansoni infection in New Halfa. Therefore the total number that had received treatment for schistosomiasis in Old Halfa was 3% but in New Halfa it was 20.5%.

A much larger number, 81 children, (11.3%) received treatment for malaria here. Eye diseases were a lesser problem here as only 102 children (14.2%) received treatment here.

Question 17.

A total of 356 children were troubled by diarrhoea in either Old Halfa or New Halfa, 219 (61.5%) were troubled by diarrhoea more in New Halfa 102 (28.7%) in Old Halfa and 35 (9.8%) did not know.

Question 18.

A total of 351 children had been troubled by fever in either Old or New Halfa, 280 of these 79.4% had been troubled more by the fever in New Halfa, 62 (17.6%) had had more trouble with the fever in Old Halfa and 9 (3%) did not know.

Questions 19 and 20.

While 56 children (7.9%) had been admitted to hospital in Old Halfa, 74 (10.3%) had been admitted to hospital in New Halfa.

Question 21.

432 children (60.5%) said their physical health was better in Old Halfa. 166 children (23.2%) said they were better in New Halfa. 116 (16.2%) children did not know if there was any difference in their health in the two areas.

The age group of those over 16 years.

519 adults were interviewed (265 males and 254 females). 504 of them

said they lived before in Old Halfa, 15 said the lived before mostly in Egypt and other parts of the country.

Their occupations were as follows:-

217 School children

121 Farmers

45 Labourers

136 Others including housewives not working, retired people etc.

Their duration of stay in New Halfa was variable, 2-5 years.

Tables 3, 4, 5 and 6 show the results of questions 11-16.

Comments on the results of the questionnaire for the resettlement area for this age group

While in Old Halfa 45 adults (8.6%) 31 males and 14 females had received treatment for haematobium and none for mansoni infection. 103 adults (20.2%) 61 males and 42 males had received treatment for haematobium infections and 25 (4.8%) 17 males and 8 females received treatment for mansoni infections in New Halfa. The number of males infected in both areas is much larger than females as shown above.

Those that received treatment for malaria in New Halfa were 72 (14%) 39 females and 23 males and in Old Halfa (.9%) previously suffered from malaria or had been given treatment for it. Treatment for eye diseases was given for 182 adults (35%) 96 males and 86 females

in Old Halfa and only to 66 (12.8%) 35 females and 31 males in New Halfa.

Question 17.

316 adults were troubled by diarrhoea in either old Halfa or New Halfa. 192 of these (60.7%) said they were more troubled by the diarrhoea in New Halfa, 104 said they were more troubled by it in New Halfa 20 (7.1%) did not know.

Question 18.

203 adults were troubled by fever in either Old or New Halfa. 143 (70.4%) of these said they more troubled by the fever in New Halfa. While 42 (20.7%) said more troubled in Old Halfa and 18 (8.8%) did not know.

Questions 19 and 20.

While 35 (6.7%) adults were admitted to hospital in Old Halfa 21 (4%) were admitted to hospital in New Halfa.

Question 21.

417 adults (80.3%) said their health was better in Old Halfa while 65 (12.5%) said they were better in New Halfa and 37 (7.1%) did not know.

Analysis of the questionnaire for the children born in New Halfa.

The questionnaire for the resettlement area was adapted for them with questions 9, 10, 11, 13, 14, 17, 18, 19 and 21 which are not applicable to this group deleted.

614 children were interviewed, 317 were girls and 297 boys.

All of them were under 6 years of age and they were all of preschool age.

Question 11.

Haematuria was noticed in 21 children (3.4%) 11 girls and 10 boys. Diarrhoea in 141 (22.9%), 79 girls and 62 boys (23 of these have passed blood in their stools). 113 were troubled by fever (22.3%) 59 girls and 54 boys. 13 developed measles rash (2.1%) 8 boys and 5 girls, and 2 possibly chickenpox. Eye troubles were reported by 51 (8.3%) 29 boys and 22 girls.

The other complaints were deleted as the answers by their parents for these questions would not have been reliable.

Questions 15 and 16.

Adapted to read "Have you been told or given treatment for these diseases?"

Their answers were as follows:-

1. 27 children (4.4%) 16 males and 11 females given treatment for urinary schistosomiasis and 16 (2.6%) 9 males and 7 females for S. mansoni infection.

2. Malaria, 32 children (5.2%) 17 females and 15 males

3. Kala azar none.

4. Worms 14 (2.3%) 9 girls and 5 boys

5. Anaemia 21 (4%) 12 boys and 9 girls

6. Eye diseases 39 (6%) 21 boys and 18 girls

7. Diarrhoea 97 (15.7%) 52 boys and 45 girls.

Question 20.

71 children (11%) 38 boys and 33 girls were admitted to hospital in New Halfa.

Age group years	Number interviewed M	F	Total	Percentage distribution of the complaints for the total number interviewed: Haematuria	Burning micturition	Frequency of micturition	Diarrhoea	Blood in stools	Passed or noticed worms	Abdominal pain	Fevers	Eye troubles
0-5	457	355	812	0%	-	-	9.7%	2.9%	1.1%	-	8%	8.9%
6-10	351	372	723	0%	-	-	12.4%	3.1%	2%	-	9.5%	20.3%
11-15	378	336	714	1.6%	-	-	17.7%	3%	2.1%	-	18.4%	36.7%
16 years and above	265	254	519	9%	7.9%	4.4%	42%	6.5%	7.3%	46.4%	25.2%	52%

Table 3

The distribution of complaints in the various age groups in New Halfa (Question 11 of the questionnaire) before their arrival.

Figure 15 (b)

The main sugar factory building in Khashm el Girba district with irrigation canals in the foreground. Nubian and immigrant workers there were interviewed for the questionnaire mentioned in the text.

Age group years	Number interviewed M	F	Total	Percentage distribution of the complaints for the total number interviewed: Haematuria	Burning micturition	Frequency of micturition	Diarrhoea	Blood in stools	Passed or noticed worms	Abdominal pain	Fevers	Eye Troubles
0-5	457	355	812	4.1%	-	-	14.1%	5.1%	2.5%	-	12.5%	5%
6-10	351	372	723	4.4%	-	-	18.4%	2.7%	2.9%	-	14.2%	13.5%
11-15	378	336	714	12.8%	6.6%	2.1%	40.9%	9.1%	10.3%	20.5%	30.2%	19%
16 years and above	265	254	519	17.7%	11.9%	3.2%	34.3%	8%	11.5%	32.7%	27.9%	20.9%

Table 4.

The distribution of complaints in the various age groups in New Halfa (Question 12 of the questionnaire) after their arrival.

Table 5.

The percentage distribution in the various age groups in New Halfa of the history of taking treatment for the common endemic diseases in Sudan (Question 13 of the questionnaire) before their arrival.

Age group years	Number interviewed			Percentage distribution of treatment								
	M	F	Total	Schistosomiasis	Malaria	Kala azar	Worms	Eye diseases	Anaemia	T.B.	Fever	Diarrhoea
0-5	457	355	812	0%	0%	0%	0.7%	3.3%	0%	0%	5.7%	7.7%
6-10	351	372	723	0%	0%	0%	2%	16.7%	0%	0%	12.4%	10.2%
11-15	378	336	714	3%	0%	0%	2.6%	30.4%	1%	0%	14.5%	13.8%
16 years and above	265	254	519	8.6%	0.9%	0%	3%	35%	14%	1.1%	17.1%	18.8%

Age group years	Number interviewed M	F	Total	Percentage distribution for treatment Schistosomiasis	Malaria	Kala azar	Worms	Eye diseases	Anaemia	T.B.	Fevers	Diarrhoea
0-5	457	355	812	3.4%	2%	0%	3.6%	2%	0%	0%	10.2%	10.7%
6-10	351	372	723	6.5%	9.8%	0%	5.2%	9.9%	4.2%	0%	12.7%	8.1%
11-15	378	336	714	20.5%	11.3%	0%	11.1%	14.2%	6.3%	0%	26.6%	29.1%
16 years and above	265	254	519	26.5%	14%	0%	9.4%	12.8%	15.7%	1.7%	21%	25%

Table 6.

The percentage distribution in the various age groups in New Halfa of the history of taking treatment for the common endemic diseases in Sudan (Question 15 of the questionnaire) after their arrival in New Halfa.

Percentage distribution of treatment

Age group years	Number interviewed	SCHISTOSOMIASIS Before their arrival	SCHISTOSOMIASIS After their arrival	MALARIA Before their arrival	MALARIA After their arrival
0-5	812	0%	3.4%	0%	2.%
6-10	723	0%	6.5%	0%	9.8%
11-15	714	3%	20.5%	0%	11.3%
16 years and above	519	8.6%	26.5%	.9%	14%

Table 7.

The percentage distribution in the various age groups of the history of taking treatment for malaria and schistosomiasis before and after arrival of the Nubians in New Halfa.

The clinical examination

A group of persons living in Old Halfa were examined to be compared with a group who moved to New Halfa and in addition the children born in New Halfa.

The clinical examination sheet is shown in pages 118 and 119 and it was used for Old and New Halfa resettlement area. All those who were clinically examined were subjected to the questionnaire in both areas and therefore the results of the clinical examination included only the general examination findings and the examination of the systems.

Special attention as seen was given to the abdomen and in particular to the size of the liver and the spleen. Various methods of measurements were used to record the size of the liver and the spleen. These methods were influenced by the shape of the chest wall, the age of the patient and the thickness of the fingers of the examiner. It was found that using one method in both areas and doing the measurements in the mid line below the costal margin and in centimetres was easy and practical for such an extensive survey and the enlargement of the liver and spleen was graded as follows:

a. Not palpable, is a liver or a spleen which is not felt on deep inspiration.

b. Just palpable, is that which is definitely felt on inspiration.

c. 2-4 cm, is a liver or spleen which was clearly palpable without inspiration and having this measurement below the costal margin in the mid-line.

d. More than 4 cms, is a large liver or spleen felt more than 4 cms below the costal margin (in the mid-line) without inspiration.

If there was any greater enlargements of these organs e.g. reaching or below the umbilicus it would be mentioned in each age group.

The Clinical Examination in Old Halfa

The age group 0-5

The children selected for this age group were 124, 65 boys and 59 girls. They were born in Wadi Halfa district.

Complaints

101 children (48 boys and 53 girls), 81.4%, had no complaints at the time of examination while the rest 23, (18.6%) had various complaints.

General examination

Physique - 97 appeared to have average physique

16 appeared to be underweight

11 appeared to be overweight.

Only 5 children were ill at the time of examination, 3 of them were febrile with a rapid pulse.

No abnormality was detected in the skin colour of this group.

21 children were thought to be anaemic and no other finding in the general examination except that 25 children had either squint or some other eye problem.

Chest

11 children had respiratory tract infections at the time of examination with crepitations and or rhonchi. One child had pneumonia and was admitted to hospital.

Heart

One child had ventricular septal defect, 2 mitral incompetence not in failure, and 3 had innocent murmurs.

Abdomen

Taking into consideration the normal soft palpable liver of early childhood, the pathological liver enlargments were as follows:-

a. Just palpable 3

b. 2-4 cms 2

c. more than 4 cm none.

119 children had normal livers (96%).

Spleen

Not palpable in	121 (96.7%)
just palpable in	2
2-4 cms	1
more than 4 cms	0

No case of ascites was detected.

C.N.S.

No abnormality detected except one case suggestive of old poliomyelitis.

Lower limbs

No oedema of the lower limbs was detected in any case.

The age group 6-10 years

168 children were clinically examined, 102 boys and 66 girls. 137 (81.5%) children had no complaints at the time of examination while 31 (18.5%) had various complaints.

General examination

Physique

142 children appeared to have average physique, 14 underweight, 12 overweight.

Only 4 children were febrile and ill at the time of examination. 16 children appeared to be clinically anaemic, 2 appeared to be severely anaemic. There were 2 cases of oedema, one of them had congestive

heart failure and the other ?nephrotic syndrome.

32 patients had obvious squint and 10 had other eye problems.

2 children had enlarged cervical glands and were probably tuberculous.

Systems

11 children had chest signs of respiratory tract infections, one case had pleural effusion and was admitted to hospital.

Heart

3 cases of rheumatic heart disease (one pure mitral stenosis and 2 were mitral stenosis and incompetence. One case of ventricular septal defect.

Abdomen

The Liver	not palpable	163 (97%)
	just palpable	3
	2-4 cms	1
	more than 4 cms	1
The Spleen	not palpable	161 (96.4%)
	just palpable	4
	2-4 cms	2
	more than 4 cms	1

One had a large spleen reaching the umbilicus and was admitted to hospital for investigations. He had been to other parts of the country. There was one patient with hepatosplenomegaly and he had Schistosoma haematobium infection. There was no case of ascites.

C.N.S.

No abnormality detected.

The age group 11-15 years

The number of children clinically examined in this age group was 183, 98 males and 85 females. As mentioned in the results of the questionnaire, they were all school boys, lived in old Halfa since their birth, except that 15 of them had made brief visits to New Halfa and 12 others to other parts of the country.

Complaints

171 (94.3%) children had no complaints, 12 (5.7%) had various complaints, 2 were febrile at the time of examination, one had just recovered from pneumonia and was still complaining of malaise, 2 complained of lethargy and were breathless.

General examination

Physique

169 appeared to have average physique

8 appeared to be underweight

6 appeared to be overweight.

Only 6 children were ill at the time of examination. 2 children had evidence of recent chickenpox (scabs). 3 had old burns, one was jaundiced and was admitted to hospital. 20 appeared clinically anaemic including 3 who appeared to have severe anaemia, one child was cyanosed and 4 had enlarged cervical glands.

Chest

2 chest deformities. Crepitations and/or rhonchi in 8, 2 were asthmatics.

Heart

2 cases of mitral stenosis and incompetence and one case of predominant mitral incompetence with heart failure, he was admitted to hospital. One case of ? pulmonary stenosis, 2 children had oedema of the lower limbs, one was the case of C.H.F. and the other was a ?nephrotic syndrome.

Abdomen

The Liver	not palpable in	177	(96.7%)
	just palpable in	4	(3 proved to be S. haematobium cases and one was put under investigation but his urine and stools were repeatedly negative for Schistosoma eggs.

The liver was 2-4 cm palpable in 2, both were haematobium cases and one was also in C.H.F.

The Spleen	not palpable in	179	(97.2%)
	just palpable in	2,	both are S. haematobium cases.
	2-4 cms	enlarged in 2,	one is a S. haematobium case and the other gave a history of travelling to the northern province (Dongola area) where he was once diagnosed as having malaria.
	more than 4 cms	None.	

No ascites in any child, oedema of the lower limbs in one case in the child with congestive heart failure.

C.N.S.

Normal in all children

The age group of 16 years and above

The number of adults examined were 216, 114 males and 102 females after excluding the non Nubians who were not interviewed. The general information about them was mentioned in the questionnaire (being the same

group of those interviewed).

Complaints

182 (84.2%) adults had no complaints at the time of examination, while 43 (15.8%) of them had various complaints.

General examination

Physique

198 appeared to have average physique

10 appeared to be underweight

8 appeared to be overweight

13 were ill at the time of examination, 2 were in heart failure and dyspnoeic, 3 were asthmatics, 2 pregnant women with oedema, one recovering from a cerebrovascular stroke and two hypertensives, one was a diabetic.

Chest

Rhonchi and crepitations in the 3 asthmatics, crepitations in 7, 2 had suggestive evidence of apical fibrosis (both gave a history of tuberculosis).

Heart

2 cases of mitral incompetence, one case of aortic stenosis and incompetence in failure. One case of hypertensive heart disease, with a suggestive history of ischaemic heart in failure.

Abdomen

The liver

not palpable in	197	(91.3%)
Just palpable in	6	
2-4 cms enlarged	2	
more than 4 cms enlarged	1.	

Those with the just palpable livers were as follows:-

4 had urinary schistosomiasis

1 had a past history of jaundice and not bilharzial

1 gave a doubtful history of fever being diagnosed as malaria.

Those having a liver of 2-4 cms enlargement were the tender enlarged livers in the cases of C.H.F. one of them had also urinary schistosomiasis.

One case with the large liver of more than 4 cms was a case suggestive of myeloid leukaemia.

The Spleen

Not palpable in	210	(97.3%)
just palpable in	3	two with urinary schistosomiasis and the other one of the cases of suggestive history of past malarial attacks.
2-4 cms enlarged	2	both are urinary schistosomiasis cases but one had also had a past history suggestive of malaria.
more than 4 cms in only one, the case which is suggestive of myeloid leukaemia.		

No cases of ascites. 4 patients with oedema of the lower limbs

C.N.S.

One case of old hemiplegia

One case of early Parkinson's disease

2 cases gave a history suggestive of epilepsy

One case of residual Bell's palsy.

