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A SURVEY OF THE INTESTINAL ENTOZOA, BOTH PROTOZOAL AND HELMINTHIC, OBSERVED AMONG NATIVES IN JOHANNESBURG, FROM JUNE TO NOVEMBER, 1917.

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WITH TWO PLATES.

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I.—INTRODUCTION.

In a tropical or sub-tropical country, where there is a large resident, yet fluctuating, native population, as well as a European community, it is desirable to have definite information as to what intestinal animal parasites are present among the coloured races, and the possibilities of sporadic or epidemic diseases of entozoal origin that may arise among these people.

During the six months June to November, 1917, I was engaged in a systematic examination of the stools of male Natives in hospital in Johannesburg, whether for surgical or medical reasons, suffering chiefly from other than intestinal complaints, while the stools of a smaller number of similarly circumstanced white men were examined for Entozoa. A small number of dysenteric stools were also examined, which may be considered as representative of those cases of dysentery which normally occur among the indigenous population under non-war conditions. A detailed examination of the protozoal and helminthic contents of the intestines of over 100 Natives examined *post mortem* was also made. The work enables a preliminary statement to be made as to the nature and distribution of the animal parasites among the Natives. It further sheds some light on the existence of a very limited protozoal fauna that may, perhaps, be considered normal to the human intestine, although exceedingly limited in extent as compared with the abundant bacterial flora that is usually present. Definite information as to the action and effects of certain parasitic Protozoa upon the human intestine has also been obtained.

The results, while not indicating the presence of parasites causing diseases of marked economic importance, yet clearly indicate that certain Protozoa do occur, *e.g.*, *Giardia* (*Lamblia*) *intestinalis*, which, under circumstances causing general lowered vitality among many Natives, would multiply rapidly, and produce intestinal diseases, such as diarrhœa, in epidemic form. Several comments regarding such Entozoa will be found in the paper.

While careful work was done by the late Dr. G. A. Turner (1907, 1910) in connection with the helminthic parasites occurring among mine natives, the present paper deals with both protozoal and helminthic parasites, not only of mine boys but also of the inhabitants of the city as represented in the native wards of the Johannesburg Hospital. It is believed to be the first detailed account of the parasitic Protozoa observed in the intestines and stools of Natives working on the Witwatersrand.

II.—MATERIAL AND METHODS.

As before-mentioned, the stools examined were those of male patients in the native wards of the General Hospital, Johannesburg; cases of amœbic dysentery form only a small part of the investigation, though such stools were examined microscopically and in some cases every day throughout the illness. At a minimum, three examinations were made of the stools of each patient at intervals during his stay in hospital, and the total protozoal and helminthic content was thus estimated in each case. The history of the patient was ascertained, and the details noted.

In each case, a stool passed soon after the patient was admitted to hospital was examined. In accordance with the hospital routine, an aperient, such as magnesium sulphate, was given to each patient on admission; the first stool was thus practically fluid, and its entozoal content comprised representatives of the great majority of the animal parasites present in the intestinal canal. Subsequent examinations sometimes revealed the presence of additional entozoa, but after a number of cases in which daily examinations were made for twenty days, the conclusion was reached that in the majority of cases the additional examinations yielded no more parasites than the first three had done.

The method of examination was as follows:—A bedpan from each patient was kept by the ward orderly, labelled with the name of the ward and bed number of the patient, and deposited in a small room provided with water, lavatory sinks, etc. In the morning I went to this room and examined the stools thus saved. In each case, a small bottle or swab was used, and a typical sample of the stool placed therein, special care being taken to include mucus or blood, if present, tapeworm segments and any other obvious helminthic parasites. A note was made as to the general nature of the stool. The average sample of stool thus secured was about 10 c.c. in volume. The remainder of the stool was then broken up and sedimented in order to detect worms, if present. Finally, the history of the patient was obtained from his bed-letter. The detailed examination of the fæces was made in the laboratory at the adjoining S.A. Institute for Medical Research. Fresh preparations were always employed, and were examined in the ordinary way, while in some cases the paraboloid condenser was also used. Stained preparations were made in special cases.

Concentration methods for the detection of protozoal cysts and helminthic ova were also tried, but it was found that such were of relatively little service, and, as they took too long for practical purposes, they were abandoned after a time.

It will, perhaps, be convenient to consider first the parasites found in stools, and then those detected at post-mortem examinations.

I would wish here to return hearty thanks to Dr. Watkins-Pitchford, Director of the Institute, and to the Superintendent of the Johannesburg Hospital and his staff, particularly to Sisters Cassidy and O'Rafferty, for the cordial co-operation which has greatly facilitated my work.

The post-mortem examinations of intestines were made at the laboratory of the S.A. Institute for Medical Research; the deceased subjects were "mine boys," or very occasionally new recruits, who had died at the Hospital of the Witwatersrand Native Labour Association.

Scrapings of the intestinal mucosa were examined from pylorus to anus, as well as preparations of the intestinal contents. The history of each case examined was also obtained. I would thank most heartily Dr. A. I. Girdwood and Dr. A. Percival Watkins, of the W.N.L.A. Hospital, for their invariable kindness and courtesy to me in connection with this work.

SECTION A.—ENTOZOA FOUND IN STOOLS.

III.—DISTRIBUTION OF FÆCAL ENTOZOA AMONGST THE VARIOUS TRIBES EXAMINED.

As a result of detailed examination of the stools of Natives of the various races, tribes or divisions of tribes, set forth in Table I overleaf, it was found that 56·8 per cent. of those examined contained parasitic Protozoa, or Helminthes, or both. Single infections, that is, infections with one species of organism only, occurred, both Protista and Helminthes being represented. Double infections consisted either of two kinds of Protist or of one Protist and one Helminth, double helminthic infections not being found in stools of hospital patients, though a few instances were observed *post mortem*. The multiple infections consisted of three or more Protists, or of two or more Protists and one Helminth found in the same stool.

In the adjoined table, the number of infected patients examined of each race, tribe, or division of tribe is indicated, together with the number actually found to be infected, and the character of the infection (whether single Protist, single Helminth, double or multiple entozoal infections).

The term "Protist" is used throughout to comprise parasitic Protozoa in the restricted sense, together with Spirochætacea and Blastocystis.

TABLE I.

Tribal Distribution of Patients, with General Character of Entozoal Infections of Stools.

Race or Tribe.	Number Examined.	Number Infected.	Number infected with Protista only.	Number infected with Helminthes only.	Number infected with both Protista and Helminthes.	Single Protistan Infections.	Single Helminthic Infections.	Double Entozoal Infections.	Multiple Entozoal Infections.
Cape	61	33	31	1	1	15	1	15	2
Transkei—									
M'Xosa	17	9	9	0	0	4	0	5	0
Pondo	4	4	3	0	1	2	0	0	2
Tambooki	1	1	1	0	0	0	0	1	0
Fingo	1	1	1	0	0	0	0	1	0
Baca	1	1	0	0	1	0	0	0	1
Kaffir	1	0	0	0	0	0	0	0	0
Hottentot	9	5	4	0	1	1	0	1	3
Griqua	1	1	1	0	0	0	0	1	0
Basutos—									
Basuto	27	17	14	2	1	9	2	5	1
M'Kalonga	1	1	0	0	1	0	0	1	0
M'Naring	1	0	0	0	0	0	0	0	0
M'Gato	1	1	1	0	0	1	0	0	0
M'Nvali	1	0	0	0	0	0	0	0	0
Marolo	4	3	3	0	0	1	0	2	0
Bechuana	3	1	1	0	0	1	0	0	0
Baralong	2	2	2	0	0	1	0	1	0

TABLE I.—(*Continued*).

Race or Tribe.	Number Examined.	Number Infected.	Number infected with Protista only.	Number infected with Helminthes only.	Number infected with both Protista and Helminthes.	Single Protistan Infections.	Single Helminthic Infections.	Double Entozoal Infections.	Multiple Entozoal Infections.
Zulu	97	56	32	10	14	20	10	16	10
Swazi and Dwazi	6	4	4	0	0	2	0	0	2
Msutu	64	29	28	1	0	18	1	8	2
East Coast—									
Delagoa Bay	1	0	0	0	0	0	0	0	0
Tonga	1	1	1	0	0	0	0	1	0
Shangaan	24	17	13	2	2	7	2	7	1
Portuguese East African	5	2	2	0	0	1	0	0	1
Moçambique	6	5	4	1	0	3	1	1	0
Blantyre	3	1	0	0	1	0	0	1	0
Nyambaan	4	2	2	0	0	2	0	0	0
M'Chopi	2	1	1	0	0	0	0	1	0
Bantu (Uganda)	1	1	0	1	0	0	1	0	0
Nyasa	1	1	1	0	0	1	0	0	0
Somali	1	0	0	0	0	0	0	0	0
Indian	20	12	10	1	1	3	1	6	2
Chinese	3	1	1	0	0	1	0	0	0
TOTALS	375	213	170	19	24	93	19	74*	27

*Of these 74 cases, 60 were double Protist infections and the remaining 14 were mixed double infections.

From Table I it will be seen that one or more parasites were harboured by a relatively large proportion of the Natives, the Protista being far more numerous than the Helminthes. The largest number of Natives examined belonged to the Zulu race, while Msutus, Cape coloured persons, Basutos and Shangaans comprised the bulk of the remainder. The value of observations in regard to percentage infection in the majority of the remaining cases is almost nullified by the small numbers of individuals involved, though they were all that were available. Of the tribes sufficiently represented to yield a fairly accurate estimate, it was found that approximately 70·8 per cent. of the Shangaans, 52·57 per cent. of the Zulus, 64·7 per cent. of the Basutos (with their sub-families), 45·3 per cent. of the Msutus and 54 per cent. of the Cape coloured people harboured parasites. It may also be noted that the helminthic infections were in the main confined to these tribes.

IV.—SINGLE PROTIST INFECTIONS OF STOOLS, WITH THEIR TRIBAL DISTRIBUTION.

Infections with a single Protist were found in the stools of 93 Natives. The number of subjects in whom the Protists occurred were as follows:—

TABLE II.

Single Protist Infections of Stools, with Numbers of Cases in which each Infection was found.

Entamoeba coli	42
Giardia (Lamblia) intestinalis	3
Trichomonas intestinalis	2
Chilomastix mesnili	1
Prowazekia cruzi	3
Cercomonas parva	5
Spirochæta eurygyrata	29
"*Free-living*" *Amoebae*	2
Blastocystis hominis	6
	93

The examinations of the single infections show that *Entamoeba coli* and *Spirochaeta eurygyrata* occurred most frequently in these stools. It was noted that *S. eurygyrata* was more abundant in stools of patients who had temporary intestinal troubles consequent mainly on a change of diet.

In six cases, parasitic Flagellata, namely, *Giardia intestinalis*, *Trichomonas intestinalis*, and *Chilomastix mesnili*, which are often associated with flagellate diarrhœa, were present; vague accounts of intestinal trouble were given by each of the patients concerned, and they were placed under appropriate treatment.

The tribal distribution of the single protistan infections is shown in the following table:—

TABLE III.

Tribal Distribution of Patients with Single Protist Infections of Stools.

Tribe.	Entamœba coli.	Giardia intestinalis.	Chilomastix. mesnili.	Trichomonas intestinalis.	Spirochæta eurygyrata.	Other Protozoa.	Blastocystis hominis
Cape	6	—	—	—	4	2 Cercomonas 1 Prowazekia	2
M'Xosa	—	—	—	1	3	—	—
Pondo	1	—	—	—	1	—	—
Hottentot	—	1	—	—	—	—	—
Basuto	6	—	1	—	1	—	1
M'Gato	1	—	—	—	—	—	—
Marolo	1	—	—	—	—	—	—
Bechuana	1	—	—	—	—	—	—
Baralong	—	1	—	—	—	—	—
Zulu	9	—	—	1	6	2 Cercomonas 1 Prowazekia	1
Swazi and Dwazi	1	—	—	—	1	—	—
Msutu	9	—	—	—	6	1 "Free-living" Amoeba	2
Shangaan	3	—	—	—	4	—	—
Portuguese East African	1	—	—	—	—	—	—
Moçambique	1	—	—	—	—	1 Prowazekia 1 "Free-living" Amoeba	—
Nyambaan	—	1	—	—	1	—	—
Nyasa	1	—	—	—	—	—	—
Indian	1	—	—	—	1	1 Cercomonas	—
Chinese	—	—	—	—	1	—	—
TOTALS	42	3	1	2	29	5 Cercomonas 3 Prowazekia 2 "Free-living" Amoeba	6

It is evident that *Entamœba coli* and *Spirochœta eurygyrata* were the most widely distributed Protists among the tribes, the parasitic Flagellata being present in relatively few cases. However, organisms which, when present in numbers, produce flagellate diarrhœas occurred in six patients representing six different tribes. As the Natives concerned came from Cape Colony, the Transkei, Zululand, Basutoland, Bechuanaland and the East Coast, it may be inferred that the geographical distribution of Giardia, Chilomastix, and Trichomonas is a wide one in the sub-continent, and it is probable that a more extended series of examinations would show a wider tribal distribution of these organisms.

V.—SINGLE HELMINTHIC INFECTIONS OF STOOLS.

Helminthic parasites, unaccompanied by Protista, were observed in the dejecta of 19 patients, in the specimens from each of whom one kind of worm only was found. Both Cestoda and Nematoda were represented. Among the Cestoda, two species of Tænia and one of Hymenolepis were found. *Tænia solium* occurred in one Zulu, two Basutos, one Moçambique, and one Indian; *Tænia saginata* was found in the fæces of eight Zulus, one Basuto, and one Shangaan; while *Hymenolepis nana* was parasitic in one Cape coloured man.

The Nematoda observed were *Oxyuris vermicularis* in a Shangaan, and *Ascaris lumbricoides* in a Msutu and a Zulu.

Details regarding Helminthes associated in the same patient with Protista will be given subsequently. A summary of the single helminthic infections is given in Table IV.

TABLE IV.

Single Helminthic Infections of Stools, with Numbers of Cases in which each Infection was found.

