Ankylostomiasis and bilharziasis in Egypt : from the Public health laboratories, Department of public health, Cairo.

No. 6.

MINISTRY OF THE INTERIOR, EGYPT.

Department of Public Health.

Reports and Notes of the Public Health Laboratories Cairo.

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I.—The History and Progress of Anti-Ankylostomiasis and Anti-Bilharziasis Work in Egypt.

Compiled by M. KHALIL.

PREFACE.

The Ankylostoma and Bilharzia Consultative Committee has felt for some time the necessity of publishing a progress report, and as this would be incomplete without referring to previous work, it has been thought advisable to collect such information as is available concerning what has been done for these diseases in Egypt up to the present date.

The present report covers ten years, including the years of the war, and in considering the results obtained in the various phases of the work, the time at which it was done should not be overlooked, as at the beginning of this period the more exact methods of diagnosis and treatment were not yet available and during the war the work could only be carried out under considerable difficulties.

The year 1913 marks the first serious attempt by the Government to deal with Ankylostomiasis in Egypt, and thanks to the financial aid of the Rockefeller International Health Board, the campaign was carried out on a larger scale than was originally planned by the Egyptian authorities.

In writing this report, the files kept in the various Sections of the Department of Public Health dealing with Ankylostomiasis and Bilharziasis have been consulted and facts worthy of record selected from a large mass of ordinary correspondence dealing with administration and personnel. The intention was to have made the reports on the work of the different hospitals follow a uniform plan, but this was not possible in every case, as the necessary data were omitted by some medical officers. On the whole, however, this plan has been adhered to.

The large number of cases examined and treated at the Travelling Hospitals and Annexes testifies to the ability and perseverance of the young medical officers in charge of the work. The number of intravenous antimony injections given during a day by a single medical officer sometimes exceeded 400 and the medical officers, as a result of the large number of intravenous injections given by them, became so expert that 150 patients could be injected in an hour without difficulty.

The report has been compiled by Dr. M. Khalil, who is in charge of the research side of the work and to whom the thanks of the Committee are due for the very conscientious way in which he has gone into the question.

It is hoped that due credit has been given to all concerned in carrying out the work reported in these pages and that a faithful account of their work has been included as far as was possible.

The Ankylostomiasis and Bilharziasis treatment centres have been most successful and the number of patients crowding the various Annexes testifies to their popularity. There is an urgent demand for Annexes at other centres of infection, and it is hoped that the Provincial Councils, realizing the enormous benefit Bilharziasis and Ankylostomiasis treatment, will provide the necessary funds for the establishment of such treatment centres.

The Minufiya Provincial Council has already led the way by establishing an Ankylostomiasis and Bilharziasis treatment centre under the supervision of the Department of Public Health.

The extent of the present undertaking is of course insignificant as compared with the magnitude of the problem in Egypt, but a good beginning has been made and the interest taken nowadays in Ankylostomiasis and Bilharziasis by responsible authorities is a most hopeful sign.

C. TODD, *Chairman,*
Ankylostomiasis and Bilharziasis Consultative Committee.

January 1924.

PART I.

Historical Review on Ankylostomiasis and Bilharziasis in Egypt up to 1913.

Introduction.

Up to 1913, when a scientific advisory committee was formed in the Department of Public Health to advise on Ankylostoma work in the provinces, no united effort had been made to check or ameliorate Bilharzia or Ankylostoma infections in Egypt.

At various periods in the past there were individual efforts to study and investigate these diseases in Egypt, resulting in brilliant discoveries regarding their ætiology, epidemiology, and pathology. It is safe to conclude that our present knowledge of these diseases is mainly a combination of the work done in Egypt at different periods with some additions from abroad. Outstanding names amongst the investigators are: Bilharz, Griesinger, Pruner, and Looss, the German investigators; Leiper, Sandwith, Symmers, and Madden, amongst the English, and Sonsino, the well-known Italian parasitologist. It is to the efforts of these investigators that the country owes a deep sense of gratitude in affording a sure basis for the proper understanding of these diseases as a necessary step to combating their ravages.

Ankylostomiasis in Egypt.

Ankylostomiasis is endemic in Egypt. There is no evidence of its being introduced from other countries, and thus it was probably present in ancient times. A disease resembling Ankylostomiasis is said to have been depicted by the Ancient Egyptians, but it is as yet doubtful if its causal agent was recognized at those remote periods.

Ankylostoma worms were first found in Egypt by Pruner in 1847 at the autopsies of Egyptians in Cairo. Till that time these parasites were considered as harmless organisms. It was Bilharz (1853) and Griesinger (1854), both teachers at the Cairo Medical School, who first connected the parasites with the extremely prevalent chlorosis noted in Egypt. The disease, for lack of ætiological factor, was then known as "Egyptian Chlorosis," or "Egyptian Anæmia." It was regarded by Bilharz and Griesinger to be the cause of more than one-fourth of all deaths in Egypt.

The valuable observations of Bilharz and Griesinger were not followed up, but the interest in this disease was revived by Sonsino in 1878. This was followed by a period of great activity, both in the clinical aspects of the disease carried out by Sandwith and in the zoological aspect of the parasite and its life history by Prof. A. Looss.

The researches of Prof. A. Looss resulted in his discovery of the dermal method of infection by Ancylostoma larvæ, one of the most far-reaching discoveries in parasitology in recent years. His monographs on the anatomy and life history of Ancylostoma duodenale published in the Records of the School of Medicine, Cairo, are outstanding landmarks in the history of the disease.

In the early years of the present century an effort was made by Sandwith to treat Ankylostomiasis cases at Qasr el ʿAini Hospital, Cairo, on a large scale.

Up to 1913, however, no exact knowledge as to the incidence of Ankylostomiasis in Egyptian villages was available. It was only indirectly inferred that the infection was widespread, judging from the incidence of infection in cases seeking medical advice at Qasr el ʿAini Hospital from different provinces of the country.

Bilharziasis in Egypt.

Bilharziasis had been traced definitely to ancient times. Ruffer (1910) demonstrated Bilharzia ova in sections of kidneys from Ancient Egyptian mummies of 1250–1000 B.C. Hæmaturia was one of the diseases recorded by the Ancient Egyptians and prescriptions for the treatment of the condition have been discovered in medical papyri. It is, however, doubtful if the parasitic nature of the disease was recognized.

It was Bilharz in 1852 who first discovered the Bilharzia worms in the portal system and connected them with the endemic hæmaturia common amongst the Egyptians. Subsequent to Bilharz's discovery several attempts were made to discover the life history of the Bilharzia worms and of the method of infection of the human host. Sonsino, from 1874 to 1884, examined a large number of the snails of Egypt for the evidence of an intermediary stage of Bilharzia worms. He was unsuccessful in his attempt, although his researches were valuable in determining other cercariæ in Egyptian fresh water mollusca. The subject was next taken up by Looss, who endeavoured for many years to discover the intermediary host which he suspected to be a mollusc, but he was also unsuccessful. This led him to infer that no molluscan intermediary host was essential in the Bilharzia cycle and that man himself acts both as a definitive and intermediary host, but his experimental attempts at proving this inference gave negative results.

The question of finally elucidating the life history of the Bilharzia worm was left to Leiper, who in a series of brilliant and well thought out investigations carried out in Egypt between 1915 and 1918 definitely elucidated the life history. He was also able to prove that the urinary and intestinal varieties of the disease are due generally to two different species: *Schistosomum hæmatobium* and *Schistosomum mansoni* respectively, thus finally supporting the views of Sambon.

Up to the time of the discovery of the life history of the parasite no curative treatment was known. MacDonagh (1915), in his book on the "Biology and Treatment of Venereal Diseases," stated that he had succeeded in curing cases of Bilharzia infection with tartar emetic. This statement attracted no attention, and it was the detailed reports of Christopherson upon the treatment carried out at the Khartoum Civil Hospital that introduced the drug into general use.

No exact data as to the extent of infection with Bilharzia in Egypt were available before 1913, although it was concluded, from the high percentage of incidence among patients attending general hospitals, that the disease was possibly the most widespread serious malady in Egypt.

The following records are, however, significant:—

Larry (1812–1817), in his "Mémoires de Chirurgie Militaire et Compagnes," stated that the symptoms of the disease, especially "hæmaturia," were frequent amongst the French troops during the Napoleonic Expedition to Egypt (1799–1801).

Griesinger (1866) recorded that in 32 per cent of 363 autopsies at Cairo he found evidence of Bilharzia infection.

Sonsino (1874), in a series of 91 autopsies in Egypt, reported the incidence of Bilharzia infection in 46 per cent.

In 1894 *Kaufmann* recorded from 500 autopsies that of 368 males 40 per cent and of 131 females 11·5 per cent, *i.e.* a general average of 33·3 per cent, showed evidence of Bilharzia infection.

In 1910 *Ferguson* stated that his observations, based on considerably more than 1000 post-mortem examinations at Qasr el 'Aini Hospital, revealed the presence of Bilharziasis in no less than 40 per cent of Egyptian male subjects between 5 and 60 years of age. Ferguson, as a result of post-mortem examination of 500 male subjects, ascribed the cause of death in 8 per cent of all cases to the effects of severe Bilharzial infection.

PART II.

The Inauguration of the Anti-Ankylostomiasis Campaign.

The first serious effort to check the ravages of Ankylostomiasis in Egypt was undertaken by the Department of Public Health towards the end of 1913 on the initiative of Lord Kitchener. In his annual report of 1913 Lord Kitchener, referring to Ankylostomiasis and Bilharziasis, stated: ". . . . it is high time that serious steps should be taken to prevent the continuity of infection that has been going on so long in this country."

A Scientific Advisory Committee was formed consisting of the following:—

Prof. Arthur Looss	*President.*
Dr. A. F. Ferguson	*Secretary.*
Dr. C. Todd	*Members.*
Dr. H. B. Day	
Dr. W. Hastings	

The function and purpose of the Committee was to co-operate as a scientific advisory body with those directly responsible for dealing with Ankylostomiasis in Egypt. The Committee's terms of reference were:—

(*a*) To recommend the general course of treatment to be adopted and to make suggestions as to special modes of treatment required for particular types of cases.

(*b*) To indicate any problems which might still require scientific investigation as a basis for efficient prophylaxis.

(*c*) To specify those data which may be collected by the working staff in the course of routine treatment and to deduce from these information as regards the incidence, distribution, etc., of the disease in Egypt.

(*d*) To publish a scientific and analytical report of all the results obtained.

An Ankylostomiasis Annexe was established at Qalyûb. This was practically a travelling tent hospital with accommodation for 100 in-patients. The organization was carried out on lines similar to those of the Travelling Ophthalmic Hospitals in Egypt. The treatment was entirely free and voluntary, people who could afford treatment in their own houses were not admitted.

The whole field work was placed under the direction of Dr. MacCallan, Director of the Ophthalmic Hospitals of the Department of Public Health. It was fortunate that such a choice was made in view of the accumulated experience of Dr. MacCallan, who was successfully superintending similar hospitals for ophthalmic diseases throughout Egypt. This ensured the success of the Ankylostomiasis campaign from its beginning.

Modification in the Scope of the Work.

In addition to combating Ankylostomiasis, it was found advisable to add to the work of the Ankylostomiasis Field Hospitals the duty of collecting data as to the incidence and symptomatology of Bilharziasis and Pellagra.

In order to appreciate the good cause of such an addition, the endemic diseases of the country must be referred to. In Egypt there are four widespread diseases causing incapacity, chronic illness, and death of a high percentage of the population. These diseases are Bilharziasis, Ankylostomiasis, Ophthalmia, and Pellagra.

Ophthalmia was the first disease to be combated on a large scale, thanks to the magnificent initial gift of Sir Ernest Cassel of L.E. 40,000, the income of which was to be devoted to the relief of eye diseases in Egypt. The Egyptian Government has since undertaken the organization of Ophthalmic Hospitals, both travelling and stationary, all over the country. The value of the good work done is highly appreciated throughout Egypt, and the Ophthalmic Hospitals now represent an integral part of the Department of Public Health.

Bilharziasis and Pellagra, at the time of the inauguration of the work (1913), were both diseases the means of spread of which were unknown and no certain cure for which was available. Ankylostomiasis, on the other hand, was curable in a high percentage of the cases, although there was considerable difference of opinion as to the efficiency of the many drugs advocated. The method of infection, thanks to the work of Looss, was known, although how it occurred in nature and the details of prophylaxis were still left to be worked out.

It was thus the duty of the Committee to carry out treatment for Ankylostomiasis whilst studying on a large scale Bilharziasis and Pellagra.

1.—Report on the Campaign from December 1913 to April 1915.

(Extracted from the Reports of Dr. MacCallan.)

Plan of Work.

To the work conducted in Egypt there were two main features: (*a*) *Hospital Work, and* (*b*) *Survey Work.*

The first was directed to relieving the sufferers, the second to locating the areas of heaviest infection and the danger points in those areas from which the infection was spread. The survey work also attempted incidentally to establish, by clinical examinations, the degree of prevalence in Egypt of two other diseases: Bilharziasis and Pellagra.

Travelling tent hospitals were established at convenient centres to which the inhabitants were invited to come for diagnosis and treatment. Infected persons were usually kept in the hospitals as in-patients until a complete anthelmintic course had been administered.

Extent of Operations.

The hospital work was confined to two provinces, Qalyubîya and Sharqîya. The following tent hospitals were in operation:—

Town.	Province.	Date of Opening.	Date of Closure.
Qalyûb	Qalyubîya	13–12–1913	10–8–1914
Qalama	,, ...	1–3–1914	10–8–1914
El Deir	,, ...	26–4–1914	April 1915
Bilbeis...	Sharqîya	5–9–1914	,, 1915
Minyet el Qamh	,, ...	5–9–1914	,, 1915

The Rockefeller Foundation Grant.

The Director-General of the International Health Commission of the Rockefeller Foundation, Mr. Wickliffe Rose, visited Egypt in February 1914 and made a careful study of the experimental arrangements for treating Ankylostomiasis. As a result of his recommendations, the Commission granted a sum of 30,000 dollars (L.E. 6,000) on the condition that the Egyptian Government paid an equal amount. Thus the sum of L.E. 12,000 was available during the financial year April 1914–March 1915.

The magnificent gift of the Rockefeller Foundation enabled of the proper carrying out of the campaign on a larger scale than was originally anticipated.

(*a*) Hospital Work:—

The number of persons microscopically examined for Ankylostoma infection during the period from December 13, 1914, to March 31, 1915, was 29,281. Of these, 10,876 (60·8 per cent) were found infected.

The number of persons admitted to the hospitals was 11,280 (89·2 per cent) of those found infected.

10,694 (95 per cent) of those admitted were given full treatment and 450 (4 per cent) were discharged before the completion of the full course of treatment.

The patients who completed the full course of treatment were notified to return to the hospitals for re-examination one month after being discharged. The total number of persons who were thus re-examined was 1,859 (17·4 per cent) of those who received the full course of treatment. Of these, 1,632 (87·3 per cent) were found to be still negative for Ancylostoma ova. The greatest pains were taken to make a large number of re-examinations with the greatest possible care. 156 cases were re-examined thirty days after discharge, and in each case the fæces were centrifugalized and examined by a practised physician. Two slides for each negative case were examined. 17·4 per cent of the patients were found to still have ova in their stools. Even in the case of positive specimens, only one or two ova were found, showing that the infection was very mild.

Microscopic Examination for all Parasitic Worms.

In addition to the microscopic examinations for Ankylostomiasis, specimens of urine were examined microscopically for Bilharziasis. Other ova of intestinal parasites were incidentally recorded in addition to Ancylostoma ova. 17,987 specimens of fæces were microscopically examined. The findings were as follows :—

10,876 showed Ancylostoma ova	60·8	per cent.
3,543 showed Oxyuris ova	19·8	,,
3,067 showed Ascaris ova	17·1	,,

10,400 specimens of urine were examined for evidence of Bilharzia infection and Bilharzia ova were detected in 5,821 (56 per cent) of the cases.

Clinical Examinations for Diseases other than Ankylostomiasis.

Patients admitted to the hospitals with Ankylostomiasis were subjected to miscrocopic examinations for Bilharziasis and Albuminuria and to clinical examinations for Pellagra, Oedema, enlarged liver, dilated heart, and enlarged spleen. The total number thus examined was 10,397, showing the following results :—

Disease or Morbid Condition.	Percentage Positive.
Bilharziasis	57·2
Albuminuria (total)	53·8
Albuminuria (without red blood corpuscles in urine or Bilharzia ova)...	1·8
Enlarged spleen	14·0
Pellagra	13·0
Dilated heart	8·7
Enlarged liver	8·3
Oedema	3·5

Hæmoglobin Index of Ankylostomiasis Patients.

Hæmoglobin tests (Talquvist's) were made of the blood of 9,696 patients when admitted to the hospitals for treatment for Ankylostomiasis.

The average percentage of hæmoglobin on admission was 44.

The average percentage of hæmoglobin of 4,031 patients, one month or more after treatment, was 49.

The range of the hæmoglobin index in two series was as shown in the following table :—

	On Admission.		One or more Months after Treatment.	
	Number.	Per Cent.	Number.	Per Cent.
Total hæmoglobin tests made	9,696	100	4,031	100
Hæmoglobin index :—				
100–91 per cent	—	—	—	—
90–81 „ „	—	—	12	0·3
80–71 „ „	55	0·6	101	2·5
70–61 „ „	742	7·7	812	15·2
60–51 „ „	2,769	28·6	1,261	31·3
50–41 „ „	3,065	31·6	1,017	25·2
40–31 „ „	1,708	17·6	788	19·6
30–21 „ „	779	8·0	158	3·9
20–11 „ „	293	3·0	59	1·5
10– 1 „ „	285	2·9	23	0·6

Age of Patients treated for Ankylostomiasis.

The majority of the cases treated were between the ages of eleven and forty years. The number and percentage of each of the age periods was as shown in the following table :—

Age Periods.	Number.	Per Cent.
1– 5 years	22	0.2
6–10 „	1,434	14·8
11–15 „	2,621	27·1
16–20 „	1,578	16·3
21–40 „	3,407	35·1
Over 40 years	634	6·5
TOTAL	9,696	—

Per Capita Cost of Examining and Treating for Ankylostomiasis.

During the period under consideration, it was thought necessary to treat all the cases as in-patients in the travelling hospital tents. It was necessary to feed and attend to these cases at the expense of the authorities undertaking the campaign. For these reasons the *per capita* cost was necessarily high, especially at the beginning of the work.

Up to March 1915 a total of 34,173·46 American dollars (about L.E. 6,835) had been expended in Egypt for examining 19,281 and fully treating 10,694 persons. This gives an average of 1·77 American dollars (L.E. 0·355) per person examined, and of 3·20 American dollars (L.E. 0·640) per person treated.

Since the expense was shared equally by the Egyptian Government and the International Health Commission of the Rockefeller Foundation, the expenditure brone by the Commission was 0·89 American dollar (L.E. 0·177) per person examined and 1·6 American dollars (L.E. 0·320) per person treated.

Methods of Treatment of Ankylostomiasis.

1. Treatment by Thymol : 3 doses.

First day of admission :—

Detection of ova in fæces.
Physical examination and clinical note taking magnesium sulphate two ounces in evening.
Diet : dinner only at midday.

Second, third, and fourth days :—

Thymol 4 grammes (60 grains) in cachets.
Magnesium sulphate two ounces.
Diet : dinner and supper.

Fifth day :—

Diet : breakfast only.
Discharge.

2. Treatment by *Oleum Chenopodii.*

This treatment was applied to children or others who were unable to take thymol cachets.

First day :—

Midday meal.
Magnesium sulphate.

Secondary :—

7 a.m. : adult dose *Oleum Chenopodii* 24 drops on sugar.
9 a.m. : adult dose *Oleum Chenopodii* 24 drops on sugar.
11 a.m. : adult dose castor oil 70 grammes, chloroform water 45 drops.

Third day :—

Repeat treatment if no previous ill effects.

Fourth day :—

Repeat treatment if no previous ill effects.

Fifth day :—

Discharge.

N.B.—(1) If there are symptoms of intoxication after the first dose of *oleum chenopodii* the treatment should be abandoned and a careful note made as to the signs of intoxication observed.

(2) If an evacuation of the bowels has not occurred by 1 p.m. an enema of soap and water should be immediately given. This should be followed by sodium sulphate 30 grammes whether or not the enema has been successful.

(*b*) Survey Work.

Survey work was begun on October 1, 1914, and continued to April 8, 1915, when both hospital work and survey work in Egypt had to be abandoned because of the European War.

The aim of the survey was to determine the extent and degree of infection with Ankylostomiasis and to locate the danger centres from which the disease was spread. Incidental observations were made concerning the incidence of Pellagra and Bilharziasis.

The staff assigned to the work consisted of five physicians, two of whom served as microscopists, a laboratory attendant, and a night watchman.

Two of the fourteen provinces of Egypt were selected for the survey. Sharqîya was selected as a typical province of Lower Egypt and Asyût as a typical province of Upper Egypt.

The Province of Sharqîya lies in the region of the Delta, to the east of the Damietta Branch of the Nile. It has an area of approximately 1,316 square miles and its population at the 1907 census was 879,646—density of 668 persons per square mile. The Police districts of this province vary in density of population from 333 to 1,297 per square mile. The province embraces within its limits every kind of soil : low and marshy lands, well-drained land producing cotton of a high grade, and land which, merging into the eastern desert, is high and poorly irrigated.

Asyût Province is situated approximately 200 miles south of Sharqîya and consists of narrow alluvial plains on both sides of the Nile. It has an area of approximately 764 square miles and its population at the 1907 census was 876,584, a density of 1,145 persons per square mile. The various districts comprising this province range in density of population from 926 to 1,452 per square mile.

During the survey only males were examined owing to the difficulty in inducing females to submit themselves for examination. The survey of rural areas in the Province of Asyût was based entirely upon the examination of boys, who could be examined with less difficulty than men. The difference of incidence of infection amongst boys and men was found to be appreciable only in the town inhabitants, where it was the custom to examine 100 men and 201 boys.

INCIDENCE OF ANKYLOSTOMIASIS INFECTION IN ASYÛT AND SHARQÎYA PROVINCES.

District.	Asyût Province.			District.	Sharqîya Province.		
	Number examined.	Number infected.	Per Cent.		Number examined.	Number infected.	Per Cent.
Dairût	600	433	72·2	Hehya	885	579	65·4
Mallâwi	600	404	67·3	Zagazig	1,178	713	60·5
Abnûb	600	335	55·8	Faqûs	833	489	58·7
Badâri	600	286	47·5	Minyet el Qamh	985	545	55·3
Manfalût...	605	213	35·2	Bilbeis	1,047	508	48·5
Abu Tig	600	202	33·7	Kafr Saqr	814	323	39·7
Asyût	806	147	18·2				
TOTAL	4,411	2,020	45·8	TOTAL	5,742	3,157	55·0

Comparison of Infection.

Population of the two provinces surveyed...	1,756,230	
Number examined...	10,153	(0·60 per cent).
Number infected with Ankylostomiasis ...	5,175	(51·0 per cent).

A glance at the above table will show that infection with Ankylostomiasis is more evenly distributed throughout the Sharqîya Province than throughout Asyût.

Comparison between the incidence of infection of rural with town population is interesting. This was carried out in Asyût Province as shown in the following table :—

District.		Population.	Number examined.	Number infected.	Per Cent.
Asyût	Town	44,106	301	12	4·0
	Rural	85,165	505	135	26·7
Manfalût	Town	14,500	100	19	19·0
	Rutal	117,664	505	194	38·4
Dairût...	Town	5,700	100	39	39·0
	Rural	142,442	500	394	78·8
Mallâwi	Town	20,249	100	35	35·0
	Rural	152,606	500	369	73·6
Abnûb...	Town	6,878	100	44	44·0
	Rural	87,840	500	291	58·2
Abu Tîg	Town	12,024	100	26	26·0
	Rural	122,455	500	176	35·2
Badâri...	Town	9,300	100	49	49·0
	Rural	55,655	500	237	47·0

Method of conducting the Survey.

For securing specimens the custom was to request the village headman by telephone, one day in advance, to have the required number of boys or men on hand at his house, at a fixed hour on the following day. Each person was supplied with a tin box in which, in the presence of a village watchman, he had to place a specimen of his fæces. The boxes were later returned personally to the collector, who numbered them serially and then entered them in survey cards, one for each individual, bearing the number of the box, the name of the village district in which he lived, and the clinical data relative to other diseases.

Technique of Microscopic Examination.

From each specimen box a portion, the size of a bean, was taken and placed in a test tube with water and thoroughly shaken. The emulsion thus formed was strained through coarse gauze into a centrifuge tube, one end of which had been previously corked, and twenty-four such specimens were placed in correspondingly numbered sections of the centrifuge. After rotation the supernatant fluid was drained off, and by removing the cork, the last drops were obtained. This was divided into two parts, mixed with an equal quantity of methylene blue, and spread on two slides. Search was then made for ova under a microscope equipped with a travelling stage. No specimen was considered negative until two slides had been examined each for the period of five minutes. When ova were found by one physician, the fact was verified by the second physician looking down the other's microscope.

A test was carried out on seventeen specimens examined by the centrifugal method which were cultivated for larvæ. Two, which were positive to the microscope gave a negative result on cultivation, and one which had been found negative was found positive by cultivation. (*N.B.*—Recent work not yet published on cultivation of Ankylostoma fæces showed that 16 per cent of the stools during summer in Egypt maintain an acid reaction, and in these no larvæ reach maturity. The larvæ die directly after hatching. The addition of calcium carbonate in small amounts to fresh stools ensures the success of cultivation. M. KHALIL.)

The results of the survey represent the absolute minimum of infection. In view of the large number of specimens examined the results cannot be absolutely accurate, for a certain number of the eggs will escape detection. Another source of error may be found in the unsuitability and insufficiency of specimens supplied by boys. For example, out of twenty such specimens taken at random, five were in such small quantity as to prejudice the result.

Presence of Ankylostomiasis amongst Prisoners.

Two groups of prisoners were examined, one group in Sharqîya and the other in Asyût. The result was as follows :—

	Number examined.	Number infected.	Per Cent.
Sharqîya	341	254	74·5
Asyût	193	141	73·1
TOTAL	534	395	74·0

The results as regards prisoners is more accurate than in the case of the general population in view of the work being controlled in all its stages.

Hæmoglobin Index.

In the entire survey work in Egypt, 2,923 specimens of blood were tested for hæmoglobin by the Talquvist scale with an average index of 61 per cent.

For men the index was ... ... 60 per cent.
For boys the index was ... ... 61 „
For prisoners the index was ... ... 60 „

For special groups of persons in schools and ophthalmic hospitals the index was 63 per cent.

For Asyût Province only the indices were :—

Average index	67	per cent.
Boys	69	,,
Prisoners	62	,,

Summary of Results of Hæmoglobin Tests.

Summary Divisions of Hæmoglobin Scale.	Per Cent of Total Hæmoglobin Tests.	Per Cent of Hæmoglobin Tests by Groups.			
		Men.	Boys.	Prisoners.	Other Schools and Ophthalmic Hospitals.
0– 40 per cent	6·3	8·5	6·5	9·4	1·9
41– 60 ,, ...	32·0	27·8	33·4	33·9	31·7
61–100 ,, ...	61·7	63·6	60·1	56·7	66·3

2.—Prevalence of Pellagra.

Only a cursory examination for Pellagra symptoms was made, *i.e.* dermatitis on face, neck, hands and feet and enlarged parotids. The survey was conducted during the autumn or winter, when Pellagra was seldom prevalent, so that the disease was not diagnosed unless it was very obvious.

Of the 10,153 persons examined, 250 (2·5 per cent) were recorded as showing Pellagra symptoms.

Amongst 4,411 persons examined in Asyût, 89 (2·0 per cent) were recorded as pellagrous.

Of the total of 543 prisoners, 14 (2·6 per cent) were recorded as pellagrous.

3.—Prevalence of Bilharziasis.

A crude estimate of the prevalence of Bilharziasis of the bladder only was obtained in both provinces by listing as infected all those who stated that they had noticed blood in their urine. No microscopic examination of the urine was made. There is no doubt that that procedure grossly under-estimated the real condition of affairs.

Of the 10,153 persons who were questioned as to hæmaturia, 2,073 (20·3 per cent) were classed as infected.

In Sharqîya Province, 6,082 persons were thus questioned, 27·7 per cent were classed as infected.

The highest rate of infection was in Markaz Minyet el Qamh, which was 42 per cent; the lowest was in Markaz Faqûs, 16·9 per cent.

In Asyût Province, 4,411 were questioned as to hæmaturia, and of these 443 gave a positive answer, *i.e.* 10 per cent.

The highest rate of infection was in Markaz Mallâwi, giving 36·2 per cent, the lowest in Markaz Asyût, giving 1·2 per cent.

Presence of Birkas.

It was shown that the presence of *birkas* (ponds) does not bear an important relationship to the spread of Ankylostomiasis.

4.—Experience gained from the Hospital and Survey Work of 1914-1915.

The work of 1914–1915 demonstrated fully the practicability of treating Ankylostomiasis on a large scale. The survey has provided us with definite information as to the incidence of this disease.

The whole work was a pioneer attempt at field work in Egypt and its success encourages further attempts in the same direction.

The undertaking was, however, very expensive, when it is compared with similar work carried out in other countries. This was due partly to treating all infected persons as in-patients. The cost per individual examined was also high.

As the work is increasing, the cost is becoming very low, comparing favourably with the *per capita* cost in other countries, although in the case of Bilharziasis at least twelve intravenous injections of tartar emetic are given to every infected case.

The method of examining for Ancylostoma ova in the survey was the standard method at that time. It has been superseded nowadays by the flotation method. It is probable that the results arrived at in the survey under-estimate by 10–20 per cent the actual condition of affairs. The exclusion of women and in many cases of men in the survey reduced to agreat extent its value. Although it is a difficult task to secure specimens from women in Egypt, yet the difficulty could be overcome.

The figures for Bilharziasis are based solely on questioning the patients as to the presence of hæmaturia. This, in the light of our present knowledge, is of little value as an indication of the real condition of affairs.

In view of these drawbacks a survey based on our newer methods of examination is urgently required.

PART III.

Resumption of the Campaign in 1919.

1.—The Premature Closing down of the Campaign (1913–1915) due to the Great European War.

The extension of hostilities to the Near East and the beginning of the Dardanelles Campaign unfortunately paralysed much of the work in Egypt, as a great demand was made on hospital accommodation for British wounded.

The work in the Ankylostomiasis tent hospitals was discontinued on April 8, 1915. All the equipments were despatched to Alexandria together with all ophthalmic hospitals to form the Stationary Public Health Department Hospital at Glymenopoulo, of 650 beds, for the care of wounded soldiers.

Meanwhile all Ankylostomiasis work in Egypt was indefinitely suspended. When things returned to normal towards the end of 1919, Prof. Day, one of the original members of the Ankylostomiasis Consultative Committee, revived the interest in combating this disease. In view of the discovery by Christopherson at Khartoum in 1918 of tartar emetic as a specific cure for Bilharziasis it was thought advisable to include treatment of Bilharziasis in the programme of the Ankylostomiasis Annexes.

Upon the suggestion of Prof. Day an Annexe was attached to Qasr el ʿAini Hospital under his direct supervision. This Annexe was useful in definitely establishing the principles of treatment to be carried out and in acting as a teaching centre for the physicians to be detailed for such work in the provinces.

The two main objects of the Qasr el ʿAini Annexe, as put by Prof. Day, were :—

(1) To test the practical value of out-patient treatment of Bilharziasis as regards the attendance of patients and the efficiency of routine treatment.

(2) To find the best methods of specific treatment and the minimum dosage and attendance necessary for the average case.

Re-establishing the Ankylostomiasis and Bilharziasis Consultative Committee.

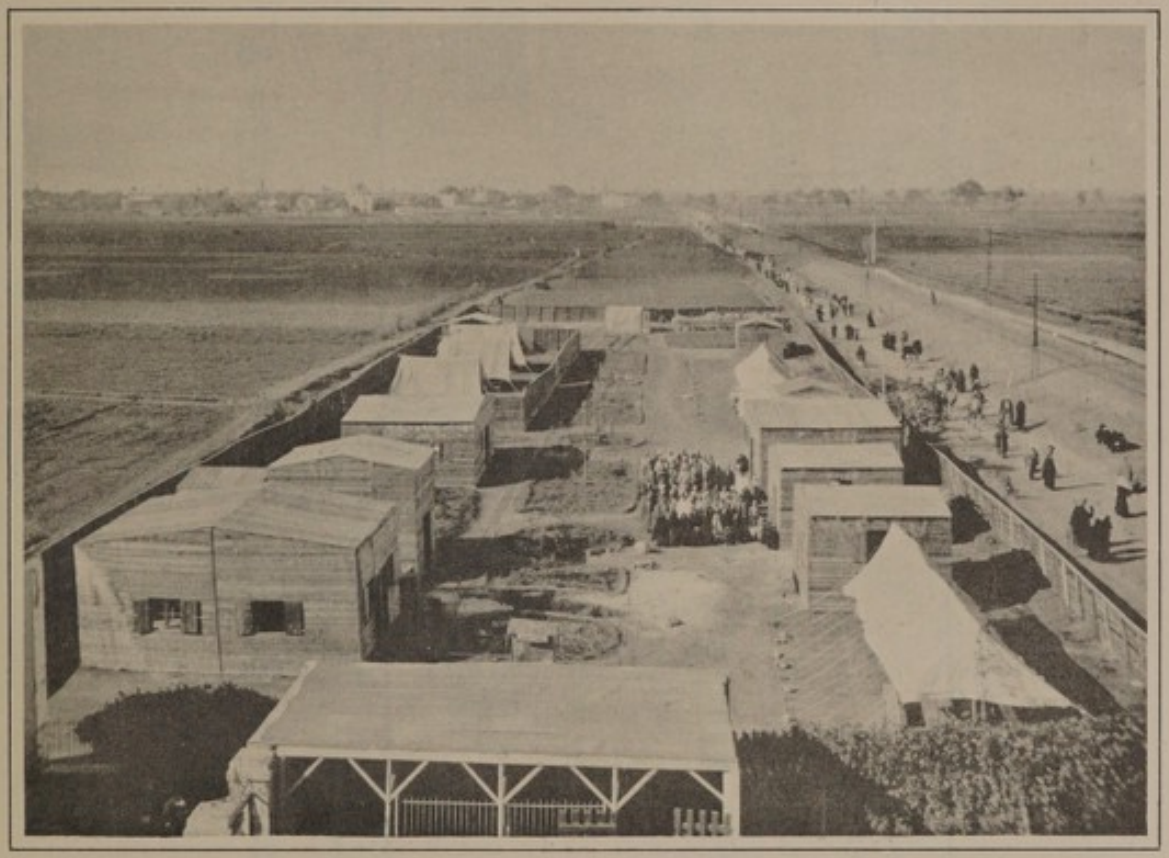
The Chairman of the Ankylostomiasis Committee of 1913, Prof. A. Looss, being of German nationality, was obliged to leave the country at the beginning of the war. The Secretary, Dr. A. Ferguson, Professor of Pathology, School of Medicine, Cairo, died on February 21, 1920.

The second Committee was appointed by the Department of Public Health about the end of 1920 under the chairmanship of Dr. C. Todd, Director of the Public Health Laboratories. The members of the Committee were :—

Dr. MacCallan, Director of the Ophthalmic Section, D.P.H.
Dr. H. B. Day, Professor of Clinical Medicine, Qasr el ʿAini Hospital.
Dr. MacCarthy Morrogh, Director of the Hospitals Section, D.P.H.
Dr. Nessim Daoud, P.M.O. of Qalyûb Hospital.
Prof. Hindle, Professor of Biology, School of Medicine.
Major Thomson, Director of the Epidemic Section, D.P.H.
Dr. W. Hastings, Director, Section I, D.P.H.

The Committee held its first meeting on January 19, 1921, and the lines of action against these two diseases were laid down as :—

Treatment.
Investigation and Survey.
Propaganda.
Experimental work in connection with soil and water pollution.

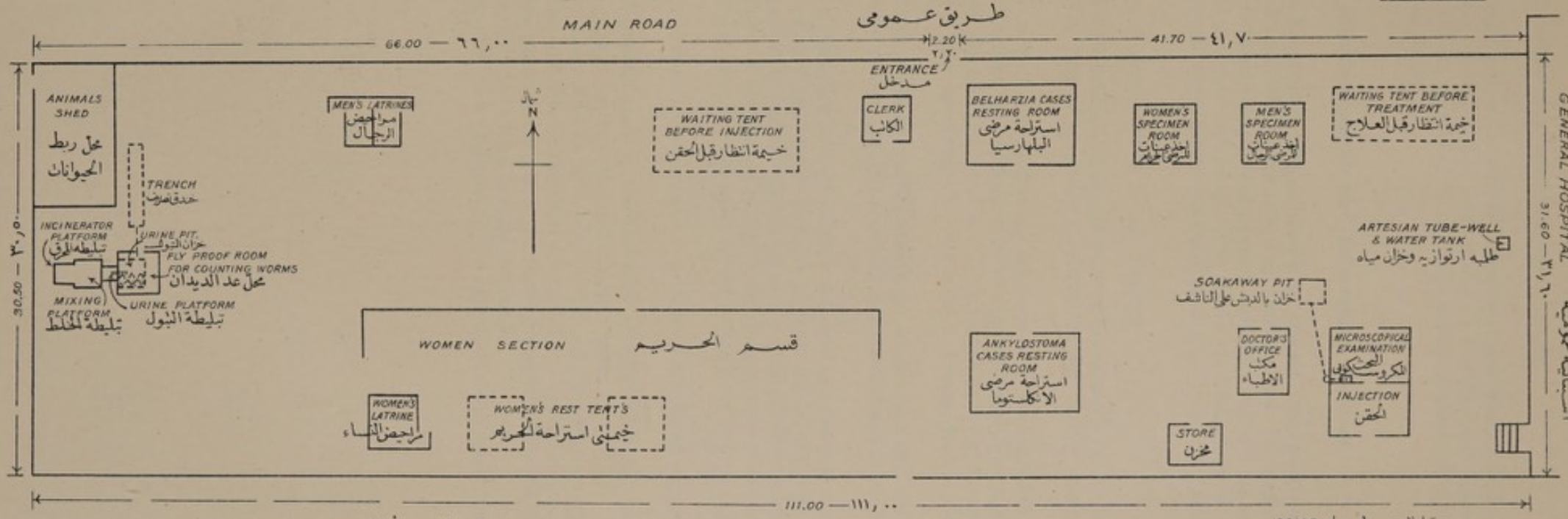


Bird's Eye View of Qalyûb Annexe.

ANKYLOSTOMA TREATMENT CAMP AT QALYÛB

مستشفى الانكلستوما بقليوب

PLAN Nº 5613
رسم نمرة ٥٦١٣



انظر رسم نمرة ٥٦١٢

SCALE 1/400 مقياس الرسم

With regard to the type of investigation and survey necessary it was decided that the problems requiring elucidation would be best tackled by the institution of a complete and intensive survey of a small centre, preferably in the close vicinity of Cairo. The details of the work in this direction are given later in Part IX of this report.

2. Provincial Ankylostomiasis and Bilharziasis Annexes.

The Annexes were started at Government expense both as regards construction and upkeep.

In order to economise in administration expenses, the Annexes were established as far as was possible close to an already existing Government general hospital so as to form an extension to it as far as general administration was considered. The senior medical officer of the Annexe is, however, in charge of all technical work carried out there as well as the internal administration of the Annexe.

(*a*) The Construction of an Annexe.

A plot of land of about half a feddan (2,100 square metres) is selected in a convenient place close to the general hospital. The land is generally a cultivated plot and is rented from the proprietor for the purpose.

A fence enclosing the area is constructed of matting supported by wooden posts.

A series of tents are erected within and arranged in two groups at different parts of the enclosure, one group for males and the other for females. Each tent holds about twenty stretcher-beds upon which the patients rest after receiving the treatment. A large tent is also provided as a waiting place for patients.

In a suitable part of the enclosure there are two wooden huts, one for each sex, where a sample of fæces or urine can be collected for examination in a special receptable given to each patient for the purpose.

At another suitable part of the enclosure, a wooden hut is arranged as a doctors' room, in which also the clerical work is carried out and the ledgers and the patients cards' are kept.

Next to this is a big wooden hut having an impervious roof and divided by a partition into two rooms. In one of these, samples of excreta are prepared and microscopic examination carried out. The other room has two doors, one for the entrance of patients to receive injections and the other for their exit.

A wooden hut with an impervious roof is reserved for storage of drugs and equipment of the Annexe.

A tube well is sunk at a convenient place in the enclosure and the water is pumped into a high storage tank from which a pipe is led into the examination room.

At the far end of the enclosure there are two huts, one for each sex, each containing two closets arranged on the pail system. The contents of the pails are taken to a special incinerator, mixed with straw and burnt. The waste water is led into a percolating cesspit. In some Annexes the contents of the pails are removed daily by a local sewage company.

Below is a bird's eye photographic view and plan of the Qalyûb Annexe which may be taken as a type of the others.

At the present time (January 1924), there are five Annexes at work and one under construction.

The Port Said Annexe was established for a short period in 1923 but was closed down owing to the lack of patients suffering from these diseases in the vicinity.

The Annexes referred to above were opened on the following dates :—

(1) Qasr el 'Aini	December 1919	Still open.
(2) Qalyûb	July 20, 1920	
(3) Mansûra	August 1, 1920	
(4) Benha	September 1, 1920 ...	
(5) Tanta	July 1, 1921	
(6) Port Said	March 1, 1923	Closed down on 31–7–1923.
(7) Damanhûr	Under construction.	

The towns in which these Annexes are established are shown on the accompanying map. No Annexes have yet been opened in Upper Egypt.

(*b*) Short Description of the Annexes.

(1) *Qasr el 'Aini Annexe.*

This Annexe is attached to the Qasr el 'Aini Hospital in Cairo. It is constructed of a number of tents pitched in the hospital grounds. All out-patients who are suspected to be suffering from Ankylostomiasis or Bilharziasis are referred to the tents. The patients come from all over the country. One medical officer is in charge of the work under the supervision of Prof. H. B. Day, the Professor of Clinical Medicine at the Medical School.

(2) *Qalyûb Annexe.*

This Annexe is erected on a plot of land adjoining the Qalyûb Hospital. Qalyûb town is close to Cairo, being only ten miles distant from it. On account of its proximity to Cairo it was chosen to be the centre of investigations in connection with Ankylostomiasis and Bilharziasis.

Patients attending the Qalyûb Annexe come from 118 villages in the neighbourhood having a population of 604,258. In spite of the crowded area a comparatively small proportion of the people avail themselves of the Annexe. They often seek medical advice in Cairo, either at the general hospitals or at private practitioners.

Most of the patients attending the hospital suffer from Ankylostomiasis. Intestinal Bilharziasis is seldom met with.

(3) *Mansûra Annexe.*

This Annexe is erected close to the Government Hospital in the same town. The town itself lies on the eastern bank of the Damietta Branch of the Nile to the north of Cairo. Patients attending this Annexe come from thirty-seven villages in the neighbourhood having a population of 159,766. Bilharziasis is more prevalent than Ankylostomiasis amongst the patients attending this Annexe. Intestinal Bilharziasis is more frequent here than in any other Annexe.

(4) *Benha Annexe.*

This Annexe is erected close to Benha Government Hospital at Benha. Benha town is only thirty miles to the north of Cairo and twenty miles to the north of Qalyûb. Patients attending this Annexe come from the three neighbouring provinces, Qalyûbîya, Minufîya, and Sharqîya. Sixty-one villages contribute patients to this Annexe. These villages have a population of 220,808. Ankylostomiasis is the predominant disease amongst the patients while intestinal Bilharziasis is not frequent.

(5) *Tanta Annexe.*

This Annexe is erected in Tanta, the principal town of Gharbîya Province. It lies a little distance away from the Government Hospital. Tanta town is practically midway between Cairo


MEDITERRANEAN SEA
البحر الابيض المتوسط
Rosetta
رشيد
Damietta
دمياط
ALEXANDRIA
الاسكندرية
PORT SAID
بورسعيد
Fuwa
فوه
Shirbin
شربين
Kafr el Dauwar
كفر الدوار
Abu Hummus
ابو حمص
Disuq
دسوق
Kafr el Sheikh
كفر الشيخ
Talkha
طلخا
El Mansura
المنصوره
Dikirnis
دكرنس
Damanhur
دمنهور
Shubra Khit
شبراخيت
El Mahalla el Kubra
المحله الكبرى
Aga
اجا
El Simbillawein
السنبلاوين
Itvai el Barud
ايتاى البارود
El Dilingat
الدلجات
Kafr el Zaiyat
كفر الزيات
Tanta
طنطا
Kafr Sagr
كفر صقر
Kom Hamada
كوم حماده
El Santa
السنطه
Zifta
زفتى
Mit Ghamr
ميت غمر
Faqus
فاقوس
Tala
تلا
Hihya
هيا
ISMAILIA
الاسماعيلية
Shibin el Kom
شبين الكوم
Quweisna
قويسنا
Zagazig
الزقازيق
Minyet el Qamh
منية القمح
Bilbeis
بلبيس
Minuf
منوف
Benha
بنها
Tukh
طوخ
Ashmun
اشمون
Nawa
نوى
Qalyub
قليوب
CAIRO
القاهرة
SUEZ
السويس

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and Alexandria. Patients attending this Annexe come from thirty-four villages in the neighbourhood having a population of 159,766. Bilharziasis is the predominant disease amongst the clientele of this Annexe. Intestinal Bilharziasis is fairly common though not to the same extent as amongst the patients of Mansûra Annexe.

(6) *Port Said Annexe.*

This Annexe was open for five months only. Its site and the causes of discontinuation of the work at Port Said are dealt with later on in this report.

(7) *Damanhûr Annexe.*

This Annexe is still under construction. The site chosen is a little distance away from the Damanhûr Government Hospital. Damanhûr town lies on the main railway line from Cairo to Alexandria, about forty miles from the latter city. A preliminary investigation in a village in the neighbourhood showed a preponderance of infection with Bilharziasis. Intestinal Bilharziasis is fairly common and will probably approximate to the percentage found in the patients attending the Mansûra Annexe.

(*c*) Routine followed at the Provincial Ankylostomiasis and Bilharziasis Annexes.

Registration of Patients.

(1) A nominal daily roll is entered in a register book giving the name, age, sex, and address of patients, a serial number being assigned to each patient.

(2) An attendance card is given to each patient to be presented whenever he returns for treatment or re-examination.

(3) A treatment card is assigned to each patient. Ankylostomiasis cards are yellow and Bilharziasis ones red. The treatment given is entered on the cards together with the result of examination.

(4) Index cards are arranged alphabetically according to the patients' names for identification in the event of a patient losing his attendance card.

Ankylostomiasis Division.

On registration, the patient is given a bed pan into which he passes a stool for microscopical examination. Ankylostomiasis cases are seen by the Medical Officer who takes a drop of blood for estimation of the hæmoglobin and enters the results on the treatment card. Patients who are too weak for out-patient treatment are admitted into the general hospital.

The treatment is as follows: oil of chenopodium is put in gelatine capsules each containing 0·5 cc. The ordinary dose for an adult is 1·5–2 cc. (three to four capsules). The patient who has been given a purge the previous evening is given two capsules in the morning, sent to lie down one and half hours, when another one or two capsules are given. One hour after this last dose castor oil (30 cc.) is given. When the bowels have acted the patient is allowed to go home. He is instructed to return in about four days when the treatment is repeated. He is usually supplied with an iron and arsenic mixture to take for one week, and instructed to return. At his third visit the treatment is again repeated, another bottle of iron mixture is given to him and he is instructed to return after two weeks for re-examination.

Thymol is given in cachets after being well ground up in a mortar and mixed with an equal amount of sodium bicarbonate. Each cachet contains 0·5 gramme of thymol. The adult dose is 3 grammes (six cachets). A saline purge should precede and follow thymol treatment. Three treatments are given in the same way as the chenopodium treatment.

Patients found on microscopic examination to be harbouring *Tænia saginata* or *Ascaris* are given the appropriate treatment.

Patients found to be harbouring both Ancylostoma and Bilharzia worms are treated first for Ankylostomiasis, and after these parasites have been expelled, tartar emetic is given. It was found that such patients do not recover well from Ankylostoma anæmia if a depressant drug (antimony) is given at the same time.

Bilharzia Division.

At the first attendance the patient is requested to furnish a specimen of urine or stool, according to the symptoms of the case.

Selection of Cases.—Pregnant women, patients obviously unfit, as well as cases of Pyuria without living Bilharzia ova, are not given tartar emetic.

The Drug used.—Sodium antimony tartrate is the drug generally used. In expert hands it is safe to use a small syringe (2 cc.) and 6 per cent solution, *i.e.* 1 grain in 1 cc., the injections being made directly into the vein. The photographs given below represent the procedure followed.

Should any antimony solution escape into the tissues, it causes immediate burning pain. If this happens the fluid is aspirated by withdrawal of the piston and hot fomentations applied. Such accidents are rarely met with in the Annexes as a result of the experience gained by the Medical Officers.

Dosage and Course.—For an adult the routine course consists of twelve injections given every alternate day or three times a week, not counting Fridays.

	Grains of Antimony Sodium Tartrate.		
	First Time.	Second Time.	Third Time.
First week	1	1½	2
Second week	2	2	2
Third week	2	2	2
Fourth week	2	2	2

For children and women, smaller doses are required, the full dose being 1¼–1½ grains. The dose should be reduced if persistent giddiness or repeated vomiting occurs.

The Use of Emetine.—This drug is used for young children and others when it is found impossible or unwise to attempt an intravenous injection. Emetine can be given subcutaneously but not more than 1 or 1½ grains should be injected into one site.

Precautions :—

(1) Antimony solution must be made in sufficient quantity and sterilized properly. One bottle only should be opened at a time, and should not be kept more than three days.

(2) Patients must be inspected after having the injections and any symptoms noted.

(3) Patients should be informed that the medicine has a weakening effect and that they must not try to do as much work as usual while undergoing treatment.

Attendance.—Patients must be warned when beginning the course of injections that they must undergo the full treatment for four weeks, otherwise they will not be cured and the disease will return.

Re-examination.—After having taken eleven injections, the patient's urine is examined and the result recorded. After finishing the course, the patient is told to return for re-examination in three months' time.

Cases with Complications.—Cases of Pyuria after finishing the tartar emetic course may be injected with urotropine.

Upper Photograph.—Intravenous injection with Tartar emetic at Qalyûb Annexe.

Lower Photograph.—The needle inside the vein. Syringe held for photographing.