The clinical examination in New Halfa resettlement area

The base line clinical examination in New Halfa was done in April and September, 1969 where all those who were interviewed were immediately clinically examined. The examination would either be in the village dispensary or dressing stations or sometimes the school children could be interviewed (Fig. 16) and clinically examined (Fig. 17) in their classrooms

The children 0-10 years of age who were examined in 1969 in villages 13, 16 and 26 were followed up.

The results of New Halfa clinical examination in 1969

The age group 0-5 years

The children examined in this age group were 812, 457 males and 355 females. The average period that they have spent in New Halfa at the time of this examination was 1-3 years depending on their age.

Complaints

595 children (342 boys and 253 girls), 73.2% had no complaints at

the time of examination while the rest 217 (26.8%) had various complaints at the time of examination.

General examination

Physique

716 appeared to have average physique.

55 appeared to be underweight

41 appeared to be overweight.

49 children were ill at the time of examination and 31 children were febrile. 152 children (18.7%) were thought to be anaemic. 114 children had eye troubles, the majority of these had squint.

Chest

73 (9.1%) children had upper respiratory tract infections or chest problems at the time of examination.

Heart

9 (1.1%) cases of mitral valve disease, 4 pure mitral stenosis and 5 stenosis with incompetence. 11 cases (1.3%) of ventricular septal defect. 4 cases of possibly atrial septal defect.

Abdomen

Taking into consideration the normal soft palpable liver of early childhood, the pathological liver enlargements were as follows:-

a. Just palpable liver 29

b. 2-4 cms liver 16

c. more than 4 cms 9

Figure 16.

The questionnaire being conducted in a classroom. The teacher and the father or a relative would be present with us when the child was interviewed.

Figure 17.

The clinical examination was sometimes done in the classrooms using ordinary tables if the dispensary or dressing station was small or busy.

758 children, 93.3% had normal livers.

Spleen

a. just palpable 22

b. 2-4 cms enlarged 27

c. more than 4 cms 18

745 children (91.7%) had no palpable spleens.

No case of ascites was detected.

C.N.S.

No abnormalities detected except 2 cases of old poliomyelitis.

Lower limbs

3 cases of oedema of the lower limbs.

The age group 6-10 years

723 children were clinically examined, 372 were boys and 351 girls. These children had spent at the time of examination about 3-4 years in New Halfa resettlement area. 571 children (78.9%) 294 females and 277 males had no complaints at the time of examination while 152 (21.9%) had various complaints.

General examination

Physique

677 appeared to have average physique

27 appeared to be underweight

19 appeared to be overweight.

13 children were ill at the time of examination, 123 (17%) children were anaemic, 34 of them had severe anaemia.

Although eye diseases and squint were relatively less than in Old Halfa yet 104 children had eye problems, obvious squint or other eye troubles, (Figs 18 and 19). 4 children had enlarged cervical glands, two cases of goitre.

Systems

Chest

35 (4.9%) children had upper respiratory tract infections or mild chest problems. 2 had pneumonia and were admitted to hospital.

Heart

15 cases of rheumatic heart disease, 6 mitral stenosis, 5 mitral stenosis with incompetence , 2 mitral incompetence, 1 double mitral and aortic incompetence and one aortic incompetence alone. 2 cases of ventricular septal defect, one case of pulmonary stenosis.

Abdomen

Liver	Not palpable in	640 (88.5%)
	just palpable in	39
	2-4 cms enlarged	31
	more than 4 cms	13

32 patients of those with enlarged livers were found to be infected with S. mansoni, a disease unknown in Old Halfa.

Spleen

not palpable	652 (91.1%)
just palpable	37
2-4 cms enlarged	19
more than 4cms enlarged	15

4 had a very large spleen, in 2 of them reaching the umbilicus.

Ascites None

4 cases of oedema of the lower limbs, 2 had cardiac disease, one had nephrotic syndrome and in the fourth the diagnosis was not established.

C.N.S.

2 cases of old poliomyelitis, one case of myopathy and 2 cases of residual Bell's palsy.

Figure 18.

Squint was detected in the present survey to be common among the Nubians.

Figure 19.

Although eye diseases were creating a lesser problem in the resettlement area, yet they were also common in New Halfa

Figure 20.

Liver enlargement is more common in New Halfa resettlement area. The child shown here had an enlarged liver of 5 cms by the marked lines and projected light. Had had Schistosoma mansoni infection which is unknown in Old Halfa area.

The clinical examination of the age group 11-15 years in New Halfa Resettlement area

The number of children clinically examined in this age group was 714, 378 were males and 336 females. They were all school children and had spent in this area 2-4 years.

Complaints

63 children (8.8%) had various complaints at the time of examination, the rest 651 (91.2%) had no complaints.

Physique

661 (92.5%) appeared to have average physique

29 appeared to be underweight

24 appeared to be overweight

34 children were ill at the time of examination, the majority with fever or diarrhoea. 104 children (14.5%) were anaemic, 21 of them had severe anaemia, 2 children had generalised oedema. One child had goitre, 2 children were mentally retarded. One child had lymphadenopathy and severe anaemia (?acute leukaemia).

Chest

7 had chest deformities, 49 had upper respiratory tract infections or mild chest infections. One case had pleural effusion and was admitted to hospital.

Heart

6 cases of mitral valve disease, 3 pure mitral stenosis, 2 double mitral and one mitral incompetence. 2 cases of aortic valve disease, one with mitral incompetence and the second with pure aortic incompetence. 2 cases of ventricular septal defect and one case of possibly atrial septal defect.

Abdomen

Liver

Not palpable	635 (88.9%)
Just palpable	37
2-4 cms	31
more than 4 cms	11

49 of the hepatic enlargement cases had either Schistosoma mansoni or haematobium infections or both.

Spleen

Not palpable	622 (87.1%)
Just palpable	47
2-4 cms	27
more than 4 cms	18

68 of those with splenic enlargement had either schistosomiasis (mansoni or haematobium) at the time of examination or gave such a

history, the rest, 23, did not give this history, some of them gave a definite history of malaria.

Ascites

One case with the generalised oedema, possibly a nephrotic syndrome.

C.N.S.

4 cases of old Bell's palsy, 2 cases mentally retarded, one case history of epilepsy, 2 cases of myopathy.

Oedema of the lower limbs

3 cases, one cardiac and two, the other generalised oedema cases.

The age group of those over 16 years

All the adults over 16 years who were interviewed 519 (265 males and 254 females) were clinically examined. Their occupation, duration of stay in New Halfa, and previous movements were mentioned in the analysis of their questionnaire.

Physique

428 appeared to have average physique

52 appeared to be overweight

39 appeared to be underweight.

Complaints

417 (80.3%) had no complaints at the time of examination while the rest 102 (19.7%) had various complaints, including haematuria, fever abdominal pain etc.

General examination

62 (11.7%) adults were ill at the time of examination with various causes 85 (16.3%) had anaemia, 15 were clinically severely anaemic, 4 with enlarged cervical glands (2 very suggestive of tuberculous lymphadenopathy) 3, with generalised oedema (2 very suggestive of nephrotic syndrome).

Chest

9 with chest deformities. 3 had evidence of fibrosis (suggestive of tuberculosis). 4 asthmatics, 37 had upper respiratory tract infection or mild chest infection. 2 recently discharged from hospital recovering from pleural effusion.

Heart

3 cases being recently discharged from hospital and on digitalis treatment, 2 possibly ischaemic and the third hypertensive heart failure. 2 cases of double mitral valve disease, one case of pure mitral stenosis, one mitral incompetence and aortic incompetence. One case of ventricular septal defect. 32 hypertensives with a

diastolic blood pressure of more than 120 mm mercury.

Abdomen

Liver

not palpable	412 (81.2%)
Just palpable	24
2-4 cms enlarged	39
more than 4 cms	35

2 had grossly enlarged livers.

Spleen

not palpable	401 (77.2%)
just palpable	28
2-4 cms enlarged	43
more than 4 cms	31

4 had spleens reaching the level of the umbilicus.

Ascites

2 cases of ascites, one possibly tuberculous ascites and the second a case of suggestive nephrotic syndrome.

C.N.S.

2 patients recovering from hemiplegia one was hypertensive

and the second was possibly embolic hemiplegia (mitral valve disease) 2 cases of Parkinson's disease, 1 case of motor neurone disease (diagnosed and discharged from hospital). 2 cases of old facial paralysis.

Lower limbs

In addition to the 3 cases of generalised oedema there were 3 cases with lower limb oedema (2 cardiac and one a pregnant female).

The children born in New Halfa

All the children were born in New Halfa. They have also remained in this area. All the children that visited other parts of the country were excluded from the questionnaire and the clinical examination for those born in New Halfa. Therefore the findings in this group represents the diseases acquired in New Halfa.

614 children were clinically examined, 317 girls and 297 boys.

Complaints

470 children (76.5%) had no complaints at the time of examination, the rest 144 (13.5%) had various complaints including fever, diarrhoea cough etc.

General examination

Physique

537 appeared to have average weight

41 appeared to be overweight

36 appeared to be underweight

34 children were ill at the time of examination, mostly feverish and with gastrointestinal disturbances and chest infections. 125 children (20.3%) were anaemic, 13 with severe anaemia. Eye problems were definitely less than their age group in Old Halfa but obvious squint was still fairly common in the resettlement area. 72 children born in New Halfa (1.6%) had squint (Fig. 21).

Systems

Chest

2 children had chest deformities. 49 children had either upper respiratory tract infection or mild chest infection at the time of examination. One child had pneumonia and was admitted to hospital.

Heart

One case of dextrocardia, otherwise the heart and abdominal viscera were normal. 5 cases of mitral valve disease (1 double mitral, 1 incompetence, 3 of mitral stenosis), 3 cases of ventricular septal defect.

Abdomen

Taking into consideration the normal soft palpable liver than can be felt in this age group, the pathological liver enlargements were as follows:-

Liver

Not palpable	528 (85.9%)
Just palpable	43
2-4 cms enlarged	34
more than 4 cms enlarged	9

Spleen

Not palpable	503 (81.9%)
Just palpable	57
2-4 cms enlarged	30
more than 4 cms enlarged	14

Ascites None

C.N.S.

One case of poliomyelitis, 1 child mentally retarded, 2 cases of facial paralysis.

Figure 21.

Squint was also common among Nubian children born in New Halfa

The follow up clinical study in New Halfa resettlement area

Schistosomiasis and malaria were thought to be the future medical problems of the resettlement area and therefore it was decided to take the hepatic and splenic enlargements as the parameters of the follow up clinical study.

The children of the age groups 0-5 years and 6-10 years who were clinically examined in 1969 in villages 13, 16 and 26 and sugar factory area were eligible for the longitudinal clinical study. As shown in the clinical study of the resettlement area, 812 children of the age group 0-5 were examined in 1969 and also 723 children of the age group 6-10 were examined clinically in the same year. Excluding the children from other villages, the number examined in 1969 from the area chosen for the longitudinal study is as follows:-

Age group 0-5 years	537 children
Age group 6-10 years	469 children.

These children having spent by 1969 about 3-5 years in the resettlement area were followed for a further 3 years. The results of the hepatic and splenic enlargements that occurred during this period are shown in Table 8. The examination done in 1969 is taken as the base line for this follow up study.

While the incidence of hepatic enlargements in 1969 were 39 (7.2%)

in the age group 0 5 years and 59 (12.5%) in the age group 6-10 years, it rose to 73 (15.7%) and 72 (17.7%) in these age groups respectively in 1973.

While the incidence of enlarged spleens in the age group 0 5 years was 52 (9.6%) in 1969 it rose to 79 (17%) in 1973. The incidence of splenic enlargements in the older age group 6-10 years was 47 (10%) in 1969 and rose to 67 (16.6%) in 1972. Any palpable organ irrespective or its size was considered as enlarged without distinction, so these figures give the evidence of enlargements in those previously recorded as being not palpable.

As shown in 1973 figures, it was evident that 73 (13.4%) children from the age group 0-5 years who were examined in 1969 were not available for the clinical examination in 1973 and 69 children (17.1%) of the age group 6-10 years examined in 1969 were not available for the clinical examination in 1973. When the absentees clinical findings were checked in 1969, they were found to be nearly similar to their group in that year and therefore it was concluded that this is a true rise in the incidence of the enlargements of these organs. There was no case of ascites or evidence of portal hypertension in any of the children neither in 1969 nor in 1973. It was found that the children

from the sugar factory area and village 16 had a higher incidence of enlargements of these organs than those of villages 13 and 26.

Thus the findings of this longitudinal clinical study as well as the clinical findings in the children born in New Halfa and the clinical findings in similar age groups in both New Halfa resettlement area and Old Halfa district show that there is a higher incidence of hepatomegaly and splenomegaly in the Nubians in the new area.

	Age group 0-5 years				Age group 6-10 years			
	1969		1972		1969		1972-72	
	Number examined	% with enlargements	Number examined	% with enlargements	Number examined	% with enlargements	Number examined	% with enlargements
Liver	537	7.2	464	15.7	469	12.5	403	17.7
Spleen	537	9.6	464	17	469	10	403	17.7

Table 8

Hepatic and splenic enlargements in the New Halfa resettlement area in 3 years period (1969-1972).

CHAPTER 13

Basic investigations results Old Halfa

A. The results of the stool examination in Old Halfa

1009 individuals of both sexes and of various age groups had their stools e xamined by the direct smear method (Table 9).

It was observed that at least two thin smears (for the presence of cysts) and two thick ones (for ova) were made from each stool specimen in a 2% eosin solution (methods described in part II). If cysts were detected another smear was made in iodine solution to identify their type. Two well trained technicians checked each other when examining the smears and all the work was checked by the author.

Table 9 shows the results of the stool examinations in the various age groups in Old Halfa.

No case of Schistosoma mansoni was detected in any of the various age groups and similarly hookworm infection was absent in this area. Hymenolepis nana was fairly common in the young age groups, 17.5% in boys 0-15 years and 24.6% in girls 0-5 years. The infection tends to decrease with age. Giardia lamblia was also fairly common especially in the age groups 11-15 years (19.4% in males and 17% in females).

Ascaris and Strongyloides stercoralis infections were fairly uncommon

and absent in certain age groups.

The incidence of those harbouring amoebic cysts tends to rise with age and there is a sudden increase in the age group 6-10 years.

Results of the urine examinations in Old Halfa for Schistosoma haematobium infections

1016 individuals of all age groups and both sexes (including all those that gave stool specimens) had their urines centrifuged and examined for Schistosoma haematobium infection. Table 10 shows the infection with Schistosoma haematobium among the various age groups in both sexes.

Those below 6 years of age are free from the infection. The prevalence is low in the younger children age group 6-10 years but rises sharply in the age group 11-15 years to 11.3% in males and 9.7% in females. There is no significant difference between this age group and those over 16 years in the prevalence of infection.

The prevalence in all males was 7.5% and in the females 6.8%. It was noticed that most of the infected children came from the neighbouring Nubian villages. The children of the remaining town are almost free of infection.

Stools examination by the digestion concentration technique in Old Halfa

The stools of 322 individuals of the age group 0-54 years (132 below 15 and 190 above 15 years). 176 males and 146 females were examined by the digestion concentration technique for the presence of Schistosoma eggs

to check the result of the examination by the direct smear method described before. They were all negative for the presence of Schistosoma mansoni eggs.

Hospital patients in Old Halfa

At the time of our visit to Old Halfa there were 42 patients in the hospital wards. Their stools were examined by the digestion concentration technique for the presence of ova. No case of S. mansoni was detected in them and there was only one case of acute amoebic dysentery with vegetative amoebae detected in the smear. The number being small, these were the only findings of interest to us.

The results of the stool and urine examinations in New Halfa Resettlement area

Table 11 shows the results of the stool examination by the direct smear method described before in the Nubians of the resettlement area.

Among the important findings of this study is the prevalence of Schistosoma mansoni infections. As shown before the Nubians came from an area free from this infection. The prevalence of S. mansoni infection varied from 2% in children 0-5 years of age to 8.8% in those over 16 years. It was lower in females than males. In the children born in New Halfa the prevalence was 4%.