Tænia solium	5
Tænia saginata	10
Hymenolepis nana	1
Oxyuris vermicularis	1
Ascaris lumbricoides	2
	19

VI.—DOUBLE PROTIST INFECTIONS OF STOOLS.

In each of the 60 cases now to be considered, two Protists co-existed in the same patient. From a series of observations, it was found that one of the parasites was at times much more abundant than the other, and also that on some occasions one might be absent from the stool while the other was abundant, although both had previously co-existed. In other words, both here and in the multiple infections to be discussed later, there was a periodicity in the appearance of the maximum numbers of the different parasites, just as was determined for the various Protista observed in European patients by Fantham (1916).

The different combinations of Protists, and the numbers of instances of each combination observed, are set forth in Table V.

TABLE V.

Double Protist Infections of Stools, with Numbers of Cases in which each Infection was found.

			No.
Entamœba coli	and	"*Free-living*" *Amœbæ*	1
,, ,,	,,	*Giardia intestinalis*	2
,, ,,	,,	*Trichomonas intestinalis*	3
,, ,,	,,	*Chilomastix mesnili*	1
,, ,,	,,	*Prowazekia cruzi*	1
,, ,,	,,	*Cercomonas parva*	1
,, ,,	,,	*Bodo stercoralis*	1
,, ,,	,,	*Spirochæta eurygyrata*	38
,, ,,	,,	*Blastocystis hominis*	6
Giardia intestinalis	and	*Trichomonas hominis*	1
,, ,,	,,	*Spirochæta eurygyrata*	1
Spirochæta eurygyrata	and	"*Free-living*" *Amœbæ*	1
,, ,,	,,	*Blastocystis hominis*	1
Blastocystis hominis	and	"*Free-living*" *Amœbæ*	2

The grouping of the tribes with respect to the Protista found as double infections is given in Table VI.

TABLE VI.

Tribal Distribution of Patients with Double Protist Infections of Stools.

Tribe.	Double Protist Infections			No.
Cape	*Entamœba coli*	and	"*Free-living*" *Amœbæ*	1
	Entamœba coli	,,	*Chilomastix mesnili*	1
	Entamœba coli	,,	*Trichomonas intestinalis*	1
	Entamœba coli	,,	*Spirochæta eurygyrata*	9
	Entamœba coli	,,	*Blastocystis hominis*	1
	Giardia intestinalis	,,	*Trichomonas intestinalis*	1

TABLE VI.—(*Continued.*)

Tribe.	Double Protist	Infections.	No.
M'Xosa	*Entamœba coli*	and *Cercomonas parva*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	4
Tambooki	"*Free-living*" *Amœbæ*	,, *Blastocystis hominis*	1
Fingo	*Entamœba coli*	,, *Giardia intestinalis*	1
Hottentot	*Entamœba coli*	,, *Blastocystis hominis*	1
Griqua	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
Basuto	*Entamœba coli*	,, *Bodo stercoralis*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	1
	Entamœba coli	,, *Blastocystis hominis*	1
	"*Free-living*" *Amœbæ*	,, *Spirochæta eurygyrata*	1
Marolo	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
	"*Free-living*" *Amœbæ*	,, *Blastocystis hominis*	1
Baralong	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
Zulu	*Entamœba coli*	,, *Trichomonas intestinalis*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	5
	Entamœba coli	,, *Blastocystis hominis*	1
	Giardia intestinalis	,, *Spirochæta eurygyrata*	1
Msutu	*Entamœba coli*	,, *Giardia intestinalis*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	5
	Entamœba coli	,, *Blastocystis hominis*	2
Tonga	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
Shangaan	*Entamœba coli*	,, *Prowazekia cruzi*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	5
Moçambique	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
M'Chopi	*Entamœba coli*	,, *Spirochæta eurygyrata*	1
Indian	*Entamœba coli*	,, *Trichomonas intestinalis*	1
	Entamœba coli	,, *Spirochæta eurygyrata*	3
	Spirochæta eurygyrata	,, *Blastocystis hominis*	1

It may be noted that among these double Protist infections, *Giardia intestinalis*, *Chilomastix mesnili*, and *Trichomonas intestinalis* occurred in several cases, while one double infection of Giardia and Trichomonas was observed. Here, as with the single infections of the afore-mentioned parasites, there was a vague history of intestinal trouble, and the man who harboured both Giardia and Trichomonas definitely suffered from alternating periods of constipation and diarrhœa, as was observed by Fantham and myself in the case of European military patients suffering from the same infections acquired in Gallipoli and Salonika. The most frequent double infection was that of *Entamocba coli* and *Spirochæta curygyrata*.

VII.—MIXED DOUBLE INFECTIONS OF STOOLS WITH PROTISTA AND HELMINTHES.

In fourteen cases it was found that the stools of the patients contained both Helminthes and Protista. A simultaneous infection of the stools of a hospital patient with two different Helminthes was not observed, although two and three different genera of worms were obtained, as will be shown later, from the intestines of "mine-boys" examined in detail *post mortem*. Both Cestode and Trematode parasites were found in the stools of the patients, the ova usually being first detected and the worms themselves being subsequently recovered after appropriate anti-helminthic treatment.

The mixed double infections grouped according to the parasites present are given in Table VII.

TABLE VII.

Mixed Double Entozoal Infections of Stools, with Numbers of Cases in which each Infection was found.

				No.
Cestoda and Protista	*Tænia solium*	and	*Entamœba coli*	1
	Tænia solium	,,	*Spirochæta curygyrata*	1
	Tænia solium	,,	*Blastocystis hominis*	1
	Tænia saginata	,,	*Entamœba coli*	7
	Tænia saginata	,,	*Giardia intestinalis*	1
	Tænia saginata	,,	*Spirochæta curygyrata*	1
Trematoda and Protista	*Schistosoma (Bilharzia) mansoni*	,,	*Cercomonas parva*	1
	Schistosoma (Bilharzia) mansoni	,,	*Entamœba coli*	1

The tribal distribution of the mixed double entozoal infections in stools is shown in Table VIII.

TABLE VIII.

Tribal Distribution of Patients with Mixed Double Entozoal Infections of Stools.

Tribe.	Mixed Double Entozoal Infection.			No.
Zulu	*Tænia solium*	and	*Entamœba coli*	1
	Tænia solium	,,	*Spirochæta eurygyrata*	1
	Tænia saginata	,,	*Entamœba coli*	4
	Tænia saginata	,,	*Spirochæta eurygyrata*	1
	Schistosoma mansoni	,,	*Entamœba coli*	1
Cape	*Tænia saginata*	,,	*Entamœba coli*	1
Basuto	*Tænia saginata*	,,	*Entamœba coli*	1
M'Kalonga	*Tænia saginata*	,,	*Giardia intestinalis*	1
Shangaan	*Tænia solium*	,,	*Blastocystis hominis*	1
Blantyre	*Schistosoma mansoni*	,,	*Cercomonas parva*	1
Indian	*Tænia saginata*	,,	*Entamœba coli*	1

VIII.—MULTIPLE PROTIST INFECTIONS OF STOOLS.

The stools of 27 of the men examined contained three or more parasites. As in the double infections, there were pure protistan infections (17 cases) and mixed infections of Protista and Helminthes (10 cases). In 16 cases, three Protists were present, while in the 17th case four Protists occurred simultaneously. A periodicity in the time of appearance of the different organisms in maximum numbers in the stools was observed.

The multiple Protist infections, grouped according to the parasites present, are indicated in Table IX, together with the number of cases in which each infection occurred.

TABLE IX.

Multiple Protist Infections of Stools.

				No.
Entamœba coli,	*Giardia intestinalis*	and	*Spirochæta eurygyrata*	4
,, ,,	*Giardia intestinalis*	,,	"*Free-living*" *Amœbæ*	1
,, ,,	*Chilomastix mesnili*	,,	*Spirochæta eurygyrata*	4
,, ,,	*Spirochæta eurygyrata*	,,	"*Free-living*" *Amœbæ*	1
,, ,,	*Spirochæta eurygyrata*	,,	*Blastocystis hominis*	4
,, ,,	*Cercomonas parva*	,,	*Spirochæta eurygyrata*	1
,, ,,	*Cercomonas parva*	,,	*Isospora bigemina* var. *hominis*	1
Entamœba coli, Giardia intestinalis,	*Spirochæta eurygyrata*	and	*Blastocystis hominis*	1

The tribal distribution of the multiple Protists in stools was as follows:—

TABLE X.

Tribal Distribution of Patients with Multiple Protist Infections of Stools.

Tribe.	Multiple Protist Infections.	No.
Cape	*Entamœba coli*, "*Free-living*" *Amœbæ* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Spirochæta eurygyrata* and *Blastocystis hominis*	1
Pondo	*Entamœba coli*, *Giardia intestinalis*, *Spirochæta eurygyrata* and *Blastocystis hominis*	1
Hottentot	*Entamœba coli*, *Giardia intestinalis* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Cercomonas parva* and *Isospora bigemina* var. *hominis*	1
Basuto	*Entamœba coli*, *Giardia intestinalis* and "*Free-living*" *Amœbæ*	1
Swazi	*Entamœba coli*. *Giardia intestinalis* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Chilomastix mesnili* and *Spirochæta eurygyrata*	1
Zulu	*Entamœba coli*, *Chilomastix mesnili* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Cercomonas parva* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Spirochæta eurygyrata* and *Blastocystis hominis*	2
Msutu	*Entamœba coli*, *Chilomastix mesnili* and *Spirochæta eurygyrata*	1
	Entamœba coli, *Spirochæta eurygyrata* and *Blastocystis hominis*	1
Portuguese East African	*Entamœba coli*, *Chilomastix mesnili* and *Spirochæta eurygyrata*	1
Indian	*Entamœba coli*, *Giardia intestinalis* and *Spirochæta eurygyrata*	2

It may be noted that ten out of the seventeen infections listed in Table X were with parasitic Flagellata (*Giardia intestinalis*, *Chilomastix mesnili*) which are capable of pathogenic effects, when abnormal conditions lead to their multiplicative activity, or when they later reach a susceptible subject.

IX.—MIXED MULTIPLE INFECTIONS OBSERVED IN STOOLS.

The 10 multiple infections that comprised both Protist and Helminth parasites are shown in Table XI, together with the number of cases in which they were observed.

TABLE XI.

Mixed Multiple Infections in Stools.

		No.
Tænia solium, *Entamœba coli*	and *Spirochæta eurygyrata*	1
Tænia solium, *Cercomonas parva*	and *Blastocystis hominis*	1
Tænia solium, *Spirochæta eurygyrata*	and *Blastocystis hominis*	1
Tænia saginata, *Entamœba coli*	and *Giardia intestinalis*	1
Tænia saginata, *Entamœba coli*	and *Bodo stercoralis*	1
Tænia saginata, *Entamœba coli*	and *Spirochæta eurygyrata*	3
Tænia saginata, *Entamœba coli*	and *Blastocystis hominis*	1
Tænia saginata, *Trichomonas hominis*	and *Spirochæta eurygyrata*	1

Bodo stercoralis, already listed in Tables V and VI (pp. 11, 12), is a Flagellate from human fæces believed to be new to science and to be recorded in this paper for the first time. Details regarding its structure are given on pp. 43, 44, and it is figured on Plate I, Fig. 19.

The tribal distribution of the mixed multiple infections is given in Table XII.

TABLE XII.

Tribal Distribution of Patients with Mixed Multiple Infections of Stools.

Tribe.	Combination of Parasites.	No.
Pondo	*Tænia saginata, Entamœba coli* and *Blastocystis hominis*	1
Baca	*Tænia saginata, Entamœba coli* and *Spirochæta eurygyrata*	1
Hottentot	*Tænia saginata, Entamœba coli* and *Giardia intestinalis*	1
Zulu	*Tænia solium, Entamœba coli* and *Spirochæta eurygyrata*	1
	Tænia solium, Cercomonas parva and *Blastocystis hominis*	1
	Tænia saginata, Entamœba coli and *Bodo stercoralis*	1
	Tænia saginata, Entamœba coli and *Spirochæta eurygyrata*	2
	Tænia saginata, Trichomonas hominis and *Spirochæta eurygyrata*	1
Shangaan	*Tænia solium, Spirochæta eurygyrata* and *Blastocystis hominis*	1

It is of interest to note that in almost all cases of infection with tapeworms, whether single, double or multiple infections, the patients were men of classes mostly in close contact with white races—cooks, kitchen boys, house boys, and store boys furnished most of the cases, while farm-hands were also parasitised. Although the normal hosts of the bladderworm stages are domestic animals, for example, the ox and the pig, such stages are sometimes known in man. Hence the possible communication of Cestode infections to the white population needs to be borne in mind when such intimate association of infected natives with the food of Europeans, and sometimes with European children, is in vogue.

X.—GENERAL SURVEY OF THE PROTIST PARASITES OBSERVED IN THE STOOLS OF NATIVES.

It may be advisable at this stage to show the number of times each organism listed was actually recorded, and with this object in view, one table showing the total number of times each Protist was recorded in the various tribesmen, and a second one giving similar particulars for the Helminth infections, have been prepared (see Tables XIII, XIV) from the preceding data.

As a general statement, the Protist parasites most commonly occurring were *Entamœba coli* and *Spirochæta eurygyrata*. While both organisms are non-pathogenic in the general opinion, it has been noted by several workers that *E. coli* multiplies more vigorously in an unhealthy intestine than in a healthy one, while Fantham (1916) has found that *S. eurygyrata* is much more numerous in diarrhœic or dysenteric stools than in normal ones; an observation I can readily confirm. The presence of either *E. coli* or *S. eurygyrata* in very large numbers, then, may serve as an early indication of latent or potential intestinal disorders.

The Mastigophora associated with flagellate diarrhœas were observed on relatively few occasions. Nevertheless, the number of tribes represented is fairly considerable—Cape, M'Xosa, Basuto, Zulu, Msutu, Portuguese East African and Indians being infected. A wide geographical distribution of these potentially pathogenic flagellates is also indicated.