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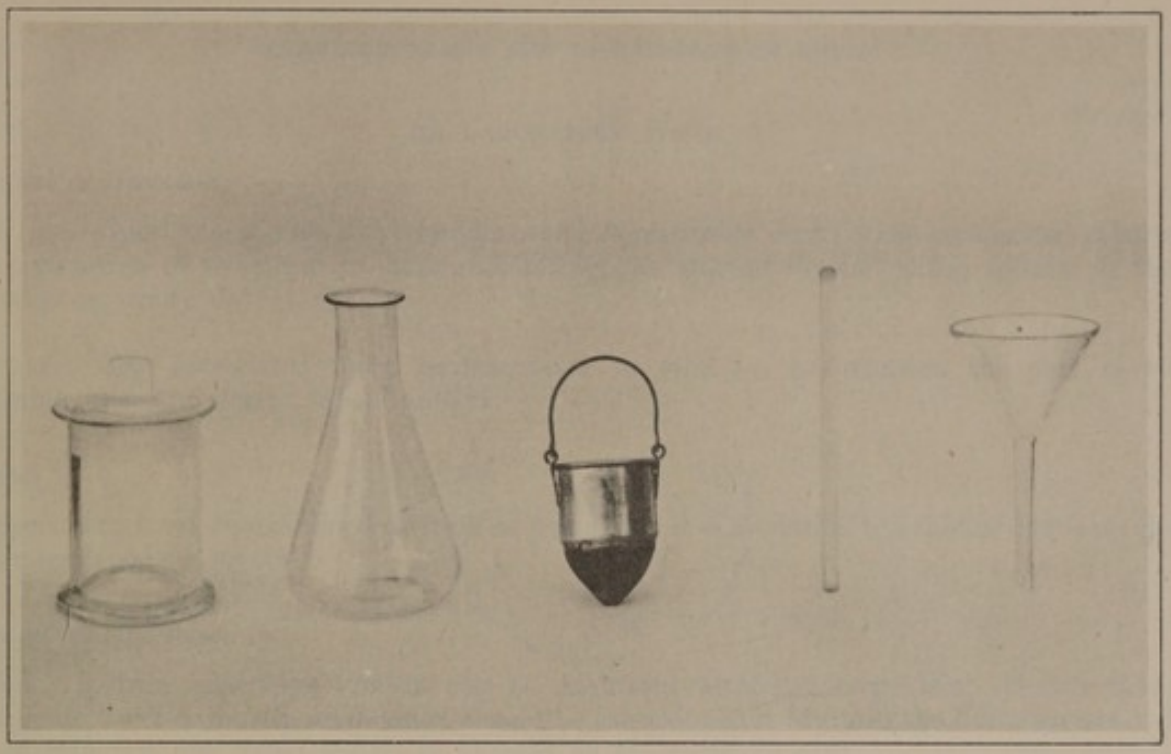

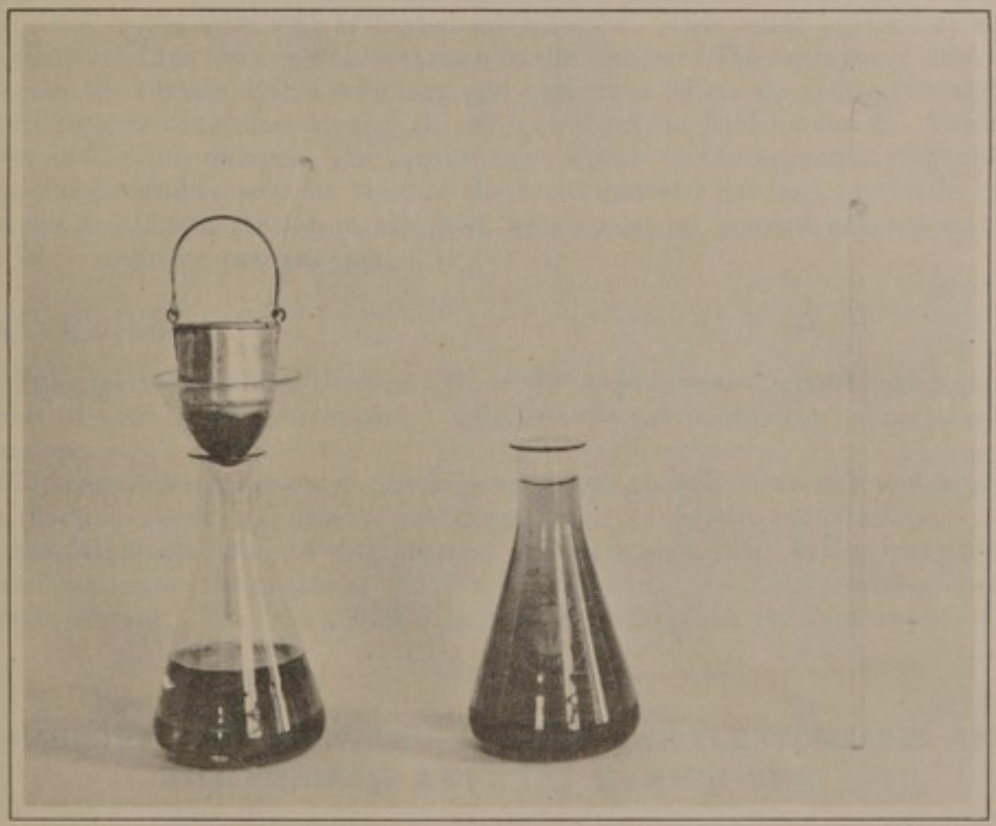

Upper Figure.—Apparatus used for the Detection of Ancylostoma Ova by the Floatation Method. From left to right:—

(1) Glass-stoppered bottle for emulsifying the fæces in concentrated salt solution.

(2) Conical Erlenmeyer flask into which the fæcal emulsion is poured till it is full to the neck. The surface area of the fluid is very small in comparison with the capacity of the flask.

(3) Copper wire sieve 100 meshes to the linear inch for sieving the fæcal emulsion and thus getting rid of debris.

(4) Glass rod for stirring the fæcal emulsion in the sieve.

(5) Glass funnel in which the copper wire sieve is put while filling the flask.

Lower Figure.—Apparatus used for the Detection of Ancylostoma Ova by the Floatation Method. From left to right:—

(1) Fæcal emulsion placed in sieve and stirred.

(2) Erlenmeyer filled up.

(3) Platinum loop for lifting the surface film.

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(*d*) Laboratory Work.

Collection of Specimens :—

Urine.—Specimen glasses must be clean and kept upside down when not in use, otherwise the examination of specimens is made difficult by the amount of dust which collects in them, especially on windy days.

Stools.—The attendants must be instructed to send for examination the part of stool containing blood or mucus, when present.

Routine.

Specimens must be examined as fresh as possible. It is advisable to examine first any stools containing blood or mucus.

Examination of Stools.

With a little experience smears can be examined without a cover slip. If it is thought advisable to use a cover slip no pressure should be exercised as it ruptures the Bilharzia ova. The type of Bilharzia ova found should be entered on the patient's card.

Stools of patients suspected to be suffering from Ankylostomiasis are examined by the smear method. If no ova are detected, the floatation method must be used.

A small portion of the fæces, the size of a bean, is emulsified in a saturated solution of ordinary salt (NaCl) by shaking vigorously in a stoppered bottle or test-tube. This emulsion is then filtered through a small copper wire sieve (100 meshes to the inch) into a conical Erlenmeyer flask, which is then filled to the brim with saturated salt solution. This is left to stand at least fifteen minutes, during which time the ova will have risen to the surface. The top layer of fluid is removed by dipping under the surface with a wire loop and tapping it off on the centre of a slide. Three or four dips will remove the surface layer. Do not spread out the fluid too much. Examine under the low power of the microscope. The apparatus is shown in the accompanying photographs.

Any ova will be readily seen, as most of the fæcal material has been removed. Remember that the ova are floating on the top of the fluid, which must be focussed, and not on the surface of the glass as in ordinary preparations.

Examination of the Urine.

With a fine pipette transfer a drop or two of the deposit from a conical urine glass on to a slide. There is no need to use a cover glass. Bilharzia ova are easily detected under a low power of the microscope.

When Bilharziasis is suspected on clinical grounds but no ova are to be found in an ordinary examination made as above, the urine is centrifuged and the deposit examined.

In re-examination, the state of the Bilharzia ova must be noted. Living ova are clear with refractile miracidia inside, the organs of which are easily seen. Dead ova are discoloured, shrunk with a granular content. They do not hatch living miracidia when put into water.

A.—REPORT ON THE WORK OF THE ANKYLOSTOMIASIS AND BILHARZIASIS ANNEXES DURING 1920.

(1) Qasr el Aini Annexe, 1920.

(*Extracts from Professor Day's Report.*)

The Annexe was opened in December 1919 and has been well patronised since then.

931 cases of Bilharzial infection were treated from December 1919 till November 1920.

134 cases of Ankylostomiasis attended during the same period.

Bilharziasis.

The majority of the Bilharziasis cases suffered from urinary disease, as is shown below :—

Bladder infection	875
Intestinal infection	26
Bladder and intestinal	29
Urethra	1
TOTAL	931

A large number of patients ceased to attend as soon as their symptoms were relieved, as usually occurs within a week or two of commencing treatment with tartar emetic injections intravenously.

On the other hand, most patients with septic cystitis as a complication were diligent in attendance, though little benefit could be procured, and took as many injections as was deemed necessary.

The attendance of patients for tartar emetic injection can be judged well from the following table based on an analysis of the first thousand cases :—

Rejected as unsuitable for treatment	68
Patients refused treatment	4
Patients treated with colloidal antimony	4
Patients receiving less than 5 grains of tartar emetic	313
,, ,, 5–10 ,, ,, ,, ...	215
,, ,, 10–15 ,, ,, ,, ...	146
,, ,, 15–20 ,, ,, ,, ...	92
,, ,, 20–25 ,, ,, ,, ...	55
,, ,, 25–30 ,, ,, ,, ...	84
,, ,, over 30 grains of tartar emetic	19
TOTAL	1,000

An intensive course of tartar emetic injections, 4–5 in number (a total of 8–9 grains), was found to be sufficient to kill the ova if given in the first ten days. The late results of the cases were unsatisfactory.

Treatment of Bilharziasis with emetine, introduced by Diamantis and Erian, was given a trial and was found to be effective. The high cost of emetine militates against its routine use for out-patients ; but it is a most useful alternative to use under certain conditions such as :—

(*a*) For young children or others whose veins are too small or inconspicuous for intravenous injections.

(*b*) For patients who exhibit an intolerance for tartar emetic or where an error in technique has resulted in abscess.

(*c*) For cases of Bilharzial dysentery complicated by amœbiasis.

(2) QALYÛB ANNEXE, 1920.

The Annexe was opened for work on July 20, 1920. From the beginning it was well patronized by patients.

1,264 new patients applied for treatment at the Annexe, either for Bilharziasis or Ankylostomiasis or for both. Of these, 409 (33 per cent) were found to be negative, on microscopical examination, for the disease from which they were suspected to suffer, according to their complaints. Ova were detected in 855 cases, of which 208 were suffering from Ankylostomiasis and 647 from Bilharziasis. The average number of new cases seen at the Annexe was 9·5 per working day. The Annexe had an accommodation of 78 beds for the patients to rest on, after the administration of the treatment.

Bilharziasis.

More than half the patients, found to be suffering from Bilharziasis, discontinued the treatment after a variable number of injections.

1,435 microscopical examinations were made on specimens submitted by patients completing the prescribed course of twelve injections. Bilharzia ova were detected in 541 patients (37·7 per cent) who returned for re-examination at varying times after the completion of the course. There were no figures available to show in what percentage of these positive findings the ova were living or dead.

The average attendance of a Bilharziasis case was 7·6 times, thus having practically this number of injections of tartar emetic.

The average number of injections given daily was thirty-seven. The number fluctuated according to the season of the year, weather, or work in the fields. The highest number injected in a single day was 67 cases, on September 6; the lowest was 4 on September 13.

A certain percentage of the cases which discontinued treatment, resumed it after a lapse of time but as new cases.

Ankylostomiasis.

The average attendance of the 208 cases found on microscopical examination to be harbouring the Ancylostoma worm was 2·7 times. This is a fairly good result, as on an average the Ankylostomiasis case was given three treatments, necessitating his attendance three times.

No data are available as regards re-examination of cases after full treatment was administered.

(3) Mansûra Annexe, 1920.

The Annexe was opened for work on August 1, 1920. There was a good attendance of patients right from the beginning.

The Annexe was equipped with seventy-eight stretcher-beds for patients to rest on after the administration of treatment.

During the five months of 1920 in which the Annexe was at work, 968 new cases presented themselves for examination and treatment. Of these:—

77 (8 per cent) were found on microscopical examination to be suffering from Ankylostomiasis.
690 (72 per cent) were found on microscopical examination to be suffering from Bilharziasis.
201 (20 per cent) were found to be negative on microscopical examination to the disease from which they were suspected to be suffering.

The average number of new cases seen at the Annexe during that period was eight daily.

Bilharziasis.

Amongst the 779 new patients who were suspected on clinical evidence to be suffering from Bilharziasis, 89 were found to be negative on microscopical examination. The average attendance of Bilharziasis cases was 6·6 times each. The full course of treatment was twelve injections.

Patients completing the full course of treatment were advised to come later to have their excreta examined. 402 such examinations were made and Bilharzia ova were detected in 335 specimens, *i.e.* 84 per cent, and 67 specimens were negative to Bilharzia ova, *i.e.* 17 per cent. Unfortunately no data are available to show in what percentage of positive cases were the ova living or dead. Taken as they are, these results were discouraging.

The average number of injections given daily was 37. The highest number given on a single day was 83, on September 4, and the lowest number was 1, on November 14.

Ankylostomiasis.

The average attendance of the 77 cases found on microscopical examination to be suffering from Ankylostomiasis was a little above three times each. This is a good average attendance for Ankylostomiasis cases.

(4) Benha Annexe, 1920.

The Annexe was opened for work on September 1, 1920. Although it was the last Annexe to open during the year (working for a period of four months only) the total number of new cases that sought examination and treatment was higher than in any of the other Annexes, showing that the district was in great need of such an establishment. This is the more so as Qalyûb Annexe is in the same province and is only twenty miles distant from it. The Annexe was equipped with 64 stretcher-beds for patients to rest after the administration of treatment.

During the four months in which the Annexe was open, 1,395 cases presented themselves for examination and treatment. Of these :—

635 (45·5 per cent) were found on microscopical examination to be suffering from Ankylostomiasis.
563 (40·3 per cent) were found to have Bilharziasis eggs in the excreta.
197 (14·2 per cent) gave a negative result on microscopical examination for the parasite they were suspected to harbour.

The average number of cases seen daily at the Annexe during the period under review was about 14 cases, but as many as 43 new cases presented themselves for examination and treatment in a single day.

Bilharziasis.

The average attendance of a Bilharziasis case was 6·3 times, receiving as many injections of tartar emetic.

Of the patients completing the full course of treatment and advised to come later for re-examination, 127 turned up and were examined. 55 per cent were found to be negative for Bilharzia ova and 45 per cent showed eggs in their excreta. Unfortunately there is no record as to the state of these ova, whether they were living or dead.

The average number of injections given daily was 35. The largest number given in a single day was 90, on December 29 ; the lowest was 1, on the day of opening (September 1, 1920).

Ankylostomiasis.

In this Annexe only, the Ankylostomiasis cases exceeded the Bilharziasis ones, quite in contradistinction to the other two Annexes and the Qasr el 'Aini Annexe.

The average attendance of the 635 cases in whom Ancylostoma ova were detected was about two visits each. This is less satisfactory than that of the other Annexes.

No data are available as to the result of re-examination of cases after full course of treatment.

B.—REPORT ON THE WORK OF THE ANKYLOSTOMIASIS AND BILHARHIASIS ANNEXES DURING 1921.

(1) Qasr el 'Aini Annexe, 1921.

During the year the work of the Annexe had been more than doubled. 4,188 new patients were admitted, about 10 per cent of these were females.

Bilharziasis.

3,520 patients attended the Annexe during the year. Of these :—

95 per cent with bladder disease.
4 „ suffered from pure Bilharzia mansoni.
20 „ received no injections.

Of those receiving tartar emetic injections, the attendance was as follows :—

28·9 per cent received less than 5 injections.
27·4 „ received between 5 and 9 injections.
34·3 „ received between 10 and 14 injections.
9·4 „ received 15 or more injections.

Thus it may be reckoned that 40 per cent of the cases took a sufficient quantity of antimony to kill the parasites.

The regular course consists of twelve injections containing 22·5 grains of tartar emetic.

Three injections a week on alternate days was the routine course. An analysis of the results shows that both the rapidity of effect and permanent cure are less dependant on the total amount of antimony given than on a regular tri-weekly sequence of injections.

Sodium antimony tartrate was substituted during the year for the potassium salt. On the evidence at hand there does not appear to be much difference in toxicity or effect.

A great many experiments were carried out in the hope of finding a substitute for antimony. Of the metals, copper gave satisfactory results in vitro, but though used in fairly large doses on patients (after testing on animals), only a very moderate effect was produced on the ova.

Ankylostomiasis.

568 patients attended the Annexe during 1921. The examination of stools of 554 cases gave the following results :—

	Number of Cases.
Ankylostoma infection, pure or mixed	330
Ascaris only	8
Tape worm only	2
Oxyuris only	1
Hyterophyes	1
Chronic dysentery :—	
Bilharzial	28
Amœbic	15
Bacillary	14
Negative cases	152

23 per cent of the patients whose stools were examined failed to return for treatment. Of those who returned a large proportion was satisfied with only one treatment, as shown below :—

138 received one treatment.
39 received two treatments.
36 received three or more treatments.

As one dose of anthelmintic is beneficial in ridding the patient of a great proportion of the parasites, it was recommended that oil of chenopodium (or thymol) should be administered to every patient suspected of Ankylostomiasis at the first visit without waiting to examine his stools beforehand.

(2) Qalyûb Annexe, 1921.

The number of new cases attending the Annexe during 1921 showed a steady increase, especially as regards Ankylostomiasis cases. For statistical purposes new cases attending the Ankylostomiasis Section were counted separately although they might be treated at the same time for Bilharziasis. The total number of new cases attending both sections during 1921 was 6,108.* Of these, 54 per cent were examined for Ankylostomiasis and 46 per cent for Bilharziasis.

On microscopical examination of the excreta of the 6,108 new cases according to their complaints, 4·1 per cent gave negative results ; 51·2 per cent were positive for Ankylostomiasis, and 44·7 per cent were positive for Bilharziasis.

The average number of new cases presenting themselves for treatment daily was 21 cases.

The greatest number of new patients attending in a single day was 59, on September 5. The lowest number attending in a single day was 1 case, on December 21.

Bilharziasis.

The number of Bilharziasis patients attending the Annexe during the year was 2,726 new cases. These attended for injections 19,590 times. On an average a Bilharziasis case attended seven times for tartar emetic injection. This was little lower than in the year before.

Patients who completed the course of treatment were advised to return for re-examination. 137 patients were examined at the end of four weeks. Of these, 74 were found to be positive for ova and 63 were negative. Unfortunately no clue as to vitality of the ova seen was recorded.

Eleven cases were examined after three months from the completion of the course of treatment and all were found to be positive for ova. Here also the condition of the ova was not stated.

The average number of injections given daily was 60. The highest number of injections administered in a single day was 176, on September 7 ; the lowest was 18, on December 27.

Ankylostomiasis.

Amongst the 3,293 new cases that were suspected on clinical evidence to be suffering from Ankylostomiasis, the infection was verified by microscopical examination in 3,128 cases ; the rest, 165 cases, were found to be negative for Ancylostoma ova, *i.e.* 5 per cent.

The average attendance of the Ankylostomiasis patients was 2·3 times. Ankylostomiasis cases were required to attend three times for treatment.

4,076 examinations were made on cases that completed the Ankylostomiasis treatment.

These cases were advised to report themselves for re-examination after two weeks and after three months from the completion of the treatment. The result of the re-examination was : 94·3 per cent found positive for ova and only 5·7 per cent negative. Treatment was repeated in all positive cases.

(3) Mansûra Annexe, 1921.

The number of new cases attending the Annexe during 1921 showed a steady increase over the number of those attending during 1920.

6,124 new cases attended the Annexe during the year.

The excreta of 33 per cent of these were microscopically examined for Ankylostomiasis and 67 per cent for Bilharziasis. Ten per cent of the new cases were found to be negative for the respective parasite.

The average attendance of new cases per day throughout the year was 21, practically the same as in Qalyûb.

The greatest number of new patients attending on a single day was 81, on July 16 ; the lowest was 2, on January 16.

Bilharziasis.

The number of Bilharziasis patients attending the Annexe during the year was 4,079. Of these, 213 were rejected after microscopical examination being done when no Bilharzia ova were found in their excreta.

On an average a Bilharziasis case attended for injections 7·8 times.

Patients who completed the course of twelve injections of tartar emetic were advised to return for re-examination. 1,183 such cases were examined after four weeks, and, of these, 71 per cent were found to be negative for ova.

Eighty-nine cases were re-examined after three months from the completion of the course of treatment, and of these 16 (18 per cent) were found to be still passing ova in their excreta. It is not stated, however, if these ova were living or dead.

In view of this apparently large percentage of cases of persistent infection, it is necessary to direct attention to the fact that in Egypt patients return for examination only in case their symptoms are not relieved. Cases with advanced Bilharzial infection with septic urinary apparatus are not relieved by the tartar emetic course. Calcified ova continue to reappear in the urine by ulcerating through the mucous membrane.

The average number of intravenous injections given daily was 102. The greatest number of injections given in a single day was 318, on July 16; the lowest was 6, on January 2. The total number of intravenous injections administered during the year was 30,487.

Ankylostomiasis.

Amongst the 2,045 new cases that were suspected on clinical evidence to be suffering from Ankylostomiasis, the infection was verified microscopically in all but 398 cases, *i.e.* 19 per cent, who were rejected.

The average attendance of the positive cases was three times each, which was quite satisfactory.

Patients completing the course of treatment were advised to report themselves after fourteen days and after three months for re-examination. 6,067 such microscopical re-examinations were made which revealed that in 14 per cent no ova were detected, whereas in 86 per cent Ancylostoma ova were found.

(4) Benha Annexe, 1921.

The number of new cases attending the Annexe during 1921 was very much higher than in the case of the other Annexes. 11,885 cases sought relief from Ankylostomiasis and Bilharziasis at this Annexe during the year.

Of the total number, 6,025 (50·7 per cent) attended for Ankylostomiasis and 5,860 (49·5 per cent) attended for Bilharziasis.

Of the Ankylostomiasis cases, 1,217 cases (20 per cent) were rejected as the result of microscopical examinations revealed no Ancylostoma ova in their stools.

Of the Bilharziasis cases, 852 (14 per cent) were rejected as no Bilharzia ova were detected in their excreta.

The average number of new cases presenting themselves daily for treatment at the Annexe during the year was 40 cases. This was practically double the average number treated at Mansûra or Qalyûb Annexes during the same period.

The greatest number of new cases attending in a single day was 137 cases, on August 21; the lowest number was 5, on May 26.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 5,860. The diagnosis was verified microscopically in 5,008 cases. On an average each Bilharziasis case attended seven times, receiving seven injections. The average case is expected to attend twelve times.

Patients who completed the course of treatment were advised to report themselves at the Annexe for re-examination.

525 returned four weeks after receiving the final injection of tartar emetic. Microscopic examination showed that 32 per cent of these cases were still passing Bilharzia ova in their excreta. The condition of viability of the ova in these cases was not stated. Fifty-seven reported themselves for re-examination after three months from the completion of the course of treatment and of these 53 per cent were still passing Bilharzia ova in their excreta.

The total number of intravenous tartar emetic injections given at this Annexe during the year was 36,046.

The average number of injections administered daily was 122 injections. The greatest number of injections administered in a single day was 315, on September 5; the lowest was 12, on June 5 (the day before the Bairam, a religious feast).

Ankylostomiasis.

4,808 cases were diagnosed microscopically as being infected by the Ancylostoma worms. The average attendance of these cases was 2·3 times each.

Patients completing the course of treatment were advised to report themselves later for re-examination. 1,170 were re-examined microscopically. Of these, 40 per cent were found to be still harbouring the parasite. The rest were negative for Ancylostoma ova. All positive cases were again treated.

(5) Tanta Annexe, 1921.

This Annexe was established at Tanta during the year. It was opened for work on July 1, 1921.

The number of new cases attending the Annexe during the six months in which it was open during 1921 was 6,977 cases, comparing favourably with any of the other Annexes. 25·4 per cent of the total number were examined for Ankylostomiasis and 74·6 per cent for Bilharziasis. 9 per cent of the new cases were rejected after microscopical examination, as no evidence of the infection was detected.

The average number of new cases per day throughout the period under review was 47. This was higher than the average number of new cases in any of the other Annexes.

The greatest number of new cases attending in a single day was 140, on July 16, *i.e.* two weeks from the date of opening; the lowest number was 14, on November 9.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the last six months of 1921 was 5,204 cases. Of these, 204 were rejected, as no ova were detected microscopically in their excreta. On an average each case attended 7·4 times, receiving as many injections of tartar emetic.

Patients who completed the course of treatment were advised to report themselves at the Annexe for re-examination. 503 returned for re-examination after four weeks from the completion of the course, and in 43 per cent of these Bilharzia ova could still be detected although there is no record as to their state of viability.

Fifty cases returned for re-examination after three months and of these 44 per cent were still passing Bilharzia ova.

The total number of intravenous tartar emetic injections administered during the six months at this Annexe was 37,929. The average number administered daily was 256. The greatest number of injections administered in a single day was 452, on July 27; the lowest was 64, on July 2.

Ankylostomiasis.

Of the 1,773 new cases microscopically examined for Ankylostomiasis, 413 were rejected, as no ova were found in their stools. The rest were treated. The average attendance was 2·2 visits per patient.

Patients completing the course of treatment were advised to report themselves later for re-examination. 144 cases complied with that request, and of these 28 per cent showed ova in their stools while the rest were negative.

C.—REPORT ON THE WORK OF THE ANKYLOSTOMIASIS AND BILHARZIASIS ANNEXES DURING 1922.

(1) Kasr el 'Aini Annexe, 1922.

The number of patients examined at the Annexe during the year was 5,801. Of these, 4,560 were examined for Bilharziasis and 1,241 for Ankylostomiasis.

About 12 per cent of the patients were females and 20 per cent were children under twelve years of age. The rest were adult males.

Bilharziasis.

About 20 per cent of the patients sent to the Section showed a negative result for helminth infection on microscopic examination of the dejecta.

Of the 80 per cent positive cases, half the number completed the full course of treatment for Bilharziasis and the other half received less than 10 injections.

It was observed that vomiting and coughing were less marked when sodium antimony tartrate was substituted for the potassium salt.

Nocturnal enuresis in children was noticed to be sometimes an early sign of Bilharziasis.

One death occurred as a result of tartar emetic injection. The subject was a girl of fourteen years who had received eight injections without any symptoms. After the ninth she coughed a while and then felt better. She left the tents in a good condition, but in the same afternoon was brought to the hospital in a collapsed condition and died that night.

Compounds of bismuth were tried in bilharziasis treatment with some mild cases, which were cured, the ova being killed. More active infections were much less affected. The drug was not considered as a satisfactory substitute for antimony in this disease.

Ankylostomiasis.

1,241 patients were sent to the Annexe with the tentative diagnosis of Ankylostomiasis.

The analysis of 351 cases gave the following result :—

Negative cases	165
Ankylostomiasis (pure or mixed)	139
Ascaris only	10
Tænia only	3
Oxyuris only	2

Chronic diarrhœa and dysentery :—

Amœbic	13
Bilharzial	9
Bacillary	8
Flagellate	2

Of the 351 cases above detailed :—

Received no treatment	95
Received one treatment	78
Received two treatments	100
Received three or more treatments	56
Treated with emetine for amœbiasis	13
Treated with antimony for Bilharziasis	9

Oil of chenopodium was almost the only drug used as a vermicide.

Carbon tetrachloride was under trial. At first it was given in doses of 6 cc. (adult) and 4 cc. (children), mixed with an equal dose of castor oil. It was later given pure in doses of 4 cc. and 3 cc. respectively.

The daily attendance of patients for tartar emetic injection at the Annexe varied between 171 injections on June 28 and 31 injections on January 29.

The re-examination of Bilharziasis cases after full course of treatment showed that 96 per cent were cured, no eggs being detected in their excreta.

Most of the Ankylostomiasis cases discontinued attending for treatment after receiving one or two doses of the anthelmintic.

Analysis of 500 consecutive cases showed the following result :—

Refused treatment	72	(14 per cent.)
Received one treatment	184	(37 „)
Received two treatments	110	(22 „)
Received three treatments	134	(27 „)

The re-examination of Ankylostomiasis cases after full course of chenopodium oil treatment showed that 97 per cent were cured.

(2) Qalyûb Annexe, 1922.

The number of new cases attending the Annexe during 1922 was 3,337, showing an appreciable decrease from the number attending during 1921. The number of stretcher beds in this Annexe was reduced to 73 during the year.

Of the total number, 49 per cent sought relief from Ankylostomiasis and 51 per cent from Bilharziasis. 31 per cent of the total number were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 11.

The greatest number of new cases attending in a single day was 48 on August 21 ; the lowest number was 3 on May 24.

Bilharziasis.

The number of Bilharziasis patients attending the Annexe during the year was 1,702. Of these, 186 were rejected after microscopical examination when no ova were found in their excreta, *i.e.* 11 per cent. On an average a Bilharziasis case attended six times for injection.

Statistics as regards re-examination after full course of treatment are only available for the first half of the year. 323 cases were examined four weeks after receiving the last tartar emetic injection. Of these, 18 per cent showed Bilharzia ova in their excreta, the rest were negative. 100 cases were re-examined three months after treatment, and of these, 30 per cent revealed ova in the excreta. All the Bilharziasis cases attending Qalyûb Annexe in the latter half of the year were infected with Schistosoma hæmatobia. No cases with *Sch. mansoni* infection attended during this period. 10,294 intravenous tartar emetic injections were administered during the year. The average number given daily was 26·5.

The greatest number of injections given in a single day was 145 on August 10 ; the smallest number was 8 on June 1.

For purpose of arriving at the average number of injections administered to the Bilharziasis cases at Qalyûb, the records of 600 consecutive cases attending the Annexe between July 23 and December 20, 1922, are tabulated below :—

	Number.	Per Cent.
Total number	600	100·0
Microscopically negative	130	21·6
Received 1–3 injections (1–4·5 gr.)	167	28·0
,, 4–7 ,, (6·5–12·5 gr.)... ...	110	18·3
,, 8–11 ,, (14·5–20·5 gr.) ...	87	14·5
,, 12 ,, (22·5 gr. upwards)	106	17·6

Ankylostomiasis.

Amongst the 1,635 cases that were suspected on clinical evidence to be suffering from Ankylostomiasis the infection was verified microscopically in 790 cases, *i.e.* 48 per cent. The negative cases were rejected. The average attendance of an Ankylostomiasis patient was 3·3 visits.

Statistics are available for the first half of the year, showing the result of re-examination of cases after a full course of treatment. 919 cases were thus re-examined, in 201 (22 per cent) of whom the Ankylostoma ova were detected microscopically.

Analysis of 800 consecutive cases of Ankylostomiasis attending the Annexe showed the following result as to the number of attendances :—

One dose of oil of chenopodium...	243	(30·4 per cent).
Two doses of oil of chenopodium	195	(24·4 ,,).
Three doses of oil of chenopodium	362	(45·2 ,,).

Ascariasis.

Ascaris infection was incidentally recorded while examining the stools microscopically for Ancylostoma ova during the last five months of the year. As the examination in each case was discontinued as soon as an Ancylostoma ovum was seen, this record of Ascaris infection underestimates the real condition of affairs.

The result of microscopical examination of stools during the year was as follows. The number of cases was 679.

Ancylostoma Ova	93	(13·7 per cent)
Ascaris Ova	213	(31·4 ,,)
Negative	301	(45·2 ,,)

Age and Sex of Patients attending the Annexe.

Figures showing the sex of patients attending the Annexe are available for the last five months of the year. The majority of the cases were adult males. Females in Egypt do not generally seek such treatment unless they are severely ill. Cases of mild infection with parasitic worms in females and especially young adults of that sex are too shy to consult a male doctor for their complaints.

The distribution of these cases (according to sex and age) is as follows :—

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	520	86·8	489	72·0	1,009	87·9
Females of all ages	79	13·2	190	18·0	269	21·1
Children of both sexes (under 12 years)	52	8·6	74	10·9	126	9·8

(3) Mansûra Annexe, 1922.

The number of new cases attending the Annexe during 1922 was 6,967, showing a little increase on the number attending during 1921. The number of stretcher beds was increased to 192 during the year.

Of the total number, 37·2 per cent sought relief from Ankylostomiasis and 62·8 per cent from Bilharziasis. 3·8 per cent were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 23·5.

The greatest number of new cases attending in a single day was 100 on September 6 ; the lowest was 2 on March 16.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 4,375. Of these, 143 were rejected after microscopical examination as no ova were found in their excreta. On an average a Bilharziasis case attended 8·5 times for injection, which was a very favourable result in comparison with other Annexes.

Statistics as regards re-examination after a full course of treatment are only available for the first seven months of the year. 1,050 cases were examined at the end of four weeks from finishing the treatment, and in the case of 14 per cent, ova were found in their excreta.

35,932 intravenous injections of tartar emetic were given during the year. The average number of injections given daily was 122. The greatest number of injections given in a single day was 319 on August 30 ; the lowest number was 30 on April 16.

In order to arrive at the average number of injections administered to the Bilharziasis cases at Mansûra, the record of 4,054 cases was as follows :—

Refused treatment	105	(2·5	per cent)
Received 1–3 injections (1–4·5 gr.)	758	(18·7	,,)
,, 4–7 injections (6·5–12 gr.)...	827	(20·4	,,)
,, 8–11 injections (14·5–20·5 gr.)	1,640	(40·4	,,)
,, 12 injections or more (22·5 gr. or more)	724	(18·0	,,)

Schistosoma mansoni infection (Intestinal Bilharziasis) was recorded in more than a quarter of the cases suffering from Bilharziasis. The following table shows the result of microscopical examination of 2,075 cases who attended the Annexe during the last five months of the year :—

Schistosoma hæmatobium infection (urinary Bilharziasis)	1,429	(68·8	per cent.)
Schistosoma mansoni infection (Intestinal Bilharziasis)	544	(26·2	,,)
Negative cases	103	(5·0	,,)

Ankylostomiasis.

Amongst the 2,592 cases which were suspected on clinical grounds to be suffering from Ankylostomiasis the infection was verified microscopically in 2,466 (95·1 per cent). The negative cases were rejected. The average attendance of an Ankylostomiasis case was 4·3 times. Statistics are available for the first seven months of the year, showing the result of re-examination of cases after a full course of treatment. 4,778 such examinations were made on cases returning after a full course of treatment. Many patients were examined on several occasions. 89·4 per cent of the specimens examined revealed the presence of Ancylostoma ova and in 10·7 per cent of the specimens only no ova were found.

The number of attendances of Ankylostomiasis cases for treatment at the Annexe during the year can be gleaned from the following table :—

Refused treatment	6·6 per cent.
Received one treatment	21·4 ,,
,, two treatments	45·0 ,,
,, three treatments or more	27·0 ,,

Ascariasis.

Ascaris infection was incidently recorded while examining the stools microscopically for Ancylostoma ova during the last five months of the year. The number of cases was 1,175. The result of examination was as follows :—

Ancylostoma ova	1,171	(99·7	per cent)
Ascaris ova	103	(9·0	,,)
Negative	2	(0·1	,,)

Age and Sex of Patients attending the Annexe.

The figures in the table below relate only to the last five months of the year. The majority of these attending the Annexe were males. Females are reluctant to consult a male doctor and do not seek medical advice unless they are severely ill.

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	1,505	79·3	876	74·5	2,381	77·4
Females of all ages	393	20·7	299	25·1	692	22·6
Children of both sexes (under 12 years)	458	24·1	319	25·2	777	25·2

(4) Benha Annexe, 1922.

The number of new cases attending the Annexe during 1922 was 10,195, showing a little decrease from the figures of the previous year.

The number of stretcher beds was increased to 88 during the year.

Of the total number of cases, 45 per cent sought relief from Ankylostomiasis and 55 per cent from Bilharziasis. 18 per cent of the total number of new cases were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 34·5.

The greatest number of new cases attending in a single day was 123 on August 12 ; the lowest was 3 on May 25.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 4,746. Of these, 994 (21 per cent) were rejected after microscopical examination when no ova were found in their excreta. On an average a Bilharziasis case attended 6·5 times for injection. This is not as favourable a result as in some of the other Annexes.

Statistics as regards re-examination after full course of treatment are only available for the first half of the year. 323 cases were re-examined four weeks after finishing the treatment, and of these, 18 per cent were found to be still passing ova in their excreta. Unfortunately no data are available as to the state of viability of these ova.

100 cases were re-examined three months after finishing the treatment, and in 30 per cent of these, ova were found in the excreta.

31,088 intravenous injections of tartar emetic were given during the year. The average number of injections given daily was 105. The greatest number of injections given in a single day was 228 on August 30 ; the lowest was 36 on May 25.

In order to judge the perseverance of patients for treatment the records of the number of injections administered to 3,622 Bilharziasis cases were analysed and the result tabulated as follows :—

Refused treatment	21	(0·6 per cent)
Received 1–3 injections (1–4·5 gr.)...	1,064	(29·3 ,,)
,, 4–7 injections (6·5–12·5 gr.)	987	(27·2 ,,)
,, 8–11 injections (14·5–20·5 gr.)	692	(19·1 ,,)
,, 12 injections (22·5 gr. upwards)	858	(23·8 ,,)

Schistosoma mansoni infection (Intestinal Bilharziasis) was recorded in less than 10 per cent of the cases suffering from Bilharziasis. The following table shows the result of microscopical examination of 1,873 cases who attended the Annexe during the last five months of the year :—

Schisiosoma hæmatobium infection (Urinary Bilharziasis)	1,448	(77·3 per cent)
Schistosoma mansoni infection (Intestinal Bilharziasis)	133	(7·3 ,,)
Negative	295	(15·6 ,,)

Ankylostomiasis.

Amongst the 5,449 cases which were suspected on clinical grounds to be suffering from Ankylostomiasis, the infection was verified microscopically in 4,593 (84·2 per cent). The negative cases were rejected. The average attendance of an Ankylostomiasis case was 2·7 times. It was found that :—

21 per cent received one treatment.
27 ,, received two treatments.
52 ,, went through the whole course of treatment.

Statistics are available for the first seven months of the year, showing the result of re-examination of cases after a full course of treatment.

919 such examinations were made on cases returning after a full course of treatment. Of these, 22 per cent revealed the presence of Ancylostoma ova in the stools and 78 per cent were negative for Ancylostoma ova.

Ascariasis.

Ascaris infection was incidentally recorded while examining the stools microscopically for Ancylostoma ova during the last five months of the year. The examination in each case was given up, once the Ancylostoma ovum was detected.

The number of cases was 2,186. The result of examination was as follows :—

Ancylostoma ova	1,718	(78·8 per cent)
Ascaris ova	407	(18·6 ,,)
Negative	295	(13·4 ,,)

Age and Sex of Patients attending the Annexe.

Figures showing the sex of patients attending the Annexe are available for the last five months of the year. The majority of the cases were adult males.

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	1,615	86·5	1,544	70·6	3,159	78·0
Females of all ages	249	13·5	642	29·4	891	22·0
Children of both sexes (under 12 years)...	218	11·6	297	13·5	515	12·7

(5) Tanta Annexe, 1922.

The number of new cases attending the Annexe during 1922 was 10,315 patients ; 16·5 per cent of these sought relief from Ankylostomiasis and 83·5 per cent from Bilharziasis.

7·8 per cent of the new cases were rejected as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment was 35 patients.

The greatest number of new cases attending in a single day was 94 on March 14 ; the lowest was 2 on July 22.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe was 8,604. This is the greatest number of Bilharziasis cases applying for treatment at a single Annexe during a year up to the present. Of these, 486 (5·6 per cent) were rejected after microscopical examination when no Bilharzia ova were detected. On an average a Bilharziasis case attended 9·3 times for injection—a very favourable result.

Statistics as regards re-examination after full course of treatment are only available for the first seven months of the year. 1,290 cases were examined at the end of four weeks from finishing the treatment, and of these, 51·9 per cent revealed Bilharzia ova in their excreta.

136 cases were examined at the end of three months from finishing the treatment, and of these, 38·2 per cent revealed the persence of Bilharzia ova in their excreta.

75,564 intravenous tartar emetic injections were given during the year. The average number of injections given daily was 256 injections. The greatest number of injections given in a single day was 483 on April 22 ; the lowest was 98 on March 28.

For the purpose of arriving at the average number of injections administered to Bilharziasis cases and the number of cases which completed the course of treatment, the records of 8,654 cases were analysed and the result was as follows :—

Refused treatment	375	(4·4 per cent)
Received 1 injection	985	(11·4 ,,)
,, 2 injections	600	(6·9 ,,)
,, 3 ,,	621	(7·2 ,,)
,, 4 ,,	555	(6·4 ,,)
,, 5 ,,	590	(6·8 ,,)
,, 6 ,,	532	(6·2 ,,)
,, 7 ,,	509	(5·8 ,,)
,, 8 ,,	469	(5·4 ,,)
,, 9 ,,	407	(4·7 ,,)
,, 10 ,,	404	(4·7 ,,)
,, 11 ,,	376	(4·4 ,,)
,, 12 ,,	622	(7·2 ,,)
,, 13 ,,	333	(3·8 ,,)
,, 14 ,,	326	(3·7 ,,)
,, 15 ,, or more	950	(11·0 ,,)

Schistosoma mansoni infection (Intestinal Bilharziasis) was recorded in about a quarter of the cases presenting themselves for Bilharziasis infection. The following table shows the result of microscopical examination of 4,023 cases which attended the Annexe during the last five months of the year :—

Schistosoma hæmatobium infection (Urinary Bilharziasis)	2,772	(68·9 per cent)
Schistosoma mansoni infection (Intestinal Bilharziasis)	997	(24·8 ,,)
Negative	245	(6·3 ,,)

Ankylostomiasis.

Amongst the 1,711 new cases which were suspected on clinical evidence to be suffering from Ankylostomiasis, the infection was verified microscopically in 1,379 (80·6 per cent) cases. The negative cases were rejected. The average attendance of an Ankylostomiasis patient was 2·6 times.

Statistics are available for the first seven months of the year, showing the result of re-examination of cases after a full course of treatment. 148 cases were examined, of whom 5·7 per cent revealed the presence of Ancylostoma ova in their stools. The rest were negative as regards the presence of ova.

The regularity of attendance of Ankylostomiasis patients and the after-results of the treatment can be gleaned from the following table :—

Number of patients attended	1,772	
Refused treatment and cases found negative	440	
Anthelmintic administered once only	794	(56·1 per cent)
,, ,, twice	429	(24·9 ,,)
,, ,, three times	266	(15·4 ,,)
,, ,, four times or more	233	(13·6 ,,)
Number of patients treated with chenopodium oil	257	(14·9 ,,)
,, ,, ,, thymol	1,465	(85·1 ,,)

The result of re-examination after treatment was as follows :—

	Positive.	*Negative.*
After two doses	28 (15·7 per cent)	150 (84·3 per cent)
After three doses	38 (16·0 ,,)	201 (84·0 ,,)
Three months after treatment	1 (6·2 ,,)	15 (93·8 ,,)

Ascariasis.

Ascaris infection was incidentally recorded while examining the stools microscopically for Ancylostoma ova during the last five months of the year. As the examination in each case was discontinued once an Ancylostoma ovum was detected, the record of Ascaris infection must have been much lower than what was actually present.

The number of cases was 576. The result of examinations was as follows :—

Ancylostoma ova	395	(68·6 per cent).
Ascaris ova	22	(3·9 ,,)
Negative	159	(27·6 ,,)

Age and Sex of Patients attending the Annexe.

The figures in the table below relate only to the last five months of the year. The majority of those attending the Annexe were males.

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	2,748	67·2	307	53·1	3,054	65·4
Females of all ages	580	32·8	270	46·9	850	34·6
Children of both sexes (under 12 years)	444	10·8	85	14·7	529	11·3

D.—REPORT ON THE WORK OF THE ANKYLOSTOMIASIS AND BILHARZIASIS ANNEXES DURING 1923.

(1) Qasr el 'Aini Annexe, 1923.

The number of new cases attending the Annexe during the year was 5,521. Of these, 4,142 (75 per cent) were examined for Bilharziasis and 1,379 (25 per cent) were examined for Ankylostomiasis.

The average number of new cases attending daily for examination and treatment was 30.

Bilharziasis.

4,142 cases were examined for Bilharziasis during the year. An analysis of the first 1,000 cases is given below :—

Urinary Bilharziasis	660	(66·0 per cent)
Intestinal Bilharziasis	26	(2·6 ,,)
Urinary and Intestinal Bilharziasis in same patient	8	(0·8 ,,)
Negative for Bilharziasis	306	(30·6 ,,)
Amœbiasis	8	(0·8 ,,)

Treatment was administered to 694 patients, of whom 442 (63·7 per cent) received the complete treatment and 252 (36·3 per cent) did not complete it. The result of treatment was as follows :—

Satisfactory	378	(54·5 per cent.)
Needed extra injection	12	(2·0 ,,)
Persistent sepsis	44	(6·3 ,,)

Two patients developed jaundice after the course of sodium antimony tartrate.

Two patients died after leaving the Annexe in apparently good condition.

One girl, after receiving the seventh injection was seized with convulsions, vomiting and diarrhœa the following day; died six hours after the appearance of these symptoms.

One male collapsed the same night after receiving the eighth injection. Patient stated to have travelled six miles on donkey back after receiving the injection.

Ankylostomiasis.

1,379 cases were examined for Ankylostomiasis and other intestinal parasitic infections at the Annexe during the year. Analysis of the records of the first 300 cases gave the following result:—

Negative cases	146
Ankylostoma (pure or mixed)	119
Ascaris only	8
Tænia only	5
Heterophyes only	3

Chronic diarrhœa and dysentery:—

Amœbic	6
Bilharzial	4
Bacillary	3
Flagellate	2

Oil of chenopodium was given to the majority of the Ankylostomiasis cases. Carbon tetrachloride was given to a fair percentage of the patients.

Attendance for oil of chenopodium treatment can be judged from the following analysis of 500 cases:—

Refused treatment	64	(12·8 per cent)
Received one treatment only	192	(38·4 „)
„ two treatments	115	(23·0 „)
„ three treatments	129	(25·8 „)

Age and Sex of Cases attending the Annexe.

72 per cent of the total number of cases were adult males, 12 per cent were adult females, and 16 per cent were children under 12 years of age.

(2) Qalyûb Annexe, 1923.

The number of new cases attending the Annexe during the year was 15,348, *i.e.* more than four times the number of those attending during the whole of 1922.

During the last six months of the year, every new patient attending the Annexe had to submit a specimen of urine and another of stools for microscopical examination, regardless of his symptoms. The average number of new cases presenting themselves daily for examination and treatment was 53.

The greatest number of new cases attending in a single day was 308 on August 11; the lowest number was 2 on January 8.

Bilharziasis.

The number of new cases examined microscopically for Bilharziasis at the Annexe during the year was 8,186. Of these, 3,325 (40 per cent) were negative for ova, on microscopical examination. This high percentage of negative cases was mainly due to the fact that the excreta of every person presenting himself at the Annexe were examined for both Bilharziasis and Ankylostomiasis regardless of the particular complaints.

On an average a Bilharziasis case received six injections, which was less than in any of the other Annexes. This might have apparently been due to the large number of Bilharziasis cases detected, as a result of microscopic examination of the urine of every patient. Cases that were mildly infected did not think it worth their while to complete the course of tartar emetic injections and dropped out after a few injections.

The records of 2,700 consecutive cases show the following result as regards the regularity in attending for tartar emetic injections :—

Negative for Bilharziasis	497	(18·4 per cent).
Refused treatment	457	(16·9 ,,)
Received 1–3 injections	786	(29·1 ,,)
,, 4–7 injections	358	(13·2 ,,)
,, 8–11 injections	206	(7·6 ,,)
,, 12 or more injections	396	(14·8 ,,)

28,341 intravenous tartar emetic injections were given during the year. The average number of injections given daily was 96. The greatest number of injections given in a single day was 318 on August 20 ; the lowest number was 7 on May 15.

Re-examination after the course of twelve injections showed that in 85 per cent of the cases no living ova were detected, while in 15 per cent living ova were still to be found and were given more injections.

Schistosoma mansoni.

Amongst the 4,959 cases in whose excreta Schistosoma ova were detected, 4,766 (92·2 per cent) harboured *Schistosoma hæmatobium* (Urinary Bilharziasis) and 193 (3·9 per cent) harboured *Schistosoma mansoni* (Intestinal Bilharziasis). The number of intestinal infection with *Schistosoma hæmatobium* was not recorded. Three cases of urinary infection with *Schistosoma mansoni* were recorded.

Monthly Records of Bilharziasis Cases attending the Annexe.

Months.	Number of New Cases.	Bilharziasis.			Attendances of Old Cases.
		Urinary.	Intestinal.	Negative.	
January	83	66	4	16	406
February	138	84	6	42	407
March	464	303	27	132	1,006
April	463	291	35	136	1,487
May	526	283	4	221	1,501
June	1,074	546	16	519	2,170
July	797	420	15	362	2,382
August	1,776	959	9	864	3,847
September	893	519	5	369	3,382
October	557	333	11	216	1,746
November	549	350	32	196	1,064
December	866	612	30	252	3,082
Total	8,186	4,766	193	3,325	23,480

Ankylostomiasis.

Microscopical examination of the stools of 7,162 new cases revealed the following result :—

Ancylostoma ova	5,716	(80·0 per cent).
Ascaris ova...	846	(11·8 ,,)
Negative	1,310	(18·3 ,,)

The average attendance of an Ankylostomiasis case was 1·6 times. This low number of attendance was due to the substitution of carbon tetrachloride for thymol and oleum chenopodii. One dose of the former was found to be more effective than three treatments of the latter drugs. The result of carbon tetrachloride treatment is the subject of another report in this volume.

Routine Microscopical Examination of Urine and Stools of all Cases attending the Annexe.

During the last six months of the year every case attending the Annexe was required to submit a specimen of urine and stools, for examination. The treatment was administered according to the findings of this examination. The total number examined was 5,438.

Ancylostoma ova	4,092	(75·2 per cent).
Schistosoma hæmatobium ova	3,193	(58·7 ,,)
Schistosoma mansoni ova	102	(2·0 ,,)
Ascaris ova	716	(13·1 ,,)

The negative cases for ova were very few, much less than 1 per cent. Their exact number was not recorded, as the urine and the stools were examined and entered into separate cards.

This series of cases demonstrates fully that a large percentage of the patients attending the Annexe, although complaining of the symptoms of one parasitic disease, on examination were found to be harbouring other parasites. Nothing but a microscopical examination detected mild cases of infection. On the other hand, treatment of mild cases of infection, especially Bilharziasis, proved unsatisfactory. The presence of urgent or painful symptoms was apparently the only factor that urged most patients to continue treatment to the end. Most of the patients with mild infection dropped off, after a few injections.

Monthly Records of Ankylostomiasis Cases attending the Annexe.

Months.	Number of New Cases.	Examination of Stools.			Attendances of Old Cases.
		Ankylostomiasis.	Ascaris.	Negative.	
January	80	59	4	24	84
February	91	71	6	11	67
March	202	182	3	—	117
April	181	142	—	—	264
May	381	381	—	—	292
June	789	789	117	—	314
July	797	625	87	172	393
August	1,776	1,386	125	381	782
September	893	640	95	239	262
October	557	341	51	196	176
November	549	439	117	92	135
December	866	661	242	195	431
Total	7,162	5,716	846	1,310	3,317

Age and Sex of Patients attending the Annexe.

	Bilharziasis.		*Ankylostomiasis.*		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	5,832	71·3	5,073	71·0	10,905	71·1
Females of all ages	2,354	28·7	2,089	29·0	4,443	28·9
Children of both sexes (under 12 years)	1,473	18·0	1,324	18·4	2,797	18·2

(3) Mansûra Annexe, 1923.

The number of new cases attending the Annexe during the year was 7,988, showing an increase of more than a 1,000 cases over those attending during 1922.

Of the total number, 28·2 per cent sought relief from Ankylostomiasis and 71·8 per cent from Bilharziasis. 1,253 (15·6 per cent) cases were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 28. The greatest number of new cases attending in a single day was 87 on March 22; the lowest number was 1 on February 3.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 5,733. Of these, 812 (14·2 per cent) were rejected after microscopical examination, as no Bilharzia ova were detected in the excreta. On an average a Bilharziasis case attended 7·7 times for injection.

The re-examination of cases which completed the course of twelve injections revealed that 78 per cent were cured.

42,060 intravenous tartar emetic injections were given during the year. The average number of injections given daily was 145. The greatest number of injections given in a single day was 367 on August 29; the lowest number was 44 on March 28.

The following table gives an analysis of the records of 4,930 cases as regards regularity in attending for injection.

Refused treatment	74	(1·7 per cent)
Received 1–3 injections	817	(18·6 ,,)
,, 4–7 injections	859	(19·6 ,,)
,, 8–11 injections	1,363	(31·0 ,,)
,, 12 or more injections	1,277	(29·1 ,,)

MONTHLY RECORDS OF BILHARZIASIS CASES ATTENDING THE ANNEXE.

MONTHS.	Number of New Cases.	Bilharziasis.			Attendances of Old Cases.
		Uninary.	Intestinal.	Negative.	
January	227	172	70	10	1,561
February	244	207	69	5	1,745
March	359	300	110	11	2,110
April	366	295	95	16	2,792
May	311	243	67	25	1,838
June	746	572	171	77	3,827
July	625	444	97	132	4,025
August	1,151	770	290	294	5,739
September	809	569	192	136	6,286
October	257	169	83	37	2,669
November	251	182	93	24	1,802
December	387	269	128	45	2,745
TOTAL	5,733	4,192	1,365	812	37,139

Schistosoma mansoni.

Amongst the 4,921 cases in whose excreta Schistosoma ova were detected, 4,192 (85·2 per cent) harboured *Schistosoma hæmatobium* (Urinary Bilharziasis) and 1,365 (27·7 per cent) harboured *Schistosoma mansoni* (Intestinal Bilharziasis). The number of intestinal infections with *Schistosoma hæmatobium* was not recorded.

Ankylostomiasis.