	MALES				FEMALES			
	0-5 yrs	6-10 yrs	11-15 yrs	16 yrs and above	0-5 yrs	6-10 yrs	11-15 yrs	16 yrs and above
Number examined	97	134	149	183	81	83	123	159
Percentage Schistosoma mansoni	-	-	-	-	-	-	-	-
Taenia saginata	-	.74%	1.3%	1%	-	-	1.5%	1.8%
Hymenolepis nana	17.5%	14.1%	15.5%	9.3%	24.6%	18%	14.6%	12%
Trichuris trichuria	-	1.4%	.6%	1.6%	-	-	1.6%	2.5%
Strongyloides stercoralis	-	-	-	.5%	-	-	-	-
Ascaris lumbricoides	-	-	1.3%	1%	-	-	-	1.2%
Enterobius vermicularis	2%	5.2%	4%	2.7%	2.4%	6%	7.4%	4%
Entamoeba histolytica vegetative	-	-	1.3%	.5%	-	1.2%	1.5%	-
Entamoeba histolytica cysts	5.1%	9.7%	12.8%	14.2%	3.7%	8.4%	13.8%	15%
Giardia lamblia cysts and flagellates	14.4%	16.4%	19.3%	18%	12.3%	18%	17%	15.7%

Table 9

The infestation of intestinal parasites in different age groups in Old Halfa

The commonest helminth was Hymenolepis nana which ranged from 8.8% to 23.4% in the various age groups, and as shown in the Table it was generally commoner in the younger age groups.

Giardia lamblia was also fairly common in all age groups ranging from 12.8% to 20.8%.

The prevalence of Entamoeba histolytica cysts was also fairly common ranging from 5.7 in the younger age groups to 21.2% in females over 16 years of age. It was observed that the prevalence of amoebic cyst carriers is higher in village 26.

When a number of the age group 0-10 years were followed for schistosomiasis for 4 years as shown in Table 13 it was found that the prevalence of S. mansoni infections was rising in the Nubians in the resettlement area. The examination for this special group was done by the direct smear method in all occasions.

While the prevalence in the age group 0-10 years was 2.9% in 1969 it rose to 13.2% in January, 1973. As S. mansoni infection was proved to be absent in Old Halfa it is suggested that this age group came to the area free from this infection and the prevalence steadily rose to 2.9% in 1969, 5.5% in 1971 and 13.2% in 1973. These changes in prevalence occurred in spite of the treatment given after each visit.

The stool examination by the digestion concentration technique in the Nubians in New Halfa

To check the results of the direct smear method of stool examination, the stools of 762 individuals examined by the direct smear method were checked by the digestion concentration technique. While in the 762 individuals 49 were positive for S. mansoni by the direct smear method, 66 were positive by the concentration technique. Apart from a higher prevalence by the concentration technique for E. histolytica cysts no significant difference was detected in the other intestinal parasites.

The sugar factory area*

It was observed that there is a higher prevalence of S. mansoni infections among the Nubians and other tribes in this area, so it was decided in 1973 to survey the elementary schools for this infection.

All the children in two classrooms were eligible for examination (there were 115 aged 6-11 years).

95 children brought specimens for examination. All the stool specimens were examined by the digestion concentration technique.

27 boys had S. mansoni infection, 28.5%.

The results of the urine examination showed that only 4 were positive for S. haematobium 4.4%.

Age group	MALES			FEMALES		
	Number examined	Number infected	% infected	Number examined	Number infe cted	% infected
0-5 yrs	99	-	-	82	-	-
6-10 yrs	134	3	2.2%	84	2	2.3%
11-15 yrs	150	17	11.3%	123	12	9.7%
16 yrs and above	184	23	12.4%	160	17	10.6%
TOTAL	567	43	7.5%	449	31	6.8%

Table 10.

Prevalence of Schistosoma haematobium infection among the Nubians in Old Halfa district.

320 children aged 6-10 years in this area were examined in 1969 and the prevalence of S. mansoni by the digestion concentration technique was 8.4% The prevalence of S. haematobium was 9% in this group at that time.

The prevalence of S. haematobium among the Nubians in New Halfa Resettlement area

Table 12 shows the results of the urine examinations in 1667 males and 1542 female Nubians of various age groups. The prevalence is higher in those over 16 years. It is also higher in males than in females.

15 cases were passing mansoni eggs in the urine.

The canal cleaners

This is an interesting group of people who are at a special risk of infection by S. haematobium and S. mansoni because they work for about 8 hours a day half immersed under the canal waters cleaning the vegetation from the canals. They mostly come from western Sudan and other parts of the country to work here. They are not only at risk of acquiring the infection but they are also hazards for the transmission if they are infected.

It was decided to examine all the canal cleaners of a district, 47 were eligible for examination but 43 only brought urine and stools for examination (they were all males aged 20-47 years). The stool examination in this group was done by the digestion concentration

technique and the results were as follows:-

Out of 43 examined 17 (39.5%) were positive for S. mansoni, 4 had S. haematobium (9.3%), 2 had Ancylostoma eggs in their stools.

The results of urine and stool examination in the nomadic tribes

297 individuals aged 6-57 years, 190 males and 107 females from the Elgafala village and other scattered nomadic tribes camps had their stools examined by the digestion concentration technique and their urines examined for S. haematobium. It was important to find the prevalence of schistosomiasis among the indigenous population of the area, with whom the Nubians were going to come into contact. 29 cases of S. mansoni were detected, prevalence of 9.6% and only 12 cases (4%) of Schistosoma haematobium were detected. The pattern of the other helminths and protozoa was nearly similar to those of the Nubians, Taenia saginata 13, (4.4%), Hymenolepis nana, 36 (12.1%), Trichuris 17, (5.6%), Strongyloides stercoralis 6 cases only (2%), Ascaris 4, (1.3%), Enterobius 15 (5%) Giardia 45, (15.4%). The amoebic cyst carriers were 34 (11.4%)

The examination of the school children of village 16

It was observed during the survey that the prevalence of schistosomiasis is variable in the different villages. Village number 1 was free from S. mansoni while the prevalence of S. mansoni was higher in village 16 and S. haematobium higher in village 15.

It was therefore decided in 1973 to examine the stools and urine of all the children of the elementary school of village 16. The stool examination was done by the digestion concentration technique.

The number of children examined was 308, they were 6-11 years old and of both sexes. Out of 306 children who brought stool specimens 46 were positive for S. mansoni (15.3%) and 5 of 308 who brought urine specimens were positive for S. haematobium (1.6%). 3 children passed S. mansoni eggs in their urine.

Other urinary findings in the Nubians.

The urine of 129 S. haematobium cases aged 6-49 years from 3 neighbouring villages in New Halfa together with 124 control subjects of similar age and sex was inspected and the deposit examined. Table 14 shows the findings of this study. The most striking differences between the two groups are:-

a. 35.7% of the bilharzial cases had turbid urine compared with 8.8% in the non bilharzial cases.

b. Microscopic haematuria is much commoner in the haematobium cases. 82.1% compared with 9.4% in the non bilharzial ones.

c. 21.7% of the haematobium cases had proteinuria compared with 13.7% in the control group.

	MALES				FEMALES				Children born in New Halfa	
	0-5 yrs	6-10 yrs	11-15 yrs	16 yrs and above	0-5 yrs	6-10 yrs	11-15 yrs	16 yrs and above	Males	Females
Number examined	432	322	365	261	317	350	321	249	271	293
% infected										
S. mansoni	2%	6.2%	8.4%	8.8%	1.8%	3.4%	8%	8.4%	4%	4%
T. saginata	.9%	3.1%	4.1%	5%	.9%	2.8%	4.3%	5.2%	1.8%	2%
H. nana	15.5%	13%	12.8%	8.8%	20.1%	23.4%	19%	10%	13.2%	13.9%
T. trichuria	-	1.8%	2.4%	2.6%	.9%	2%	3.1%	2%	.4%	.6%
S. stercoralis	-	-	.8%	1.5%	-	.5%	1.5%	2.4%	-	-
A. lumbricoides	-	-	.5%	1.9%	-	-	1.8%	1.2%	-	-
E. vermicularis	2.7%	5.2%	5.4%	6.1%	3.1%	8%	8.1%	6%	3.7%	4.4%
E. histolytica cysts	5.7%	10.5%	18%	16%	7.2%	10.6%	18.3%	21.2%	7.3%	8%
E. histolytica vegetative	-	1.8%	3.2%	3.8%	.9%	.6%	2.8%	3.2%	.7%	1.3%
G. lamblia	13.6%	19.8%	12.8%	19.1%	12.3%	20.8%	20.2%	13.2%	15.5%	17.4%

Table 11

The prevalence of intestinal parasites in the Nubians in New Halfa resettlement area.

	MALES			FEMALES		
	Number examined	Number infected	% infected	Number examined	Number infected	% infected
Age group						
0-5 yrs	437	13	2.9	321	9	2.8
6-10 yrs	326	17	5.2	354	14	3.9
11-15 yrs	367	25	6.9	322	18	5.5
16 yrs and above	263	23	8.7	250	15	6
children born in New Halfa	274	5	1.8	295	7	2.3
Total	1667	83	4.9	1542	63	4.1

Table 12.

The prevalence of *Schistosoma haematobium* infections among the Nubians in New Halfa.

	1969		1971		Dec. 1972-Jan, 1973	
	Number examined	% infected	Number examined	% infected	Number examined	% infected
Schistosoma haematobium	929	5.3	787	6	693	3.4
Schistosoma mansoni	927	2.9	779	5.5	690	13.2

Table 13.

Follow up study for schistosomiasis in the age group 0-10 years in New Halfa resettlement area. Stool and urine examinations.

	Number examined	colour of urine clear	colour of urine turbid	macroscopic haematuria	deposits RBC	deposits proteinuria	pus cells 5/HPF	oxalates or phosphates	sugar in urine
Schistosoma haematobium cases	129	83	46	28	107	31	21	23	3
		64.3%	35.7%	21.6%	82.1%	24%	16.1%	17.7%	2.3%
Control group	124	111	11	4	13	17	12	19	4
		91.1%	8.8%	3.3%	10.4%	13.7%	9.6%	15.3%	3.2%

Table 14.

Urinary findings in S. haematobium cases and a control group (New Halfa).

	0-5 yrs		6-10 yrs		11-15 yrs		16 yrs & above		
	Old Halfa	New Halfa	Old Halfa	New Halfa	Old Halfa	New Halfa	Old Halfa	New Halfa	Children born in New Halfa
% infected									
S. mansoni	0	1.9	0	4.9	0	8.4	0	8.3	4
S. haematobium	0	2.9	2.3	4.5	10.6	6.3	11.6	7.4	2.1

Table 15.

The percentage distribution of the prevalence of schistosomiasis in the various age groups in Old Halfa and the resettlement area.

The class and physical performance of the school children infected with S. mansoni.

In an attempt to find the effect of schistosomiasis on the performance of the children a simple test was performed with the help of a school headmaster.

The mixed elementary school of village 16 was selected for this test. 46 children were infected with S. mansoni in this school and the headmaster was given the names of 40 of these children without being told that they were ill or infected with schistosomiasis. The other 6 children were excluded because they joined the school recently.

The headmaster with the help of the other teachers were asked to prepare for us the answers to the following questions within 2 days.

1) What is the performance of the child in his studies?

a. good b. fair c. average d. below average.

2) Was the child absent from his studies this year due to illness ?

Yes or No. If yes how many days?

3) Did the child report to the hospital this year frequently?

Yes or No.

4) Is the child contributing normally to the games, ?

Yes or No.

The result of the questionnaire

1) The performances of the children in their studies.

They are from different classes. Good = 8 children, Fair = 9 children Average = 16, below average = 7. 3 of the children were very bad and 2 were very good.

2) 22 children (55%) were absent from their studies during the last 5 months (1972-1973 academic year). The duration of their absence varied between 1-4 days and the average was 2 days.

3) 34 children (90%) used to report to hospital frequently during the last 5 months compared with their colleagues.

4) 9 children only (22.5%) contributed normally to the games. The rest either did not report to the games or reported infrequently during the academic year (last 5 months). They were regarded as not being interested in their games.

Haemoglobin estimation in the bilharzial cases and a control group

The Sahli method was used in this survey being more practical for the existing field conditions in that district. The instrument used was calibrated so that 100% = 14 gms of haemoglobin. The individuals selected for both groups were from nearly similar age groups, their age ranging from 7-45 years and were of both sexes.

Bilharzial cases

216 (S. mansoni and S. haematobium cases) were investigated. Their haemoglobins found to be ranging from 45 to 94% with an average of 71%. There were only 5 cases with a haemoglobin of less than 50% but otherwise there was a wide range between the various individuals.

Control group (non bilharzial cases)

97 individuals were selected and their haemoglobins were also estimated by the Sahli method. Their haemoglobins were found to be ranging from 40% to 98% with an average of 75%. There were 3 cases of severe anaemia of haemoglobins less than 50%.

The differences between the two groups were not significant especially when we consider the possible error in the Sahli method.

The white cell count and the eosinophilia in the bilharzial cases

The eosinophil count was estimated in a limited number of S. mansoni cases. They were of both sexes and age varying from 9-47 years.

157 cases were investigated. There was a very wide range in the eosinophil count and white cell count of the various individuals.

White cell count found to be ranging from 3500 to 12000 with an average of 6185. The minimum eosinophil count was 82 and the maximum 3328 with an average of 728 eosinophils/cu. mm.

Figure 22.

Young children from the elementary school of village 16 in the resettlement area. All these children are infected with Schistosoma mansoni (A disease unknown in Old Halfa).

In spite of the wide range in counts, the eosinophil count was generally high in the bilharzial cases.

The results of the malaria survey in Old Halfa

Thick and thin blood films for malaria were taken from three groups of individuals in Old Halfa.

GROUP A From 657 individuals called by the team to the survey.

These were divided into the following age groups and sexes.

age group 0-5 years	-	52	(29 males and 23 females)
6-10 "	-	74	(31 " " 43 ")
11-15 "	-	112	(57 " " 55 ")
16 yrs and above		419	(218 " " 211 ")

Thus a larger number was selected from the older age group.

GROUP B Random house to house survey. 213 adults (132 males and 81 females) not previously tested were selected and thick and thin blood films taken from them.

GROUP C Thick and thin blood films were taken also from the febrile patients reporting with fever to Old Halfa hospital during our stay in the district.

The number of individuals examined in this group were 91 (49 females and 42 males) 52 were below 15 years and 39 above 15 years).

Thus a total of 961 individuals were examined. The films were stained with Giemsa stain. All the films were negative for malaria. The checking by the malaria section in Khartoum confirmed this.

Malaria survey in New Halfa district

Thick and thin blood films were taken from the following groups, of individuals in New Halfa and stained with Giemsa stain as described in part II.

GROUP A From individuals that were called to the survey by the team and the random house to house survey in the various villages.

GROUP B From the Nubians and other tribes reporting to New Halfa hospital in certain days during the survey.

GROUP C From the sugar factory area

GROUP D From the nomadic tribes living around the resettlement area

GROUP E Children born in New Halfa

The blood films were taken during the visits to the district that occurred in different periods of the year, and it was observed that a higher percentage of positive cases occurred in September-October up to 35% in passive hospital detection and more that 20% in some village collections.

Table 16 shows the prevalence of -malaria in the resettlement area and the neighbouring nomadic tribes district (riverain area).

The young children born in New Halfa showed an infection rate of 2.7%. No blood films for malaria were taken in the present survey from infants under 1 year of age.

The sugar factory area where there was a lot of stagnant water showed a prevalence of 10.5%.

The survey of the Nubian resettlement area showed a positive rate of 6.7% compared with a zero percentage in Old Halfa.

There was a predominance of falciparum species in all the groups and it is of interest that ovale malaria was absent completely from this region.

	Individuals examined	falciparum	vivax	malariae	ovale	mixed	Total positive	% positive
The Nubian resettlement villages survey. Group A (Active case detection)	2178	97	32	15	-	1	147	6.7
Sugar factory area Group C (Active case detection)	387	25	8	5	-	3	41	10.5
Children born in New Halfa (Active case detection)	327	6	1	2	-	-	9	2.7
Nomadic tribes (riverain) area Group D (active case detection)	892	44	13	22	-	2	81	9
Hospital collection Group B (Passive case detection)	1789	151	54	79	-	2	286	15.9

Table 16.

Malaria prevalence in New Halfa resettlement area and the neighbouring region
N.B. No case of malaria was detected in this survey in Old Halfa.

CHAPTER 14

Results of the intradermal tests

The Leishmanin skin test

Old Halfa - 254 individuals aged 9 to 53 years and of both sexes were subjected to the leishmanin test and the result read after 72 hours. They included all the patients in the hospital. All those who left Old Halfa even for brief visits were excluded. All those tested showed no reaction to the test. 7 were absent when reading the result

New Halfa - The leishmanin test in the Nubians:-

1. 312 Nubians aged 7-58 of both sexes were tested in 1969, the reaction was examined 72 hours later, 9 were absent when reading the test. 14 were positive (4.6%)

2. In 1971, 217 were tested aged 8-60 years of both sexes, the test read 72 hours later. 19 were absent, 15 were positive (7.5%)

3. In 1973, 420 both in hospital and the villages were tested. Their age was 8-62 years and were of both sexes. When the rest was read 72 hours later 23 did not report and 39 were positive (9.8%). Among hospital cases there were nomadic tribes and non-Nubians - these were not included in this group.