In connection with flagellate diarrhœa, I may state that I was able, during the course of these observations, to transmit Giardia, Trichomonas and Chilomastix of human origin to clean white rats by allowing their food to be contaminated with the excrement of cockroaches (*Periplaneta orientalis* and *P. americana*) that had been given access to infected stools and had fed thereon. The rôle of cockroaches as transmitters of flagellate diarrhœas of man can be readily understood, especially in semi-tropical and tropical countries, where their access to fæcal matter is relatively easy.

Another occurrence of scientific interest was the finding of *Isospora bigemina* var. *hominis* in the stools of a Hottentot. (See Table X). This parasite has previously been reported with certainty only in the stools of a few Europeans in Europe, who had contracted the infection while on active service in the Mediterranean War Zone.

The organism is evidently not restricted to Europeans, as the fairly heavy infection of the Hottentot showed. It may be mentioned that I have found the parasite also in the excrement of a South African of Dutch descent, who had lived all his life in South Africa, mainly in the Transvaal. His condition at first was thought to be amœbic dysentery, but *Isospora bigemina* var. *hominis* was the only Protozoön present (see p. 27), and with its destruction and elimination the symptoms also disappeared. By animal experiments (Fantham, 1917) it has been shown that this Isospora has a definite pathogenic action, and the possible presence of the organism should be borne in mind in cases of unusual dysenteric illnesses.

Cercomonas parva was observed at ten examinations. This organism has also been observed by Fantham (1916) and myself (1916) in military patients from Gallipoli, in whom no other parasitic agent of disease could be found. While its pathogenicity has not been fully tested by animal experiments, it may be regarded as a suspect. *Prowazekia cruzi*, now reported in African natives, has previously been found in cases of diarrhœa in South America.

Blastocystis hominis, an organism usually considered to be of fungoid origin, but possibly a stage of a Flagellate, has been frequently observed in the stools of military patients from the European War Zone, and its geographical distribution is now extended to South and East Africa.

The organisms now described as "Free-living" Amœbæ—of the *limax* type—can hardly be regarded as normal inhabitants of the human intestine. They were usually present in the encysted condition and resembled, in structure, the cysts of amœbæ that occur on vegetable matter, in moss, and on damp earth. It is probable that they had been ingested with vegetable food—similar amœbæ were obtained by me from lettuce leaves grown near Johannesburg on one occasion—and had passed through the human body, finally leaving it in an encysted condition. The "free-living" Amœbæ that I observed were not the same as those recently described under the name of *Entamœba nana*, which organism was not found.

It may be mentioned that, as a result of these systematic stool examinations, several carriers of amœbic dysentery were detected, the men being detained in hospital and treated until *Entamœba histolytica* was absent from their stools. Such carrier cases are not included in the tables already presented, but their detection gives an increased value to systematic stool examinations.

As will be seen from Table XIII, the total number of times Protista were recorded from the stools of Natives during the investigation was 299. However, the number of individuals harbouring the Protista was only 194, as will be gathered from Table I, columns 3 and 5, or from Tables II, V, VII, IX, XI.

TABLE XIII.

Number of Times each Protist was Recorded in Stools of Natives.

Tribe.	Entamœba coli.	Giardia intestinalis.	Chilomastix mesnili.	Trichomonas intestinalis.	Spirochæta eurygyrata	Prowazekia cruzi.	Bodo stercoralis.	Cercomonas parva.	Isospora bigemina var. hominis.	"Free-living" Amœbæ.	Blastocystis hominis.
Cape	22	1	1	2	15	1	—	2	—	2	4
Transkei—											
M'Xosa ...	5	—	—	1	7	—	—	1	—	—	—
Pondo... ...	3	1	—	—	2	—	—	—	—	—	2
Tambooki ...	—	—	—	—	—	—	—	—	—	1	1
Fingo	1	1	—	—	—	—	—	—	—	—	—
Baca	1	—	—	—	1	—	—	—	—	—	—
Kaffir	—	—	—	—	—	—	—	—	—	—	—
Hottentot ...	4	3	—	—	1	—	—	1	1	—	1
Griqua	1	—	—	—	1	—	—	—	—	—	—
Basutos—											
Basuto ...	11	1	1	—	3	—	1	—	—	2	2
M'Kalonga...	—	1	—	—	—	—	—	—	—	—	—
M'Naring ...	—	—	—	—	—	—	—	—	—	—	—
M'Gato ...	1	—	—	—	—	—	—	—	—	—	—
M'Nvali ...	—	—	—	—	—	—	—	—	—	—	—
Marolo ...	2	—	—	—	1	—	—	—	—	1	1
Bechuana ...	1	—	—	—	—	—	—	—	—	—	—
Baralong ...	1	1	—	—	1	—	—	—	—	—	—
Zulu...	30	1	1	3	22	1	1	4	—	—	5

TABLE XIII.—(*Continued*).

Tribe.	Entamœba coli.	Giardia intestinalis.	Chilomastix mesnili.	Trichomonas intestinalis.	Spirochæta eurygyrata.	Prowazekia cruzi.	Bodo stercoralis.	Cercomonas parva.	Isospora bigemina var. hominis.	"Free-living" Amœbæ.	Blastocystis hominis.
Swazi & Dwazi	3	1	1	—	3	—	—	—	—	—	—
Msutu	19	1	1	—	13	—	—	—	—	1	5
East Coast—											
Delagoa Bay	—	—	—	—	—	—	—	—	—	—	—
Tonga... ...	1	—	—	—	1	—	—	—	—	—	—
Shangaan ...	9	—	—	—	10	1	—	—	—	—	2
Portuguese East African	2	—	1	—	1	—	—	—	—	—	—
Moçambique	2	—	—	—	1	1	—	—	—	1	—
Blantyre ...	—	—	—	—	—	—	—	1	—	—	—
Nyambaan...	—	1	—	—	1	—	—	—	—	—	—
M'Chopi ...	1	—	—	—	1	—	—	—	—	—	—
Bantu (Uganda) ...	—	—	—	—	—	—	—	—	—	—	—
Nyasa	1	—	—	—	—	—	—	—	—	—	—
Somali	—	—	—	—	—	—	—	—	—	—	—
Indian	8	2	—	1	7	—	—	1	—	—	1
Chinese	—	—	—	—	1	—	—	—	—	—	—
TOTALS ...	129	15	6	7	93	4	2	10	1	8	24

XI.—DYSENTERIC STOOLS OF NATIVES.

The stools of 13 dysenteric Natives were examined, many of them daily, and in each case the infecting organism was *Entamœba histolytica*. Three cases were carriers, two were acute cases that rapidly proved fatal, the remainder being at first acute and then passing to the sub-acute form. Four Zulus, four Msutus, two Shangaans. one Somali, one Hottentot, and one Blantyre Native were infected.

These 13 cases were encountered during the ordinary course of the investigation. They may, perhaps, be regarded as affording some indication of the proportion of cases of amœbic dysentery which may occur ordinarily among the native population under relatively normal conditions.

XII.—GENERAL SURVEY OF THE HELMINTHES FOUND IN STOOLS OF NATIVES.

The most common helminthic infections detected in stools were those of the beef tape-worm, *Tænia saginata*, and the pork tape-worm, *Tænia solium*. Men having more access to meat than their fellows appeared to be more parasitised. Members of the tribes located from Cape Colony to the Transvaal formed the bulk of those whose stools were critically examined, the East Coast and Asiatic peoples being in the minority. However, when the results of infestation with helminthic parasites, as observed at post-mortem examinations, are considered, it seems correct to infer that the East Coast natives harbour more helminthic parasites than those of the Union of South Africa.

The number of times each Helminth was recorded is set forth in Table XIV. As no stool examined ever contained more than one kind of Helminth, the number of times each Helminth was recorded is the same as the number of individuals infected therewith, namely, 43, as will be seen from Table I, columns 4 and 5, or from Tables IV, VII, XI.

TABLE XIV.

Number of Times each Helminth was Recorded in Stools of Natives.

Tribe.	Tænia solium.	Tænia saginata.	Hymenolepis nana.	Schistosoma mansoni.	Oxyuris vermicularis.	Ascaris lumbricoides.
Cape	—	1	1	—	—	—
Pondo	—	1	—	—	—	—
Baca	—	1	—	—	—	—
Hottentot	—	1	—	—	—	—
Basuto...	2	1	—	—	—	—
M'Kalonga	—	1	—	—	—	—
Zulu	5	17	—	1	—	1
Msutu	—	—	—	—	—	1
Shangaan	2	1	—	—	1	—
Moçambique	1	—	—	—	—	—
Blantyre	—	—	—	1	—	—
Bantu	—	1	—	—	—	—
Indian	1	1	—	—	—	—
Totals	11	26	1	2	1	2

One kind of Helminth only was found in each Native stool (see p. 22).

Tape-worm infections, derived from improperly cooked beef and pork, form a large proportion of the total number of the Helminthes found in stools. Such occurrences direct attention not only to the infection among Natives, but to the necessity for proper disposal of human excrement on the one hand, and to systematic meat-inspection on the other.

XIII.—COMPARISON OF THE ENTOZOA FOUND IN NATIVE STOOLS WITH THOSE FOUND IN EUROPEAN STOOLS.

It was thought that it might be useful to compare the Protist and Helminth fauna of the stools of white men domiciled in South Africa with that found in Natives. For this purpose, a series of stools was examined from one of the European wards in the hospital, the same procedure being adopted as in the case of stools of Natives. The stools of men suffering from such maladies as dysentery and enteric fever are excluded from the results now tabulated, as the content of the intestine under such conditions is abnormal. Also, although a number of cases of amœbic dysentery among both white men and Natives was investigated, these are not included in the table, but are summarised in separate paragraphs. (See pp. 22, 27.)

The report on the first sixty stools of white men examined is now set forward on the same lines as for natives. The race given is in accordance with the statements of the men, the term " Colonial " being used for men born in South Africa, all of whom, it happened, were of mixed British and Dutch ancestry.

The distribution of the Entozoa detected in the stools of these various white men is set forth in Table XV, and further particulars regarding the occurrence of the organisms are summarised on the page following.

TABLE XV.

Distribution of Entozoa in the stools of various White Races examined.

Race.	Number examined.	Number infected.	Number of patients infected with Protista only.	Number of patients infected with Helminthes only.	Number of patients infected with both Protista and Helminthes.	Single protistan infections.	Double entozoal infections.	Multiple entozoal infections.
British	32	16	16	—	—	11	4	1
Colonial	8	5	5	—	—	4	1	—
Dutch	4	3	2	—	1	1	1	1
Russian Jews ...	14	7	7	—	—	4	3	—
German	1	1	1	—	—	1	—	—
Portuguese... ...	1	1	1	—	—	—	1	—
TOTALS	60	33	32	—	1	21	10	2

Infection with Entozoa thus occurred in 55 per cent. of the white men examined, as compared with 56·8 per cent. infection among the natives, of whom it must be remembered many more were examined. Helminthic infection was relatively rare—a result doubtless to be correlated with more attention to the cooking of food on the part of the white man.

Single infections with Protista occurred in twenty-one cases, each nationality, except the Portuguese, being represented.

Entamœba coli was present in the stools of eight British, three Colonial, one Dutch, and three Jews. *Spirochæta eurygyrata* occurred in three British, one Colonial, one Jew, and one German.

The ten double entozoal (Protist) infections were distributed among all the nationalities represented except the German.

Entamœba coli and *Spirochæta eurygyrata* co-existed in the stools of three British, one Dutch, three Jews, and one Portuguese. *Entamœba coli* occurred with *Blastocystis hominis* in one British, and *Spirochæta eurygyrata* together with "Free-living" Amœbæ was present in the fæces of a Colonial.

One multiple Protist infection only was found in a man of British race, the combination of parasites being *Entamœba coli*, *Trichomonas intestinalis* and *Spirochæta eurygyrata*.

The only mixed multiple infection, and also the only case in which helminthic parasites were observed, was in a man of Dutch descent, who harboured *Tœnia saginata*, *Spirochæta eurygyrata*, and "Free-living" Amœbæ in his intestine, the last-named parasites being found in several successive stools, suggesting that they had become somewhat habituated to the intestinal environment.

The general occurrence of *Entamœba coli* and of *Spirochæta eurygyrata*, either separately or together, among men of various nationalities as well as among the different Natives of Africa and of India examined, shows the wide distribution of these organisms. While both parasites multiply more vigorously in an unhealthy intestine than in a healthy one, they appear to do relatively little or no gross harm to their hosts. These organisms, then, apparently have long been parasitic in man, and a mutual tolerance has become established between host and parasite, manifesting itself in non-pathogenicity on the part of the parasite.

Blastocystis hominis was found in the stools of one patient, and the said stool was markedly sour in smell and acid in reaction when this organism was detected. At first the Blastocystis was present in rather large numbers. As the acid reaction diminished, the Blastocystis also decreased, and when the reaction of the stools became markedly alkaline no Blastocystis could be found. In the cases of Blastocystis in Natives the parasite was usually most abundant in slightly acid stools, though also present in alkaline ones.

Dysenteric Stools of Europeans.

During the same period as the stools of men unaffected by intestinal complaints were examined, stools of ten dysenteric white men were examined. In each of these cases the excitant of the dysentery was *Entamœba histolytica*, and in most of the cases, the malady was of the acute type. The nationalities represented were three Colonials, two English, two Dutch, two Russian Jews, and one Greek. The parasites were usually observed in both the trophic and the encysted condition. It was relatively a heavy proportion of men infected, seeing that ten out of a total of seventy stools, all from one ward in the Johannesburg Hospital, contained *E. histolytica*. It is, however, probable that the percentage of infections is above the average, and that the number of sporadic cases among the total white persons under ordinary conditions is not so large. It may be mentioned that only one of the amœbic dysentery patients had been serving with the Forces, and his service had been in France for two years. He stated that, while in France, he had not suffered from any intestinal complaint, but had had several attacks of malaria and was sent back to South Africa after being gassed.

I may mention that, as noted on p. 19, I was also able to examine the stools of a non-hospital patient, a South African of Dutch descent, believed to be suffering from amœbic dysentery, but whose motions contained a pure infection of various stages of *Isospora bigemina* var. *hominis*. After the elimination of the parasite by appropriate treatment the man recovered.

SECTION B.—ENTOZOA FOUND AT POST-MORTEM EXAMINATIONS.