The result of microscopical examination of the stools of the 2,255 new cases who were suspected on clinical grounds, to be suffering from Ankylostomiasis was as follows:—

Ancylostoma ova	2,253	(99·9 per cent)
Ascaris ova...	441	(19·5 ,,)
Negative	1	(0·04 ,,)

The average attendance for treatment of an Ankylostomiasis case was 2·7 times. The anthelmintic generally used was oleum chenopodii.

Analysis of the records of 500 cases showed that the attendance was as follows :—

Refused treatment	7	(1·4 per cent.)
Received one treatment only	100	(20·0 ,,)
,, two treatments	222	(44·4 ,,)
,, three treatments or more	171	(34·2 ,,)

Re-examination of the stools after a complete course of treatment showed that 69 per cent were cured. Apparently a smear preparation of the stool was examined.

MONTHLY RECORDS OF ANKYLOSTOMIASIS CASES ATTENDING THE ANNEXE.

MONTHS.	Number of New Cases.	Examination of Stools.			Attendances of Old Cases.
		Ankylostomiasis.	Ascaris.	Negative.	
January	119	119	19	—	250
February	149	149	39	—	287
March	211	211	40	—	434
April	236	236	58	—	544
May	192	192	36	—	337
June	333	330	48	—	406
July	238	238	40	—	541
August	270	270	51	—	295
September	232	232	35	—	337
October	88	88	23	—	169
November	67	67	19	—	113
December	120	120	33	—	205
TOTAL	2,255	2,252	441	—	3,918

AGE AND SEX OF PATIENTS ATTENDING THE ANNEXE.

	Bilharziasis.		Ankylostomiasis.		TOTAL.	
	Number.	Per Cent.	Number.	Per Cent	Number.	Per Cent.
Males of all ages	4,571	79·7	1,691	75·0	6,262	78·4
Females of all ages	1,162	20·3	564	25·0	1,726	21·6
Children of both sexes (under 12 years)	1,095	19·1	492	21·8	1,587	20·0

(4) BENHA ANNEXE, 1923.

The number of new cases attending the Annexe during 1923 was 11,135, an increase of about 1,000 over those attending during 1922.

Of the total number, 60·7 per cent sought relief from Ankylostomiasis and 3·9 per cent from Bilharziasis. 1,816 cases (16·3 per cent) were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 38.

The greatest number of new cases attending in a single day was 122 on September 8 ; the lowest number was 2 on May 14.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 4,369 patients. Of these, 702 (16 per cent) were rejected after microscopical examination, as no Bilharzia ova were detected. On an average a Bilharzia case attended seven times for injection—an unsatisfactory result as compared with other Annexes.

Re-examination of cases completing the course of twelve injections revealed that 97 per cent were cured, passing no ova or only dead ova in their excreta.

26,826 intravenous tartar emetic injections were given during the year. The average number of injections given in a single day was 92 injections. The greatest number of injections given in a single day was 182 on August 27; the lowest number was 17 on May 15.

The following table shows an analysis of the records of 2,850 Bilharziasis cases as regards regularity in attending for injections:—

Refused treatment	261	(9·2 per cent)
Received 1–3 injections	714	(25·0 ,,)
,, 4–7 injections	692	(24·3 ,,)
,, 8–11 injections	521	(18·2 ,,)
,, 12 or more injections	662	(23·3 ,,)

Monthly Records of Bilharziasis Cases attending the Annexe.

Months.	Number of New Cases.	Bilharziasis.			Attendances of Old Cases.
		Urinary.	Intestinal.	Negative.	
January	217	166	24	29	1,683
February	197	147	32	26	1,451
March	418	315	48	59	2,013
April	307	222	35	54	2,475
May	164	123	16	29	1,208
June	342	263	30	59	1,509
July	338	277	19	54	1,282
August	650	543	25	101	2,475
September	612	512	26	93	3,297
October	331	281	16	43	2,294
November	307	270	12	33	992
December	486	416	32	62	2,480
Total	4,369	3,535	315	702	23,159

Schistosoma mansoni.

Amongst the 3,667 cases in whose excreta Schistosoma ova were detected, 3,535 (96·4 per cent) cases harboured *Schistosoma hæmatobium* (Urinary Bilharziasis) and 315 (8·6 per cent) harboured *Schistosoma mansoni* (Intestinal Bilharziasis). The percentage of intestinal infection with *Schistosoma hæmatobium* was not recorded.

Ankylostomiasis.

Microscopical examination of the stools of 6,766 new cases suspected on clinical evidence to be suffering from Ankylostomiasis showed the following result:—

Ancylostoma ova	4,338	(64·0 per cent)
Ascaris ova	1,808	(26·7 ,,)
Negative	2,040	(30·2 ,,)

The average attendance of an Ankylostomiasis case was 3·8 times. The drug generally used was oleum chenopodium. Analysis of the records of 500 cases showed that their attendance was as follows:—

Refused treatment	—
Received one treatment only	149 (29·8 per cent)
,, two treatments	127 (25·4 ,,)
,, three or more treatments	224 (44·8 ,,)

Re-examination of the stools after a complete course of three treatments with oleum chenopodium showed that 74 per cent were cured. Apparently examination of a smear of the stool was made.

MONTHLY RECORDS OF ANKYLOSTOMIASIS CASES ATTENDING THE ANNEXE.

MONTHS.	Number of New Cases.	Examination of Stools.			Attendances of Old Cases.
		Ankylostomiasis.	Ascaris.	Negative.	
January	131	100	30	19	369
February	155	101	34	39	307
March	600	385	132	135	797
April	544	343	134	119	1,170
May	201	146	30	38	373
June	534	368	118	107	832
July	613	439	223	903	878
August	1,262	858	503	178	2,160
September	1,198	773	483	203	2,491
October	619	375	290	103	1,203
November	331	168	157	66	662
December	578	282	274	128	855
TOTAL	6,766	4,338	1,808	2,040	12,097

AGE AND SEX OF PATIENTS ATTENDING THE ANNEXE.

	Bilharziasis.		Ankylostomiasis.		TOTAL.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	3,718	85·0	4,778	70·6	8,496	76·3
Females of all ages	651	15·0	1,988	29·4	2,639	23·7
Children of both sexes (under 12 years)	708	11·6	1,108	16·3	1,816	16·3

(5) TANTA ANNEXE, 1923.

The number of new cases attending the Annexe during the year was 12,031, showing an increase of about 2,000 over those attending during 1922.

Of the total number, 13 per cent sought relief from Ankylostomiasis and 87 per cent from Bilharziasis. 853 (7 per cent) were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the year was 41.

The greatest number of new cases attending in a single day was 135 cases on August 19; the lowest number was 4 on May 13.

Bilharziasis.

The number of Bilharziasis cases attending the Annexe during the year was 10,474 patients. This was the greatest number of Bilharziasis cases applying for treatment at a single Annexe during the year. Of these, 692 (6·6 per cent) were rejected after microscopical examination, as no Bilharzia ova were detected in their excreta. On an average a Bilharziasis case attended 8·2 times for injection.

Re-examination of cases completing the course of twelve injections revealed that 60 per cent were cured and that 40 per cent had Bilharzia ova in their excreta. Unfortunately the state of viability of these ova was not stated.

80,734 intravenous tartar emetic injections were given during the year. The average number of injections given daily was 274 injections. The greatest number of injections given in a single day was 615 on August 29; the lowest number was 60 on May 20.

The following table gives an analysis of the records of 2,700 cases as regards regularity of attendance for injection:—

Refused treatment	457	(17·0 per cent)
Received 1–3 injections	786	(29·1 ,,)
,, 4–7 injections	358	(13·2 ,,)
,, 8–11 injections	206	(7·6 ,,)
,, 12 or more injections	396	(14·7 ,,)

Monthly Records of Bilharziasis Cases attending the Annexe.

Months.	Number of New Cases.	Bilharziasis.			Attendances of Old Cases.
		Urinary.	Intestinal.	Negative.	
January	629	448	113	68	5,308
February	380	274	102	4	3,337
March	728	591	168	30	4,492
April	607	420	169	18	5,864
May	364	269	91	4	3,226
June	944	633	295	16	5,701
July	632	390	233	9	4,435
August	1,622	1,099	455	68	7,819
September	1,627	1,004	456	167	11,069
October	842	485	275	82	6,925
November	1,025	601	354	70	6,233
December	1,074	571	337	166	6,540
Total	10,474	6,785	3,048	692	70,949

Schistosoma mansoni.

Amongst the 9,782 cases in whose excreta Schistosoma ova were detected, 6,785 (69·3 per cent) harboured *Schistosoma hæmatobium* (Urinary Bilharziasis) and 3,048 (31·2 per cent) harboured *Schistosoma mansoni* (Intestinal Bilharziasis). The number of intestinal infection with *Schistosoma hæmatobium* was not recorded.

Ankylostomiasis.

Microscopical examination of the stools of the 1,557 new cases who were suspected on clinical grounds to be suffering from Ankylostomiasis showed the following result:—

Ancylostoma ova	1,315	(84·5 per cent)
Ascaris ova	99	(6·4 ,,)
Negative	161	(10·3 ,,)

The average attendance of an Ankylostomiasis case was 3 times. The drug generally used was oleum chenopodii.

Analysis of the records of 500 cases showed that their attendance was as follows:—

Refused treatment	3	(0·6 per cent)
Received one treatment only	240	(48·0 ,,)
,, two treatments	105	(21·0 ,,)
,, three or more treatments	152	(30·4 ,,)

Re-examination of the stools after a complete course of three treatments showed that 75 per cent were cured and 25 per cent were still harbouring the parasite. Apparently only a smear preparation of the stool was examined.

Monthly Record of Ankylostomiasis Cases attending the Annexe.

Months.	Number of New Cases.	Examination of Stools.			Attendances of Old Cases.
		Ankylostomiasis.	Ascaris.	Negative.	
January	75	66	—	7	
February	65	53	—	12	126
March	76	63	—	13	151
April	53	33	—	20	89
May	73	71	—	2	121
June	235	228	—	7	400
July	159	139	7	13	315
August	287	260	5	22	511
September	218	194	14	10	405
October	54	40	—	14	177
November	50	31	3	16	52
December	212	137	70	5	198
Total	1,557	1,315	99	141	2,636

Age and Sex of Patients attending the Annexe.

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	9,162	88·0	921	59·1	10,043	84·3
Females of all ages	1,312	12·0	636	40·9	1,948	15·7
Children of both sexes (under 12 years).	1,759	17·0	279	18·0	2,038	16·9

(6) Port Said Annexe, 1923.

Establishment of the Annexe.

Port Said is a unique city amongst the towns of Egypt. It was built comparatively recently and practically all its inhabitants were recruited from the interior of the country during the construction of the Suez Canal. The town is surrounded by salt water practically on all sides. No cultivable land exists within reach of the town, so that the town depends on food brought from the Damietta area across the Lake of Menzala. The inhabitants are mostly dock labourers and employees of commercial houses. The water supply is drawn from the fresh water canal of Ismailia and is filtered before distribution. The town is provided with a good system of sewers. In such a city it is expected that there will be no endemic Bilharziasis or Ankylostomiasis.

Fishermen coming to Port Said from across the Lake were the main clientèle of the Annexe as far as Ankylostomiasis and Bilharziasis were concerned. Experience at the Annexe showed that there were very few cases of Bilharziasis and Ankylostomiasis and it might be safely concluded that most of these cases contracted their infection elsewhere. It was for this reason that the Annexe was transferred to Damanhûr, where infection with Bilharziasis is said to be prevalent.

Most of the cases attending the Annexe from the town itself and no less than 2,344 (68 per cent) of all the cases that attended, suffered from Ascariasis. The high incidence of infection with Ascaris at Port Said demands investigation.

Infection with Tænia (probably *saginata* in all cases) was more prevalent than anywhere else in the country. Port Said is supplied with meat from many sources. Frozen meat imported from Australia and New Zealand is consumed in fair amounts at Port Said, where there are special cold storage depôts. In addition there is a local slaughter-house. Meat might also be brought across the Lake of Menzala. This subject demands enquiry.

Work of the Annexe.

The Annexe was opened on March 8, 1923, and was working for about five months, during which period only 29 Ankylostomiasis cases applied for treatment; it was consequently closed down on July 29, 1923.

The Annexe was attached to the Government General Hospital at Port Said, under the supervision of the Director of the Hospital, for the study of the effectiveness of carbon tetrachloride as an anthelmintic.

During the period, 3,448 new cases were examined, of whom 650 (18 per cent) were rejected after microscopical examination, as no ova were detected in their excreta. Out of the total number, 267 (7·4 per cent) attended the Bilharziasis Section and 3,181 (92·6 per cent) attended the Ankylostomiasis Section.

Bilharziasis.

During the period under review the excreta of 267 new cases were examined microscopically for Bilharzia ova. The result of the examination was as follows :—

Schistosoma hæmatobium	197	(73·9 per cent)
Schistosoma mansoni	53	(19·8 „)
Negative	17	(6·5 „)

Ankylostomiasis.

3,181 cases were examined microscopically for Ankylostomiasis and other intestinal helminth infections. The result of the examination was as follows :—

Ankylostomiasis...	29	(0·91 per cent)
Ascaris	2,344	(73·6 „)
Tænia	28	(0·89 „)
Oxyuris	149	(4·0 „)
Negative	633	(19·9 „)

Monthly Record of Bilharziasis Cases attending the Annexe.

Months.	Number of New Cases.	Bilharziasis.			Attendances of Old Cases.
		Urinary.	Intestinal.	Negative.	
March	56	41	4	11	—
April	51	42	7	2	—
May	41	25	12	4	—
June	80	59	21	—	—
July	39	30	9	—	—
Total	267	197	53	17	—

MONTHLY RECORD OF ANKYLOSTOMIASIS CASES ATTENDING THE ANNEXE.

MONTHS.	Number of New Cases.	Examination of Stools.			Attendances of Old Cases
		Ankylostomiasis	Ascaris.	Negative.	
March	12	6	5	1	—
April	35	12	20	2	—
May	408	6	295	104	—
June	2,147	—	1,619	405	—
July	579	5	405	121	—
TOTAL	3,181	29	2,344	554	—

APPENDIX I.—TABULAR RÉSUMÉ OF THE NUMBER OF PATIENTS EXAMINED AND TREATED AT THE ANNEXES DURING 1920-1923.

NUMBER OF PATIENTS EXAMINED AND TREATED AT THE ANNEXES DURING 1920.

ANNEXE.	Date of Opening.	New Cases.	Microscopical Examination.			Attendances for Treatment.		Grand Total of Attendances.
			Bilharzia Ova present.	Ancylostoma Ova present.	Negative.	Bilharziasis.	Ankylostomiasis.	
Qalyûb	20–7–1920	1,246	647	208	409	4,950	565	5,515
Mansûra	1–8–1920	968	690	77	201	4,578	243	4,821
Benha	1–9–1920	1,395	583	635	197	3,548	1,201	4,749
TOTAL ...		3,627	1,900	920	807	13,076	2,009	15,085

NUMBER OF PATIENTS EXAMINED AND TREATED AT THE ANKYLOSTOMIASIS ANNEXES DURING 1921.

ANNEXE.	Grand Total of New Cases.	Grand Total of Attendances.	Bilharziasis.				Ankylostomiasis.			
			Total New Cases.	Microscopical Examinations.		Attendances.	Total New Cases.	Microscopical Examinations.		Attendances.
				Bilharzia Ova present.	Negative.			Ancylostoma Ova present.	Negative.	
Qalyûb ...	6,108	26,964	2,815	2,726	89	19,590	3,293	3,128	165	7,374
Mansûra ...	6,124	38,477	4,079	3,866	213	30,487	2,045	1,647	398	7,990
Benha	11,885	48,438	5,860	5,008	852	36,046	5,025	4,808	1,217	12,392
Tanta ... ... (July–Dec.)	6,977	41,067	5,204	5,000	204	37,929	1,773	1,360	413	3,138
TOTAL ...	31,094	154,946	17,958	16,600	1,356	124,052	12,136	10,943	2,193	30,894

NUMBER OF PATIENTS EXAMINED AND TREATED AT THE ANKYLOSTOMIASIS ANNEXES DURING 1922.

ANNEXE.	Grand Total of New Cases.	Grand Total of Attendances.	Bilharziasis.				Ankylostomiasis.			
			Total New Cases.	Microscopical Examinations.		Attendances.	Total New Cases.	Microscopical Examinations.		Attendances.
				Bilharzia Ova Present.	Negative.			Ancylostoma Ova Present.	Negative.	
Qalyûb ...	3,337	12,926	1,702	1,516	186	10,294	1,635	790	843	2,632
Mansûra ...	6,967	46,536	4,375	4,232	143	35,932	2,592	2,466	126	10,604
Benha	10,195	43,489	4,746	3,752	994	31,088	5,449	4,593	856	12,401
Tanta	10,315	79,150	8,604	8,118	486	75,564	1,711	1,379	332	3,586
TOTAL ...	30,814	182,101	19,427	17,618	1,809	152,878	11,387	9,228	2,159	29,223

NUMBER OF THE PATIENTS EXAMINED AND TREATED AT THE ANKYLOSTOMIASIS ANNEXES DURING 1923.

ANNEXE.	Grand Total of New Cases.	Total Attendances.	Bilharziasis.					Ankylostomiasis.				
			Total New Cases.	Microscopical Examination.			Attendances.	Total New Cases.	Microscopical Examination.			Attendances.
				Urinary.	Intestinal.	Negative.			Ancylostoma.	Ascaris.	Negative.	
Qalyûb ...	15,348	37,510	8,186	4,766	193	3,325	28,341	7,162	5,716	846	1,310	9,169
Mansûra ...	7,988	48,232	5,733	4,192	1,365	812	42,060	2,255	2,253	441	1	6,172
Benha	11,135	43,649	4,369	3,535	315	702	26,826	6,766	4,338	1,808	2,040	16,823
Tanta	12,031	84,784	10,474	6,785	3,048	692	80,731	1,557	1,315	99	141	4,053
TOTAL ...	46,501	214,175	28,762	19,278	4,221	6,531	177,968	17,740	13,622	3,194	3,492	36,217

APPENDIX II.—FLUCTUATIONS IN THE NUMBER OF NEW CASES AT THE ANKYLOSTOMIASIS AND BILHARZIASIS ANNEXES.

The number of new cases applying for treatment at the Annexes was not uniformly distributed throughout the year. There were periods in which the number of patients was so great that they could not all be accepted for examination and treatment and so some had to be deferred to a later date. At Tanta and Benha Annexes patients complained of being unable to get into the Annexes in spite of attempting to do so for several consecutive days. Some were often seen at the door of the Annexes at sunrise, coming from distant villages. It was found necessary to provide a place for donkeys at Qalyûb Annexe in order to prevent congestion of traffic on the main road in front of the General Hospital there.

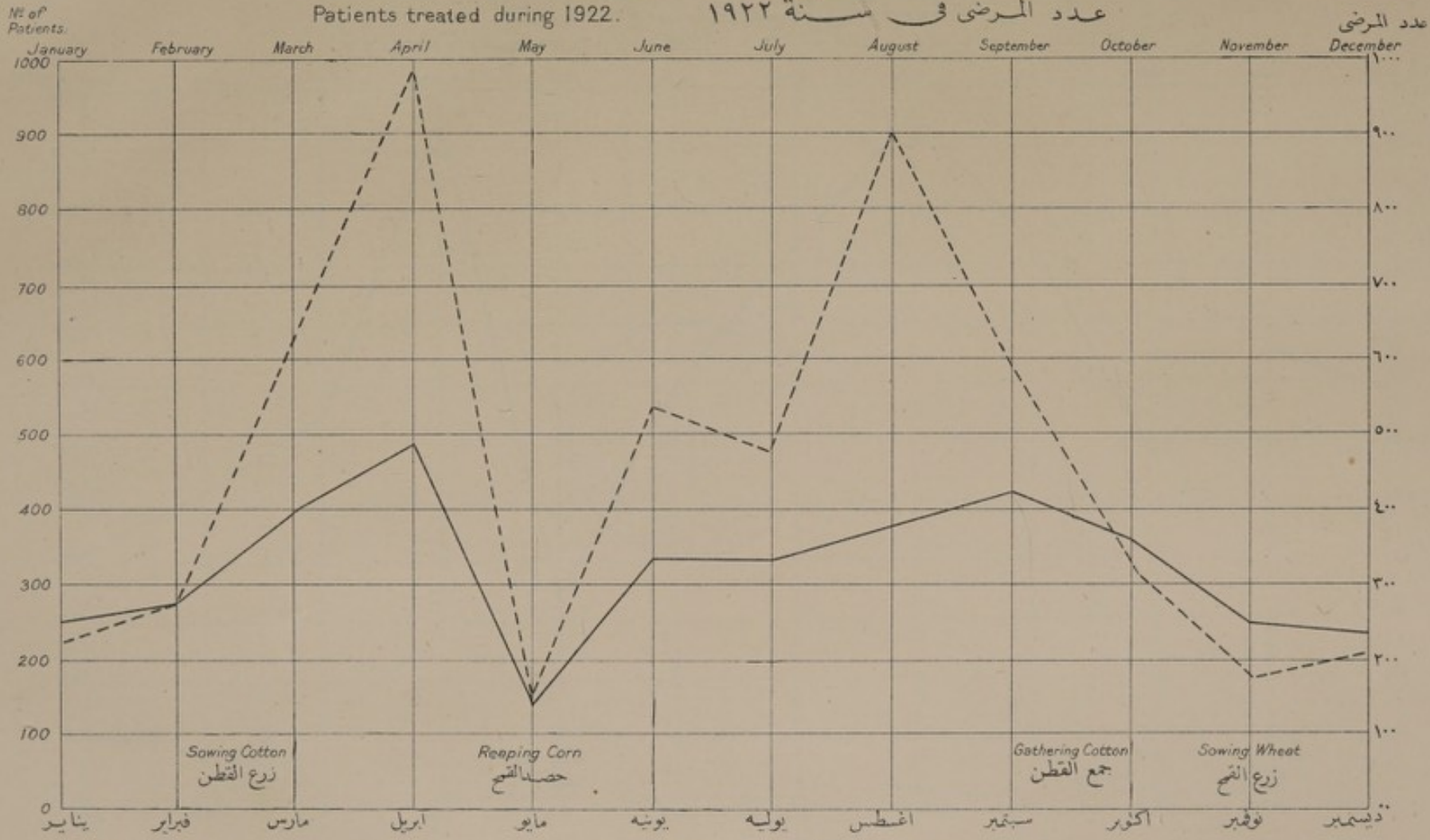
On the other hand there were periods in which the work was very slack, the number of new cases very low and attendance for treatment very irregular.

It was noted that the sudden rise or fall in the number of patients occurs more or less simultaneously at all the Annexes.

BENHA ANKYLOSTOMA ANNEXE

مستشفى الانكلستوما ببنها

Patients treated during 1922. عدد المرضى فى سنة ١٩٢٢



S.of E. 24/416.

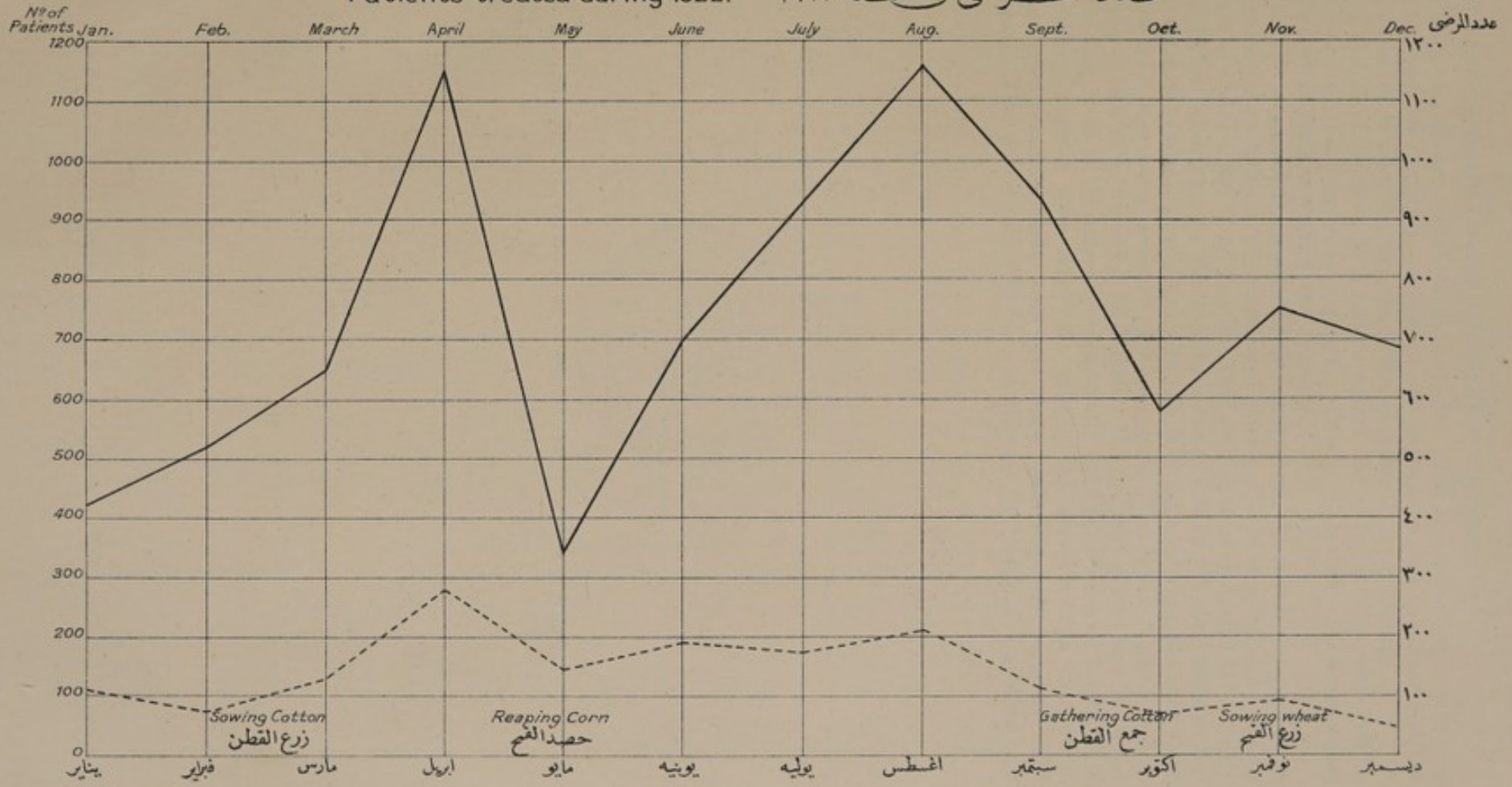
Bilhar. ——— البلهارسيا

Ankyl. - - - - - - - الانكلستوما

TANTA ANKYLOSTOMA ANNEXE

مستشفى الانكلستوما بطنطا

Patients treated during 1922. عدد المرضى فى سنة ١٩٢٢



S. of E. 24/416.

Bilhar. ——— البلهارسيا

Ankyl. - - - - - - الانكلستوما

The following are some of the factors causing irregularity in attendance :—

(1) The demand or otherwise of manual labour in the fields. The accompanying two graphs from two of the Annexes show the monthly number of new cases attending in a year and the relation between the fluctuation in number and the principal seasons of agriculture.

(2) The state of the weather influences to a certain extent the attendance of cases. More patients apply for treatment during summer than during the winter. Rainy days are phenomenal in the very small number of patients attending the Annexes.

(3) During Ramadan, the month of fasting of the Mohammedans, the number of patients is usually very low, as the taking of medicine or injections during this period is regarded as a breaking of the fast. Only those who are severely ill or incapacitated seek treatment during this month.

It is evident that economic conditions are the important factor influencing the attendance of patients for treatment. In seasons when work is scarce people flock for treatment, but once there is a chance of employment they postpone it, however urgent it seems. The day on which a patient attends the Annexe is a loss to him as no wage will be earned. He generally comes from a distant village and has to wait a long time at the Annexe, leaving the Annexe at noon or later. It is probable that if the treatment centre were close to a village, the loss of a little time would not prevent the patients from resuming their work and would ensure greater regularity and perseverance in attendance. This would probably be best effected by means of travelling tent units.

PART IV.

Financial Statement.

1.—Cost of Examination and Treatment at the Ankylostomiasis and Bilharziasis Annexes.

In considering a scheme for an attempt at the relief of such widespread diseases as Ankylostomiasis and Bilharziasis in Egypt, the item of cost must receive careful attention. The appended tables show the capital expenditure and per capita cost for examination and treatment during the years in which the work was undertaken.

It was found that the cost of drugs was an insignificant fraction of the expenditure.

The salaries of the medical officers amount to about 40 per cent of the total expenditure. Since 1922 two medical officers have been attached to each Annexe ; before that date one only was in charge.

The salaries of attendants amount to about 20 per cent, whilst the cost of equipment and apparatus, drugs and rents amount to 40 per cent of the total expenditure.

It will be noted that all microscopical examinations and treatments are carried out by qualified medical men, in contradistinction to the practice in campaigns in other countries, where such microscopical work is entrusted to trained attendants. If the same could be adopted in Egypt it would reduce the expenses.

The Bilharzia treatment necessitating such a large number of attendances and careful preparation and administration of intravenous injections occupies most of the time of the medical officers. This work has to be carefully watched to be efficient. No similar work is undertaken anywhere in the world on a large scale except at the venereal campaign clinics in England and America.

It is gratifying to know that the per capita cost of examination and treatment is so low during the last three years and is lower than in similar undertakings in other countries.

The International Health Board of the Rockefeller Foundation has established an index expressed as per capita cost of examination or of treatment for the sake of comparison between similar works in different countries. The index is arrived at by the simple process of dividing the budgetary expenditure of the campaign by the number of persons examined or treated. While this is called "per capita cost " for want of a better term, it is understood that it is not the actual per capita cost but only an index of cost which for purposes of comparison is sufficient.

The real per capita cost in Egypt is calculated in a tabular form later.

(*a*) Per Capita Cost according to the International Health Board's Standard.

	Examination.		Treatment.	
	P.T.	Amer. Doll.	P.T.	Amer. Doll.
Campaign in Egypt (1913–1915)	35·5	1·77	64·0	3·20
During the year 1920*	137·0	6·85	187·0	9·35
During the year 1921	18·0	0· 9	23·0	1·15
During the year 1922	15·0	0·75	17·0	0·85
During the year 1923	10·5	0·53	13·0	0·65
Queensland (Australia), 1918–1919	22·4	1·12	129·6	6·48
Trinidad (West Indies), 1914–1919	22·8	1·14	34·8	1·74
Antigua (West Indies), 1916–1917	17·0	0·85	120·0	6· 0
Jamaica (West Indies), 1919	32·6	1·63	70·2	3·51
St. Vincent (West Indies), 1915–1919	14·4	0·72	26·4	1·32
British Guiana, 1914–1919	24·2	1·21	43·6	2·18
Dutch Guiana, 1915–1917	37·4	1·87	44·2	2·21

* The expenses included cost of construction of two Annexes which were open only for a period of four months during that year.

It is thus evident from the above table that in spite of the inclusion of Bilharziasis examination and treatment in addition to Ankylostomiasis work the per capita cost in 1923 was the lowest on record amongst the countries above-mentiond.

(*b*) The Real Cost of the Treatment.

As has been mentioned before, the cost of drugs used in the treatment was insignificant and so it is feasible to divide the total expenditure by the number of individual visits to the Annexes. The cost of one visit represents the per capita cost for examination. The cost of three visits represents the per capita cost for Ankylostomiasis treatment, as it is the general rule with thymol and oil of chenopodium to administer three treatments. The cost of twelve visits represents the per capita cost of Bilharziasis treatment.

The substitution of carbon tetrachloride as an anthelmintic in Ankylostomiasis instead of thymol and oil of chenopodium will reduce the per capita cost of Ankylostomiasis treatment during 1924 to one-third of its cost during 1923, one treatment with carbon tetrachloride being sufficient in 76 per cent of the cases.

2.—Cost of Examination and Treatment at the Ankylostomiasis and Bilharziasis Annexes.

Annexes.	Number of Microscopical Examinations and Re-examinations.	Number of Attendances for Treatment.	Total Expenditure.	Examination.			Ankylostomiasis Cured.			Bilharziasis Cured.		
			L.E.	P.T.	Shilling and Pence.	Amer. Dollars.	P.T.	Shilling and Pence.	Amer. Dollars.	P.T.	Shilling and Pence.	Amer. Dollars.
Qalyûb.												
1920 ...	2,699	5,515	2,210	27·0	5/4	1·40	81·0	16/3	4·00	324	66/–	16·20
1921 ...	8,746	21,112	768	2·5	0/6	0·12	7·5	1/6	0·37	30	6/–	1·50
1922 ...	4,579	12,926	1,151	6·4	1/3	0·32	19·2	4/–	0·96	77	16/–	3·80
1923 ...	21,947	37,510	1,117	1·9	0/5	0·10	5·7	1/2	0·25	22·8	4/7	1·14
Mansûra.												
1920 ...	1,370	4,821	1,270	20·5	4/2	1·00	61·5	12/4	3·10	246·0	50/–	1·23
1921 ...	11,228	31,523	840	2·0	0/5	0·10	6·0	1/2	0 30	24·0	4/10	1·20
1922 ...	12,795	46,536	1,098	1·8	0/4	0·09	5·4	1/1	0·27	21·6	4/4	1·08
1923 ...	8,693	48,232	1,220	2·1	0/5	0·10	6·3	1/3	0·31	25·2	5/1	1·26
Benha.												
1920 ...	1,522	4,749	1,058	17·0	3/3	0·80	51·0	10/3	2·50	204·0	41/–	10·20
1921 ...	9,660	34,977	726	1·6	0/4	0·08	4·8	1/–	0·24	20·0	4/–	1·00
1922 ...	11,437	43,489	1,355	2·4	0/6	0·12	7·2	1/5	0·35	28·8	6/–	1·40
1923 ...	13,945	43,649	1,135	2·0	0/5	0·10	6·0	1/3	0·30	24·0	4/10	1·20
Tanta.												
1921 ...	7,672	41,067	663	1·3	0/3	0·06	4·0	0/10	0·20	16·0	3/2	0·80
1922 ...	11,753	79,150	1,104	1·2	0/3	0·06	3·6	0/9	0·18	14·4	3/–	0·72
1923 ...	14,409	84,784	1,418	1·4	0/3	0·07	4·2	0/10	0·21	16·8	3/5	0·84
Totals and Averages for all the Annexes.												
1920 ...	5,591	15,085	4,538	22·0	4/5	1·10	66·0	13/3	3·30	264·0	53/–	13·20
1921 ...	37,306	128,679	2,997	1·8	0/4	0·09	5·4	1/1	0·27	21·6	4/4	1·08
1922 ...	40,564	182,101	4,708	2·1	0/5	0·10	6·3	1/4	0·31	25·2	5/–	1·26
1923 ...	58,989	214,175	4,890	1·8	0/4	0·09	5·4	1/1	0·27	21·6	4/4	1·08

3.—Staff Establishment of an Annexe.

The following list gives the necessary staff for starting an Ankylostomiasis and Bilharziasis treatment centre.

The expenses are so small in comparison with the number of persons that can be treated.

	Salary (L.E. per annum).	
2 medical officers	432	000
1 clerk	72	000
1 bash-tamurgy (chief male nurse)	43	200
2 male attendants	50	400
1 female attendant	21	600
1 ghafir (guard)	21	600
1 incinerator man	32	400
TOTAL	673	200

It is to be noted that in small travelling hospitals the staff as shown above can be reduced.

4.—Equipment Establishment of an Annexe capable of treating 12,000 Patients per Year.

	Quantity.	Price.	
		L.E.	Mill.
Aprons, ward, orderlies', material	4	0	316
Barrels, glass, for filters, 10 litres, complete	1	0	600
Barrels, half	2	0	600
Basin, wash-hand, 38 centimetres top-diameter	4	0	352
Baskets, wooden, correspondence	1	0	080
Baskets, wooden, waste paper	1	0	120
Blankets, woollen, brown, 230 × 155 centimetres	10	3	890
Boards, black, various sizes	1	1	144
Brooms, hair, wall, without handle	1	0	305
Bedsteads, canvas, folding	6	6	540
Boxes, card index	1	3	345
Cans, zinc, W.C.	2	0	096
Cases, slip, pillow, 2nd class, long, 95 × 45 centimetres	20	3	500
Cases, wood, packing, No. 1	9	1	080
Cases, wood, packing, No. 2	6	1	320
Chairs, wooden	2	1	078
Chairs, cane-bottomed, bentwood	4	2	760
Cupboards, ward, large	1	4	522
Cupboards, wooden	1	2	711
Flag, hospital	1	0	750
Flagstaff	1	0	354
Gallabiya, blue-grey, women's, large	2	0	572
Glasses, water, ½ pint	3	0	020
Gowns, white, drill, laboratory	3	1	800
Jackets, linen, bashtamurgies	2	1	360
Jugs, i.e., wash-hand, 3½ litres	2	0	360
Lamps, tent, spirit	4	0	600
Lamps, hurricane	3	0	480
Mugs, aluminium, drinking, ½ litre	10	0	300
Pails, i.e., 18 litres	3	0	900
Pails, i.e., for night stools	6	2	100
Pans, i.e., sauce, 1 handle, without cover, 1 litre	1	0	050
Pans, i.e., sauce, 1 handle, without cover, 2 litres	1	0	075
Pans, i.e., bed, round, with cover	50	6	000
Pillows, cotton, long, 40×90, 3 kilos.	12	1	200
Plates, i.e., gullah, 9"	6	0	150

	Quantity.	Price. L.E.	Mill.
Racks, hats and clothes, 3 pegs	2	0	200
Sacks, grain	5	0	150
Sacks, tibn	8	0	640
Scrapers, iron, door	2	0	380
Sealers, lead	1	0	590
Boots, tamurgia, large	3	0	510
Stand, iron, wash-hand	1	0	250
Tables, wooden, ward, 2 metres	1	2	570
Tables, wooden, small, various	4	6	000
Tables, wooden, office, 3 drawers	1	3	691
Teshts, copper, 100 centimetres	1	1	200
Towels, white, hospital	3	0	300
Trousers, white, bash-tamurgia, large	2	0	976
Trousers, white, linen, orderlies, large	4	1	440
Veils, nurses, 200 × 100 centimetres	2	0	144
Wardrobe, general pattern	1	3	500
TOTAL		74	356

5.—Instrument Establishment of an Annexe.

	Quantity.	Price. L.E.	Mill.
Enemas, indiarubber	2	0	278
Forceps, dissecting	1	0	174
Forceps sterilizers	1	0	844
Scalpels, operation, 6"	2	0	382
Scissors, dressing, curved, screw joints	1	0	311
Scissors, dressing, straight, open shanks	1	0	465
Sounds, bladder, Cutton's	1	0	646
Stethoscopes, binaural	1	0	300
Syrings, hypodermic, glass, 2 c.c.	30	1	050
Lamps, glass, spirit	1	0	060
Scales, dispensing, 1 : 2,000 grammes	1	2	563
Sterilizers, syringes	2	1	150
Trays, instrument, i.e., square	4	0	716
Centrifuges, blood, hand	1	6	435
Forceps, microscopic slides	1	0	112
Microscopes, stand	2	55	502
„ objectives	4	9	224
„ oculars	4	1	932
Stands, urine test, complete	2	2	386
TOTAL		85	604

PART V.

Ankylostomiasis and Bilharziasis Hospitals run by Provincial Councils, Societies, and Private Individuals.

1.—Provincial Councils Hospitals.

Ankylostomiasis and Bilharziasis Hospital at Shibîn el Kôm run by Minufîya Provincial Council.

The hospital was opened on February 4, 1922, at Shibîn el Kôm. It was arranged that while the Provincial Council paid all expenses of the hospital, the technical work was under the supervision and regular inspection of the Department of Public Health. The routine examination and treatment at this hospital conforms in all details to the routine followed at Government Annexes.

This Annexe was the first hospital of its kind to be erected by the Provincial Councils. Its establishment reflects much credit on the acumen and public enterprise of the President and members of this Provincial Council.

(*a*) Report on the Work during the Year 1922.

The number of new cases attending the hospital during the eleven months in which the hospital was open for work was 8,328.

Of the total number, 3,188 cases (38·2 per cent) sought relief from Bilharziasis.

28·6 per cent of the total number of new cases were rejected after microscopical examination of the excreta when no ova of the particular infection suspected were found.

The greatest number of new cases attending in a single day was 125 on February 11; the lowest was 2 on May 25, just before the Mohammedan Bairam.

Bilharziasis.

The number of Bilharziasis cases attending the hospital during the year was 5,140. Of these, 1,214 were rejected when no Bilharzia ova were detected in the excreta. On an average a Bilharziasis case attended 11·5 times for injection, which is, according to the figures, ideal.

The excreta of 1,630 cases were examined for Bilharzia ova after the full course of treatment was given. In 21·2 per cent of these, ova were detected, the rest were negative.

45,034 intravenous tartar emetic injections were administered during eleven months. The average number given daily was 170 injections.

No figures are available to show the percentages of *Schistosoma hæmatobium* infection and of *S. mansoni* infection amongst the Bilharziasis cases.

Ankylostomiasis.

Amongst the 3,188 cases which were suspected on clinical grounds to be suffering from Ankylostomiasis, the infection was verified microscopically in 2,030 cases (63·3 per cent). The negative cases were rejected. The average attendance of an Ankylostomiasis case was four times.

1,363 cases were re-examined after full course of treatment with the result that 34 per cent showed microscopical evidence of Ankylostomiasis infection and the rest were apparently cured.

(*b*) List showing the Number of Patients examined and treated during 1922.

Bilharziasis.

Months.	New Cases.		Old Cases.		Number of Patients treated.	
	Positive.	Negative.	Positive.	Negative.	New.	Old.
January	—	—	—	—	—	—
February...	651	110	—	—	588	2,609
March	583	132	16	140	443	4,319
April	580	135	27	138	443	5,623
May...	162	37	15	178	150	2,278
June	293	81	27	138	184	2,010
July...	349	89	73	175	329	3,106
August	383	256	34	106	361	2,614
September	249	165	37	153	238	3,085
October	204	85	38	104	195	2,012
November	226	65	28	77	219	1,759
December	246	59	51	75	237	2,041
Total	3,926	1,214	346	1,284	3,587	41,456

Ankylostomiasis.

Months.	New Cases.		Old Cases.		Number of Patients treated.	
	Positive.	Negative.	Positive.	Negative.	New.	Old.
January	—	—	—	—	—	—
February...	200	160	9	13	380	271
March	216	88	102	128	413	735
April	247	63	127	149	452	906
May...	42	21	31	56	72	283
June	127	80	47	54	240	321
July...	141	165	48	151	291	543
August	225	190	19	113	454	470
September	188	160	18	81	156	503
October	167	116	21	64	164	399
November	182	69	20	45	177	395
December	185	56	22	45	178	409
Total	1,920	1,168	464	899	2,977	5,235

(*c*) Report on the Work during 1923.

During 1923 the hospital was open for work till the end of October when it was proposed to transfer it to Minûf, in the same province.

The number of new cases attending the hospital during the ten months of 1923 was 6,479.

Of the total number, 46·9 per cent sought relief from Ankylostomiasis and 53·1 from Bilharziasis. 1,120 (17·2 per cent) new cases of the total were rejected, as microscopical examination did not confirm the clinical diagnosis.

The average number of new cases presenting themselves daily for examination and treatment during the period was 28.

Bilharziasis.

The number of Bilharziasis cases attending the hospital during the year was 3,444. Of these, 581 (17 per cent) were rejected when no Bilharzia ova were detected microscopically in their excreta.

Figures showing the average attendance of Bilharziasis cases are only available for the first five months of the year. On an average a Bilharziasis case attended 9·6 times for injection. Only 35 per cent of the patients had the full course of treatment.

555 cases were re-examined after having a full course of treatment. In 38 per cent of these cases Bilharzia ova were detected in the excreta.

During the first five months of the year 12,499 intravenous tartar emetic injections were given. The average number given daily was 105.

Incidence of Schistosoma mansoni Infection.

Amongst the 2,007 Bilharziasis cases diagnosed microscopically, 86 per cent harboured *Schistosoma hæmatobium* and 14 per cent harboured *S. mansoni*.

Ankylostomiasis.

Amongst the 3,035 new cases suspected on clinical evidence to be suffering from Ankylostomiasis, the infection was verified microscopically in 2,496 (82·6 per cent). The negative cases were rejected. The average attendance of an Ankylostomiasis case for treatment was 3·5 visits.

Of 311 cases re-examined after having the full course of treatment, 98 (31·5 per cent) were found upon microscopical examination of the excreta to be still passing Ancylostoma ova.

On analysis of the records of 500 consecutive cases it was found that :—

Refused treatment	21	(4·2 per cent)
Negative	163	(32·6 ,,)
Received one treatment only...	42	(8·4 ,,)
,, two treatments	30	(6·0 ,,)
,, three or more treatments	244	(48·8 ,,)

Age and Sex of Patients attending the hospital.

The figures in the table below relate only to seven months of the year, April to October inclusive.

	Bilharziasis.		Ankylostomiasis.		Total.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Males of all ages	2,015	86·8	1,410	64·7	3,425	76·1
Females of all ages	305	13·2	767	35·3	1,072	23·9
Children of both sexes (under 12 years)	282	12·1	273	12·6	555	12·3

(*d*) Lists showing the Number of Patients examined and treated during 1923.

Bilharziasis.

Months.	New Cases.		Old Cases.		Number of Patients treated.	
	Positive.	Negative.	Positive.	Negative.	New.	Old.
January	226	90	60	83	222	2,411
February...	189	73	21	65	186	1,606
March	411	105	42	56	439	2,498
April	310	67	42	78	308	3,237
May...	133	29	40	68	133	1,459
June	232	25	—	—	—	—
July...	258	26	—	—	—	—
August	361	55	—	—	—	—
September	451	66	—	—	—	—
October	262	45	—	—	—	—
Total	2,863	581	205	350	1,288	11,211

ANKYLOSTOMIASIS.

MONTHS.	New Cases.		Old Cases.		Number of Patients treated.	
	Positive.	Negative.	Positive.	Negative.	New.	Old.
January	181	76	26	59	180	490
February...	183	63	11	34	163	358
March	281	74	17	38	258	513
April	231	55	21	44	228	664
May...	152	42	23	38	135	268
June	286	61	—	—	—	—
July...	285	39	—	—	—	—
August	292	42	—	—	—	—
September	377	39	—	—	—	—
October	228	48	—	—	—	—
TOTAL	2,496	539	98	213	964	2,403

2.—Ankylostomiasis and Bilharziasis Treatment carried out by the Church Missionary Society (1905-1923).*

The Church Missionary Society in Egypt has taken a deep interest in the treatment of Ankylostomiasis and Bilharziasis, on a large scale. At their Central Hospital in Old Cairo, large numbers of cases are treated annually, so much so that the Society undertook similar work in the provinces with great success.

No less than 103,836 Ankylostomiasis cases were treated at the Society's hospital, Old Cairo, during the last eighteen years (1905–1923), as can be gleaned from the following table :—

YEAR.	Number of Patients.	YEAR.	Number of Patients.
1905	1,515	1915	3,253
1906	1,514	1916	5,705
1907	2,050	1917	8,692
1908	1,821	1918	9,060
1909	1,972	1919	10,273
1910	2,831	1920	13,545
1911	4,323	1921	8,251
1912	4,812	1922	5,765
1913	6,356	1923	5,143
1914	6,955		

Ankylostomiasis patients treated at the Old Cairo Hospital come from all parts of Egypt. Judging from the following list, showing the Markaz towns from which nearly 8,000 cases came, it is evident that patients come for treatment from as far south as Qena and as far north as Mahalla el Kubra, in the north of the Delta. The Province of Gîza, however, contributes proportionately far more patients than any other province in Egypt. This is principally on account of its being the nearest province to the hospital.

*The figures in this account were supplied through the courtesy of Dr. Coleman of the Church Missionary Society's Hospital at Old Cairo.

(*a*) List showing distribution of about 8,000 Male Patients suffering from Ankylostomiasis treated at the Church Missionary Hospital, Old Cairo.

Helwân (Cairo)	22
Gharbîya Province:—	
Tanta	9
Zifta	50
Santa	18
Mahalla el Kubra	2
Belqâs	1
Talkha	1
	81
Minufîya Province:—	
Minûf	599
Ashmûn	584
Quweisna	365
Shibîn el Kôm	88
Tala	5
	1,641
Beheira Province:—	
Kôm Hamâda	54
Dilingât	1
	55
Daqahlîya Province:—	
Simbillawein	12
Mît Ghamr	236
Dikirnis	1
Aga	39
	288
Sharqîya Province:—	
Bilbeis	99
Minyet el Qamh	20
Faqûs	2
Zagazig	11
Hehya	1
	133
Qalyubîya Province:—	
Benha	1
Qalyûb	572
Tûkh	379
Shibîn el Qanâtir	71
	1,023
Giza Province:—	
Gîza	606
Imbaba	1,053
El Ayat	973
El Saff	839
	3,471
Beni Suef Province:—	
Beni Suef	8
El Wasta	472
Biba	11
	491
Minya Province:—	
Maghâgha	51
Samallût	10
Beni Mazar	23
El Fashn	22
Abu Qurqas	4
	110
Asyût Province:—	
Asyût	3
Abu Tig	5
El Badâri	1
Dairût	1
Mallawi	2
	12
Girga Province:—	
Girga	12
Sohâg	45
Tahta	80
El Balyana	2
Akhmîm	1
	140
Qena Province:—	
Qena	2
Fayûm Province:—	
Fayûm	6
Sinnuris	45
Itsa	4
	55

In addition to cases admitted for Ankylostomiasis treatment, all patients admitted into the surgical wards coming from outside Cairo are examined for the presence of Ancylostoma ova in the stools. On an average 70 to 80 per cent of the admissions into the surgical wards are found to be infected and are treated for Ankylostomiasis before attempting any operative measure.

During the last five years the number of admissions into the surgical wards of the Hospital was as follows :—

1918	1,990
1919	1,806
1920	2,455
1921	2,059
1922	1,978

Thus on an average about 1,500 surgical cases are treated for Ankylostomiasis annually.

Bilharziasis.

Bilharziasis treatment with intravenous injections of tartar emetic was introduced into the Church Missionary Hospital, Old Cairo, in June 1919. Since that date the following number of patients was treated :—

1919	370
1920	1,216
1921	1,087
1922	1,051
1923	976 (up to 20–12–1923).

The attendance of patients for injection was satisfactory, especially when the treatment became popular amongst the people because of its successful results. The analysis of 630 cases of those attending during 1920 shows :—

Received less than 6 injections (less than 12 grains)			130	(20·6 per cent)
,, 6 injections	(12 grains)		13	(2·0 ,,)
,, 7 ,,	(14·5 ,,)		57	(9·0 ,,)
,, 8 ,,	(17 ,,)		56	(8·8 ,,)
,, 9 ,,	(19·5 ,,)		138	(22·0 ,,)
,, 10 ,,	(22 ,,)		107	(17·0 ,,)
,, 11 ,,	(24·5 ,,)		70	(11·1 ,,)
,, 12 ,,	or more (27 grains or more) ...		59	(9·5 ,,)

The re-examination after treatment showed that of the 500 cases treated, 238 were pronounced cured, that is, nearly 70 per cent. The case was classed as cured when no living ova were passed in the excreta.

(*b*) Report on the Work of the Provincial Hospitals of the Church Missionary Society during 1914–1915.

Apparently the Province of Minufiya was the first to be chosen for out-stations directed principally for the treatment of Ankylostomiasis and Bilharziasis. Hamûl and Ashmûn were first chosen, to be followed by a hospital at Minûf (in 1915).

Hamûl Hospital.

The number of Ankylostomiasis cases treated at this hospital during 1914 was 483. During the first three months of 1915, 86 cases were treated.

Ashmûn Hospital.

The number of Ankylostomiasis cases treated at this hospital during 1914 was 508. During the first three months of 1915, 130 cases were treated.

Minûf Hospital.

This hospital was opened in April 1915, to accommodate 100 patients.

The routine treatment at these hospitals was to give four doses of thymol and to give an iron mixture as tonic. During this period Bilharziasis was not treated, as the specific treatment was not yet discovered.

(*c*) Report on the Work of the Provincial Hospitals of the Church Missionary Society during 1920–1923.

The hospital at Minûf was re-established in 1920 with out-stations at Ashmûn and Bîr el Arab. Both Ankylostomiasis and Bilharziasis cases were treated.

	Minûf.	Ashmûn.	Bir el Arab.
Ankylostomiasis :—			
1920	4,229	1,150	—
1921	2,825	672	153
1922	1,667	775	144
1923 (January–October)	1,153	653	100
Bilharziasis :—			
1920	122	—	—
1921	495	—	—
1922	450	300	—
1923 (January–October)	430	360	—

In addition to these hospitals, a camp was pitched at Minyet el Qamh in Sharqîya Province during the winter of 1923. 408 Ankylostomiasis cases were treated there. Another camp was erected at Mît Ghamr, where 560 Ankylostomiasis cases were treated.