4. I tried to follow the Nubians tested in 1969 and 1971 and see whether they converted their reaction in 1973. 529 were tested in 1969 and 1971. 29 were excluded as they were positive in the first tests, 193 living in remote villages were also excluded. The remainder 307 were tested again with

the leishmanin test, 12 did not report for the reading, 72 hours later and 21 were positive (7.1%) i.e. 7.1% converted from negative to positive during these 4 years.

The nomadic tribes

159 individuals 12-72 years old and of both sexes from the nomadic tribes were tested with the leishmanin test. The result was read 72 hours later, 27 were absent and 33 were positive, 25.7%

The Leishmanin skin test in ElGedarif

ElFedarif is a known endemic area of kala azar and it is the nearest town to the scheme.

The test was performed on hospital inpatients, to guarantee their follow up. Only the ill, jaundiced, pregnant women or young children were excluded.

117 non kala azar patients were tested, they were of both sexes and their age ranged from 11-59 years. The test was read 48-72 hours later. 4 patients were discharged and 36 were positive (31.8%). An interesting finding was that our of the 28 tuberculous patients 17 showed a positive reaction.

The schistosomal intradermal test

The skin tests were performed on 224 individuals varying in age

and of both sexes. The adult fluke antigen prepared by WHO was used in the present study. .05ml of 1/5000 dilution was injected into one forearm and the buffer in the other forearm as a control. The tested individuals were as follows:

1. 97 S. mansoni patients

2. 85 S. haematobium patients

3. 42 control group, thoroughly investigated and proved to be negative for both infections and had no past history of bilharzia. Their ages ranging from 5-52 years.

The results were as follows:

1. In the S. mansoni cases 84 (86.5%) were positive

2. In the S. haematobium cases 68 cases were positive (80%)

So in all the bilharzial cases 152 (83.5%) were positive

3. In the control group 5 (11.9%) were positive

It was observed that no reactions occurred with the buffer solution.

The youngest child who had a positive skin test was 5 years old and he was infected with S. haematobium. Some children showed a stronger reaction and the majority of these had enlarged livers or spleen.

Filarial and Onchocerciasis survey

Old Halfa

Filarial infection is unknown in this district so in this survey it was decided to check all the blood films taken for malaria for the presence

of filarial infections. All the 961 individuals were negative for all types of microfilariae in the blood.

Onchocerciasis in Old Halfa

Old Halfa was known to be free from onchocerciasis, the only reported case from the northern province of Sudan was from the Abu Hamad area. Skin snips were taken from 318 individuals in that district and all were negative.

New Halfa

Filarial infections - A very thorough and extensive survey for microfilariae circulating in the blood was done in New Halfa district. All the blood films taken for malaria were checked for microfilariae. As shown in Table 14 these blood films were taken from various groups of people including the Nubians, the area of the sugar factory, children born in New Halfa, nomadic tribes and hospital collection. Thus a total of 5510 slides stained with Giemsa were checked and all the slides were negative for microfilariae.

In addition a special survey was carried out in the sugar factory where a large number of immigrant labourers are employed and the following groups were examined.

1. 249 Nubians living there, 138 males and 111 females, age ranging from 15 to 42 years.

2. 339 immigrant labourers, mostly from southern and western Sudan. They were all males aged 20-45 years. All these had blood films

taken during the day. An attempt was made to take blood films during the night or early morning but it was only possible to take 32 films.

The results were as follows:-

1. All the Nubians were negative.

2. In the immigrant labourers, the following results were obtained:- 3 positive slides for Acanthocheilonema perstans (.8%), they were both fromsouthern Sudan. 4 Loa loa cases (1.2%) all coming from southern Sudan. Only one patient had Wuchereria bancrofti infection (.3%). He was a labourer coming from southern Sudan.

Skin snips for onchocerciasis in the resettlement area

The individuals selected for this investigation were divided as follows:-

1. Village 1, 214 individuals, 150 males and 64 females age ranging from 17-50 years. Village 1 is the nearest village to Khashm el Girba Dam where we have found Simulium larvae and pupa.

2. Sugar factory. Nubians 115 all males aged 18-45 and immigrant labourers. 235 males aaged 22-47 years.

3. Village 26 (Nubians near the sugar factory) 198 all males aged 20-55 years.

4. Nomadic tribes 174, 150 males and 24 females age varying 16-65 years.

5. Nubians from other villages and those having itchy skin, 321 275 males, 37 females aged 9-47 years.

Thus a total of 1013 individuals were investigated, multiple snips were taken as described before.

There were only 2 positive cases detected in this survey, one was from the nomadic tribes, a man aged 44 years living near Khashm el Girba. The second case was from a southern labourer who recently came from southern Sudan and he had a typical clinical picture. No other types of micorfilariae were detected in the snips in this survey.

CHAPTER 15

G-6-P D and abnormal haemoglobins

The Nubians were living as an isolated tribe in northern Sudan separated by a long stretch of desert from the rest of the country. When they were transferred and resettled in the new area, they became surrounded by various tribes, intermarriages might occur after some time and the genetic characteristics may vary. In the new resettlement area they are now e xposed to malaria and the hazards of treatment in those with G-6-P D defieiency are great. This lead me to investigate the abnormal haemoglobins and G-6-P D deficiency in the Nubians in New Halfa.

Samples of blood were collected, preserved and transported to Khartoum as described previously from 100 unrelated male Nubians. The methods were also described.

There was only one Nubian with an abnormal haemoglobin and that was haemoglobin AS. The frequency of gene 'S' was calculated to be 0.005.

3 Nubians were found to be G-6-P D deficient subjects.

It is of interest that a country survey for the incidence of G-6-P D deficiency and abnormal haemoglobins in the indigenous and immigrant tribes in the Sudan was carried out. The present Nubian study was included in that survey (Omer, 1972 b).

The incidence of G-6-P D deficiency in the Nubians being 3% higher than the incidence in a tribe that typifies the mixed population of central Sudan where the incidence is nil and much lower than the Dinka tribe in southern Sudan where the incidence is 13.3% (14 out of 105). A number of these Dinka tribe work in the sugar factory in New Halfa resettlement area.

Table 15 shows the abnormal haemoglobin in the Nubians compared with other indigenous and immigrant tribes of the Sudan. The tribes chosed for the study are:-

1. Kalakla, central Sudan, typifies the mixed population of central Sudan.

2. Dinka, southern Sudan, the majority of the labourers in the sugar factory in New Halfa resettlement area are from southern Sudan.

3. Beja, they are nomads that inhabit the desert and semi-desert of eastern Sudan, near New Halfa and of the same genetic group as some of the other nomadic tribes of the area.

4. Nigerians, this is a Hausa tribe that settled a long time in the Gezira area (Blue Nile Province) working as labourers and some of them have already come to work in New Halfa resettlement area.

Tribe	No.	% abnormal Hb.	Expected heterozygotes for 'S' %	Frequency of gene 'S'	Expected homozygotes for Hb S %
Nubians	100	1 AS	-	0.005	-
Kalkla	100	0	-	-	-
Dinka	105	7.6 AS	7.7	0.04	0.016
Beja	100	0	-	-	-
Nigerans	100	27 AS	26	0.15	2.5
		1 AC			

Table 17.

Abnormal haemoglobins in the Nubians and other indigenous and immigrant tribes of Sudan. In addition 3 Nubians were found to be G-6-P D deficient

CHAPTER 16

SNAILS

Irrigation system

The water for this scheme is brought by gravity from Khashm el Girba Dam to the cultivated areas by two main canals. They start from the Dam as one main canal 26.5 km long, then branching into two main canals. The western branch 46 km long, irrigates 300,000 feddans (1 feddan = 1.038 acres) and the eastern branch 41 km, irrigating 155,000 feddans. From the main canals the water flows into a series of major canals and then to minor canals. Set in at 90° and at intervals along the minor canals are offtakes, or small irrigation channels, called Abu Eshreens. Each Abu Eshreen carries water to 180 feddans of cropped land. Arising from the Abu Eshreens are smaller channels called Abu Sittas. From these, water runs into the gudwals-channels running parallel to the Abu-Eshreens and then to the crop.

Several of these water courses were inspected during our visits as described in Part II. It was found that the snails are relatively few in the main and major canals. They occur in much greater numbers in minor canals where breeding conditions are more favourable. Snails were also found in the smaller field channels but they were not

expected to survive long there, nor breed as these water courses are frequently dry.

Page 260 shows the snail species that have been found in the area.

Natural infection rate in snails

Snails collected from the field in December, 1972 were placed in small beakers and exposed to light to stimulate shedding of cercariae. Of the 400 Bulinus snails examined only 2 were infected. None of the 750 Biomphalaria snails was infected.

During previous visits several water courses at different times of the year were examined with the help of the bilharzial team in the area. That study revealed that infestation with both Bulinus and Biomphalaria is perennial and they were found to be infected,, however the true natural infection rates needs to be revealed. Some of the snails were found to be shedding non human (bird) cercariae.

Susceptibility of snails to infections

Bulinus truncatus and Biomphalaria pfeifferi were collected from the canals in New Halfa and brought to Khartoum in damp cotton where they were kept in an air conditioned aquarium. Susceptibility tests were performed using Gezira strain of S. mansoni and Khartoum-North strain of S. haematobium. The snails were exposed in

small tubes to an average of 5 miracidia each. The results have confirmed that Biomphalaria pfeifferi is a vector for S. mansoni giving an infection rate of 98%. Bulinus was established to be the vector for S. haematobium, the infection rate among Bulinus snails was found to be 60%.

Insect vectors of the disease in New Halfa

Anopheles gambiae

Using spray sheets collections made with a solution of 0.2% pyrethrins in kerosine traps and outdoor searches showed that Anopheles gambiae is found in large numbers in New Halfa resettlement area especially during the rainy season. It is very rare during the cold season, December-January as revealed by our last visit, December, 1972. Anopheles gambiae is known to be the principal malaria vector in Sudan.

Sandflies collected in New Halfa resettlement area in December, 1972

1. Phlebotomus (Serqentomyia) antennatus (9 males and 15 females)

It is known to feed only on cold blooded animals and has been recorded biring man or other mammals.

2. Phlebotomus (Serqentomyia) schewtzi (3 females)

Its known hosts are warm and cold blooded animals and it frequently bites man.

3. Phlebotomus (Serqentomyia) clydei (21 males and 20 females)

It seems to feed equally well on warm and cold blooded animals. It

was reported biting man in El Gezira area.

Mosquito collections

During the visit in December, 1972 the following mosquito collections were made also in the resettlement area.

Sugar factory area - Aedes caspius (adult) and Culex fatigans (adult)

Village 24 - Culex fatigans (adult)

Simulium damnosum

A thorough search was made for Simulium in the resettlement area and we found Simulium damnosum pupae and larvae in large numbers in the Atabra river rocks under Khashm el Girba Dam. This was the first time for Simulium to be detected in this area. Several other rapid running water courses in the canals were surveyed but no Simulium was found. But now Simulium being detected by us at the beginning of these water courses, one expects that it may spread northwards along these water courses in the future.

Species	Relative frequency	Medical and Veterinary importance
Bulinus truncatus	abundant	Intermediate host of S. haematobium
Bulinus forskalli	common	Intermediate host of S. bovis (experimental)
Biomphalaria pfeifferi	abundant	Intermediate host of S. mansoni
Lymnea natalensis	common	Intermediate host of Fasciola gigantica
Melanoides tuberculata	abundant	Nil
Cleopatra sp.	abundant	Nil

Part IV

DISCUSSION

CHAPTER 17

General discussion, comparison and evaluation of the results

From the analysis in this study it emerges that the Nubian resettlement project in New Halfa is perhaps the greatest organised movement in the world. During the years 1964-1967 over 50, 000 Nubians had to be transferred from the flooded Old Halfa district to Khashm el Girba 600 miles away in eastern Sudan. Although this new agricultural scheme offered better opportunities for economic development to the Nubians yet they were subjected to stresses and so health problems were expected to arise in the new environment. These stresses started a long time before the transfer of the Nubians. The Nubians having seen that the construction of the High Dam was going on realised that they would be -uprooted from their home and their doubts and fears of the unknown continued till the decision on the selection of the alternative area was taken. Then the Nubians faced new stresses in the resettlement area. Baashar (1967) suggested the description "Socio psychological metamorphosis" being experienced by the Nubians in New Halfa. He suggested administrative challenges of the new environment had to be faced in transport, housing, employment and new organisation of social life. The present study has revealed that there are social ecological and environmental differences between Old Halfa and the resettlement area. The Nubians in their old environment lead a different type of life; the

majority of the working age group used to work either in Egypt or some other parts of the country to support their families. The Men:Women ratio in the age group 16 years and over was 0.58. Those that remained w orked either in the port, Old Halfa was an important river port handling the trade between Sudan and Egypt, or in the limited agriculture. There was a small strip of fertile land along the banks of the Nile in Old Halfa. While in New Halfa they had a large agricultural fertile land which improved their standard of living but meant a change of the type of work to the majority. There was a great difference in the housing situation in the two areas. In their original home as previously described the Nubians used to build their houses from local materials over a wide area giving them a chance of expansion as the family increased in size. In the resettlement area the houses were built from expensive material close to each other and therefore lacking privacy. This may result in future to overcrowding when the families increase in size. Overcrowding together with stress and poor diet can result in increase in the incidence of tuberculosis. The type and standard of the house in New Halfa was also fixed and thus the traditional originality of the Nubian style of building was also lost thus the Nubians are living in a different environment and working in a new system of agriculture that introduced them to controlled irrigation and

mechanisation of which they had no previous experience and thus adding to the stresses that they were facing.

The climate in the two areas was also different. It was rainless, hot and dry during summer and cold in winter in Old Halfa. The maximum temperature there reached 120°F (48.5°C) and the lowest 34°F (1.1°C). the total rain in Old Halfa in a year hardly reached 1mm. The resettlement area is semi arid with an average annual rainfall of over 300 mm. Although generally there is a slight difference between the maximum and minimum temperatures in New Halfa, yet there is a seasonal difference when the temperature in summer reaches 41°C and in winter it goes down to a minimum of 15°C. The Nubians therefore met a different climate in the new area and faced heavy rains and thunder for the first time in their life and adapting to these added to their difficulty.

The disposal of sewage in Old Halfa was a double bucket system and was operating efficiently except in some villages where sometimes open defaecation occurred, other houses had shallow pit latrines. While in New Halfa the usual plan is to have pit latrines, which are operating efficiently the problem in this area is that the agricultural land is not situated in proximity to the village and most people are forced to defaecate and urinate in the open and sometimes near canals. This practice is expected to lead to transmission of schistosomiasis and

other intestinal parasites. The situation concerning water supply varies in the two areas. While in the old area, Halfa Town used to depend on efficient chlorinated piped water supply and in the scattered villages people drank from wells or the Nile, in New Halfa although there is chlorinated water supply to the town and the villages, the people having to work a long distance away are forced sometimes to drink and to bath in canals which are often heavily infected with snails.

The population structure is also different in the two areas. Previously the Nubians in the old area used to live as an isolated tribe and apart from the Shawan (Syrians) working as traders and the government officials there were only a few other foreign labourers in the port. But in the resettlement area a considerable number of casual labourers were needed to assist in cultivation and the work in the sugar factory. This study has shown that they imported S. mansoni infection to the area and the Nubians are acquiring this infection. The study has shown also the risk of other imported infections. There is also the large number of riverain nomadic tribes living in the other phases of the scheme in close proximity to the Nubians. Thus in the resettlement area the population represents diverse ethnic and cultural backgrounds and comes from different parts of the country with various endemic disease problems and not like the past isolated Nubian race separated from the rest of the country

by the Sahara desert.

This study has shown the health problems that arose as a result of exposure to the new environmental conditions described. Schistosomiasis and malaria were the principal among these but there were also other problems.