XIV.—DISTRIBUTION OF ENTOZOA IN NATIVES AS OBSERVED IN 104 POST-MORTEM EXAMINATIONS.

Many interesting observations on various Entozoa have accrued from the detailed examination of the alimentary canals of a total of 104 Natives who had died at the W.N.L.A. Hospital, Johannesburg, generally while awaiting repatriation. The intestine was examined minutely in each case, and scrapings of the mucosa made from the pylorus to the anus, thus ensuring that each region of the whole intestinal tract was subjected to microscopical examination. Fresh preparations were chiefly used, but stained ones were made when necessary, and material was also preserved for subsequent sectioning. Whenever pathological features were noted in connection with parasitic Protozoa, reference was made to medical pathologists at the Institute, and I wish to thank very heartily Drs. Watkins-Pitchford, J. G. Becker, and Lister, who came to my assistance, and from whose descriptions the pathological notes in this section are made.

It may be observed that rather different results were obtained as to entozoal infestation as observed post-mortem, from those derived from stool examinations, this being due in part to the different tribal distribution of the Natives examined *post mortem*. Of these latter, practically two-thirds were East Coast natives; the actual numbers were 69 out of 104 examined, the remaining 35 being Natives of other parts of South Africa. Fifty-four East Coast Natives out of the 69 were infected with Entozoa, and of the other South African Natives 25 were similarly parasitised. " Mine boys " live under different conditions from those prevailing among the Natives employed as labourers and house-boys. The condition of life when relatively segregated in large numbers in compounds may be conducive to the spread of Entozoa to some extent, but it seems more probable that the Natives are already infected when they reach the Rand than that they acquire many of the infections when resident there. The examination of the bodies of several " new recruits " for the mines has shown the presence of almost the same Entozoa as were present in men who had lived on various mines for some time. Age apparently had no significance in relation to parasitism, but, as the majority of the men were between the ages of 30 and 40, and very few were outside this range, it is hardly possible to give exact information.

Post-mortem examinations showed that practically 76 per cent. of the men were parasitised, the actual numbers being 79 out of 104. Infections with a single Protist, or with one kind of Helminth only, were comparatively few, as were double infections with Protista or Helminthes. On the other hand, the numbers of mixed double infections and of multiple infections, when as many as five or six separate genera of Entozoa were present in the same intestine, were greatly increased.

The tribal distribution of the deceased Natives in whom intestinal Entozoa were found *post mortem*, together with the general character of the infections and number of times of their occurrence, is set forth in Table XVI. It will be seen that there is a greater diversity in the types of infection than was present in the stool examinations.

Detailed analyses of the infections observed *post mortem* will be found in subsequent sections.

TABLE XVI.

Tribal Distribution of deceased Natives in whom Intestinal Entozoa were found Post mortem.

Tribe.	Number examined.	Number infected.	No. with Protista only.	No. with Helminthes only.	No. with both.	Single Protist.	Single Helminth.	Double Protist.	Double Helminth.	One Protist and one Helminth.	Multiple Entozoa.
M'Chopi... ...	24	20	3	4	13	1	2	1	1	5	10
Nyambaan ...	19	16	3	1	12	1	—	2	1	1	11
Shangaan ...	18	12	1	5	6	—	3	—	2	3	4
Blantyre... ...	2	2	1	—	1	—	—	1	—	1	—
Moçambique ...	3	2	1	—	1	—	—	1	—	—	1
Tonga	3	2	1	—	1	—	—	—	—	1	1
Bechuana ...	6	4	1	—	3	1	—	—	—	2	1
Msutu	7	5	1	—	4	1	—	—	—	1	3
Basuto	8	4	2	2	—	1	2	1	—	—	—
M'Xosa	5	4	1	—	3	1	—	—	—	1	2
Pondo	5	5	—	3	2	—	3	—	—	2	—
Baca	2	2	—	1	1	—	1	—	—	—	1
Fingo	1	0	—	—	—	—	—	—	—	—	—
Swazi	1	1	—	—	1	—	—	—	—	1	—
TOTALS ...	104	79	15	16	48	6	11	6	4	18	34

XV.—SINGLE PROTIST INFECTIONS OBSERVED *POST MORTEM*.

Infections with a single kind of Protist only were observed in six cases. Three genera—Entamœba, Giardia, and Spirochæta—were represented, and were distributed among six tribes as follows:—

TABLE XVII.

Parasite.	Tribe.	No.
Entamœba coli	M'Xosa	1
	Basuto	1
	Msutu	1
Giardia intestinalis	Nyambaan	1
	Bechuana	1
Spirochæta eurygyrata	M'Chopi	1

XVI.—SINGLE HELMINTHIC INFECTIONS OBSERVED *POST MORTEM*.

Infection with one species of worm only was observed in eleven cases, three genera of worms being represented. The distribution of the parasites is shown in the accompanying table.

TABLE XVIII.

Parasite.	Tribe.	No.
Ascaris lumbricoides	Basuto	2
	Shangaan	1
	M'Chopi	1
Tænia solium	Shangaan	2
Tænia saginata	Pondo	3
	Baca	1
Trichuris trichiura	M'Chopi	1

With the exception of Trichuris, the other parasites had been detected also in the investigations of stools. Although Trichuris was found in all at twenty-two post-mortem examinations (see pp. 30—38), yet one only of the infected men was other than an East Coast Native, the exception being a M'Xosa. This may explain the non-appearance of either Trichuris ova or worms at examinations of stools, as relatively few stools of East Coast Natives were examined.

XVII.—DOUBLE PROTIST INFECTIONS OBSERVED *POST MORTEM.*

Three groups of double Protist infections, distributed among five tribes, were observed in six cases, thus:—

TABLE XIX.

Double Protist Infections.	Tribe.	No.
Entamœba coli and *Giardia intestinalis*	Nyambaan	2
Entamœba coli and *Blastocystis hominis*	Blantyre	1
	Moçambique	1
Entamœba coli and *Spirochæta eurygyrata*	Basuto	1
	M'Chopi	1

The presence of *Giardia intestinalis* was associated with an ulcerated condition of the intestine in each case, and in the inflamed areas it was the only parasite detected.

XVIII.—DOUBLE HELMINTHIC INFECTIONS OBSERVED *POST MORTEM.*

Four cases of infection with two kinds of worms were observed, the men concerned being free from Protista. The parasites present were as follows:—

TABLE XX.

Double Helminthic Infections.	Tribe.	No.
Tænia solium and *Trichuris trichiura*	M'Chopi	1
Tænia saginata and *Trichuris trichiura*	Shangaan	1
Ascaris lumbricoides and *Trichuris trichiura*	Nyambaan	1
Ancylostoma duodenale and *Trichuris trichiura*	Shangaan	1

The case of Ancylostomiasis showed emaciation and anæmia, and the intestine contained large numbers of the parasites. The certified cause of death was Pulmonary Tuberculosis and Silicosis.

XIX.—MIXED DOUBLE INFECTIONS OBSERVED *POST MORTEM*.

Eighteen cases of infection with one Protist and one Helminth were found, seven different associations of the parasites occurring, and ten tribes being represented, as shown in the following table:—

TABLE XXI.

Mixed Double Infections observed Post mortem.

	Combinations of Parasites.		Tribe.	No.
Cestoda and Protista	*Tænia solium*	and *Entamœba coli*	M'Chopi	2
	Tænia saginata	and *Entamœba coli*	Swazi	1
	Tænia saginata	and *Spirochæta eurygyrata*	Pondo	1
Nematoda and Protista	*Ascaris lumbricoides*	and *Entamœba coli*	Pondo	1
			Bechuana	1
			Msutu	1
			Shangaan	2
			Nyambaan	1
			Tonga	1
			M'Chopi	3
	Ascaris lumbricoides	and *Spirochæta eurygyrata*	Bechuana	1
	Trichuris trichiura	and *Entamœba coli*	Shangaan	1
			Blantyre	1
	Trichuris trichiura	and *Giardia intestinalis*	M'Xosa	1

The East Coast Natives, as judged by the distribution of these pure double and mixed double infections, seem very susceptible to worm infections. In some cases the number of worms observed was considerable, *Ascaris lumbricoides*, in particular, occurring in knots and bunches that appeared capable of causing considerable intestinal obstruction in some cases. In other cases as many as twenty heads of *Tænia saginata* have been recovered, both in the case of single, double, and multiple infections. *Trichuris trichiura* was usually found in the cæcum, and in a few cases these parasites (chiefly adults, but some ova) were found in numbers in the vermiform appendix.

XX.—MULTIPLE ENTOZOAL INFECTIONS OBSERVED *POST MORTEM.*

Multiple infections with Entozoa were relatively frequent in intestines of Natives examined *post mortem*. (See Table XVI, last column). The greater number were mixed Entozoa, only two cadavers containing a pure protozoal fauna of three genera, and one of four genera (see Table XXII), and one a multiple pure infection of three Helminths. In the remaining thirty cases, the parasites observed consisted of combinations of two Protists and one worm, one Protist with two worms, two Protists with two worms, three Protists with one worm, three Protists with two worms, four Protists with one worm, two Protists with three worms, and three Protists with three worms. (See pp. 35—38). More than six different genera of animal parasites living within the same intestine were not observed. Tables showing the combinations of parasites and the tribes, members of whom harboured the infections, are appended.

TABLE XXII.

Multiple Protist Infections observed Post mortem.

Combinations of Protista.	Tribe.	No.
Entamœba coli, *Trichomonas intestinalis* and *Spirochæta eurygyrata*	M'Chopi	1
Entamœba coli, *Giardia intestinalis* and *Spirochæta eurygyrata*	Shangaan	1
Entamœba coli, *Giardia intestinalis*, *Trichomonas intestinalis* and *Spirochæta eurygyrata*	M'Chopi	1

Multiple Helminthic Infections observed Post mortem.

One multiple helminthic infection only was observed. A M'Chopi was infected with *Ancylostoma duodenale*, *Ascaris lumbricoides* and *Trichuris trichiura*, the two former worms being numerous. The certified cause of death in this case was Pulmonary Tuberculosis.

Mixed Multiple Infections observed Post mortem.

Mixed multiple infections with Entozoa are perhaps best grouped according to the number of parasites present, three, four, five, and six different organisms thus being noted. The particulars are given in Tables XXIII—XXV, and on p. 38.

Multiple Infections of One Protist and Two Worms.

These infections were observed in nine cases, eight of whom had belonged to East Coast tribes. The frequency of worm infections in East Coast Natives is further emphasised by these results, which are listed in the following table.

TABLE XXIII.

Multiple Infections of One Protist and Two Worms.

Combinations of One Protist and Two Helminths.		Tribe.	No.
Entamœba coli, Tænia saginata	and *Ascaris lumbricoides*	Nyambaan	1
		Shangaan	1
Entamœba coli, Tænia saginata	and *Strongylus stercorea*	Nyambaan	1
Entamœba coli, Schistosoma mansoni	and *Ascaris lumbricoides*	Nyambaan	1
Entamœba coli, Ascaris lumbricoides	and *Trichuris trichiura*	M'Chopi	1
		Nyambaan	1
Giardia intestinalis, Tænia saginata	and *Ascaris lumbricoides*	Nyambaan	1
Giardia intestinalis, Tænia saginata	and *Trichuris trichiura*	Nyambaan	1
Spirochæta eurygyrata, Tænia solium	and *Ascaris lumbricoides*	M'Xosa	1

The infection with *Schistosoma mansoni* was very heavy, the whole of the large intestine being studded with small ulcers and bilharzial nodules, the latter containing both living and calcified ova. The infections with *Giardia intestinalis* showed ulcerative condition of the duodenum due to the flagellates, while the helminthic parasites were found in the ileum and cæcum of the cases respectively.

Multiple Infections of Two Protists and One Worm.

Multiple infections consisting of two Protists and one worm were observed in nine cases, these representing seven tribes. *Entamœba coli* was found in each of these cases, while in three cases parasitic Flagellata, representing three different genera, were present, the sites of intestinal infection showing inflammatory œdema. These mixed infections, with the tribes infested, are summarised in the appended table.

TABLE XXIV.

Multiple Infections of Two Protists and One Worm.

Combinations of Two Protists and one Helminth.	Tribe.	No.
Entamœba coli, *Spirochæta eurygyrata* and *Tænia solium*	M'Chopi	1
Entamœba coli, *Giardia intestinalis* and *Trichuris trichiura*	Moçambique	1
Entamœba coli, *Trichomonas intestinalis* and *Ascaris lumbricoides*	Baca	1
Entamœba coli, *Chilomastix mesnili* and *Ascaris lumbricoides*	M'Chopi	1
Entamœba coli, *Spirochæta eurygyrata* and *Ascaris lumbricoides*	Bechuana	1
	Msutu	1
	Shangaan	1
	Nyambaan	1
Entamœba coli, *Spirochæta eurygyrata* and *Trichuris trichiura*	Shangaan	1

Multiple Infections with Two Protists and Two Helminths.

Multiple infections consisting of two genera of Protozoa and two Helminthes were obtained in four cases. *Entamœba coli*, *Ascaris lumbricoides*, and *Trichuris trichiura* were found in three of the cases, the second Protist differing in different cases, while *Ancylostoma duodenale* was associated with *Trichuris trichiura* in the remaining case. The observations are summarised in Table XXV.

TABLE XXV.

Multiple Infections of Two Protists and Two Helminths.

Combinations of Two Protists and Two Helminths.	Tribe.	No.
Entamœba coli, *Giardia intestinalis*, *Ascaris lumbricoides* and *Trichuris trichiura*	M'Chopi	1
Entamœba coli, *Trichomonas intestinalis*, *Ascaris lumbricoides* and *Trichuris trichiura*	Tonga	1
Entamœba coli, *Spirochæta eurygyrata*, *Ancylostoma duodenale* and *Trichuris trichiura*	M'Chopi	1
Entamœba coli, *Spirochæta eurygyrata*, *Ascaris lumbricoides* and *Trichuris trichiura*	M'Chopi	1

In connection with the case of Trichomonas infection, it is of interest to quote the pathologist's statement that "at the ileo-cæcal junction was a superficial ulcer, with edges slightly raised. The ulceration went through the mucous membrane down to the submucosa." In the ulcer and around it was thick greenish-grey mucus with tiny blood clots where Trichomonas was present. The certified direct cause of death in this case was Pulmonary Tuberculosis.