(*d*) Course of Treatment followed.

The drugs used for Ankylostomiasis are Oleum Chenopodii and Thymol, and for Bilharziasis Antimony sodium tartrate.

The urine and fæces are microscopically examined before and after treatment.

A high percentage of Bilharziasis cases complete the full course of treatment. This is thought to be principally due to the fact that a fee is charged before the course is begun (P.T. 120, about 24 shillings, including food) and the money is not refunded if the patient discontinued the treatment on his own accord.

Alkaline stomachics are given to Ankylostomiasis cases before meals and an iron tonic after meals for a period of three weeks or one month.

Cases of Bilharziasis suffering from accompanying cystitis are treated by irrigation with silver nitrate solutions and Parke Davies & Co. mixed coliform vaccine.

During the first nine months of 1923, three deaths occurred at Minûf Hospital and its dispensaries. In each case the patient was suffering from Pellagra with diarrhœa, was thin and drawnfaced. Death was ascribed to heart failure. On an average each case received 14 grains of antimony sodium tartrate.

Patients cured of their Bilharzia infection are fairly often noticed to return after a year with a re-infection. Others come back after more than five years' interval.

Lectures in a simple colloquial language are often given illustrated by lantern slides explaining how the diseases are spread and how they may be avoided.

3.—Murad Pasha's Ankylostomiasis Hospital at El Deir.

On December 30, 1913, Ibrahim Murad Pasha, a wealthy land proprietor and a notable of Qalyûbîya Province, undertook to maintain an Ankylostomiasis Hospital at the village of El Deir.

The Department of Public Health undertook to provide a doctor for the hospital at Government expense while all other expenditure was to be paid by Murad Pasha.

The hospital was to accommodate 30 in-patients. The Department of Public Health was to supervise the work in the hospital.

The hospital was opened for work on April 28, 1915. From the beginning it was well patronized by patients.

It is unfortunate that the splendid work done by that hospital was discontinued early in 1916 when Murad Pasha ceased to pay the expenses of the hospital.

(*a*) Report on the Work of the Hospital during 1914.

The hospital was open for work during the last eight months of 1914. Only Ankylostomiasis cases were treated during the period. Thymol in cachets was the drug used. All patients under treatment were admitted to the hospital and supervised during the course of treatment.

799 patients suffering from Ankylostomiasis were admitted during the period. 446 patients (56 per cent) were discharged as cured when no Ancylostoma worms were discovered in their stools after the third dose of anthelmintic.

During the last four months of the year, 635 cases were examined microscopically for Ankylostomiasis, of whom 543 (85·5 per cent) were found to be positive. 520 cases were examined microscopically for Bilharziasis infection, of whom 237 (45·6 per cent) were found to be positive. No treatment was administered to the Bilharziasis cases.

(*b*) Report on the Work of the Hospital during 1915.

The hospital was open all the year round. During that time 3,472 cases were examined microscopically for Ankylostomiasis with the result that 2,452 (70·6 per cent) were found to be infected. 2,172 cases were examined microscopically for Bilharziasis, with the result that 1,414 (65 per cent) were found to be infected.

2,172 patients were admitted into the hospital for Ankylostomiasis treatment. Of these, 2,139 received the full course of treatment. 1,010 (47·2 per cent) were discharged as cured.

Discontinuation of the Work.

Early in 1916, the hospital was closed. Murad Pasha expressed his intention of ceasing payment of the expenses of the hospital and so it was closed.

It was most unfortunate that such work which benefits primarily the peasants who are the backbone of the country should have been given up.

PART VI.

Ankylostomiasis and Bilharziasis Cases treated at the Government General Hospitals.

Cases suffering from Bilharzia or Ankylostoma infection are admitted into the Government General Hospitals which exist all over Egypt. It is the rule at these hospitals to admit only the severely infected cases. Mild cases are generally treated as out-patients. The number of cases admitted into these hospitals, as suffering from the parasitic infections, during the years 1914–1921, are tabulated below.

It is not safe to conclude that the number of cases admitted into any of these hospitals can be taken as index of the incidence of infection in the neighbourhood because many factors influence the admission of patients into these hospitals. The accommodation available, the railway facilities in the district, the presence of an Ankylostomiasis and Bilharziasis Annexe in the neighbourhood, affect the number of admissions into the general hospitals.

The sudden increase in the number of cases of Bilharziasis admitted during 1921 (2,219) over the number admitted during 1920 (655) marks the generalized adoption of tartar emetic treatment in these hospitals.

List showing the Number of Ankylostomiasis Cases treated in the Government Hospitals during the Period 1914–1921.

Hospital.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.
Alexandria	69	13	61	70	21	56	91	35
Suez...	44	7	—	3	8	—	—	11
Port Said	9	—	—	3	1	8	4	43
Damietta	68	63	89	118	54	37	10	23
Tanta	2	1	1	4	8	4	7	5
Damanhûr	7	4	2	12	27	64	12	5
Mansûra	36	19	46	12	31	8	8	39
Zagazig	2	1	4	6	36	112	12	42
Shibîn el Kôm	4	1	1	—	—	3	8	34
Benha	40	10	6	9	—	27	22	52
Qalyûb	120	113	99	81	—	83	36	5
Qasr el 'Aini...	224	20	125	52	12	—	76	166
Beni Suef	8	4	4	—	—	11	10	21
Faiyûm	1	1	—	—	—	7	21	90
Minya	13	15	9	28	—	31	10	32
Asyût	9	37	5	25	66	31	20	126
Sohâg	17	21	14	38	1	65	5	65
Qena	8	2	1	27	—	178	13	929
Isna...	45	37	23	36	—	40	10	32
Aswân	7	3	—	—	—	5	9	29
Total	733	363	491	524	80	770	576	1,724

LIST SHOWING THE NUMBER OF BILHARZIASIS CASES TREATED IN THE GOVERNMENT GENERAL HOSPITALS DURING THE PERIOD OF 1914–1921.

Hospital.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.
Alexandria	209	135	174	230	157	108	129	193
Suez...	44	18	14	15	4	5	45	28
Port Said	12	9	24	29	20	16	38	93
Damietta	21	19	59	41	38	91	129	242
Tanta	46	9	36	43	54	49	81	70
Damanhûr	33	9	18	—	2	6	5	146
Mansûra	69	23	68	170	163	146	152	187
Zagazig	34	10	23	44	28	35	14	163
Shibîn el Kôm	9	5	1	13	20	76	23	83
Benha	49	26	24	65	26	78	19	96
Qalyûb	19	25	26	34	14	33	5	5
Qasr el 'Aini	238	196	267	34	86	—	201	52
Beni Suef	11	4	11	23	22	34	13	133
Faiyûm	23	10	2	18	6	39	4	181
Minya	4	15	9	27	22	61	25	53
Asyût	22	54	40	43	23	55	30	254
Sohâg	7	7	6	6	14	14	17	22
Qena	3	2	2	7	16	34	6	133
Isna...	8	12	5	8	5	20	3	28
Aswân	5	2	1	3	2	13	12	57
TOTAL	866	590	811	853	507	913	665	2,219

Bilharzia Infection amongst the Immates of the Khanka Lunatic Asylum.

During 1923 a systematic microscopical examination of the urine of all the inmates of the Khanka Lunatic Asylum was carried out at the instigation of the Director of that institution.

Male cases only are admitted into this Asylum and all of them are poor patients who are treated gratis at Government expense. They come from different parts of the country, and it will be seen from the accompanying table that every province in the country is represented.

The incidence of infection amongst the cases of every district is very high. In some cases the number examined is not large enough to justify applying the result to the district.

The incidence of infection amongst the Cairo patients demands careful attention. 72·8 per cent infection, amongst 298 patients, is a surprisingly high incidence in a town with a good system of filtered water supply. It is, however, probable that a large number of these patients are provincial patients who were brought to Cairo or reported from Cairo, but there was no means to trace their original place of residence.

Taking into consideration that Bilharziasis is, as far as we know, not in any way considered an ætiological or predisposing cause of insanity, the high incidence of infection found can be taken to indicate the conditions amongst the poorer classes of the inhabitants of Egypt.

Result of Examination of Urine.

Total number examined	1,242
Positive for Bilharzia ova	928
Dead and living ova present	362
Living ova only	566
Negative for Bilharzia ova...	314
Dead ova	83

(N.B.—The cases in which dead ova were found were probably cases that have been previously treated with tartar emetic.)

HABITATION OF THE PATIENTS.

Province.	Negative.		Positive.		TOTAL.
	Number.	Per Cent.	Number.	Per Cent.	
Cairo	81	27·2	217	72·8	298
Alexandria	58	30·2	134	69·8	192
Suez Canal...	14	42·4	19	57·6	33
Gharbîya	34	21·8	122	78·2	156
Qalyûbîya	8	25·0	24	75·0	32
Sharqîya	15	23·8	48	76·2	63
Daqahlîya	11	31·7	23	68·3	34
Minûfîya	17	22·2	64	77·8	81
Beheira	14	30·5	32	69·5	46
Giza	3	9·0	30	91·0	33
Beni Suef	5	15·1	28	84·9	33
Faiyûm	1	9·0	10	91·0	11
Minya	11	19·0	47	81·0	58
Asyût	5	14·6	30	85·4	35
Girga	11	30·5	25	69·5	36
Qena	12	31·6	26	68·4	38
Aswân...	2	10·0	18	90·0	20
Residence unknown	10	28·6	25	71·4	35
(Syria)...	2	25·0	6	75·0	8
TOTAL	314	25·8	928	74·2	1,242

PART VII.

Ankylostomiasis and Bilharziasis Propaganda.

In combating Ankylostomiasis and Bilharziasis in Egypt success cannot be attained without a hearty co-operation of the people, and this cannot be enlisted unless the inhabitants realize the ravages brought about by these diseases and how infection could be avoided.

In a country where the majority of the inhabitants are illiterate the task of educating them in this direction is not an easy one, as it has to be attempted on a large scale. Lecturing in a simple colloquial language, demonstration with the aid of simple diagrams, and the distribution of leaflets amongst the villagers were attempted with a certain measure of success.

The fact that Bilharziasis can now be cured by the newly discovered injections of tartar emetic is familiar to the inhabitants. The main reason preventing the "fellah" (peasant) from ridding himself of the disease is his inability to pay for private treatment, and an Annexe established for free treatment anywhere needs no advertising. From the beginning it is crowded with patients, from the surrounding districts. Some patients have sometimes to remain two or three days waiting their turn, to be examined and treated. Once the distressing symptoms are abated patients unfortunately discontinue treatment although they are urged to receive the full course.

As the "fellah" is totally ignorant of the means of protection against infection several posters illustrating the danger of promiscuous defæcation were distributed and the danger of polluting the small water streams was especially pointed out.

The habit of defæcating near water courses is common in Egypt and cannot be easily stopped as the Mohammedan religion orders the washing of urethral and anal openings after urination and defæcation. The "fellah" has therefore to go to the nearest collection of water whenever he feels the necessity of micturition or defæcation.

The idea of washing is certainly a hygienic one but it is only the pollution of the streams which is most objectionable. Such pollution is definitely forbidden by religion as it is dangerous to human health and life and it is absolutely necessary to convince the people of the extreme necessity of stopping it. This washing could be easily substituted by taking a small amount of water in a can or bottle, defæcating on dry ground, washing and burying the excreta. The danger, at least as far as Bilharziasis is concerned, will be checked.

The following are specimens of the leaflets circulated amongst the peasants:—

MINISTRY OF THE INTERIOR.—DEPARTMENT OF PUBLIC HEALTH.

First Leaflet.

Cure of Ankylostomiasis and Bilharziasis.

A very large number of people in Egypt suffer from diseases due to worms.

Do you ?

You will know that you are infected by the following signs:—

If from Ankylostomiasis:—

You will be pale and feeble and you feel your heart throbbing. You will breathe fast on the slightest exercise. You will not be strong for your marital duties. *The worms eat all your blood inside you.*

If from Bilharziasis.

You may have any or all of the above symptoms and also pain on micturition or you will pass blood in your urine.

You can be cured of these diseases : go to the Government Hospital at 8 a.m. any day except Friday. There is a special out-patient Department for these diseases.

You will be treated as an out-patient. There is no need for you to be admitted as in-patient.

You will be diagnosed the first day. Your treatment will start the second day.

You will be treated free of charge.

Second Leaflet.

MINISTRY OF THE INTERIOR.—DEPARTMENT OF PUBLIC HEALTH.

Cure of Ankylostomiasis and Bilharziasis.

Ankylostomiasis and Bilharziasis infections are caused by people defæcating in the manner as shown in the accompanying illustration (defæcating in the open on the ground or in a stream).

These diseases are known by the following symptoms :—

Ankylostomiasis.

You will be pale and feeble and you feel your heart throbbing and you will breathe fast on the slighest exercise. You will not be strong for your marital duties. The worms eat all your blood inside you.

Bilharziasis.

You may have any or all of the above symptoms and also pain in the bladder or you will pass blood in your urine.

The diseases are due to worms whose eggs are excreted in the urine and fæces of the sufferers.

If persons suffering from these diseases pass their urine in or near water they infect others with these worms. Therefore to avoid these diseases and to avoid infecting others follow the following rules :—

(1) Never defæcate or urinate on damp soil, in or near any canal ; or in or near any water, as is shown in the accompanying illustration.

(2) Always defæcate and urinate in a latrine if available. If not, then in a dry place far away from all dampness or water.

(3) If you see a person defæcating or urinating in or near a canal, stop him. He may be killing you in doing so.

(4) Only bathe in running water, never in a *birka* (pool) and never bathe in any water in which you know people are in the habit of urinating or defæcating.

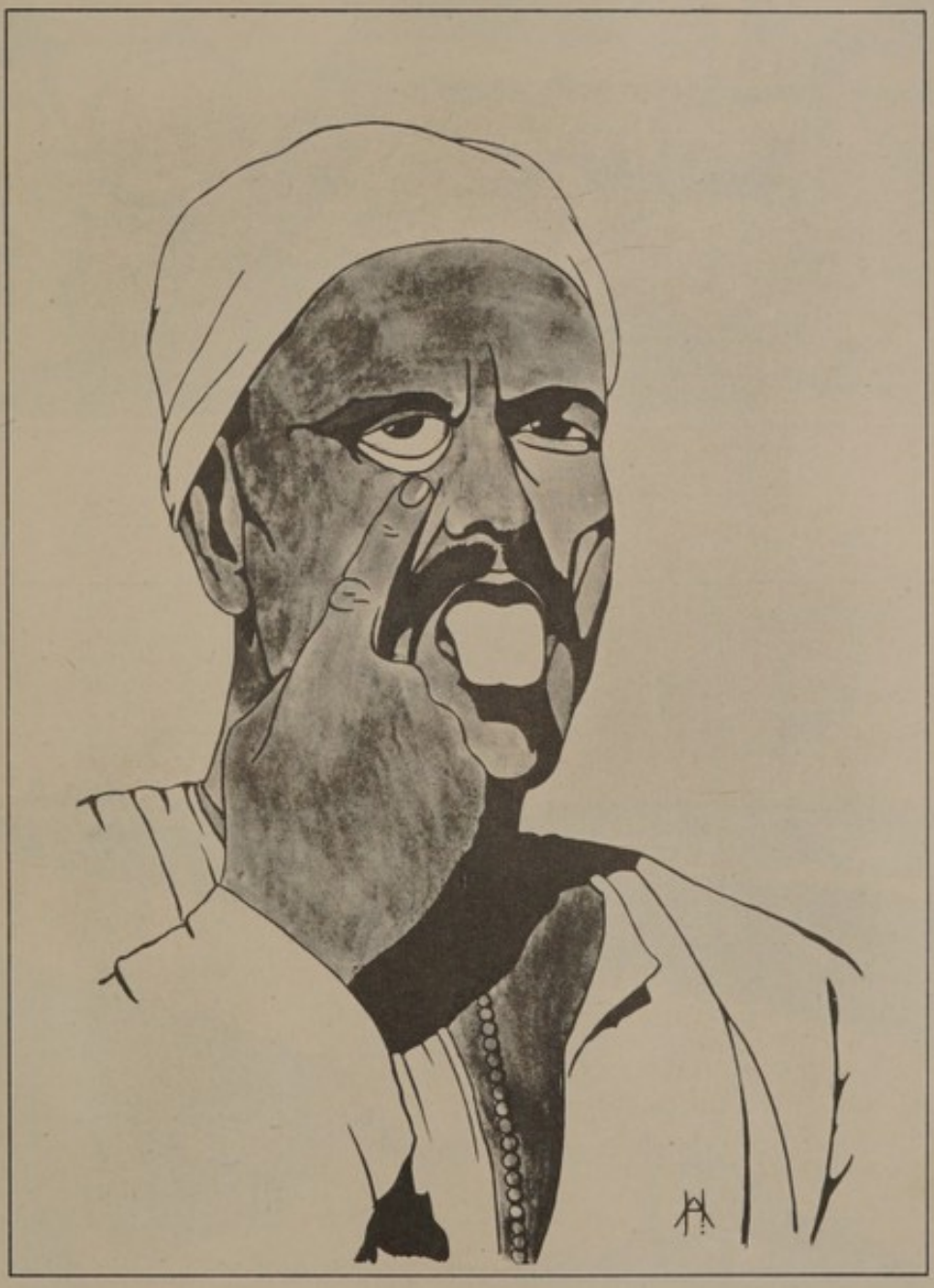
(5) If you are infected with either or the two above mentioned diseases, go to the special hospital at where you will be treated free.

Third Leaflet.

NOTE TO ANKYLOSTOMIASIS AND BILHARZIASIS PATIENTS.

(1) If you have any recurrence of symptoms, come back at once for treatment. If you do not, you will infect your relatives and it will be more difficult to cure you eventually.

(2) Tell all the people in your village who are having the same symptoms as you, to come for treatment and that it is free.



Popular Propaganda.—People suffering from Ankylostomiasis are pale in colour with a pale tongue and eyelids.

Upper Figure: Popular Propaganda.—People suffering from Ankylostomiasis are short of breath and subject to attacks of fainting whenever they exert themselves in doing their ordinary duties.

Lower Figure: Popular Propaganda.—Illustrating a Bilharziasis patient suffering from an attack of renal colic and his mother crying.

Popular Propaganda.—Infection with Ankylostoma takes place by penetration of the Ancylostoma larvae living in moist earth into the skin of the foot.

(3) *To avoid Bilharzia.*

Do not bathe in or drink water which is standing or sluggish, *e.g.* a *birka* (pool) or a dead end canal, and specially in such places where people make a habit of defæcating.

Do not urinate in or defæcate in water which people may drink.

(4) *To avoid contracting and spreading Ankylostoma.*

Always choose dry ground for passing stools or where the excreta cannot get mixed with water.

(5) While in the field take a *gulla* (water-pot) with you filled with filtered water or canal water for drinking and do not drink from a small stream or *masraf* (drain).

The following are photos of large drawings made specially for popular propaganda.

PART VIII.

Village Latrines.

The first step taken in the prevention of Ankylostomiasis and Bilharziasis in Egypt was the inauguration of a campaign directed to encourage Provincial Councils to erect village latrines and popularize their use amongst the village inhabitants.

It has been realized that pollution of the soil and streams is the cause of the spread of these diseases. If by some means or other the habit of defæcation and urination, anywhere available, could be stopped, these diseases would be eradicated. However, it seems unfair to preach the gospel of not polluting the earth and water whilst no latrines exist.

For the above reasons, the movement towards the erection of village latrines was inaugurated and it was realized that :—

(1) The erection of latrines must not be too expensive.

(2) Latrines must conform to the habits of the people.

(3) They must be effective in preventing parasitic diseases and not a centre of their propagation.

(4) They must be kept clean and sanitary.

(5) They must be erected in sufficient numbers.

(6) The inhabitants should realize the danger of polluting the soil and streams and the benefits they will derive if the latrines were to be used by everybody.

The Department of Public Health undertook to erect some latrines at its own expense, as specimens to provincial councils, and the village of Qalyûb was selected for this.

The Provincial Councils were circularized as to the benefits to be derived from the erection of village latrines, and models and estimates of the cost were sent to them.

The project was further enhanced by the Ministry of the Interior urging the Provincial Councils to adopt these sanitary measures. These sanitary measures were however not carried out except in few places.

It is regretted to record that such an important project should be allowed to die in its infancy. It is, however, sincerely hoped that the interest will be revived with much vigour as soon as the conditions of the country will allow.

The following is a copy of the Circular of the Department of Public Health above referred to :—

1. In order to improve health conditions in villages and country towns where there is no proper public water supply and in which there is generally widespread infection with Bilharziasis and Ankylostomiasis which are propagated by promiscuous defæcating and urinating of diseased persons in the fields and close to water courses, the Department af Public Health, in conjunction with the Municipalities and Local Commissions Section of the Ministry of the Interior prepared a model design of village latrines which could be adopted by local authorities all over Egypt at an expense not exceeding L.E. 120 for each building containing six latrines as shown in the accompanying model and the enclosed estimate.

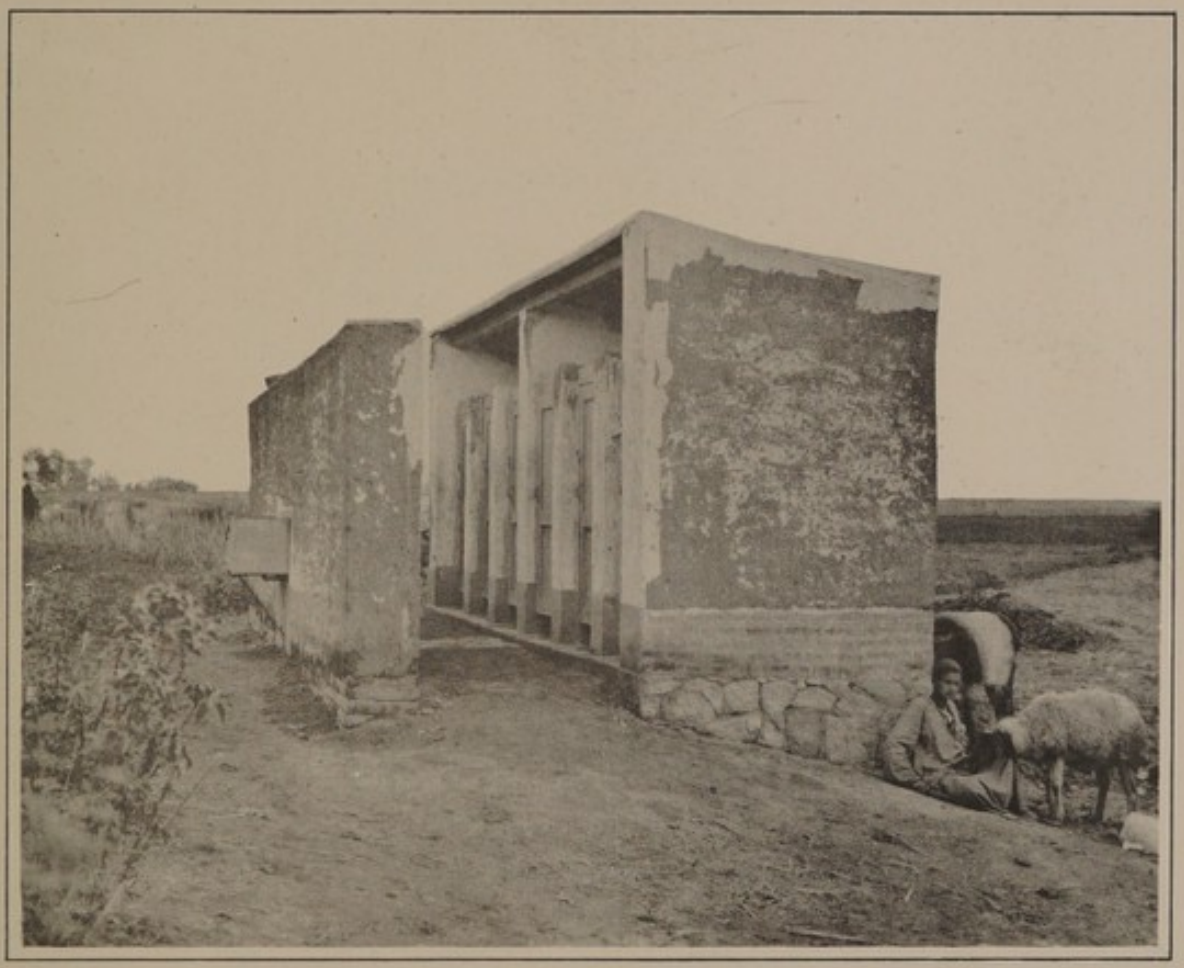
2. Care should be taken when erecting these latrines that the bottom of the cesspit should be at least 30 centimetres lower than the subsoil water level during the dry season. If this is done the cesspit will only be emptied after long intervals.

3. Latrine seats made of reinforced concrete could be procured from the Municipalities Section of the Ministry of the Interior on payment of the price.

When ordering, it is sufficient to mention the number of pans as the measurement of the seats are standardized. It is thus necessary to conform with the measurement given in the enclosed design.

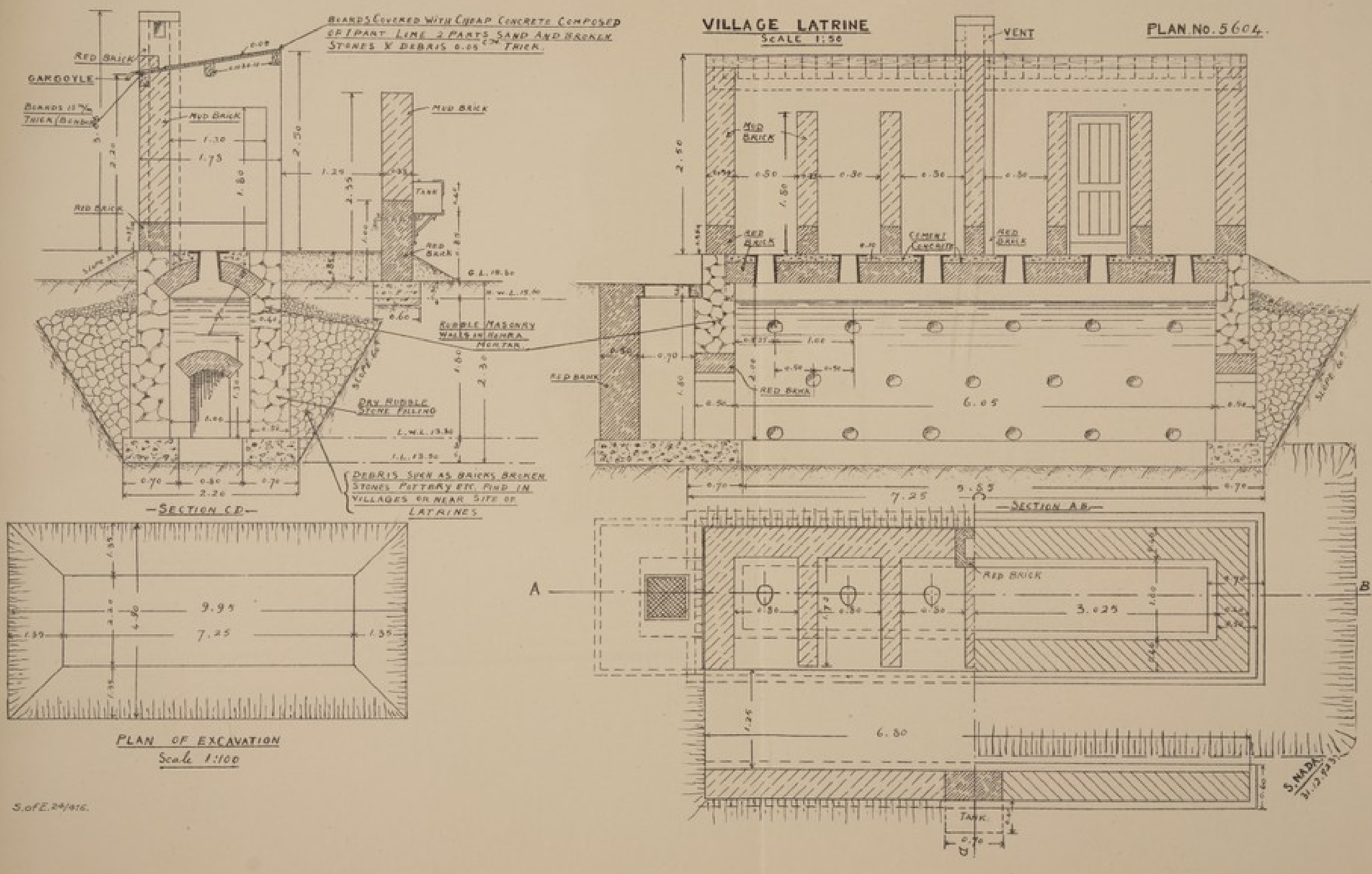
4. If the subsoil water level is subject to variation during the year, it is advisable to deepen the cesspit and fill the bottom with stones 30–40 centimetres in diameter to such a depth that the top layer of the stones will be lower than the subsoil water level during the dry season.

5. A written consent of the Local Government Medical Officer as to the site of the latrines should be secured before erecting them.



Village latrines with six closets erected at Qalyûb.


13 JAN 25
LIBRARY


VILLAGE LATRINE
SCALE 1:50
PLAN No. 5604.
BOARDS COVERED WITH CHEAP CONCRETE COMPOSED OF 1 PART LIME 2 PARTS SAND AND BROKEN STONES & DEBRIS 0.05 CM THICK.
RED BRICK
GARGOYLE
BOARDS 15 ᵐ/ₘ THICK (BENDED)
MUD BRICK
TANK
G.L. 15.50
RUBBLE MASONRY WALLS IN HUMRA MORTAR.
DRY RUBBLE STONE FILLING
L.W.L. 13.30
I.L. 13.30
DEBRIS SUCH AS BRICKS BROKEN STONES POTTERY ETC. FIND IN VILLAGES OR NEAR SITE OF LATRINES
SECTION C.D.
VENT
CEMENT CONCRETE
SECTION A.B.
A
B
PLAN OF EXCAVATION
Scale 1:100
S. of E. 24/416.

Construction of Village Latrines.

The following is the description of the work :—

71	cubic metres	excavation.
7	,,	concrete for foundation, etc.
16	,,	masonry with rubble and *homra* mortar in foundation.
11	,,	burnt brick work in elevations and foundations.
11	,,	unburnt work in elevation.
7	,,	loose rubble masonry around the *magrour*.
13	square metres	supplying and fixing filleri beams.
11	,,	*barbaka* with *dakka*.
35	,,	cement plaster for dadoes, two coats.
51	,,	internal and external lime plaster.
6	complete doors, $1{\cdot}60 \times 0{\cdot}80$.	
6	water closets concrete seats.	
1	manhole cover.	
1	water tank with tap.	

Average cost L.E. 120.

(N.B.—The cost varies according to the locality in which the latrines are to be erected.)

PART IX.

Investigation Section.

The terms of reference of the Ankylostomiasis Scientific Advisory Committee of 1913 included recommendation for carrying out investigations to combat Ankylostomiasis. No active steps were taken at that time owing to the advent of the great war.

When in 1920 the work was resumed steps were taken by the Ankylostoma and Bilharzia Consultative Committee to establish an Investigation Section under the direction of a competent European parasitologist. The London School of Tropical Medicine was approached for lending the services of Prof. Leiper. Prof. Leiper visited Egypt in January 1922 to make preliminary arrangements. Owing to pressure of work in London he found himself unable to enter into an agreement to carry out the work in question, but it was arranged to secure the services of his assistant, Dr. M. Khalil, who arrived in Egypt and commenced his duties on November 25, 1922. A section of the Public Health Laboratories was devoted to the investigation work of the Committee and a large amount of necessary preliminary work was carried out.

Since the appointment of Dr. M. Khalil it has been arranged that he should have a certain number of beds in Qasr el 'Aini Hospital for the observation and treatment of special cases and also that he should give the lectures on Parasitology in the School of Medicine.

Type collections of parasitic worms, mollusca, etc., are being formed and a considerable amount of research, mainly in connection with the work of the Committee, has been carried out, not only in the Public Health Laboratories but also in the field.

Experiments on the action of copper sulphate on the molluscan hosts of Bilharzia both in the Public Health Laboratories and under natural conditions in the field, as well as the effect of copper sulphate on farm crops, have been carried out and are still in progress.

Carbon tetrachloride was tried as an anthelmintic in Ankylostomiasis on a large scale after a preliminary study to find out the best and most efficient means of administering it in campaigns. Its action on lamblia infection was the subject of a short note which appeared in the "Journal of Tropical Medecine and Hygiene."

In the course of the work of this section certain species of mullet in Lake Menzala were found to be carriers of the intermediate stage of *Heterophyes heterophyes*. A note on this was published in the "Journal of Helminthology."

The following localities were visited and the incidence of parasitic infection and the local molluscan fauna were determined :—

Saft el Enab (a village near Damanhûr).
Gimmeiza (a village near Tanta).
Nag Hamadi (a village near Luxor).
Tura (a village near Helwân).

A morphological description of the following parasites was done during the year 1923 :—

Xenopharynx solus Nicoll.
Echinostoma Ægyptiaca n. sp.

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II.—Carbon Tetrachloride as an Anthelmintic in Ancylostoma duodenale Infection.

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INTRODUCTION.

During 1923 carbon tetrachloride was given a fair trial as an anthelmintic at Qalyûb Ankylostoma Annexe. Fifteen beds were set aside for patients undergoing treatment. After a preliminary trial the drug was given as a routine for out-patients. Careful microscopic examination preceded and followed the treatment and records were kept. The drug was administered to more than 4,000 ankylostomiasis cases. One death, which could not be ascribed to the action of the drug, occurred during the period. The patient on admission was suffering from heart failure, œdema of the legs, and ascites. It is unfortunate that a post-mortem could not be performed.

About one-half of the cases treated with the drug returned for re-examination, once or more than once, after a lapse of one week or more. It is upon the re-examination of 1,000 of these cases that the following report is based. Various modifications of the mode of treatment and dose given were tried for comparison to arrive at the most efficacious and at the same time the least troublesome method.

Properties of Carbon Tetrachloride.

Carbon tetrachloride (CCl_4) was discovered by Regnault in 1839, who prepared it by the action of chlorine on chloroform in sunshine.

It is a transparent colourless liquid with a pungent aromatic odour. It is a heavy fluid having a specific gravity of 1·63 and is highly volatile; its boiling point is 76°·7 C. and is non-inflammable.

Carbon tetrachloride is soluble in alcohol and ether; in water it is soluble to the extent of 1 in 1,250 only. It does not mix with water but forms a distinct layer at the bottom of the vessel containing both.

Carbon tetrachloride dissolves a large number of organic substances, especially those of fatty nature, and it is for the latter reason that it has a wide application in the arts. It has been used as a fire-extinguisher. When prepared on a commercial scale it generally contains, as impurities, small quantities of Carbon bisulphide (CS_2) and Carbonyl chloride (Phosgene $COCl_2$), one of the poisonous gases employed in the Great War. When used for medicinal purposes it should be free from these impurities.

Medical Uses of Carbon Tetrachloride before its recent introduction as Anthelmintic.

Carbon tetrachloride was first introduced by Tuson in 1843 as a lotion to be applied externally to cancerous growths. It was given internally in doses of four drops three times a day in gout.

Carbon tetrachloride was used as an anæsthetic, but its general use was given up as a result of a statement by Simpson that it was more depressant to the heart than chloroform.

During 1909, a woman 29 years old, a subject of Status lymphaticus, collapsed, while being shampooed with carbon tetrachloride and died.

It was used during the war for cleansing the edges of wounds.

During 1920, a girl employed in painting balls with a paint containing carbon tetrachloride suffered from vomiting after meals, headache, and anæmia. Frequent inhalation of carbon tetrachloride was reported to cause jaundice.

On the whole, up to a few years ago, carbon tetrachloride was a little known drug with a conflicting medical evidence as to its therapeutic value.

Introduction of the Drug as an Anthelmintic.

The anthelmintic value of Carbon tetrachloride, especially in hook-worm infection, was discovered by Maurice C. Hall, Senior Zoologist in the United States Bureau of Animal Industry. Humanity is indebted to the discoverer for this valuable remedy. The drug was first administered to dogs infested with hook-worms in doses of 0·3 c.c. per kilo of body-weight. It was found to be more effective than any other anthelmintic that was hitherto used. It was found to be safe, giving rise to no evident symptoms or post-mortem lesions.

Hall tried the effect of carbon tetrachloride on himself, taking 3 cc. without any precaution as to food, with no ill-effects.

Literature on its Use in Human Cases.

Leach (22) reported on the treatment of fourteen cases with carbon tetrachloride, giving doses varying from 3 to 10 cc. The patient receiving the 10 cc. was a prisoner condemned to death. He was given 22 cc. more of carbon tetrachloride fifteen days later. He passed 55 hook-worms (probably all Necator). On post-mortem examination, no hook-worms were found in the intestines, but there was Trichocephalus and Oxyuris. The organs were apparently normal.

Nicholls and Hampton (24) administered the drug to twenty students in 3 cc. doses, without subsequent purgation. No ill-effects were noted. The drug was also given to 64 students from 7 to 17 years old in doses of 1 to 3 cc. Food was allowed one hour later. One boy of 12 years vomited, but this was a usual event with him. These authors concluded that carbon tetrachloride may be administered safely in doses of 10 to 20 min. to children 3 to 4 years old.

Smillie and Pessoa (27) report that 98 per cent of the hook-worms (probably Necator) are expelled by 3 cc. of carbon tetrachloride given in 1 cc. doses at 6, 7, and 8 a.m. These authors state that the drug expels more female hook-worms than males. Symptoms resembling delayed chloroform poisoning developed in a patient who had an alcoholic bout the night before the administration of the drug.

Lambert (20) gave carbon tetrachloride in doses of 1 to 4 cc. to adults. He records 85 per cent cure after a single treatment. He observed that intoxication was greatly diminished by giving magnesium sulphate purge two to three hours after taking the carbon tetrachloride.

Lake (19) gave repeated doses of carbon tetrachloride to monkeys without any ill-effects. He concluded that the same could be done to man.

Docherty and Burgess (5) gave Carbon tetrachloride to three condemned prisoners before their execution. Fatty degeneration of the liver and cloudy swelling of the kidneys were ascribed to the action of the drug.

Lambert (21) used carbon tetrachloride on a large scale in an anti-hook-worm campaign in Fiji. No fatalities occurred in the first 42,000 cases, but he met with three deaths in the next 8,000 cases. Death was ascribed to poisonous impurities in the drug used. The adult dose adopted was 3 to 4 cc. In children 3 min. per year of age was the standard followed. All deaths occurred in children. Post-mortem examination revealed fatty degeneration of the liver and cloudy swelling of the kidneys. Five cases had severe symptoms but recovered.

THE PRESENT ENQUIRY.

The Species of Hook-worm met with.

All the cases recorded here were suffering from Ankylostomiasis due to Ancylostoma duodenale infection. No Necator americanus infection has yet been recorded in Egypt.

Selection of Cases and Method of Diagnosis.

No selection of cases was made.

The routine followed at the Annexe during the period in which Carbon tetrachloride was given, was to take from every patient attending the Annexe a specimen of his urine and another of his stools for microscopical examination without any reference to his complaints. When Bilharzia ova were detected the patient was put on sodium antimony tartrate injections. and when Ancylostoma ova were found he was put on carbon tetrachloride treatment. By following such a system it was found that practically 50 per cent of the patients harboured both parasites and were ordered both treatments. In these cases Ankylostomiasis treatment preceded the Bilharziasis injections for two reasons :—

(1) It is better to rid the patient of the Ankylostoma before undergoing the long and depressant Bilharzia treatment.

(2) To ensure the attendance of the patient for re-examination of stools, so as to record the result of the carbon tetrachloride treatment.

Examination of the Stools.

All stools were prepared by the floatation technique. Concentrated common salt solution was used. By this means detection of cases with mild infection was ensured.

Method of Administration.

Carbon tetrachloride was given in water. As has been mentioned before, the drug is not soluble and does not mix with water. The addition of water increases the volume of the dose and makes it easier to drink.

Carbon tetrachloride can be given in gelatin capsules. These must be fresh to ensure their digestion. The method was tried but was given up on account of its expense.

The intention was to find out the best method to be used on a large scale in campaigns directed to combat Ankylostomiasis.

The agricultural class to whom the drug was administered never complained of its taste. It is even thought that the sharp taste of the drug is a recommendation to it. To delicate patients or well-to-do people the drug can be given in capsules.

DOSAGE.

Carbon tetrachloride was given to adult patients in doses varying from 1 to 10 cc.

With a dose less than 4 cc., 50 or more per cent of the patients revealed ova in their stools when re-examined, seven to fourteen days after treatment. This was the case whether the patient was given a purgative before, after, or both. For this reason the administration of doses less than 4 cc. was confined only to patients under 15 years of age, as these caused less nausea and vomiting than bigger doses. On the whole the patients were not inconvienced by taking such doses.

On the other hand, doses above 7 cc. for an adult were frequently accompanied by nausea, colicky sensation in the abdomen, burning feeling in the epigastrium, and vomiting. These symptoms were not serious in character and disappeared in twelve hours. As no distinct increase was noticed in the percentage of cures on the administration of such big doses, their use was discontinued early in the work.

Adult doses varying from 4 to 7 cc. were given a fair trial and the comparative results arrived at, will be detailed in the following pages.

5 cc. was found to be the optimum dose giving the least symptoms and comparatively good results. All cases above 15 years of age were given that dose.

Children were given the drug according to the following table :—

Years.	Dose.
5– 8	2 cc.
9–11	3 ,,
12–14	4 ,,

Debilitated individuals were given comparatively smaller doses.

The amounts given to children are a little more than what their age indicates. With anthelmintic the rule of age cannot be strictly adhered to, as the anthelmintic is not intended for absorption into the system, but for its action on the parasites.

Symptoms felt after Administration of Carbon Tetrachloride.

The symptoms felt by a series of patients treated carbon tetrachloride with were systematically recorded. Various dosages followed by a saline purge were employed and both adults and children were included.

	Adults 5 cc. Doses.		Children on Basis of 5 cc. Doses.		Adults 6 cc. Doses.		Adults 7 cc. Doses.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent
No untoward symptoms felt ...	18	32·0	14	29·0	5	31·0	4	33·0
Vomiting	6	10·7	6	21·0	4	25·0	4	33·0
Dizziness...	29	52·0	5	17·0	1	6·0	5	21·6
Fainting	1	2·0	4	14·0	—	—	—	—
Colicky pains in the abdomen ...	2	3·6	2	7·0	3	19·0	3	25·0
Pains in the epigastrium	—	—	5	17·0	2	12·5	—	—
TOTAL ...	56	—	29	—	16	—	12	—

Vomiting is the most serious symptom. It sometimes occurs after administering the saline purge and thus it might be caused in some cases by the latter. The incidence of vomiting increased with an increase of the dose administered. It is more frequent in children than in adults.

In delicate individuals carbon tetrachloride causes tenesmus, which may be severe. In cases with hæmorrhoids or severe rectal Bilharziasis hæmorrage may occur which is alarming to the patient.

CONTRA-INDICATION TO THE USE OF CARBON TETRACHLORIDE.

Carbon tetrachloride should not be given to cases suffering from evident renal disease.

It is better to avoid giving it to pregnant women till more information on the subject is available.

Cases with severe Bilharziasis of the rectum with prolapse should not be given this drug, as well as cases with hæmorrhoids. Constipated individuals should be given a preliminary purge before administration of carbon tetrachloride.

Repeated doses are more dangerous than a single large dose.

Re-examination of the Stools.

Stools of patients returning after carbon tetrachloride treatment were examined with the floatation method. In order to check the results, negative specimens were examined by two experienced medical officers, one an hour after the other, in order to give more time for any ova to float to the top if they were present. In many instances a single ovum was seen.

INHIBITION OF THE OVA-LAYING CAPACITY OF THE FEMALE HOOK-WORM AFTER ADMINISTRATION OF THE ANTHELMINTIC.

Following thymol and chenopodium treatment, it was observed that although the stools may be negative for a few days, re-examination after a longer interval gives a positive result. This has

been ascribed to the inhibitory action of the drug upon the ova-laying capacity of the female worms left in the intestines. After an interval of 10 to 15 days the female worms begin laying their ova again. Unless this fact is taken into account re-examination during the inhibitory period gives a fallacious result.

It is thus important to find if a similar inhibitory period follows the administration of carbon tetrachloride. Amongst the 1,000 cases recorded in this report, there were 252 cases in whose stools Ancylostoma ova were detected upon re-examination.

Of the positive cases, 38, *i.e.* 15 per cent, were found to be positive after a previous negative result.

Ova were detected in the stools as early as the second day after treatment. In many instances ova were found during the first week following the treatment.

Of the thirty-eight positive cases mentioned above, the negative findings in thirty were the result of examinations made during the first week following the treatment. Examinations during the second week after treatment revealed the positive results. In eight cases negative findings during the second week were followed by positive results later on.

	Negative during First Week and Positive during the Second Week.	Negative during Second Week but Positive later.
Children below 15 years	10	2
Adults	20	6
TOTAL	30	8

It is probable that some of the negative results were due to the very few ova present which escaped the attention of the examiner. On the whole it may be concluded that one week at least must elapse after the administration of carbon tetrachloride before the result of re-examination can be relied upon.

APERIENT ACTION OF CARBON TETRACHLORIDE.

Carbon tetrachloride given without any purgative before or after administration causes looseness of the bowel. This is frequently accompanied with colic. For comparison five adult cases were given 5 cc. of carbon tetrachloride each, without a following purge, another five were given the same dose with a purge after three hours from taking the drug, and five were given no drug or purge, as a control.

The results were as follows :—

	Stools passed in 24 Hours.		Ancylostoma Worms passed in 24 Hours.		Ascaris Worms passed in 24 Hours.	
	Number.	Per Person.	Number.	Per Person.	Number.	Per Person.
Five cases no CCl_4 or purge	8	1·5	—	—	—	—
Five cases CCl_4 and no purge	15	3	26	5	2	0·4
Five cases CCl_4 followed by a purge...	22	4	90	16	2	0·4

It is thus evident that the drug had a distinct aperient action. The number of Ancylostoma worms voided was more when a purge was given. It is not clear, however, if the large number of worms expelled is due to a better action of the drug or to retarded elimination of the dead worms.

Carbon tetrachloride has this marked aperient effect in cases with loose stools, as it is indeed the case in most patients suffering from Ankylostomiasis. When the drug is given to a constipated person unpleasant symptoms which are sometimes alarming are felt.

The following account is based on a personal experience in addition to two cases observed. In all these cases 5 cc. of carbon tetrachloride were given with no purge following it. In my case

the drug was taken as an experiment, no parasitic infection was present. The other two cases were infected with Oxyuris only. The pungent taste of the drug is not very objectionable. It causes a sense of heat in the epigastrium.

Eructations sometimes follow the administration of the drug, causing the breath to smell of carbon tetrachloride. Colicky sensations are felt two to three hours after administration, and these increase in severity. Clammy sweats cover the body and the extremities are cold. The patient is a little dizzy. If anything is taken by mouth it is vomited. An enema relieves the symptoms and the next morning the subject feels well again. These symptoms occurred only in cases who were constipated at the time.

It is thus advisable to follow the administration of carbon tetrachloride with a purge as a routine measure.

Value of the Preliminary Purge.

A series of cases was given carbon tetrachloride on the basis of 5 cc. for an adult, preceded and followed by a saline purge of magnesium sulphate. This was compared with another series in which the preliminary purge was not given.

The patients after microscopical diagnosis were kept in hospital. In the evening 30 grammes of magnesium sulphate in water were administered to adult cases; children received the appropriate dose.

On the following morning a dose of carbon tetrachloride in about 30 cc. of water was given to each case, followed in three hours' time by another dose of magnesium sulphate.

Patients having no preliminary purge, took carbon tetrachloride four hours after the morning meal, *i.e.* practically on an empty stomach.

The result was as follows:—

	Without Preliminary Purge.	With Preliminary Purge.
Cured: stools negative after seven or more days	34	564
Uncured: still positive	4	173
TOTAL treated	38	737
Percentage of cured	89·5	76·5
Percentage of uncured	10·5	23·5

It is thus more advantageous to have a preliminary purge. On the other hand a preliminary purge necessitates the admission of patients into hospital or at least deferring the treatment to another day. In a campaign or in using this treatment on a large scale this is a distinct disadvantage, as many of the cases will not turn up at the required time or will be unwilling to pass through this tedious process. Moreover, the patient is so weakened by the two consecutive purges as to be unable to work directly after the treatment.

Considering these factors as a whole, the preliminary purge is better omitted when using the drug on a large scale.

Result of Purge given before and after varying Doses of Carbon Tetrachloride.

A trial was made with varying doses of carbon tetrachloride with a purge before and after it.

The result was as follows:—

(1) One adult case was given 2·5 cc. and was not cured.

(2) Eight adult cases were given 4 cc. each. The result was: six cured and two uncured. The percentage of uncured was 25.

(3) 38 cases (adults and children) were given carbon tetrachloride on the basis of 5 cc. as an adult dose. The percentage of cured was 89·5 and of uncured was 10·5.

(4) 59 cases (all adults), were given 6 cc. each, with the result that 45 were cured (76·3 per cent) and 14 were uncured (23·7 per cent).

More cases are attacked with vomiting when taking the 6 cc. dose, which probably accounts for the less favourable result.

The conclusion is that 5 cc. adult doses with a saline purge before and after give the best result.

Comparison between varying Doses of Carbon Tetrachloride followed by a Purge.

In all these cases carbon tetrachloride was given at noon, the patient receiving no food except breakfast. Magnesium sulphate was administered three hours later.

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
4 c.c., adult dose	15	55·6	12	44·4	27
5 „ „	564	76·5	173	23·5	737
6 „ „	9	56·5	7	43·5	16
7 „ „	19	79·0	5	21·0	24

With 4 cc. doses the patients bear the drug well but the result is not satisfactory.

With 5 cc. doses vomiting and colicky sensation occur in a small percentage of cases and the result is favourable, especially if we take into consideration the large number treated.

With 6 cc. doses a considerable number of the cases suffer from vomiting, and probably this accounts for the lower percentage of those cured.

With 7 cc. a still higher percentage of cases vomit and complain of pain in the abdomen with burning sensation in the epigastrium, but there is a higher percentage of cures. It is probable that the bigger dose given more than compensates for the vomiting which occurs. The vomiting does not follow the administration of the drug immediately, but occurs after an hour or more and especially after the purge has been given.

Carbon Tetrachloride followed by Castor Oil.

In this series no preliminary purge was given. Carbon tetrachloride 5 cc. was administered four hours after the morning meal and followed in three hours by 30 cc. of castor oil in the case of adults and a corresponding dose in the case of children.

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number	Per Cent.	
Followed by castor oil	11	73·4	4	26·6	15
Followed by magnesium sulphate ...	564	76·5	173	23·5	737

There is no appreciable difference in the two cases; if any, it is in favour of the saline purge.

Dose of Carbon Tetrachloride repeated next Day.

In this series no preliminary purge was given. Patients were given carbon tetrachloride at midday on an empty stomach followed in three hours by a purge of magnesium sulphate. The

whole procedure was repeated the following day. The result of re-examination after one or more weeks was as follows :—

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
3 c.c. adult dose	16	66·6	8	33·3	24
5 ,, ,, ...	34	81·0	8	19·0	42

Patients bear the drug well. The 3 cc. dose has no satisfactory result.

5 cc. dose repeated the following day is less satisfactory than when it is repeated after a week's interval.

Dose of Carbon Tetrachloride repeated after a Week.

In this series of ten cases, carbon tetrachloride was given in 5 cc. adult dose without any preliminary purge. It was followed in three hours by a saline purge of magnesium sulphate.

The course was repeated after a week. Re-examination was done one week or more after the last dose. The result was as follows :—

Cured ... ... 9 (90 per cent).
Uncured ... ... 1 (10 ,,).

The result is very satisfactory, but judging from the percentage of cured cases, after one treatment, it is hardly justifiable to repeat the treatment of the whole number without re-examination.

Repetition of Carbon Tetrachloride Treatment in Cases where one Treatment did not secure a Complete Disinfestation.

When any case was found to be still harbouring the Ankylostoma worms on re-examination after the first treatment, a second treatment was given. If on re-examination the stools were still positive for Ancylostoma ova the treatment was further repeated. Practically all the cases were given on the second and the third occasion a 5 cc. dose and a saline purge following it whatever might have been the first treatment.