Schistosomiasis

In the survey of Old Halfa, Schistosoma mansoni was completely absent. 1009 individuals of both sexes and of various age groups had their stools examined by the direct smear method and no S. mansoni eggs were detected in any of them. 322 individuals of the age group 0-54 years had their stools examined by the digestion concentration technique and they were all negative for S. mansoni infection. Schistosoma haematobium was present in Old Halfa. The prevalence of S. haematobium in 567 males of all age groups was (7.5%) and in 449 females of all age groups was (6.8%). It was found that the prevalence is higher in those over 11 years of age (11.3%) in males 11-15 years and (9.7%) in females 11-15 years. On the other hand the situation was found to be different in New Halfa. It was established that the Nubians have acquired S. mansoni infection and transmission was going on. Table 11 (page 234) shows the results of the stool examination by the direct smear method in various age groups and both

sexes. It also includes the children born in New Halfa. The prevalence of S. mansoni infection among the children 6-10 years was (6.2%) in boys and (3.4%) in girls. It is slightly higher in older age groups. In addition it was found that children born in New Halfa had a prevalence rate of 4%. These figures are expected to be higher if more sensitive techniques were used. . The results of this direct smear method have been compared with t he concentration digestion technique in New Halfa also and in 762 examinations 49 we re positive by the direct smear (6.4%) and 66 by the digestion concentraion technique (8.6%). A follow up study has shown that the incidence of infection is rising among young children (0-10 years) as when 927 children were followed up the prevalence of infection rose from 2.9% in 1969 to 13.2% in 1973. It i s thought that this situation constitutes a great danger. When Greany (1952a) did his study in the Gezira in Sudan he found the prevalence of S. mansoni infection to be 4.6% among men (total examined 15482) and 4% in women (total examined 16281), and 13% in children (total examined 18721). He thought that the incidence was possibly higher in children because they play and swim in the canals. A recent unpublished study in the Gezira has shown that the prevalence of schistosomiasis is nearly 60% in all age groups and is more than 90% in the age group 11-15 years, in some areas (Omer, 1973b). It therefore appears that unless control measures are started soon in this area the Nubians are going to be greatly affected by this problem. Another

problem that has emerged from this study is the observation of a decline in the prevalence of S. haematobium infection and a rise in the S. mansoni infection. As pointed out before when the Nubians came to this area they had S. haematobium infection and although an attempt was made to treat all the patients before they left Old Halfa yet the treatment was not successful and Table 11 (page 234) shows the results of urine examinations done in New Halfa. It has shown that the highest prevalence is among males over 16 years where 8.7% were infected with S. haematobium (total examined 263). Children born in New Halfa had also acquired the infection where the prevalence is 1.8% and 2.3% among boys and girls respectively. But in the group of children followed up the prevalence of S. mansoni increased from 2.9% in 1969 to 13.2% in 1973 but it decreased from 5.3% in 1969 to 3.4% in 1973 in S. haematobium infections. The reason for this phenomenon is not easy to explain. This study has shown that both intermediate host snails are present in the area. The susceptibility tests have shown also that Biomphalaria pfeifferi is a vector of S. mansoni giving infection rates of 98% and Bulinus truncatus collected from New Halfa canals was a vector for S. haematobium giving an infection rate of 60% when tested. Therefore the human cases harbouring both infections are present, both snail intermediate hosts are available and the agricultural scheme is ideal for transmission. The findings of Greany (1952a) had revealed that the prevalence of both species in the Gezira (Sudan) in 1952 was nearly equal 8.77% for S. mansoni

and 8.86% for S. haematobium (total number of cases examined 81, 027) But the recent survey done by Omer (1973b) (London-Khartoum Bilharzia project, unpublished) has shown that while the prevalence of S. mansoni in all age groups is nearly 60% and more than 90% in 11-15 years S. haematobium is very rare, only 4 in 2000 already examined. So a similar phenomenon is occurring in the Gezira. Two possibilities may be contributing. The first one is that S. haematobium is more easily treated than the S. mansoni infections and the treatment generally given in these areas by the medical assistants is irregular and inadequate. So there is a possibility that this sort of treatment is either curing the haematobium cases or at least causing marked reduction in the egg load thus affecting transmission of S. haematobium and not affecting the majority of S. mansoni cases. Other contributory factors to this phenomenon are perhaps the habits and environment of the Nubians in New Halfa. It has been already explained that the Nubian villages are usually situated far from the agricultural land, so when they are working they probably defaecate or urinate in the open. It is probably that they pass urine anywhere near their hawashas (agricultural land) but possibly they need to go near the canal for defaecation to wash and this may increase the risk of transmission of mansoni infection.

The role of the immigrant labourers in the transmission of schistosomiasis is clearly shown in this study by the findings of the survey in the sugar factory area and the canal cleaners. The examination

of the children in the sugar factory in 1973 has shown that 28.5% of school children had S. mansoni infection and 4.4% S. haematobium. It is interesting that in this area in 1969, 8.4% were infected with S. mansoni and 9% S. haematobium. The examination of the canal cleaners who are recruited mostly from western Sudan has revealed that 39.5% were positive for S. mansoni infection and 9.3% positive for S. haematobium.

This survey has shown that the incidence of schistosomiasis varies in the different villages and it was evident for example that while village 1 was nearly free from schistosomiasis there was in village 16 a 15.3% prevalence rate of S. mansoni and 1.6% prevalence of S. haematobium. Village 1 is situated in the southern end of the scheme near the major canals and is upstream of village 16 and this may be the reason for this difference. It is also known that in their original home the Nubians came from several villages where between which the prevalence of S. haematobium differed, however different villages were surveyed in this study.

Khashm el Girba scheme is now regarded as an important scheme for the economy of the country and it is unfortunate that such prevalence rates of schistosomiasis are found so early in this scheme.

The literature on the public health importance of schistosomiasis is conflicting. The studies by Forsyth (1969) in East Africa failed to find association between urinary schistosomiasis and impaired growth of the

of the children, school absenteeism, disease of the liver, spleen urinary complications etc. However this study has shown that 82.1% of the haematobium cases had microscopic haematuria and 21.7% albuminuria compared with 9.4% and 13.7% respectively in the non haematobium cases. This high incidence of haematuria in the haematobium cases is perhaps in agreement with the findings of Mahmood (1965) who studied the blood loss in urinary schistosomiasis and reported that haematuria represented potentially important blood loss in this disease. The present study has shown also that 21.6% of a group of haematobium cases had macroscopic haematuria and 16.6% significant pus cells in the urine, while the studies of Walker et al (1970) in Bantu children showed that frank haematuria occurred in 7.5% and severe albuminuria in 13.3%. These workers found no significant difference between infected and non infected children in running performance and examination results. However in this study the running performance and examination results of children infected with S. mansoni were investigated and compared with the control group of children. The examination results of the bilharzial cases was comparable with that of their colleagues but their performance in games and their school absenteeism was different from their colleagues. Their contribution in the games was much less and absenteeism much more than their colleagues.

The investigations for anaemia among the bilharzial cases in the present study failed to find a significant difference between the haemoglobin values of the bilharzial and non bilharzial cases. It is sometimes difficult to find the part played by schistosomiasis in the development of anaemia in the tropics due to the other concomitant diseases e.g. malaria and hookworm. Gelfand (1968) investigated the causes of severe anaemia cases admitted to the medical wards in Harari Hospital, Rhodesia and he found that out of 25 male cases of severe hypochromic anaemia there were 13 cases of either hookworm or bilharzia or both, 9 were pure bilharzial, 3 hookworm and one hookworm and mansoni. 31 females had severe hypochromic anaemia and 13 of these had either hookworm or bilharziasis or both. The total number of hypochromic anaemia cases in Gelfand's study were 80 males and 93 females.

Eosinophilia in the bilharzial cases was also investigated in this study. The eosinophil count was generally high in the bilharzial cases with a mean of 728 eosinophils/cu.mm. but there was a wide range in counts. Eosinophilia is an accepted finding in bilharzial cases and it is reported to become even higher after antibilharzial drugs (Omer et al, 1972, Katz et al, 1968).

The Schistosomal intradermal test

This was investigated in this trial to obtain evidence of its significance

as an epidemiological test. 83.5% of the bilharzial cases in New Halfa gave a positive reaction compared with 11.9% positive reactions in the non bilharzial cases.

Experience in areas where schistosomiasis is not endemic has shown that positive reactions in persons who are not suffering from the disease may occur as a result of penetration of the skin by cercariae of non-human schistosomes (Knight, 1973).

Various workers have studied the clinical aspects of schistosomiasis in different parts of the world but few meaningful longitudinal morbidity and clinical studies have been done. Barbosa and Voss (1969) followed the clinical evaluation of S. mansoni in Brazilian children for 6 years. They found that of 389 children initially in stage I 175 (41%) had developed to stage II and 81 (20%) to stage III. They reported 3 deaths, 2 in children in stage III and 1 with stage I disease. Kloetzel (1964) followed a group of 109 persons with bilharzial splenomegaly in Brazil for 3.6 years. During this period liver failure occurred in 8, haematemesis in 11 and a total of 15 died. However in the resettlement area schistosomiasis and malaria are both endemic medical problems and it is difficult to be sure of the part played by each in the enlargement of the liver and spleen. But in a group of young children followed for about 4 years it was found that 7.2% of the age group 0-5 years (total examined 537) had liver enlargements in 1969 and 15.7% of those reporting in 1973 had enlarged livers. In the age group

6-10 years 12.5% (total examined 469) had enlarged livers and the number of those with liver enlargements increased to 17.7% in 1973. On the other hand the splenic enlargements increased from 9.6% in 1969 to 17% in the younger age group and from 10% to 16.6% in the older age group. Those who did not report for the follow up were considered carefully and it was found that the difference between these and their original group in the splenic or liver enlargements at the time of examination was not more than $\pm$ 1%. Therefore this is not likely to affect the result of the follow up. It is important to note that the first examination in 1969 was about 4 years after the resettlement. No mortalities or further complications occurred in the follow up. The results of other clinical findings will be discussed later in this chapter.

Malaria

Malaria also constituted a major health problem in the resettlement area as a result of the new environmental conditions. This study has shown that the blood films taken from 961 individuals in Old Halfa were all negative for malaria. On the other hand the prevalence of malarial parasites in the resettlement area varied between 6.7% and 15.9% in various groups of populations in New Halfa. Even the young children born in New Halfa showed a prevalence rate of 2.7% (Table 16 page 246)

Thus malaria is a real hazard to this resettlement. The present study has shown that Anopheles gambiae is found in New Halfa in abundance apart from the winter months but it was exterminated in Old Halfa (Lewis, 1949). A recent report written by the Joint Committee for the Control of Anopheles gambiae (Abdelnur, 1973) has also confirmed the absence of Anopheles gambiae from Lake Nasir although it was found further south. Haridi (1972) confirmed high catches of Anopheles gambiae in Khashm el Girba area during the period September to November.

The present study has also shown (Table 16) that Plasmodium falciparum was the predominant species in the majority of cases followed by vivax. But in the nomadic tribes and hospital cases P. malariae came second to falciparum infection. As the pattern of the species in the Nubians is like that of the indigenous tribes, it is suggested that the indigenous tribes rather than the immigrant labour have acted as the reservoir of infection. It is interesting that no ovale cases were detected in this survey, yet ovale malaria is known in the neighbouring country, Kenya (Rickman et al, 1972). The presence of malaria in New Halfa created some difficulty in deciding the importance of malaria and schistosomiasis in contributing to the symptoms or signs in the patients examined. The correlation between malaria and parasitaemia with symptoms is controversial in a survey where there are other endemic diseases. Okeahialam et al (1972) found no correlation between common presenting symptoms of fever, cough, diarrhoea and vomiting

with malaria parasitaemia. In the present study active case detection revealed prevalence rates between 2.7% to 10.6% in the various groups compared with a prevalence of 15.9% in the hospital passive case detection presenting with fever. Thus malarial parasitaemia can occur in a large number of afebrile patients.

Leishmaniasis

Among the health problems which were expected to arise in the resettlement area was visceral and perhaps cutaneous leishmaniasis. Khashm el Girba was a known focus for both types of leishmaniasis especially the visceral type. The Nubians came from an area which is completely free from this disease. However the hospital records in New Halfa Town did not reveal any case of leishmaniasis among the Nubians until early 1973 but the leishmanin test survey in the present study suggests that the Nubians have possibly been exposed to a species of Leishmania. These results have shown that while 247 individuals tested in Old Halfa were all negative 72 hours later, 303 individuals tested in New Halfa in 1969 had a 7.5% positive rate 72 hours later. Other findings among the results of the leishmanin test were also interesting, revealing that in 1973, 9.8% of those tested were positive, and 7.1% of those tested in 1969 and proved to be negative converted to positive in 1973. It is accepted that a positive leishmanin reaction can be caused by any species of Leishmania as well as lizard Leishmania and some other flagellates (Manson-Bahr, 1971).

However the Nubians are known to have been uprooted from an area free from this disease and showed no reaction in the old area and resettled in a known endemic area showing a 7.5% positive reaction after 3 years of the resettlement. It was also shown that the incidence of positive reactors is rising when they were followed up and some of them proved to be converting to positive. The results of the leishmanin test in the nearby town of El Gedarif have also shown a positive rate of 31.8%. These findings suggest a possible risk of exposure. When the leishmanin test was first used in Sudan (Cahill et al, 1965), it was shown that the results in Omdurman hospital patients corresponds well with the epidemiology of leishmaniasis in Sudan. It was in fact suggested in that study that it would be of great interest to use the leishmanin test in the Nubians who were going to be uprooted from northem Sudan and resettled in eastern Sudan and this was done in this study. Manson-Bahr and Southgate (1964) suggested that the cause of positive skin reactions in the absence of history of the disease (a situation which can simulate the present study findings) can be explained by the fact that the skin is sensitised to leishmanin by repeated natural small inoculations of rodent or lizard strains of Leishmania from sandflies. In the present study 3 species of sandflies were collected in the resettlement area, namely Phlebotomus antennatus, Phlebotomus schuitzi and Phlebotomus clydei and it has been reported that in Sudan the evidence that rodents act

as a reservoir host of kala azar is fairly strong. (Hoogstral and Dietlein, 1964). Therefore there is also a possibility that the positive leishmanin reaction in the Nubians can be due to exposure to non-human leishmaniasis. The findings of the leishmanin test reported in the Nubians suggests however that although some of the Nubians have possibly been exposed to Leishmania strain, yet a large number are still non immune, a situation which may allow epidemic spread of the disease. The experiences of the Bengal epidemics reported by Southgate and Oriedo (1967) suggest that the periodicity of the Bengal epidemics depended upon the achievement of a high population density of non-immune individuals to allow epidemic spread to occur. The Nubian population thus being till now largely non immune as revealed by the leishmanin test done represents a vulnerable group for an epidemic of kala azar unless measures are taken. However some workers held a different opinion, Alder (1963) postulated that adults from non endemic regions seldom acquire the kala azar infection after a period of residence in an endemic focus and thus the immunity of the adult is innate and not due to previous infection. If this theory is correct it suggests that the Nubian situation may not necessarily result in an epidemic. On the other hand Southgate (1964) showed that the factors that determine the immunity depend on the relative exposure to infection of the various population subgroups and the immune state of the subgroups resulting from previous disease. As mentioned before

there is no evidence that any Nubians have acquired leishmaniasis in the resettlement area, so applying Southgate's postulation in the Nubians any immunity in the Nubians would thus only be from relative exposure to the infection. But the leishmanin test in them has shown that only a few (9.8% in the 1973 survey) were possibly exposed to the infection and thus had the chance to become immune. It is therefore concluded that this study has shown that the Nubians are likely to be vulnerable to an epidemic of visceral leishmaniasis in the future.

Onchocerciasis

The present study also anticipated that onchocerciasis would be a calculated health hazard to the Nubians. The building of Khashm el Girba Dam and the system of canalization creates more favourable conditions for the propagation of the vector Simulium. This study detected Simulium larvae and pupae in large numbers in the Atbara river rocks under the Khashm el Girba Dam, a site hitherto not described before. Undoubtedly this new favourable site for their development was only made possible by the new irrigation scheme. Lewis (1952) gives the range of flight of Simulium damnosum as to 10-30 kilometres in Sudan. This range would easily bring the Simulium to the southern end of the resettlement area inhabited by the Nubians. Gabbins (1936) reported from Uganda that the infection by onchocerciasis can be found at long distances from the river where Simulium breeds. This is not accepted

in Sudan where the disease is reported by various workers restricted to the areas near rivers. Kirk et al (1959) quoted cases coming from Bibor Akobo and Pratt in southern Sudan near the rivers. Bloss (1949) also described the disease in Bibor. post.

Kirk and Satti saw cases presenting with an onchocerciasis clinical picture about 25 years ago along the Rahad and Atabra rivers (Satti, 1973). This area is within the present resettlement scheme. However on the other hand the focus at Abu Hamad described by Morgan (1958) and other cases seen by doctors in the Sudan are from regions far south of the Old Halfa district, the old homeland of the Nubians. In the present study only 2 positive cases of onchocerciasis were detected in the 1013 individuals investigated and they were from non Nubians. Yet as the vector was found, the area was reported to be endemic for the disease and the conditions favourable for the propagation of the vector it seems there is a potential danger to the Nubians from this infection.

The situation for the other filarial infections is perhaps different. This region was neither known to be an endemic area for Wuchereria bancrofti nor Loa loa. The investigations done by us have detected 4 Loa loa cases (1.2%) all from southern immigrant labourers and only one case of Wuchereria bancrofti (0.3%) also from a southerner.

Chrysops fly was not detected in the area by this study but Culex and Aedes mosquito were collected. So in the case of Loa loa the area is not a known endemic focus and the reservoir of infection is therefore the only group of southern immigrant labourers. In the absence of the vector in this area the chances of the spread of infection to the Nubians is very remote.