Multiple Infections with Three Protists and One Helminth.

Two multiple infections with three Protists and one Helminth were found *post mortem*; the Natives concerned belonged to the Transkei and the Transvaal. A M'Xosa harboured *Entamœba coli*, *Giardia intestinalis*, *Spirochæta eurygyrata*, and *Ascaris lumbricoides*, while *Entamœba coli*, *Spirochæta eurygyrata*, *Blastocystis hominis* and *Ascaris lumbricoides* were found in the intestine of a Msutu.

Multiple Infections with Five Entozoa.

Three forms of multiple infections comprising five genera of Entozoa were observed. Two genera of Protozoa were found in one case associated with three genera of Helminthes. Three Protists and two worms occurred in three cases, and four Protists and one worm were found in the intestine of one man. The tribal distribution and combinations of parasites were as follows:—

Two genera of Protozoa and three of Helminthes were present in one Nyambaan. The Protozoa were *Entamœba coli* and *Trichomonas intestinalis*, the Helminthes being *Schistosoma mansoni*, *Ascaris lumbricoides* and *Trichuris trichiura*.

Three different infections of three Protista and two Helminthes were found. One Nyambaan harboured *Entamœba coli*, *Trichomonas hominis*, *Spirochæta eurygyrata*, *Tænia saginata*, and *Ascaris lumbricoides*. Another Nyambaan was infected with *Entamœba coli*, *Spirochæta eurygyrata*, *Blastocystis hominis*, *Ascaris lumbricoides*, and *Trichuris trichiura*. The third case was a M'Chopi whose intestine was parasitised by *Entamœba coli*, *Trichomonas intestinalis*, *Spirochæta eurygyrata*, *Ascaris lumbricoides* and *Trichuris trichiura*.

One infection only of four Protista and one Helminth was detected, a Msutu being parasitised by *Entamœba coli*, *Trichomonas intestinalis*, *Spirochæta eurygyrata*, *Blastocystis hominis* and *Ascaris lumbricoides*.

The prevalence of helminthic infections among East Coast Natives is again noticeable.

Multiple Infection with Six Entozoa.

The presence of six Entozoa at the same time has only been observed once, when the intestine of a Nyambaan contained three Protists and three Helminths. The parasites were *Entamœba coli*, *Giardia intestinalis*, *Spirochæta eurygyrata*, *Tænia solium*, *Ascaris lumbricoides* and *Trichuris trichiura*.

At each point where Giardia were present other Protozoa were absent, as were also Helminthes, and these areas, in the words of one of the pathologists who kindly examined them for me, showed "inflammatory œdema."

XXI.—GENERAL REMARKS RELATIVE MORE ESPECIALLY TO THE PRESENCE OF THE ENTOZOA DETECTED *POST MORTEM.*

In connection with the post-mortem examinations, about two-thirds of the Natives examined were East Coast boys, who form a large part (more than one-third) of the mine population of the Witwatersrand, and who seem recently to be more noticeable among the household servants than they were a relatively short time ago. Their cases, therefore, need more consideration than may appear at first sight, since it appears that there is an increase in the intimate relation of these Natives with South African households.

There is one obvious conclusion from the examination of the tables presented previously. The condition of parasitism is very prevalent among Natives. So prevalent is it, that a condition of mutual tolerance has often become established between the native host and the infecting organisms. The result of this tolerance is that, while the native host either may suffer little inconvenience personally or undergo intestinal disorders only at intervals, he becomes a potentially dangerous nuisance to non-immune hosts, and a disseminating centre for a number of gastro-intestinal troubles as a result of his promiscuous habits. An examination of the veldt in the vicinity of buildings in the course of erection will show only too readily the presence of human excrement. I collected a number of such samples for laboratory examinations and found chains of tapeworm proglottides, eggs of nematodes, cysts of various flagellates such as Giardia and Chilomastix, and on certain occasions—depending on the freshness of the stool—living Trichomonads, while I have also found cysts of *Entamœba histolytica* in such promiscuous evacuations. The excrement often swarmed with flies, and it is an established fact that certain worm eggs and numerous protozoal cysts can pass unchanged through the bodies of flies, whence they can easily reach food or water intended for human consumption. Samples obtained from shallow surface waters and spruits in certain localities have been found in the course of my examinations to be contaminated with cysts of flagellates, as well as with ova of Helminthes, and may thus serve as a source of infection both to man and to domestic animals. Also, in certain cases of infantile diarrhœa observed among Natives in the Johannesburg Hospital, I was able to obtain samples of the water used previously by the parents in preparing the food of the infants, and in several such samples there were flagellates (Trichomonas and Giardia) identical with those present in the motions of the children. Clean rats, whose food was mixed with this contaminated water, contracted flagellate diarrhœa and passed large numbers of the parasites in the fæces. Domestic vermin, such as rats and mice, and pests, such as cockroaches (see Sections X and XXIII, pp. 18 and 51) and flies, are additional agents or sources for the transference of parasitic diseases from man to man.

In this connection mention may be made of the use of night-soil for the purpose of soil fertilisation. Certain market gardeners, supplying their produce to the town, but living outside the Municipal boundary, use this material extensively, and not only is it emulsified and applied to the roots of plants, but a supply is sprinkled on the leaves of green vegetables such as lettuce. I have been able to recover cysts of parasitic flagellates (Giardia and Chilomastix) from lettuce leaves grown under the conditions just described. The cysts were mature and had not degenerated, and were fully capable of producing infection in the alimentary tract of man. As a matter of fact, in one case a persistent diarrhœa, due to *Giardia (Lamblia) intestinalis*, was traced to the consumption of such seemingly clean, but really contaminated, lettuce leaves. Great care, therefore, is necessary in the use of all salad food. The source of supply of such parasites is in the majority of cases to be found in the evacuations of Natives, and the number of infections found in stools and in the intestine itself examined *post mortem* shows, not only the frequency of their occurrence, but also their wide distribution among various tribes, the number of cases among the East Coast boys predominating.

The presence of numerous worms detected at post-mortem examinations also calls for attention. The presence of tapeworms and nematodes in human beings can be productive of bodily weakness, particularly among children. The commoner tapeworms, *Tænia saginata* from the ox and *Tænia solium* from the pig, seem very prevalent, and as many as twenty heads of *T. saginata* have been recovered from a single intestine. Such massive infection not only has its effects on the individual, but also shows the great possibilities of infection of cattle and antelopes and other game from pasture contaminated with the ova or segments of tapeworms derived from human sources. It also points to the necessity for *thorough* cooking of all animal food, and for the prevention of the access of animals used for food to garbage and excrement. The association of white children with native nurses who may be infected with Helminthes should also be strictly supervised and regulated.

XXII.—DIAGNOSTIC FEATURES OF THE ENTOZOA MENTIONED.

The diagnostic features of the various Entozoa mentioned in this paper are to be found in various standard works dealing with parasitology, such as "The Animal Parasites of Man," by Fantham, Stephens and Theobald, and "Manual of Tropical Medicine," by Castellani and Chalmers. As such books are not always available to South African practitioners and Medical Officers of Health, by request notes are appended here of the diagnostic features of the Entozoa more commonly encountered among the Natives of the Witwatersrand. The parasitic Protozoa will be first dealt with, and then the parasitic

Helminthes listed in the earlier part of this report. I wish to tender my hearty thanks to Professor H. B. Fantham for the use of his excellent illustrations of Protozoa, appearing on Plate I.

(I.) *Diagnostic Features of the Parasitic Protozoa mentioned in this paper.*

A.—*Parasitic Sarcodina.*

Entamœba histolytica and *Entamœba coli* are the organisms of this group that are represented.

Entamœba histolytica (Plate I, Figs. 1, 2), the causal agent of amœbic dysentery, is polymorphic. It occurs in freshly voided stools containing mucus, which stools are often blood-stained. Actively motile Entamœbæ move by the protrusion of processes (pseudopodia) of ectoplasm. The endoplasm is granular, and may contain red blood corpuscles, which are useful aids in the identification of *E. histolytica*. In acute cases, the motile feeding trophozoites are large, and the nucleus is often pale-staining in permanent preparations. A slightly smaller form of trophozoite, formerly termed *E. tetragena*, is found in subacute cases, and has a characteristic nucleus with a karyosome and centriole (Plate I, Fig. 1). The small precyst generation of trophozoites was formerly separately styled *E. minuta*. Multiplication is by binary fission, and occasionally by schizogony into four daughter forms.

Under favourable conditions encystment occurs; the round cysts (Fig. 2) produced measure about 10μ to 15μ in diameter, and have thin walls, though small strains with cysts varying from 7μ to 10μ in diameter are known. At first the cysts are uninucleate, but division into two, and finally four, occurs. In addition to the four nuclei, one or more dark staining masses, often termed "chromatoid" or "siderophile" bodies, are usually present in the cyst.

The transmission of *Entamœba histolytica* from man to man is usually brought about by the contamination of food or water with the infective cysts. The contamination may be direct, from excrement or sewage, or the cysts may be ingested by flies, passed unchanged through the bodies of the insects, and then be voided on fruit, milk, vegetable or other food. The "carrier" of amœbic dysentery, having become relatively immune for the time to the action of the parasite, is all the more dangerous to the community at large, and is also liable to severe recurrences of dysentery, should his general condition of vitality become lowered.

Entamœba coli (Plate I, Fig. 3), also parasitic in the human intestine, might be confused with *E. histolytica*. It is not pathogenic in its action, but multiplies more rapidly in a diseased than in a healthy intestine. The trophozoite is large, has a large round nucleus containing a fairly large karyosome, but no marked centriole. Its cysts, when mature, are double-walled, measure about 15μ to 20μ in diameter, and occasionally a diameter of 30μ is attained. Chromatoid masses as a rule are absent from the cyst of *E. coli*, which contains eight nuclei when fully mature.

"*Free-living*" *Amœbæ*, such as *A. limax*, are occasionally found in human stools or in the human intestine. They are normally found in earth, or on vegetable matter, and are to be regarded, in the main, as temporary passengers in the human alimentary tract. The trophozoite stage is often large and vacuolated, while the nucleus has a large central karyosome. These amœbæ are sometimes placed in a separate genus, *Vahlkampfia*.

B.—*Parasitic Mastigophora.*

This large group includes the organisms, found in the intestine of man, which are responsible for flagellate diarrhœas, as well as others not yet definitely inculpated as possessing pathogenic properties.

Giardia (*Lamblia*) *intestinalis* (Plate I, Figs. 4, 5) has a definitely pathogenic action, as has been ascertained by animal experiments by Fantham and Porter (1916), as well as by numerous examinations of the human intestine *post mortem*. The flagellate form (Fig. 4) is an actively motile, pear-shaped, bilaterally symmetrical Protozoön, being leaf-like and pear-shaped when seen from above, and resembling a gondola when seen *en profile*. A large, concave sucking disc or cytostome is present on the under surface, and serves to attach the parasite to the intestinal epithelial cells, especially those of the duodenum. A central supporting rod or axostyle is present. Two large karyosomatic nuclei also are present, and two parabasal bodies are situated about the middle of the length of the axostyle. Four pairs of flagella occur, each flagellum having a small basal granule at its base. Two pairs of flagella are connected with the sucking disc, while the median ventral pair, which are the most active and prominent, originate near the axostyle below the cytostome, and the fourth pair form the terminal flagella. The organism is from 10μ to 21μ long, and from 5μ to 12μ broad. Multiplication by binary longitudinal and by multiple fission occurs in the flagellate stage. Resistant oval cysts, about 10μ to 15μ long, and 7μ to 9μ broad, ultimately containing four nuclei, the remains of the axostyle and the parabasal bodies, are produced (Fig. 5), and these constitute the infective stage, serving for the transmission of the parasite to new hosts.

Infection takes place by way of contaminated food and drink. Rats, mice, and cats can act as reservoirs of lambliasis, their excrement containing numerous cysts, while I have proved experimentally that the cysts can pass unharmed through the bodies of house-flies, blow-flies, and cockroaches, and are capable of re-infecting man.

Trichomonas hominis or *Trichomonas intestinalis* (Plate I, Fig. 6) is a pear-shaped organism with three free anterior flagella and an undulating membrane bordered by the lateral flagellum. An axostyle is present, and a large nucleus can be seen. The flagellate measures 10μ to 15μ by 5μ to 10μ. Rounded, contracted forms of the parasite live a relatively long time in moist fæces. Food and water contaminated by infected human excrement, or by parasitised rats and mice, are the chief sources of infection.

Chilomastix mesnili (Plate I, Figs. 7, 8 and 9) is a pear-shaped organism allied to Trichomonas, but possessing a large cytostome about half the length of the body. Three anterior flagella are present, and a fourth, perhaps attached to a rudimentary undulating membrane, vibrates in the cytostome (Fig. 7). The flagellate measures about 14μ by 7μ. There is no axostyle. Encystment occurs, oval and lemon-shaped cysts (Figs. 8, 9) being produced. These are 7μ to 10μ long, and in addition to the nucleus the cytostome and vestiges of the flagella are found within the cyst. A vacuole containing a substance of the nature of glycogen may also be present. The cysts serve for transmission of the parasite by way of food and drink, and flies also act as transmitters.

Cercomonas parva (Plate I, Figs. 10, 11). A flagellate identical morphologically with *Cercomonas parva* was seen on several occasions. It agrees with the original description of *C. parva* given by Hartmann and Chagas (1910) from a case in South America, and with that of the same organism as observed by Fantham and Porter in cases from Gallipoli and Egypt. The presence of the organism in areas so diverse indicates it as a long-established parasite of man. The organism is pear-shaped, the body measuring 5μ to 20μ in length and 3μ to 5μ broad. A flagellum is present that traverses the length of the body and extends beyond it at both extremities. A single nucleus is present. Small, rounded cysts are produced, these being uninucleate (Fig. 11).

