

A report on the occurrence of intestinal
protozoa in the inhabitants of Britain...

by
Clifford Dobell.

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A Report on the Occurrence of Intestinal
Protozoa in the Inhabitants of Britain



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with special reference to
Entamoeba histolytica



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15 BUCKINGHAM STREET,

STRAND, W.C. 2.

A REPORT ON THE OCCURRENCE OF
INTESTINAL PROTOZOA

IN THE
INHABITANTS OF BRITAIN

WITH SPECIAL REFERENCE TO

ENTAMOEBIA HISTOLYTICA

BY

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CHAPTER I. INTRODUCTORY.

PRIOR to the outbreak of war in 1914 little was known concerning the occurrence of intestinal protozoa in the population of the British Isles: for although many British investigators had devoted their attention to the study of the intestinal protozoa of man in tropical countries, it seems to have occurred to nobody, until very recently, to carry out similar investigations at home.

The reasons for this—which seems, at first sight, somewhat curious—are not difficult to discover. Diseases due to intestinal protozoa were not generally recognized as occurring in Britain. They were—and still are—regarded by most practitioners as peculiar to the tropics; and it therefore appeared unnecessary to look for the ‘causes’ of such diseases in a country wherein they seemed generally absent. Moreover, Protozoology, as a serious study, has usually been regarded as entering into the purview of those physicians only who devote themselves to the study of Tropical Medicine: and consequently there were few medical men who were able—or, if able, who saw any necessity—to study the intestinal protozoa of the resident population of Britain. And, on the other hand, those zoologists who might have been disposed to take up this work were usually debarred from doing so by the difficulty, or the impossibility, of obtaining adequate material.

All this was soon changed by the War. Large bodies of troops were raised in Britain and sent to all the theatres of military operations, where they contracted divers intestinal diseases with which later they returned home. On their return they were subjected to careful examination, in order to diagnose their

maladies with precision. Numerous workers were specially trained for this investigation, on the protozoological side, and in due course trustworthy figures were obtained for determining the incidence of infections with various intestinal protozoa among the particular class of case studied. The results have already been published in an earlier Report,¹ and elsewhere, and need not be further considered here. It will suffice to note that these returned soldiers were infected, to a considerable degree, not only with the common and well-known non-pathogenic intestinal protozoa, but also, and in a somewhat surprisingly high proportion, with *Entamoeba histolytica*—the 'dysentery amoeba'.

It was known before the War—chiefly through E. L. Walker's observations and experiments in the Philippines—that carriers of *E. histolytica* are not uncommon. Such persons, though harbouring active and facultatively pathogenic amoebae in the walls of their intestines, may present no clinical symptoms of infection: and they are, in consequence, indistinguishable from uninfected individuals unless their stools are subjected to careful microscopic examination. In 1914 it was still uncertain what percentage of persons who become infected with *E. histolytica* might be expected to develop into carriers of this type, and what proportion might be expected to suffer from dysentery or liver abscess, or to display other clinical signs of amoebiasis. Consequently, it was impossible to state, with any certainty, the precise significance of the high rate of infection with *E. histolytica* discovered in the convalescent dysenteric patients returning to Britain from the various theatres of war.

It soon became clear, therefore, that further facts, obtained from a different class of persons, were necessary for the proper comprehension of those already accumulated. The mere fact that some 25 per cent. of dysenteric convalescents, returned from Gallipoli or elsewhere, were infected with *E. histolytica* told us very little: for we were not told how many non-dysenteric cases from the same area were infected, nor what percentage—if any—of the whole body of troops was parasitized before setting out from England originally. In other words, we were presented with the end result of an experiment in which the earlier steps were unknown, and alongside of which no control experiments had been performed.

The first steps towards acquiring the necessary knowledge were taken early in 1916, when an attempt was made to examine the stools of soldiers invalided to England for disabilities other than dysentery. In those days it was difficult to examine non-dysenteric patients, as there were large numbers of dysenteric convalescents—whose diagnosis and treatment were urgent, on military grounds—awaiting examination in the hospitals and dépôts in this country. I succeeded,² however, in investigating some cases of the former class at No. 2 New Zealand General Hospital, Walton-on-Thames. The number was not great, but the results were somewhat surprising. I examined altogether

¹ See Dobell (1917).

² See Dobell (1916).

110 non-dysenteric patients, and as a control a series of 90 dysenteric cases also—only 200 cases in all. The ‘dysenteric’ cases were all patients who had been invalided to England from Gallipoli and Egypt suffering, or having recently suffered, from ‘dysentery’—diagnosed, in most cases, on clinical grounds only. The ‘non-dysenteric’ class consisted of patients invalided from the same areas for affections other than dysentery: but they included 40 cases of non-dysenteric intestinal ailments—the remaining 70 being wounded men and others with various non-intestinal complaints. The results obtained from all these different classes of patients were as follows:

Cases.	No. examined.	Infected with <i>E. histolytica</i> , per cent.
All cases	200	11.0
{ Dysenteric	90	10.0
{ Non-dysenteric	110	11.8
{ All intestinal ailments	130	8.2
{ All non-intestinal ailments	70	15.7

So far as these figures went, therefore, they did not warrant the conclusion that the cases being returned to England labelled ‘dysentery’ were more heavily infected with *E. histolytica* than those who were coming here by reason of their wounds or other non-dysenteric disabilities.

In the summer of 1916 I undertook, in collaboration with Dr. A. C. Stevenson, the examination of another series of non-dysenteric cases—the convalescent typhoid and paratyphoid cases at Hornchurch Dépôt. We examined the stools of 472 such patients, and found that 9.74 per cent. of them were infected with *E. histolytica*.

These observations were sufficient to indicate the importance of making further investigations along similar lines: and accordingly I urged all the protozoologists whom I had trained for the work of diagnosis at military hospitals to examine as many non-dysenteric cases as possible. Some of them did so, but owing to the requirements of the Army it was difficult to obtain adequate material for investigation. Mr. W. O. Redman King examined the stools of non-dysenteric patients in Graylingwell Military Hospital, Chichester.¹ He was able to study 59 men—mostly wounded—and found 8.5 per cent. infected with *E. histolytica*. Mr. R. E. Savage, at the 2nd Southern General Hospital, Bristol,² was also able to examine a number of paratyphoid cases and a few patients suffering from wounds and other non-intestinal ailments, and obtained similar results. Miss M. W. Jepps, at Hampstead Military Hospital,³ examined 65 soldiers invalided for ‘irritable heart’; and among these she found—after an exhaustive inquiry—that no less than 24 were infected with *E. histolytica*. Some of these at least had never suffered from dysentery or other intestinal ailment. A few other workers made similar observations, but on a smaller scale. The most

¹ See Dobell (1917), p. 59.

² See Hall, Adam, and Savage (1916).

³ See Jepps and Meakins (1917).

extensive series, however, was that studied at Liverpool by Mr. A. Malins Smith and Mr. J. R. Matthews, who have published two detailed reports on their findings (Smith and Matthews, 1917, 1917 a). Taken together, their two series of cases show that, of 450 non-dysenteric patients, 35, or 7.7 per cent., were infected with *E. histolytica*.¹ All the cases were patients in hospitals—200 soldiers invalided for various diseases other than dysentery, and 250 non-dysenteric patients in a civil hospital.

It should be noted here that *E. histolytica* was not, of course, the only intestinal protozoon which was sought and found among non-dysenteric cases. Other amoebae, and all the flagellates which were so frequently encountered in the stools of the dysenteric patients, were also found to be not uncommon: sometimes, indeed, there seemed to be but little difference—if any—between the incidence of intestinal protozoal infections in the two classes of cases. It must be remembered, also, that these cases—whether they were returned as ‘dysenteric’ or ‘non-dysenteric’—were nearly all derived from similar areas. The vast majority of them came from Egypt and Gallipoli; and although the ‘non-dysenteric’ class consisted of men who were not invalided to England for dysentery, a very large proportion of them, when carefully questioned, were found to have suffered recently from dysentery or diarrhoea or some other intestinal disorder during their service abroad. Nevertheless, there were some ‘non-dysenteric’ patients—though comparatively few—who were certainly infected with *E. histolytica* and from whom no history of intestinal disorder could be elicited. These men appeared to be true contact carriers of the parasite—as defined by Walker (1913); but how long they had carried their infections, and whether they had acquired them originally abroad or at home, were questions upon which the findings threw no light.

There were, in 1916, two individual cases, well known to all of us working in London, which were of special interest. The first of these was studied and described by Dr. C. M. Wenyon (1916). The patient was ‘a labourer in London, who had never been out of England’, but who ‘had worked on a transport then lying in dock’. He contracted dysentery and was admitted to the London Hospital, where his symptoms disappeared. He remained ill, however, and was found to have a liver abscess, which was opened and drained. In the scrapings from its wall, active *E. histolytica* amoebae were found, and the cysts of the same parasite were found in his stools. The patient died, and at autopsy a second abscess was found in his liver, and a few small amoebic ulcers in his large intestine. This was undoubtedly, therefore, a case of

¹ In their first report, Smith and Matthews (1917) remark (p. 365) that their results—namely, the finding of a considerable percentage of *E. histolytica* infections among soldiers invalided for diseases other than dysentery—were ‘confirmed’ by mine (Walton Hospital, 1916). This is a somewhat misleading statement, as my results were obtained and published first, and theirs actually supplied a confirmation of mine. The work of Smith and Matthews was, indeed, carried out at my suggestion—as they fully acknowledged (p. 389): and I made the suggestion because of the results that I had already obtained whilst working along similar lines.

E. histolytica infection acquired in England; but at the time it appeared probable—as Wenyon inferred—that the patient had contracted his infection ‘from material from some carrier case who had been at the dock or on the transport’.

The second case was one which has been recorded by Dr. G. C. Low and myself (Low and Dobell (1916), Case 3). The subject was a young man who attended my class, in 1916, for instruction in the routine examination of stools, in order to take up the work of diagnosis at a military hospital. Like the other members of the class, he subjected his own stools to careful microscopic examination, and was surprised to find that he was passing cysts of *E. histolytica*—an observation which I was able to confirm. This worker had never at any time suffered from dysentery, persistent diarrhoea, or other intestinal disorder, and displayed no symptoms of intestinal disturbance at the time of the discovery. He had, however, been abroad—to Switzerland, Southern France, and Northern Italy—though never in the tropics or in any places where amoebic disorders were known to be prevalent, and had resided in England for the preceding five years. It seemed probable, at the time, that he had accidentally acquired his infection in the laboratory, in the course of examining stools containing cysts of *E. histolytica*. Two circumstances, however, led me to doubt the correctness of this supposition. In the first place, this worker was particularly careful and cleanly in his work—in fact, so fastidious, owing to his natural repugnance to handling stools, that he seemed the least likely of any member of the whole class to acquire an infection accidentally. The second point was this: he was infected with a race of *E. histolytica* forming cysts of unusually large size,¹ and—so far as I could ascertain at the time—no sample of faeces containing similar cysts had been examined by him whilst he was working with me. I am now inclined to believe that in this case the infection was really not acquired in the laboratory, but that the subject was a contact carrier who had unknowingly been infected for some years at least, and had contracted his infection very probably in the British Isles.

There is one other case which became known at about the same time and which ought, perhaps, to be placed in the same class as the two just mentioned. This is the case recorded by Worster-Drought and Rosewarne (1916). The patient was a soldier who had never left England, but had lived all his life in or near Manchester. He enlisted in 1915, and was admitted to the Royal Herbert Hospital, Woolwich, in the following year, with a typical attack of acute amoebic dysentery. *E. histolytica* was found in his stools; and he recovered rapidly, and apparently completely, as a result of emetine treatment. No carriers of *E. histolytica* could be found among this patient’s companions; but whilst it is certain that he was a case of amoebic dysentery

¹ That the cysts were those of *E. histolytica* there can be no question: and confirmation—if it were needed—is supplied by the fact that the infection was entirely eradicated by treatment with emetine bismuth iodide.

acquired in England, the manner in which he became infected is, as in the other cases just mentioned, still uncertain.

At this time it was generally recognized that carriers of *E. histolytica* are by no means rare in the tropics, and probably also in sub-tropical countries. That many soldiers returning from the Near Eastern theatres of war were infected with the parasite had been shown conclusively: and as *E. histolytica* was not known to occur in the normal civil population of Great Britain, it seemed natural to suppose that the returning carriers constituted the source from which were derived the few known cases of infection undoubtedly acquired in this country. A very important point, however, which made one hesitate to accept this conclusion unreservedly was this: *E. histolytica* was known to be disseminated in the same way as the other protozoa of the human bowel—the harmless amoebae and flagellates. These we knew to occur in persons who had never left the British Isles. Why, then, should not *E. histolytica*, if once introduced into this country, spread through the population in precisely the same manner? That there had been abundant opportunity for its introduction in the past could hardly be doubted: and considering this question in all its bearings, I soon came to the conclusion that it would be somewhat remarkable—to say the least—if *E. histolytica* were absent, at the present time, in the native British population. Against this supposition, however, was the fact that typical amoebic diseases—dysentery and liver abscess—appeared to be extremely rare in this country. Yet this objection might not be very cogent: for we were beginning to realize that amoebic diseases are not very common even in countries where *E. histolytica* is notoriously endemic, and that carriers of the parasite, displaying no clinical symptoms of infection, are far commoner than was originally supposed. We knew at that time, with a fair degree of certainty, that the dysenteric convalescents reaching this country from abroad were heavily infected with *E. histolytica*: but we also knew—or were beginning to know—that the dysentery from which these patients had suffered in the field was, in most cases, not amoebic but bacillary. From reliable observations made on the spot it seemed certain that less than 10 per cent. of the dysentery in the armies abroad was due to *E. histolytica*; whereas in the same troops, when they reached England, twice or thrice this percentage were found to be carriers of the parasite.