Second Treatment:—

Cured ... ... 56 (65 per cent).
Uncured ... ... 30 (35 ,,)

Third Treatment:—

Cured ... ... 10 (83·3 per cent).
Uncured ... ... 2 (16·7 ,,)

The conclusion is that by repeating the treatment of positive cases till a third treatment is administered, 98·6 per cent of all the cases will be completely disinfested from the Ancylostoma worms.

Comparative Effect of Carbon Tetrachloride in Children and Adults.

Amongst the 737 cases treated on a basis of 5 cc. adult dose and saline purge following it, there were 226 children. The result of re-examination after treatment was :—

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
Children (less than 15 years)	166	73·5	60	26·5	226
Adults (more than 15 years)...	398	78·0	113	22·0	511

It is thus evident that although the doses given to children are a little more than what their age indicates, the action of the drug is slightly less satisfactory.

Comparative Action of Carbon Tetrachloride in Males and Females.

In this series, all the cases were adults and 5 cc. was the dose given followed by a purge of magnesium sulphate. The result of re-examination was as follows :—

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
Adult females	122	82·0	26	18·0	148
Adult males	276	76·0	87	24·0	263

Carbon tetrachloride therefore in the doses and method followed above, is more effective in females than in males. This is probably due to the fact that the dose per kilo. of body-weight is more in females than in males.

Average Number of Ancylostoma Worms expelled on two Consecutive Days after Carbon Tetrachloride Treatment.

In this series the patients were all adults and 5 cc. was the dose of carbon tetrachloride given, followed by a magnesium sulphate purge. The stools passed during the first twenty-four hours following the administration of the drug, were collected, and all the Ancylostoma worms and Ascaris were counted. The stools passed during the second period of twenty-four hours were treated in a similar manner. The result was as follows :—

Number of Ankylostoma cases treated : 24.

	First 24 Hours.	Second 24 Hours.
Number of Ancylostoma worms passed :—		
Total	353	42
Per person	15	2
Number of cases with additional Ascaris infection : 8.		
Number of Ascaris passed	6	14

It is thus evident that most but not all the Ancylostoma worms are passed during the first twenty-four hours following carbon tetrachloride treatment, while most of the Ascaris are passed during the second twenty-four hours. More female Ancylostoma worms than male worms are expelled.

COMPARATIVE RESULT OF TREATMENT BY CARBON TETRACHLORIDE, OLEUM CHENOPODII, AND THYMOL.

The series of cases compared were taken from amongst the patients attending Benha Annexe. The patients were not specially selected, as the object was to compare the results on patients who did not receive any special attention or care. All the cases were treated as out-patients. No preliminary purge was given, but the drug was followed in three hours by a purge. In the case of Oleum chenopodii castor oil was used; with the other two anthelmintics magnesium sulphate was used.

Dosage.

Oleum Chenopodii was given in doses of 1·5 cc. for an adult, 1 cc. for children 12–14 years, and ½ cc. for children of 7 years. The drug was given in gelatin capsules. Three courses of such treatment were given.

Thymol was given in doses of 2 grammes for an adult, 1½ grammes for children 12–14 years, and ½ gramme for children of 8 years. The drug was given in cachets. Three courses of such treatment were given.

Carbon tetrachloride was given in doses of 5 cc. for adults. For children the doses were as stated in the previous table. One course of such treatment was given.

The result was as follows:—

	Cured.		Uncured.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
Carbon tetrachloride	564	76·5	173	23·5	737
Oleum chenopodii	59	50·0	59	50·0	118
Thymol	20	37·7	33	62·3	53

It is evident from this table that carbon tetrachloride under the conditions detailed above is by far the best drug of the three.

Comparative Cost of the Three Anthelmintics.

	L.E.	M.
Carbon tetrachloride and magnesium sulphate necessary for the treatment of 100 cases; one course of treatment	0	245
Thymol, in cachets, and magnesium sulphate necessary for the treatment of 100 cases, three courses of treatment	2	000
Oleum chenopodii and castor oil necessary for the treatment of 100 cases, three courses of treatment	3	690

It is evident from these figures that carbon tetrachloride is by far the cheapest to use.

EFFECT OF CARBON TETRACHLORIDE IN INTESTINAL PARASITIC INFECTIONS OTHER THAN ANKYLOSTOMIASIS.

Oxyuris Infection.

Large numbers of Oxyuris vermicularis worms are expelled as a result of the administration of carbon tetrachloride. In many cases several thousands of the parasites can be found when counting the Ancylostoma worms expelled. The drug is more effective in this infection than any other known drug, but it does not afford a complete cure. Many cases after the lapse of three to four weeks are found to be infected in a mild degree. Oxyuris infection is one of the most difficult to cure.

Ascaris Infection.

Sixty-eight cases which harboured both Ancylostoma and Ascaris worms were given carbon tetrachloride on the basis of 5 cc. adult dose followed by a purge of magnesium sulphate. The re-examination showed that 49 were cured and 19 were still harbouring the parasite, *i.e.* the percentage of cure was 72. Carbon tetrachloride is inferior to Oleum chenopodii as an anthelmintic in Ascariasis.

Trichostrongylus Infection.

Seventeen cases harbouring this parasite in addition to Ankylostomiasis were given carbon tetrachloride according to the above routine. Only one case was found on re-examination to be free from Trichostrongylus infection.

Hymenolepis nana Infection.

Six cases harbouring Hymenolepis nana were given carbon tetrachloride in 5 cc. doses. None of them was cured.

Lamblia Infection.

In conjunction with Dr. I. Shawki, of Qasr el 'Aini Hospital, carbon tetrachloride was administered to three cases who had been suffering for a long time from dysentery characterized by irregular attacks with intervals of no complaint.

Microscopical examination of the stools revealed the presence of Lamblia intestinalis only.

The three cases were relieved of their dysentery infection after taking carbon tetrachloride, and examination of the stools was negative for Lamblia intestinalis and its cysts. Six months have passed since the treatment and the cases are enjoying good health. One of them however had dysenteric symptoms for one day but these have disappeared without treatment. The stools were examined immediately after this attack, but no Lamblia or cysts were discovered. So far the results of treatment of this resistant protozoal infection are encouraging.

ANIMAL EXPERIMENTS WITH CARBON TETRACHLORIDE.

Carbon tetrachloride was administered to animals, such as dogs, cats, and monkeys, through a stomach tube, with the following results :—

(1) Two small kittens of about 500 grammes each in weight were given 5 cc. carbon tetrachloride and both died after twenty-four hours. Post-mortem examination revealed a congested small intestine with hæmorrhagic contents. Carbon tetrachloride unmixed with gut contents was collected from the lumen of the ileum close to the cæcum. The liver was congested and kidneys showed cloudy swelling. Other organs were normal. Fatal dose 10 cc. per kilo of body-weight.

(2) A dog, 10·5 kilos of body-weight, was given 168 cc. of carbon tetrachloride by stomach tube. The animal vomited after 1½ hours and again after two hours. It refused its food and had diarrhœa. The animal was apparently normal after four days. Thus a dose of 16 cc. per kilo was not fatal to the dog.

(3) The same dog was given 20 cc. of carbon tetrachloride and the dose was repeated after two days. These doses followed the first big dose detailed in No. 2. The animal suffered from diarrhœa and vomiting, abstained from food and was much emaciated and finally died, after two weeks from taking the first dose. Post-mortem examination was made. Intestines normal with no evidence of the presence of carbon tetrachloride. Lungs congested. Liver in a state of advanced fatty degeneration. Cloudy swelling of the kidneys. Bladder distended with urine containing albumen in fair amount. Other organs apparently normal.

(4) Monkey, three kilos in weight, was given 5 cc. of carbon tetrachloride by the stomach tube. The animal vomited twice, but was apparently normal the following day.

On the	3rd	day	it was	given	10 cc. and had diarrhœa.
,,	4th	,,	,,	,,	10 cc. and vomited once.
,,	6th	,,	,,	,,	20 cc.
,,	9th	,,	,,	,,	20 cc.

On the tenth day the animal was normal and took its food, although its stools were a little soft. The animal afterwards recovered completely and was well and active seven months afterwards. In this experiment the animal was given 65 cc. of carbon tetrachloride in all. The biggest dose was 6 cc. per kilo.

(5) Dog, 5 kilos in weight, was given carbon tetrachloride subcutaneously, receiving eight injections, practically one on every other day. The first dose was 2 cc. and was increased to 10 cc. The animal received in all 42 cc. of carbon tetrachloride. It died one day after the last injection was given. The only post-mortem findings were advanced fatty degeneration of the liver and kidneys. Bladder distended.

(6) Monkey, 3 kilos in weight, was given 10 cc. carbon tetrachloride by stomach tube. The dose was repeated after three days. The animal vomited and had diarrhœa for two days, but recovered completely.

Conclusions from the above Experiments on Animals.

Carbon tetrachloride in fairly large doses, 3 cc. per kilo of body-weight in monkeys is safe. The dose can be repeated once without any harm.

The drug if repeated is often fatal. The post-mortem findings are fatty degeneration of the liver, kidneys, and hyperæmia of the small intestine.

The drug is not easily absorbed from the gut. It can be collected in almost pure condition from the ileum close to the cæcum if the animal is killed within twelve hours.

Repeated small doses are more poisonous than a single large dose.

It is recommended that every fresh consignment of the drug should be tested by administration to experimental animals so as to ascertain that the drug is free from any poisonous ingredients.

SUMMARY.

Carbon tetrachloride is a valuable and safe anthelmintic in Ankylostomiasis. It is effective to some extent in Ascariasis and Oxyuriasis. It is also a valuable remedy in Lamblia infection.

The optimum dose for cases with Ancylostoma duodenale infection is 5 cc. for an adult, to be followed by a saline purge. The drug is more effective if preceded by a saline purge in addition. It is slightly aperient and is little absorbed in the intestine and is excreted in the stools.

No confinement to bed after administration is necessary.

Repeated doses of the drug are to be avoided except after a long interval.

The drug should not be given in cases with renal diseases; severe intestinal Bilharziasis, Hæmorroids, and Hepatic disturbances.

Only pure carbon tetrachloride should be used; its freedom from poisonous impurities should be guarded against by previous administration to experimental animals.

Carbon tetrachloride is much cheaper than thymol or oleum chenopodii. It is particularly suitable for anti-Ankylostomiasis campaigns.

I have received considerable help during this investigation by the staff of Qalyûb Ankylostoma Annexe to whom I offer my thanks. Dr. Mahfouz Fikri and Dr. Sadek Iskander assisted me throughout the whole period of investigation, doing a large share of the microscopical examination.

It has been thought advisable to generalize the use of carbon tetrachloride in all the Annexes and General Hospitals and for this purpose the following circular was sent to the Medical Officers for guidance as to the use of the drug.

RULES FOR THE TREATMENT OF ANKYLOSTOMIASIS CASES WITH CARBON TETRACHLORIDE.

Carbon tetrachloride is a colourless and highly volatile fluid with a characteristic etherial smell.

It must be kept in well-stoppered bottles, and if possible in a cool place.

This drug is very effective in expelling Ancylostoma duodenale and Oxyuris vermicularis worms from the human intestine.

It is partly effective in expelling Ascaris lumbricoides, but oil of chenopodium surpasses it in expelling these worms.

The drug must be given only after microscopical examination of the fæces and the finding of Ancylostoma ova.

Dosage.

The drug is administered per mouth.

The dose for an individual above 15 years old is 5 cc.; this is to be diluted at the time of administration with about 30 cc. of water.

Patients less than 15 years of age to be given on an average:—

5–8	years old:	2 cc.	with	equivalent	amount of water.
9–11	,,	3 cc.	,,	,,	,,
12–14	,,	4 cc.	,,	,,	,,

Debilitated individuals ought to be given a comparatively smaller dose.

Three hours after the administration of the drug the patient must be given a saline purge (magnesium sulphate).

Preparation of the Patient.

No restriction of diet is necessary before the administration of the drug, which can be given on a full stomach. In practice the drug is given once the diagnosis is made. In the case of in-patients a preliminary purge on the night before administration is advisable, as better results are obtained by this method.

It is not necessary to confine the patient to bed after the administration of the drug. It can be administered to out-patients who can proceed to their homes after having the purge. Patients must abstain from food till the purge has acted sufficiently.

Immediate Effect of Carbon Tetrachloride.

Patients have often sensation of discomfort in the abdomen. Sickness and dizziness may occur but vomiting is a rare occurrence, and when it occurs, it is usually the result of an over-dosage as in the case of children.

Contra-Indications.

The drug must not be given to cases with evident renal disease, pregnant women, severe Bilharziasis of the rectum, and piles.

Result of the Treatment.

When possible the fæces passed by the patient during the twenty-four hours that follow the administration of the drug should be collected and examined and a record kept of the number of worms expelled.

The examination of the stool for Ancylostoma ova should be made seven days later and if possible after another week: the treatment to be repeated should ova still be present.

Records should be kept of all cases thus treated. Monthly reports tabulated (same as in attached form) must be sent at the end of each month, addressed to the "Ankylostoma and Bilharzia Investigation Section, Public Health Laboratories, Cairo."

Ankylostoma and Bilharzia Investigation Section.

HOSPITAL OR ANNEXE AT.....
MONTH OF..... ..

MONTHLY RECORD OF ANKYLOSTOMIASIS CASES TREATED WITH CARBON TETRACHLORIDE.

DETAILS.		More than 15 Years Old.		Less than 15 Years Old.		TOTAL.	Percentage.
		Males.	Females.	Males.	Females.		
Total number treated ...	Current month						
	Re-examined from previous month						
Number of worms passed if counted.	Current month						
	Re-examined from previous months						
Stools negative for ancylostoma ova after 7–13 days.	Current month						
	Re-examined from previous months						
Stools negative for ancylostoma ova 14 days or more.	Current month						
	Re-examined from previous months						
Stools found positive for Ancylostoma ova.	Current month						
	Re-examined from previous months						

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III.—The Control of Bilharziasis in Egypt.

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I.—The Magnitude of the Problem.

The Incidence of Infection.

Bilharziasis is a widely spread disease amongst the population of Egypt. There is evidence to show that the incidence of infection in recent years is steadily increasing.

Although there is proof of the existence of Bilharzia infection in mummies of 1250–1000 B.C., reliable records as to the incidence of infection in Egypt were collected during the latter half of last century only.

Griesinger (1866) as a result of observations based upon 363 post-mortems at Cairo, recorded the incidence of infection with Bilharziasis to be 32 per cent.

Sonsino (1874) as a result of examining 91 post-mortems arrived at the conclusion that the incidence of infection was 46 per cent.

Kaufmann (1894) examined 500 post-mortems and recorded the incidence of infection to be 33·3 per cent. He also found that the incidence of infection was more amongst males than amongst females, being 40 per cent in the former and 11·5 per cent in the latter.

Ferguson (1910) examined more than 1,000 post-mortems and recorded that the incidence of infection was 40 per cent amongst males (5 to 60 years of age). He claimed that Bilharziasis was the direct cause of death in 8 per cent of the post-mortems examined by him.

The records above detailed apply to the incidence of infection with Bilharziasis amongst patients admitted to the hospitals for all diseases and dying there. The incidence of infection might consequently be expected to be higher amongst hospital patients than amongst the average healthy communities.

MacCallan (1913–1915) recorded the incidence of infection amongst the general population of Egypt to range between 10 and 42 per cent. His diagnosis was based on the interrogation of individuals as to the presence or absence of hæmaturia. In the light of our present knowledge this is of little value as an indication of the real condition of affairs.

During 1923 and 1924, the incidence of Bilharziasis infection amongst the inhabitants in different localities in Egypt was ascertained by means of microscopic examinations of the excreta without any reference to absence or presence of symptoms.

The localities referred to were :—

(1) Saft el Enab village (near Damanhûr in the north of the Delta). 83 per cent of the population were found to be harbouring either Sch. hæmatobia or Sch. mansoni or both. 74 per cent of the population were infected with Sch. hæmatobia and 34 per cent with Sch. mansoni.

(2) Gemmeiza village (near Tanta in the centre of the Delta). 63 per cent of the population were found to be harbouring either Sch. hæmatobia or Sch. mansoni or both. 53·3 per cent of the population were infected with Sch. hæmatobia and 14 per cent with Sch. mansoni.

(3) Tura village (near Cairo). 77 per cent were found to be harbouring Sch. hæmatobia. Of 360 cases examined none was found to be harbouring Sch. mansoni.

(4) Nag Hamadi town (near Luxor in Upper Egypt). 75·2 per cent of the population were found to be harbouring Sch. hæmatobia. None was found to be infected with Sch. mansoni.

A résumé of the above results is shown below :—

Date.	Locality.	Examination of Excreta of General Population.	P.M. Examination.	Bilharziasis.		
				General.	Sch. hæmatob.	S. mansoni.
				Per Cent.	Per Cent.	Per Cent.
1866	Qasr el Aini Hospital	—	363	32·0	—	—
1874	,, ,,	—	91	46·0	—	—
1894	,, ,,	—	500	33·3	—	—
1910	,, ,,	—	1,000	40·0	—	—
1923	Saft el Enab	366	—	83·0	74·0	34·0
1923	Gemmeiza	157	—	63·0	53·3	14·0
1923	Nag Hamâdi	260	—	75·2	75·2	0·0
1924	Tura	360	—	77·0	77·0	0·0

The statistics above mentioned show that :—

(1) The infection with Bilharziasis is probably increasing in Egypt. This may be accounted for by the continuous construction of small irrigation canals and drains throughout the country. These are favourable places to the snail-carriers of Bilharzia.

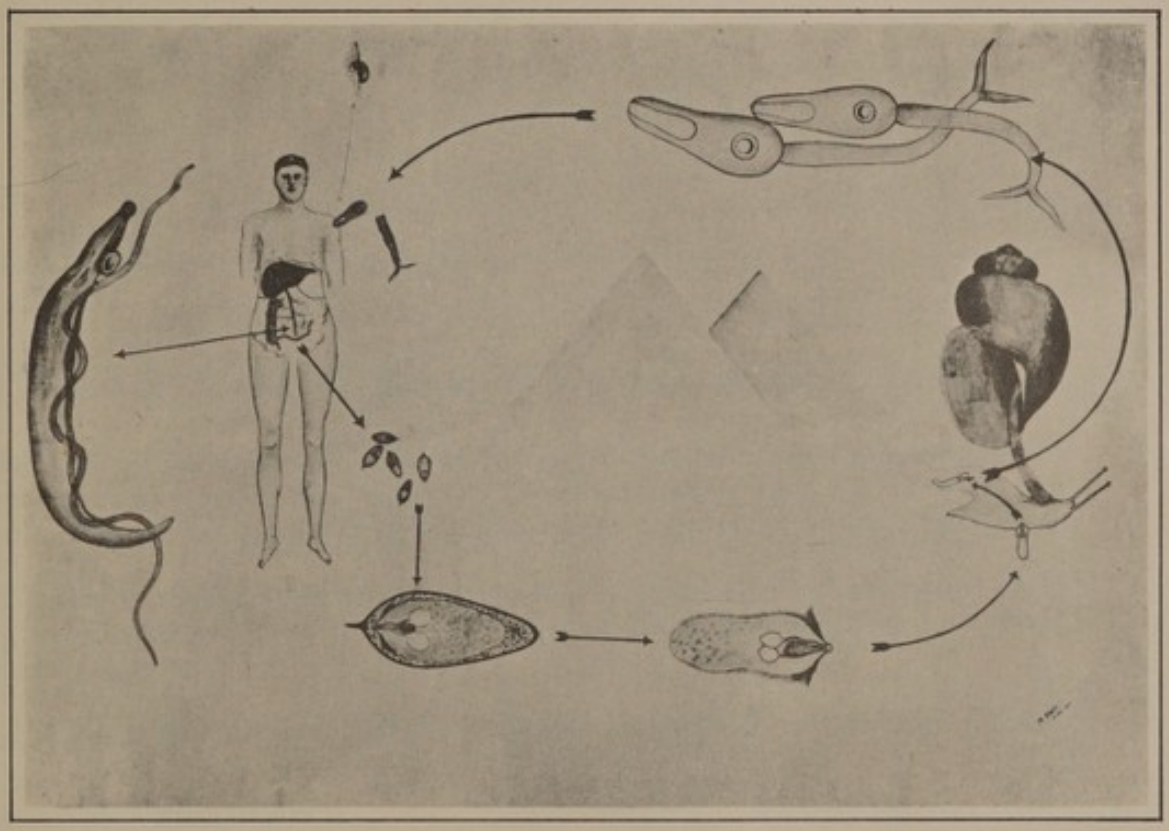
(2) About 70 to 80 per cent of the total population of Egypt are infected with Bilharziasis *i.e.* 9 to 10 millions of a total population of about 13 millions.

(3) Infection with Sch. hæmatobium is probably homogeneous throughout the country whilst infection with Sch. mansoni is practically localized to the north of the Delta. Other localities have still to be investigated before this conclusion can be accepted as final.

Distribution of the Disease.

Examination of 1,242 inmates of the Lunatic Asylum at Khanka showed that every province of Egypt was represented and that the incidence of infection in the province varied from 68·4 per cent to 91 per cent. This definitely shows that infection is widespread throughout the whole country.

The disease is propagated by species of *Mollusca* belonging to the genera *Bullinus* and *Planorbis*. The distribution of infection is necessarily governed by the distribution of the above-mentioned mollusca. The following table gives a record of the different species collected at various localities in Egypt.



The Life Cycle of Schistosoma hæmatobium.

Locality.	Gheit el Nasara Damietta.	Lake Maryût.	Lake Menzala.	Helwân.	Near Pyramids.	Naga Hammadi.	Gimmeiza, Santa.	Mahmudiya Canal Alexandria.	Saft el Enab Kom Hammada.	Marg.	Public Works Garden, Pond.
Physa acuta	—	—	—	—	—	—	+	—	+	+	+
Physa subopaca	—	—	—	—	+	+	+	—	+	+	+
Limnæa caillaudi	—	—	—	—	+	—	+	—	+	+	+
Bullinus brocchii	—	—	—	+	—	—	—	—	—	—	—
Bullinus dybowski	+	—	—	+	+	+	+	+	+	+	+
Bullinus innesi	—	—	—	+	—	—	—	—	—	—	—
Bullinus contortus	+	—	—	+	+	+	+	+	+	+	+
Pyrgophysa forskali	—	—	—	—	—	+	+	—	+	+	—
Planorbis boissyi	+	+	+	—	+	—	+	+	+	+	—
Planorbis mareoticus	—	—	—	—	—	—	+	—	+	—	—
Lanistes bolteni	+	+	+	—	+	+	+	+	+	+	—
Vivipara unicolor	+	+	+	+	+	+	+	+	+	+	—
Cleopatra bulimoides	+	—	+	+	+	+	+	+	+	+	—
Cleopatra cyclostomoides	—	+	+	—	+	+	+	—	+	+	—
Hydrobia stagnalis	—	—	—	—	—	—	—	—	—	+	—
Melania tuberculata	—	—	—	—	+	—	+	+	—	+	—
Nodularia nilotica	—	—	—	—	+	—	—	—	—	—	—
Helix obstructa	—	—	—	—	—	—	—	—	—	+	—
Corbicula consorbina	—	+	+	+	+	—	+	+	+	+	—
Limnea laurenti	—	—	—	—	—	—	—	—	—	—	+

II.—The Scientific Basis of Means of Control of Bilharziasis.

Before the discovery of the life history of the *Schistoma* parasites, the means of infection with the disease was not known and consequently prevention was merely guess work. It was suspected at an early period that water was the source of infection, but no serious efforts were attempted at prevention.

When the life history of the Egyptian human *Schistosoma* was discovered by Leiper, 1915–1918, it served as a sure basis for preventive measures. The life cycle of *Sch. hæmatobium* is represented in the accompanying diagram.

Three species of genus *Bullinus* act as the intermediate hosts of *Sch. hæmatobium* (Bilharz, 1852) :—

Bullinus contortus Michaud, 1829.
Bullinus dybowsky Fischer, 1891.
Bullinus innesi Bourguignat.

The life cycle of *Sch. mansoni* Sambon 1907 is similar to that of *Sch. hæmatobium*, substituting *Planorbis boissyi* Potiez and Michaud 1388 for snails of the genus *Bullinus*.

If the life cycle could be broken at any of its stages, the parasites would not develop and the disease will be controlled. If the break in the cycle is a complete one the disease will be abolished, but if it is not thorough the incidence of infection will be decreased to a certain extent.

The possibilities of breaking the cycle can be discussed under the following headings :—

1. Protection of man from being infected with the cercariæ.
2. Guarding streams against pollution.
3. Killing the miracidia.
4. Extermination of the molluscan intermediary host.

1.—PROTECTION OF MAN FROM BEING INFECTED WITH THE CERCARIÆ.

Habitat of the Bilharzia Cercariæ.

Schistosoma cercariæ are discharged by the molluscan intermediate host into water, in which they swim actively. The movement of the *cercariæ* in water does not result in an appreciable change of place. The *cercariæ* are constantly sinking down in water at the least disturbance and floating again to the top. The cercariæ are carried along by the current if any is present. The ideal habitat of the snails being small canals and drains where the water current is very sluggish, result in keeping the *cercariæ* more or less close to their molluscan hosts. The *cercariæ* discharged into the stream at one village might be carried to the next village downstream. The large deep streams with an appreciable water current and no vegetation are practically free from the molluscan carriers of Bilharzia.

Life Span of the Cercariæ.

In order to determine the life span of the *Schistosoma cercariæ* the following procedure was followed.

Snails found to be discharging *Schistosoma cercariæ* were placed in clean test-tubes, half full with tap water. After a period of two hours the snails were removed and the water containing the *cercariæ* was left to stand. The *cercariæ* were observed at intervals within the twenty-four hours by means of a hand lens.

It was found that the maximum duration of life was sixty hours. The majority of the *cercariæ*, however, died within forty-eight hours.

Effect of Temperature on Cercariæ.

Cercariæ are killed at a temperature of 50° C. Natural hot springs in Tunis have been known to be safe to use as regards Bilharzia infection while neighbouring springs at ordinary temperature were known to be infective.

Method of Infection.

Cercariæ penetrate the body of man through the skin or the mucus membranes. When water charged with *cercariæ* is drunk, infection may take place through the mucus membrane of the mouth. This means of infection, however, plays a secondary part. In an agricultural country like Egypt, most of the male inhabitants are more or less constantly exposed to infection when irrigating their fields or draining their land. The skin is not protected from the water, as most of the working classes are bare-footed. Women wash their clothes in these canals and draw water for domestic purposes from them and so they are exposed to infection. Children of both sexes when bathing, fishing or playing in these canals are likewise exposed to infection.

How to avoid Infection.

Infection may be avoided by :—

(1) Prevention of bathing in canals or drains.
(2) Prohibiting drinking directly from canals or drains. Water when stored in a utensil for two days is safe ; so is also the water which has been boiled.
(3) Avoiding contact of any part of bare skin with canal or drain water.
(4) Water drawn for public use should be stored for forty-eight hours before filtration.

These suggestions could possibly be complied with by well-to-do persons not engaged in agricultural work.

As far as the agricultural population are concerned it is not possible to follow these suggestions in such a way as to be effective in combating the disease. The working class population have to work in water as long as the methods of cultivation remain as they are. Economic conditions prevent a generalized use of water-proof boots as has been suggested by some authorities.

Women and children not performing field work can, however, avoid infection with *Bilharzia* if they use water stored for two days on the premises. Children can also be persuaded not to frequent

small canals or drains to bathe. This has been attempted to a certain extent in the villages, not as a means of prevention of Bilharziasis, but as a safeguard against drowning. School children are stamped on the legs with aniline dye which is very soluble in water. This is done by the school master and any child frequenting the water washes off the mark and is punished. The method is certainly interesting, but does not encourage personal hygiene amongst the children.

On the whole, under the present conditions in Egypt, the peasants are bound to be infected with Bilharziasis if they happen to be living in an infected district. People not directly engaged in agriculture can protect themselves from infection.

2.—GUARDING STREAMS AGAINST POLLUTION.

If it were possible that all the inhabitants of Egypt abstain from polluting the water courses of the country by their dejecta, Bilharziasis would be eradicated. Unfortunately this is very difficult to accomplish. In Egypt man is the only definitive host of the Bilharzia worms, and thus he is the sole origin of infection. This is not the case in Japan for example, where Bilharziasis infects man as well as domesticated animals. Thus, although the task of preventing the pollution of water courses in Egypt is easier than the corresponding task in China or Japan, yet it is far from being practical as a sole means of prevention.

If such an object is attempted at, the co-operation of all the inhabitants has to be enlisted, and without such co-operation little or nothing could be done. The dangers resulting from pollution of the water courses must be appreciated by the ordinary worker in fields in order to give his co-operation. Unfortunately this individual is difficult to get at. Being illiterate, pamphlets and circulars are of no use. The parasitic infections from which about 90 per cent of this class suffer makes them apathetic if not resenting any interference in their daily routine.

There are two means which could be adopted to present the case of health to a peasant and thus enlist his co-operation :—

(1) *Religious Teaching as an Aid to the Prevention of Bilharziasis.*

Before discussing how religion can best be utilized in combating Bilharziasis, it might be stated, that at present, it is a factor and probably a strong factor in disseminating it.

The Mohammedan religion prescribes the washing with water of the urethral and anal openings after urination or defæcation. The peasants who follow strictly the religious rites comply with these orders. They seek the bank of the nearest stream to defæcate or urinate to be able to wash afterwards. The result is that a very hygienic principle of personal cleanliness turns out to be a factor in disseminating Bilharziasis.

On the other hand, the Mohammedan religion prohibits the pollution of water with human excreta. Such pollution is, however, allowed if the volume of the water is large and the water is running. This is not the case with most of the small irrigation channels in Egypt. If the religious authorities could be convinced of the dangers brought about by the pollution of the streams, they will aid in preventing such pollution. After urination and defæcation on dry earth ablution could still be carried out with water drawn in a bottle or tin. The excreta could then be buried with soil.

Whenever a Bilharziasis campaign is contemplated it ought to be preceded by the erection of latrines in the neighbourhood of towns and villages, to help at least in reducing the extent of water and soil pollution.

The religious heads of mosques all over the country can also co-operate in such a scheme by referring in the sermons to the danger of stream pollution, supporting their statements by extracts from the Sacred Book and the sayings of the Prophet, and thus an appreciable amount of success could be anticipated.

(2) *Circulars, Illustrated Posters, and Popular Lectures.*

The second means of enlisting the co-operation of field workers is by disseminating knowledge about this disease and its prevention amongst the educated members of the villages, by using circulars, illustrated posters, and popular lectures. These people can then disseminate the information in their own circles of illiterate field workers. Kuttab children can also be employed as health emissaries among their own families.

3.—KILLING THE MIRACIDIA.

Miracidia hatch out from the Bilharzia ova 5 to 20 minutes after reaching the water. The period depends to a great extent upon the temperature. Once free in the water Miracidia swim actively. They then become gradually sluggish and finally die if they are not successful in invading the body of the proper molluscan intermediary host in the meantime.

Miracidia are susceptible to changes in the reaction of medium. They are killed at once in a dilution of 1 in 2,000 of hydrochloric acid.

The time that Miracidia have to pass in water depends upon the presence or absence of the proper molluscan intermediary host, and thus it is a factor that cannot be easily controlled.

4.—EXTERMINATION OF THE MOLLUSCAN INTERMEDIARY HOSTS.

The recent discovery of the rôle played by snails in the transmission of Bilharziasis paved the way for an attempt to eradicate the disease by extermination of the molluscan hosts.

Attempts to eradicate diseases caused by flukes by extermination of the snails were advocated by Thomas (1883) in the case of liver fluke disease in sheep. Sheep grazing on pastures in salty areas were found to be free from liver fluke disease, and it was proposed to scatter common salt on pastures where sheep were known to become infected with the disease. The salt was meant to destroy the snail Limnea which acted as the intermediate host for the liver fluke. This method could not be utilized in Egypt as agricultural experts state that common salt is deleterious to the soil. Moreover, the snail intermediate hosts of *Schistosoma* in Egypt survive indefinitely in solution containing less than 1 per cent of sodium chloride.

Ando (1915) reported that 1 per cent lime water killed six out of ten snails (intermediate hosts of *Paragonimas westermanni*) in seven hours and 1 per cent solution of copper sulphate would kill them in six hours. Although these findings are very important from a scientific point of view the concentration used was so high as to prohibit its use on a large scale.

Leiper (1915–1918) observed that snails found in the dry beds of canals were dead. He proposed the utilization of periodical dryness of tertiary canals as a means of combating Bilharziasis in Egypt. He also reported that weak solution of ammonium sulphate (commonly used as a fertilizer) killed the molluscan intermediary hosts of Bilharziasis within a few hours. He proposed also the combination of the two methods for attacking the snails. Simple dryness of the irrigation channels in Egypt always leave occasional puddles owing to the unevenness of the canal beds. These puddles could be treated with ammonium sulphate.

Chandler (1920), experimenting with local snails in the United States of America, found that they were susceptible to very low dilutions of copper sulphate. This author was unable to procure the actual molluscan intermediary hosts of fluke disease, but he concluded that his results were applicable to the latter snails as well. He reported that all species of snails experimented with died within forty-eight hours in solutions of 1 in 500,000 to 1 in 1,000,000 of copper sulphate.

Khalil and Lee (1921), experimenting with *Planorbis boissyi* and *bullinus contortus*, found that these snails were killed in 1 in 1,000,000 copper sulphate solution in tap water after five and a half hours immersion.

(A) Effect of Dryness on the Snails.

The unoperculated snail carriers of *Schistosome* in Egypt are susceptible to dryness. When the small irrigation channels are inspected during the dry season the dry bed is found strewn with shells of dead snails.

The irrigation and drainage channels are cleaned annually when the silt deposited in them is removed and placed on the banks. This silt is found a few days later to be full of empty shells of dead snails.

The canals, however, are never thoroughly dried. Water is often seen here and there forming small ponds in their beds. In these some of the snails survive the dry season.

In order to ascertain the effect of dryness on the snails a series of experiments were planned using *Planorbis boissyi*, *Bullinus dybowski* and *Bullinus contortus*.

Procedure followed :—

Snails were freshly collected from a stream. They were picked out of the water with forceps and placed in a petri-dish lined with filter paper to absorb the water adhering to them. The uncovered petri-dish is left in the shade and at definite intervals some of the snails are removed and put in water to find out how far they can survive.

Experiment No. 1.

Planorbis boissyi.

Temperature 20–25° C.

Number of Snails.	Time of Dryness.	Revived.		Dead.	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	3	60	2	40
5	48	5	100	0	—
5	72	2	40	3	60
5	96	0	—	5	100
5	120	0	—	5	100

Conclusion : None survived after four or more days.

Experiment No. 2.

Planorbis boissyi.

Temperature 11–21° C.

Number of Snails.	Time of Dryness.	Revived.		Dead.	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	3	60	2	40
5	48	2	40	3	60
5	72	5	100	0	—
5	96	5	100	0	—
5	120	0	—	5	100

Conclusion : None survived after five days.

Experiment No. 3.

Planorbis boissyi.

Temperature 11–18° C.

Number of Snails.	Time of Dryness.	Survived.		Dead.	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	1	20	4	80
5	48	0	—	5	100
5	72	0	—	5	100
5	96	0	—	5	100

Conclusion : None survived after two days.

EXPERIMENT No. 4.

Bullinus dybowski and B. contortus.

Temperature 11–18° C.

Number of Snails.	Time of Dryness.	Survived.		Dead	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	1	20	4	80
5	48	5	100	0	—
5	72	1	20	4	80
5	96	0	—	5	100

Conclusion: None survived after four days.

EXPERIMENT No. 5.

Bullinus dybowski and B. contortus.

Temperature 10–17° C.

Number of Snails.	Time of Dryness.	Recovered.		Dead.	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	5	100	0	—
5	48	5	100	0	—
5	72	0	—	5	100
5	96	0	—	5	100

Conclusion: None survived after three days.

EXPERIMENT No. 6.

Bullinus dybowski and B. contortus.

Temperature 20–25° C.

Number of Snails.	Time of Dryness.	Recovered.		Dead.	
		Number.	Per Cent.	Number.	Per Cent.
	Hours.				
5	24	3	60	2	40
5	48	1	20	4	80
5	72	0	—	5	100
5	96	0	—	5	100
5	120	0	—	5	100

Conclusion: None survived after three days.

From the above experiments it is apparent that the snail intermediate hosts of Bilharziasis in Egypt are susceptible to dryness at room temperature when kept in the shade. In their normal habitat the snails are exposed during the dry season to the scorching rays of the sun, they probably succumb earlier. Snails protected by the shade of vegetation, along the sides of the canals, will die in five days if outside the water.

It has been observed that snails kept in glass receptacles in the laboratory often move along the side of the vessel above the water level. They become dry in a short time, retract within their shells and remain sticking to the side of the vessel by the dried sticky secretion of the mollusc. These snails die if left in that situation for four or more days and do not revive when put again in water.

If dryness is to be utilized as a means of eradiction of the snails, it has to be effective on the different phases of its life cycle. The ova of molusca are laid in masses enveloped in a gelatinous fluid which hardens soon after the ova are laid. This gelatinous mass protects the ova to a certain extent against dryness. It was found to be inefficient if the mass is lifted out of the water and exposed to the air. In the case of *Planorbis corneus* five hours dryness at ordinary temperature in England were sufficient to kill the ova. These results were confirmed in the case of *Planorbis boissyi*, *Bullinus contortus* and *Bullinus dyboswki* in Egypt.

Application.

Dryness of irrigation channels in Egypt is regularly carried out during the early summer months in Egypt. It has been observed that a large percentage of the snails are incidentally killed. Unfortunately, as has been mentioned before the dryness is never complete. The irregularity of the channel beds causes a number of pools to be left behind which help to tide the snails over the dry season.

If some means could be found to secure the complete dryness of the tertiary water channels in Egypt, the number of snails and hence the incidence of the Bilharzia disease will greatly be reduced.

(*b*) Effect of Copper Salts on the Snails.

Review of the Literature on the Effect of Copper Salts upon Living Organisms.

The effect of copper compounds on different classes of organisms is extremely variable. In general, animal life is said to be less susceptible to injury by copper than plant life, though most of the higher plants, some fungi and algæ, will live in concentrations of copper sulphate that would be fatal in a few hours to fish and frogs.

Effect upon Algæ.

A concentration of copper sulphate of 0·5 to 1 part per million parts of water was found to be efficient to keep water reservoirs free from algaæ. The method is used on a large scale in public water works in the United States of America. It was introduced upon the suggestion of Moore (G. T.) and Kellerman (K. F.).

Effect upon Protozoa.

Moore and Kellerman reported that some protozoa, *Paramecium*, *Amoeba*, *Difflugia* and *Spirostomum* die within few hours in a solution of 1 part of copper sulphate per 1 million parts of water.

Effect upon Crustacea and Insecta.

Crustacea are not very susceptible to the action of copper salts. *Cypris* and *Daphnia* require as much as 1 part copper sulphate to 10,000 of water to kill them. Mosquito larvæ die at a concentration varying from 1 in 10,000 to 1 in 200,000.

Effect upon Fish.

Game fish is more susceptible to the action of copper salts than such fish as carp and cat-fish. Black bass in good condition have endured a concentration of 1 to 50,000 for many weeks with no apparent discomfort, while 1 to 100,000 was sufficient to kill German and mirror-carp in a few hours, and 1 in 500,000 killed the most susceptible in a few days. Yellow perch is less susceptible. Perry and Adams state that minnows and goldfish live indefinitely in a 1 to 200,000 solution.

Effect upon Higher Animals.

Moore and Kellerman reported that dogs which were given half a grain of copper acetate in their food per day for twenty-four days suffered but slightly; one dog was unaffected by doses as high as 5 grammes at a time.

Du Moulin gave dogs and rabbits as much as 3 to 5 grammes, causing sickness but in no case death occurred. Hippolyte Kubborn stated that a dog can take 4 grammes of copper sulphate with but slight effect.

Ellenberger and Hofmeister experimented with sheep, giving them 18 to 182·5 grammes of copper sulphate in quantities sometimes as large as two grammes per days with fatal results. One sheep lived 53 days and another 128 days.

Copper Sulphate in the Food of Man.

Lafar attributes the green colour of Lodisan and Parmesan cheese to the presence of copper, giving the maximum amount for Lodisan cheese as 215 milligrammes per kilogramme.

Chocolate contains 0·005 to 0·125 gramme per kilogramme. There is 0·01 gramme of copper sulphate in 1·5 lbs. of bread. 0·1 grammes of copper oxide has been found in 1 kilogramme of preserves, and similar amounts are normally present in a large number of commodities used for food. The largest amount of copper in foodstuffs is found in green peas which is artificially coloured with copper compounds. As much as 0·06 grammes of copper per pound of peas has been reported·

Tschirch would limit the amount of copper to 50 milligrammes per kilogramme of vegetables. In this proportion he believes it to be absolutely harmless even if a kilogramme of vegetables thus artificially coloured is eaten by one person daily.

In Germany, Austria, Belgium, Spain, Russia, and Switzerland, the use of copper for colouring green vegetables is forbidden. In Italy 0·1 gramme of metallic copper per kilogramme of vegetables is allowed.

The New York Board of Health allow canned peas to be sold that contain not more than three quarters of a grain of metallic copper (equal to three grains of the crystallized sulphate) per pound provided that the label on each tin contains a statement to that effect.

Pawl and Gownly found that oysters contain from 1·81 to 3·03 of copper per 10,000 of substance.

Effect of Copper on Human Beings.

There is a considerable difference of opinion among eminent authorities as to the exact amount of copper which may be injurious to health.

Taylor reported that six subjects were given 25 milligrammes of copper daily in the form of coloured peas for a period of sixty days. The sole results that were clinically apparent were possibly a slight disturbance in the alimentary tract, in one of them.

Moore and Kellerman are of opinion that 0·02 grammes of copper is the amount that may with safety be absorbed daily.

Copper salts added to the water of streams and reservoirs are moreover eliminated in a short time by combining with algæ and by being precipitated in other ways. According to Moore and Kellerman samples of water taken from a reservoir treated with sufficient copper sulphate to make a solution of 1 per 1,000,000 failed to show any reaction for copper after twenty-four hours, although all the algæ were killed.

A. S. Taylor reports that in a case tried for copper poisoning, no one in court could produce any evidence of any genuine case of chronic copper poisoning having occurred comparable let us say in the remotest degree with lead or mercury.

Effect opon Plants.

Devaux found that both Phænogams and Cryptogams were poisoned by solution of copper diluted up to the ten-millionth part or less.

Coupin found that 1 part of copper sulphate to 20,000,000 of water was sufficient to affect the growth of seedlings when applied to their roots, and that this was the most injurious of the heavy salts tested by him.

Deherain and De Moussy reported that the development of the roots of seedlings was arrested in distilled water containing the slightest trace of copper and they concluded from this that higher plants during germination as well as fungi and algæ are extremely sensitive to copper.

Bain's experiments indicated that 1 part of metallic copper to 25,000,000 of water was fatal to apple seedlings in one day. On the other hand, according to Raulin, copper chloride does not injure *Sterigmitocystis* until a concentration of 1 in 240 is reached, although silver nitrate is toxic in dilutions of 1 in 1,600,000. Dilute solutions of copper sulphate are reported to have a stimulating action on the growth of many higher plants, having been tested particularly on various grains.

It is evident from the résumé of the literature cited above that the evidence available is to a certain degree contradictory, but it may be safely concluded that algæ are very susceptible while higher animals and plants are less susceptible.

It is, however, interesting to know that copper sulphate is used as a spray to potato to prevent potato plight. Copper mixtures are used for spraying vine in France on a large scale. No deleterious effects were reported as result of the employment of these solutions.

(i) Experimental Study on the Effect of Copper Sulphate upon the Moluscan Intermediary Hosts of Schistosomes.

Molusca used in the Experiments.

In the experiments detailed in this report the following snails were used :—

Planorbis boissyi (Intermediate host of *S. mansoni*).
Bullinus dybowski (Intermediate host of *S. hæmatobium*).
Bullinus contortus (Intermediate host of *S. hæmatobium*).
Physa acuta.
Physa subopaca.

Viability of the Molusca.

The snails were collected from a small fresh water canal at Marg (village near Cairo) and brought to the Laboratory the same morning.

In this way the use of specimens as fresh as possible was ensured, in order that the normal resisting power of the snails would not be diminished by keeping them for a short or a long time under unnatural surroundings.

Along with every experiment a control was kept in which fresh snails in water were observed for comparison.

Plan of the Experiment.

Large glass cylinders (3 litres in capacity) were used. Into these, water, earth, or algæ, as the case might be, were put together with copper sulphate of the particular concentration wanted.

Fresh snails were then dropped into the solution and the exact time recorded. Generally ten *Planorbis* and ten *Bullinus* were placed in each glass cylinder containing one litre of water.

The condition of the snails as regards activity was recorded at least once every twenty-four hours. At the end of the experiment the water in each cylinder was poured over a sieve and the snails washed freely under the tap and then placed in fresh water and observed for one or more days to see if any had survived.

The Copper Salt used.

In all the experiments reported hereafter copper sulphate crystals were used. The concentrations employed refer to parts of copper sulphate crystals, $Cu\ SO_4,\ 5H_2O$.

The actual amount of copper available in these concentrations amounts to 25·4 per cent of the weight used.

(1) *Copper Sulphate in Distilled Water.*

A series of experiments was planned to test the effect of copper sulphate upon snails in distilled water as is shown in (Table I, p. 114).

The dilutions prepared ranged from 1 in 30,000 to 1 in 1,000,000.

The control, however, showed that distilled water to which no copper sulphate was added was harmful to the snails. The experiment was repeated and gave always practically the same result.

This led to the investigation of the effect of distilled water upon the snails. It was at first suspected that the absence of dissolved oxygen in the water might be the cause. To verify this the following experiment was carried out.

Two litres of the distilled water employed were boiled to drive away any oxygen in solution. It was then cooled and divided into two equal portions, each portion placed in a glass cylinder. Into each of these a number of snails were put. By means of a mechanical contrivance air was continuously bubbled through one of these for twenty-four hours while the other was kept as a control. The snails in both cylinders behaved exactly in the same manner and were motionless after twenty-four hours.

It was therefore concluded that the absence of oxygen could not be the cause.

The process of preparing distilled water was then enquired into. It was found that a copper still was used for that purpose. It was thus possible that the distilled water used contained a trace of copper which was affecting the snails.

To settle this point distilled water was prepared in the laboratory by means of an all-glass apparatus. The snails lived in the water so prepared and no harmful effect was noticeable.

It was therefore concluded that water distilled in a copper still contained a trace of copper and that the snails were susceptible to such a contamination. An attempt was made to estimate the amount of copper in this distilled water. For this purpose two litres were evaporated in a glass flask down to a 100 cc. and the amount of copper was estimated by the calorimetric method. This was found to be 1 part in 4,000,000 parts of the distilled water used.

This observation shows how susceptible snails are to the action of copper even in very low dilutions.

(*See* Tables I to III, pp. 114-119).

Summary of Experiment.

(1) The moluscan intermediary hosts of *Schistosomes* in Egypt are killed in dilute solutions of copper sulphate in distilled water.

(2) Members of the genus *Bullinus* are more susceptible than members of the genus *Planorbis*.

(3) Water distilled in copper vessels contains a trace of copper which affects harmfully the molusca.

(4) Some molusca that revive after being removed from the copper sulphate solution and then put in water are short lived and succumb later.

(5) The harmful effect of the copper sulphate solution increases with the increase of the time the snails are allowed to remain in it.

(6) Individuals snails of the same species are apparently more resistant to the action of copper sulphate than others kept under precisely similar conditions.

(2) *Copper Sulphate in Tap Water.*

The Cairo tap water is filtered Nile water, the intake being at Rod el Farag close to the City.

Its composition may be taken for practical purposes to be that of the Nile water less the suspended matter.

The composition of the Nile water differs slightly during the different months of the year. The maximum and minimum amounts of its contents during 1918 are given below :—

	Parts per Million.	
	Maximum.	Minimum.
Solid matter in suspension...	1,062	32·4
Solid matter in solution (dried at 110° C.)	258	126
Alkalinity (French degrees)	18	8·5
Alkalinity after boiling, expressed as $CaCO_3$...	40	15
Chlorine	14·2	3·5
Free and saline ammonia	0·03	0·01
Albuminoid ammonia	0·13	0·04
Oxygen required to oxidize organic matter	1·9	1·0
Sulphates	8·9	3·1
Silica	34·0	15·5
Calcium oxide	59·0	25·5
Magnesium oxide	20·0	10·6

The largest amount of suspended matter exists during the month of August, the lowest during May.

Plan of the Experiments.

The plan followed in these experiments was exactly the same as that described for distilled water. In every set of experiments a control was kept and no deleterious effect on the snails was noted.

(*See* Tables IV to IX, pp. 120-131).

Summary of Experiments.

(1) The same concentration of copper sulphate in distilled water is more effective in destroying the molusca than when tap water is used.

(2) The results of the experiments when repeated are not always identical. This might be due to certain factors such ast emperature, light, etc., or to difference in the susceptibility of individual snails to the effect of copper sulphate.

(3) *Copper Sulphate in Crude Nile Water.*

In the series of experiments detailed below crude Nile water was used. The average composition of this water was given before. The water was drawn from two sources :—

(1) A tap of unfiltered water system in Cairo used principally for the irrigation of gardens and the watering of streets. The water undergoes a certain amount of sedimentation in its passage through the reservoir and in the pipes.

(2) An artificial pond in a garden containing a certain amount of vegetation, algæ, snails, tadpoles, and fish. The water in this pond is derived from the above-mentioned source but is frequently renewed. This water contains more suspended matter than water from source No. 1. The procedure followed in these experiments was exactly similar to that described before.

(*See* Tables X to XV, pp. 132-143.)

Summary of the Experiments.

Substituting crude Nile water for filtered water caused a distinct increase in the resistence of molusca to the toxic action of copper sulphate. 1 in 200,000 to 1 in 300,000 copper sulphate solution was found to be the lowest dilution that could be relied upon to kill *Planorbis* and *Bullinus* under laboratory conditions using crude Nile water.

(4) *The Effect of the Addition of Algæ upon the Action of Copper Sulphate upon Molusca.*

The algæ used were collected from an artificial pond in the Ministry of Public Works Gardens, Cairo, where they grow in abundance. They were mostly *Spirogyra*. The algæ were added to the control as well, and there they remained alive and grew. In copper sulphate solution the algæ soon died, their colour changed to dirty grey colour.

(*See* Tables XVI and XVII. pp. 144–147.)

Summary of the Experiments.

The effect of the presence of algæ in the water upon the action of copper sulphate on the molusca was not definite. On the whole it lessens its toxic action on the molusca.

(5) *The Effect of the Presence of Algæ and Soil upon the Action of Copper Sulphate upon the Molusca.*

The soil used in these experiments was ordinary garden soil. It was estimated by measurement and not by weight. In all the experiments detailed below both algæ and garden soil were added to water derived from the pond alluded to before.

(*See* Tables XVIII to XXII, pp. 148–157.)

Summary of Experiments.

The addition of both algæ and soil inhibits to a certain degree the action of copper sulphate on the snails. This is apparently due to a part of the copper sulphate being eliminated from the solution by the algæ and soil. The loss, however, is not great.

It has been noted that the results are not always uniform. Sometimes a lower dilution is found to be slightly more effective than a little more concentrated solution. The true explanation of this could not be arrived at. It may be due to the difference in the resisting power of different snails. It has been suggested that copper sulphate acts on the snails indirectly by inactivation of enzymes necessary to life. If this is true it might be conceivable that the effect on the snails might not be proportional to the concentration employed.

(ii) Discussion.

The observations here recorded show that copper sulphate solution, in very low dilutions, is a potent poison for molusca.

It was found that the same concentration of copper sulphate solution is more effective in distilled water than in tap water and is more effective in the latter than in crude Nile water. Moreover, the presence of algæ and soil interferes to a certain extent with the potency of the drug.

Moore and Kellerman advise an increase of 2 per cent in the concentration of copper sulphate employed to kill algæ, for each part per 100,000 of organic matter.

If copper sulphate solution is to be utilized in combating Bilharziasis in Egypt, it will have to be put into the small irrigation channels and drains choked with vegetation and algæ and hence a concentration of 1 in 300,000 to 1 in 200,000 will be the lowest practicable one, if the laboratory results were to be found applicable to the conditions in the field.

Before attempting any field experiments it was found necessary to ascertain the action of this salt on animals and plants.

As far as man and the higher animals are concerned there is no harmful effect. The amount utilized in drinking is very small. Moreover, the water will be charged with copper sulphate for three or four days only at a time. Copper sulphate is eliminated quickly from the water by precipitation as insoluble salt or is being fixed by algæ and vegetation.