Prowazekia cruzi (Plate I, Figs. 12, 13) is a pear-shaped flagellate possessing two flagella, one anterior and one lateral trailing flagellum. The nucleus is large and round. A blepharoplast is present, and, near to it, the flagella originate from two contiguous basal granules, which often appear as one. The flagellate forms are polymorphic, a few being more or less sausage-shaped, others pear-shaped, and yet others rounded. The organisms possess a slight cytostome. The oval and pear-shaped forms measure 8μ to 12μ long, and they and the round forms are about 5μ broad. The few sausage-shaped forms seen by me measured about 12μ long and 5μ broad. Multiplication is by binary fission. Encystment occurs, the round or oval cysts measuring 5μ to 7μ in diameter (Fig. 13).

Bodo stercoralis, n. sp. (Plate I, Fig. 19). This organism is recorded from human fæces for the first time, so far as is known. The genus Bodo differs from Prowazekia in possessing no blepharoplast. *Bodo stercoralis* closely resembles *Prowazekia cruzi*, but has no blepharoplast, and the cytostome is shallow and inconspicuous. The body measures from 14μ to 19μ long and is from 6μ to 9μ broad. The nucleus is large with a distinct karyosome and well-marked nuclear membrane, on which six chromatoid granules are often deposited. Two small basal granules are present, from which the flagella originate.

The anterior flagellum is relatively stiff, the postero-lateral one is trailing and executes lashing movements. The postero-lateral flagellum is about as long again as the body. Oval cysts, about 6μ long by 5μ broad, each containing a nucleus of similar structure to that of the flagellate, are produced. This flagellate organism may possibly be connected with *Blastocystis hominis* (see below).

Spirochæta eurygyrata (Plate I, Fig. 14). This organism, as already noted by Fantham (1915, 1917), seems to be more numerous in a diseased than in a healthy intestine. The spirochæte has tapering ends, measures up to 15μ long, is about $0{\cdot}25\mu$ broad, and exhibits morphological variation. The number of its coils or waves varies with the rate of progression and the thickness of the organism. Resistant coccoid bodies are formed by *S. eurygyrata* and serve for the transmission of the parasite. The Spirochætes are not strictly Mastigophora, but form a group of their own, the Spirochætacea. They are considered here for convenience only.

Blastocystis hominis (Plate I, Figs. 15, 16), according to Alexeieff (1911), Brumpt (1912), and most workers, is of fungoid origin. The parasite appears as shining spheres, varying in diameter from 2μ to 15μ, which at first are uninucleate, with a film of cytoplasm surrounding a large vacuole. Binucleate stages are frequently seen (Fig. 15), as well as dividing forms (Fig. 16). At times, multinucleate forms are present, and still more rarely cysts containing numerous daughter spheres are found. Recently (1917) Chatton has stated that a Blastocystis which he has studied in geckos is a stage of a flagellate organism, having affinities with Bodo.

C.—*Parasitic Sporozoa.*

The chief Sporozoa parasitic in the human intestine are members of the Coccidiidea, namely, *Eimeria stiedæ* and *Isospora bigemina* var. *hominis*. Of these two organisms I have found Isospora both in stools and at post-mortem examinations. It is probable that *Eimeria stiedæ* will also be found parasitic in man in South Africa, as it is a fairly frequent parasite of the intestine and liver of rabbits here, among which it causes epizoötics.

Isospora bigemina var. *hominis* undergoes multiplication and sexual reproduction in the mucosa of the small intestine, the ileum often being most heavily infected. Sexual reproduction results in the formation of the infective oöcysts, which are voided with the fæces, and reach man by way of contaminated food or drink. These oöcysts (Plate I, Fig. 17) are somewhat lemon-shaped, are thin-walled, and are relatively frail in appearance. They measure 23μ to 33μ long, and are 11μ to 15μ broad. Each oöcyst, when mature, contains two oval sporocysts, 10μ to 13μ long by 8μ to 10μ broad. Four sporozoites differentiate within each sporocyst, and are grouped around a large residual mass. When such oöcysts are ingested by man, the sporozoites are liberated as small, vermicular bodies in the small intestine. They rapidly penetrate the epithelial cells in the jejunum and ileum, become round, and grow at the expense of the host cell, thus becoming trophozoites. After a time asexual reproduction commences, 15 to 20 merozoites being produced from one schizont, and much epithelial destruction results. Schizogony is followed by gametogony, and after the union of the sexual elements, sporogony occurs. The infective oöcysts and sometimes epithelial cells containing trophozoites or schizonts are found in fæces and serve for diagnosis. I have proved experimentally that the oöcysts can pass unharmed through the alimentary canals of the house-fly, *Musca domestica*, and the green-bottles, *Lucilia caesar* and *L. serenissima*, which thus may act as carriers of Isospora.

Eimeria stiedæ (Plate I, Fig. 18), normally a parasite of hares and rabbits, is occasionally found in man. The oöcysts are oval, varying from 24μ to 49μ in length, and from 12μ to 28μ in breadth. Each oöcyst produces four sporocysts and each sporocyst contains two sporozoites. The life-history is similar to that of Isospora, and the infective oöcysts are diagnostic.

(II.) *Diagnostic Features of the Parasitic Helminthes mentioned in this paper.*

Since members of the Trematoda, Cestoda, and Nematoda have all been identified in the contents of the human intestine, they may be considered in the above zoological order.

A.—*Parasitic Trematoda.*

One genus of Trematoda has been detected in stools and in the human intestine, the parasite, *Schistosoma* (*Bilharzia*) *mansoni*, being first found in the form of the typical lateral-spined eggs or ova (Plate II, Fig. 8). At times portions of the adult worms were also found in fæces. The ova are oval, the lateral spine being situated nearer one pole of the body. The ova measure from 110μ to 165μ in length, and are from 60μ to 70μ broad. Mature living ova contain active miracidia, and when the ova are placed in warm water on a slide and examined under the microscope the miracidia show active vibrations of their cilia, and eventually force their way out of the eggs. A mature egg, as recovered from fæces, is shown on Plate II, Fig. 8. The adult worms are rarely found except at post-mortem examinations. Sometimes terminal spined eggs of *Schistosoma hæmatobium* (Plate II, Fig. 7) are found in fæces which have been contaminated with urine.

B.—*Parasitic Cestoda.*

Three forms of Cestoda are noted in this report, and they constitute some of the most widely distributed tapeworms. The pork tapeworm, *Tænia solium*, and the beef tapeworm, *Tænia saginata*, are probably better known than *Hymenolepis nana*, the cysticercus of which probably will be found in some insect such as a flea, while the adult tapeworm is very probably primarily a parasite of rats and mice.

Tænia solium and *Tænia saginata* may be detected as either scolices (" heads "), proglottides (segments), or as embryophores containing onchospheres (six-hooked embryos), incorrectly called eggs. The head in each worm has four cup-like suckers, and the segments measure from 9 to 35 mm. in length. The genital pores are lateral, and there is a median uterus with lateral branches.

Tænia solium (Plate II, Figs. 1, 4, 9).—The worm, when entire, measures usually 2 to 3 metres in length, but occasionally longer specimens occur.

The head or scolex is quadrangular, about one millimetre in diameter (Plate II, Fig. 1). It has a rostrum which bears two circlets of from 25 to 50 hooklets, one ring of which measures 160μ to 180μ, and the other 110μ to 140μ. The four suckers are rounded and conspicuous. The neck is fairly long and thin. The number of proglottides varies from 800 to 900.

The proglottides vary in size according to their position and age. Segments near the head are much broader than they are long, and about three feet from the scolex the length and breadth are equal, while after that they are longer than they are broad. The genital pores alternate fairly regularly. Sexually mature segments, after clearing, show the uterus with few, usually 7 to 10, lateral branches, these being often dendriform (Plate II, Fig. 4). Segments sufficiently mature for detachment are from 10 to 12 mm. long, and from 5 to 6 mm. broad. The mature segments often escape in chains, and do not exhibit active movements like those of *Tænia saginata*.

The " ova," really embryophores (Plate II, Fig. 9), are spherical, with a radially striated shell. Each measures 31μ to 36μ in diameter, and the onchosphere or hexacanth embryo, which is provided with six hooklets, is also spherical and is about 20μ in diameter.

Tænia saginata (Plate II, Figs. 2, 5, 10), the beef tapeworm, is larger than *T. solium*. It measures from 4 to 10 metres in length.

The head is pyriform to cubical in shape, and has neither rostrum nor hooks; it is 1 to 2 mm. in diameter. The suckers are hemispherical and are often pigmented. A small sucker-like organ replaces the rostellum (Plate II, Fig. 2).

The neck is long and about half the breadth of the head.

The proglottides number about 1,000, and are about 16 mm. to 20 mm. long by 4 mm. to 7 mm. broad when mature enough for detachment. They have been compared in appearance with melon and pumpkin seeds. The genital pores alternate fairly regularly. The uterine branches are numerous, 20 to 30 being present in a segment, and usually show dichotomy (Plate II, Fig. 5).

The embryophores are ovoid, 30μ to 40μ long by 20μ to 30μ broad (Plate II, Fig. 10). The shell is somewhat more transparent than that of *T. solium*, and the onchosphere has the three pairs of hooks sometimes diverging somewhat more widely than those of *T. solium*. However, in actual practice, it is not easy to distinguish between the embryophores of *T. solium* and *T. saginata*.

Hymenolepis nana (Plate II, Figs. 3, 6, 11) is a smaller tapeworm of man, being usually from 10 mm. to 40 mm. long and from 0·5 mm. to 0·9 mm. broad.

The head has a short, thick retractile rostrum, furnished with a single circle of 20 to 30 hooklets (Plate II, Fig. 3). The conspicuous suckers are about 0·08 mm. in diameter.

The proglottides are about 200 in number and are very narrow. They are from 0·4 mm. to 0·9 mm. in breadth and 0·14 mm. to 0·3 mm. in length. The genital pores are unilateral and marginal. The sexually mature segments contain three testes (a diagnostic feature), with a single vesicula seminalis, a branched ovary beneath which is a vitelline gland, and a large simple vagina (Plate II, Fig. 6).

The "eggs," or embryophores, are globular or oval with two distinct membranes, one of which is an uterine shell (Plate II, Fig. 11). The outer dimensions are 30μ to 60μ, the inner 16μ to 34μ. A mammillate projection may be present at each pole.

C.—*Parasitic Nematoda.*

The principal parasitic Nematoda observed in the stools or intestines of Natives are *Ancylostoma duodenale*, *Ascaris lumbricoides*, and *Trichuris trichiura*. I have also found *Oxyuris vermicularis* on one occasion.

Ancylostoma duodenale, or "hookworm," one of the chief causal agents of tropical anæmia, is a round worm with a cylindrical body tapering to the head. The anterior extremity is curved towards the dorsal surface of the body. The mouth is large and round, and two pairs of hook-like teeth are present on the ventral margin, and there is a small pair on the dorsal surface of the mouth. Two ventral chitinous plates are present in the floor of the mouth, and there is a prominent projection due to the opening of the dorsal head gland, this prominence being sometimes termed a tooth. Both male and female agree in the above particulars.

The male Ancylostoma is about 8 mm. to 11 mm. long by 0·4 mm. to 0·5 mm. broad. It has a bursa copulatrix at the posterior end, the bursa being umbrella-shaped and supported by chitinous rods. These rods or costæ are characteristic in their arrangement. In the median dorsal line is the dorsal costa, which bifurcates into two, each of which is trifid. Posterolaterally one root passes out, the single costa dorsalis externa. In front of the costa dorsalis externa is a broad root with three branches, these being termed the costa lateralis posterior, costa lateralis media, and costa lateralis externa respectively. The ventral portion of the bursa is supported by the bifid costa ventralis on each side. Two long copulatory spicules project through the opening of the bursa. They may be as much as 2 mm. in length. The testis is tubular, the vesicula seminalis is oval, and a long cement gland is present.

The female Ancylostoma is about 12 mm. long, and the body ends posteriorly in a spike which may be broken off. The vagina opens about 1 mm. behind the middle of the length of the body. Two long tubular bodies uniting to form a single vagina constitute the female reproductive organs. The ovaries form oblique coils, and each is thickened at its distal end to form a uterus, the oviduct lying between the ovary and the uterus. The part of the uterus continuous with the oviduct acts as a seminal receptacle. The eggs or ova are oval, and thin shelled, the shell appearing to be single (Plate II, Fig. 12), though it is really double in contour. The eggs are about 60μ long by 40μ broad, and as found in freshly shed fæces show 2 to 4 blastomeres, as a rule. Larvæ are found only in eggs from old fæces, but at a temperature of from 25° C. to 30° C. an embryo is developed in about 48 hours.

For diagnostic purposes, slightly developed eggs are to be sought in fresh stools prior to treatment, eggs containing embryos are found in stools that have been kept, but the embryos are not so far developed as those of *Strongyloides stercoralis*, with which they might be confused. The Ancylostomes themselves are usually recovered from the fæces after treatment of the patient with thymol.

Infection occurs by way of contaminated soil. A rhabditiform larva issues from the egg, and after an ecdysis or moulting alters somewhat in structure and becomes the resistant, infective, filariform larva, which forms a new skin beneath the old one, but retains the old one as a loose covering. This filariform larva pierces the skin of man and ultimately finds its way to the alimentary tract, especially the jejunum, where development into the adult worm subsequently occurs.

Ascaris lumbricoides, or round worm of man. These worms are large. The males measure from 15 to 17 or even 25 cm. long, and the females may attain a length of 40 cm., though most are about 25 cm. long. The body varies in colour from greyish yellow to reddish yellow, has a striated cuticle, and is capable of considerable extension due to its elasticity. Two well-marked lateral lines are present. The head is small and has three oral papillæ or lips, which are finely denticulate. The dorsal papilla bears two sensory papillæ, and the other two papillæ each have one sensory papilla.

The male Ascaris has a curved posterior extremity provided with two marked spicules, each about 2 mm. long. The cloacal orifice is provided with 70 to 75 papillæ, seven pairs being post-anal.

The female has convoluted ovaries, and the genital aperture is in the anterior third of the body. The posterior end of the body is relatively straight and without spicules.