Another fact also came to light in the winter of 1916–17. Soldiers returning to England from the French front, many of them men who had never at any time been in any countries save England and France, were also found to be infected to a considerable extent with *E. histolytica*. Mr. Redman King, at Barton Dysentery Dépôt, investigated a number of such cases; and in a series of 1,300 convalescent dysenteric patients, whom I examined at this time at the Manor War Hospital, Epsom, I found¹

¹ See Dobell, Gettings, Jepps, and Stephens (1918).

—after a most careful inquiry into their past histories—that no less than 8.37 per cent. of the men (788 in number) who had been in England and France only, were carriers of *E. histolytica*. Amoebic diseases were not known to be more prevalent, in normal circumstances, in Northern France than in Great Britain; and moreover, it was fairly certain that by far the greater number of the dysentery cases occurring on the French front were bacillary—not amoebic. Consequently, unless infection with *E. histolytica* had spread through our armies from the associated colonial troops—and had spread with remarkable rapidity, and without concomitant clinical manifestations—it seemed certain that carriers of the parasite must be far commoner than had hitherto been supposed in the native population of Great Britain, of France, or of both countries.

The only way to arrive at the truth of the matter was obvious. The civilians—the normal resident population—would have to be subjected to examination in the same way as the military patients. In this way alone could the findings from the latter class be properly interpreted. But this was not easily done. It was difficult to obtain samples of faeces from a large number of persons who had never been abroad; and yet such material was obviously necessary for this investigation. Anybody who had been out of Britain would have to be excluded; for it would be impossible, if protozoa of any sort were found in his stools, to ascertain whether the infection had been acquired at home or during his sojourn in foreign parts: and this meant that a very careful inquiry would have to be made into the history of every case that was to be included in our ‘British’ series. Then again, it was obviously necessary to examine as large a number of the ‘British’ population as possible, since a small sample might give a wrong idea of the real conditions. And finally there was the difficulty of obtaining workers for the undertaking. The investigation, if it were to be of any value, would have to be made by competent workers, whose findings could be trusted: and the men and women whom I had trained for this purpose, and upon whose diagnoses reliance could be placed, could ill be spared from the hospitals where they were then employed in the examination of military patients. Their work for the Army naturally took precedence of all other work.

I made several attempts to carry out investigations of this sort myself, but owing to preoccupation with other more urgent duties the results which I obtained were insignificant. But I endeavoured to impress upon all the workers whom I trained from time to time for the War Office the importance of conducting inquiries into this problem; and I urged them all to seize every opportunity of obtaining the information needed. For various reasons the majority of these workers were unable to devote their attention to the matter; but one group of them, acting upon my suggestions, ultimately succeeded in obtaining data of the greatest interest. I refer, of course, to the workers at the Liverpool School of Tropical Medicine, whose results have

now been fully published and are already well known. The work was begun by Mr. A. Malins Smith, Mr. J. R. Matthews, and Miss Doris L. Mackinnon, who passed through a course of training with me in London in the early part of 1916, under the scheme arranged by the Medical Research Committee and the Royal Society for the War Office. On going to Liverpool these workers were joined by Mr. H. F. Carter, and received the assistance of Professor Warrington Yorke. Later Mr. Malins Smith and Mr. Matthews continued the work alone, and it is to their efforts that most of our present knowledge is due.

I shall consider this important work, carried out in Liverpool, in greater detail in later chapters, and will here merely note briefly the general results. In a first report (Yorke, Carter, Mackinnon, Matthews, and Malins Smith, 1917), results were recorded of examinations of the stools of 344 persons who had never left Great Britain. Of these, 138 were 'patients, for the most part surgical, in the Liverpool Royal Infirmary; they consisted of both males and females of various ages': the rest (206) 'were healthy young men of about 18 years of age who had recently entered the army and were in training at a camp in the vicinity of Liverpool'. No less than 10 of these (2 in the first group, 8 in the second) were found to be infected with *E. histolytica*—a percentage, for the whole, of 2.9, or roughly 3. This figure was obtained, moreover, as a result of making only a single examination of the stools of each case, so that it certainly represents less than the number actually infected. None of these 10 infected individuals had ever suffered from dysentery. The cysts in their stools were typical in every way; and further evidence that they were really those of *E. histolytica* was obtained by animal experiment—a kitten fed upon cysts from one case developing typical and fatal amoebic dysentery:

Further results were announced in the following year in a Report to the Medical Research Committee (Carter, Matthews, Mackinnon, and Smith, 1918), and at a meeting of the Society of Tropical Medicine and Hygiene (Yorke, 1918); and again in 1919, at a meeting of the British Medical Association (Yorke, 1919). Since then Mr. Malins Smith and Mr. Matthews have published a complete account of all their findings (Matthews and Smith, 1919, 1919 a). The five reports published by them summarize the results obtained in the examination of British residents—never abroad—belonging to the following classes: (1) Civilians in an infirmary, (2) Army recruits, (3) Children, (4) Asylum patients, (5) University and school cadets. Infections with *E. histolytica*, ranging from 1.5 per cent. (infirmary patients) to 9.7 per cent. (asylum patients), were found in all these series. Other protozoa were, of course, also found and recorded, but will be considered later in the analysis of the total findings from all sources.

Investigations along somewhat different lines were made during 1917 by Dr. P. P. Laidlaw at Guy's Hospital. He searched for *E. histolytica* in patients with symptoms suggestive of infection

with this parasite in the hope of finding indigenous cases of amoebiasis; and he soon succeeded in finding three such cases (Laidlaw, 1918). The first case was one of chronic amoebic dysentery: the second a case of amoebic abscess of the liver, without concomitant dysentery but with abundant cysts of *E. histolytica* in the stools. Neither of the patients had ever been abroad. Both were males, aged 38 and 48 respectively, admitted to hospital in the usual way—Case 1 for ‘ulcerative colitis’, Case 2 with ‘lumbar and abdominal pain’. The diagnosis of the second case was arrived at only after laparotomy and evacuation of the abscess thereby discovered. Typical specimens of *E. histolytica* were obtained from both cases,¹ and from both kittens were inoculated and successfully infected. Emetine treatment also had a beneficial effect on both patients. The third case reported by Laidlaw was based upon material supplied by Dr. Perdrau, who showed him sections of an intestinal ulcer and a liver abscess found *post mortem* in a woman who had never left Britain. In both these *E. histolytica* was present.

Evidently these were all cases of indigenous amoebiasis, and they would probably all have passed unrecognized if they had not been specially looked for. They were found among the ordinary admissions to a large London hospital in the same year; and from his experience Dr. Laidlaw was led to suggest that, even in Britain, ‘cases of this type are not so rare as might be thought from the literature’. He concluded ‘that cases of ulcerative colitis, colitis, and liver abscess should always be examined with a view to excluding amoebic infection’.

In the summer of 1918, the War Office Committee on Dysentery,² with the results of the Liverpool workers and others before them, decided that further inquiry into the incidence of *E. histolytica* infection among the resident civilian population of Great Britain was desirable. The time was considered opportune to utilize the services of some of the trained workers, then engaged in examining dysenteric convalescents at military hospitals, for this purpose—the pressure of work at these establishments having, at that moment, somewhat abated: and I was asked by the Chairman of the Committee to organize and supervise investigations, with the aid of the personnel then available at various centres, along the lines followed by the workers at Liverpool and with the object of checking and amplifying their findings. Accordingly, in July 1918, I invited five of the protozoologists working at military hospitals to investigate, as far as possible, the protozoal infections occurring in the resident civilian populations in the areas in which they were situated. These workers had all been through a course of instruction with me in London before they were employed at military hospitals; and as they had all, by this time,

¹ Dr. Laidlaw kindly sent me specimens for examination, and I had no difficulty in confirming his diagnosis.

² Consisting of Major-General Sir William Leishman, K.C.M.G. (Chairman), Sir Walter Fletcher, K.B.E., Professor (now Sir) F. W. Andrewes, Dr. G. S. Buchanan, C.B., Dr. G. T. Western (Secretary), and the present writer.

had considerable experience in this line of work, it was believed that reliance could be placed upon their findings. These five protozoologists were :

- A. H. Campbell, B.Sc., 2nd Southern General Hospital, Bristol.
- T. Goodey, D.Sc., 1st and 2nd/1st Southern General Hospitals, Birmingham.
- R. C. McLean, M.A., Reading War Hospital.
- Miss M. M. Nutt (Bathurst Student, Newnham College, Cambridge), Leeds and Sheffield Military Hospitals.
- A. G. Thacker, A.R.C.S., Kitchener Hospital, Brighton.

Mr. Campbell and Mr. Thacker were working under grants from the Medical Research Committee: the three others were in the service of the War Office. They all expressed their willingness to collaborate in the undertaking, and were then supplied with cards for the recording of their findings. These cards, which were issued by the Medical Research Committee, were designed—by myself, in consultation with Sir Walter Fletcher—so as to indicate the kind of information required, and in order to enable the examiners to record their findings, and such essential facts as they could elicit regarding the histories of the cases studied, in a uniform manner and with economy of space and time. The form of the card is shown on p. 14—its actual measurements being 12.5 × 20 cm.—and it may be added that it appears to have fulfilled its objects. Apart from this provision for collecting and correlating the results, all arrangements for the work were left in the hands of the protozoologists themselves. They were all able, with the assistance of the medical officers in charge, and in some instances with aid from the Medical Research Committee and the Local Government Board, to obtain the necessary material from various local institutions.

As all the workers were engaged simultaneously in the routine work of diagnosis for military hospitals, they could devote only a fraction of their time, as opportunities occurred, to the examination of civilians. There were naturally many difficulties to be surmounted—differing from time to time and from place to place—and the several workers did not all enjoy equal facilities for the prosecution of their inquiries. This explains, to a large extent, the inequality of their results. Nevertheless, every worker was able to investigate a certain number of cases; and in due course each was able to submit a report of the results. The largest series of cases—and the fullest report—came from Miss M. M. Nutt (Leeds and Sheffield); but she had already begun her inquiry, at my suggestion, before the matter was taken up by the War Office Committee. The reports are all printed here for the first time (see Chapter III), and deal, in the aggregate, with the findings from the examination of the stools of over one thousand

Examined
at

Case No.

Name

Sex

Occupation

Age

Usual Place of Residence

Places of Residence abroad, with dates

Previous attacks of Dysentery

Where?

When?

Persistent Diarrhoea?

Liver Abscess?

PROTOZOOLOGICAL EXAMINATIONS OF STOOLS.

Dates

Findings.

Remarks

British civilians who have never, at any time, been abroad. Nobody who realizes the difficulties involved in such an undertaking will be disposed to complain of the smallness of this number. On the contrary, it will, I think, be generally conceded that to have found and examined so large a number of persons of this class constitutes, when all the circumstances are borne in mind, a performance which does the greatest credit to all the workers concerned.

The investigation was gradually discontinued in 1919, following the Armistice and the disbanding of the Army, and the consequent reorganization of Dysentery Hospitals and Dépôts and the return of the temporary protozoologists to their ordinary civil employments. By the beginning of the present year (1920) the reports from all the centres, together with the cards, duly filled up, were in my hands; and it was then possible to collect, analyse, and classify the results obtained from all sources. This is the main purpose of the present Report.

It should be added here that at the time when the War Office Committee decided to promote these inquiries, a similar investigation had already been begun in the Navy. After the publication of the results obtained by the Liverpool workers, Surgeon Captain P. W. Bassett-Smith, C.B., R.N., urged upon the Admiralty the importance of investigating the new entries to the Royal Navy, in order to ascertain the extent to which they were infected with *E. histolytica* and other intestinal protozoa. Accordingly, arrangements were made by Surgeon Lieutenant-Commander P. Fildes, R.N.V.R., at the Royal Naval Hospital, Haslar, for carrying out this investigation. Examinations were made by Mr. H. A. Baylis—one of the protozoologists previously trained for this work, like the others, by me in London—of 400 healthy men joining the Navy and Marines. Reports on his findings have already been published (Baylis, 1919, 1920), and will be noted in greater detail later. It will suffice to notice here that ten cases of *E. histolytica* infection were found among these men—all healthy individuals, drawn from various parts of the British Isles.

It is not possible to include this series with the others for the purposes of this Report. Particulars of past history were not obtained for every case, as 'it was thought sufficient to make special inquiry as to the history of each case found to be a carrier of *Entamoeba histolytica*'. Consequently, as some of the cases had probably been abroad, they cannot be regarded as forming a series exactly comparable with the others in this respect. A set of cards was sent to Mr. Baylis, but at that time his investigations were already in progress, so that he was only able to enter on them particulars of the cases infected with *E. histolytica*. As Mr. Baylis kindly returned these cards to me when his inquiry was published, I have been able to utilize them in considering his results and comparing them with the rest.

In dealing with the material at my disposal for this Report I have not confined myself to analysing the work that was instituted by the War Office Committee. This work, to be properly

appreciated, must be taken in conjunction with that done previously. The cases examined by the Liverpool workers were more numerous, and really form the backbone of the whole inquiry. The newer findings here presented are supplementary, and the two series must be added together in order that their significance may have a maximal value. Moreover, since no comprehensive treatment of this subject has previously been possible, and since, in consequence, no complete survey of it has been attempted, it has seemed to me opportune to summarize all the information at present available. I have therefore extended the scope of the present Report so as to include the following subjects—to each of which a separate chapter will be devoted :

1. The older records of the occurrence of intestinal protozoa in the population of Britain.
2. The recent reports on the same subject—comprising a summary of the results obtained by the Liverpool workers, and the newer findings of the workers under the War Office Committee (now published here for the first time).
3. A summary of all the results so far obtained, with a discussion of certain points of particular interest.
4. A brief review of certain similar observations recently made in France, Holland, and Germany.

And in a final chapter I will present very briefly what seem to me to be the most important conclusions deducible from the facts recorded in all the antecedent chapters.