The effect of copper sulphate in such concentration on fish is doubtful. The small irrigation channels and drains are, however, not important sources of fish. Fish is caught in the large canals, and in the Nile, and principally in the salt water lakes adjoining the Mediterranean sea.

(c) The Effet of Copper Sulphate on Egyptian Crops.

Before proceeding any further with the experiments on copper sulphate it was thought essential to find out if in the proposed concentration, copper sulphate would have any effect on Egyptian crops.

The importance of such a matter cannot be fully over-emphasized.

In a country depending mostly on agriculture, especially upon the cotton crop, any proposed scheme for the eradication of Bilharziasis on a large scale must definitely prove to be innocuous to agriculture. The literature dealing with the action of copper sulphate on plants was given in previous pages and the evidence appeared to be controversial. In order to settle definitely the question, field experiments were carried out.

The Ministry of Agriculture was approached and willingly sanctioned the carrying out of any experiments upon the varied crops in the Model Experimental Farms at Gemmeiza, near Tanta. The officials in charge of the farm as well as the employees assisted in carrying out these experiments in a truly scientific spirit worthy of admiration.

Plan of the Experiments.

The small irrigation channel leading to a field was charged with water kept at a constant level all through the experiment. The water was led into the field through two small iron pipes which could be closed or opened at will.

The rate of flow from these pipes was first calculated by letting them flow into petroleum tins of known capacity till they were full. This was repeated ten to fifteen times. Another petroleum tin provided with a tap at its bottom was placed on an embankment so that the water from the tap mixed freely with the water flowing from the pipes.

The latter tin was filled with copper sulphate solution and the tap adjusted so that the copper sulphate solution mixing with the stream flowing from the iron pipes, charged the water with the required concentration of copper sulphate. The experiment lasted 20 to 30 minutes till the copper sulphate tin was practically empty. The pipes were then closed and the area irrigated bordered.

The area was kept under observation, comparing the crop in it with that of the surrounding areas. The crops so irrigated were :—

(1) On August 13, 1923, a cotton field (Sakellarides variety) was irrigated. The plant was five and a half months old, at the time of the experiment. Copper sulphate was used in a concentration of 6 parts per 1,000,000. Later observations showed that the plant was not affected either for good or bad.

(2) On August 15, 1923, a rice field was irrigated. The plant was half grown. Copper sulphate was used in a concentration of 11 parts per 1,000,000. Later observations showed that the plant was not affected. It was, however, slightly better than the surrounding crop.

(3) On August 16, 1923, a maize field was irrigated. The plant was twenty-five days old. Irrigation with water charged with copper sulphate was its first irrigation. The concentration used was 8 parts par 1,000,000. Later observations showed that there was no difference between that maize and the other crop surrounding it.

(4) On August 17, 1923, a sugar cane field was irrigated. The plant was half grown. Copper sulphate was used in concentration of 10 parts per 1,000,000. No harmful effect was observed.

(5) On March 5, 1924, a bean field was irrigated. The plant was nearly fully grown. Copper sulphate was used in a concentration of 50 parts per 1,000,000. Up to the end of March 1924 no bad effect was noticed.

(6) On March 5, 1924, a clover (berseem) field was irrigated. The plant was half grown. Copper sulphate was used in a concentration of 50 parts per 1,000,000. Up to the end of March 1924 no bad effects were noticed.

(7) On March 3, 1924, a flax field was irrigated. The plant was in flower. Copper sulphate was used in a concentration of 50 parts per 1,000,000. Up to the end of March 1924 no bad effects were noticed.

So far the results of field experiments have been satisfactory.

It has, however, been suggested that plants may be susceptible to copper sulphate when they are in the germination stage. The following experiments have been planned to settle this point.

Seeds experimented with.

The effect of dilute solutions of copper sulphate on germination was tried in the case of cotton, maize, and wheat.

Plan of Experiments.

Small and shallow glazed earthenware pots were employed. These were filled with dry garden soil. Four pots were allotted to each of the seeds in question. One served as control, using ordinary tap water. The other three were watered with water containing 1 in 100,000, 1 in 200,000, and 1 in 400,000 parts of copper sulphate respectively. The cotton and maize seeds were soaked, moreover, for twenty-four hours in copper sulphate solution of the corresponding concentration.

Result.

Seeds germinated in all the pots and the plants grew normally. There was no noticeable difference between those irriggated with copper sulphate solution and those irrigated with ordinary tap water.

Conclusion.

Copper sulphate employed in a concentration of 10 parts per 1,000,000 has no deleterious effect on cotton, maize, and wheat, in their germination stage.

(*d*) Elimination of Copper Sulphate from Nile Water.

In order to ascertain if copper sulphate is eliminated from Nile water solution the following quantitative tests were carried out :—

(1) Copper sulphate was added to crude pond water to make a concentration of 1 in 100,000. No algæ were present. After forty-four hours the amount of copper in solution was estimated by the calorimetric method. It was found to be 1 in 250,000. 60 per cent of the salt was eliminated.

(2) Copper sulphate was added to crude pond water to make a concentration of 1 in 24,000. Algæ were added. After forty-four hours, the amount of copper sulphate in solution was estimated and was found to be 1 in 120,000, *i.e.* 80 per cent of the salt was eliminated.

It is therefore obvious that copper sulphate is eliminated from crude pond water and is more so if algæ were present.

(*e*) Colloidal Copper.

When copper sulphate is dissolved in crude Nile water in small amounts, *i.e.* 1 in 50,000, the solution is seen to be turbid, due to the precipitation of part of the copper as carbonate. As far as the molusca are concerned, the part thus deposited may probably be inactive.

Upon the suggestion of Dr. C. Todd, Chairman of the Ankylostoma and Bilharzia Consultative Committee, colloidal copper was given a trial. Dr. Todd prepared a colloidal solution in the laboratory, having a strength of 15 parts of copper metal in 100,000. In that concentration, it has a deep rich violet colour. It does not precipitate on keeping. When mixed with water, it retains the violet tint, up to 1 in 200,000. In lower dilutions the violet colour is not perceptible, but there is a turbidity which does not settle although the solution may be left standing for seven days.

Using Nile water a dilution of 1 per 4,000,000 of colloidal copper killed the molusca in three days and none of the specimens survived.

The colloidal solution is very promising but unless it can be produced at a very low cost its use on a large scale will not be practicable. Moreover, the colloidal copper prepared in the laboratory is of a concentration of 3 parts per 10,000. This entails a big volume to carry about. It is hoped that a method will be found enabling the preparation locally of a more concentrated colloidal solution.

(*f*) Effect of Chemical Compounds other than Copper Sulphate on Molusca.

The following compounds have been tried on the moluscan carriers of Bilharziasis in Egypt. The snails were placed for three days in tap water to which the particular concentration of the salt was added. Different dilutions of the same compound were tried and the following is a summary of the results :—

Compound.	Lowest Dilution causing Death of the Snails.
Sodium chloride	1 in 100.
Lime	1 in 1,000.
Ammonium sulphate	1 in 1,000 (killed *Bullinus* only, *Planorbis* survived).
Nickel chloride	1 in 100,000.
Cobalt chloride	1 in 8,000.
Colloidal copper	1 in 4,000,000.

Chandler tried the effect of different chemical compounds on fresh water molusca of the United States of America. In all these experiments the snails were left in the solution for twenty-four hours. The results were as follows :—

Chemical Compound.	Dilutions.	Observations.
As_2O_3	1 in 100,000	No evident effect.
Bu $(NO_3)_2$	1 in 100,000	No evident effect.
Ca OCl_2	2·6 available chlorine per 1,000,000	No evident effect.
Ca $(OH)_2$	1 in 10,000	No evident effect.
Hg Cl_2	1 in 1,000,000	70 per cent killed.
NaCl	1 in 1,000	No evident effect.
NaCN	1 in 100,000	No evident effect.
$(NH_4)_2$ SO_4	1 in 100,000	No evident effect.
Pb $(CH_2COOH)_2$	1 in 100,000	None dead but snails ill.
Zn Cl_2	1 in 1,000,000	No evident effect.

III.—Conclusions as to the Measures necessary for Combating Bilharziasis in Egypt.

Bilharziasis in Egypt is a problem of grave national importance. Statistics show that about 75 per cent of the inhabitants are infected. The disease affecting children in early life arrests to a certain extent their bodily and mental development, whilst amongst adults it deteriorates the value of manual labour. It causes a good deal of suffering and claims a big toll of mortality which has been estimated by Griesinger at 25 per cent of all deaths and according to Ferguson at 8 per cent. In addition it predisposes to infection with other disesases and diminishes the normal resisting power of the body.

The problem of combating this disease as could be gleaned from the preceding pages is both difficult and complicated in addition to its enormous magnitude. The difficulties, however, are not unsurmountable.

A campaign proposed to combat this disease ought to be so planned as to attack the disease from different aspects at the same time. Each measure, although by itself might be inefficient, yet it will ensure to a certain extent the success of other measures. The following are the promising points of attack :—

(1) Prevention of the pollution of irrigation channels by :—

(*a*) Erection of house and village latrines and inducing the inhabitants to use them.

(*b*) Propaganda amongst inhabitants illustrating the dangers of stream pollution.

(*c*) If possible enlisting the co-operation of religious authorities in condemning stream pollution.

(2) Guarding water used for drinking and household use by :—

(*a*) Localizing the spots where villages can draw their water. These must be from the river or canal where no snails are present.

(*b*) Protecting that locality from pollution.

(*c*) Advising the inhabitants to store their water on the premises for forty-eight hours before use.

(3) Attempt at exterminating the molusca by :—

(*a*) Utilizing the summer rotation of irrigation in Egypt causing dryness of the small irrigation channels.

(*b*) Treating the small amount of water left in these channels with copper sulphate solution.

(*c*) Guarding the intake of these channels against the introduction of snails by proper sieves if possible.

(4) Treatment of infected individuals on a large scale.

At present the attempt at the extermination of snails appears the most promising. The system of irrigation in Egypt controls in a unique manner the water supplied to any particular area. The co-operation of the Irrigation Department with the Department of Public Health in such a project is fundamental. Leiper in his report on Bilharziasis in Egypt states " If campaigns against Bilharziasis were commenced, it is evident that the whole scheme should be under the charge of a medical zoologist who should be attached, not solely to the Public Health Service, but also to the Department of Irrigation."

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TABLE I.—Shows that snails exposed to the action of a solution of copper sulphate in distilled water (from copper stil

		Control.			1/30,000 Copper Sulphate Solution.			1/40,000 Copper Sulphate Solution.			1/50,000 Copper Sulphate Solution.			1/75,000 Copper Sulphate Solution.		
		2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	
Time in copper sulphate solution: 24 hours.	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	2	5	5	2	5	5	2	5	5	2	5	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Washed and placed in tap water.																
1. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	2	5	5	2	5	5	2	5	5	2	5	5	2	5	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	2	5	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	5	—	—	—	—	2	5	5	2	5	
	D	—	—	5	2	—	5	2	5	5	—	—	—	—	—	
3. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	5	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	2	—	5	2	5	5	2	5	5	2	5	5	2	5	
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	5	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	2	—	5	2	5	5	2	5	5	2	5	5	2	5	
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

The effect of copper sulphate on fresh water Molusca:

A=Active. R=Reacts to touch. M=Motionless. D=Dea

be killed in 24 hours in a concentration more than 1 in 100,000.

$\frac{1}{100,000}$ pper Sulphate Solution.		$\frac{1}{200,000}$ Copper Sulphate Solution.			$\frac{1}{250,000}$ Copper Sulphate Solution.			$\frac{1}{300,000}$ Copper Sulphate Solution.			$\frac{1}{500,000}$ Copper Sulphate Solution.			$\frac{1}{1,000,000}$ Copper Sulphate Solution.		
5 Planorbis.	5 Physa.	Bullinus.	Planorbis.	Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	Bullinus.	Planorbis.	Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	—	—	—	2	5	5	—	—	—	2	5	5	2	5	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	5	—
5	5	—	—	—	2	4	5	—	—	—	2	5	5	2	—	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	5	—	—	—	—	—	5	—	—	5	—
5	5	—	—	—	2	—	5	—	—	—	2	—	5	2	—	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	5	—	—	—	—	1	5	—	—	5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	—	—	—	2	—	5	—	—	—	1	—	5	2	—	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	5	—	—	—	—	—	5	—	—	5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	—	—	—	2	—	5	—	—	—	2	—	5	2	—	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

tilled water (from copper still), one litre employed in each experiment.

TABLE II.—Shows that snails exposed to the action of copper sulphate solution for three days will not survive

		Control Distilled Water from Glass Apparatus,			Control Distilled Water from a Copper Still.			$\frac{1}{30,000}$			$\frac{1}{50,000}$			$\frac{1}{75,000}$	
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	10	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	—	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.															
1. Day	A	10	10	10	—	5	—	—	—	—	—	—	—	—	—
	R	—	—	—	3	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	7	5	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	2	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	8	10	10	10	10	10	10	10	10	10
3. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	2	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	8	10	10	10	10	10	10	10	10	10
4. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	2	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	8	10	10	10	10	10	10	10	10	10
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca:

A=Active. R=Reacts to touch. M=Motionless. D=Dea

oncentration of 1 in 500,000 or more. The water used was distilled in copper still except the control.

1/100,000		1/200,000			1/300,000			1/400,000			1/500,000			1/1,000,000		
10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —
— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— 1 9 —	— — 10 —	— — 10 —	— 2 8 —	— — 10 —
— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— 2 — 8	— — — 10
— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— 2 — 8	— — — 10
— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— 2 — 8	— — — 10
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —

illed water (from copper, still, except control) one litre employed in each experiment.

TABLE III.—Shows that using distilled water from a glass apparatus the molusca experimented with, will not survive

		Control.			1/30,000 Copper Sulphate Solution.			1/50,000 Copper Sulphate Solution.			1/75,000 Copper Sulphate Solution.			1/100,000 Copper Sulphate Solution.		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 24 hours.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	10	9	10
	D	—	—	—	10	10	10	10	10	10	10	10	10	—	—	—
3. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	9	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	—	10
4. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	7	10
5. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	8	10
6. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	8	10
7. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

* Distilled in a glass apparatus.

4 hours exposure to 1 in 75,000 copper sulphate solution.

1/150,000 Copper Sulpahte Solution.			1/200,000 Copper Sulphate Solution.			1/250,000 Copper Sulphate Solution.			1/300,000 Copper Sulphate Solution.			1/500,000 Copper Sulphate Solution.			1/1,000,000 Copper Sulphate Solution.		
10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	10	10	—	—	—	—	—	—	—
—	3	—	2	4	—	6	5	—	—	—	10	4	6	—	—	—	—
10	7	10	8	6	10	4	5	10	—	—	6	4	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	3	—	2	4	—	6	5	—	6	9	—	4	6	—	—	—	—
—	7	—	8	6	—	4	5	10	4	1	—	6	4	10	—	—	—
10	—	10	—	—	10	—	—	—	—	—	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	3	—	2	4	—	6	5	—	6	9	—	3	5	—	—	—	—
—	7	—	8	6	—	4	5	10	4	1	—	7	5	10	—	—	—
10	—	10	—	—	10	—	—	—	—	—	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	4	—	5	5	—	6	8	—	3	4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	9	10	10	6	10	5	5	10	4	2	10	7	6	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	4	—	5	5	—	6	8	—	3	4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	9	10	10	6	10	5	5	10	4	2	10	7	6	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	4	—	5	5	—	6	8	—	3	4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	9	10	10	6	10	5	5	10	4	2	10	7	6	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Distilled water,* one litre employed in each experiment.

TABLE IV.—Shows the records of a series of experiments using different dilutions of copper sulphate. The snails were
Dilutions ranging from 1 in 300,000 upwards killed all the snails put in it while in lower dilutions up to 1 in

DATE January 17 to 27, 1923.		Control.			1/30,000			1/40,000			1/50,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: during the whole experiment.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	10	10	10	10	10	10
	D	—	—	—	10	10	10	10	10	10	—	—	—	—	—	—
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	10	10	10
	D	—	—	—	—	—	—	—	—	—	10	10	10	—	—	—
3. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
4. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
5. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
6. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
7. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10

The effect of copper sulphate on fresh water Molusca :-

A=Active. R=Reacts to touch. M=Motionless. D=Dead

eft in the solution throughout the whole experiment which lasted for eight days.
,000,000 all *Bullinus* and *Physa* died, while 50 per cent of the *Planorbis* survived.

$\frac{1}{150,000}$			$\frac{1}{200,000}$			$\frac{1}{300,000}$			$\frac{1}{400,000}$			$\frac{1}{500,000}$			$\frac{1}{1,000,000}$		
Bullinus.	Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	5/5	—/10	—/10	1/9	—/10	2/8	6/4	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	5/5	—/10	—/10	1/9	—/10	2/8	6/4	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	5/5	—/10	—/10	—/10	—/10	—/10	5/5	—/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	5/5	—/10	—/10	—/10	—/10	—/10	5/5	—/10

Tap water, one litre in each experiment.

TABLE V.—In this series of experiments the snails were left in the copper sulphate solution for 24 hours only. The
further observation.
In dilutions ranging from 1 in 100,000 upwards all snails were killed. In dilutions 1 in 250,000 and lower

DATE December 27, 1922, to January, 1923.		Control.			1/30,000			1/40,000			1/50,000			1/75,000		
		2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.
Time in copper sulphate solution: 24 hours.	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
2. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
3. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

snails were then washed in running tap water to remove all traces of copper sulphate and then placed in tap water for dilutions a percentage of the snails revived when transferred to water free from copper sulphate.

$\frac{1}{100,000}$			$\frac{1}{200,000}$			$\frac{1}{250,000}$			$\frac{1}{500,000}$			$\frac{1}{750,000}$			$\frac{1}{1,000,000}$		
2 Bullinus.	5 Planorbis.	5 Physa.	Bullinus.	Planorbis.	Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Pranorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	5	—	2	5	—	2	5	5	2	—	5
2	5	5	—	—	—	2	—	5	—	—	5	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	5	4
—	—	—	—	—	—	—	5	—	2	5	—	1	5	5	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	—	5	—	—	5	1	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	5	4
—	—	—	—	—	—	—	5	—	2	5	—	1	5	5	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	—	5	—	—	5	1	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ap water, one litre in each experiment.

TABLE VI.—This series is a repitition of Table V with practically the same result. Dilutions of 1 in 100,000 and

DATE January 3 to 9, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 24 hours.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wasked and placed in tap water.																
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
3. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
4. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

upwards killed the snails in 24 hours. In lower dilutions a certain percentage of the snails revived.

1/150,000			1/200,000			1/250,000			1/300,000			1/500,000			1/1,000,000		
10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	1	2	—	2	3	—	1	3	—	4	3	1	—	—	—
10	9	10	9	8	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	10	8	7	10	9	7	10	6	7	9	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	3	—	1	2	—	2	3	—	1	3	—	4	3	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	7	10	9	8	10	8	7	10	9	7	10	6	7	9	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	3	—	—	—	—	2	3	—	1	3	—	4	3	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	7	10	10	10	10	8	7	10	9	7	10	6	7	9	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Tap water, one litre in each experiment.

TABLE VII.—In this series the snails were left in the copper sulphate solution for three days. After this period the snai

DATE January 10 to 15, 1923.		Control.			$\frac{1}{30,000}$			$\frac{1}{50,000}$			$\frac{1}{75,000}$			$\frac{1}{100,000}$		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	10	10	10	—	—	—	10	10	10	10	10	1
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Washed and placed in tap water.																
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	10	10	10	—	—	—	10	10	10	10	10	1
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	10	10	10	—	—	—	10	10	10	10	10	1
3. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
4. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

The effect of copper sulphate on fresh water Molusca :-

A=Active. R=Reacts to touch. M=Motionless. D=Dead

re washed in tap water and put in fresh tap water. In dilutions ranging from 1 in 1,000,000 upwards all snails were killed.

1/150,000		1/200,000			1/300,000			1/400,000			1/500,000			1/1,000,000		
Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
— — — —	— — — —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —
— — — —	— — — —	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— 1 — 9	— — — 10
— — — —	— — — —	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —

water, one titre in each experiment.

TABLE VIII.—The series of experiments in Table VII was repeated. The dilutions used ranged from 1 in 300,000 to 1 in 750,0
survived three days exposure to a dilution of 1 in 300,000 and 1 in 500,000 died a little later, showing that they we

DATE February 21 to 27, 1923.		Control.			1/30,000			1/40,000			1/55,000			1/75,000	
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.															
1. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10
3. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca

A=Active. R=Reacts to touch. M=Motionless. D=De

In all except one specimen in the lowest dilutions the snails were killed. In addition few specimens that affected by the copper sulphate solution.

$\frac{1}{100,000}$		$\frac{1}{200,000}$			$\frac{1}{250,000}$			$\frac{1}{300,000}$			$\frac{1}{500,000}$			$\frac{1}{750,000}$		
10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / 10 / — / —	— / — / 10 / —	— / — / 10 / —
— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —
— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / 10	— / 1 / — / 9	— / — / — / 10	— / — / — / 10	— / 2 / — / 8	— / — / — / 10	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —
— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	— / — / — / 10	1 / — / — / 9	— / — / — / 10
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —

p water, one litre in each experiment.

TABLE IX.—This series of experiments was a repetition of Tables VII and VIII, utilizing the lower dilutions
In dilutions as low as 1 in 500,000 all *Bullinus* were killed and only 60 per cent of the *Planorbis*.

DATE January 24 to 31, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000	
		10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.															
1. Day...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3. Day...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4. Day...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca

A=Active. R=Reacts to touch. M=Motionless. D=D

shows definitely that *Planorbis* is more resistant to the effect of copper sulphate solution than either *Bullinus* or *Physa*.

1/200,000		1/300,000			1/400,000			1/500,000			1/769,000			1/1,000,000		
10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10	—/—/10
1/9	—/10	1/9	2/8	—/10	2/8	1/9	—/10	2/8	4/6	—/10	1/9	9/1	—/10	5/4	8/2	1/1
1/9	—/10	—/10	1/9	—/10	2/8	1/9	—/10	—/10	4/6	—/10	1/9	8/2	—/10	4/6	8/2	1/9
1/9	—/10	—/10	1/9	—/10	—/10	1/9	—/10	—/10	4/6	—/10	1/9	3/2	—/10	2/8	8/2	1/9
—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—
—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—
—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—
—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—	—/—/—/—

p water, one litre in each experiment.

TABLE X.—In this series of experiments the snails were left in the copper sulphate solution for seven days with
Using lower dilutions a certain percentage of the snails survived.

DATE January 17 to 24, 1923.		Control.			1/30,000			1/40,000			1/50,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	
Time in copper sulphate solution: During the whole dur. of exper.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	1
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	1
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	1
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
3. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	10	10	10	10	10	10	10	10	
	D	—	—	—	10	10	10	—	—	—	—	—	—	—	—	
4. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	
5. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	
6. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

The effect of copper sulphate on fresh water Molusca

A=Active. R=Reacts to touch. M=Motionless. D=De

changing the fluid. Dilutions of 1 in 300,000 and more were fatal to all the snails employed.

1/150,000			1/200,000			1/300,000			1/400,000			1/500,000			1/1,000,000		
Bullinus.	Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10	—/10
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	4/6	1/9	—/10	2/8	1/9	—/10	9/1	5/5	1/9
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	4/6	1/9	—/10	2/8	1/9	—/10	9/1	5/5	1/9
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	4/6	1/9	—/10	2/8	1/9	—/10	9/1	5/5	1/9
—/—	—/—	—/—	—/10	—/10	—/10	—/10	—/10	—/10	4/6	1/9	—/10	2/8	1/9	—/10	9/1	5/5	1/9
—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—/—

Tap water, one litre in each experiment.

TABLE XI.—In this series of experiments the snails were placed in the copper sulphate solution for twenty-four hour
Dilutions of 1 in 100,000 upwards killed all the snails used.
Bullinus were found to be more susceptible than *Planorbis*.

DATE December 27, 1922. to January 1, 1923.		Control.			1/30,000			1/40,000			1/50,000			1/75,000		
		2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.
Time in copper sulphate solution: 24 hours.	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	5	—	—	5	—	—	5	—
	M	—	—	—	2	5	5	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	2	—	5	2	—	5	2	—	5
2. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
3. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
4. Day	A	2	5	5	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

only, after which they were washed freely in running tap water and placed in clean tap water.

In lower dilutions a certain percentage of the snails survived.

During the time this series of experiments was carried out very few *Bullinus* could be found in the irrigation channel.

1/100,000			1/200,000			1/250,000			1/500,000			1/750,000			1/1,000,000		
2 Bullinus.	5 Planorbis.	5 Physa.	Bullinus.	Planorbis.	Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.	2 Bullinus.	5 Planorbis.	5 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	5	5	2	5	5	2	5	5	2	5	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	1
—	5	—	—	—	—	1	5	—	1	5	—	—	5	—	1	—	4
—	—	—	—	—	—	—	—	—	1	—	5	2	—	5	1	—	—
2	—	5	—	—	—	1	—	5	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	2	5	5
—	—	—	—	—	—	—	5	—	—	4	2	1	5	2	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	—	5	1	1	3	1	—	3	—	—	—
—	—	—	—	—	—	—	—	—	1	4	2	1	5	2	2	5	5
—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	—	5	1	1	3	1	—	3	—	—	—
—	—	—	—	—	—	—	—	—	1	4	2	1	5	2	2	5	5
—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	5	5	—	—	—	2	—	5	1	1	3	1	—	3	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Crude Nile water, one litre in each experiment.

TABLE XII.—This series is practically a repetition of Table XI, but it was possible to procure a larger number of the snails, The result shows that in dilutions of 1 in 150,000 upwards all *Bullinus* were killed. *Planorbis* survived an

DATE January 3 to 9, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 24 hours.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	9	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	7	10
3. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	7	10
4. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	7	10
5. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	19	10	10	10	7	10
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

ten of each for every dilution.
immersion for twenty-four hours in 1 in 75,000 dilution of copper sulphate.

$\frac{1}{150,000}$			$\frac{1}{200,000}$			$\frac{1}{250,000}$			$\frac{1}{300,000}$			$\frac{1}{500,000}$			$\frac{1}{1,000,000}$		
10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / 10 / —	— / — / — / —	— / — / — / —	— / — / — / —
— / — / 10 / —	— / 6 / 4 / —	— / — / 10 / —	— / 5 / 5 / —	— / 8 / 2 / —	— / — / 10 / —	5 / — / 5 / —	10 / — / — / —	1 / — / 9 / —	10 / — / — / —	10 / — / — / —	7 / — / 3 / —	7 / — / 3 / —	10 / — / — / —	4 / — / 6 / —	— / — / — / —	— / — / — / —	— / — / — / —
— / 4 / — / 6	— / 5 / — / 5	— / — / — / 10	— / 5 / — / 5	— / 8 / — / 2	— / — / — / 10	3 / — / — / 7	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	10 / — / — / —	3 / — / — / 7	— / — / — / —	— / — / — / —	— / — / — / —
— / 3 / — / 7	— / 1 / — / 9	— / — / — / 10	— / 3 / — / 7	— / 4 / — / 6	— / — / — / 10	3 / — / — / 7	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	10 / — / — / —	3 / — / — / 7	— / — / — / —	— / — / — / —	— / — / — / —
— / 3 / — / 7	— / 1 / — / 9	— / — / — / 10	— / 3 / — / 7	— / 3 / — / 7	— / — / — / 10	3 / — / — / 7	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	8 / — / — / 2	1 / — / — / 9	6 / — / — / 4	9 / — / — / 1	3 / — / — / 7	— / — / — / —	— / — / — / —	— / — / — / —
— / 3 / — / 7	— / 1 / — / 9	— / — / — / 10	— / 3 / — / 7	— / 3 / — / 7	— / — / — / 10	3 / — / — / 7	9 / — / — / 1	1 / — / — / 9	6 / — / — / 4	8 / — / — / 2	1 / — / — / 9	6 / — / — / 4	9 / — / — / 1	3 / — / — / 7	— / — / — / —	— / — / — / —	— / — / — / —
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —
— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —	— / — / — / —

Crude Nile water, one litre in each experiment.

TABLE XIII.—In this series of experiments the snails were left in the copper sulphate solution for three days and then they
In dilutions of 1 in 400,000 and more all snails were killed.
It is apparent that the effect of copper sulphate on the snails is increased in proportion to the time the

DATE January 10 to 16, 1924.		Control.			1/30,000			1/50,000			1/75,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
2. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
3. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
4. Day	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

vere washed in running tap water and placed in fresh water.

In higher dilutions a small percentage survived.

noluscа are exposed to it.

	$\frac{1}{200,000}$		$\frac{1}{300,000}$			$\frac{1}{400,000}$			$\frac{1}{500,000}$			$\frac{1}{750,000}$			$\frac{1}{1,000,000}$		
10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
— — 0 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — 10 —	— — — —	— — — —	— — — —	— — 9 —	1 — 9 —	— — 10 —
— — — 0	— — — 10	— — — 10	— 1 — 9	— 1 — 9	— — — 10	— — — 10	— — — 10	— — — 10	— 4 — 6	— 1 — 9	— — — 10	— — — —	— — — —	— — — —	3 — — 7	4 — — 6	1 — — 9
— — — 0	— — — 10	— — — 10	— 1 — 9	— 1 — 9	— — — 10	— — — 10	— — — 10	— — — 10	— 4 — 6	— 1 — 9	— — — 10	— — — —	— — — —	— — — —	3 — — 7	4 — — 6	1 — — 9
— — — 0	— — — 10	— — — 10	— 1 — 9	— 1 — 9	— — — 10	— — — 10	— — — 20	— — — 10	— 4 — 6	— 1 — 9	— — — 10	— — — —	— — — —	— — — —	5 — — 5	4 — — 6	— — — 10
— — — 0	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— — — 10	— 3 — 7	— — — 10	— — — 10	— — — —	— — — —	— — — —	4 — — 5	5 — — 6	— — — 10
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —

le water, one litre in each experiment.

TABLE XIV.—In this series no specimens of *Bullinus* were employed as none could be found in the irrigation channel visited. The snails were left in the copper sulphate solution for three days, after which they were washed and put in. In dilutions of 1 in 500,000 and more all *Planorbis* were killed.

DATE February 21 to 27, 1923.		Control.			1/30,000			1/40,000			1/50,000			1/75,000		
		Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis	10 Physa.
Time in copper sulphate solution: 3 days.	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

for collecting the specimens.
fresh water to revive.
In lower dilutions small percentage survived.

$\frac{1}{100,000}$			$\frac{1}{200,000}$			$\frac{1}{250,000}$			$\frac{1}{300,000}$			$\frac{1}{500,000}$			$\frac{1}{750,000}$		
Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	—	—	—	10	10	—	10	10	—	10	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	—	—	—	10	10	—	10	10	—	7	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—
—	10	10	—	10	10	—	—	—	—	8	10	—	9	10	—	7	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	—	—	—	10	10	—	10	10	—	7	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Nile water, one litre in each experiment.

TABLE XV.—This series was a repetition of Table XIV. The results are, however, different. All specimens of *Bullinus*

DATE January 24 to 31, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

e killed in dilutions of 1 in 300,000 and more while 1 out of 10 of the *Planorbis* survived in 1 in 200,000.

1/200,000		1/300,000			1/400,000			1/500,000			1/769,000			1/1,000,000		
10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Billinus	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	2	8	3	5	8	6	9	10	5
1	—	—	4	—	2	4	—	—	—	—	—	—	—	—	—	—
9	10	10	6	10	8	6	10	8	2	7	5	2	4	1	—	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	2	7	2	3	7	5	—	4	4
1	—	—	4	—	2	4	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	10	10	6	10	8	6	10	8	3	8	7	3	5	10	6	6
—	—	—	—	—	—	—	—	—	7	2	3	7	5	—	2	—
1	—	—	4	—	1	4	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	10	10	6	10	9	6	10	10	3	8	7	3	5	10	8	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

water, one litre in each experiment.

TABLE XVI.—In this series of experiments about 20 grammes of fresh algæ were placed in every dilution of copper sulpha
Bullinus was available at that time.
In dilutions of 1 in 300,000 and upwards all specimens of *Planorbis* were killed. In lower dilutions fe
In this series it is apparent that the addition of algæ did not interfere with the action of copper sulpha

DATE March 29 to 4, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000	
		Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.
Time in copper sulphate solution; 3 days.	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
washed and placed in tap water															
1. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	4
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	6
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	—
2. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	9
3. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	10	10	—	10	10	—	10	10	—	10	10	—	9
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca

A=Active. R=Reacts to touch. M=Motionless. D=Dea

loyed. After three days the snails were washed in fresh tap water and placed in fresh water with no algæ in it. No
ived.
Planorbis although the algæ were killed.

1/150,000		1/200,000			1/300,000			1/400,000			1/500,000			1/1,000,000		
Planorbis.	Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	10	10	—	10	10	—	10	10	—	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	10	10
—	—	—	—	—	—	9	10	—	4	1	—	5	—	—	—	—
—	—	—	10	10	—	—	—	—	6	9	—	5	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	10
—	—	—	—	—	—	—	—	—	3	1	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	7	9	—	—	—	—	—	—
—	—	—	10	10	—	10	10	—	—	—	—	5	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	3	1	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	10	10	—	10	10	—	7	9	—	5	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

nd water, one litre, and 20 grammes of algæ in each experiment.

TABLE XVII.—This series is a repetition of Table XVI, but the result is different. One *Planorbis* out of ten survive

DATE April 11 to 16, 1923.		Control.			$\frac{1}{30,000}$			$\frac{1}{50,000}$			$\frac{1}{75,000}$			$\frac{1}{100,000}$		
		Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	10 Planorbis.	
Time in copper sulphate solution: 3 days.	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	10	10	—	10	10	—	—	—	—	10	1
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Washed and placed in tap water.																
1. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	10	10	—	10	10	—	—	—	—	10	1
2. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	10	10	—	10	10	—	—	—	—	10	1
3. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=De

in 1 in 200,000 solution of copper sulphate.

1/100,000			1/250,000			1/300,000			1/400,000			1/500,000			1/1,000,000		
Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	10	10	—	10	10	—	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	8	5	—	7	6	—	—	—
—	—	—	—	2	2	—	2	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	9	10	—	8	8	—	7	9	—	2	5	—	3	4	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	2	2	—	3	1	—	8	5	—	7	6	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	9	10	—	8	8	—	7	9	—	2	5	—	3	4	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pond water, one litre, and 20 grammes of algæ in each experiment.

TABLE XVIII.—In this series 250 cc. of garden soil and 20 grammes of algæ were put in each glass vessel. After three days In this series no *Bullinus* snails were available. In a dilution of 1 in 200,000 no *Planorbis* survived.

DATE April 18 to 24, 1923.		Control.			1/30,000			1/50,000			1/75,000			1/100,000		
		Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 3 days.	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
2. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
3. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

the snails were taken and washed in tap water and put in fresh water with no soil or Algæ in it.
In dilutions of 1 in 250,000 only a single specimen out of ten survived, but in lower dilutions most of the *Planorbis* survived.

1/200,000			1/250,000			1/300,000			1/350,000			1/400,000			1/500,000		
Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	10	10	—	10	10	—	10	10	—	10	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	10	10	—	10	10	—	9	10
—	—	—	—	3	—	—	2	1	—	—	—	—	—	—	—	—	—
—	10	10	—	7	10	—	8	9	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	10	10	—	10	10	—	8	10
—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	9	10	—	9	9	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	10	10	—	10	10	—	8	10
—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	9	10	—	9	9	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pond water, one litre, 250 cc. of garden soil and 20 grammes of algæ in each experiment.

TABLE XIX.—This series is a repetition of Table XVIII. The results were nearly similar. The lowest dilution in which

DATE April 25 to Jan. 1, 1923.		Control.			1/30,000			1/50,000			1/100,000			1/200,000		
		Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 3 days.	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.																
1. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
2. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
3. Day	A	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	10	—	10	10	—	10	10	—	10	10
4. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R		—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

no *Planorbis* survived, was 1 in 300,000.

1/250,000			1/300,000			1/350,000			1/400,000			1/500,000			1/1,000,000		
Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	10 Planorbis.	10 Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	10	10	—	10	10	—	10	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	4	3	—	3	—	—	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	6	7	—	7	10	—	—	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—
—	—	—	—	—	—	—	4	3	—	3	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	6	7	—	7	10	—	—	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—
—	—	—	—	—	—	—	4	3	—	3	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	10	—	10	10	—	6	7	—	7	10	—	—	10	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pond water, one litre, 250 cc. of garden soil and 20 grammes of algæ in each experiment.

TABLE XX.—This series of experiments is a repetition of Tables XVIII and XIX. In dilutions of 1 in 200,000 or higher In a dilution of 1 in 250,000 a single specimen or *Bullinus* survived.

DATE May 30 to June 5, 1923.		Control.			1/100,000			1/200,000			1/250,000			1/300,000		
		10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.
Time in copper sulphate solution: 3 days.	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	10	10	10	10	10	10	10	10	10	10
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed ane placed in tap water.																
1. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	5	—	—
	R	—	—	—	—	—	—	3	—	—	1	—	—	—	6	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	7	10	10	9	10	10	5	4	10
2. Day ...	A	10	10	10	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	3	—	—	1	—	—	5	6	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	7	10	10	9	10	10	5	4	10
3. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	3	—	—	1	—	—	5	6	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	10	7	10	10	9	10	10	5	4	10
4. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca.

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

no snails survived.

In lower dilutions a variable percentage of the snails survived.

1/300,000			1/400,000			1/450,000			1/500,000			1/500,000			1/1,000,000		
10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	10 Bullinus.	10 Planorbis.	10 Physa.	Bullinus.	Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	10	10	10	10	10	10	10	10	10	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	9	4	—	8	8	10	10	9	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	10	10	1	6	10	2	2	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	9	4	—	8	8	10	10	9	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	10	10	1	6	10	2	2	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	9	4	—	8	8	10	10	—	10	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	10	10	1	6	10	2	2	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pond water one litre, 250 cc. of garden soil and 20 grammes of algæ in each experiment.

TABLE XXI.—In this series the amount of soil added was increased to 500 cc.

Only *Planorbis* was available for experimenting with. In dilutions of 1 in 200,000 and upwards no vessel in which 1 in 300,000 dilution was repeated no snails survived. In dilutions of 1 in 450,000

DATE May 9 to 15, 1923.		Control.			1/100,000			1/150·000			1/200000			1/250,000		
		Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.
Time in copper sulphate solution: 3 days.	A	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	—	—	10	—	—	10	—	—	10	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed ann placed in tap water.																
1. Day ...	A	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	10	—	—	10	—	—	10	—	—	10	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Day ...	A	—	10	—	—	—	—	—	—	—	—	—	—	—	2	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	—	—	10	—	—	10	—	—	8	—
3. Day ...	A	—	10	—	—	—	—	—	—	—	—	—	—	—	2	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	10	—	—	10	—	—	10	—	—	8	—
4. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effct of copper sulphate on fresh water Molusca.

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

snails survived. Although 20 per cent of the snails survived in dilutions of 1 in 250,000 and 1 in 300,000 in another glass also no snails survived.

$\frac{1}{300,000}$			$\frac{1}{300,000}$			$\frac{1}{350,000}$			$\frac{1}{400,000}$			$\frac{1}{500,000}$			$\frac{1}{1,000,000}$		
Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	Bullinus.	10 Planorbis.	Physa.	2 Bullinus.	10 Planorbis.	5 Physa.	Bullinus.	10 Planorbis.	Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	—	—	10	—	—	10	—	—	10	—	—	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	10	—	—	10	—	—	10	—	—	10	—	—	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	—	—	—	—	—	2	—	—	1	—	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	8	—	—	10	—	—	8	—	—	9	—	—	5	—	—	—	—
—	2	—	—	—	—	—	2	—	—	1	—	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	8	—	—	10	—	—	10	—	—	9	—	—	5	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Pond water, one litre, 500 cc. of garden soil and 20 grammes of algæ in each experiment.

TABLE XXII.—This series is a repetition of the one before it. In dilutions of 1 in 200,000 and more no snails survived while in dilutions of 1 in 350,000 none survived.

DATE June 6 to , 1923		Control.			1/100,000			1/150,000			1/200,000			1/250,000		
		10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planor.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.
Time in copper sulphate solution: 3 days.	A	10	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	10	10	—	10	10	—	10	10	—	10	10	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Washed and placed in tap water.										—	—	—	—	—	—	—
1. Day ...	A	10	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	2	1	—	10	10	—	10	10	—
	M	—	—	—	—	—	—	8	9	—	—	—	—	—	—	—
	D	—	—	—	10	10	—	—	—							
2. Day ...	A	10	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	2	1	—	—	—	—	3	7	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	—	8	9	—	10	10	—	7	3	—
3. Day ...	A	10	10	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	2	1	—	—	—	—	3	7	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	10	10	—	8	9	—	10	10	—	7	3	—
4. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Day ...	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The effect of copper sulphate on fresh water Molusca :—

A=Active. R=Reacts to touch. M=Motionless. D=Dead.

In dilutions of 1 in 300,000 a percentage of the snails survived.

$\frac{1}{300,000}$			$\frac{1}{350,000}$			$\frac{1}{400,000}$			$\frac{1}{450,000}$			$\frac{1}{500,000}$			$\frac{1}{1,000,000}$		
10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	10 Bullinus.	10 Planorbis.	Physa.	Bullinus.	Planorbis.	Physa.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	—	10	10	—	10	10	—	10	10	—	10	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	10	—	10	10	—	10	10	—	10	10	—	10	10	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	8	9	—	4	4	—	8	7	—	—	—	—
5	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	10	10	—	—	—	—	6	6	—	2	3	—	—	—	—
5	3	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—
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5	3	—	—	—	—	8	9	—	4	4	—	8	7	—	—	—	—
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Pond water, one litre, 500 cc. of garden soil and 20 grammes of algæ in each experiment.

IV.—Parasitic Diseases at Saft el Enab Village.

By M. KHALIL, Ph.D., M.R.C.P.

In charge of the Parasitology Section, Public Health Laboratories.

The Chairman,

Ankylostoma and Bilharzia Consultative Committee,

Public Health Laboratories.

Sir,

I have the honour to submit to your Committee a Report on the investigations carried out at Safr el Enab. This village was the scene of an intense outbreak of a serious malady resulting in the death of over 100 adult males. I have come to the conclusion that the outbreak was principally due to intestinal bilharziasis. This result is confirmed by post-mortem examinations, laboratory findings, and also by the means adopted with success to bring the outbreak to an end.

The report is divided into two parts.

Part I deals with the results of a systematic examination of a fair sample of the population as to the incidence of parasitic worm infection. The main sources of infection with the two species of bilharzia were discovered. The presence of a series of end-canals around the village helped to explain definitely why the field workers were the class that was principally affected. Only 4·4 per cent of the population were found to be free from evidence of parasitic infection.

Part II deals with the outbreak itself. The clinical, laboratory, and post-mortem evidence are discussed in turn. The house incidence, age and sex of those attacked are illustrated by graphs. The outbreak, I believe, is the first recorded of its nature. Statistics from other villages show that similar increase in the mortality of adults is occurring on a lesser scale that attracted little or no attention. The conditions revealed, to say the least, are alarming. Here we have a chronic malady

undermining the health of the adults in many villages of this country and claiming a big toll of mortality.

If this report helps to draw the attention of medical men in Egypt, especially the Medical Officers of Health, to the ravages of intestinal bilharziasis, so that more endemic centres will be discovered, it will have succeeded in attaining its purpose.

I am, Sir,
Your obedient servant,
M. KHALIL.

July, 1923.

PART I.

Intestinal and Urinary Parasitic Worm Infection in an Egyptian Village.

The investigations detailed in this report were carried out at Saft el Enab, a village near Damanhûr, in the Delta. There was an unexplained high incidence of mortality in the village during 1922. The opportunity of investigations being undertaken at the village was utilised to arrive at the extent of parasitic worm infection in a fair sample of the population. This included representatives of all age periods of both sexes, as well as the different social classes met with in such a village.

Four registered midwives were employed in visiting houses and collecting samples from women. It was evident that only the poor women who were mostly field workers submitted specimens easily. The midwives could not influence women from better class families to do the same.

With males, conditions were different. They were easily influenced by argument and demonstration of the different phases of the life history of some parasites and the havoc brought about by them. Microscopical demonstration of living specimens always appealed to them. In spite of their lack of education, these people were very sensible and inquisitive, discussing what they see when they are treated in a gentle manner.

I cannot do better than record the following incident to illustrate this. A barefooted fellah was shown bilharzia eggs under the microscope from the urine of three men including his own. He asked if he could be shown normal urine under the microscope, to see that the eggs were absent from it. This I did and he was quite satisfied.

The "kuttab" headmasters co-operated with us in influencing their pupils to submit specimens for examination and administering treatment when it was found necessary.

Method of Examination.

Urine was centrifugalized and the deposit was pipetted into a watch glass and examined with a low power of the microscope for *S. hæmatobium* eggs. It was found that sedimentation in a conical urine glass and examining the sediment was not sufficiently accurate to show cases of mild infection.

A smear of the fæces on a slide 3×1 inches was examined. In addition about one gramme of the stool was emulsified, strained in a wire sieve and concentrated sodium chloride solution added to it (floatation method). After fifteen to twenty minutes the suface film was lifted by means of a platinum loop and examined for eggs.

In most cases the hæmoglobin index was tested by the Talquist Hæmoglobinometer; blood films were made for differential counts and the weight and height of the person were recorded as as index to his state of nutrition.

Treatment was administered to those who voluntarily applied for it, which after a few demonstrations of *Ascaris* and *Tænia saginata* expelled, included most of those examined.

Number of different Species of Parasites harboured
by inhabitants of Saft-el-Enab

عدد انواع الطفيليات التى تأويها سكان صفط العنب

26·7 % of Inhabitants
one species each.

٢٦,٧ ٪ من السكان
بهم نوع واحد من الطفيليات

42·3 % of Inhabitants
2 species each

٤٢,٣ ٪ من السكان
بهم نوعين من الطفيليات

22·3 % of Inhabitants
3 species each

٢٢,٣ ٪ من السكان بهم
ثلاثة انواع من الطفيليات

4 % of Inhabitants 4 species each

٤ ٪ من السكان بهم أربعة انواع من الطفيليات

0,4 % of Inhabitants 5 species each

٠,٤ ٪ " " خمسة "

4,4 % of Inhabitants Free from parasites

٤,٤ ٪ " خالين من العدوى

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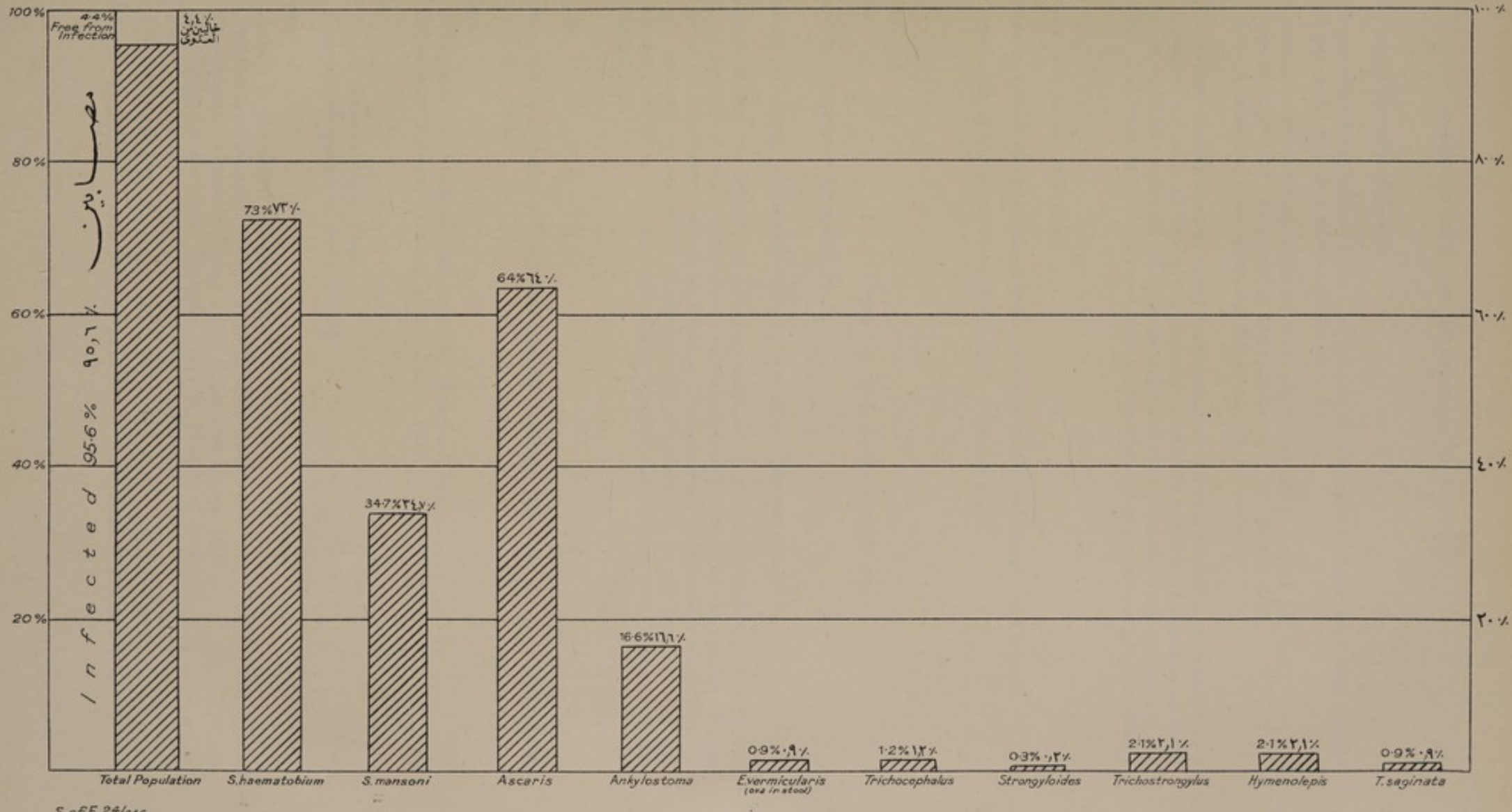
No. 1.



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No. 2.

General Incidence of Parasitic Infection.

In all 375 persons were examined from a population estimated to be 5,629 according to 1917 census, *i.e.* 6·6 per cent ; 285 were males and 80 were females.

44 persons submitted their urine only for the examination, *i.e.* 15 per cent.
75 persons submitted specimens of their stools only, *i.e.* 20 per cent.
274 persons submitted both urine and fæces, *i.e.* 65 per cent.

Of the 274 persons whose urine and fæces were examined 262 were found to be infected with one or more parasites and only 12 individuals were free from any evidence of infection as could be detected by the methods employed. This gives an incidence of parasitic worm infection in the whole population of at least 95·6 per cent and only 4·4 per cent of the population are presumably free.

Plurality of Infection in the Individual.

The number of species of Helminths infecting a single individual varied from 1 to 5.

26·7	per cent	of	those	examined	harboured	1	species each.
42·3	,,	,,	,,	,,	2	,,	,,
22·3	,,	,,	,,	,,	3	,,	,,
4·0	,,	,,	,,	,,	4	,,	,,
0·4	,,	,,	,,	,,	5	,,	,,
4·4	,,	,,	,,	were free from parasitic infection.			

This result is represented by graph No. 1.

Lack of Standard of Severity of Infection derived from Fæcal Examination.

It is unfortunate that the severity of infection could not be accurately represented in figures by any practical method of fæcal examination. It is arbitrarily gauged by the number of eggs found in a slide which is, however, influenced by many diverse factors. The number of adult worms harboured is an accurate representative of the severity of infection. In the investigation here reported it was not possible to treat the cases under hospital condition in order to count all the parasites discharged.

Species met with.

Ova of nine species of Helminth parasites and the larvæ of one were met with during the investigation. These were :—

Trematodes.

(1) *Schistosoma hæmatobium* (Bilharz 1852) Weinland 1858.
(2) *Schistosoma mansoni* (Sambon 1907) Leiper 1918.

Cestodes.

(3) *Tænia saginata* Goeze 1782.
(4) *Hymenolepis nana* von Siebold 1852.

Nematodes.

(5) *Ascaris lumbricoides* Linnæus 1758.
(6) *Ancylostoma duodenale* (Dubini 1843) Creplin 1845.
(7) *Strongyloides stercoralis* (Bavay 1876) Stiles and Hassal 1902.
(8) *Trichocephalus trichiurus* (Linnæus 1771) R. Blanchard 1895.
(9) *Enterobius vermicularis* (Linnæus 1758) Leach 1853.
(10) *Trichostrongylus* sp.

The incidence of infection of each of these parasites is represented in graph No. 11.

BILHARZIA INFECTION.

Irrigation Canals around Saft el Enab.