The eggs or ova (Plate II, Fig. 13) are elliptical, with a thick, transparent shell, which, in the case of the freshly laid egg, is invested with a gelatinous or albuminous coat forming a series of wave-like protuberances, and may be bile-stained. The ova measure 50μ to 75μ long, and are from 40μ to 55μ broad. The ova when freshly deposited are unsegmented. The albuminous coat disappears on keeping the stool.

Trichuris trichiura, the "whip-worm," is a small worm having the anterior part of the body very long and thread-like, while the posterior part is much thicker, that of the male being spirally coiled. The anus is posterior.

The male measures from 35 mm. to 45 mm. long, and has a spicule about 2·5 mm. long, surrounded by a retractile sheath possessing numerous minute spicules.

The female measures 35 mm. to 50 mm. long, the anterior filiform portion of the body being about two-fifths of the total length.

The eggs or ova have a characteristic barrel-shaped or "tea-tray" contour, the thick shell being brownish in colour and perforated at the poles (Plate II, Fig. 14). The perforations are each closed by a light-coloured plug, and the egg covering then resembles a tea-tray in shape. The ova, as found in fresh fæces, have undifferentiated contents. The ova measure on the average 50μ long by 23μ broad.

Oxyuris vermicularis, or "seat-worm," is white in colour, having a striated cuticle which projects outwards from the anterior part of the body as flanges in the mid-dorsal and mid-ventral lines, lateral flanges also being produced. The mouth possesses three small retractile labial papillæ.

The male Oxyuris is small, measuring 2 mm. to 5 mm. long. The posterior end of the body is curved and shows six papillæ. A hook-like spicule 70μ long is present.

The female is larger, measuring up to 10 mm. in length. The vulva is situated in the anterior third of the body. The anus is about 2 mm. from the tip of the tail.

The eggs or ova are oval, asymmetric, with double contoured though rather thin walls (Plate II, Fig. 15). They measure 50μ to 55μ by 16μ to 25μ. When fresh, they contain clear, tadpole-like embryos, which become coiled and nematode-like later. The ova escape per anum, and are usually re-introduced into the host or conveyed to new hosts by the fingers, which become contaminated by scratching. Adult worms can also escape per anum, and are capable of re-infecting man.

XXIII.—ON THE EXISTENCE OF A "NORMAL" PROTISTAN FAUNA OF THE HUMAN INTESTINE.

The use of analogy is a dangerous procedure. Recently, possibly from motives of expediency, it has been alleged by Wenyon (1917) that a "normal protozoal fauna" of the human intestine exists because a bacterial flora has been recognised, which has been considered both non-pathogenic and universal. It is overlooked that the life processes of bacteria—many "bacteria" of a few years ago are now proved to be fungoid in nature—are of a very different character from those of animals. The conditions under which many bacteria live are totally repellent to animal life, and the environment of the culture, in which many bacteria flourish exceedingly, often proves fatal to a Protozoön introduced therein.

Again, because flagellates have been found in the stools of patients not obviously suffering from intestinal affections, that is, in " carrier " cases, it is unwarranted to conclude that such flagellates are harmless. The effects of mass reactions always need consideration, and while the effect of a few organisms may be very slight, the consequences of their vigorous multiplication may be serious. It is unsound to ignore the presence of any unicellular organism that is dependent for its nourishment on the intestinal contents or the tissues of the body of man; more especially is this so in the cases of certain of them when their pathogenicity has been established, not from morphological considerations alone (as has apparently been inferred by Wenyon), but from a series of animal experiments, details of which were published in the *British Medical Journal* of July 29, 1916, which evidence, easily accessible in Egypt, has been ignored.

It is one thing to allege dogmatically that a natural intestinal fauna exists, but quite another thing either to prove such a hypothesis or to produce definite evidence in support of such a statement. From a consideration of the Protista found in many thousands of stools of Europeans examined in England, as well as those of the Natives detailed in this report, it seems to me that of all the Protist organisms found in the human intestine, two only can be regarded as of general occurrence, namely, *Entamœba coli and Spirochæta eurygyrata.* Even in these cases, in which a certain degree of mutual tolerance between host and parasite has been established, the presence of the organisms in large numbers serves as an indication of a more or less diseased condition of the alimentary tract. Such organisms as *Blastocystis hominis* have been regarded by some as so harmless that their presence can be totally disregarded. The evidence on which such an assumption rests is extremely scanty, and the frequent association of these organisms with stools of abnormal consistencies, odours, and reactions needs further investigation.

Other parasitic organisms such as *Giardia intestinalis*, *Trichomonas hominis*, and *Chilomastix mesnili* are definitely known to be pathogenic in their action. The work of Escomel (1913, 1917), Mello Leitao (1913), and others in South America, of Lynch (1915) in the United States, of Mathis (1914) and of Noc (1909) in Tonkin, of Chalmers and Pekkola (1918) in Khartoum, of Brumpt (1912) in France, and of Fantham and Porter (1916) in England, among others, has firmly established that these organisms can, and do, produce intestinal disorders that are sufficiently distressing and debilitating to warrant careful attention. The present work has shown that in no case were these flagellates detected in men whose motions were absolutely normal, and that in every case in which these parasites were discovered *post mortem*, inflammatory œdema was manifested, and in some cases definite ulcers with overhanging margins had been produced. As a special memoir on flagellate diarrhœas is in course of preparation, the subject need not be pursued further here, but it is certain that to regard *Giardia*, *Trichomonas*, and *Chilomastix* as " normal " inhabitants of the human intestinal tract is both inaccurate and misleading. There is no doubt that the original source of these intestinal flagellates is to be found in parasites of domestic vermin, such as rats and mice, by whose infected excrement human food and drink are contaminated. Such an origin has been established by the work of many investigators in Italy, France, England, Tonkin, and many parts of South America. I can add to the list of hosts usually implicated in the transference of *Giardia intestinalis*, *Trichomonas intestinalis* and *Chilomastix mesnili* to human food those common pests of kitchens, the cockroaches, frequently found in bakehouses and similar establishments. By allowing these insects access to infected excrement and collecting and examining the fæcal masses voided by them, I have ascertained that they could ingest the cysts of these flagellate Protozoa, and that the latter passed unchanged through their bodies. The said cysts when fed to white rats with bread caused the rodents to contract a flagellate diarrhœa, and from the fæcal pellets of the rodents cysts again were recovered. Thus, cysts of Giardia, Trichomonas, and Chilomastix originally derived from man were transferred successively from man to the cockroach, thence to the rat, whence by way of contamination of cereal food by the fæces of the prowling rat, the parasite could again reach man.

The route of the flagellates associated with diarrhœa can also be a direct one, cysts from an infected person reaching another by way of sewage-contaminated water, or vegetable food similarly fouled. The effects of the parasites on the hosts are hardly consistent with normal conditions, nor can the parasites be considered normal occupants of the human intestine.

The widespread occurrence of Helminthes among Natives contributing to the Johannesburg population has been shown both by Dr. Turner's investigations (1910) and by my present results. It has been well established that such worms are harmful, and I do not think that anyone would venture to designate *Tænia solium*, *Ancylostoma duodenale* or *Schistosoma mansoni* as factors of a " normal " fauna of the human intestine. Since such fallacious statements are not applied to the Helminthes found in man, there is no reason why they should be applied to the Protista found in the body of man. Harmony between host and parasite may become established, but as soon as anything occurs to interfere in any degree with the balance thus established, the mutual tolerance breaks down, the true nature of the Protist asserts itself, the reaction on the part of the host is temporarily insufficient to re-establish the balance of power, and pathogenicity becomes apparent. The seemingly harmless " passenger " Protist under normal health conditions can become the virulent parasite under conditions somewhat removed from the normal.

Thus, it seems highly probable that a protozoal fauna of the human intestine, that is in any way comparable with the bacterial flora of that organ, does not exist except perhaps in the very limited form provided by *Entamœba coli* and *Spirochœta eurygyrata*; and, as before mentioned, large numbers of these organisms are an indication of intestinal disorder, and hence strictly cannot be regarded as normal.

XXIV.—GENERAL CONCLUSIONS.

The native population of the Johannesburg area is very heterogeneous in character, the chief contributing areas from which its fluctuating constituents are derived being the East Coast, Cape Province, the Transvaal, Basutoland and Natal. Among all these Natives endoparasitic infestation is common, both Protozoa and Helminthes being represented.

Infections with one, two or more Entozoa occur. Six kinds of parasitic organisms have been found simultaneously in a single intestine. Protista are common, but being microscopic are more easily overlooked than the larger, obvious helminthic parasites. Nevertheless, the mass action of minute Protozoa may be more serious in their effects on the host than the larger and obvious helminthic parasites.

The parasitic Protozoa of known pathogenic action that have been detected in the stools of Natives and of a few Europeans in Johannesburg include *Entamœba histolytica*, the excitant of amœbic dysentery; *Giardia intestinalis*, *Trichomonas intestinalis*, and *Chilomastix mesnili*, which are associated with various flagellate diarrhœas; and *Isospora bigemina* var. *hominis*, which can cause coccidial diarrhœa.

In a few cases, rarer parasites have been observed. These include species of Prowazekia, Bodo and Cercomonas, often considered not to be pathogenic, and " free-living " Amœbæ, which latter are transient occupants of the intestinal tract, their normal habitat being earth or vegetation.

Entamœba coli and *Spirochœta eurygyrata* are very widely distributed parasites, have long been habituated to life in the human intestine, and a state of mutual harmony more or less exists between them and their hosts. Nevertheless, it has been found that these parasites multiply more abundantly in an unhealthy intestine than they do in a normal one, and their presence in large numbers may serve as an indication of intestinal disorder.

The number of infections with *Entamœba histolytica* that have been observed can be considered as some index of the number of sporadic cases normally present among a population living under normal conditions, and indicate also the possibilities of amœbic dysentery occurring in epidemic form, should conditions of living lower the standard of health now prevailing. Under less favourable conditions of living, diseases now relatively quiescent and sporadic tend to become fulminating and epidemic. The main modes of transmission of *E. histolytica* to man are by direct infection of food and water, and by indirect infection by way of flies. Carriers of cysts are serious sources of danger or potential danger to those persons with whom they associate.

The same remarks apply to the wide tribal distribution of such parasitic Flagellata as *Giardia intestinalis*, *Trichomonas intestinalis*, and *Chilomastix mesnili*. Each of these organisms is capable of producing flagellate diarrhœa, and also each is difficult of elimination from the alimentary tract when it has once become established there.

Distressing diarrhœa in adults, and some forms of "green" or "infantile" diarrhœa in children, in Johannesburg, have been traced to the presence of these parasites, and with their elimination under suitable treatment the diarrhœa has ceased. Post-mortem examinations of Natives and of subinoculated animals have established their pathogenic action, and it seems probable that many obscure intestinal troubles that are difficult of elimination may be due to these organisms. Natural reservoirs of these flagellates are found in such domestic vermin as rats, mice and cockroaches, whose infected excrement in cereal and farinaceous food is one source of infection, the cysts voided with human fæces which contaminate food being the other.

Sporozoa, such as *Isospora bigemina* var. *hominis*, have been proved to be pathogenic to laboratory animals such as cats and white rats, in which they may excite marked enteritis, sometimes with fatal results. In man, though they do not always produce acute symptoms, they have been found in conditions of severe diarrhœa, blood and mucus being present in the evacuations, as I have myself observed. The oöcysts pass unchanged through the alimentary canals of the house-fly, *Musca domestica*, and the green-bottles, *Lucilia cæsar* and *Lucilia serenissima*, which consequently may act as carriers of Isospora. Cats and rats may also act as reservoirs.

The danger of the promiscuous habits of some of the Natives, whose evacuations are so deposited as to contaminate water and foliage, as well as serving as an attraction to such transmitters or carriers as flies, is obvious. It seems very probable that infected Natives serve as reservoirs of disease. Preventive measures against soil pollution and fly breeding and fly activities need vigorous prosecution.

Helminthic infections are widely distributed among Natives. Eosinophilia and anæmia are common results of worm infestation, and, if only in a slight degree, lower the vitality of the infected person, whose resistance to other diseases is less marked in consequence. The elimination of worm infections needs attention, and it appears desirable that some attempt should be made to inculcate sanitary habits, both with respect to preparation of food and to disposal of sewage.

The numerous cases of infestation with *Tænia saginata* and *Tænia solium*, due to the use of imperfectly cooked beef or pork respectively, call for more attention to the proper cooking of meat and consequent destruction of the bladder-worm stages of these parasites. Further, the disposal of infected human excrement, in which tape-worm eggs may be present, should be so arranged that there is no contamination of herbage on which pigs or cattle feed. By preventing the development of the eggs into bladder-worms in pigs or cattle, the development of tape-worm stages in man are rendered impossible, while the proper cooking of meat also aids in tape-worm eradication. The presence of Hymenolepis in man is the result of faulty protection of food from pollution by domestic pests, such as rats and mice, the fleas infesting these animals transmitting the bladder-worms to human food. The necessary preventive measures are obvious.

Nematode infections also are numerous. The anæmia due to *Ancylostoma duodenale* is too well known to need comment. As the infective filariform larvæ of Ancylostoma gain access from polluted soil to the skin of man, the prevention of soil pollution is essential. This, combined with energetic treatment of persons found to be infected, is necessary to prevent sporadic infections assuming an epizoötic form under favourable circumstances.

Ascaris lumbricoides and *Trichuris trichiura* are also common. A toxin has already been isolated from Ascaris, and the possible effect of masses of these worms in causing intestinal obstruction is obvious. The fact that they are common does not diminish the necessity for their elimination from the human body, and the said elimination is followed by improved health.

Infections with the Trematode, *Schistosoma mansoni*, were observed in a few cases, severe diarrhœic or dysenteric conditions being present in each case. The danger of pollution of water with infected fæces, and of thus infecting the water snails whence the Schistosome cercariæ can reach man, is obvious. Similar remarks apply to the pollution of water with urine containing the eggs of *Schistosoma hæmatobium*.

Thus, helminthic infections of man need elimination, and the old statement that no animal parasite is entirely harmless to man is as true to-day as it was many years ago, and neither Protozoön nor Helminth can be excepted.