Infections with intestinal protozoa are, in general, very persistent; and we know that they are by no means uncommon in many foreign countries. Consequently, it has seemed to me necessary, for present purposes, to investigate particularly the intestinal protozoa of persons who have never been abroad. When such persons are found to be infected, it can be said with certainty that their infections were acquired in Britain. It may be urged, however, that even in such cases the infection may not be truly indigenous, but may have been acquired from some imported foreign source—from a home-coming soldier, for example, returning from a country where the infection is endemic. This objection is, I think, negligible; for even if the explanation were true, it would not invalidate the conclusion that infection can be acquired in this country, and it would demonstrate, moreover, that the conditions here are suitable for such infections to spread—a very important point. For if they can spread now, they could have done so before, and with a fluctuating population like ours there is every reason to suppose that the infection—whatever it may be, and whenever it may have been first imported in the past—would thus long ago have established itself and become as truly 'endemic' as it was in its country of origin.

As regards the present classification of records into 'old' and 'new', I would only remark that it is purely arbitrary, and done for convenience. What we have seen occurring during the War

must have been going on—probably more slowly—for centuries: but it is only recently that attention has been devoted to the subject, and that any considerable body of observations has been amassed. The outbreak of war in 1914 forms a convenient dividing line for my present purposes, and I have therefore called all records prior to this date ‘old’, and all those since ‘new’.

In the next chapter I shall now analyse, as briefly as possible, all the old records which I have been able to find in the literature.

CHAPTER II. THE OLDER RECORDS OF THE OCCURRENCE OF INTESTINAL PROTOZOA IN THE POPULATION OF BRITAIN.

THE occurrence of intestinal protozoa in the population of the British Isles—that is, in residents who have never been abroad—has been the subject of serious inquiry only since the outbreak of the War. Consequently almost all that has been definitely ascertained has been the product of the last half-dozen years. Nevertheless, it was known prior to 1914 that amoebic dysentery and liver abscess do occur sporadically in Britain, and several apparently indigenous cases had been recorded. Of such cases I have been able to find but five for which the evidence appears at all convincing. I shall summarize them briefly at this point, as they are of interest in two respects: first, from a historic standpoint; secondly, because they show that *E. histolytica* occurred in the population of Britain before the War—that is, before the recent demonstration of its presence.

Although it was doubtless well known to many people before the War that *E. coli*, *Giardia*, and other non-pathogenic species of intestinal protozoa occur in the resident population of the British Isles, I have been unable to discover any printed records of this in pre-war literature. Consequently this chapter will deal entirely with records relating to the occurrence of *E. histolytica*.

The older evidence for the existence of *E. histolytica* in persons who have never left Britain is, of course, mainly pathological and clinical. But the symptoms and lesions of such infections are very characteristic; so that, notwithstanding the fact that the certain recognition of *E. histolytica* is a comparatively recent achievement, it is possible to draw conclusions from several of the older records with some degree of certainty.

I shall now review, in their historic sequence, all the ‘old’ records which I have been able to find.

Dickinson's two cases.—The earliest British case of *E. histolytica* infection known to me is that recorded by W. Howship Dickinson (1862). His patient was a woman aged 37, who came under observation at St. George's Hospital. ‘She had never been out of England.’ She was ‘sallow’, and complained of ‘pain in the right hypochondrium’, and a tumour could be felt extending

from the liver area to below the umbilicus. 'The bowels were confined.' She 'had been ill for one year', with 'pain about the region of the liver'; but she did not 'admit that she had ever had any looseness of the bowels'. 'The ordinary symptoms of dysentery were, as far as could be ascertained, altogether absent.' In hospital she was constipated, and died 8 days after admission.

At the *post-mortem* examination a large single abscess, containing about 1 gallon of pus, was found in the right lobe of the liver. 'The upper part of the large intestine was in a state of ragged ulceration, such as occurs in dysentery. It ceased abruptly at the edge of the ileo-caecal valve. The absorbent glands in the neighbourhood were red and swollen.'

Though no amoebae were described in the pus from the abscess or in the ulcers in the gut, the symptoms and lesions recorded are so typical, in every way, that it is hardly possible to doubt that this was a case of *E. histolytica* infection.

Nearly 20 years later, Dickinson (1881) recorded a second case. The patient was a man—a lath-splitter, aged 36—who was also admitted to St. George's Hospital. On admission he was 'febrile', with a 'temperature ranging pretty regularly from about 98° in the morning to 102° in the evening'. He was found to be suffering from severe dysentery, which was followed by a liver abscess. The disease ended fatally '38 days after the first symptom'. Previous to this illness the patient had enjoyed good health, and it is stated that he 'had never left England'.

At the autopsy, 'the large intestine presented from end to end a patchwork of dysenteric ulcers, separated by narrow ridges of thickened mucous membrane. The ulcers were very irregular in size and shape; they were for the most part deep, some exposing the muscular coat of the bowel. . . . The small intestine was healthy. The liver contained a large single abscess which held about four ounces; it lay in the back part of the right lobe near its upper and posterior surface. The shape was irregular, its walls ragged, and without lining membrane.'

After discussing the *post-mortem* findings, Dickinson says: 'I think we have no choice but to look upon the ulceration and the abscess as cause and effect, and upon the portal vein as the connexion.' He thus came very near to what is probably the correct interpretation, for I have no doubt that this also was a case of *E. histolytica* infection. Everything recorded is absolutely typical of amoebic dysentery and liver abscess. It requires only the finding of amoebae in the abscess and the ulcers to make the description complete. Such a discovery, however, could hardly have been expected at the time when Dickinson's observations were recorded.

Moore's case.—In the year in which the preceding case was recorded, another probable case of *E. histolytica* infection was briefly noted by Norman Moore (1881). His patient was a little girl, aged 3½ years, admitted to St. Bartholomew's Hospital, where she died about 5 weeks after admission. 'The child had never been out of London.' She had two abscesses in her liver,

'one in the right lobe as large as a small orange, and one in the left lobe of the size of a filbert.' The abscesses had 'very definite boundaries', and the neighbouring liver-tissue appeared healthy. 'The whole of the large intestine was extensively ulcerated'; and it is further recorded that the child 'had been ill ten months with diarrhoea, and for about two months there were slime, blood, and general symptoms of dysentery'.

Though little else of importance is recorded, it seems highly probable that this was another case of amoebic dysentery and liver abscess—due to *E. histolytica*—in a person who had never left Britain.

The case of Saundby and Miller.—'A case of amoebic dysentery with abscess of the liver in a patient who had never been out of England' was described some years ago by Saundby and Miller (1909) in Birmingham. This was another fatal case. Their patient was a man—a cycle-rim maker who had lived in the Birmingham district all his life. From the clinical description and the recorded *post-mortem* findings, the case appears undoubtedly to have been one of amoebic abscess of the liver, with typical amoebic ulceration of the large bowel. No history of dysentery is recorded, but it is stated that 'four days after admission' the patient 'passed a stool containing a considerable quantity of blood'—which apparently was not examined microscopically—and thereafter he had 'no more diarrhoea'. The liver abscess was 5 in. in diameter, in 'the posterior part' of the liver, and contained 'brownish-red pus and masses of necrosed liver substance'. Amoebae were found in the pus, from which no bacteria were cultivated 'in ordinary media', and similar amoebae were present in the intestinal ulcers. The authors identified them as 'the *Entamoeba histolytica* (Schaudinn)', though unfortunately this organism cannot be recognized in their description and figures. There can be little doubt, however, on other grounds, that this was really a case of *E. histolytica* infection.

Saundby and Miller claimed that theirs was 'the first observation of the kind which has been recorded in Great Britain'; and it appears probable that it was, indeed, the first such case in which amoebae were actually found. They appear to have thought that the patient contracted his infection from some 'imported' case of amoebic dysentery: but they adduced no evidence in support of the suggestion. They concluded that 'the disease, although no doubt imported into this country from time to time, rarely spreads; that it may do so, however, when circumstances favour it, seems to be established by the present case'. The authors could hardly have written this last sentence if they had known all that we now know concerning the occurrence of *E. histolytica* in Britain.

Marshall's case.—This is another comparatively recent case, described by Marshall in 1912. The patient was a ploughman, aged 28, living near Dunbar. He had never been out of Scotland. He was admitted to the Royal Infirmary, Edinburgh, 'suffering from chronic diarrhoea', which had begun about seven weeks

before. His stools were generally 'watery', but also contained blood and mucus; and numerous amoebae—identified as *Entamoeba histolytica*—were present in them. Attempts were made to infect cats with the amoebae, but at the time of writing the result of the experiments was not known. The patient was treated with ipecacuanha, which appears to have benefited him: for though he relapsed after a first course, he was, when the paper was written, 'almost convalescent' after a second.

It is uncertain how this patient acquired his infection. Marshall suspected that he might have got it from a soldier, who had been in India, in the same neighbourhood. But this soldier was not proved to be a carrier of *E. histolytica*. 'Spores' were present in his stools, 'but whether they were the spores of *Entamoeba histolytica* could not be determined by mere microscopic examination'.

It appears probable that Marshall's case was also one of *E. histolytica* infection, though the published evidence is not wholly satisfactory. The author appears to have held peculiar views regarding the life-history of *E. histolytica*; and from his description and figures it is, unfortunately, impossible to identify the organisms with which he was dealing. Corroborative evidence from animal experiments and emetine treatment is also—as already implied—lacking.

There are other cases of possibly indigenous *E. histolytica* infection on record, but as they all appear doubtful as 'British' cases, I shall not consider them here. It is possible, however, that some of them were really indigenous. The case of Bassett-Smith (1900) will serve as an instance of these doubtful cases, and illustrates the difficulties of interpretation. His patient, a petty officer in the Navy, had been abroad, but had never previously suffered from dysentery. More than two years after returning home to Portsmouth he had an attack of dysentery, followed by the formation of abscesses in the liver and lung. The pus from the former was bacteriologically sterile, but contained active forms of 'the amoeba coli'. The disease ultimately proved fatal. It seems clear that this was a case of *E. histolytica* infection; but there is no evidence to show where or when the patient originally became infected. He may have acquired his infection whilst abroad, and have remained a contact carrier of the parasite until his fatal illness developed. On the other hand, in the absence of evidence to the contrary, it is possible that he contracted his infection in England—either before he went abroad or at any time after his return.

As it is impossible to determine the facts with certainty, I have excluded several other doubtful cases, of a similar type, from the present chapter.

CHAPTER III. RECENT REPORTS ON THE OCCURRENCE OF INTESTINAL PROTOZOA IN THE POPULATION OF BRITAIN.

In this chapter I propose to set out the recent records of the occurrence of intestinal protozoa in the British population. The greater part of the chapter will consist of the new reports—now published for the first time—from the investigators working at Birmingham, Brighton, Bristol, Leeds, Sheffield, and Reading. Reference to these investigations has already been made in the Introduction (p. 12). As there noted, they were undertaken, under the direction of the War Office Committee on Dysentery, in order to amplify the observations of the workers at Liverpool. It thus seems proper to preface them with some account of the Liverpool workers' results, which have now been fully published. I shall therefore begin by giving a brief summary of this pioneer work, before passing on to the later records.

I may note here that there are, in addition to the reports given in this chapter, three other recently published records of the occurrence of *E. histolytica* in persons who have never been abroad. (1) Baylis (1919, 1920), as already noted, found 10 men infected among 400 naval cases at Haslar; and of these 8 had never left the British Isles. (2) Miss D. L. Mackinnon (1918) examined 34 'British' cases among patients at University War Hospital, Southampton, and found one *E. histolytica* infection in a man who had never been abroad.¹ (3) Tayler has recorded an infection with *E. histolytica* in 'one man who has never been out of England', examined at Addington Park War Hospital, Croydon. It is stated that he 'probably contracted the infection while employed unloading transports at Southampton Docks', but the evidence for this conclusion is not given. (See Turner and Tayler (1919), p. 249, footnote.) All these cases are of interest, in that they supply further information concerning the occurrence of *E. histolytica* in Britain; but as other essential particulars are not available, I have not been able to include them with the other results recorded in this chapter.

A. The Liverpool Reports.

Four years ago Smith and Matthews (1916) recorded—apparently for the first time—the occurrence of *Giardia intestinalis* (= *Lamblia*) in two men who had never been out of England. Later, in collaboration with others (Yorke, Carter, Mackinnon, Matthews, and Smith, 1917), they reported the presence of *Entamoeba histolytica*, *E. coli*, and *Chilomastix mesnili* also, found during the examination of a series of 344 persons who had never been

¹ This man was 'an R.A.M.C. sergeant who had attended to dysentery patients on hospital trains'. The other infections found in this series were with *E. coli* (5), *E. nana* (3), *Giardia* (6), and *Chilomastix* (1).

abroad. The same workers gave further accounts of their observations later (Carter, Matthews, Mackinnon, and Smith (1918); Yorke (1918, 1919); Matthews and Smith (1919, 1919 a); Smith (1919)). The last two reports published by Matthews and Smith in 1919 contain their final results in detail, and it is from these that the following figures have been mainly compiled.

(1) CIVILIANS IN LIVERPOOL ROYAL INFIRMARY.

At this institution 450 cases—chiefly surgical—were examined. None of the patients had ever been abroad. The series included men, women, and children, selected at random. Only 'a comparatively small number' had been admitted for intestinal ailments. The stools were examined only once apiece for the whole series, and the findings recorded were as follows:

Total No. of cases examined	450
Infected with:	per cent.
<i>Entamoeba histolytica</i>	1.5
<i>E. coli</i>	6.7
<i>Endolimax nana</i>	2.4
<i>Iodamoeba bütschlii</i>	1 case
<i>Giardia intestinalis</i>	6.0
<i>Chilomastix mesnili</i>	1.5

(2) ARMY RECRUITS.