The accompanying map (No. 3) shows diagrammatically the local conditions. The village lies close to the railway line from Cairo to Teh el Barûd.

The only source of water for irrigation and home use is derived indirectly from the large Abu Diab Canal through its branch, the Safra Canal, which lies to the west of the railway line.

The village itself and the land to the eastern side of the railway line derive their water from a side branch of the Safra Canal which passes underneath the railway line to the south of the village. Five branches spring from that canal, one of which passes through the village. All these branches have dead-ends. These end canal are small in sizes averaging 1·5 metres in width and 1–1·5 metres in depth.

The inhabitants draw their water for drinking and home use from the sites marked 1 and 2.

The water current in these canals is necessarily very slow, being governed by the amount of water drawn for irrigation which for varying intervals may be little or none. The canals are generally choked with vegetation. The inhabitants are supposed to clean them once every year, but this rule is not strictly adhered to.

The water level in these canals is fairly high, being only a little below the ground level. The "tambour" (*Archimedean* screw) is the universal means of irrigation in this area. Only one "sakia" (water-wheel) was seen.

Snails in the Irrigation Canals.

The canals depicted in the map were all surveyed for their moluscan fauna. The following species were found :—

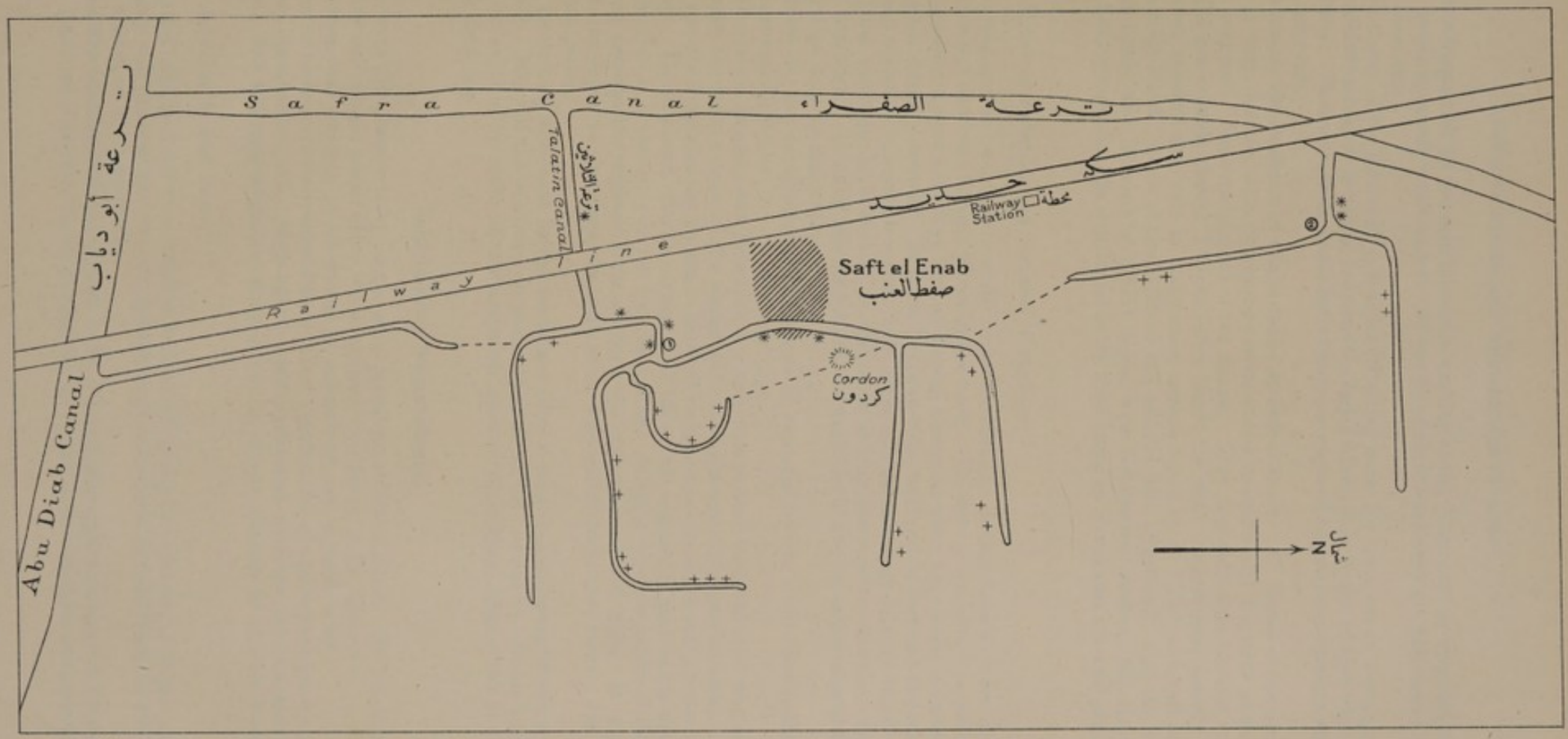
1. *Bullinus contortus*, Michaud 1928.
2. *Bullinus dybowski*, Fischer 1891.
3. *Bullinus* (*Pyrgophysa*) *forskali*, Ehrenberg 1831.
4. *Cleopatra bulimoides*, Olivier 1804.
5. *Lanistes bolteni*, Chemnitz 1786.
6. *Planorbis boissyi*, Potiez and Michaud 1838.
7. *Planorbis mareoticus*, Innes 1884.
8. *Vivipara unicolor*, Olivier 1801.

Of these species Nos. 1 and 2 interest us as carriers of *Schistosoma hæmatobium* and Nos. 6 and 7 as carriers of *Schistosoma mansoni*. The species of *Planorbis* were fairly common all along the terminal branches of the irrigation canals. Where these canals heve been cleaned lately the shells were quite evident in the dry mud on either side of the channel, attracting the attention by their white colour. *Planorbis boissyi* was by far the commonest species met with. The actual sites where they were collected are marked with a cross in the map(†).

Only eight specimens of *Planorbis mareoticus* were collected. In the larger canals close to the village and to the west of the railway line very few *Planorbis* were met with. On the other hand, *Bullinus* was fairly common in these canals although in less number than *Planorbis*. The sites where *Bullinus* was found is marked thus*. In Safra Canal itself and Abu Diab no snails were found. At the sites where the inhabitants draw water for home use *Bullinus contortus* was found.

Schistosoma hæmatobium Infection more widespread than Infection with Schistosoma mansoni.

In this area I can reaffirm the observation of Leiper, Manson-Bahr and Fairley that bilharziasis of the intestinal tract was less common than bilharziasis of the urinary tract, although *Planorbis boissyi* was found in by far larger numbers than *Bullinus contortus* and *Bullinus dybowski*. This, in my opinion, is explained by the different numbers of inhabitants who expose themselves to infection in the different canals. The small channels with a slow current that are the ideal home



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Scheme of Irrigation Canals around Saft El Enab.

رسم تخطيطى للمساقى حول صفط العنب

No. 3.

of *Planorbis* are frequented by the field labourers working at the "tambour" or irrigating the land. This class of people is mostly adult males. By nature of their work they are exposed to infection on frequent occasions.

The other classes of the community, females collecting water for home use or washing clothes, children and adults bathing or drinking, frequent the larger canals close to the villages where species of *Bullinus* thrive. Moreover, these latter individuals are exposed to infection during a short time and at long intervals.

This was mainly the condition of affairs found at Saft el Enab. All classes of the community and both sexes were infected with *Schistosoma hæmatobium* to practically the same extent. The infection was very mild. None complained of the disease. They had very mild bladder symptoms which they did not trouble about. On the other hand, the field workers were heavily infected with *Schistosoma mansoni* and were in many cases incapacitated by it. The universal complaint was diarrhœa with blood. Some of the children and females who occasionally visit the fields and do some work there, were infected in a mild degree with *Schistosoma mansoni*, but they seldom complained of any symptoms, the ova found in the stool being in most cases the only clue to their infection.

Evidence of Means of Infection and Seasonal Prevalence.

Workmen engaged in cleaning the small irrigation channels during January were questioned as to any irritation of their skin brought about by the work. The answer was always in the negative. They were, however, agreed that they feel an itching sensation when they work in the irrigation canals during the summer months. In some localities field workers volunteered the statements that the itching sensation was so severe that they had to scratch their legs till they bleed. Others described popules resulting from working in the water during the summer months, particularly work at the "tambour." In using this instrument the workman has to sit on the edge of the canal with his bare legs deep in the water.

Observations on the development and output of cercariæ by the snail intermediate hosts explain the seasonal incidence.

During December, January and February it is very rare to find snails infected with bilharzia. It is apparently the temperature of the atmosphere that governs such development.

Further enquiry elucidated the statement that the itching sensation is felt only after withdrawal from the water. The workmen offer the explanation that while engaged in performing their work, they are so absorbed in it that they do not feel the itching. Judging from the nature of their work which does not demand the slightest mental effort, the explanation is not right. It is probable that the cercariæ begin to penetrate the skin after withdrawal from the water. The subject demands investigation.

Another interesting statement by the workmen is that if work is done at night time no itching sensation is felt. Many of the workmen do prefer to work at the "tambour" during night time. If is difficult to explain the cause of this nocturnal absence of itching. Again this is a subject that is worth studying.

Schistosoma hæmatobium.

Infection with this parasite is by far the most prevalent at Saft el Enab. No less than 73 per cent of the 318 individuals whose urine was examined were found to be infected.

The infection was common in all classes of community and in both sexes.

Specimens of urine were centrifugalized, if direct examination of the deposit proved negative to *Schistosoma hæmatobium* ova. High speed centrifugalization destroys the ova and liberates the miracidia. 300–400 revolutions per minute for one or two minutes is all that is required.

Incidence of Infection in both Sexes.

Of 259 males examined 194 were found to be infected, giving an incidence of 75 per cent. This represents fairly well the condition at Saft el Enab, as the number is derived from the different age periods and classes of the community.

Of 59 females examined 38 were found to be infected, giving an incidence of 64·5 per cent. The number examined is too small to be representative. It is also derived from one particular class,

"women field labourers," as it was difficult to secure specimens from better class families. It is thus probable that the incidence of infection in families whose females are kept strictly at home is much lower.

The incidence of infection in the different age periods of the males is as follows :—

	Age Periods.	Number examined.	Incidence of Infection per Cent.	
	Years.			
1	1–10	58	77·6	
2	11–20	56	89·0	Age period 11–50 years. Number = 188. Incidence = 74·5 per cent.
3	21–30	80	74·0	
4	31–40	30	70·0	
5	41–50	22	45·5	
6	Above 50	6	5 infected.	

Intestinal Infection with Schistosoma hæmatobium.

In most of the 232 positive cases of *Schistosoma hæmatobium* infection, the characteristic ova were met with in the urine.

In 16 cases, however, the terminal spined ova were met with in both the urine and the stool. Before concluding that those were cases of *hæmatobium* infection of both the urinary and intestinal tract, the possibility of urinary contamination of the stool must be eliminated. Unfortunately this cannot be definitely ascertained. The individuals were instructed to pass urine separate from the stool, but one cannot guarantee that these rules were strictly adhered to.

In four cases terminal spined ova were met with in the stool, but no specimens of urine were submitted for examination. Again in this group the possibility of urinary contamination cannot be excluded definitely.

More instructive is the fact that in four more cases *Schistosomum hæmatobium* ova were met with in the stools while they were absent from the urine. In this group one can definitely assert that they represent genuine cases of intestinal infection with *Schistosoma hæmatobium.*

In two of these cases previous records showed that they had terminal spined ova in their urine and tartar emetic was administered to them. Although they did not complete the course, the ova disappeared from the urine but persisted in the stool.

It might be interesting to add that when tartar emetic is administered to cases with both *Schistosoma hæmatobium* and *mansoni* infection, the ova disappear from the urine long before any change could be noticed on *Schistosoma mansoni* ova in the stools.

In no case was *Schistosoma mansoni* ova met with in the urine.

Clinical Symptoms of Schistosoma hæmatobium Infection at Saft el Enab.

The infection in general was mild although widespread among the inhabitants. This is judged by :—

(1) In a large percentage of individuals who regarded themselves healthy and were persuaded to give samples, *Schistosoma hæmatobium* infection was found.

(2) Few cases complained of bladder symptoms.

(3) The urine in most cases was free from pus and rarely contained any appreciable amount of blood to be noticed with the naked eye.

(4) Urinary fistulæ, a complication of advanced Bilharziasis, was absent.

(5) Post-mortems at Damanhûr Hospital showed that the bladder lesions were limited to areas of echymoses or sandy patches, no papillomata or ulceration were found.

Schistosoma mansoni.

Infection with *Schistosoma mansoni* is limited to the intestinal tract, particularly to the large intestine.

Few cases are on record of infection of the urinary tract with *Schistosoma mansoni*, but in the present investigation no such cases were met with.

Detection of Schistosoma mansoni ova.

The ova of this parasite are detected in smear preparations of the stools mixed with normal saline or water and examined with a low power of the microscope.

The floatation method devised for detecting Ancylostoma ova destroys the ova of *Schistosoma mansoni* owing to the high osmotic pressure of the solution causing the ova of the latter parasite to collapse and thus rupture.

Uneven Distribution of Schistosoma mansoni ova in the Stools.

This subject has attracted no attention in spite of its supreme importance in examining for the ova of this parasite.

The ova of parasites living in the small intestine, *i.e.* Ancylostoma, Ascaris, etc., are thoroughly mixed with the liquid contents of the bowel and can be looked for with safety in any portion of stool.

The condition is different with *Schistosoma mansoni*, the ova are voided through the mucus membrane of the large intestine, particularly that of the sigmoid and rectum. The fæcal contents of the sigmoid portion of the gut under normal conditions are solid or semi-solid in consistance. The rectum under normal conditions is empty.

The ova are found smeared on the surface of the fæces in a layer of mucus that surrounds the fæcal mass and particularly in the last portion of the stool mixed with blood and mucus if present.

Smears taken from the centre of a fæcal mass were found to be negative in three cases where the stools were particularly solid, while scrapings from the surface of the fæcal mass were positive.

In cases where there is diarrhœa the eggs are mixed with the motion to a certain extent. In such cases if blood is present, it is in the portion containing it that most of the ova are found.

It is extremely important where *Schistosoma mansoni* infection is suspected to have the whole stool sent for examination and the proper portion selected for making the smears. Instructing the patient to bring a piece of the stool in a small glass tube will certainly lead to negative findings where proper examination would have revealed infection with this parasite.

In view of the difficulty in finding *Schistosoma mansoni* ova in the stool, especially when one smear is examined, it is almost certain that the reported incidence with this parasite underestimates the true condition of affairs. *Schistosoma hæmotobium* infection of the urinary tract is easily detected and thus the reported results probably reveal the actual condition as regards the prevalence of that infection.

Incidence of Infection.

Amongst the 331 individuals whose stools were examined, the ova of *Schistosoma mansoni* were found in 115 cases, giving an incidence of 34·7 per cent.

Of the 258 males examined, 37 per cent were found to be infected.

Of the 78 females examined, 28 per cent were found to be infected.

It is thus apparent that more males are infected than females. The difference, however, is not very striking because most of the females here examined are field workers performing more or less men's work.

No signs of infection with *Schistosoma mansoni* were detected in any person above 50 years old. Although the number lying in this age group does not justify any conclusions, it is significant and certainly demands further observations.

Relation of Field-work to the Incidence of Infection with Schistosoma mansoni.

Individuals of the age periods 11–50 were classified into three groups :—

(1) Field-workers on the land to the east of the railway line where the canals have dead ends.

(2) Field-workers on the land to the west of the railway line where the canal is of large size and always contains running water.

(3) Individuals that do not work on the fields.

This classification applies to both sexes.

168 males of whom 67 harboured *Schistosoma mansoni* were thus classified :—

(1) Field-workers on the eastern side of the railway line were 82, of whom 46 were found to be infected, giving an incidence of infection in that area of 56 per cent.

(2) Field-workers on the western side of the railway line were 40, of whom 17 were found to be infected, giving an incidence of infection in that area of 42·5 per cent.

(3) Individuals who did not do field work were 64, of whom 4 were found to be infected, giving an incidence of infection of 8·7 per cent.

These figures demonstrate clearly the bearing of the irrigation canals upon the incidence of *Schistosoma mansoni* infection. This classification is by no means definite as it is practically impossible for field workers in a village to be engaged in one particular area throughout their lives. Individuals that are tenants or small proprietors in one area will occasionally do some work for long or short periods in another area. In spite of that the figures show definitely a higher incidence of infection among workers in fields traversed by the dead end canals.

The very low incidence of infection in the third group is striking. It would have been more so if we have excluded land proprietors from this group. Those individuals although they employ others to do the work on the field, they in most cases participate to a less extent in the work and thus are liable to become infected. They are, however, lightly infected and enjoy good health.

56 females of whom 16 harboured *Schistosoma mansoni* fall in the age group 11–50 years and were classified thus :—

(1) Field workers on the eastern side of the railway line were 40, of whom 14 were found to be infected, giving an incidence of infection in that area of 36 per cent.

(2) Field workers on the western side of the railway line were 5, of whom 1 was found to be infected, giving an incidence of infection in that area of 20 per cent.

(3) Individuals who did not do the work on the field were 11, of whom 1 was found to be infected, giving an incidence of infection of 9 per cent.

These figures bear out the conclusion arrived at by classifying the males. It will also help to show that most of the females from whom we could secure samples were field workers, practically 80 per cent of age group 11–50 years. They were in most cases members of the families of males who had succumbed to this disease. Thus being under the supervision of the Public Health authorities samples were easily secured from them. Females doing field work never do so regularly or to the same extent as the males. They are in most cases occasional helpers. They were not so severely infected as the males.

Relationship of Field Work to the Incidence of Infection with Schistosoma hæmatobium.

193 males whose ages range between 11–50 years were classified thus :—

(1) Field workers on the eastern side of the railway line were 89, of whom 73 were found to be infected, giving an incidence of infection of 83 per sent.

(2) Field workers on the western side of the railway line were 47 of whom 40 were found to be infected, giving an incidence of infection of 85 per cent.

(3) Individuals who did not do field work were 57, of whom 31 were found to be infected, giving an incidence of infection of 54 per cent.

It is thus evident that the incidence of infection does not differ in the two areas separated by the railway line. The snail carrier—*Bullinus*—inhabits the larger canals round the village and to the west of the railway line and their cercariæ are carried by the current throughout the whole system.

Individuals who did not do field work were also infected; this probably was due to occasional exposure by bathing or drinking.

34 females whose ages range between 11–50 years were classified thus :—

(1) Field workers on the eastern side of the railway line were 22, of whom 12 were found to be infected, giving an incidence of infection of 55 per cent.

(2) Field workers on the western side of the railway line were 3, all of whom were found to be infected, giving an incidence of infection of 100 per cent.

(3) Individuals who did not do field work were 9, of whom 5 were found to be infected, giving an incidence of infection of 55·5 per cent.

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Bearing of locality and occupation upon Bilharzia infection Males

علاقة المكان والصناعة بعدوى البلهارسيا فى الذكور

No. 4.

These results bear out those arrived at by classifying the statistics of male. It is worthy of note that the third group of both sexes are infected to practically the same extent.

Tænia saginata.

Ova or segments of *Tænia saginata* were met with in the fæces of three individuals only. They were all males. It is interesting to note that two were brothers and both were butchers by trade. On enquiry as to ingestion of uncooked meat it was revealed that both brothers used to eat a little of the raw peri-nephritic fat so as to entice the customers as to the good quality of their meat.

Four cc. of Felix mass extract were administered after a preliminary twenty-four hours fasting and a saline purge. Another purge followed three hours later. The older brother (24 years old) passed one *Tænia saginata* coiled in one lump complete with head and very few detached mature segments. The whole worm measured 425 centimetres when it was in a fresh condition. The younger brother (18 years old) passed two *Tænia saginata* worms. They came out in a long string and took more than two hours in passing. It was a very tedious process. In spite of instructions not to pull them out, forcible traction was evidently used with the result that the string of strobila was broken. Neither head was found, although pieces measuring more than two metres of both worms were passed comprising the very small immature segments 1–2 centimetres from the neck region. These unmistakably belonged to two different worms. Both worms measured 1,050 centimetres.

The older brother harboured in addition *Schistosoma hæmatobium* and *mansoni*. His hæmoglobin index was 85 per cent. The younger brother harboured *Schistosoma hæmatobium* and *Ascaris* in addition to the *Tænia saginata*. His hæmoglobin index was 70 per cent.

The third case was a carpenter 28 years old. There was no history of his eating raw meat. He harboured in addition *Schistosoma hæmatobium* and *Ascaris*. Treatment was administered to him after my departure from the village.

It is to be expected that *T. saginata* infection will be found to be comparatively common in Egyptian villages. The meat is not inspected and thus there is no means of condemning infected carcasses before consumption.

Tænia solium was not met with. The majority of the inhabitants being Mohammedans who never eat pork, infection with this parasite will be only limited to Copts and foreigners who partake of such meat.

Hymenolepis nana.

This parasite of man is identical morphologically with *Hymenolepis fraterna*, a cestode which is a common parasite of rats and mice. It is, however, distinct from it biologically, each species being peculiar to its host only.

There is a good deal of evidence to show that the ova of this parasite are seldom recognized by practitioners in Egypt, and so it has so far attracted little or no attention.

Fives cases of *Hymenolepis* infection were met with. Three were males under 10 years of age and two were females both between 20 and 30 years old.

It was not possible to treat these cases and secure specimens of the parasite and study their pathogenic effect on the host.

The eggs which were quite distinctive, float in concentrated saline solutions and thus could be detected by the floatation method.

Very little is known about the pathogenic action of *Hymenolepis* infection. Nervous symptoms and derangement of digestion are ascribed to it. It is commonly a parasite of children, although it is sometimes found in adults.

Ascaris lumbricoides.

Next to *Schistosoma hæmatobium*, *Ascariasis* is the most widespread parasitic infection met with at Saft el Enab. No less than 64 per cent of the inhabitants showed evidence of its presence.

Unfertilized Ova.

In most of the 210 positive cases the ordinary fertilized ova of *Ascaris* were seen. In seven cases, however, unfertilized ova only were found. These are irregular in shape, rather elongated and bear

the characteristic knobs seen on the normal eggs which are frequently stained yellow or brown with bile.

Unfertilized eggs signify the absence of male worms from the intestine. This is frequently the case when the host harbours a single worm or at most two. Two of the seven cases showing unfertilized eggs were treated with Santonin. One passed a single female and the other passed two females.

It is peculiar that infection with a single *Ascaris* is frequently accompanied with serious nervous symptoms, especially in children and young adults.

In one case both fertilized and unfertilized *Ascaris* eggs were seen. Such a coincidence could not be easily explained unless we suppose that one female got isolated from the rest of males. Whatever may be the right explanation the fact is worth recording.

Decorticated Ova.

Ova of *Ascaris* were sometimes met with having a smooth outline and no bosses on the surface. The ovum is easily mistaken by the uninitiated for that of Ancylostoma duodenale. Its thick shell and unsegmented content ought to be sufficient to indicate its true nature.

Source of Infection.

Sweepings from the unpaved courtyard of a house whose inhabitants were severely infected with *Ascaris* were collected. Two litres of that dust were shaken in 10 litre of concentrated saline solution in a narrow necked water-jug. The surface film was removed by a wire loop into small petri dishes and examined microscopically. Few ova of *Ascaris* were seen and two contained fully developed embryos.

This floatation method is not useful in detecting cases of mild infection with *Ascaris*, although in heavily infected cases a fair number of ova float.

Age and Sex Incidence of Ascaris Infection.

Amongst the 253 males whose fæces were examined, 145 showed evidence of *Ascaris* infection, giving an incidence amongst the males of 57·3 per cent.

Amongst the 78 females whose fæces were examined 65 showed evidence of *Ascaris* infection, giving an incidence amongst the females of 83·3 per cent.

This indicates clearly a higher incidence of infection amongst the females than amongst the males.

The number of females classified according to age periods is not large enough to justify further analysis.

The incidence of infection in the males is highest in children of less than 10 years of age and gradually becomes less as age advances. Amongst children the incidence approximates that of the females. This indicates home infection.

Male age period	1–10	years,	80·0	per cent	are	infected.
,, ,,	11–20	,,	65·5	,,	,,	
,, ,,	21–30	,,	46·0	,,	,,	
,, ,,	31–40	,,	43·0	,,	,,	
,, ,,	41–50	,,	41·0	,,	,,	

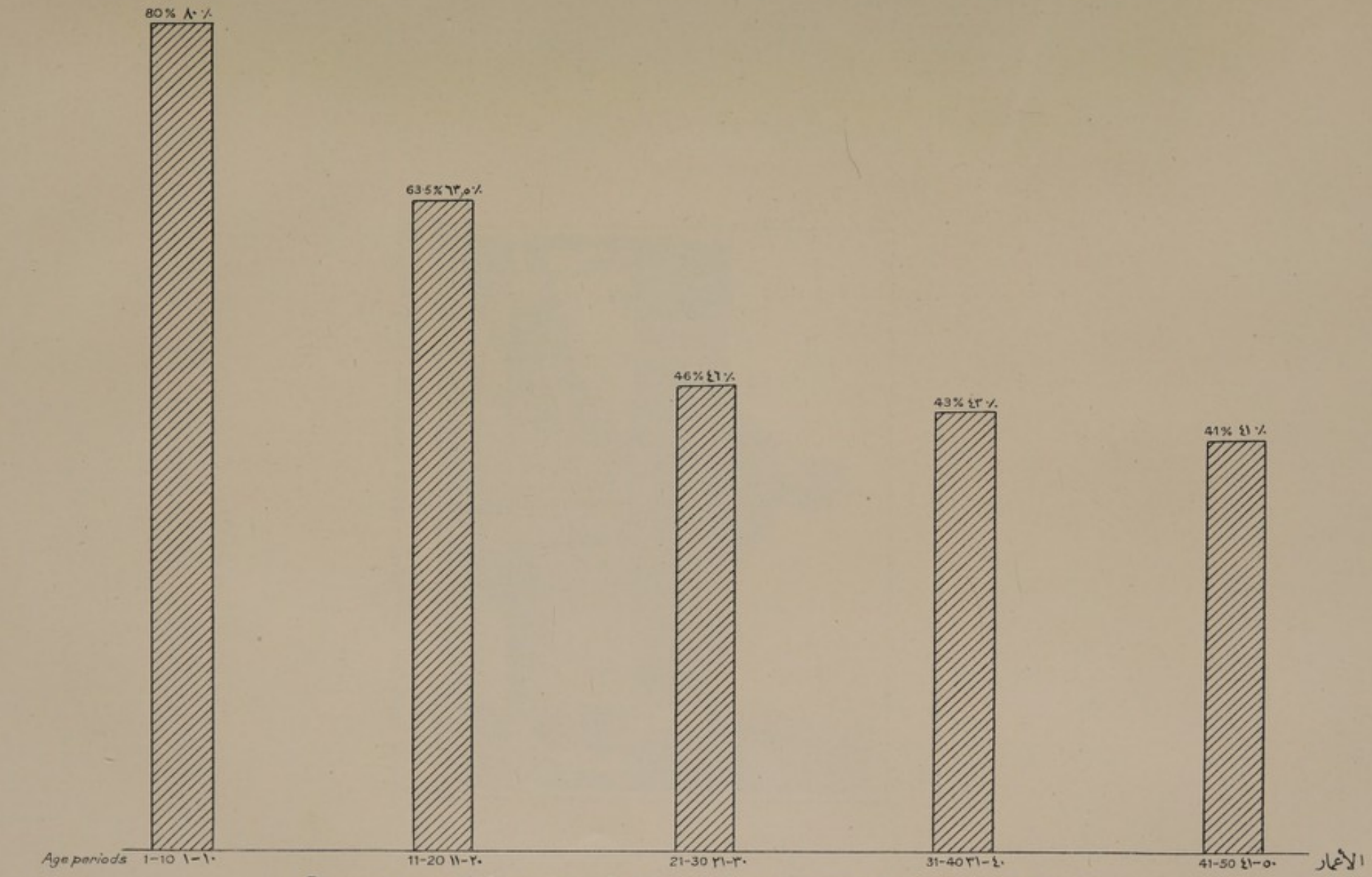
This is graphically represented in Graph No. 5.

The youngest individual met with harbouring *Ascaris* was a male three years old who passed as a result of treatment 13 *Ascaris*.

The oldest was a female 70 years. She was not treated.

Severety of the Infection.

Judging from the approximate number of ova met with in one slide the infection was found to be severest amongst children. In one case (No. 186), photo No. 6, a male child of 7 years expelled as a result of treatment with one dose (0·20 gm. Santonin) 81 *Ascaris* and he was still passing



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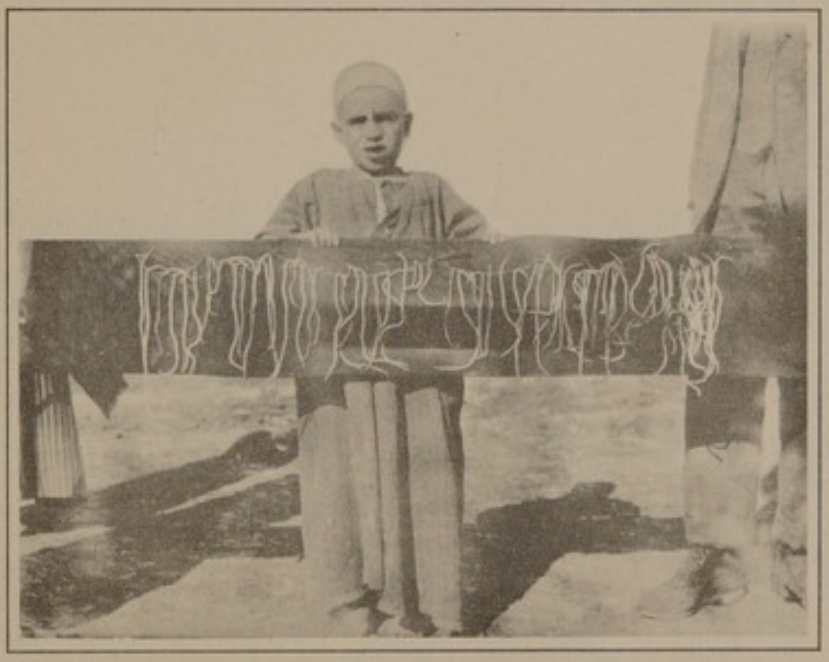
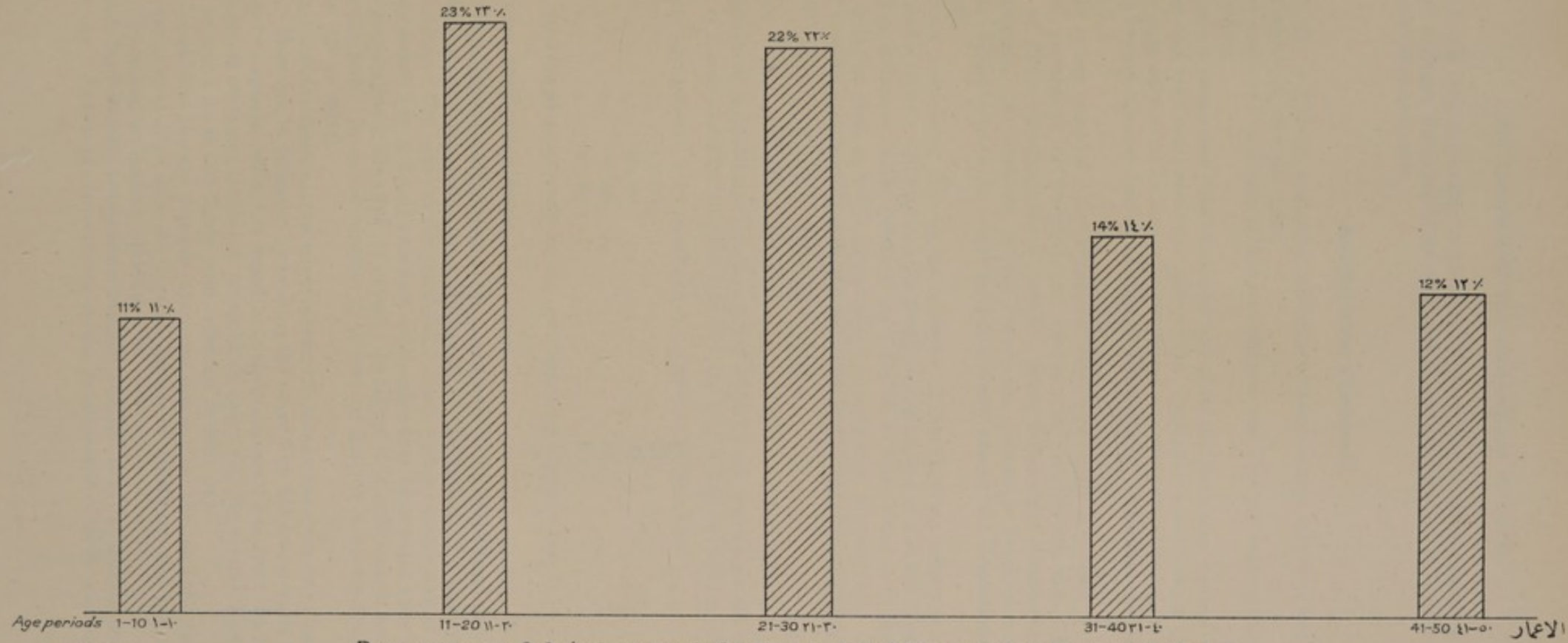
Percentage of Ascaris infection in the different Age periods in Males.

النسبة المئوية لعدوى الاسكارس فى مختلف الأعمار فى الذكور



Photograph No. 6.—81 Ascaris worms expelled from boy shown above.



S. of E. 24/416.

Percentage of Ankylostoma infection in the different age periods in Males.

النسبة المئوية لعدوى الانكلستوما في مختلف الاعمار في الذكور

No. 7.

worms when I left three days after treatment. The number of worms passed by this child caused an excitement amongst the inhabitants who applied for examination in large numbers as a result of this practical demonstration.

Ancylostoma duodenale.

Amongst 331 individuals examined, evidence of Ancylostoma infection was found in 55 cases, giving an incidence of 16·6 per cent.

Amongst males the incidence of Ankylostomiasis was 16·2 per cent and amongst the females it was 18 per cent.

In all cases a smear was first examined and then the floatation method was applied. The latter method was very successful especially as the Ancylostoma infection in most cases was very mild and few eggs only could be seen. It was found necessary to leave specimens in salt solution for fifteen to twenty minutes before examining the surface. Otherwise the results could not be relied upon.

Clinically severe cases of Ankylostomiasis were very rarely met with.

This low percentage of Ancylostoma infection is very interesting. Similar results are experienced at Tanta Ankylostomiasis Annexe, where Bilharziasis (bladder and intestine) is the dominant infection. At Qalyûb, further south, the picture is reversed. Ankylostomiasis is predominant. Bilharziasis of the intestine is practically absent and Bilharziasis of the bladder is fairly common.

The factors influencing this varied incidence of Ancylostoma infection are very important to elucidate and certainly will help in a thorough understanding of this infection in Egypt. There is apparently no difference in the habits of the villagers in these areas or in their sanitary accommodation. A factor that is worth discussing is atmospheric temperature. This varies widely according to locality and possibly it might be found to influence the extracorporeal development of Ancylostoma.

Age Incidence.

The incidence of Ancylostoma infection in the different age periods reveals that the percentage of infection is lowest amongst children and old age and is highest among adults.

Males	age	period	1–10	incidence	of	infection, 11	per cent.
,,	,,		11–20	,,	,,	,, 23	,,
,,	,,		21–30	,,	,,	,, 22	,,
,,	,,		31–40	,,	,,	,, 14	,,
,,	,,		41–50	,,	,,	,, 12	,,

This is represented graphically in the accompanying diagram No. 7.

Examination for Ancylostoma Larvæ.

The following method was found to be the most effective. About 40 grammes of fæces are taken and mixed with 2 cc. of water to form a thin paste in the bottom of a large petri-dish 17 centimetres in diameter. The cover of the petri-dish is lined with a circular disk of filter paper which is always kept moist. It is found necessary to moisten that filter paper once every twenty-four hours. The preparation is always kept closed. In Egypt it is sufficient to keep the petri-dishes at room temperature. In colder climates it is best to keep it in an incubator at temperature ranging from 25° to 30° C.

It is found that the mature larvæ migrate from the fæcal mass upwards to the moist filter paper in the cover. They can be collected by swelling the cover with few ccs. of warm water and pouring it into a proper receptacle when it is found to contain the larvæ free from the fæcal matter.

The process of collecting larvæ can be repeated every day for several days. From one such preparation as much as 40,000 larvæ were collected in four days.

It was found that success depends upon the reaction of the medium, the slighest acidity continuing over several days kills the larvæ. Excess of alkalinity has the same effect. The best medium is neutral or slightly alkaline.

In cultures kept at room temperature ranging from 33° to 37° C. mature larvæ were collected on the third day. Details of observations on the development of larvæ will be published later.

Strongyloides stercoralis.

Only one case of *Strongyloides stercoralis* was met with. The patient was an adult male.

The appearance of larvæ in the freshly passed stool is taken as an indication for the presence of *Strongyloides*. In stools that were left for ten or more hours, the presence of larvæ cannot be relied upon, as Ancylostoma eggs are known to hatch in a very short time after defæcation.

In such cases the safest way is to re-examine a fresh specimen. This was not possible in all cases at Saft el Enab. The presence of larvæ and eggs does not indicate *Strongyloides* infection, as Ancylostoma eggs in the undisturbed stool develop at different rates. Those at the surface might hatch and mature while eggs below the surface remain in the 4-cell stage owing to the absence of oxygen.

Trichocephalus trichiuris.

Two cases of *Trichocephalus* infection were met with. Both were in males.

It is rather unexpected to find *Trichocephalus* infection so rare.

The eggs do not float easily in concentrated saline solution and they are detected by the smear method. In the large majority of cases one smear only was examined. This does not suffice to detect all cases of *Trichocephalus* infection, but it is certain that cases of heavy infection could not have escaped notice.

Enterobius vermicularis.

The eggs of this parasite were met with in the stools of five cases only. This does not give any idea as to the real incidence of infection with this parasite. The eggs are seen in the stools only in rare circumstances when the adult female is ruptured due to injury or manipulation of the specimen.

In connection with another investigation at Qalyûb, *Enterobius vermicularis* eggs were seldom seen in the stools, but on administration of anthelmintics for Ancylostoma, adult *Enterobius vermicularis* were met with in a high percentage of the cases.

It is probable that the infection is widespread, although it cannot be gauged by the examination of the stools for eggs. That the presence of eggs in the stools is in most cases the result of rupture of the adult females is confirmed by the common experience that eggs, whenever met with, are found in large numbers.

Trichostrongylus sp.

The egg of *Trichostrongylus* as seen in the fresh stool has a thin transparent shell and contains a morula. It is rather longer and narrower than the Ancylostoma egg, for which it is commonly mistaken.

This egg was met with in eight cases. It is easily detected by the floatation method as applied to Ancylostoma.

There are three species of *Trichostrongylus* that are reported from man in Egypt. All three species inhabit also the intestine of sheep and camels in Egypt.

These species are :—

(1) *Trichostrongylus instabilis* (Railliet 1893) Looss 1895.

(2) *Trichostrongylus probolurus* (Railliet 1896) Looss 1905.

(3) *Trichostrongylus vitrinus*, Looss 1905.

It is practically impossible to distinguish between these various species from the ova which are closely identical. It is only by adult specimens that the species can be determined.

The pathogenesis of these parasites is not known.

CONCLUSIONS.

(1) 95·6 per cent of the inhabitants of Saft el Enab are harbouring one or more parasitic worms.

(2) Bilharziasis of the bladder affects 73 per cent of the population but the infection is mild. Bilharziasis of the intestinal tract affects 34 per cent but the infection is severe.

(3) Ths snail carriers of Bilharzia were found in abundance in the irrigation channels surrounding the village. These canals being end-channels act as a favourable habitat for the *Planorbis* snails which are the carriers of intestinal Bilharziasis.

(4) Field workers are the principal class exposed to infection with intestinal Bilharziasis. By nature of their work they are brought in frequent contact with the water in the end-canals.

(5) *Ascaris* infection is widespread amongst the inhabitants, but it is more prevalent in children and females than in adult males.

(6) Ancylostoma infection is mild and not widespread in contradistinction to results arrived at in other areas. It is probable that the cool atmosphere at Saft el Enab accounts for this.

PART II.

Intestinal Bilharziasis causing an Epidemic-like Increase of Mortality in an Egyptian Village.

The outbreak detailed in this report took place at Saft el Enab, a village in Markaz Kôm Hamâda in Mudirîyet el Beheira. The situation of the village is shown in the accompanying map No. 8.

History of the outbreak.

Towards the end of August 1922 the Medical Officer of Markaz Kôm Hamâda noticed that for some time past there was a steady increase in the number of deaths at Saft el Enab. The number of deaths per month was 9 during February 1922, 14 during March, 17 during April, rose to 19 during July and 21 during August.

A cordon was established at the village on August 26 and all sick people were compulsorily isolated.

From the beginning there was no uniformity in the symptoms or signs manifested by the patients. The medical officers in touch with the cases were not in agreement as to the cause of the outbreak or as to the diagnosis of the malady.

The following diagnoses were either suspected or thought advisable to eliminate by help of laboratory examination :—

Dysentery (*bacillary* and *amœbic*).
Typhoid, Paratyphoid A and B.
Malaria and Relapsing fevers.
Thyphus.
Cholera.

Mixed bacillary dysentery was the diagnosis tentatively arrived at. Antidysenteric serum was given a trial, but its results were unfavourable. Better results followed the use of emetine which was tried empirically although amœbæ or cysts were not found in the stools of patients to any extent.

We are in a position now to understand why emetime gave better results. It benefited the Bilharzia which was the main cause. Typical cases of the disease were sent to Damanhûr Government Hospital for study under favourable conditions and where they could be better nursed. In addition as the disease ended in some cases fatally there was an opportunity for a careful post-mortem examination to be carried out.

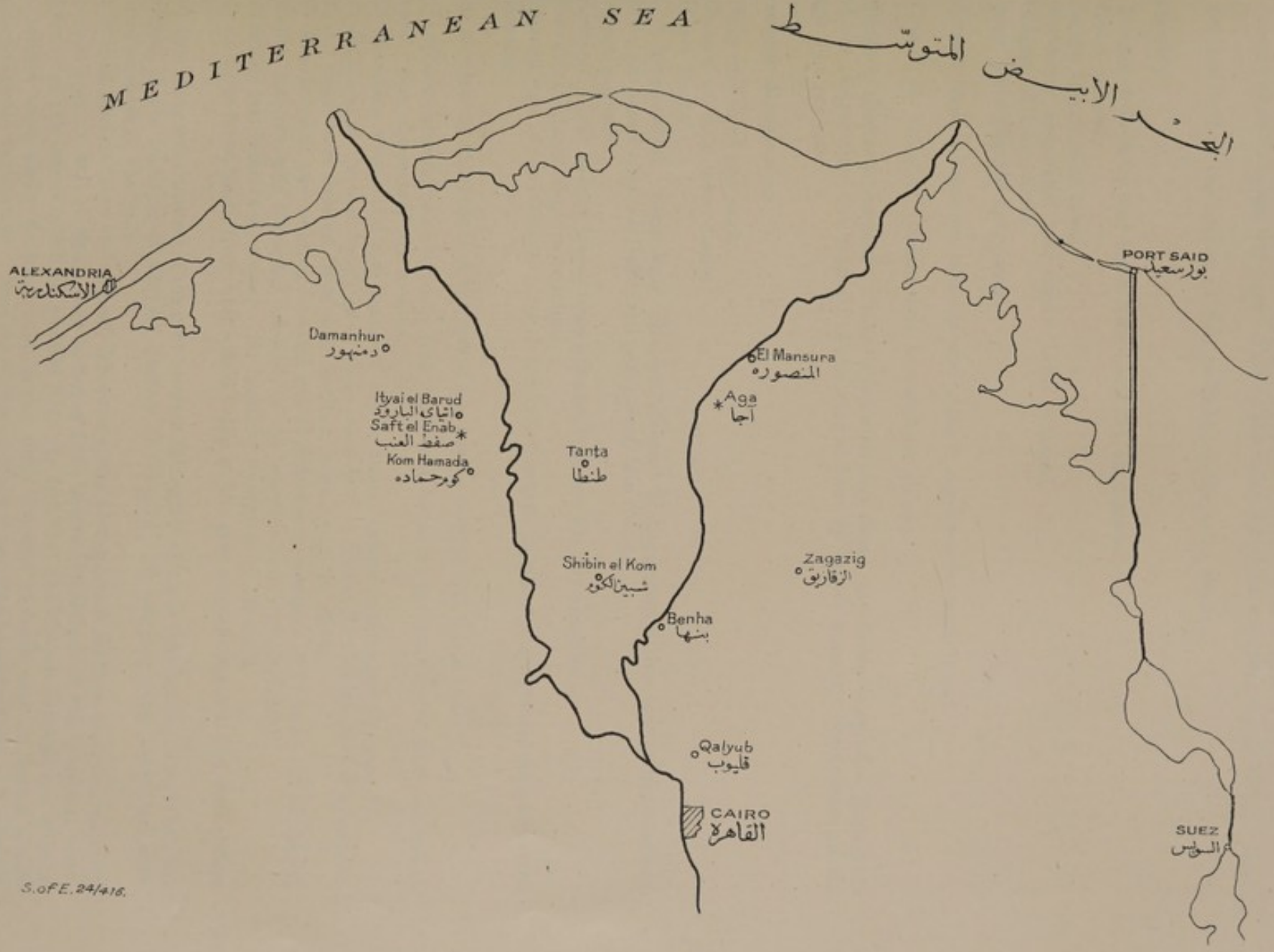
The number of cases received at the hospital was 12, of whom 5 died. None of these cases had any rise of temperature in hospital except for an occasional day following intravenous injection of tartar emetic.

All of them were emaciated and weak although not confined to bed. They had suffered from diarrhœa with blood for a long time in the past with periods of improvement and subsequent relapses.

Many of these cases lost one or more adult male relatives by the same disease. Their women relatives were healthy.

The freedom of women and children from the disease was one of the most interesting and peculiar features of the outbreak. Even to the casual observer in the streets of the village it was apparent that the women were healthy, carrying their heavy water jugs or corn for milling with apparent ease while the men seen about the streets or in the fields were pale, emaciated, and half starved creatures.

On instructing the midwives to collect specimens of urine and fæces from women in the village, we were told with evident chagrin that the women were flourishing and healthy and it was only the poor men who were affected.


MEDITERRANEAN SEA
البحر الابيض المتوسط
ALEXANDRIA
الاسكندرية
Damanhur
دمنهور
Itya el Barud
اتياى البارود
Saft el Enab
صفط العنب
Kom Hamada
كوم حماده
Tanta
طنطا
El Mansura
المنصوره
Aga
اجا
PORT SAID
بورسعيد
Shibin el Kom
شبين الكوم
Zagazig
الزقازيق
Benha
بنها
Qalyub
قليوب
CAIRO
القاهرة
SUEZ
السويس
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No. 8.

Typical Cases in Hospital with Post-Mortem.

Notes of this case were recorded by the staff of Damanhûr Hospital.

Patient M.M. Male, 30 years old, field worker, admitted on 21–1–1923.

History of two months duration. Pain in the sides, diarrhœa with mucus and blood. Tenesmus.

Brother died in the cordon of Saft el Enab of the same disease.

Examination :—

Tongue clean in tip and edges, furred and dry on dorsum.
Heart normal.
Lungs fine râles at bases.
Abdomen: abdominal wall rigid. Liver enlarged.
Œdema of lower limbs.
Knee jerks slightly exaggerated.

Fæces: Ova *Schistosoma mansoni* and *Ascaris lumbricoides* were found.

Urine: No albumin. *Schistosoma hæmatobium* absent.

Course of disease in hospital: Patient died after five days' stay in the hospital. During the period the temperature was normal. Pulse ranged from 50–89 per minute. Stools were on the average five per day.

Post-mortem Examination.

Body emaciated and weak.
Œdema of both lower limbs.
Heart flabby.
Left lung normal. Right lung collapsed adherent to diaphgram with a hæmorrhagic infacrt.
Liver advanced cirrhosis (bilharzial peri-portal) bile stained.
Spleen normal.
Kidneys: right kidney larger than left and both are slightly anæmic.
Mesenteric glands slightly enlarged.
Sigmoid part of the intestine is much thickened, mucus membrance echymosed with bilharzial papillomata.

On analysis of the records of the rest of the twelve cases it was found that :—

(1) All were chronic cases suffering from their complaints for periods varying from one month to several years, frequently six months.

(2) Diarrhœa with blood and mucus is the common complaint amongst all cases.

(3) Eighteen of the male relatives of these cases died at Saft el Enab with similar affections.

(4) All cases were derived from poor families, working in the fields.

(5) Microscopical examination revealed ova of *Schistosoma mansoni* in 11 cases out of the 12. The twelfth case revealed bilharzial infection of the intestine and liver after death.

(6) Stools and blood were negative for bacillary dysentery in all cases.

(7) Cultures from heart, liver, and spleen taken at the post-mortem examination were always sterile.

(8) One thing was common in the post-mortem findings of all cases thus examined and that was Bilharziasis of the intestine in varying degrees of severity. It was frequently associated with periportal cirrhois of the liver.

It is thus evident from the clinical, laboratory and post-mortem findings that the majority of the cases seen at Saft el Enab were suffering from severe Bilharziasis of the intestinal tract. The severity of the infection can be gleaned from the fact that *Schistosoma mansoni* ova often in large numbers were easily demonstrated in the small amount of fæces sent on cotton swabs for bacteriologicale xamination. Nine out of twelve swabs were found to contain ova. It is hardly justifiable to include the negative cases as the amount of fæces was hardly sufficient to make an ordinary smear.

Incidence of Intestinal Bilharziasis amongst Patients.

Soon after the establishment of the segregation camp "cordon" all sick people whatever their complaints were, isolated there. Out of the 84 cases thus segregated were, 71 were suffering from intestinal bilharziasis confirmed by microscopical examination. The rest were cases of pellagra and ankylostomiasis. Thus the incidence of intestinal bilharziasis amongst the patients was 84·5 per cent as contrasted with 34 per cent amongst the general population.

Typical cases of the type of disease seen at the village and sent to Damanhûr were all suffering from intestinal Bilharziasis.

Why the Cause of the Outbreak was Doubtful.

Although clinical and post-mortem examination pointed to intestinal bilharziasis as the main cause of the disease and mortality at Saft el Enab, the outbreak was labelled bacillary dysentery. Bilharzia is so common in Egypt that it is held in contempt by the medical profession. It is not thought to be a sufficient cause for death. This is borne out by the numbers of death returns labelled as due to bilharziasis or ankylostomiasis in the whole country. This was :—

Year.	Bilharziasis.		Ankylostomiasis.	
	Deaths.	Per Cent in relation to total number of Deaths	Deaths.	Per Cent in relation to total number of Deaths.
1919	114	0·06	33	0·02
1920	103	0·05	53	0·03
1921	105	0·06	33	0·02

These figures do not represent the actual state of affairs in a country where two-thirds of its population are suffering from one or other of these parasitic infections and frequently from both.

Intestinal bilharziasis in fairly advanced condition is a serious disease. With the large intestine studded with large fleshly papillomata that are liable to slough and leave ulceration, the raw surfaces are constantly irritated by the fæcal contents of the bowel and exposed to their multifarious bacterial contents. They are occasionally parasitized by the *Entamoeba histolytica* of dysentery. *Cirrhosis* of the liver (periportal type) is frequently present in advanced cases.

The inevitable diarrhœa caused by irritation of the bowel is chronic, lasting for months. This is generally accompanied with a certain degree of toxæmia having in most cases a fatal termination. The cause of death is labelled in many cases dysentery, heart failure, cirrhosis, etc., and the primary cause is not mentioned.

Bacillary Dysentery is not the Main Cause of the Outbreak.

(1) Clinically no cases were diagnosed bacillary dysentery.