Wuchereria bancrofti is found in southern and some areas of western Sudan but is unknown in Khashm el Girba area. Therefore in spite of the presence of the vector, the reservoir of infection being the recruited labour only, the chances of spread are perhaps limited.

Acanthocheilonema perstans was detected in the recruited southern labourers in the sugar factory and the infection is only known in southern Sudan. The chances of spread to the Nubians is possibly also limited. However the clinical significance of this infection is accepted to be of minor importance.

Intestinal parasites

The epidemiology of intestinal parasites is related to a number of ecological factors and influenced by social, economic conditions, the state of hygiene and sanitation in the community. It therefore seems that following the changing pattern of intestinal parasites in the Nubians in their two environments would be of value. This study has shown that the prevalence pattern of the intestinal parasites in the two areas is nearly the same

except for Schistosoma mansoni which has been discussed, E. histolytica Taenia saginata (Tables 9 and 11). The commonest intestinal helminth in both areas was Hymenolepis nana. The highest incidence of this infection was among young children reaching 24.6% in the girls age group 0-5 years in Old Halfa. This considered to be a high prevalence compared with the figures given by other countries. Meir Yoeli et al (1972) reported an incidence of 0.13% from 10,947 patients examined in a New York poor area. The incidence reported from Nairobi varies between 0 and 8% among various groups, (Wijers et al. 1972). The high incidence of this helminth in the survey can be explained by the contaminative nature of the spread of this infection. Hymenolepis nana does not need intermediate host and the ova is directly infective when passed in the faeces. In a closely linked community like that of the Nubians with relatives being occasionally gathered together and overcrowded sometimes this infection would occur more frequently. The infection is not detected in the Nubians as routine stool examinations in this relatively asymptomatic infection are rarely done. Moreover if the infection is detected it is rarely treated by the medical personnel who may not know the advances in the treatment of this infection which is usually resistant to many previously recommended drugs.

The prevalence of Enterobius vermicularis is also nearly similar in both areas and seems to be slightly more common in females. The prevalence rates ranging from 2% to 8.1% in the various age groups and sexes

As more sensitive techniques could have detected higher prevalence, this infection seems to be common in both areas. This infection also does not need an intermediate host; the egg is directly infective. As the prevalence depends on the habits that did not change in the Nubians due to this uprooting and resettlement, the prevalence is as expected nearly similar in the two areas.

Hookworm infection was absent in the Nubians in both areas and Strongyloides stercoralis and Ascaris lumbricoides were very rare, being absent in younger age groups. The only explanation for this is perhaps the character of the soil. It is desert in Old Halfa and semi arid in New Halfa. There is practically no rain in Old Halfa and the soil in New Halfa is dry most of the year. It is only the agricultural land which is irrigated most of the year. Wijers et al (1972) reported higher prevalence of these infections in Nairobi with Ascaris infection reaching 54.5% hookworm reaching 46.8% and Strongyloides 8.5% in some groups. But the prevalence in their series varied in different tribes and their duration and their stay in the town.

The prevalence of Taenia saginata infection is higher in New Halfa than Old Halfa reaching 5.2% in the older age groups in New Halfa compared with 1.8% in Old Halfa. The supervision of the slaughter of animals is the same in both areas and the only explanation for this disparity

is perhaps the Nubians are now eating more meat in the resettlement area and therefore more prone to get the infection if the chances of contaminated meat are the same. It is evident that this agricultural scheme and its surroundings provides more meat for the Nubians than in their original home.

Giardia lamblia was also common among the Nubians in both areas especially in the younger age groups reaching 20.8%. The incidence of this infection seems to be common in most tropical countries. Wijers et al (1972) found that this infection is common in all the tribes that he investigated irrespective of the duration of their stay in the town. On the other hand this infection is reported to be very rare in Chinese individuals, Grant (1969) reported an incidence of 0.2% among 15952 patients investigated by a single direct smear method.

The prevalence of amoebic cyst carriers and those with the vegetative form is higher in the resettlement area than Old Halfa, and the prevalence of both is also commoner in children born in New Halfa than the corresponding age group in Old Halfa. The prevalence of both is higher in the older age groups, that of the cyst carriers reaching 21.2% in females over 16 years of age in New Halfa. It was observed that the prevalence varies in the various villages in the resettlement area. Village 26 had the highest prevalence and it was noted that they

were always complaining of their water supply. When the tank was inspected in this survey it was observed that the water source was a small canal with immigrant tribes living nearby defaecating in the open and the water supply was not guarded. It is expected that this situation can result in dissemination of water borne diseases. Attacks of gastroenteritis among children were often reported from the resettlement area and villages like village 26 have a high record of this. Walker et al (1972) reported similar experiences from South Africa with medical problems related to water supply concerning the Africans. They found that the prevalence of Salmonella and Shigella infections among African children of the age group 6-16 years in an isolated African village in 1963 was 72% when that village received its water supply from contaminated shallow ponds. But when a bore hole was sunk and the water was of good purity, studies in similar groups of children revealed that the combined prevalence of the two bacterial diseases was reduced to 28.2%. Thus an effort to guard against contamination of the water supply and improve the purification and the source of supply in the villages of the resettlement area could result in greater reduction of water borne diseases.

G-6-P D and abnormal haemoglobins

This study included also the investigations of the enzyme G-6-P D deficiency and the abnormal haemoglobins among the Nubians. It is known that there is a great heterogenicity in the ethnic composition of the Sudanese population, some of pure Arab extraction, others of negroid origin and a wide spectrum in between. The Nubian ancestry probably came originally from Egypt, and it was thought that they remained in an isolated ethnic composition with no cross breeding with other tribes. The findings of this study supports this theory as while the percentage of subjects deficient in the enzyme G-6-P D was 3% in the Nubians compared with 0% with people of Arab origin (Beja) and 14% in those of negroid origin (Denka) 1% of the Nubians had haemoglobin AS while 7.6% of the Dinka had haemoglobin AS. It seems therefore that the Nubians are going to face malaria in this area with 3% of their population deficient in the enzyme G-6-P D and therefore some caution should be observed in the use of antimalarial drugs. It is also of interest to note that the percentage of those with the sickle cell trait is very low and thus probably a very small percentage of the population has any protection against malaria.

The clinical examination

The present study included a questionnaire and clinical examinations in Old Halfa and the resettlement area and the analysis of the symptoms and

and clinical findings was in line with the investigations done. The commonest complaint in the Nubians when there were in Old Halfa was eye troubles reaching 65.7% in those over 16 years of age and it is of interest that when they came to New Halfa only 20.9% of this age group continued to complain of eye diseases. In this group 52% used to complain of eye diseases before their arrival. This supports the previously reported prevalence and severity of trachoma and other eye diseases (Delon, 1962). He found prevalence rates of trachoma in boys to be 78% and 60% in girls (aged 0-14 years). The prevalence of conjunctivitis in his study was 68% and was mainly in a mild form. These prevalence rates are higher than the rest of the country. It is difficult to explain the reason for this high prevalence among the Nubians but there are sand storms in Old Halfa district which may contribute to inflammatory conditions of the eye. Another theory is that the Nubian women dress (Khalkhal) which is a long black dress that reaches the ground is probably contaminated and makes them more prone to suffer from eye diseases. But there is no evidence that eye diseases are commoner in women than men and it is evident that eye diseases are also common in children. However it will be of interest to follow the Nubians in their new environment and if the eye complaints tend to decrease as shown in the questionnaire, this is going to be probably the only major health problem which improved as a result of this uprooting and resettlement of the Nubians.

Haematuria has been a very important complaintin the bilharzial patients in this study as discussed before and in the analysis of the questionnaire it was evident that none of the children aged 0-5 years in Old Halfa had history of haematuria but 8.7% of those 11-15 years and 11.1% of those over 16 years gave this history. This suggests that the incidence of haematobium infection suddenly increases in the age group 11-15 years. While in the resettlement area (Table 4) 4.1% of the age group 0-5 years had a history of haematuria and this history gradually increases to reach 17.7% in those over 16 years. It is interesting also that when the Nubians were asked about the history before their arrival it was nearly similar to the history given by the Nubians who are still remaining in Old Halfa. Other important findings of the questionnaire was the high percentage of individuals who received treatment for malaria in New Halfa 14% of those over 16 years compared with 1% in Old Halfa. Furthermore 11.3% of those in the age group 11-15 years received treatment for malaria in New Halfa compared with none of this age group in Old Halfa. It was also evident that the numbers of those that passed or noticed worms in their stools is higher in all age groups in New Halfa than Old Halfa. It was also interesting that the complaint of fever was commoner in all age groups after their arrival in New Halfa than before their arrival. It was also commoner in all those under 16 years of age in New Halfa than the corresponding age in Old Halfa, but it was commoner in those over 16 years in Old Halfa

than after their arrival in New Halfa and this is obviously due to the shorter period that this age group spent in New Halfa compared with that in the old area. The questionnaire revealed also that the Nubians felt generally better in Old Halfa, had less fever, less diarrhoeal attacks and lesser admissions to hospital there. So in general the findings of the questionnaire are in line with the results of the investigations discussed previously, thus giving them more supportive evidence.

It was attempted in the clinical study of this survey, to see how the Nubians were affected clinically by the new environment and how serious is the impact of these diseases on them. It has already been discussed that the follow up study has shown a progressive increase in the incidence of hepatic and splenic enlargements in the Nubians after their resettlement in New Halfa. The possible role of malaria and schistosomiasis in this was also discussed, but this was not the only evidence of the clinical impact of the new environment. The comparison of the incidence of hepatomegaly and splenomegaly in the corresponding age groups in this study clearly shows that the prevalence of the enlargements is always higher in New than Old Halfa. In the age group 6-10 years for example 3% had enlarged livers compared with 11.5% in New Halfa and 3.3% splenic enlargements in Old Halfa compared with8.9% in New Halfa with 15 (2%) of the total having large spleens more than

4cms below the costal margin. Large spleens and livers more than 4 cms are also much commoner in New Halfa than the old area. As the investigations and history have shown that malaria and Schistosoma mansoni infections are found in Old Halfa, it seems that both of them are responsible for the prevalence of hepatomegaly and splenomegaly in the new area. The absence of the advanced stages of schistosomiasis like portal hypertension and ascites and the few cases of the huge spleens of malaria can be explained because both these diseases have not been established in the Nubians long enough for the last stages to be reached with any frequency. The only other clinical field surveys which were carried out in Sudan were that of Greeny (1952 a & b) and the London Khartoum project, both of them being in the Gezira. Greany (1952b) found that the liver was a very striking physical sign in the cases of intestinal schistosomiasis seen in the Gezira. He used the liver index system described by Bang et al (1946) in analysing the liver enlargements of his cases. The observations made by Greany in his village surveys were that "The liver index of 333 children found to be infected with S. mansoni was 1.16, the index of 384 uninfected was 0.39. The liver index of 198 adults found to be infected was 1.05, that of 796 uninfected adults was 0.3". In that part of the Gezira malaria was also common, a

situation which simulates New Halfa resettlement area. Greany (1952b) examined school boys in an area 100 miles south of the Gezira where schistosomiasis is rarely seen but malaria was prevalent. He found that in 242 boys aged 5-15 years, the liver index was 0.18 and in another area free from both schistosomiasis and practically from malaria the liver index in 30 boys aged 7-15 years was zero. When Greany carried out his study in 1952 the Gezira agricultural scheme was still expanding and new. The problem of schistosomiasis has grown now to give a prevalence rate in some areas reaching over 90%. The pattern of irrigation scheme and agriculture in the Gezira is similar to the resettlement area and schistosomiasis may therefore follow the same course in New Halfa unless measures are taken. Malaria is also common in both areas.

The clinical examination in this study was also complementary to the skin snips survey in the search for onchocerciasis. The Atbara river area was known to be an endemic area for onchocerciasis and in the present study Simulium larvae and pupae have been detected in the region of Khashm el Girba Dam. The principal clinical features of onchocerciasis in the Sudan are described by Kirk et al (1959). They reported that the main clinical features are onchocercal nodules, eye lesions, including blindness, various skin manifestations, lymphadenopathy and genital

lesions. The clinical picture was also described in another African country by Woodruff et al (1966b). The common findings in the 84 patients studied by them were, pruritus in 83.3%, excoriation with mottled depigmentation 61.9%, thickening of the skin and limbs 28.6% enlarged inguinal or femoral lymph nodes in 28.6%. The nodules were found mostly in the hip region (46.4%) only 2.4% had nodules over the ribs and none over head or neck. Thus the various skin manifestations, the nodules and lymphadenopathy were common in both African studies and were the criteria in this study for the search for onchocerciasis. Any patient with this suspicious clinical picture had skin snips taken from him in addition to the general survey described. However only 2 cases of onchocerciasis were detected in this survey and both were not Nubians. Only one of them was first seen clinically and suspected before the skin snips were taken. He had 2 nodules on the hip, skin thickening and depigmentation and moderately enlarged glands in the groin. Although a thorough survey was done to detect onchocerciasis in the area it is expected that if transmission occurs, it will take some time for the typical clinical picture to develop in the Nubians. It was also of interest in this clinical study to look for the other common medical problems and among the important findings was the prevalence of rheumatic heart diseases in the Nubians. The study had shown that the prevalence is nearly the same in the two areas. The prevalence of mitral and aortic valve

disease varied between 0.76% and 2% in all age groups. The prevalence in the total number examined in both areas is 1.2% (total number examined is 3454). Mitral valve disease is commoner than aortic valve disease. This was followed by ventricular septal defect in the young age groups 0-5 years. ranging between 0.8% and 1.1% in the two areas. Atrial septal defect and pulmonary stenosis were detected but are rare. It has been mentioned by doctors working in New Halfa that hypertension is common in this district and in the present series as previously mentioned 6.1% of 519 individuals over 16 years of age of both sexes had a diastolic blood pressure of over 120 mm Hg. Respiratory tract infections were also common in both areas and they represent the most frequent cause of fever in Old Halfa where dust is probably an acknowledged cause. In New Halfa malaria too is a common cause of fever and creates some difficulty in the differential diagnosis of large livers and spleens in the area.

The psychological unrest and social dissatisfaction among the Nubians due to the uprooting and their resettlement in a new environment resulted in an increase of neurosis and other psychiatric diseases as reported by Baashar (1960). The present study reported on the cases with high diastolic blood pressure in Old Halfa and these findings may suggest that other stress diseases like peptic ulcer and asthma may also be on the increase. Some cases of asthma were detected in this

survey but no accurate figures can be given for the incidence of these diseases. The hospital records were not helpful but there is an impression that they are commoner in New Halfa and perhaps it is now still early for those diseases to develop and show a higher incidence. It was also of interest that diseases of temperate climates like rheumatoid arthritis were extremely rare and no case of rheumatoid arthritis was detected by this study in both sexes.

PART V

Control methods

CHAPTER 18

Suggested methods of control and treatment of the population

The present study has shown that the Nubians that came from a desert area, Old Halfa in northern Sudan and being resettled in an agricultural scheme, Khashm el Girba district in eastern Sudan with a different social, ecological and environmental conditions had acquired certain diseases. This study has also shown the danger of imported diseases by the immigrant labourers, the pattern of diseases among the indigenous tribes of the district, the vectors of diseases in the area and the snail population of various water courses. The danger of possible future diseases and epidemics has also been discussed. It is therefore planned that the theme of this chapter would be the discussion of methods of control of the diseases detected by this study and the treatment of the population. It is planned to deal with the important diseases separately as methods of their control are different and then deal with some common factors.

Schistosomiasis

It has been shown that Schistosomà mansoni infection did not exist in Old Halfa but the prevalence of infection in NewHalfa in the older age groups is 8.4 8.8% and the children born in New Halfa had a prevalence

rate of 4%. Schistosoma haematobium is present in both areas but the prevalence rate is higher in the younger age groups in New Halfa. The snail intermediate hosts of schistosomiasis had been found in the water courses of the Khashm el Girba scheme and proved to be infected. Their infection rate has also been demonstrated experimentally to be high. The canal cleaners, imported labour and indigenous tribes were found to harbour this infection. These findings are alarming and suggest that this disease may spread in this agricultural scheme. Earlier before 1964 and the establishment of irrigation, this area was a semi arid plain with seasonal rainfall of about 200 mm per year. Judging from the findings of this survey there could have been few cases of both types of schistosomiasis among the indigenous tribes. But in 1964 when the building of Khashm el Girba Dam and the irrigation canals were completed the environment completely changed, a situation which is similar to the changes that occurred in the Gezira area and caused a high prevalence rate in schistosomiasis.

The control and elimination of schistosomiasis often needs complicated and expensive measures. But success can be expected if the goal is realistic and in the present situation the resources are known to be limited and the water courses reasonably extensive. A large number of casual labourers are also employed. There are various measures which can be applied in the control of schistosomiasis and the views of various workers in the choice of these measures are conflicting.