More than a thousand young army recruits who had never been out of England were examined in this series. They were stationed near Liverpool, and had been in camp for times ranging from a few days up to five months. Only one examination per case was made, and the total findings were as follows:

Total No. of cases examined	1,098
Infected with:	per cent.
<i>Entamoeba histolytica</i>	5.6
<i>E. coli</i>	18.2
<i>Endolimax nana</i>	5.5
<i>Iodamoeba bütschlii</i>	0.4
<i>Giardia intestinalis</i>	7.0
<i>Chilomastix mesnili</i>	2 cases

(3) CHILDREN.

'Material for the investigation was obtained at the Liverpool Infirmary for Children, where all the patients are under 12 years of age. The cases examined were in hospital for various diseases, the great majority being non-intestinal.' None had ever been abroad, and the total findings, based on a single examination per case, were as follows:

Total No. of cases examined	548
Infected with:	per cent.
<i>Entamoeba histolytica</i>	1.8
<i>E. coli</i>	11.1
<i>Endolimax nana</i>	2.7
<i>Iodamoeba bütschlii</i>	1 case
<i>Giardia intestinalis</i>	14.1
<i>Chilomastix mesnili</i>	1.8

(4) ASYLUM PATIENTS.

Matthews and Smith (1919 *a*) examined the stools of 207 patients in the Lancashire County Asylum, Whittingham. The patients were all males, their ages ranging from 17 to 87. As in the other series, only one examination per case was made. None of the patients had ever been abroad. The findings were as follows:

Total No. of cases examined	207
Infected with :	per cent.
<i>Entamoeba histolytica</i>	9.7
<i>E. coli</i>	45.9
<i>Endolimax nana</i>	12.1
<i>Giardia intestinalis</i>	3.4
<i>Chilomastix mesnili</i>	23.2

In a later paper Smith (1919) reported his findings from a larger series of cases examined at the Lancashire County Asylum at Rainhill. His results were as follows:

Total No. of cases examined	504
Infected with :	per cent.
<i>Entamoeba histolytica</i>	4.2
<i>E. coli</i>	21.4
<i>Endolimax nana</i>	3.0
<i>Iodamoeba bütschlii</i>	1.0
<i>Giardia intestinalis</i>	5.0
<i>Chilomastix mesnili</i>	6.7
<i>Trichomonas hominis</i>	0.8

A few of the patients in this series were examined more than once; but the figures given were calculated from the results of only one examination per case—to keep them in line with the others.

It should be noted that this series is not strictly comparable with the others, as it includes a few persons who had been abroad. It is stated that 'only thirty-four of the five hundred and four patients at Rainhill had, so far as could be traced, ever been abroad': but the findings for the 'British' cases alone are not given, and as the individual histories are recorded for very few cases, it is impossible to estimate—from what is published—how far the inclusion of 'foreign' cases may have influenced the results.

(5) UNIVERSITY AND SCHOOL CADETS.

A very small series—unfinished—was examined by Matthews and Smith (1919 *a*) from the University Platoon in an Officers' Training Corps, and older boys from a secondary school near Liverpool. All were males who had never been abroad—their ages being from 15 to 19 years. Results (one examination per case):

Total No. of cases examined	41
No. infected with :	
<i>Entamoeba histolytica</i>	1
<i>E. coli</i>	11
<i>Endolimax nana</i>	1
<i>Giardia intestinalis</i>	1

The authors say of this series that their original object had been 'to examine a number of youths from a higher social class and from better homes than the Army recruits whom we had previously reported on. We can only say that infections of the various protozoa exist among such persons.'

I shall not attempt to summarize at this point the many other important facts brought out and discussed in the foregoing reports. All who are interested in the subject with which they deal will read the originals. There are, however, several matters which require detailed consideration, and to these I shall return in the next chapter. It will be more profitable, and much more convenient, to consider these points after the newer results obtained by the other workers have been given.

B. The Later Reports.

As already noted in the Introduction, the five investigators working for the War Office Committee on Dysentery (see p. 13) presented, in due course, reports on their work. They also (with one exception) sent me back the cards—fully filled up, for the most part—with which they had been supplied for the purpose of recording their findings. I have thus been able to check the reports by means of the cards, and in many cases I have added relevant details from the latter when they were not given in the reports themselves. I have also freely exercised my editorial privileges in preparing these reports for press: for it has been possible, and, indeed, necessary, to introduce a greater uniformity of treatment of the material than was possible to the writers of individual reports—unacquainted as they were with the work of one another. I have cast all the tables in the same form, and eliminated or simplified a number of complicated ones when this appeared desirable. I have throughout removed everything which appeared to me superfluous, and have endeavoured to present the essentials as concisely as possible. I have also—as I have, indeed, throughout the whole of the present work—silently corrected the nomenclature of the protozoa to which reference is made, when the names employed have not accorded with current zoological usage. With these modifications, the reports now presented are the work of the authors whose names they bear. Remarks or additions of my own—which mostly consist of supplementary information which I have copied from the cards—are distinguished by being enclosed in square brackets.

1. BIRMINGHAM REPORT.

By T. Goodey.

Faeces samples were obtained from civilians undergoing treatment for phthisis at two sanatoria, viz. Salterley Grange Sanatorium, Cheltenham, one of the Birmingham Corporation sanatoria, and Cranham Lodge Sanatorium, near Stroud, a private

sanatorium. Samples were sent in from 101 persons who had never been abroad, and of these, 70 were residents of Birmingham, and the remaining 31 were, for the most part, residents of places in South Wales, Somerset, and Gloucester, and thus representative of a more rural type of population than the 70 from Birmingham. The examinations were made in the Research Laboratory in Agricultural Zoology, Birmingham University.

Altogether 72 males and 29 females were examined. Three samples of faeces from each were examined in all except three cases, two of which were examined twice and the other only once.

Practically all the individuals examined belonged to the artisan classes. *Entamoeba histolytica* cysts were found in the stools of six persons, only one of whom (Case 10) had experienced any previous bowel trouble.

The results in the case of the other intestinal protozoa are set out in the following table, and call for no special remark here:

Total No. of cases examined	101
Protozoa :	No. of cases infected.
<i>Entamoeba histolytica</i>	6
<i>E. coli</i>	28
<i>Endolimax nana</i>	7
<i>Iodamoeba bütschlii</i>	1
<i>Giardia intestinalis</i>	5
<i>Chilomastix mesnili</i>	1

[As the total number of cases examined in this series is 101, it has not been thought necessary to present these results as percentages.]

I am indebted to Dr. Robertson, Medical Officer of Health for the City of Birmingham, for very kindly granting me facilities to obtain stool samples from Salterley Grange Sanatorium. To Dr. E. G. Glover, M.O. in charge of this sanatorium, my very best thanks are due for the great interest which he took in the work both in the collection and dispatch of the samples and in obtaining the previous medical histories of those cases carrying *E. histolytica*. Through his keenness, too, he obtained samples from patients at the Cranham Lodge Sanatorium, Stroud, in the charge of Dr. Arthur H. Hoffman, to whom also my best thanks are due for the interest taken in the work and for the readiness with which he sent information about the carrier cases.

[The following additional particulars concerning the six cases infected with *E. histolytica* are given on the cards returned from Birmingham, and are added here as they contain interesting information.]

Cases infected with *E. histolytica*.

Case No.	Sex.	Age.	Occupation.	Place of residence.
1	M.	15	Fitter's assistant	Birmingham.
10	M.	51	Engraver	Birmingham.
62	M.	22	Fitter	Bristol.
70	M.	18½	Engineer	Chard, Somerset.
82	M.	35	Munition worker	Birmingham.
103	F.	42	Housewife	Birmingham.

[The following information about five of these cases was elicited by Dr. E. G. Glover (Cases 1, 10, 82) and Dr. A. H. Hoffman (Cases 62, 70).]

Case 1.—Left school when 14 years old. Delivered milk for about 3 months: since employed in about 20 different jobs. Never any tools in mouth, and never repaired old clothing, &c. Born in Birmingham, and has not been elsewhere save for one short visit to a Shropshire village (where he drank tap-water), and one to Bournemouth. Bowels regular as a rule: never constipated. Had diarrhoea lasting one day in 1917, but never passed blood. Has occasional flatulence after heavy meals. No abdominal discomfort. Father a Birmingham man, who died (*aet.* 45) of pneumonia. Mother a Birmingham woman. One brother consumptive, no bowel trouble. No record of dysentery in family. Has never been in contact with foreigners.

Case 10.—Born in Birmingham, where he has lived all his life. Only away on holidays. In engraving industry (steel, gold, &c.) since age of 13—not dusty work. Occasionally holds steel tools in mouth, and does jewellery repairs for private houses. Water-supply always municipal. Healthy boyhood: after 19 years chest troubles. Pleurisy at 22. *Bowels*: seemingly normal till 19, when he had an attack of diarrhoea lasting 2 weeks in midsummer. Free until following summer, when it recurred. Occasional attacks till age of 40, when he went to hospital and had ‘draughts’. Since then well to Christmas 1917, when he had diarrhoea for a week, arrested by treatment. Has haemorrhoids, and is rather constipated as a rule. No special abdominal pain during either constipation or diarrhoea, except colic. *Liver* normal: no jaundice. Wife healthy, never abroad.

Case 62.—Born at Brislington, Bristol, where he has lived all his life. Drinks tap-water. Has been a fitter for 8 years. Does not put tools in mouth, and does not repair old clothes or personal articles. Has had diarrhoea very occasionally, but not lately. No blood or slime in stools. No members of family or household with bowel troubles. No foreigners have lived in his house.

Case 70.—Born in Chard, Somerset, and has lived there all his life. Drinks well-water. In present employment for 1 year. Does not hold tools in mouth. Has not repaired old clothes or personal articles. Has not suffered from diarrhoea or any bowel trouble, nor has any member of his household. No foreigners have lived in his house.

Case 82.—Born in Birmingham, and has lived there all his life: never absent on holiday for more than a few days. Has always drunk tap-water. Cabinet maker and upholsterer from age of 14 to 17—chiefly doing repairs from public-houses, smoke-rooms, and private houses (never bedrooms)—and used to put tacks in his mouth. Polisher (metal) from age of 17 to 32. Joined army in 1914. In training in England September 1914 to February 1915: then discharged with septic poisoning, &c. Usual sanitary arrangements in army: in billets—cottages,

&c.—and drank well-water for 2 months. Not in contact with dysentery cases, and never had diarrhoea himself. At age of 3-4 years he had looseness of bowels (hearsay evidence of parents): since then no diarrhoea. But 6 years ago he had so-called 'catarrh of the stomach' (? due to eating pork), which lasted one week, with diarrhoea and abdominal pain—no blood or mucus or straining—and has been quite well since. No history of diarrhoea in parents, wife, or family. Never in contact with foreigners.

[The following further information regarding the infections of the 6 positive cases has been compiled from the cards.]

Case No. 1.—Cysts of *E. histolytica* present in stools in fair numbers. Diameter 9.5μ to 12.5μ (in fixed and stained condition). No other protozoa found.

No. 10.—Cysts in moderate numbers. Diameter 10μ to 12.7μ , in stained preparation. No other protozoa found.

No. 62.—Cysts in moderate numbers, $12-13.8 \mu$ in diameter. Large numbers of *Giardia* cysts also present.

No. 70.—Cysts in moderate numbers, $10-12 \mu$ in diameter. No other protozoa found.

No. 82.—Cysts in moderate numbers, 12.5μ to 14.8μ in diameter. Cysts of *E. coli* and *Giardia* also present in stools.

No. 103.—Cysts in fair numbers. Diameter 10.7μ to 12.2μ . No other protozoa found. Stool examined only once.

2. BRIGHTON REPORT.

By A. G. Thacker.

A small number of microscopic examinations of faeces of civilians were carried out at the Central Laboratory, Kitchener Hospital, Brighton, in August 1918 and again in June 1919. Sixty-nine persons were examined in all. Most of these persons were inmates of the Workhouse Infirmary, but a few were patients in the Borough Sanatorium. None of the sixty-nine persons concerned were suffering from any intestinal complaint.

The ages of the persons varied from nine years to over seventy, and the sexes were almost equally divided. Forty-six cases were examined once only, sixteen were examined twice, three were examined three times, and the other four more often. The intestinal protozoa were found during these examinations in the following numbers:

<i>Entamoeba histolytica</i>	2 cases
<i>E. coli</i>	15 "
<i>Endolimax nana</i>	4 "
<i>Giardia intestinalis</i>	2 "
<i>Chilomastix mesnili</i>	4 "

Certain particulars were obtained relating to the lives of the persons concerned, and it was found that fourteen of the persons had been abroad at one time or another, most of them to tropical countries. Thus, one of the persons having *Entamoeba histolytica*

was the wife of a soldier and had been to India with her husband, and had suffered from dysentery whilst there. The other person carrying *Entamoeba histolytica* had never been abroad and had never suffered from dysentery. He had been a butcher, but had been in the workhouse infirmary about six years.

In the fifty-five persons who had never been abroad the intestinal protozoa were found in the following numbers:

<i>Entamoeba histolytica</i>	1 case
<i>E. coli</i>	10 cases
<i>Endolimax nana</i>	4 "
<i>Giardia intestinalis</i>	2 "
<i>Chilomastix mesnili</i>	3 "

My thanks are due to Captain J. R. Dickson, R.A.M.C., officer in charge of the Central Laboratory, for kindly arranging for the work to be done under his supervision; and also to Dr. Forbes, Medical Officer of Health for Brighton, to whom we were indebted for the supply of specimens.

[In addition to the foregoing brief report, Mr. Thacker has sent an account of two military patients investigated by him at Brighton. These cases were studied with great care, and their histories inquired into in considerable detail; but as both of them had been abroad, they could not be included in the 'British' series. As the evidence shows, both were cases of typical amoebic dysentery: but the evidence shows, further, that they probably contracted this disease in England. There are, moreover, indications of the way in which they may have acquired their infections with *E. histolytica*. So little is known at present about cases of English amoebic dysentery, and about the manner of acquiring infection with the parasite, that no excuse seems needed for publishing these two cases here in some detail.]