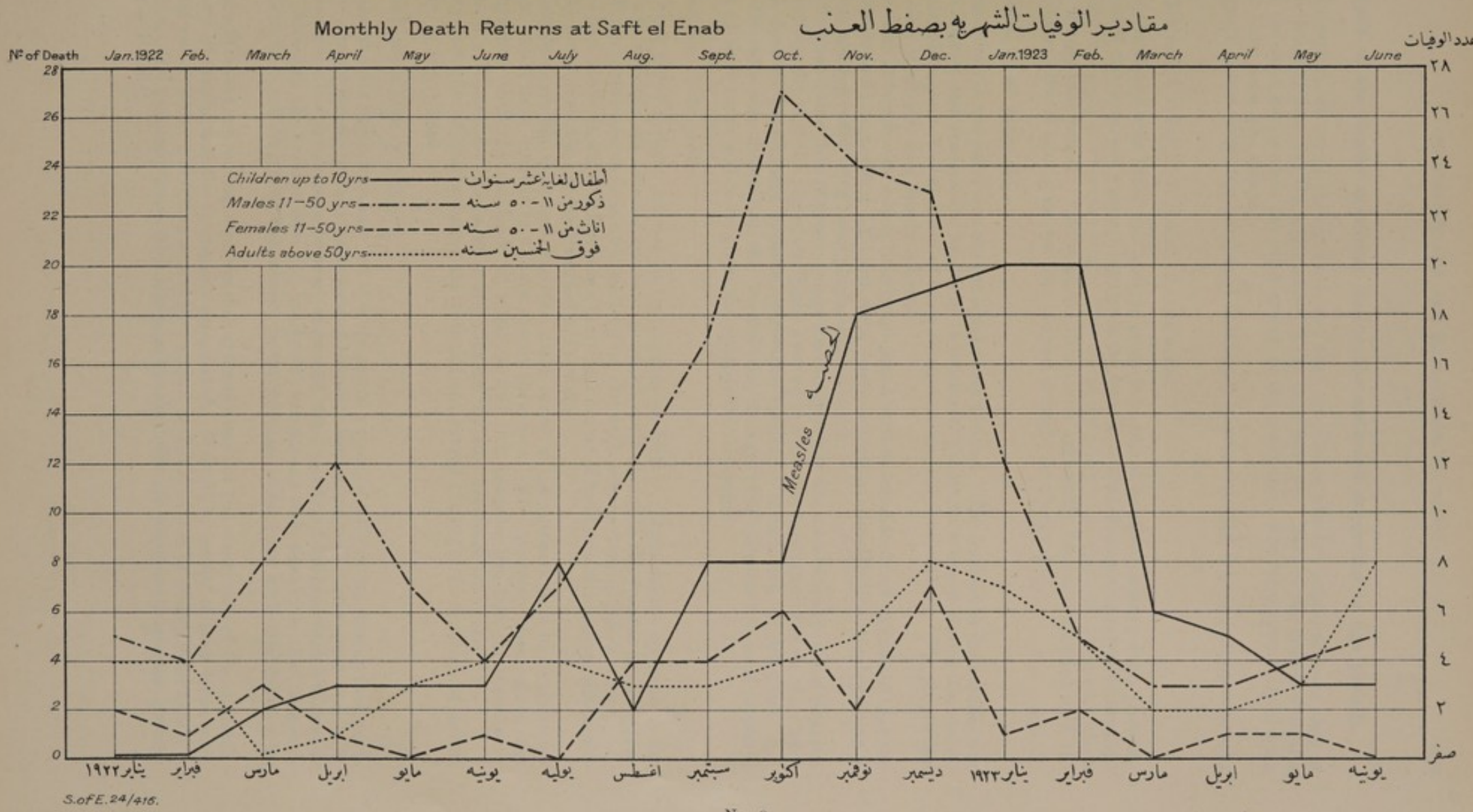
(2) Specimens of blood or fæces from 102 cases were examined bacteriologically for dysentery, typhoid, paratyphoid A and B, malaria, and relapsing. Of these, three cases were positive for Flexner, 9 for Shiga, and 1 for paratyphoid A. In some of the cases found positive for dysentery, the diagnosis was arrived at by the Widal Reaction. This is of lesser value than the isolation of the organism from the stool.

(3) All the supposed typical cases isolated at Damanhûr were negative to dysentery, both by culture and agglutination.

(4) Antidysenteric serum failed to produce any improvement. Its use was given up as a result of the reports of the treating medical men. Emetine was substituted with better clinical results. Only three cases were found positive for amœbic dysentery. The favourable effect of emetime was due to its action on the bilharzia infection.

(5) Post-mortem showed no dysenteric affection of the small intestine which is the site of infection in bacillary dysentery. No amœbic ulceration was met with in the large bowel.

(6) The outbreak came to a favourable termination as a result of administration of tartar emetic on a large scale, feeding all the sick with full diet which was supplied free. Isolation of the sick was given up and all cases were allowed to live in their houses.



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No. 9.

Analysis of the deaths occurring during the outbreak according to age periods.

An important feature of the outbreak was that the disease affected principally one class of the population and that was the adult males of the poor families. Most of the deaths were also limited to the same group while the other groups of the community who were apparently sharing with them their home life, escaped.

The graph below shows the number of deaths per month classified for our purpose into four groups.

(1) Children of 1 day to 10 years, of both sexes.

The curve shows that there was a slight increase in infant mortality during July, probably due to summer diarrhœa, and a second big rise in the number of deaths beginning in September 1922 and reaching its height in February 1923. This is due definitely to an epidemic of measles which broke out during that period. This is quite distinct and apparently has no connection with the disease and mortality of adults and for that purpose it might be disregarded.

(2) Males 11–50 years old.

This as shown in the curve was the principal group affected. The increase in the number was noticed in August and reached its height in October and gradually dropped during December, January, and February. The majority of those dying were manual field-workers. The proprietors or better class labourers were hardly affected.

These cases although seen a long time before death were so emaciated and exhausted that the medical officers could do nothing but treat them symptomatically although from the beginning it was felt that nothing could bring those people back to health.

The affection of this class of people brings the outbreak into the class of occupational diseases.

It is noteworthy that the procedure finally evolved towards the treatment of these cases was : free ample food at government expense, systematic treatment of bilharzia, ankylostoma, and pellagra. No cases were detained in the "cordon" but patients were instructed to come regularly to partake of their meals and to be given the appropriate treatment.

(3) Females 11–50 years.

The curve shows a slight increase in the number of deaths. Three deaths occurred at the "cordon" and were directly ascribed by the medical officers in charge to the peculiar disease at the village. These three cases were women working on the fields who performed men's work.

As had been shown in Part I, there was a fairly high degree of incidence of intestinal bilharziasis amongst the few women who regularly worked in the fields.

If bilharziasis of the intestines was the main cause of the outbreak it is to be expected that women would have suffered to a lesser extent than men. The mortality rate would not be in comparison with the incidence of infection with Sch. mansoni but with the severity of that infection. Women are less liable to infection on repeated occasions that men.

The total number of deaths during the year did not exceed the expected numbers of deaths for females in the village.

(4) Both sexes over 50 years.

This also shows a slight increase. At this age period people to some extent give up field work. They leave manual labour to their children and content themselves with supervision and light work. Among the few people over 50 years examined, none was found infected with *Schistosoma mansoni*. Although the number does not justify any conclusions it is significant that, although some of them were suffering from *Schistosoma hæmatobium* infection, none harboured *Schistosoma mansoni*.

This graph is very instructing, it proves that dysentery was not the main cause of the outbreak. In dysentery all members of the community are affected. Women, by nature of their home work and washing soiled clothes and acting as primitive nurses, are liable to be infected in greater numbers than the men. Old men easily succumb to dysentery as they offer less resistance to infection because of their low vitality.

In this outbreak the incidence of mortality was just the opposite. Women and old people escaped. This was explained by one of the inspectors as possibly due to infection with dysentery contracted in the mosques which are principally visited by adult males. Although this explanation will hold well in accounting for the first cases of the outbreak, it is not justified by its course. The infection contracted in the mosques or elsewhere is bound to be carried into the houses where no means of isolation or any shadow of hygiene is present. The women, old people and children are thus exposed to it. In this outbreak from the beginning to the end the women showed an astounding freedom from the disease that selected the adult males living under the same roof.

Closing of the mosques and establishing artesian tube wells throughout the village had not any noticeable effect on the course of the outbreak.

The same argument can be used against the possibility of the disease being typhoid, paratyphoid A or B, typhus, or relapsing. In addition these were excluded by the laboratory investigation.

House Incidence of the Disease.

The disease and mortality affected the male members of certain families more than others. The families affected were those of the poor manual labourers. A fact recorded by Prof. Day of Qasr el 'Aini Hospital who visited the village once during the outbreak, is that the inhabitants of the eastern part of the village were apparently more attacked than those of the western part. It has been shown in Part I that the principal site of infection with *Schistosoma mansoni* is to the east of the village where the canals have dead ends with practically stagnant water and where conditions are favourable for the life of *Planorbis boissyi*, the snail carrier of this species.

The land to the west of the village, on the other side of the railway line, is supplied by a large canal (Safra Canal) which contains running water and does not offer favourable conditions for the life of this species of snails.

Figure No. 10 shows a map of the village with a mark (+) representing each death. It is apparent that more deaths occurred in the eastern than in the western part of the village. No part of the village was, however, exempt.

Opinions as regards the Cause of the Outbreak.

Prof. H. B. Day of the Qasr el 'Aini Hospital visited the "cordon" once to diagnose the disease prevalent there.

The following are abstracts from his report dated December 18, 1922 :—

" With one possible exception all the sick I saw in the 'cordon' were suffering from various chronic diseases.

" There was no evidence of severe diarrhœa or dysentery in these cases.

" I was able to satisfy myself that the villagers kept in the cordon were not suffering from any mysterious disease. I examined all the sick and others appearing unwell and found that they could be divided into four groups as follows : (1) Pellagra, (2) Cirrhosis, (3) Ankylostomiasis, (4) Intestinal bilharziasis. It was the presence of these cases (No. 4) among contacts that I believe gave rise to the impression that the original epidemic was acute dysentery."

The Public Health Inspector of Beheira sent a report on the outbreak at Saft el Enab dated December 17, 1922. The following are abstracts from this report :—

" Most cases which occurred at this village are chronic, their period of sickness differs from one month to several months."

His conclusions were :—

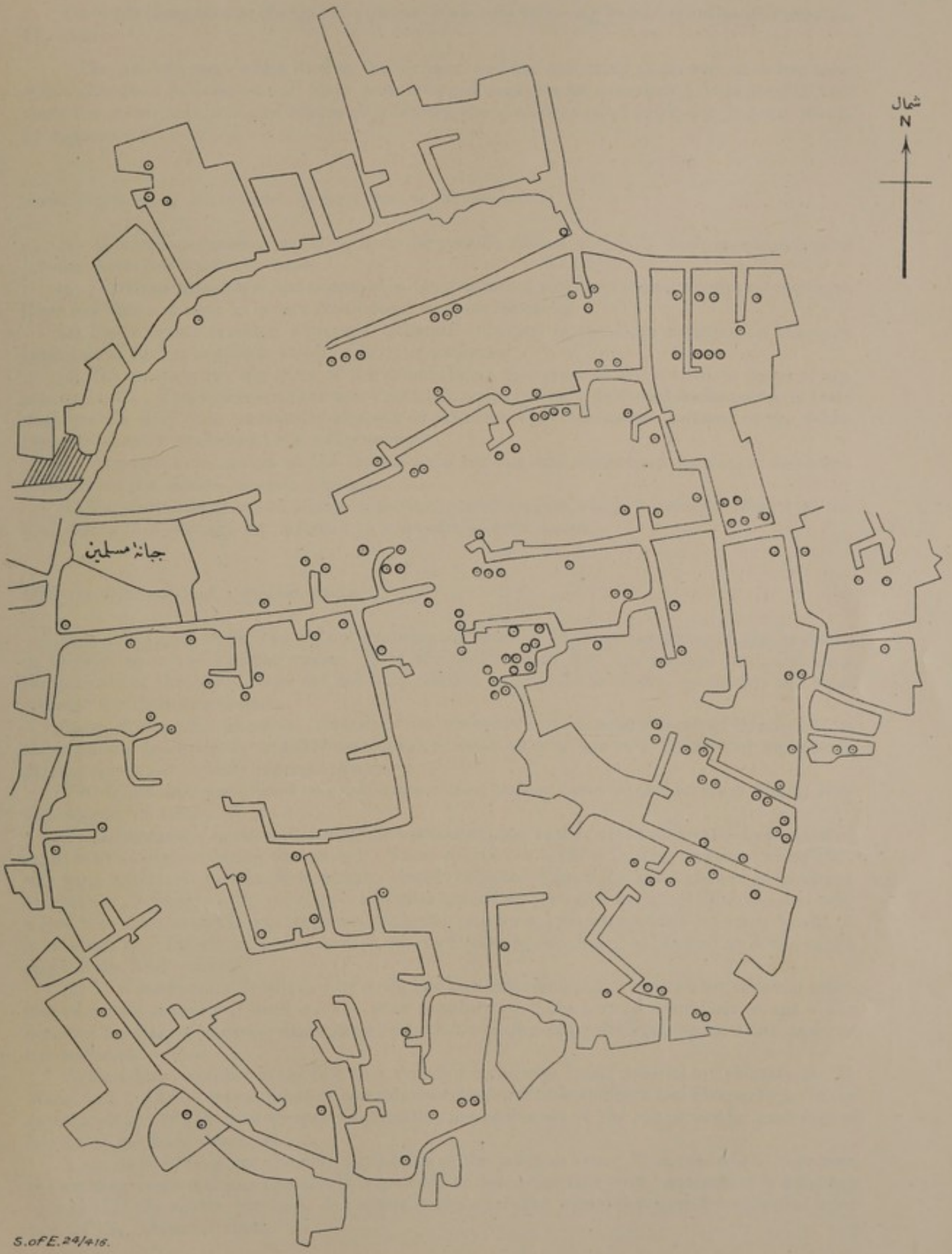
" (1) The disease in general is chronic and not acute."

" (2) Among the symptoms of the disease is diarrhœa. Stools are sometimes mixed with blood.

" (3) There are no symptoms of fever at all. If found they are very rare."

DEATHS AT SAFT EL ENAB

وفيّات صفط العنب



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No. 10.

Dr. Scott (Inspector in charge of outbreak) stated the following in his report dated December 11, 1922 :—

" The last two cases which died in the 'cordon' and the one dying at present have had their stools examined in Cairo and all three were returned negative for dysentery. It is possible that there was some fault in the technique of collecting the specimens but I could not find any reason to suppose so."

Facts in favour of Bilharziasis as the Cause of the Outbreak.

(1) All cases suspected as suffering from the peculiar disease at Saft el Enab were found to be infected with *Schistosoma mansoni.*

(2) Diarrhœa with blood and mucus of a long duration was the common symptom met with there and this is caused by severe *Schistosoma mansoni* infection.

(3) Post-mortem revealed advanced bilharzial infection of the large intestine as the only pathological finding common to all cases thus examined.

(4) The peculiar age incidence of the disease being to a great extent limited to males of age periods 11–50. This agrees with the fact that adult males specially field workers by nature of their work are the only class continually exposed to infection with *Schistosoma mansoni* in the fields. Being frequently reinfected they suffer severely.

(5) Non-infectious nature of the disease : the females and children of families whose males succumb to the disease escaped infection.

(6) Tartar emetic given on a large scale and nourishing diet which was supplied free were the final means that brought the outbreak to a favourable termination.

Why the Outbreak had a Sudden Onset.

It is difficult for those who did not examine the cases at the very beginning of the epidemic to theorize as to the exciting cause. It is also unfortunate that the medical men attending the patients at that early stage did not keep reliable records of the clinical symptoms and signs revealed by their examination.

Cases of advanced intestinal bilharziasis are susceptible to secondary bacterial infection from the intestinal tract. It is probable that death in most cases is due to a toxæmia or septicæmia gaining access to the body through this route.

Two hypotheses are offered to explain the almost sudden onset of the outbreak during July and August of 1922.

(1) Bilharziasis is contracted during the summer months as the output of cercariæ from infected snails is at its highest during that period. There is evidence to show that the weather during 1922 was very favourable to this development. Snails collected from some areas showed an incidence of infection of cercariæ of 75 per cent. If similar conditions prevailed at Saft el Enab coupled with a low Nile flood necessitating irrigation with the 'tambour,' the superadded infection would, it is believed, be sufficient to cause a sudden outbreak like the one described, limited as it was to the adult male field workers.

(2) In a community debilitated by a chronic bilharzial infection a superadded bacterial infection of a mild nature will weed out the weak members while the normal individuals escape. The reported bacillary dysentery might have been that exciting cause determining an acute onset of the outbreak.

Against this possiblity is the fact that very few cases were found positive to dysentery by the Widal test. Also it was a peculiar coincidence to meet with both Shiga and Flexner types in the same locality, while the post-mortem examination revealed none of the characteristic pathological lesions of bacillary dysentery.

I am inclined to adopt the first hypothesis as the probable one. Whatever might have been the exciting cause which is practically impossible to determine now with certainty, it is definitely proved that the course, incidence and specially the mortality were determined by bilharzial infection of the intestinal tract.

Similar outbreaks in other Villages.

The main feature of the outbreak at Saft el Enab is the excessive mortality of adult males. Similar conditions have been prevailing at this and other villges during the previous years. The only difference was that these deaths were spread throughout the year and thus had attracted no attention. In some villages the number of deaths in adults was as much as five times the expected number of deaths.

These facts are only apparent if the number of deaths occurring throughout the year is analyzed into age periods. If the total number of deaths is the only figure taken into account, the real condition of affairs will not be realized. This is because the excessive mortality in adults is compensated for, especially if it is occurring for a number of years, by (1) a low mortality in old age because few survive to that age and also (2) a low mortality in children because the excessive number of deaths of individuals in the child bearing period reduces the number of births and consequently the number of deaths during childhood.

Statistical Figures for Saft el Enab and other Villages.

1. Saft el Enab: Population 5,629.

	0–10.	11–50.		Over 50.	Total.
		M.	F.		
Expected deaths	104	35	30	65	234
1922 deaths	74	150	31	43	298
1921 „	25	60	9	56	150
1920 „	30	33	12	59	134

It is evident from these figures that during 1922, when the outbreak occurred, the mortality in children and old people were less than normal, women were practically normal while adult males were more than four times the normal in number of deaths.

2. Qalashan, Close to Saft el Enab.

	10–50.	Above 50.	Total.
Expected deaths	36	27	63
1922 deaths	64	25	89
1921 „	65	31	96

3. Abioka, an hour's journey from Saft el Enab, same Markaz.

	10 to old age.
Expected deaths	33
1922 deaths	52
1921 „	40

I paid a visit to this village accompanied by the Medical Officer of Health who reported that the villagers were suffering from similar diseases as the inhabitants of Saft el Enab.

Twenty sick individuals collected by the village barber were examined. All of them were adult males. Very few females were said to be sick. Examination of the stools showed 15 to be suffering from intestinal bilharziasis due to *Schistosoma mansoni*. 7 were suffering from pellagra and 7 from Egyptian splenomegaly with cirrhosis of the liver.

The following villages of Markaz Aga have been reported to be the site of a widespread bilharzial infection especially of the intestinal type. The Medical Officers collected a number of the snail carriers from the canals surrounding these villages.

1. Orman. Population 899.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expectd deaths	10	10	5·4	6	31·4
Deaths during 1922	11	5	24	6	46
,, ,, 1921	5	3	8	7	23
,, ,, 1920	11	16	25	4	56

It is apparent from column 3 that the death rate in adults was four times the expected number while the other age periods showed a mortality less than that expected.

2. Darawa. Population 1,174.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	13	13	7	10	43
Deaths during 1922	3	3	32	10	48
,, ,, 1921	8	4	35	10	57
,, ,, 1920	5	16	29	20	70

In this village the number of deaths in adults ranged from four to five times the expected number of deaths in each of the three years.

3. Shubra Bahu. Population 680.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	7·5	7·5	4	6	25
Deaths during 1922	2	2	13	9	26
,, ,, 1921	4	4	9	12	29
,, ,, 1920	10	2	10	6	28

These figures show a total number of deaths approaching the normal although the number of deaths in adults ranged from two to three times that of the expected number of deaths.

4. Shubra Huir. Population 1,509.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	16	16	9	12	53
Deaths during 1922	10	8	13	9	40
,, ,, 1921	7	13	17	10	47
,, ,, 1920	15	20	8	14	57

5. Ezbet Abdel Houssein. Population 2,429.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	26	26	14	20	86
Deaths during 1922	17	10	25	21	73
,, ,, 1921	27	8	23	18	76
,, ,, 1920	25	14	14	48	101

6. Kafr Abdel Amin. Population 1,172.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	13	13	7	10	43
Deaths during 1922	7	5	16	4	32
,, ,, 1921	4	9	15	8	36
,, ,, 1920	11	5	13	11	40

7. Mit Fadula. Population 3,185.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	34	34	20	27	115
Deaths during 1922	19	20	27	22	88
,, ,, 1921	20	16	12	29	91
,, ,, 1920	37	20	31	32	120

8. Sangid. Population 1,571.

	Less than 1 Year.	1–10.	11–50.	Above 50.	Total.
Expected deaths	16	16	9	12	53
Deaths during 1922	8	12	19	6	45
,, ,, 1921	9	9	42	8	68
,, ,, 1920	6	5	14	24	49

RECOMMENDATIONS CARRIED OUT AT SAFT EL ENAB.

At the time during which the investigations were carried out the following routine was gradually evolved.

(1) Tartar emetic to be administered intravenously to all cases of bilharzial infection.

(2) Ankylostomiasis cases were treated with Thymol and Ascariasis with Santonin.

(3) Segregation of the sick was stopped. All patients were allowed to proceed to their houses. They were instructed to visit the cordon at the proper time for treatment.

(4) All debilitated individuals were given free meals at the cordon three times a day.

The following proposals were submitted to the Irrigation authorities with a view to modifying the course of the canals round Saft el Enab to make them less suitable as a habitat for the snails.

(1) The canal passing through the village to be abolished.

(2) Reconstruction of the irrigation canals to ensure a continuously flowing water with no dead ends.

(3) To establish such a canal at a considerable distance from the village buildings, to lessen the chance of young children becoming infected and to prevent the people from using it for the disposal of refuse.

(4). Encouraging the people to use "sakias" (water wheel) instead of the universal use of the "tambour."

(5) The extension of Kalashan drain which ends within two kilometres from the village so that it may help in draining the surrounding marshes. It will also be useful in another way. During " taharik " when most canals are dry, the canals at Saft el Enab contain a certain amount of water which preserves the life of the snails. A drain in the locality will help in drying up these canals and thus destroying their snail inhabitants.

The Irrigation Department have planned a scheme to carry out most of these proposals. The course of the new canal is represented on the map by a dotted line (Fig. 3, Part I).

Abou Diab canal being on a higher level than Safra Canal a continuous flow is ensured.

A drain was found to be expensive to extend and so its extension was given up.

It will be interesting to watch the effect of the new scheme upon the incidence of bilharzia infection.

CONCLUSIONS.

(1) An outbreak of intestinal bilharziasis occurred at Saft el Enab resulting in the death of more than 100 adult males.

(2) Children, adult females and old people practically escaped infection.

(3) The disease is contracted during work in the fields and thus it is practically an industrial disease.

(4) The disease causes an increase in the mortality of adults in many Egyptian villages in the Delta.

(5) The disease being chronic, the deaths caused by it do not attract the attention of the Medical Officers of Health. The increase in the mortality of adults is compensated for by a decrease in the mortality of children and old people.

(6) Why the disease assumed in an epidemic like course at Saft el Enab is not definitely known, but two theories are offered :—

(*a*) A super-imposed heavy infection with intestinal bilharziasis occurred during the summer of 1922. The channels around Saft el Enab are a suitable habitat for the snails; or

(*b*) A mild bacterial infection broke out, *i.e.* bacillary dysentery to which the adult males previously debilitated by bilharzia succumbed while the other members of the community escaped.

(7) The series of end canals surrounding Saft el Enab sufficiently explained the high incidence and severity of intestinal bilharzial infection.

ACKNOWLEDGEMENT.

It is a pleasure to me to express my deep indebtedness to the following gentlemen who have helped in one way or another to make my task easier.

I have first to thank Dr. Todd, Director of the Public Health Laboratories, upon whose suggestion I visited Saft el Enab to study the conditions there. Dr. White, the Deputy-Director of the Public Health Laboratories, took a deep interest in the work throughout all its phases. His remarks were always both encouraging and suggestive.

Major Thomson, Director of the Epidemic Section, was always ready to grant all possible facilities for doing the work. It was mainly due to his untiring efforts that the scheme of modifying the course of irrigation channels was agreed to by the Irrigation Department. Capt. Milne Inspector in charge of the outbreak, did his best to make me feel comfortable during my stay at the cordon.

Hassan Bey Farid, Public Health Inspector of Beheira Province, and his Assistant Dr. Sayid, paid several visits to the cordon to enquire about the progress of the work and were deeply interested in my findings.

Dr. N. Attia, Dr. N. Guindi, and Dr. I. Mashali, the Medical Officers in charge of the cordon, were very helpful in every way. They assisted in securing specimens and in inducing inhabitants to apply for examination.

I have utilized freely the notes and reports about the outbreak kept in the official files. I mentioned specially the valuable report of Prof. Day who in spite of the very short time spent at the cordon was able to record several important facts which testify to his great skill as a clinician.

V.—Incidence of Bilharziasis and Ankylostomiasis Amongst the Inhabitants of Nag Hamadi District.

By M. KHALIL.

In order to gauge the extent of infection with Bilharziasis and Ankylostomiasis at Nag Hamadi District, Qena Province (Upper Egypt), a fair sample of the population representing all classes was systematically examined.

Every individual was requested to supply a sample of his urine and another of his stools in proper receptables handed to him for this purpose. The results arrived at depend solely upon a careful microscopical examination of the specimens supplied without any reference to clinical complaints volunteered by some of the individuals. This ensured the detection of mild cases of infection of which the individual is not aware or in which the disease did not advance to such a stage as to inconvenience him.

The individuals selected for examination were :—

(1) 68 students of the Provincial Council Technical School.

(2) 54 students of the Government Primary School.

(3) 24 students from the Coptic Elementary School.

(4) 21 girls from the Prince Kamal's Girls School.

(5) 93 individuals of the general population coming from Nag Hamadi itself and from the surrounding villages.

RESULTS OF EXAMINATION OF THE URINE.

	Number examined.	Bilharzia Present.	Percentage.
Technical School	68	57	83·8
Government Primary School	54	23	42·6
Coptic Elementary School	24	21	87·5
Prince Kamal's Girls School	21	11	52·4
General population	93	70	75·2
TOTAL	260	182	70·0

It is apparent from the above figures that the incidence of infection with urinary Bilharziasis is least amongst the Government Primary School pupils. This is accounted for by the fact that these pupils come from the best families at Nag Hamadi and the surrounding district. A fair percentage of these boys are the children of Government officials temporarily stationed at the place. The children of those families do not indulge in bathing in small water streams or drains and are usually well shod and are particular about their drinking water. These reasons amply account for the comparatively lower incidence of infection in this class of the population. It is significant to note that in spite of a higher standard of life of this class the incidence of infection is still considerable.

The incidence of infection amongst the girls attending the Prince's school is a little higher than that of the boys of the Government School. What has been said about the pupils attending the above-mentioned school is more or less applicable to the girls attending the Prince's school.

The incidence of infection amongst the general population is a truer index applicable to the whole district. The individuals were drawn from different classes and from different localities in the district.

The pupiis of the Provincial Council Technical School were severely infected. Every individual attending the school was examined as it was in connection with a complaint of one of the pupils of that school that led to the present enquiry. Out of the 68 students examined only 9 were found free from Bilharzia infection. The boys attending this school are recruited from the poorer classes of the community and they are fitted up to be skilled workmen. Their home conditions, water supply and their habits of going about bare-footed and indulging in bathing in small streams account for the high incidence of infection. They probably represent the state of affairs amongst the farm labourers in general.

The incidence of infection amongst the pupils of the Coptic School was very high. This is due to the fact that the headmaster of the school picked for examination the boys who were ill and did not send one or two classes as a whole as was the case in the other schools.

RESULT OF EXAMINATION OF THE STOOLS.

Destinations.	Schist. hæmatobium.	Ankylostomiasis.	Ascaris.	Oxyuris.	Trichocephalus.	Hymen.	T. saginata.	Total.
Technical School	1	7	4	4	—	—	—	57
Government Primary School ...	1	—	—	2	—	1	—	25
Coptic Elementary School	—	—	—	—	—	—	—	6
Prince Kamal's Girls School ...	—	—	—	—	—	—	—	2
General population	5	17	1	1	1	2	1	41
Total	7	24	5	7	1	3	1	131

It is evident from the above table that about half the total number of individuals examined submitted a specimen of their stools for examination although every individual was urged to do so.

The result of this examination is very significant. No infection with *Schistosoma mansoni* (intestinal Bilharziasis) was detected although several cases of intestinal infection with *Schistosoma hæmatobium* were found.

No Ankylostomiasis infection was found amongst the boys attending the Government Primary School, demonstrating the value of cleanly habits and wearing shoes in preventing infection with this parasite.

The extent of infection with Ankylostomiasis in the district can be gleaned from the incidence in the 41 individuals of the general population who submitted fæcal specimens for examination. 44 per cent of these wre found to be infected with the Ancylostoma worms but the number was not large enough to allow of drawing a definite conclusion therefrom.

12·3 per cent of the boys attending the Technical School were found to be harbouring the Ancylostoma worms.

Hæmoglobin Index.

The hæmoglobin index was ascertained in every place. The average was 60 per cent for the whole 93 individuals of the general population. It ranged from 80 per cent to 30 per cent.

Survey of the Canals and Drains.

Some of the canals and drains surrounding Nag Hamadi were searched for their moluscan fauna. *Bullinus* snails, the carriers of urinary Bilharziasis were found in fairly large numbers. *Planorbis* snails were absent. This is in complete agreement with the microscopical results as to the absence of *Schistosoma mansoni* infection.

Other Parasitic Infection.

Ascaris infection was rarely met with. Oxyuris eggs were met with in few cases. One case of *Tænia saginata* infection was detected.

Conclusions and comments.

Bilharziasis of the urinary tract is widely spread amongst the inhabitants of Nag Hamadi district. About 75 per cent of the total inhabitants are infected. Ankylostomiasis infection is present to a lesser extent. About 44 per cent of the inhabitants are infected.

The widespread Bilharzia infection is significant as it has been stated by authorities that Bilharzia infection is not widespread in Upper Egypt. This was thought to be principally due to the absence of irrigation schemes which necessitate the presence of canals and drains which are the principal habitat of the snail carriers of Bilharzia.

Such irrigation channels are found around Nag Hamadi district.

Most of these canals are the result of private enterprise on the part of His Highness Prince Youssef Kamal and a European Company established in the neighbouhood. It might be safely concluded that these irrigation schemes caused the spread of Bilharzia infection amongst the people.

It is in the interest of those large proprietors that the inhabitants of Nag Hamadi district should be freed of their infection as they would become better fitted to carry on the agricultural work for the landowners. At present most of the agricultural class are depleted by this chronic disease, which is often contracted during childhood, of a good share of their energy. The landowners are obliged to employ them weak as they are at the standard market value.

VI.—A New Trematode Parasite of the Rat, Echinostoma Ægyptiaca nov. sp.

By M. Khalil, M.D., Ph.D., Lond., and M. S. Abaza, M.B., Ch.B., Edin.

(*From the Parasitological Section, Public Health Laboratories.*)

During the summer of 1923 a rat *R. rattus* was caught in the Pubic Health Laboratories, Cairo. The animal was killed and dissected for evidence of parasitic infection. Blood films contained *Trypanosoma lewisi* in large numbers. In the small intestine seven *trematode* parasites were found.

The *trematodes* were living and microscopic examination revealed that they were members of the family *Echinostomidæ*. All the parasites were adults with the uterus full of ova. The ova were detected in the fæces of the animal.

Hitherto only one species of this family, *Echinostoma spiculator*, was described from the rat by Dujardin in 1845. We are indebted to Prof. R. T. Leiper of the London School of Tropical Medicine for supplying us with the account given by Dujardin on *Echinostoma spiculator*. On careful study of the scanty literature available of this parasite we came to the conclusion that the *Echinostoma* met with in Cairo is specifically different from Dujardin's species. We propose to name it *Echinostoma Ægyptiaca*.

Description of the Parasites.

Colour.—Fresh specimens are pinkish in colour. Specimens fixed in Schaudinn are dirty white.

Size.—Preserved specimens are about 6·5 millimetres in length and 0·8 millimetre in breadth. Fresh specimens vary in length according to their condition of contraction of relaxation.

Form.—The parasite is elongated, ribbon like with a tapering cephalic end and a rounded caudal extremity.

The cephalic end is triangular in shape, its apex contains the oral sucker with the mouth opening.

The body is flattened dorso-ventrally.

Cuticle.—The cephalic extremity is surrounded by a double row of 43 thick pointed spines. The cephalic third of the body is closely beset with small spines over the whole surface. Caudal to the ventral sucker, the cuticular spines become fewer and far between, caudal to the tastes they apparently cease altogether.

The Cephalic Extremity.—The cephalic pole is triangular in shape and is separated from the rest of the body by a distinct groove. It is surrounded peripherally by a double row of spines, which encircles the head except at the middle line ventrally. They are forty-three in number. On either side of the middle line ventrally there is a group of five spines, *i.e.* close to one another. Each spine is 50μ in length. The spines are crowded laterally but are wider apart dorsally (Fig. 1).

Acetabulum.—The ventral sucket is placed in the mid ventral line closer to the cephalic than to the caudal end. It is 1 millimetre distant from the cephalic extremity. The sucker is large in comparison with the size of the *Echinostoma*. It is 0·5 millimetre in diameter.

Digestive System.—The oral aperture opens at the pointed cephalic end. It is 0·10 millimetre in length, being little longer than it is broad. The opening leads into a thin elongated œsophagus

surrounded with a thick globular muscular bulb. The intestinal cæca branch from the œsophagus 0·7 millimetre from the cephalic extremity.

The intestinal cæca are thin and curving round the acetabulum, pursue a direct course caudally till they end blindly close to one another at the posterior end. Each intestinal cæcum is a little shorter than the length of the parasite and lies close and parallel to the lateral border of the worm. The cæca are hidden from view in most of their course by the profuse vitelline glands.

The Genital System.

All the genital organs with the exception of the vitelline glands lie between the two intestinal cæca.

Male Organs.—The two large testis lie caudad of the ovary one cephalad of the other, close to the caudal end of the worm. The caudal testis lies 1·5 millimetres from the posterior end. Each testis is elongated and slightly lobed. The anterior testis is 0·78 millimetre in length and 0·46 millimetre in breadth. The posterior testis is 0·9 millimetre in length and 0·37 millimetre in breadth. The space between the testes is 7μ. The course of the vas deferens could not be traced. The cirrus sac is large and elongated, being 0·5 millimetre in length. It opens into the genital pore close to the bifurcation of the intestinal cæca cephaled of the *acetabulum* (Fig. 2).

Female Organs.

The ovary lies in the midventral line practically midway between the cephalic and caudal ends. It is pre-testicular. The ovary is rounded in shape, being 0·3 millimetre in diameter and 0·3 millimetre cephaled of the anterior testis. The fine ovarian duct begins at its caudal extremity and is surrounded by the large and irregularly shaped shell gland which lies close to the ovary. To the right of the shell gland lies the large receptaculum seminis while caudal to it, the two vitelline ducts meet and join the ovarian duct (Fig. 3).

The vitelline glands are numerous and extend over more than two-thirds of the total length of the body surrounding and obscuring from view the intestinal cæca. The glands on either side approach each other candad of the posterior testis extending as far as the mid ventral line.

The uterus is slightly convoluted and lies mostly in the mid ventral plane between the two intestinal cæca cephalad of the ovary. It is packed with ova. The termination of the uterine canal passes dorsal of the *acetabulum* ending in the vagina which opens into the common genital pore in conjunction with the male organs.

Ova.—The ova are deep brown in colour and oval in shape. They are operculated. The ovum is 100μ in length and 57 μ in breadth (Fig. 4). Ova contain collections of cells with a large amount of yolk. The genital opening lies in the mid ventral line anterior to the *acetabulum* and posterior to the junction of the intestinal cæca. The genital opening is not raised above the surface of the body.

Excretory Organs.—The excretory pore lies at the caudal extremity. The excretory vesicle is hidden by the vitelline glands.

Host.—The common house rat (*R. rattus*).

Habitat.—Small intestine.

Locality.—Cairo, Egypt.

Type Species.—The type species has been deposited in the Parasitological Museum of the Public Health Laboratories, Cairo.

Cephalic end of Echinostoma aegyptiaca – Nov. Sp.

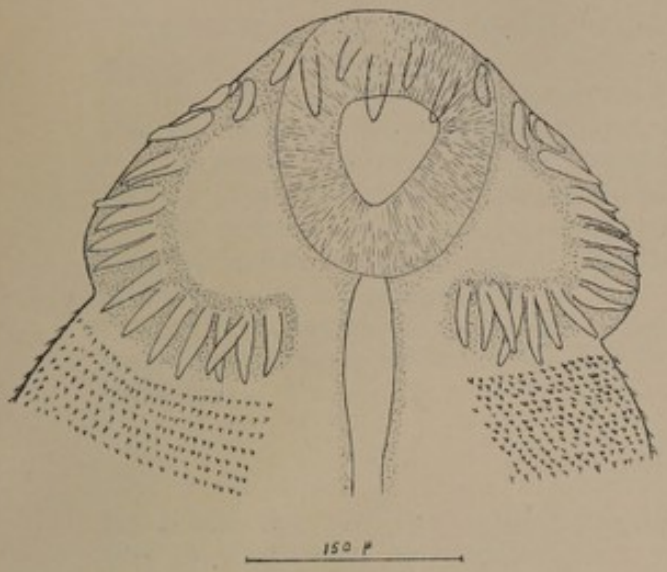

Fig. I شكل ١

Ventral view of Echinostoma aegyptiaca – Nov. Sp.

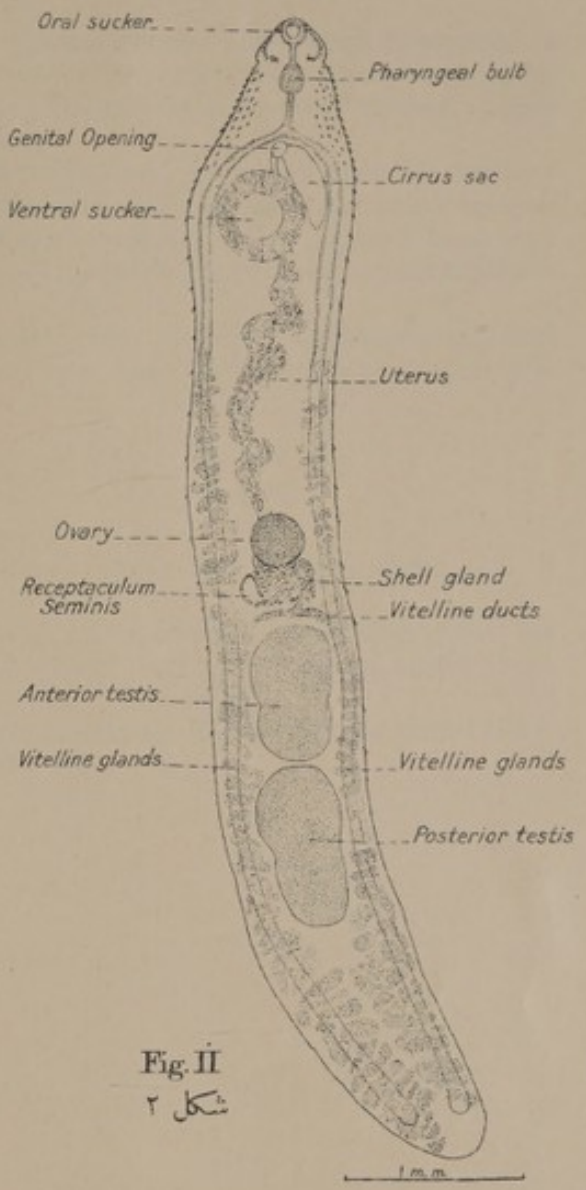

Fig. II
شكل ٢

Latera view of Echinostoma aegyptiaca – Nov. Sp.

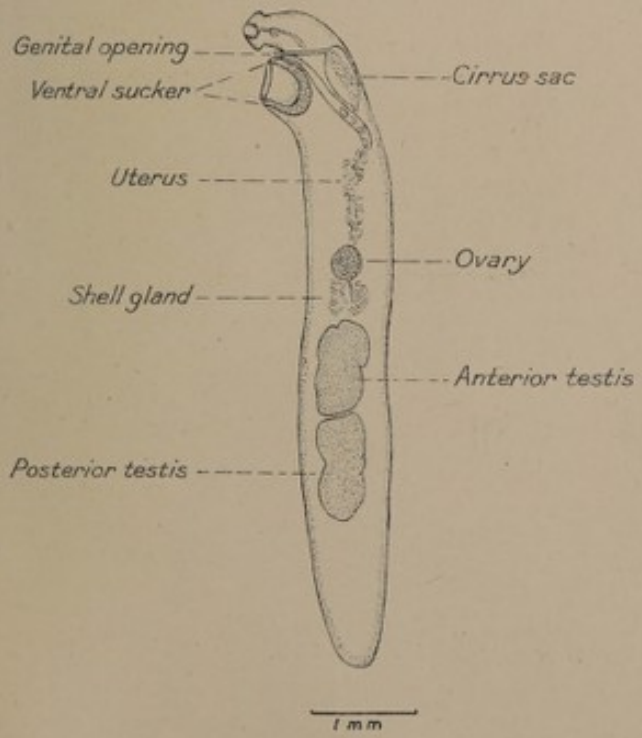

Fig. III شكل ٣

Ovum of Echinostoma aegyptiaca – Nov. Sp.

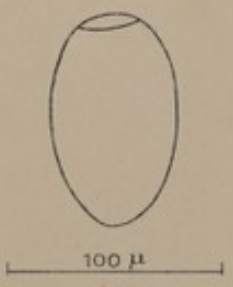

Fig. IV شكل ٤

S. of E. 24/416

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Discussion.

Echinostoma spiculator Dujardin is a species that is little known. Dujardin's description is incomplete and applies to immature forms. Lühe in 1909 lists this species under species inquirenda.

The number of spines surrounding the head is stated by Dujardin to be 20 in number. Later observers recorded the presence of 27, 26, and 19 spines.

The length of the mature parasite is given as 1·7 to 4 millimetres. Scanty as these informations are, one is justified in differentiating the parasite described in this note from Dujardin's species.

The number of cephalic spines in *Echinostoma Ægyptiaca* is 43, widely different from that recorded for *Echinostoma spiculator*. Also the body is much longer than any of the various measurements recorded for *E. spiculator*.

For these reasons the species here recorded is described as new while *Ech. spiculator* is regarded as species inquirenda till its existing description is revised by re-examination of the type or co-type material.

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VII.—Complement Fixation Reaction in Bilharziasis by the use of Fasciola hepatica Extract as an Antigen.

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The present investigation was undertaken before the writer was aware that some serologists in Europe have already attempted the serum diagnosis of Bilharziasis by using Fasciola hepatica extract as an antingen.

The idea was that as liver fluke infection and Bilharziasis were two diseases caused by two parasites of the same class, a serological group reaction might be present, similar to that found in bacterial infections.

Fairly's (1) complement fixation for Bilharziasis requires an antigen prepared from cercaria infected snail livers. Such material is not always available and cannot moreover be easily prepared. Liver flukes on the other hand are met with in every slaughter-house and exist in such large quantities to allow of easy preparation.

Hoppli (2) appears to be the first to have recorded results showing that he obtained positive complement fixation in infections of both *Sch. mansoni* and *Sch. bovis*. He employed alcoholic extracts of adult Fasciola hepatica as an antigen.

Bettencourt and Borges (3) repeating Hoppli's experiments were unable to confirm his results with cases of *Sch. hæmatobium*. Out of 23 bilharzia cases, 17 gave negative results and 6 only were positive.

Le Bas (4) found that alcoholic extracts of Fasciola hepatica were capable of fixing complement in a greater degree with sera from persons infected with *Schistosoma* than with normal sera. The fixation with the sera investigated was found to be weak and of little diagnostic value.

Recently Fairly and Williams (5) showed, in corroboration to other former co-workers, that in hepatica distomiasis of sheep, specific antibodies were present in the blood of the infected animals, and that extracts of Fasciola hepatica possess true antigenic properties. The authors recommended the complement fixation test for the diagnosis of Fluke infection in man.

Preparation of the Antigen.

(1) *Alcoholic Extract.*

Fresh flukes obtained from the bile ducts of infected sheep were thoroughly washed with normal saline solution to get rid of the bile. 20 grammes of the washed flukes were well-ground with sand in a mortar. 200 cc. of alcohol (95 per cent) were added to the resulting paste, and the whole was put in a sterile bottle. The bottle was left for seven days in the incubator at 37° C., being well-shaken daily. The extract was then filtered through filter paper.

(2) *Watery Extract.*

This extract was prepared in the same way as the previous one with the exception that half per cent carbolic saline was used instead of alcohol, and the incubation was for twenty-four hours only.

The antigens were then standardized for the estimation of their anti-complementary dose. One-third of this dose was taken as an antigen dose for the complement fixation test.

Technique of the Complement Fixation Test.

0·5 cc. of a 1 : 4 dilution of the patient's serum, 0·5 c.c. of antigen and 0·5 c.c. of fresh serum of guinea-pig (diluted 1 : 10) were placed in a water bath at 37° C. for 40 minutes. To this, 0·5 c.c. of a 5 per cent emulsion of sheep's red blood corpuscles and 0·5 c.c. amboceptor (4 m. h. d.) were added. After remaining for 20 minutes in the water bath, the result was read.

The investigation here recorded was made on 79 cases of Bilharzia hæmatobium infection in which ova were present in the urine, and on 32 negative cases in which no ova were found. The alcoholic extract was used in 45 of the positive cases and in 20 of the negative cases.

The carbolic saline extract was used in 34 of the positive cases and in 12 of the negative cases.

The Wasserman reaction was done with all sera, using the alcoholic extract. Cases showing positive Wassermann reaction were eliminated.

Result of Complement Fixation in Bilharziasis cases using the Alcoholic Extract.

1. Cases infected with Bilharzia :—

Positive	++++...	8
Positive	+++...	4
Positive	++...	11
Positive	+...	9
	Positive	32
	Negative	13
	Total	45

2. Controls (presumably uninfected cases) :—

Positive	++++...	0
Positive	+++...	1
Positive	++...	0
Positive	+...	3
	Positive	4
	Negative	16
	Total	20

Result of Complement Fixation in Bilharziasis cases using the Carbolic Saline Extract.

1. Cases infected with Bilharzia :—

Positive	++++...	5
Positive	+++...	5
Positive	++...	8
Positive	+...	4
	Positive	23
	Negative	11
	Total ...	34

2. Controls (presumably uninfected cases) :—

Positive	++++...	0
Positive	+++...	0
Positive	++...	2
Positive	+...	0
	Positive	2
	Negative	10
	Total ...	12

It will be seen from the above figures that the alcoholic fluke extract is capable of binding complement with 71·1 per cent of the positive Bilharziasis sera.

With carbolic saline extract, fixation occurred in 67·6 per cent.

Some of the negative cases gave also complement fixation with fluke extracts. This may be explained by the fact that these cases were not after all negative. Microscopical examination alone of the urine does not eliminate the possibility of Bilharzia infection in a country like Egypt where the disease is widespread.

In addition intestinal Bilharziasis which is also fairly common in Egypt has not been excluded in the negative cases here cited.

Conclusion.

Alcoholic and watery extracts of Fasciola hepatica possess antigenic properties against sera of Bilharziasis cases, which can be demonstrated by the Complement Fixation Test.

The diagnostic value of the test is limited as practically 30 per cent of the positive cases gave negative results.

Fasciola hepatica extracts cannot be utilised for the diagnosis of F. hepatica infection in man in countries where Bilharzia is endemic.

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The Classification of the Family Ancylostomidæ.

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The classification of the Ancylostomidæ has been the subject of discussion among helminthologists for a long time. Lane in 1917 reviewed the subject and proposed to amend the definition of the sub-family Ancylostominæ, limiting it to the genus Ancylostoma only. This would appear to be justifiable, but he also poposed a new sub-family Necatorinæ synonymous with *Bunostominæ* Looss 1911 with certain amendations.

The reasons given by Lane for proposing a new sub-family were :—

(1) The possibility that the genus *Bunostomum* Rail. 1902 may be a synonym of *Monodontus* Molin 1681. Railliet and Henry had, however, disposed of this in 1910 in a paper entitled "Quelques heliminthes nouveaux" in which they defined the genus *Bunostomum* and proposed the name *Eumonodontus* for *Monodontus* and defined it. The name *Eumonodontus* is now merely a synonym.

(2) Lane preferred to have the type of the family the genus *Necator* which was more familiar than *Bunostomum*. This does not justify discarding a previously established family name.

Leiper 1908 was the first to divide the bursate nematodes with a mouth capsule into : (*a*) those with a mouth guarded by a corona radiata "Strongylinæ" and (*b*) those with a dilated mouth-capsule guarded by teeth or cutting plates and curved dorsally Ancylostominæ. This is a classification based on very natural and outstanding characteristics.

Railliet and Henry 1909 classified all bursate nematodes with a mouth capsule under the Ancylostominæ. Looss 1911 raised the sub-family Ancylostominæ Leiper 1908 into a family rank Ancylostomidæ. He restricted the sub-family Ancylostominæ to Ancylostoma and Uncinaria. The genus Uncinaria is certainly more allied to *Bunostomum* and Necator than to Ancylostoma. This is the view held by Lane 1917 who restricted the sub-family to the genus Ancylostoma only.

The classification proposed by Hall suppressing the family Ancylostomidæ is a retrograde step on what had been advanced before.

The following scheme agrees in essential detail with Lane's classification with the single exception of re-establishing the sub-family *Bunostominæ* in an amended form.

Family Ancylostomidæ Looss 1911.

Definition.—Bursate nematodes, with a horny mouth capsule with its aperture pointing dorsally. No corona radiata. The family contains so far two sub-families :—

1. *Ancylostominæ* Leiper 1908 emended Lane 1917.

Opening of mouth capsule is provided ventrally with paired chitinous teeth, vulva in the posterior part of the body.

Type genus : Ancylostoma Dubini 1843. Type species A. duodenale Dub. 1843.

Other genera : Galoncus Railliet and Henry 1918. Type species G. perniciosus von Linstow 1885.

Key to Genera of Ancylostominae.

Mouth capsule greatly reduced in size and is provided with a dorsal cone and two dorsal lancets ; inhabits cysts in the intestinal call ... ... *Galoncus.*

Mouth capsule not reduced in size ; opening of dorsal œsophageal gland does not project freely into the mouth cavity, inhabits the lumen of the intestine... ... ... *Ancylostoma.*

2. *Bunostominæ* Looss 1911 emended.

Opening of mouth capsule is provided with smooth chitinous plates, vulva about the middle of the body.

Type genus *Bunostomum* Railliet 1902. T.S. *trigonocephalum* (Rud. 1908). Railliet 1902.

Other genera :—

Bustomum Lane 1917. T.S. B. *phlebotomum* Raill. 1900.
Necator Stiles 1903 T.S. *N. americanus* Stiles 1902.
Brachyclonus Rail. and Henry 1910. *T.S. B. indicus* R. and H. 1910.
Gaigeria R. and H. 1910 *T.S. G. pachyscelis* R. and H. 1910.
Bathmostomum R. and H. 1909. *T.S. B. sangeri* Cobbold 1879.
Grammocephalus R. and H. 1910. *T.S. G.* clathratus Baird 1868.
Monodontus Molin 1861. *T.S. M. semicircularis* Molin 1861.
Uncinaria (Froelich 1789) Looss 1905. *T.S. U. criniformis* (Goeze 1782) Rail. 1899.

Key to the Genera of Bunostominæ.

1. Intestine with a diverticulum running towards head end.

Teeth springing from floor of mouth with tips notched ... ... *Grammocephalus.*

Intestine simple :—

2. Buccal capsule with shelf like projections. Externo-dorsal ray arises from the corresponding branch of dorsal ray ... ... *Bathmostomum.*

3. Dorsal and externo-dorsal rays asymmetrical :—

2 ventral lancets in floor of mouth ... ... *Bunostomum.*
2 ventral and 2 dorsal lancets present ... ... *Bustomum.*

4. Bursa pincer-like, dorsal lobe well developed ; mouth with two ventral lancets only :—

Dorsal ray tridigitate ; vulva in anterior half of body ... ... *Gaigeria.*
Dorsal ray bidigitate, vulva in posterior half of body ... ... *Monodontus.*

5. Buccal capsule with 4 lancets in relation to the dorsal cone :—

Externo-dorsal ray narrowed at its origin ; spicules barbed at their tip ... ... *Necator.*
Externo-dorsal ray not narrowed at its origin ; spicules not barbed ... *Brachyclonus.*
Buccal capsule with 2 ventral lancets only in relation to dorsal cone... *Uncinaria.*

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