It has been argued that the most hopeful method of controlling schistosomiasis would be the elimination of the snail host by molluscicides. The earlier two molluscicides which were in common use for almost 10 years namely copper sulphate and sodium pentochlorphenate are now regarded by many authorities as being obsolete. Their trial in Sudan was reported by Sharf el Din and El Nagar (1955). They concluded that clearing the weeds and initial application of copper sulphate at a dose of 30 parts per million followed by a maintenance dose of 0.125 parts per million applied at the commencement of the canals, controls snails in the system. They thought that copper sulphate is cheaper and easier in application than sodium pentachlorphenate. The two molluscicides which are now in common use are Frescon and Bayluscide However although some success has been reported with Bayluscide the experience with this molluscicide in Sudan is lacking. It is not yet known whether it will be suitable to the irrigation system of Sudan or not. Recently the London-Khartoum Bilharzia Research Project (London School of Hygiene and Tropical Medicine with local scientists in Sudan, in progress) selected Frescon as the most promising molluscicide for application in the Gezira irrigation scheme and therefore was put in the field trial. Fenwick reported the reason for this selection (Fenwick, 1973). He suggested that Frescon is effective at a much lower concentration than Bayluscide

and can be used at long exposure times, while Bayluscide is more efficient for short exposures at high concentrations. He also thought that for both drip feed and aerial application the emulsifiable concentrate formulation of Frescon was preferable to the wetable powder formulation of Bayluscide and moreover Bayluscide is reported to be inactivated by silt. Amin (1972) carried out an assessment of copper sulphate and N-tritylmorphaline (Frescon) in the Gezira scheme. He concluded that copper sulphate is far from being an ideal molluscicide in the scheme while the continuous application of Frescon at a dose of 0.075 p.p.m. for 30 days resulted in complete coverage of all water courses and the snail populations were kept at a low level for approximately 3 months. However the only molluscicide used in Khashm el Girba area was copper sulphate which was applied earlier during the years 1965-1966 and 1966-1967, but there was no budget assigned for the control of bilharzia after 1967. This resulted in discontinuing the control programme. The estimated expenditure during those two years was respectively 15,000 and 10,000 Sudanese pounds.

So the experience gained from the Gezira trial proved that Frescon is superior to copper sulphate and it had already been discussed that Frescon is probably more practical and more efficient than Bayluscide for the irrigation scheme in the Gezira. Therefore it seems that Frescon can also

be tried as the molluscide of first choice in New Halfa. But as the irrigation scheme and local conditions are different in New Halfa a trial of the other molluscicides in limited regions would be worth while. The application of Frescon is by drip feed technique. The chemical is applied by a dispenser at the head waters at a dose of approximately 0.075 p.p.m. From this point the chemical is carried by the flow of water to other water courses. In Khashm el Girba scheme the canals are straight and the irrigation practice is ideal for drip feed technique, so that the dose and duration of application of the molluscicide can vary from the Gezira application.

The prevalence of schistosomiasis remained high in tropical countries in spite of the application of molluscicides and this is a justification for adding another control method, mass chemotherapy especially to areas where molluscicides alone did not achieve good success. Moreover treatment improves the health of the individual and causes cessation of egg laying. Mass chemotherapy in schistosomiasis unlike malaria, is the treatment in a defined area of those who are shown to be infected by parasitological screening provided they do not possess known contraindications to the drug used. Thus it means the use of the drug to a sector of the community cutting the expenses and avoiding the side effects of the drugs. The drugs which can be of value in mass chemotherapy are niridazole, metrifonate and hycanthone. Evaluation of the 3 antimony drugs

sodium antimony tartrate, antimony dimercaptusuccinate and sodium antimony gluconate demonstrated that the nature of the organic vehicle for the antimony modified the rate of excretion and that retention of metal in the tissues was directly related to both cure rate and side effects (Davis, 1968). It was concluded that none of these was suitable for mass chemotherapy.

The choice of a drug for mass chemotherapy in New Halfa will probably create some difficulty as both Schistosoma mansoni and S. haematobium are present in this district and some drugs are effective in one species more than the other, or even not effective at all in one species. Their toxicity may also sometimes present a hazard.

Niridazole has been known for some yearas as effective in the treatment of both species but more in haematobium infection. It is also known that the tolerance of the drug depends on variation in the ability of the patient to degrade it. The drug is also contraindicated in conditions of severe liver damage and psychotic disturbances. Thus in cases where S. mansoni infection is found and liver damage expected, the drug must be administered carefully. However it is given orally, the course of treatment needs only 7 days and is effective in both mansoni and haematobium infections which favours its use in mass chemotherapy. The cost of

treatment to the adult is about one Sudanese pound (equivalent to £1 sterling). Treatment of children costs 50 pence.

Metrifonate unlike the other organo-phosphorous compounds is a relatively safe drug. The only reported toxicity apart from the mild transient side effects is the depression of cholinesterase activity on both plasma and red cells. This depression returns rapidly to normal in plasma but takes several weeks in red cells (Plestina et al 1972). However the function of erythrocyte cholinesterase is not known and the significance of the depression and its activity cannot therefore be evaluated. Metrifonate proved to be effective in urinary schistosomiasis (Davis, 1969) Unfortunately the drug is not effective in S. mansoni infection. This is a disadvantage for its use in New Halfa unless another drug is used for the S. mansoni infections. This drug is very cheap and is the cheapest known antibilharzial drug. The cost of treatment for the adult is only 5 Sudanese piastres (5 pence). This drug needs to be used also with caution if organophosphorous compounds are used as pesticides and in New Halfa organophosphorous compounds are used as pesticides, but treated individuals can be warned to avoid exposing themselves to these compounds when they are taking the drug.

Hycanthone a metabolite of lucanthone, was found to be more

effective in the.treatment of schistosomiasis. Dennis (1970) reviewed the clinical evaluation of hycanthone. He reported that hycanthone is potent against both S. mansoni and S. haematobium when used orally at 2-3 mg/kg/day for 3 days of intramuscularly at 3 mg/kg in a single injectinn. The side effects were mild and transient. More serious side effects are isolated instances of acute liver damage and jaundice. The experience when using this drug in Sudan is also good (Omer et al 1972). The d rug was found to be very active and produced a high cure rate in S. mansoni infections. It was. also found that there was clinical improvement in some patients as measured by regression of the size of the liver and spleen and there was a significant improvement in the haematological and biochemical indices in the patients treated as described before.

Thus if only one drug had to be chosen for mass chemotherapy in New Halfa the choice rests between hycanthone and niridazole. Hycanthone is slightly cheaper than niridazole, the cost of treating the adult is about 70 piastres (70 pence) plus the cost of giving the injection. Hycanthone is given by a single intramuscular injection and therefore more convenient in mass chemotherapy. The side effects of hycanthone are probably milder if the contraindications are observed. Therefore hycanthone given by intramuscular injection is probably the drug of

choice for mass chemotherapy in New Halfa. There may be a point in using a combination of hycanthone and metrifonate (hycanthone for the mansoni cases and metrifonate for the haematobium cases) thus cutting down the cost.

Having discussed the use of both molluscicides and chemotherapy as a combination in New Halfa, it is planned to discuss the other means of control only briefly as they are probably of little practical use here. Education is regarded by some authorities as being helpful in control measures. Certainly it can be tried in New Halfa especially with the presence of health workers in the area but it will be of little benefit as schistosomiasis is mostly an occupational hazard and the Nubians work in contact with the water when irrigating their land. Young children should be warned against swimming but they are attracted to the water and the nomadic tribes being deprived before of such an environment they would very much like to have a bath in these canals (Figs. 24 and 25). These tribes used to travel long distances to get such water and sight. Sanitary measures towards preventing people from urinating or defaecating near the canals should be advocated but it will have a limited effect as they often need to go to the canals to wash or drink and are far from their homes with no nearby available latrines (Fig. 23). The mechanical removal of weeds from the canals can be very helpful as the snails feed on these vegetations and their removal clears the canals making the current of water more swift and thus not suitable for the snail population.

Figure 23.

Eliminating the possibility of human contact with canal waters as a measure of control in New Halfa is a difficult procedure. The canal water is used for washing clothes and is a source of water for the animals as shown in this photograph. It is often the site of a gathering as shown here also where the passengers rest, drink and wash.

Figure 24

Children are attrated to the water in New Halfa, they are shown here near a canal which was found to be heavily infected with snails.

Figure 25.

The nomadic tribes are also attrated to water. The indigenous population of this district used to travel long distances for water. Two bilharzia men are shown collecting snails for this study and a man from one of the nomadic tribes.

Malaria

The present study has shown that the Nubians in Old Halfa were living in an area where malaria was completely eradicated by the efforts done to exterminate Anopheles gambiae from the district (Lewis, 1949). Later another campaign was carried out by El Shamy in 1954 (El Shamy, 1958). In the present study the examination of 961 individuals of the remaining population revealed no cases of malaria and the recent survey by the combined Egyptian and Sudanese Committee detected no Anopheles gambiae in Lake Nasir district but it was found further south (Abd el Nur, 1973). Thus the Nubians were completely non-immune to malaria. However the present survey has shown that malaria is common in the resettlement area and that the Nubians and their children who were born in New Halfa had a prevalence rate of (6.7%) and (2.7%) respectively. Higher prevalence rates were detected in the sugar factory area and in the nomadic tribes (10.6%) and (9%) respectively. The hospital collection in New Halfa gave a prevalence rate of (15.9%) while it was 0% in New Halfa. Anopheles gambiae was found in large numbers in New Halfa resettlement area. Thus the larger number of non immune Nubians are now in an area where the vector is present and the reservoir host (infected cases) are also present, a situation that may result in epidemics or in the creation of an endemic

zone unless control measures are undertaken.

During the early phase of resettlement in 1964 the Ministry of Health started a malarial control programme to protect the Nubians. The control project was divided into two operational areas, namely the Riverain area consisting of villages along River Atbara and occupied by the indigenous nomadic tribes and the resettlement area. This programme consisted of the application of DDT, previously only the Riverain area was sprayed with GAMMA-HCH. Endrine and organo-phosphorous compounds were regularly applied to cotton crops to control insect pests. However it was evident during this survey that due to lack of funds, the malaria unit in New Halfa could not achieve any real success in the control programme. The results of the screening of the population had shown this clearly. Therefore the following is discussed - malarial control programme in New Halfa based on the survey findings.

In New Halfa resettlement area the malaria unit has a reasonable number of qualified personnel at different levels as shown previously who could easily supervise a control campaign. It is now accepted that efforts should preferably be directed towards control programmes rather than eradication programmes as they are more practical. The following malarial control scheme is suggested for New Halfa resettlement area.

This study has shown that Anopheles gambiae mosquitoes are abundant during the rainy season and in October just after the end of the rainy season. It is rare during the cooler months especially in December. So the best months for the application of the spraying round are probably in June just before the rising curve of the mosquito invasion of the area and October which is considered to be the peak for the Anopheles gambiae presence. October was also found to be the peak month for the prevalence of malaria in the area. DDT has been tried in the area and found to be successful. It is important that an efficient spraying of all the houses in the resettlement area and the riverain district is done at the same time to achieve good results as the mosquitoes can easily go from one area to another, so the application of DDT at a level of 2 grams/square metre surface area twice a year in June and October is suggested. New Halfa Town is now regarded as an important town in Kassala province and a lot of traffic passes through New Halfa town to the other parts of the province. Trains also pass through Khashm el Girba at the southern end of the scheme from Kassala. These need to be sprayed but it is obvious that it is practically impossible to render this area completely free from Anopheles gambiae, the aim is therefore to achieve maximum reduction in its presence. However Haridi(1972) studied the resting habits of Anopheles gambiae species B in Khashm el Girba area. He found that a considerable

number of species B were resting outdoors. In his studies most of the outdoor collections were made more than 0.8 km from the village indicating that Anopheles gambiae can fly that distance searching for a suitable outdoor shelter. It is worth mentioning that DDT has been applied in this area 3 years prior to his study. This p oses some problems in explaining this phenomena, i.e. whether it is a natural behaviour pattern of the mosquito or an irritant action of DDT. Haridi had also found that 26% of the blood samples collected from mosquitoes tested gave positive reactions to human blood which either suggests that these mosquitoes are escaping from human habitation or mosquitoes that actually feed outside. The irritant effect of DDT has been reported by several authors (Davidson, 1953, Hamon, 1963). However the possibility of poor quality spraying cannot be excluded. Thus repeated surveys for the vector are needed and if DDT did not prove to be effective or has no active deposits after some t ime another insecticide like GAMMA-HCH or Dieldrin would be required. In all these cases the whole of the walls of the inhabited houses of the riverain and resettlement area are sprayed with the residual insecticide to kill all the indoor resting mosquitoes and stop transmission.

The application of larvicides is also useful as adulticides miss the outdoor resting and feeding mosquitoes. The probable breeding places

in Khashm el Girba can easily be detected and once located a programme for larvicide application can easily be worked out. The stagnant water of the sugar factory, the slow running canals and small pools in the fields are the most likely places. A suggested scheme for this area is to apply the larvicide once weekly during the months June-October in all the probable sites. The mosquito men can be trained to recognise mosquito larvae and inspect the different water courses for them to be treated but it is always better to treat all possible breeding places irrespective of the presence of larvae or not. Malaria control by larvicides can prove to be a practical method. Lewis (1949) reported the achievement of the larvicide Paris green dust. Now better larvicides like DDT, GAMMA-HCH, dieldrin are available. It is always better to use one larvicide and train the mosquito men to use it properly. DDT was used in that district and the personnel are therefore used to it.

The Gambusia fish are now bred in the Gezira area and proved to be successful in eating the larvae. The water courses in New Halfa are ideal for their breeding and these water courses cover most of the resettlement and Riverain area. This can be helpful as an additional means of control.

The use of prophylactic antimalarials in New Halfa should be restricted to special medical problems of anaemic children with repeated attacks of malaria, pregnant women or sickle cell anaemia cases etc. The general use of prophylactic antimalarials must be avoided as it may lead to drug resistance or side effects. On the other hand passive and active case detection must continue and all cases of fever investigated for malaria. Positive cases should be treated so that transmission can be avoided. Special attention must be given to the Riverain area and the sugar factory where a higher prevalence is found.

The riverain area may represent a problem as these people live a nomadic life. There are continuous tribal movements which creates difficulty for insecticide spraying and impregnation. A similar situation exists in southern Iran where Motabar and Behbehani (1973) reported on trials of residual insecticides in nomadic tribes tents. They used various formulations of DDT, dieldrin and HCH at different concentrations. They found that DDT solution in kerosine sprayed at a dose of 2 grams DDT/M^2 has a residual effect of 6 weeks in non movable tents and a much shorter period in movable tents while DDT in water disposable powder (WDP) at a higher dose of 4 grams/M^2 remained effective for a shorter period of 4 weeks. HCH 50% WDP in their trial sprayed at a dose of 1.0 g gamma-isomer/M^2 or HCH resin 25% at a dose of 1.0 gamma-isomer/M^2 had shown only a biological effect for 2-3 weeks.

The best preparation was dieldrin WDP which when used at a dose of 0.5 technical dieldrin/M^2 for the impregnation of movable tents showed an effect of about 2 months (70% killed in bio assay tests).

Thus it seems that this method which is applicable to the nomadic tribes surrounding the Nubians can be suitable for spraying their tents and be effective but for a shorter period. The nomadic tribes can sometimes move with their tents inside the resettlement area and therefore unless these tents are repeatedly sprayed the insecticide spraying scheme in the resettlement area can be rendered a failure.

Leishmaniasis

Visceral leishmaniasis is another example of a disease which is propagated with agricultural economic development. In the thirties and forties kala azar cases were never above 400 cases a year in all Sudan and was limited in its regional distribution (Satti, 1973). Now the disease has spread to many regions in the country due to the changing ecological conditions. Although no cases of visceral leishmaniasis are yet reported among the Nubians it is a calculated danger as species of Phlebotomus were detected by this study in the region and the leishmanin test done revealed that the Nubians are probably showing some evidence of exposure to leishmaniasis. These findings point to a possible future danger from the disease and even epidemics can occur in the non immune Nubians. Kala azar first appeared in epidemic form in East Africa in 1952 when very little was known about its epidemiology (Manson-Bahr and Southgate, 1964).

Although it has been stated that there is still no immediate danger from the disease that justify expensive control measures the experiences gained elsewhere suggest that the incidence of leishmaniasis has fallen rapidly since the malaria eradication campaign and has almost completely disappeared from sprayed districts (Rama-Krishman, 1968). Corradetti et al (1966) also noted that no fresh cases of cutaneous leishmaniasis appeared in Italy for 3 -years following residual spraying. Thus it seems that the measures taken against malaria in New Halfa (residual spraying with DDT and other chemicals) would also help in the sandfly control. A search for the vector among the sandflies of the area is also worthwhile and if the feeding and breeding places are detected they could be sprayed. Turner et al. (1965) achieved success by spraying the test plots of Acacia-Balanites forests in Sudan which are known feeding areas of P. orientalis.