Notes on two cases of amoebic dysentery probably acquired in England.

Case 1.—This patient's father was in the army. During the Egyptian campaign of 1882 he had a severe attack of dysentery. He never recovered from this dysentery, but had repeated relapses, and died in 1890 of dysentery and Bright's disease. The present patient, who was born in 1884, developed dysentery when a small child (about 2 years old), and it was surmised that he had 'caught it from his father'. He did not have it very severely; but in the acute stage he passed about 20 stools *per diem* with much pain in the region of the colon. After this, all through his life, he had periodic severe relapses, four to six times a year. He had 15 to 20 stools *per diem* in these relapses, with severe pain. The patient states that he used sometimes to see blood in his stools during these attacks, but as a rule the bleeding was not profuse. He grew up generally delicate, and became a boot repairer. He joined the army in 1915, and while in the army had several of his usual rather mild

attacks of dysentery. He had a more severe attack at Albert in December 1916—about 25 stools *per diem*, with blood and slime. He was in hospital at Abbeville for nearly six months, and was treated with emetine. After rejoining his unit in May 1917, he had two more mild attacks, and then came home on leave in November 1917. Whilst in England (his home is in Brighton) he entered hospital for ulcers on his legs, and whilst in hospital had another attack of dysentery and was transferred to the 2nd Eastern General Hospital, Brighton, where I first saw him (March 1918). *E. histolytica* was found in his stools at the first examination. He was treated first with emetine injections (1 grain a day for 12 days), but remained positive during the course, and cysts were afterwards found in his stools in great numbers. He was then treated with emetine bismuth iodide (3 grains daily for 12 days); but he again remained positive during the course, and numerous cysts were passed afterwards. As this treatment made him very ill, he was next treated with 'Chaparro'—the usual 10-day course. Ten subsequent negative examinations made over a period of nearly a month allowed him to be passed on to the Dysentery Dépôt at Barton as 'negative'. Here, however, he was again found positive at the third examination. He was then treated twice with emetine bismuth iodide (at Barton)—each course lasting 16 days. After his second course he was passed out of Barton as 'cured'. (He forgets exactly how many negative examinations were made.)

This patient was infected with *E. coli*, *E. nana*, and *Trichocephalus*, in addition to *E. histolytica*. Save for his service in France in the army, he had never at any time been abroad.

Case 2.—This patient had never had dysentery or even severe diarrhoea before the War. He had, however, travelled a lot in Europe—France, Belgium, Holland, Germany, and Spain. (Only once in Spain, in 1902: never further south than Madrid.) He joined the army in September 1916, when 39 years old, and went to Aldershot about November 20, 1916. In Aldershot he shared a room with five other men, one of whom had been in Mesopotamia, and the other four in India. Several of these had had dysentery out East. Patient's battery and another battery used the same latrine; and about December 10 a dispute arose between the two batteries in regard to the cleaning of this joint latrine, with the result that neither battery would arrange for the cleaning to be done. The latrine remained in a dirty state for several days. On December 13 my patient had a sudden attack of dysentery. He was due to go on leave on December 15, so did not report sick, but went home to Halifax. After he reached home he got rapidly much worse, but was treated by his own doctor and had no laboratory diagnosis. He passed about 20 stools daily with much blood. Returned to Aldershot in February 1917 and subsequently went to France, where he had periodic severe attacks of diarrhoea. He was invalided for trench fever in November 1917, and sent to various hospitals. In January 1918 he went into training again at Shoreham. His diarrhoea got worse, and he was invalided

into the 2nd Eastern General Hospital as an 'Enteritis' case in May 1918. I found him positive for *E. histolytica* on the first test. He was then transferred to the Kitchener Hospital, and treated first with emetine injections (1 gr. daily for 12 days). This failed. He was then treated with emetine bismuth iodide (usual 12-day course, 3 gr. *per diem*). This apparently succeeded. Ten negative tests were made by me over a period of six weeks following treatment, and he then passed successfully through Barton Dépôt as a 'negative' case.

3. BRISTOL REPORT.

By A. H. Campbell.

The material for examination was obtained from Stapleton Workhouse, Bristol, and the Children's Hospital, St. Michael's Hill, Bristol. The stools were examined in saline or iodine solution in the usual way, and if necessary fixed and stained preparations were also made.

This work would have been impossible without the very careful collection of material by Dr. W. R. Norgate at the Stapleton Workhouse and the Medical Officers at the Children's Hospital. I am much indebted to them for their assistance, and also to Professor Walker Hall, M.D., for making the general arrangements and for continual interest and advice. The work was carried out in the Pathological Laboratory of the University of Bristol.

Altogether, the stools of 213 adults (including all persons over 12 years of age) and 49 children under 12 were examined. Repeated examination of the same case was not always possible—owing to death or discharge from hospital. The number of examinations made per case was as follows:

	Adults (over 12).	Children (under 12).
One examination	22	41
Two examinations	54	2
Three examinations	137	6
Total No. examined	213	49

[It was found on inquiry that 31 inmates of the workhouse had been abroad, whilst particulars of 4 others were unobtainable. If these 35 cases are eliminated from the series, the total number of persons who had never been out of Britain was 227 (178 adults, 49 children). The protozoological findings in these 227 cases are shown in the following table.]

Persons who have never been abroad.

Total No. of cases examined		227
Protozoa:	No. infected.	Percentage.
<i>Entamoeba histolytica</i>	7	3.08
<i>Entamoeba coli</i>	105	46.2
<i>Endolimax nana</i>	15	6.6
<i>Giardia intestinalis</i>	15	6.6
<i>Chilomastix mesnili</i>	24	0.5

[Although the incidence of *E. histolytica* infection in the adults and in the children was not very different, when the small numbers examined are taken into account, there was a notable difference in the two groups with regard to the other protozoa. This will be evident from the following table.]

Total No. examined	Adults.	Children.
	178	49
Percent. infected with :		
<i>E. histolytica</i>	3.3	2.0
<i>E. coli</i>	53.9	18.3
<i>E. nana</i>	7.8	2.0
<i>G. intestinalis</i>	3.9	16.3
<i>Ch. mesnili</i>	13.4	0.0

[The Stapleton Workhouse series included a number of mental cases (68 in all). The figures obtained for all of the inmates of this institution (213) were :

	Mental.	Non-mental.
Percent. infected with <i>E. histolytica</i>	2.94	2.75

It is thus evident that the 'mental' and 'non-mental' cases were not appreciably different, so far as their degree of infection with *E. histolytica* was concerned.]

[The following are particulars—compiled from the cards—of the 7 persons who had never been abroad and in whose stools cysts of *E. histolytica* were found.]

Case No.	Sex.	Age.	Occupation.	Other protozoa found.
32	M.	52	Porter.	Nil.
78	M.	74	Sanitary worker.	<i>E. coli</i> .
103	M.	65	Lithographic writer.	<i>E. coli</i> ; <i>Chilomastix</i> .
114	M.	3	Nil (infant).	<i>E. coli</i> ; <i>E. nana</i> .
198	F.	44	Nil (mental case).	<i>E. nana</i> .
207	F.	49	Nil (mental case).	<i>E. coli</i> ; <i>Chilomastix</i> .
237 a	M.	14	Nil.	<i>E. coli</i> .

[Case No. 32 had recently had an attack of typhoid, whilst No. 78 is stated to have suffered from dysentery 6 years before. The remainder gave no history of dysentery, diarrhoea, or other intestinal ailment.]

In all these cases *E. histolytica* was found in the encysted condition in the stools. The cysts were all of races ranging from 11.5 μ to 12.8 μ in average diameter. None of the races of *E. histolytica* with smaller cysts were met with.

Out of the whole series of cases (213 adults, 49 children), 22 (all adults) had a previous history of dysentery. Only one of these was found infected with *E. histolytica*. But 50 adults and 16 children had suffered at some time from chronic diarrhoea, and in none of these were the cysts of the parasite detected.

4. LEEDS AND SHEFFIELD REPORTS.

By Muriel M. Nutt.

The following are the results obtained from the examination of the stools of civilians with a view to ascertaining what percentage of the normal population of this country is infected

with *Entamoeba histolytica* and other intestinal protozoa. The majority of the examinations were done at Leeds on specimens obtained from patients at the General Infirmary and Workhouse Infirmary. A number of specimens have also been obtained from the Royal Hospital, Sheffield.

Acknowledgements.—I am extremely indebted to Professor M. J. Stewart for the trouble he took in getting me specimens from the Leeds General Infirmary, and for his kindness and the interest he took in this work. I also wish to thank Dr. Allen of the Leeds Workhouse Infirmary for allowing me to obtain specimens from the workhouse patients, and Major Jamieson for the facilities he gave in starting the work at the East Leeds War Hospital. To Dr. Gruner I am indebted for the specimens from the non-dysenteric military patients at Killingbeck and East Leeds War Hospitals (see Appendix, p. 36). At Sheffield my work at the University has been greatly facilitated by Professor Sholto Douglas's kindness and help. I must also express my gratitude to Dr. Hall for his kind assistance in obtaining specimens for me from the Royal Hospital, and to Dr. Naish for those obtained from the Children's Ward of the same Hospital.

Technique.—The technique employed has been exactly similar to that used in the routine examination of the military cases. Two preparations were made from every specimen, from different parts of the stool, the preparations being made in normal saline or Weigert's iodine solution.

(a) *Leeds.*

Two classes of civilians have been examined—adults, and children under twelve years old. The following table gives the percentages of protozoa found in the total number of persons examined:

Total No. of persons examined	461
Percent. infected with :	
<i>Entamoeba histolytica</i>	Adults (333). Children (128).
<i>E. coli</i>	1.2 1.6
<i>Endolimax nana</i>	21.0 13.3
<i>Iodamoeba bütschlii</i>	2.4 4.7
<i>Giardia intestinalis</i>	0.3 0.0
<i>Chilomastix mesnili</i>	3.6 39.8
<i>Trichomonas hominis</i>	11.4 7.8
	0.3 0.0

It was necessary to find out how many of the 461 civilians examined had ever been abroad. In the next table, therefore, these are divided into different groups, A, B, C. In *Group A* none of the 210 adults had ever been out of this country, and of these 3 were infected with *E. histolytica*. All the 128 children examined were found to belong to *Group A*, and of these 2 were passing *E. histolytica* cysts. *Group B* consists of those persons of whom it was impossible to ascertain with certainty whether they had ever been abroad. As far as could be gathered from the sisters in the wards and other indirect sources it seemed very

unlikely, but as information could not be obtained from the patients themselves it seemed best to place them in a separate class as uncertain. In *Group C* are placed 31 cases who have been abroad at some period of life. One out of these was positive for *E. histolytica*. The small number of persons in this group necessarily makes the percentage of positives higher here than in the other two:

Percent. infected with:	Group A.		Group B.	Group C.
	Adults.	Children.		
	(210)	(128)	(92)	(31)
<i>Entamoeba histolytica</i>	1.4	1.6	0.0	3.2
<i>E. coli</i>	21.9	13.3	22.8	9.7
<i>Endolimax nana</i>	2.9	4.7	1.1	3.2
<i>Iodamoeba bütschlii</i>	0.0	0.0	1.1	0.0
<i>Giardia intestinalis</i>	3.8	39.8	4.3	0.0
<i>Chilomastix mesnili</i>	12.4	7.8	8.7	12.9
<i>Trichomonas hominis</i>	0.0	0.0	1.1	0.0

Notes on the Cases infected with E. histolytica.

Case I. 1. Woman of 69. Has never been out of the country. Was formerly in a mill, now does charring. Place of residence, Leeds. Has had occasional attacks of diarrhoea, both lately and in the past. This was a case showing precystic ('*minuta*') amoebae, average diameter 12–13 μ . (Also infected with *E. coli* and *Giardia*.)

Case I. 2. Man of 67. Never been out of this country. Residence, Castleford. Never troubled with diarrhoea or any other intestinal complaint. Cysts few, with an average diameter of 13 μ . (Also infected with *E. coli*.)

Case W. 3. Man of 66. This man was paralysed and had great difficulty in speaking and making himself understood, but as far as could be gathered it seemed very unlikely that he had ever been abroad. Occupation, gardener. Residence, Leeds. No history of dysentery or diarrhoea. Cysts few, 12–13 μ in diameter. (Also infected with *E. coli*.)

Case I. 4. Woman of 72. Fifty years ago had been in New York. Used to take in sewing as an occupation. Residence, Leeds. Never had any trouble with diarrhoea nor a day's illness in her life until she entered the Infirmary for eye treatment. Cysts few, average diameter 7–8 μ . (No other protozoa found.)

Case I. 334. Boy of 11. Has never himself been abroad, but parents are Russian Jews. Never troubled with diarrhoea, and seemed quite healthy and sturdy. Was in the Infirmary for treatment of his eyes. Cysts few, average diameter 12 μ . (Also infected with *E. coli*, *E. nana*, and *Trichuris*.)

Case W. 335. Girl of 10. Tubercular. Never been out of the country. Had no trouble with diarrhoea. Residence, Leeds. Parents have never been abroad. Cysts few, 13 μ in diameter. (Also infected with *E. coli*, *Giardia*, and *Chilomastix*.)

Number of examinations.

The majority of the cases could be examined only once, but a certain number were examined two or more times. Three out of the four adults who were positive for *E. histolytica* were discovered at the first examination, and one at the third examination. Among the children, both positives were found at the first examination. The following table shows the number of examinations made per case for the whole series :

	Adults.	Children.
No. examined once	275	103
" " twice	39	20
" " 3 times	17	4
" " 4 "	1	1
" " 7 "	1	0
	333	128

Sex and Protozoal Infection.