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EXPLANATION OF PLATES.

All figures were outlined with an Abbé-Zeiss camera lucida, using 16 mm., 4 mm. or 2 mm. apochromatic or 1-12 inch achromatic objectives, with compensating oculars 8, 12 or 18 or Huyghenian ocular 2. The approximate magnification is given in each case.

Plate I.

Figs. 1, 2.—*Entamœba histolytica.*

Fig. 1.—*Entamœba histolytica.* Trophozoite showing nucleus with karyosome and centriole, and two ingested red blood corpuscles. x 1300.

Fig. 2.—*Entamœba histolytica.* Typical cyst with four nuclei and chromatoid body. x 2000.

Fig. 3.—*Entamœba coli.* Typical cyst with eight nuclei. x 2000.

Figs. 4, 5.—*Giardia (Lamblia) intestinalis.*

Fig. 4.—*Giardia intestinalis.* Flagellate form. x 2500.

Fig. 5.—*Giardia intestinalis.* Cyst. x 2500

Fig. 6.—*Trichomonas hominis* or *intestinalis.* Flagellate form. x 2000.

Figs. 7, 8, 9.—*Chilomastix (Tetramitus) mesnili.*

Fig. 7.—*Chilomastix mesnili.* Flagellate form. x 2500.

Figs. 8, 9.—*Chilomastix mesnili.* Cysts. Fig. 8, Oval cyst. Fig. 9, Lemon-shaped cyst. x 2500.

Figs. 10, 11.—*Cercomonas parva.*

Fig. 10.—*Cercomonas parva.* Flagellate form. x 2500.

Fig. 11.—*Cercomonas parva.* Cyst. x 2500.

Figs. 12, 13.—*Prowazekia cruzi.*

Fig. 12.—*Prowazekia cruzi.* Flagellate form. x 2400.

Fig. 13.—*Prowazekia cruzi.* Encysted form. x 2400.

Fig. 14.—*Spirochæta eurygyrata,* group showing morphological variation. x 1400.

Figs. 15, 16.—*Blastocystis hominis.*

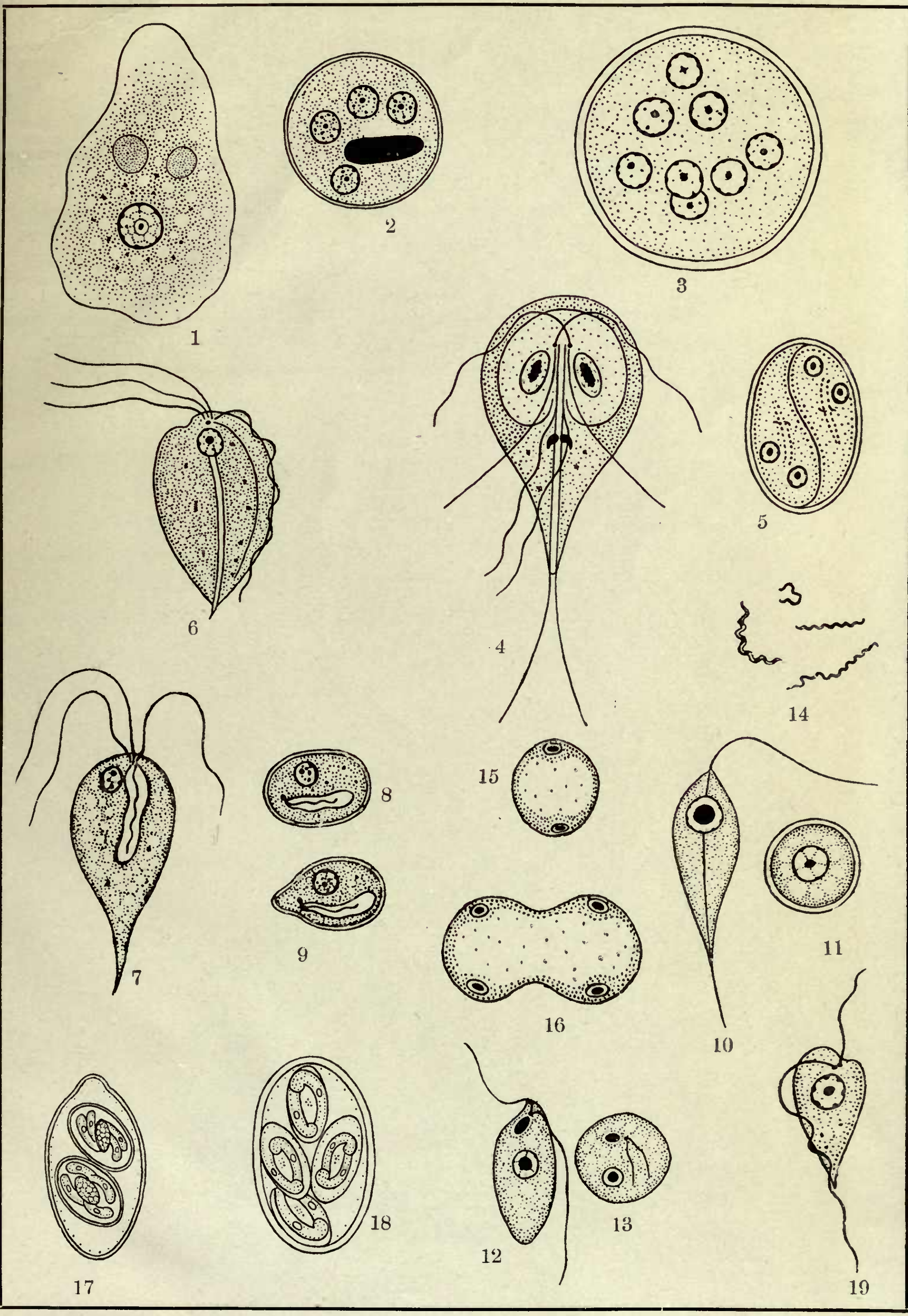
Fig. 15.—*Blastocystis hominis.* Typical binucleate form. x 1800.

Fig. 16.—*Blastocystis hominis.* Dividing form. x 1800.

Fig. 17.—*Isospora bigemina* var. *hominis.* Oöcyst containing two sporocysts each with four sporozoites. x 1000.

Fig. 18.—*Eimeria stiedæ.* Oöcyst containing four sporocysts each with two sporozoites. x 1000.

Fig. 19.—*Bodo stercoralis,* n. sp. Flagellate form. x 1500.



H. B. Fantham and A. Porter del.

EXPLANATION OF PLATE II

OVERLEAF.

PLATE II.

Fig. 1.—*Tænia solium.* Head showing suckers and hooks. x 45.

Fig. 2.—*Tænia saginata.* Head showing four suckers. x 25.

Fig. 3.—*Hymenolepis nana.* Head. x 75.

Fig. 4.—*Tænia solium.* Mature proglottis showing fully developed uterine branches. x 4.

Fig. 5.—*Tænia saginata.* Mature proglottis showing fully developed uterine branches. x 4.

Fig. 6.—*Hymenolepis nana.* Two proglottides showing three testes and one ovary per segment. x 80.

Fig. 7.—*Schistosoma hæmatobium.* From urine. Egg or ovum with terminal spine and miracidium inside. x 250.

Fig. 8.—*Schistosoma mansoni.* Egg or ovum with lateral spine. x 250.

Fig. 9.—*Tænia solium.* Embryophore. x 500.

Fig. 10.—*Tænia saginata.* Embryophore. x 500.

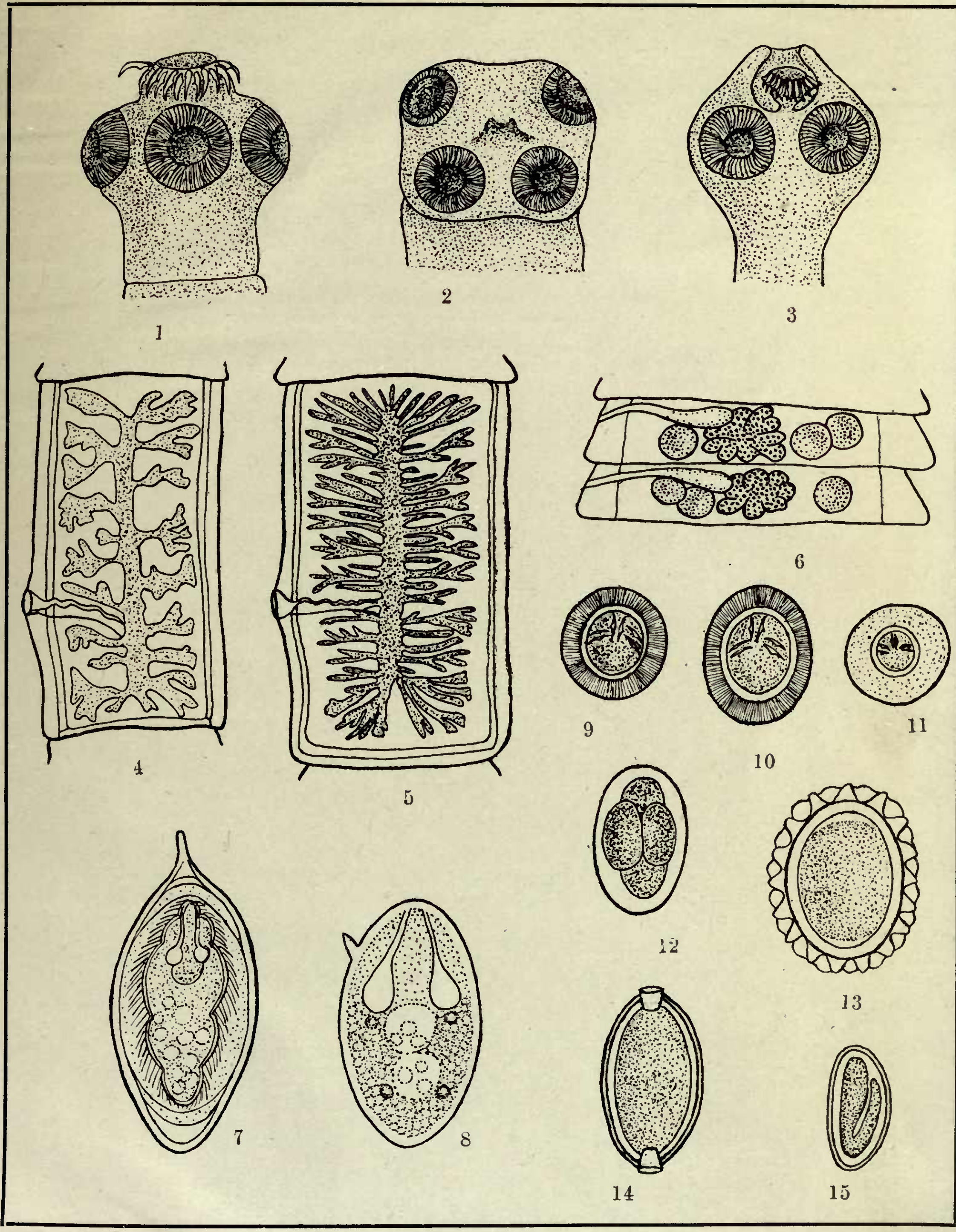
Fig. 11.—*Hymenolepis nana.* Globular embryophore with thick membrane and outer uterine shell. x 250.

Fig. 12.—*Ancylostoma duodenale.* Egg, as found in fæces. x 350.

Fig. 13.—*Ascaris lumbricoides.* Egg, with gelatinous coat. x 450.

Fig. 14.—*Trichuris trichiura.* Tea-tray shaped egg. x 400.

Fig. 15.—*Oxyuris vermicularis.* Asymmetrical egg, with tadpole-like embryo. x 350.



A. Porter del.

PUBLICATIONS OF THE RESEARCH DIVISION OF THE SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH.

(Correspondence with respect to the publications should be addressed to the Director of the Institute.)

I.—"The Ash of Silicotic Lungs" (March, 1913). (JOHN McCRAE, Ph.D., F.I.C.)

II.—"An Enquiry into the Etiology, Manifestations and Prevention of Pneumonia amongst Natives on the Rand, recruited from Tropical Areas" (Memoir No. 1, November, 1913). (G. D. MAYNARD, F.R.C.S.E.)

III.—"Specific Serological Reactions with ~~Pneumonia~~ Pneumococci from different Sources" (Memoir No. 2, December, 1913). (F. S. LISTER, M.R.C.S., L.R.C.P.)

IV.—"Anthropological Notes on Bantu Natives from Portuguese East Africa" (August, 1914). (G. D. MAYNARD, F.R.C.S.E., and G. A. TURNER, M.B., D.P.H.)

V.—"Plantication and Anaplantication" (January, 1915). (A. R. FRIEL, M.D., F.R.C.S.I.)

VI.—"The Trypanosomes of Sleeping Sickness; being a Study of the Grounds for the alleged Identity of *T. brucei* with those causing Disease in Man in Nyasaland" (December, 1915). (G. D. MAYNARD, F.R.C.S.E.)

VII.—"On the Nature of the doubly-~~separating~~ refracting Particles seen in Microscopic Sections of Silicotic Lungs, and an Improved Method for disclosing Siliceous Particles in such Sections" (September, 1916). (W. WATKINS-PITCHFORD, M.D., and JAMES MOIR, D.Sc.).

VIII.—"An Experimental Study of Prophylactic Inoculation against Pneumococcal Infection in the Rabbit and in Man" (October, 1916). (F. S. LISTER, M.R.C.S., L.R.C.P.)

IX.—(1) "Lysed Bacterial Serum." (2) "Further Observations on Plantication." (3) "A Note on Phagocytosis in the Absence of Serum" (April, 1917). (A. R. FRIEL, M.D., and F. S. LISTER, M.R.C.S., L.R.C.P.)

X.—"Prophylactic Inoculation of Man against Pneumococcal Infections, and more particularly against Lobar Pneumonia" (November, 1917). (F. S. LISTER, M.R.C.S., L.R.C.P.)

XI.—"A Survey of the Intestinal Entozoa, both Protozoal and Helminthic, observed among Natives in Johannesburg" (October, 1918). (ANNIE PORTER, D.Sc., F.L.S.)