Immunisation against kala azar with live cultures has been tried in East Africa (Manson-Bahr and Southgate, 1964) and they found that although immunity could be induced experimentally in volunteers, a field trial in northern Kenya failed to show any protection in nature and they thought that this could be due to loss of virulence in the cultures used in the vaccine. However the present situation in New Halfa with no cases detected yet does not justify the use of a vaccine and the spraying for the malaria is a reasonable control measure for the present situation of this disease in the area.

Onchocerciasis

The present study has shown that there is probably no immediate danger from onchocerciasis in the resettlement area. However this survey detected Simulium larvae and pupae in the rocks at the bottom of Khashm el Girba Dam the possibility of its propagation into the resettlement area either by flying southwards or breeding in the canals was discussed. It is interesting that previous surveys by the entomological unit of Sudan, Ministry of Health, reported that the Khashm el Girba Dam area is free from Simulium and therefore it seems that Simulium is probably now invading the area. The importation of labour to the sugar factory and the agricultural scheme will add to the danger as a large number of the recruited labour force come from southern Sudan where onchocerciasis is common.

Onchocerciasis was also reported in the indigenous population of Khahsm el Girba area and thus both the indigenous population and the recruited labour can be a source of infection. Indeed the two onchocerciasis cases detected in the survey were from these groups, so although there is no immediate danger from onchocerciasis in New Halfa resettlement area yet it is a calculated health hazard. The lesson learned from other fertile river valleys in Africa where they remained undeveloped due to the existence of disease and its vector Simulium should warn other countries that onchocerciasis is linked with development and especially with the construction of dams and

and canals. Now a few years after the construction of Khashm el Girba dam, this study detected Simulium under it. So as to avoid the danger of onchocerciasis becoming an endemic problem of this area in future some measures need to be taken and the following programme is suggested.

Reconnaissance survey should be carried out in other neighbouring areas because a complete picture about the distribution of the disease is needed. The nearest suspected area where onchocerciasis transmission is taking place is at Showak which is 90k. south of the resettlement scheme. Simulium damnosum was known to breed seasonally in the river Atbara.

Searches for Simulium naevi and Simulium damnosum need to be intensified especially near the Dam and irrigation canals. All suspected areas should be inspected regularly. Seasonal variation should be noted. The application of larvicides especially the carbomates which are easily soluble in water, to areas where Simulium is detected and all suspected areas is needed. The attack on the adults may be difficult as good knowledge of their resting places is lacking. But in New Halfa area the application of adulticides on the river near the Dam and on vegetation in the various water courses may be helpful. Demolishing the rocks where Simulium is known to breed will also certainly help the situation.

It is felt that mass chemotherapy is not yet needed in the resettlement

area as onchocerciasis is not yet a major health problem. But the investigation of all suspected cases especially among the recruited labour is essential and all detected cases should be treated to break the transmission.

It is felt that no special measures are needed now against the other filarial infections as the small risk does not justify spending money which is needed elsewhere but it is thought that the insecticide operations mentioned would also control other mosquitoes. Case detection and treatment especially in the sugar factory where a possible source exists would also be helpful.

Intestinal parasites

The present study had shown that the pattern of most intestinal parasites apart from schistosomiasis, amoebiasis and *Taenia saginata* infections is nearly the same in both areas and schistosomiasis was already discussed.

It is known that the epidemiology of parasitic infections is closely related to a number of ecological factors which affect the survival and propagation of the pathogenic parasite. It is also influenced by the economic, social conditions, the state of hygiene and sanitation in the community. The very low incidence of *Ancylostoma* and ascariasis

in both areas can be explained by the dry soil. But with the changes that occurred in New Halfa that affected the soil which is now irrigated and the influx of labourers from areas where ancylostomiasis is common, the picture may change in future in both these infections. It was discussed already that the high incidence of diarrhoeal diseases and probably amoebiasis in villages like village 16 may be related to contaminated water supply. The sanitary engineering section of the Ministry of Health had reported on the villages filtration plants and considered them to be overloaded and poorly maintained and it was evident in this survey that this is applicable to most villages. Another important factor contributing to a bad state of hygiene in these villages is the siting of small settlements for housing the agricultural labourers near them. These settlements have poor sanitation facilities. They have no water supply and they either use the canals for drinking and bathing or go to the village tank to get their water. They may spend some time near the tank and increase the chance of contamination (Fig 26). The ideal way of controlling the transmission of intestinal parasites and possible causes for diarrhoea diseases among the Nubians in New Halfa is to improve their standard of hygiene. Health education and teaching them to wash their hands especially after defaecation and before meals is very important. New Halfa is perhaps an ideal situation for health education, unlike other parts of the country, there are many health workers distributed in the various villages. The health workers are not fully utilized and they can do a goodjob if they are taught properly. Their role in the control of

of other infections can also be very helpful.

Chemotherapy can also play an important role in the control of intestinal parasites. Speci al attention needs to be given to the various schools, the imported labour camp s and the sugar factory where a large number of imported labourers work. Stool examination surveys need to be conducted regularly and all thoseinfected to be treated. It is also important to improve the standard of the water supply sources. The c ontamination of these sources can be reduced by piping the water to the village from larger canals rather than the small branches where the current of water is slow. These small canals are usually accessible to the people w hile working and easily contaminated by urination and defaecation and other refuse poured into them. The plant operators also need training to improve their standard in managing these water courses.

Having discussed the practical scheme of control of the important diseases in New Halfa I would like to stress the fact that a reasonable cost of such control scheme in Sudan and other developing countries would determine its success. New Halfa is an agricultural shceme where these infections would certainly result in the loss of working hours and reduce the production and it is therefore suggested that the money spent on the control schemes should be regarded as part of the cost of the products and the industrial

corporation, local councils and the ministeries concerned should contribute to the cost of these control programmes to get a good revenue return from the scheme. Moreover these control programmes of the various diseases should not be regarded as isolated projects, they should be under the province medical officer of health for economy into the number of personnel, cars and the organisation of prevalence surveys.

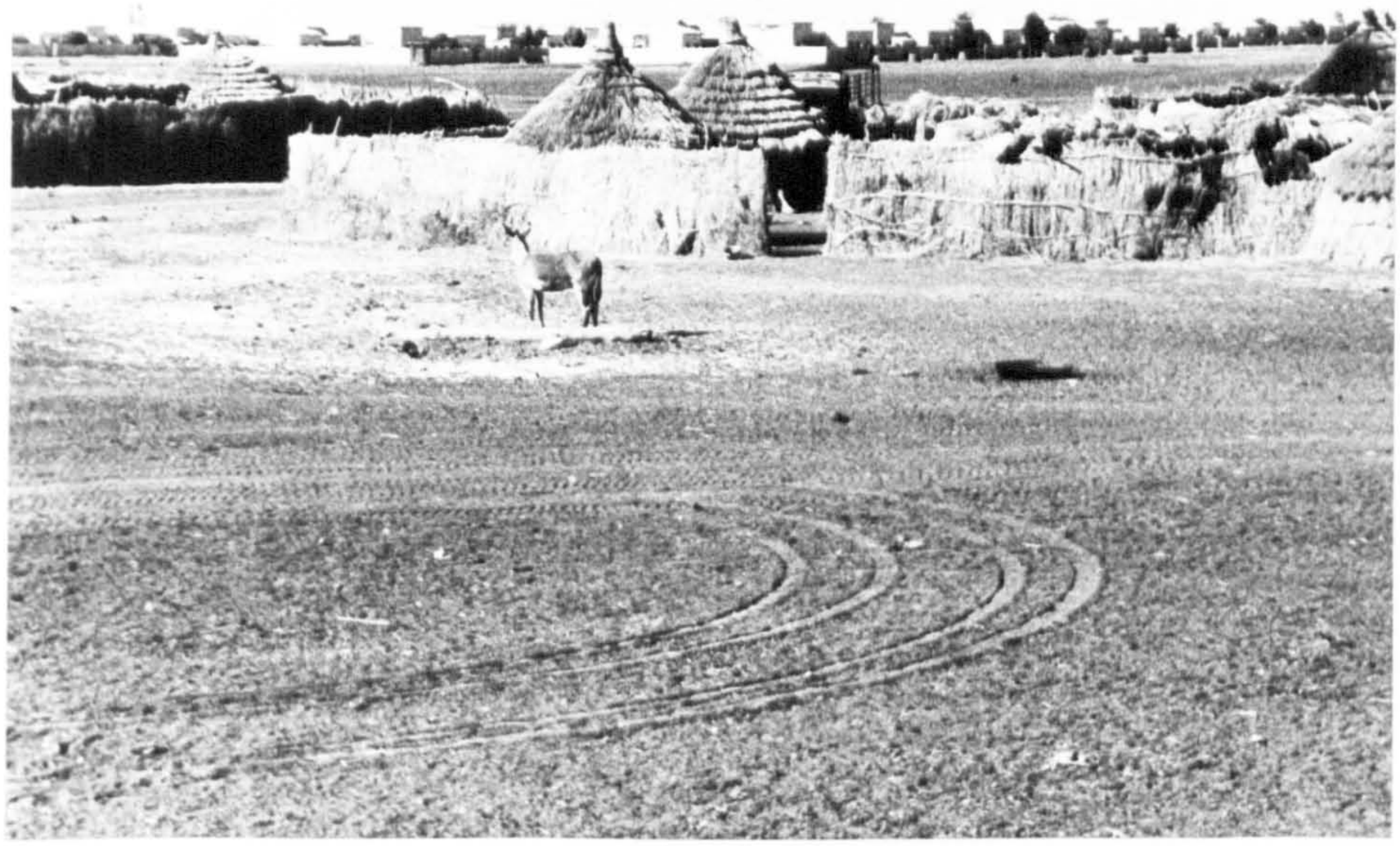


Figure 26

A small settlement for housing the agricultural labourers sited near village 16 which is shown in the background. This village showed a high prevalence rate of Schistosoma mansoni and Enterobius vermicularis infection was also common among children. Such settlement would sometimes contaminate the water sources of the Nubian villages.

PART IV

Summary and Conclusions

CHAPTER 19

Summary and Conclusions.

The flooding of Wadi Halfa region in northern Sudan in 1964 by the lake created behind the Aswan High Dam resulted in the uprooting and mass resettlement of 50, 000 Nubians in a new agricultural scheme. This new scheme at Khashm el Girba 600 miles away meant a change of environment for the Nubians. The climate of the two regions was different being rainless hot and dry during summer and cold in winter in Old Halfa with annual temperatures ranging between 1.1°C and 48.5°C compared with temperatures ranging between 15°C and 41°C and an annual rainfall of over 300 mm in New Halfa.

Their housing and working conditions are also different in the two areas. Moreover they were situated at the northern end of Sudan with the desert spearating them from the rest of the country and more linked to Egypt than to Sudan, being almost culturally and economically isolated from the other Sudanese communities. Thus in the new agricultural resettlement area, they were exposed to different social, ecological and environmental conditions.

The theme of this work was therefore to study the health problems that were expected to arise as a result of the exposure of the Nubians to the new environmental conditions with a view to suggesting means for their control and setting an example for similar future problems.

In order to study these health problems it was decided to examine the remaining Nubians in Old Halfa as this will show the pattern of diseases in the old area and also the Nubians who were uprooted and resettled in the new area. A sample of the remaining population in Old Halfa were selected, clinically examined and investigated. In New Halfa the clinical examination and investigations were performed in a sample of the population, children born in New Halfa, the indigenous population of the areaand the immigrant labourers. Then a follow up study for a group of Nubians was done. The insect vectors of diseases and the snail population of the water courses were also studied in New Halfa. Thus it was possible to report on the acquisition of disease in the resettlement area, the danger of possible imported diseases by the recruited labour in future and hence to suggest means whereby these diseases can be controlled.

The study has shown that Schistosoma haematobium infection which was present in Old Halfa had increased its incidence initially in New Halfa but later on the Nubians started to acquire Schistosoma mansoni infection for the first time and this infection gained predominance over haematobium infection. Bulinus truncatus and Biomphalaria pfeifferi, the snail intermediate hosts of S. haematobium and S. mansoni infection were collected from the water courses of the agricultural scheme in New Halfa and found to be infected. Thus the prevalence of schistosomiasis is expected to rise and represent a major health

problem.

Malaria proved to be a major health hazard also to the Nubians. The Nubians came to New Halfa completely non immune to this disease as malaria was eradicated in Old Halfa. But this survey detected prevalence rates of (6.7%) and 10.6%) among Nubians in various regions in New Halfa. The prevalence in the passive detection group of New Halfa hospital was 15.9%. The prevalence among the indigenous population was also high (9%). Anopheles gambiae were collected and were abundant during the months September-October. So malaria transmission will continue and its prevalence increase unless well planned control measures are performed.

Onchocerciasis was not found to be an immediate danger but as this area is near the known endemic region of El Showak and Simulium larvae and pupae were detected by this study at Khashm el Girba dam transmission is expected to occur. Moreover the new agricultural scheme with the various water courses is favourable for Simulium propagation and the recruited labour from the endemic regions add to the danger.

The Leishmanin skin test had shown that the Nubians were originially non-immune and their reaction to the test revealed a changing pattern and a possibility of exposure to the disease. Therefore in spite of the absence of kala azar cases among the Nubians, the disease is thought to be a potential danger in the future especially as Phlebotomus species were collected during the survey.

The screening stool examination in the two areas revealed that there was no significant difference between the two areas in the prevalence of most of the intestinal parasites. However the prevalence of Taenia saginata and amoebic cyst carriers was higher in the resettlement area. Diarrhoeal diseases were also commoner in the new area and it is thought that this is due to the contamination of the water supply of the villages which was found to be mostly inadequate. The medical condition which had probably improved due to this uprooting and resettlement is eye disease. Their incidence is lower in the resettlement area and is thought to be due to less sand storms in this region.

An interesting finding of this study is the incidence of G-6-PD deficiency and abnormal haemoglobins among the Nubians compared with other tribes. 3% of the Nubians were deficient in the enzyme G-6-PD and 1% had abnormal haemoglobin AS. The incidence of G-6-PD among the Nubians probably indicates that they lived in isolation from the mixed population of central Sudan where the incidence was zero percent. Therefore in the new area caution must be taken in the treatment of malaria as complications may arise in those deficient in the enzyme. However it is thought that with the previously isolated Nubian race now favourably situated among other tribes, intermarriages could occur, their ethnic composition change and so also their genetic inheritance.

The clinical examination and questionnaire findings in this study were in line with the results of the investigations. It was found that the effect of these

diseases on the Nubians was on the incidence of hepatomegaly and splenomegaly which were higher in all age groups in the new area. The prevalence of cardiovascular and respiratory diseases was nearly the same in the two areas. It was also found that hypertension was common among the Nubians. It was difficult to assess the role of stress conditions on diseases like asthma and peptic ulcer accurately but there is an impression that they are commoner in the new area.

Having detected that the immediate medical problems to the Nubians are schistosomiasis and malaria and the possible future problems are onchocerciasis and leishmaniasis suggestions for a programme of control measures was discussed. It was suggested that chemotherapy with hycanthone alone or hycanthone for S. mansoni infections and metrifonate for S. haematobium cases plus the application of a molluscicide preferably Frescon should be the line of control for schistosomiasis. It is thought that the line of control of malaria in New Halfa would better be an attack on the vector and chemotherapy. Thus the application of larvicides to possible mosquito breeding places and spraying the houses with an adulticide like DDT in July and October to cover the season where there are abundant Anopheline mosquitoes. This application together with passive and active case detection followed with treating all cases of parasitaemia would control malaria. Mass chemotherapy in -malaria is not recommended for the area to avoid drug resistance and unnecessary complications.

The only measure suggested for the control of leishmaniasis and onchocerciasis is to spray all possible breeding places of Simulium and Phlebotomus

after careful search for them. All detected cases should be treated to stop transmission.

The agricultural scheme in New Halfa is proving to be a successful and prosperous scheme and it is suggested that the sugar factory and the agricultural scheme should subsidise the cost needed for these control measures to improve the productivity of the farmers, the agricultural workers and imported labour. This was shown in this study in the Nubian children infected with schistosomiasis who have a poorer performance and have lost more study days. It was also suggested that all the control programmes should be integrated under the province medical officer of health to economise in staff and transport and to unify the policy. It is hoped that these measures would control these diseases and this study in general would be an example for future similar situations. The Sudan Government is now embarking on settlement schemes for nomadic tribes and major agricultural schemes where results of this study could be applicable.

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