In the following table all the adults examined (333) are divided into males and females, so that a comparison between the incidence of protozoal infections in the two sexes can be made. It will be seen, however, that there is very little difference between them in this respect :

	Adults.	
	Males.	Females.
Total No. examined	172	161
Percent. infected with :		
<i>E. histolytica</i>	1.2	1.2
<i>E. coli</i>	22.5	20.5
<i>E. nana</i>	2.9	1.9
<i>I. bütschlii</i>	0.6	0.0
<i>G. intestinalis</i>	3.5	3.7
<i>Ch. mesnili</i>	10.5	12.4
<i>T. hominis</i>	0.0	0.6

Age, Occupation, Residence.

From the above tables age seems to have little or no bearing upon the protozoal infection except possibly in one case, that of infection with lamblia (*Giardia intestinalis*). Children appear to be infected in greater numbers than adults. This is shown in the first table, where for children the percentage is 39.8, while for adults it is 3.8 only. Two groups of children have been examined, and in each group the lamblia infection is higher among them than among adults taken from the same institution. The higher percentage was found among the Workhouse children, where it reached 48.8 per cent., as against 3.6 per cent. found in adults from that institution. Among the children examined from the Leeds General Infirmary the percentage was 23.9 compared with 3.9 found in the corresponding adults.

The age at which children were found to be infected in the greatest numbers was between one and four years.

There does not seem any relation between occupation and infection, neither does the place of residence, whether in a large

town or small country village, seem to have any connexion with the protozoal infection. It should be noted, however, that the majority of the cases examined at Leeds are resident in the poorer parts of the city.

(b) *Sheffield.*

From January to May, 1919, I examined the stools of 174 civilians at Sheffield. Of these, 117 were adults and 57 children—all inmates of Sheffield Royal Hospital and Royal Infirmary. On investigation it was found that 6 of the adults had been abroad. These have been eliminated from the series, so that the results summarized in the following table were obtained from 168 cases (111 adults, 57 children) who had never left England. Of these cases, 84 adults and 39 children were examined once only—the remainder twice, thrice, or more often (only 5 cases more than 3 times). The table corresponds to that given for the Leeds civilians, and shows the percentages of the various protozoa found:

Total No. of persons examined	. . . . . 168	
Percent. infected with :	Adults (111).	Children (57).
<i>Entamoeba histolytica</i>	1.8	5.3
<i>E. coli</i>	26.1	24.6
<i>Endolimax nana</i>	6.3	7.0
<i>Giardia intestinalis</i>	7.2	15.8
<i>Chilomastix mesnili</i>	5.4	5.3

No infections with *Iodamoeba* or *Trichomonas* were found in this series.

[It may be noted, however, that several infections with *Trichuris* were found at both Leeds and Sheffield. The total number of persons found to be passing ova of this worm in their stools was 5, or approximately 1 per cent. of the whole series of 506 persons who had never been abroad.]

The total number of persons found to be infected with *E. histolytica* was 5 (2 adults, 3 children). Below are further notes on these positive cases—none of whom had, of course, ever been out of the British Isles.

Case 1.—Boy of 17. Has never suffered from dysentery or persistent diarrhoea. Residence, Sheffield. Occupation connected with grinding stone. Cysts few, diameter 12–13 μ . (Also infected with *E. coli* and *Giardia*.)

Case 2.—Man of 30. Butcher, residing in Sheffield. Has never suffered from dysentery, diarrhoea, or any other intestinal trouble. Cysts few, 12–13 μ in diameter. (No other protozoa found.)

Case 3.—Boy of 13, living in Sheffield. Has never suffered from dysentery, but occasionally has slight diarrhoea—never severe. Cysts ca. 12 μ in diameter, few. (Also infected with *E. coli* and *Giardia*.)

Case 4.—Girl of 8, living at Conisborough. Has never been troubled with dysentery or diarrhoea; but whilst in hospital had

bowels moved 2-3 times a day. In hospital for tuberculosis of knee. Father a soldier, in France. Cysts few, ca. 12 μ in diameter. (Also infected with *E. coli* and *Giardia*.)

Case 5.—Boy of 9, living in Sheffield. Has never suffered from dysentery or diarrhoea—and appears perfectly healthy. In hospital for amputation of leg. Cysts few, belonging to two different races—ca. 7 μ and 12 μ in diameter. (Also infected with *E. coli*.)

Summary and Conclusions.

At Leeds and Sheffield I examined altogether 506 members of the civil population who had never been abroad. These consisted of 321 adults and 185 children. Out of this number 10 individuals were found to be infected with *Entamoeba histolytica*—that is, approximately 2 per cent. A higher rate of infection was found in children than in adults, the figures being:

5 out of 185, or 2.7 per cent. of children infected with *E. histolytica*.
5 " " 321, " 1.5 " " adults " " " "

The other intestinal protozoa were also found more frequently in children than in adults. At Leeds 32.7 per cent. of adults and 50.8 per cent. of children were found infected with protozoa other than *E. histolytica*. The most striking difference was in the rate of infection with lamblia (*Giardia intestinalis*), the figures being:

Percentage	Leeds.		Sheffield.	
	Adults.	Children.	Adults.	Children.
	3.8	39.8	7.2	15.8

The percentages given are all probably too low, since in the majority of cases they are calculated on the result of one examination only.

APPENDIX.

Non-dysenteric military patients.

In order that a comparison might be made with the foregoing results obtained from civilians, a certain number of non-dysenteric military patients were examined during July 1918. The majority were nephritis cases at Killingbeck Military Hospital, Leeds, the remainder being surgical cases at East Leeds War Hospital, and about five were from the Leeds General Infirmary. The results are tabulated below:

Total No. of cases examined	Percent. infected.
Protozoa :	71
<i>Entamoeba histolytica</i>	7.0
<i>Entamoeba coli</i>	40.8
<i>Endolimax nana</i>	11.3
<i>Iodamoeba bütschlii</i>	4.2
<i>Giardia intestinalis</i>	8.5
<i>Chilomastix mesnili</i>	4.2

Notes on the cases carrying E. histolytica.

Case M. 462, had been in France $2\frac{1}{2}$ years but never in the East. Had no history of dysentery or diarrhoea or any other intestinal trouble. Surgical case. Cysts $7\ \mu$ in diameter.

Case M. 463, had been in France, South Africa, Ceylon, Singapore, but never had dysentery, diarrhoea, or any other intestinal ailment. Nephritis case. Cysts $7-8\ \mu$ in diameter.

Case M. 464, had been in France but not in the East. Slight diarrhoea in France about a year ago. Nephritis case. Cysts $10\ \mu$.

Case M. 465. Trench fever case. Unfortunately, this patient was sent away before any information could be obtained from him. Had certainly been in France. Cysts $12\ \mu$.

Case I. 466. Discharged soldier in Leeds General Infirmary. Had been in France but not in the East. Never had a day's illness in his life before he was wounded in France in 1917. The majority of the men in his regiment in France had suffered from dysentery. Cysts $12\ \mu$.

Thus it appears as if about 7 per cent. of the military patients who are sent to hospitals for diseases other than dysentery are carriers of *Entamoeba histolytica*.

5. READING REPORT.

By R. C. McLean.

The following examinations were carried out in the laboratories attached to the Royal Berkshire Hospital and the Reading War Hospital.

Those examined were, with few exceptions, inmates of either the Royal Berkshire Hospital or of the Park Isolation Hospital, Reading. I wish to acknowledge my indebtedness to the medical staff of those institutions for permission to conduct the investigation, and to the Matrons and Sisters for their kind help in collecting and forwarding specimens for examination.

The total number of persons examined was 140, divided thus :

Adults	{	Males 57.
	{	Females 60.

Children under twelve 23.

Of these, 20 (15 males, 5 females) gave particulars of residence abroad. Among these were 7 ex-soldiers with a record of service in France during the War. None of them had dysentery recorded in their medical histories. [The total number of persons who had never been abroad was thus 120. The stools of each were examined only once.]

The total number giving an account of previous intestinal disorder was 4, of whom the following are the particulars :

M. 58. Carcinoma of rectum in July 1918. No residence abroad. No protozoa.

- M. 81. Dysentery in Reading 1896. Visited China 1850. No protozoa.
 F. 26. Dysentery in Reading 1913—'slight.' Visited the West Indies 1912. No protozoa.
 F. 115. 'Clinical Dysentery' at date of examination. A military nursing sister. No residence abroad. No protozoa.

Below is a summary, in tabular form, of the results of the protozoological examinations of the stools of the persons who had never been abroad.

Total No. of cases examined	120	
Protozoa :	No. of cases infected.	Percentage.
<i>Entamoeba histolytica</i>	3	2.5
<i>Entamoeba coli</i>	20	16.6
<i>Endolimax nana</i>	10	8.3
<i>Giardia intestinalis</i>	13	10.8
<i>Chilomastix mesnili</i>	1	0.8

It is interesting to note that the three cases in which cysts of *E. histolytica* were found were all females in the same ward of the Berkshire Hospital. Their ages and occupations were:

Case No.	Age.	Occupation.
6	66	Nil (house duties only).
15	19	Domestic servant.
38	18	Laundry maid.

As two of these—Nos. 15 and 38—were young girls in employment in villages, they may be regarded as liable to contact with returned soldiers. The third was a woman living in a good residential district of Reading. None had any trace of intestinal disorder present or past, but they were all three evacuating the cysts in large numbers.

[From the entries on the cards, it appears that the cysts of Case 6 measured 9–13 μ in diameter; those of Case 15, 8–11 μ . The diameter of the cysts of Case 38 is not recorded. It may be added that Cases 15 and 38 were also infected with *E. nana*, and Case 6 with *Giardia*.]

Finally, it may be noted that worm eggs were found in the stools of 11 cases (*Trichuris trichiura*, 7; *Ascaris lumbricoides*, 3; *Oxyuris vermicularis*, 1).

CHAPTER IV. SUMMARY OF ALL REPORTS, AND DISCUSSION OF CERTAIN POINTS OF PARTICULAR INTEREST.

In this chapter I propose to combine and discuss the results obtained by all the workers concerned in the present investigation. I shall begin with a consideration of the incidence of infection with the various protozoa studied.

A. The Incidence of Protozoal Infections in Persons who have never left Britain.

There is now a fairly large accumulation of statistics bearing on this subject, and it is therefore now possible to estimate the probable incidence of several different protozoal infections with some precision. In order to arrive at a just estimate of the results as a whole it will be necessary, in the first place, to add together the findings recorded in the several Reports.

The findings of Smith and Matthews are mostly presented in the form of percentages; and I have therefore worked out their actual figures in order to be able to combine them with those of the later workers. I have thought it necessary, for the present purpose, to exclude the results recorded by them for asylum patients. The people of this category are in several ways not fair samples of the population, and there is reason to suppose that their habits and mode of life are conducive to the acquisition of intestinal infections to an abnormal extent. Excluding, therefore, the mental cases examined by Matthews and Smith (1919 *a*) and Smith (1919), I have obtained the following figures from all the Reports published by the Liverpool workers:

Cases.	Total No.	Protozoa ¹					
		<i>E. h.</i>	<i>E. c.</i>	<i>E. n.</i>	<i>I. b.</i>	<i>G. i.</i>	<i>Ch. m.</i>
Civilians, Royal Infirmary	450	7	30	11	1	27	7
Army Recruits	1098	62	200	60	5	77	2
Children	548	10	61	15	1	77	10
Cadets	41	1	11	1	0	1	0
Grand total	2137	80	302	87	7	182	19

This table gives the actual numbers of persons found infected with intestinal protozoa in the four series of cases investigated by

¹ In this and the two subsequent tables the following abbreviations are used for the names of the intestinal protozoa which come into consideration:

E. h. = *Entamoeba histolytica*.
E. c. = *Entamoeba coli*.
E. n. = *Endolimax nana*.
I. b. = *Iodamoeba bütschlii*.
G. i. = *Giardia intestinalis*.
Ch. m. = *Chilomastix mesnili*.

Matthews and Smith: but it must be remembered that the findings are based throughout on the results of only one examination per case. None of the 2,137 persons in the whole series had ever been abroad.

If we now take the results of the newer Reports, given on earlier pages, and express them in the same way—converting percentages into actual numbers as before, when necessary—we obtain the figures shown in the following table:

Cases at	Total No.	Protozoa.					
		<i>E. h.</i>	<i>E. c.</i>	<i>E. n.</i>	<i>I. b.</i>	<i>G. i.</i>	<i>Ch. m.</i>
Birmingham	101	6	28	7	1	5	1
Brighton	55	1	10	4	0	2	3
Bristol	227	7	105	15	0	15	24
Leeds and Sheffield	506	10	106	23	0	76	45
Reading	120	3	20	10	0	13	1
Grand total	1009	27	269	59	1	111	74

If we add these findings from 1,009 individuals who have never been abroad to those from the 2,137 similar cases in the Liverpool series, we obtain the following results:

Cases.	Total No.	Protozoa.					
		<i>E. h.</i>	<i>E. c.</i>	<i>E. n.</i>	<i>I. b.</i>	<i>G. i.</i>	<i>Ch. m.</i>
Liverpool (4 series)	2137	80	302	87	7	182	19
Six new series	1009	27	269	59	1	111	74
Grand total	3146	107	571	146	8	293	93
Percent.		3.4	18.1	4.6	0.25	9.3	2.9

These final percentages, based on the records obtained from the examination of over three thousand individuals—men, women, and children—who have lived all their lives in Britain, give us material for making an approximately correct estimate of the extent to which the indigenous population of these islands is infected with intestinal protozoa. But they cannot be accepted, as they stand, as correct; and for the following reasons.

The greater part of the series (over 2,000 persons) is composed of the Liverpool cases. These were all examined but once apiece, and they thus form—in this respect—a homogeneous series. The other series, however (over 1,000 cases, or roughly one-third of the whole), consist of persons examined a variable number of times each, and consequently the whole series is not homogeneous in respect to the number of examinations made per case. It is well known—from the figures already collected and published by myself (1917) and others—that the number of infections found in any series examined depends upon several factors: and one of the most important of these is the number of examinations made per case in the series. (I leave out of account now the other factors—such as the competence of the examiner, the time taken in making the examination, &c.—since there is no reason to

discuss these questions here. All the examiners whose work is under consideration were specially trained for this work, and not employed in it until I was personally satisfied of their competence. They all used similar methods, and may, I think, be trusted to have exercised due care and diligence.) The number of examinations made per case in the new series is roughly as follows:

In the Birmingham series (101 cases), all but three cases were examined thrice each. At Brighton (55 cases), most cases had only one examination, but a few two or three. At Bristol, about a half of the 227 cases studied had three examinations apiece, and the rest one or two. The Leeds and Sheffield cases (338 and 168 cases respectively) mostly received one examination each, but a number received two or more. The 120 cases at Reading were examined only once each. It is thus evident that the majority of the cases in the whole series received but one examination apiece; though a significant proportion received two or three, and a negligible number more than three.

Now from figures which I have published elsewhere (1917), from those recorded by the Liverpool workers and others, and from those which I have accumulated since, it is clear that if any series of cases is examined only once apiece, the number of infections found is very considerably less than that which actually existed. The errors due to deficient examination are not easily determinable with precision; but it is probable that, *if the series examined is sufficiently large*, they are approximately of the following order of magnitude: *A series of cases examined once apiece may be expected to disclose about one-third of the infections actually present.* The number of infections found will, at all events, almost certainly be less than one-half of the real number. The error for a series examined *thrice per case* is more easily determined: and it is probable that, in such a series, *between one-half and two-thirds of the actual number* of infections will have been detected.

From these considerations it is clear that the percentages given in the last table—since they are based, for the most part, on series examined only once per case—must be multiplied by at least two, or even by as much as three, in order to obtain the true incidence of infection. To multiply by two would almost certainly give too low a value, since a relatively small number of cases received more than one examination; but if we multiply by three, we shall run the risk of obtaining too high a figure, since this would be the factor appropriate to a series examined throughout only once apiece. It is not at present possible to deal with findings of this sort with great mathematical accuracy, but it is probably safe to assume that the true figures lie between the limits which can be approximately determined in this manner. I believe, therefore, that the following figures give a fair estimate of the true incidence of infection with the various protozoa, as indicated by the minimal actual findings exhibited in the preceding table:

Protozoon :	Estimated percentage incidence.
<i>Entamoeba histolytica</i>	7—10
<i>Entamoeba coli</i>	36—54
<i>Endolimax nana</i>	9—13
<i>Iodamoeba bütschlii</i>	0.5—0.75
<i>Giardia intestinalis</i>	18—27
<i>Chilomastix mesnili</i>	6—9

It is now necessary to consider each intestinal protozoon in greater detail, since there are special points of interest connected with each and these have hitherto been omitted. I shall begin with *Entamoeba histolytica*, which is the most important, and which must therefore be considered in greatest detail.

1. *Entamoeba histolytica*.—It is clear that infections with this protozoon are by no means uncommon in the resident population of Britain. At least one carrier of this parasite has been found by every worker who has taken part in the present investigation. It has been demonstrated that 3.4 per cent. of examined persons who have never been abroad (over 3,000 cases) are infected; and, as already stated, this probably indicates that some 7 to 10 per cent. of these individuals actually harboured the parasite.

If it be permissible to generalize from these findings, for a relatively small number of cases, to the population as a whole, then it appears that the people of these islands are infected to a noteworthy extent—an extent, at any rate, which was quite unsuspected until recently. It may, of course, be objected that such generalization is not yet justified. The sample examined is small: it may not be representative. On the other hand, it may be remarked that the sample, though small, is not very small; and there is no obvious reason why it should not constitute a fair sample—unless it be that it consists mainly of persons belonging to the lower grades of society. It must not be forgotten, however, that among the higher grades it becomes increasingly difficult to find persons who have never been abroad, and who have therefore only been exposed to infection at home. When this is borne in mind, it appears not improbable that the entire population—including all who have and all who have not been abroad—would, if subjected to examination, prove to be even more heavily infected with *E. histolytica* than the figures here recorded seem to indicate. There seem no good grounds, at all events, for supposing that the incidence for the total population is less.

The first indigenous case of *E. histolytica* infection recorded in Britain is probably that of Dickinson (1862), though the diagnosis rests on indirect evidence.¹ The case of Saundby and Miller (1909) appears to be the first in which *E. histolytica* was actually seen,² and the case described by Wenyon (1916) was apparently the earliest recognized carrier showing cysts in the stools.³ The later cases, described by the Liverpool workers and others, belong almost entirely to this class—more or less healthy persons (carriers) showing no clinical signs of disease due to their infections.

¹ See p. 17.

² See p. 19.

³ See p. 7.

It is certain, from the morphology of the organism and its pathogenicity to the cat—and sometimes to human beings—that the amoebae and cysts found in British subjects really belong to the species known as *Entamoeba histolytica*—already familiar as the ‘cause’ of amoebic dysentery and hepatic abscess in the tropics. It has been shown (Wenyon and O’Connor (1917), Dobell and Jepps (1918), &c.) that there are different strains of this species, distinguishable by the dimensions of their cysts. No detailed study of the strains found in British infections has yet been made: but it is clear, from the measurements recorded by several workers (see Chapter III), that similar strains exist in Britain. The commonest—as in the case of the ‘tropical’ infections—appear to be those with cysts measuring 7–9 μ or 12–13 μ in mean diameter; but there is not yet sufficient evidence to show the relative frequency of the various strains in Britain.

Up to the present I have considered the incidence of *E. histolytica* infection in Britain *en bloc*—without distinction of age, sex, locality, or occupation of the infected individuals. Something on each of these heads must be added here.

Age.—The age at which infection with *E. histolytica* may be first acquired has not yet been established with certainty, but it is undoubtedly very early. The largest series of children examined are those of Matthews and Smith (1919), who examined 548, and of Miss Nutt, who examined 185. The first series showed that 1.8 per cent. were infected with *E. histolytica*, the second 2.7 per cent.

Matthews and Smith (1919) state that ‘among fifty children, under one year of age, no infections were found’; but one infection with *E. histolytica* was discovered by them ‘in a girl just three years of age’. This is probably the youngest case in all the series, but Mr. Campbell has recorded (p. 31) another *E. histolytica* infection in a child of 3; and it may be recalled that Moore’s patient (1881) died—apparently of an amoebic abscess of the liver—at the age of 3½ years. It is possible that in the case recorded by Mr. Thacker (p. 28) the patient contracted amoebic dysentery when only two years old.

There is now definite evidence that infections with intestinal protozoa may be acquired during the first year of life (cf. *Giardia*, p. 52); and, although such early infection has not yet been observed in the case of *E. histolytica*, there appears to be no reason to suppose that it behaves, in this respect, differently from the other common intestinal organisms.

Infections with *E. histolytica*—and all other intestinal protozoa—appear to be remarkably persistent, and it is probable that when an infection is once acquired it lasts, in most cases, for the rest of life. (Cf. Wenyon and O’Connor (1917), Dobell and Stevenson (1918).) The longer a person lives, the longer he is exposed to the risk of becoming infected; and consequently one would expect that, *ceteris paribus*, older people would show a higher degree of infection than younger. This appears to be true. Matthews and Smith have given the following figures bearing on this point:

Age of Cases.	No. examined.	Percentage of <i>E. histolytica</i> .
1—5	275	1.1
5—12	223	3.1
circa 18	1098	5.6

I am not sure whether these authors accept this interpretation of their figures, for they appear to believe that some intestinal infections may be commoner in children than in adults. This supposition is linked with their hypothesis that protozoal infections of the intestine do not persist indefinitely, but tend to die out in the course of time. They have not been able, however, to obtain any direct or conclusive evidence of this, and there are many observations which are not consistent with such a belief. It must be noted here, further, that the above figures are selected, and it is possible to select others which might lead to a different conclusion. The numbers constituting most of their series are comparatively small, however, and the error inherent in a system of only one examination per case is large. And consequently when results such as those recorded by Miss Nutt (p. 36) are considered—she found 2.7 per cent. of 185 children and only 1.5 per cent. of 321 adults infected with *E. histolytica*—it is by no means easy to draw certain conclusions from them. It is at least debatable whether these findings indicate—as they might seem to at first sight—that the children were more heavily infected than the adults: and on other grounds such a generalization appears to me unwarranted.

Sex.—In several series the cases have been sorted into sexes, and the findings presented for the two classes separately. The results have been consistent throughout, and show clearly that *E. histolytica* occurs in males and females with equal frequency. It will be unnecessary to recapitulate all the findings here: an example will suffice. Miss Nutt, in the Leeds series, found 1.2 per cent. of adult males infected, and the same percentage of adult females. Other series gave comparable results, and Matthews and Smith have already concluded that the distribution of *E. histolytica*—and other intestinal protozoa—is ‘irrespective of sex’.

Occupation.—Matthews and Smith (1919) note that ‘some of the results we have obtained seem to indicate that there may be occupational differences in the incidence of infection’ with *E. histolytica*. They give the occupations of a number of the cases which they studied, and these have been recorded also for most of the individuals in the newer reports printed in the previous chapter. From all the records—including those of Baylis (1919), and others already printed elsewhere—I have been able to collect information concerning the occupation of one hundred persons found to be infected with *E. histolytica* in Britain. Not one of these had ever been abroad prior to the time of examination. I have purposely excluded from this series all children under 12, and patients in lunatic asylums. On analysing and classifying these cases I obtained the following list:

Occupation.	No.
Miners	17
Engineers, mechanics, &c.	13
Clerks, shop assistants, &c.	8
Housewives, domestic servants, &c.	6
Dock labourers, &c.	5
Farm labourers	4
Metal workers	4
Spinners and weavers	4
Carters	4
Railwaymen, porters	3
Stone-workers, &c.	3
Labourers	3
Butchers	3
Glass-workers	2
Chemical workers	2
Carpenters, &c.	2
Bootmakers	2
Packers, warehousemen	2
Schoolboys	2
Sanitary worker	1
Fisherman	1
Tailor	1
Gardener	1
Grocer	1
Greengrocer	1
Miller	1
Baker	1
No occupation (paupers)	3
Total	<u>100</u>

I give these figures for what they may be worth. They do not, unfortunately, give us any indication of the relative frequency of infection among different classes of workers: but they are of some interest in other ways. For example, the fact that *E. histolytica* occurs among domestic servants, bakers, butchers, grocers, and other persons who habitually handle food, suggests possibilities which cannot be ignored in considering the spread of infection through the community. (Cf. p. 54 *infra*.)

On general grounds one would expect *E. histolytica* and other intestinal protozoa to occur most frequently among people who live under the most insanitary conditions. Prompt and efficient disposal of faeces, and great personal cleanliness, would certainly limit the spread of infection. It is scarcely surprising to find that farm hands and dockers are infected, and nobody is likely to be astonished at seeing a 'sanitary worker' in the above list. It is unfortunate that no figures are available to indicate the incidence of infection among these various classes, and among groups of persons belonging to higher social strata. It will be remembered that practically all the persons hitherto studied belong to the labouring and artisan classes; and consequently all the carriers found are of the same status.

The large number of miners in the list will be noted, and this record is of particular interest. The infected individuals were mostly found by Matthews and Smith in a series of colliers. In this series, consisting of 78 men, no less than 10, or 12·8 per cent., were found to be infected with *E. histolytica*. All the infected

individuals came from the South Wales coalfields. Although the series is small this percentage is remarkably high, when it is remembered that the stools were examined only once apiece. It is probably too high to be without significance, and appears to indicate that miners are infected to a greater extent than many other classes of the community: which might, indeed, have been expected, since the localization and spread of some other parasites in mines is already well known.

The high rate of infection with *E. histolytica* found among lunatics should also be noted here. At one asylum Matthews and Smith (1919 *a*) found 9·7 per cent. of the inmates infected, as a result of making only one examination per case. This is a high rate, but not so high as a previously published record for the same asylum appeared to indicate (Yorke, 1918). This series well illustrates the possible errors in small samples. In the first report, when only 46 cases had been examined, no less than 19·5 per cent. were found infected with *E. histolytica*. Later, when 207 cases had been studied, this percentage fell to 9·7. At another asylum, where he examined 504 patients (once apiece), Smith (1919) found only 4·2 per cent. infected. Campbell (*supra*, p. 31) found 2·94 per cent. of 'mental cases', in a workhouse, infected with *E. histolytica*—as compared with 2·75 per cent. in a larger series of 'non-mental' cases in the same institution. Such figures as these do not justify the conclusion that all lunatic asylums are hotbeds of *E. histolytica* infection.

In considering the possible correlation of *E. histolytica* infection with particular occupations or modes of life, it is important to remember that the parasite occurs in children—even in those of very tender age. When this is borne in mind, and the results of the investigation of several families by Smith and Matthews¹ and Kuenen² are also taken into account, it seems clear that the home is no longer negligible as a source of contagion; and that occupation may, perhaps, be one of the less important of the factors which determine the acquisition of infection with *E. histolytica*.

Geographical Distribution.—In the reports already published, and in those now presented in Chapter III, there is some information about the present distribution of *E. histolytica* in Britain. It is not complete, but it is, in some respects, suggestive.

Most of the persons in whom *E. histolytica* has been found have been interrogated regarding their usual place of residence: and this has been recorded. The workers at Liverpool, Birmingham, Bristol, Brighton, Leeds, Sheffield, and Reading, have found most of their infected cases among residents in the districts in which they worked. The fact that not one of these workers failed to find local cases of infection shows that *E. histolytica* probably has a wide distribution. But by no means all the cases examined were habitually resident in the places in which their examination took place. Some of them had left their native towns or villages—to undergo military training,

¹ See p. 55, *infra*.

² See p. 60.

and for other reasons—and were found, consequently, in places to which they did not properly belong. For example, the Welsh colliers examined by Matthews and Smith at Liverpool did not belong to this city: and it seems probable that they had contracted their infections in their native country rather than in Lancashire. Yet this is not absolutely certain, of course: and this uncertainty must be borne in mind in attempting to draw conclusions from the incomplete records which are available.

With the foregoing reservation, it may be stated that cases of indigenous *E. histolytica* infection have now been found in England—north, south, east, west, and the midlands; and in natives of Wales, Scotland, and Ireland. The records, from all sources, contain instances of the occurrence of *E. histolytica* in persons usually resident in the following counties:

ENGLAND	{	Lancashire	WALES	{	Carnarvon
		Yorkshire			Cardigan
		Cumberland			Carmarthen
		Westmoreland			Glamorgan
		Cheshire			
		Shropshire			
		Staffordshire			
		Warwickshire			
		Monmouth			
		Gloucestershire			
		Somerset			
		Berkshire			
		Hertfordshire			
		Northamptonshire			
Sussex					
London					
SCOTLAND	{	East Lothian	IRELAND	{	Derry
		Shetland Isles			Cork

I have not thought it worth while to record the precise localities; for the incomplete records at present available do not supply sufficient evidence for attempting to estimate the geographical distribution of *E. histolytica* in detail. It is possible that the parasite is commoner in some places than in others, but there is no clear evidence of this in the records. The largest numbers of cases have been found in the places where the longest search has been made for them; and since no cases have yet been looked for in many areas, a complete survey is out of the question at the present moment.

Nevertheless, I believe that the available evidence indicates clearly that *E. histolytica* infection is prevalent throughout the length and breadth of the British Isles. Probably no region—not excepting even the smallest inhabited islands—will be found, if investigated, to be free from infection. This conclusion harmonizes with what is already known about the distribution of this parasite in the rest of the world: for the evidence is steadily accumulating to show that its occurrence is world-wide, and is not limited to any particular region of the globe or race of mankind.

Relation to Disease.—The workers at Liverpool have, apparently, found no evidence that the large number of healthy but

infected persons whom they studied were, as a class, more prone to suffer from dysentery or other intestinal diseases than uninfected persons from the same walks in life. The later workers—whose results are here recorded—have obtained concordant results. Histories of all the cases studied were obtained, as far as possible, and recorded: and inspection of these records shows that a past or present history of dysentery is apparently no commoner in persons infected with *E. histolytica* than in those who are nominally 'uninfected'. The figures are, however, for various reasons inconclusive. For example, when a person is found to have suffered in the past from 'dysentery', it is now usually impossible to ascertain its cause. The complaint was generally diagnosed on clinical grounds; and even if the patient is found later to harbour *E. histolytica* it is by no means certain that this parasite was the cause of the trouble. The patient may have suffered from bacillary dysentery, whilst remaining a 'healthy' carrier of the amoeba; or he may have acquired his infection after the attack of dysentery. A history of 'diarrhoea' is even more difficult to interpret; for there are but few who, on being closely interrogated, are found not to have suffered, upon occasion, from this common complaint. Furthermore, when a person has been examined but once, and found 'negative' for *E. histolytica*, the conclusion that he is 'not infected' is by no means warranted. Consequently, in all our series the 'negative' cases with a past history of dysentery or diarrhoea cannot furnish us with reliable statistics of the incidence of these diseases in persons uninfected with *E. histolytica*.

The findings, given for what they are worth, appear to be as follows for the infected persons so far studied. The Liverpool workers, in their first published series, state of the ten cases of *E. histolytica* infection investigated that 'none of them gave a history of dysentery'. The full histories of the cases in their later series are not recorded, but it seems unlikely that these cases were—in this respect—substantially different from those in the earlier series. Of the twenty-seven British carriers of *E. histolytica* studied at Birmingham, Brighton, Bristol, Leeds, Sheffield, and Reading, only one has a history of 'dysentery', while three are stated to have suffered from more or less serious attacks of 'diarrhoea' in the past. It is easy to pick out random samples of twenty-seven individuals from the 'uninfected' persons in the same series showing past records of diarrhoea or dysentery in approximately the same proportion. It is noteworthy, moreover, that there is not a single infected individual, in any series, with a history of hepatic abscess.¹

(2) *Entamoeba coli*.—It is now clear that *E. coli*, the large harmless amoeba of the human bowel, occurs commonly through-

¹ I exclude the case recorded by Armitage (1919) from the 'British' series; for the patient, though he apparently contracted an amoebic abscess of the liver, followed by another in the brain, in England, and had never been in tropical or subtropical countries, was a native of New Zealand.

out the British Isles. This was to have been expected, and calls for no particular comment. It occurs in both sexes, apparently with equal frequency, and has been found in persons of all ages from the second year onwards (Matthews and Smith, Miss Nutt).

Although indigenous cases of *E. coli* infection were doubtless known to workers in this country before the war, the first recorded in the literature appear to be two described by Smith and Matthews (1917). Since then many others have been found by the same workers and others. From the records it appears probable that the true incidence of infection with this organism in the British Isles is high. Of the persons already examined, probably between one-third and one-half were infected—taking them in the aggregate. Some differences in distribution appear in the various records, but for various reasons, already considered, it is doubtful how far these are real. Campbell (p. 31) at Bristol, and Miss Nutt (p. 33) at Leeds, found the organism commoner in adults than in children: but at Sheffield Miss Nutt (p. 35) found the incidence in the two classes approximately equal. Matthews and Smith (1919, p. 364) give the following figures—based on one examination per case—for three classes of persons examined by them:

	Children.	Civilian Adults.	Army Recruits.
Percent. infected with <i>E. coli</i> ...	11.1 ...	6.7 ...	18.2

In a group of 207 asylum patients they found no less than 45.9 per cent. infected—as a result of only one examination per case. This indicates a very high rate of infection in this group. (See Matthews and Smith (1919 *a*), p. 91.) High figures were also obtained for Welsh miners and some other groups. To judge from most of the larger series, and those in which more than one examination per case was made—these series being freer from errors due to small sampling and deficient examination—it appears probable that 50 per cent. is a conservative estimate of the true incidence of infection with *E. coli* in the general population of the British Isles. At present there is no conclusive evidence indicating a localized distribution, except that derived from lunatics in asylums—to which reference has just been made.

(3) *Endolimax nana*.—This small non-pathogenic amoeba appears to be common in Britain. The first British cases of infection were found by Matthews and Smith—reported by Yorke (1918)—and by Miss D. L. Mackinnon (1918). The latter found three out of thirty-four soldiers, who ‘had never been out of England’, infected with this organism. Since then Matthews and Smith and all the workers under the War Office Dysentery Committee have found further infections in other classes of cases.

The percentages recorded in most series are low—the highest being 12.1 per cent. found in asylum patients by Matthews and Smith (1919 *a*). The patients were examined only once apiece:

and it may be noted that the inmates of another asylum, similarly examined by Smith (1919) subsequently, gave a percentage of only 3. Nothing else noteworthy regarding the incidence or distribution of this amoeba appears in the records.

Although the figures so far obtained indicate that only some 9 to 13 per cent. of Britons harbour this organism, there is reason to believe that this figure is too low. The organism is very small, and infections are in consequence easily overlooked; and it was not until comparatively late in the War that most protozoologists in this country became familiar with it. Careful examination of large numbers of soldiers returning from abroad has shown that *E. nana* is very common in them—being the next commonest amoeba after *E. coli*. My own records show that it probably occurs in not less than 50 per cent. of such cases.

(4) *Iodamoeba bütschlii*.—So far as records are available, this amoeba appears to be rare in Britain. It undoubtedly occurs, however, though the findings indicate that it is present in less than 1 per cent. of the population. The first indigenous infections described appear to be those found by Matthews and Smith (1919).¹ Only one case of infection has as yet been recorded in a child under twelve (Matthews and Smith), and at present the records are too meagre for it to be possible to draw any conclusions regarding the incidence of the organism in relation to sex, age, or occupation. I will merely note that this amoeba appears to be less common in British residents than in troops returning from overseas. The highest rate of infection hitherto recorded in British cases is 1 per cent.—found by Smith (1919) in a series of 504 inmates of a lunatic asylum.

The published records give figures for England and Wales only. I may add, however, that Case 393 of Baylis (1919)—as appears from his card entries, though not stated in his published paper—was infected with *I. bütschlii*, and this shows that the organism probably also occurs in Ireland. This is all that can be said at present regarding its distribution in these islands.

(5) *Dientamoeba fragilis*.—Not a single instance of infection with this small and apparently rare amoeba has been recorded in any of the series here considered. That it occurs in persons who have never left Britain is, however, certain: for I have recorded, with Miss M. W. Jepps, one case of infection in a person belonging to this category (see Jepps and Dobell, 1918). At present this is the only British case known to me.

The organism may be commoner than these findings appear to indicate, for it is small and extremely delicate, and perishes soon after leaving the body. Its cysts are still unknown, and the organism itself can only be found in soft stools examined in a very fresh condition. Consequently, even when present it is

¹ Recorded by these workers throughout under the name of 'Iodine cysts'. See my book (1919) for the history of this organism.

probably often overlooked, and negative records cannot be regarded as reliable evidence of its absence.

(6) *Giardia intestinalis*.—This flagellate—better known under the name of *Lambli*a—occurs commonly in people who have never left Britain. The first British infections were recorded by Smith and Matthews (1916), and since then it has been found by every worker who has examined cases of this class—including Miss Mackinnon (1918) and Baylis (1919), in addition to those whose work is here reported.

The chief noteworthy fact about this protozoon is that it has been found more frequently in children than in adults. The recorded figures are very striking, and may be briefly recapitulated here :

Investigator.	Place.	Percent. <i>G. intestinalis</i>	
		Adults.	Children.
Matthews and Smith ¹	Liverpool	7.0	14.1
Campbell	Bristol	3.9	16.3
Miss Nutt	Leeds	3.8	39.8
"	Sheffield	7.2	15.8
McLean ²	Reading	9.3	17.4

The uniformity with which *Giardia* has been found more frequently in children cannot be accidental, and it seems clear that these figures must have a real significance. But what this significance is, is not so clear. Matthews and Smith (1919) interpret their findings as indicating that infection with *Giardia* is actually commoner in children than in adults. They believe that this protozoon—and others found in the human bowel—'may disappear from the intestine in the course of time': 'it may be that the flagellate is mainly a parasite of children and becomes rarer in older people'. This may be true: but it must be remembered that failure to find a given organism in the stools is by no means the same thing as absence of it from the intestine. It is often extremely difficult to detect *Giardia* infections—in adults, at all events—by examination of the faeces; and to find an infection it may be necessary to prolong the examination until the stools have been carefully searched on dozens of occasions.³ Figures which I have elsewhere published⁴ appear to indicate that the chances are about 7 to 2 against the infection being detected by means of a single examination of the stools of the average infected individual. Further, neither Matthews and Smith, nor any other workers, have yet been able to adduce a single concrete case in which a *Giardia* infection has been proved to have died out. This organism is, in my experience, remarkably persistent. I have had one infected individual under observation for over ten years; and although it is frequently impossible to find the organism in the stools, the infection is still

¹ These figures (adults) are for 1,098 Army recruits.

² Percentages calculated by me from particulars entered on cards.

³ See my previous Report (1917), where this subject is considered at length.

⁴ *Ibid.* p. 18.

present, and has shown no signs of disappearing from the bowel. The other common intestinal protozoa appear to be equally persistent.

I therefore hesitate to accept this obvious explanation. I believe the figures merely show that *Giardia* is more easily found in the stools of children than in those of adults: they do not prove that children as a whole are more frequently infected. On the other hand, it appears quite probable that children, individually, when infected have heavier infections than adult individuals. This would not be surprising, and many analogous instances in which young animals show, individually, a far higher degree of protozoal infection than adults of the same species could easily be quoted. It seems not at all improbable that in children, when recently infected, *Giardia* multiplies more rapidly, and appears more copiously in the stools, than it does later in adult individuals in whom the infection has become chronic. It is perhaps easier, therefore, to find evidence of infection in children; but there is as yet no real evidence that children as a class are more frequently infected than adults, and none that *Giardia* infections tend to disappear when once established.

There is some very interesting evidence to show the age at which *Giardia* infections may be acquired. Matthews and Smith (1919) found no intestinal protozoa in infants during the first year of life: but they found several infections with *Giardia*—and also with other protozoa—in children aged between one and two years, and concluded that they 'may become infected with intestinal protozoa soon after they are twelve months old'. There is conclusive evidence now, however, that *Giardia* infections at least are contracted still earlier.

Miss Nutt, at Leeds and Sheffield, examined the stools of 25 children aged 12 months or less: and she found *Giardia* in no less than 6 of these. Her results—compiled from her cards—were as follows:

Age of Child.	No. infected with <i>Giardia</i> .
3 weeks	1
3 months	1
9 "	1
11 "	1
12 "	2

These findings are, I think, very remarkable. That a child only 3 weeks old may already harbour *Giardia* would hardly have been suspected. It implies gross contamination of its food with human faeces: and since all the intestinal protozoa are transmitted by similar means, it shows that—where suitably dirty conditions obtain—a child may become infected with any intestinal protozoon shortly after birth.

(7) *Chilomastix mesnili*.—This flagellate appears to be fairly common in Britain. It has been found by all the workers engaged in the present investigation, but the incidence of infection varies greatly in different records. Matthews and Smith (1919,

1919 *a*) found 19 infections in all the cases (2,137, excluding asylum patients) which they examined; a percentage of only about 0.9. The other workers, whose reports are printed here, found altogether 74 cases in 1,009 examined, or 7.3 per cent. Even when allowance is made for the fact that the first series was examined only once per case, and the second more frequently in some instances, the discrepancy in these findings is considerable. Miss Mackinnon (1918) found 1 infection in 34 'British' cases at Southampton; and Baylis (1919) records only 0.25 per cent. in his series of 400 naval cases. The highest figure recorded in any British series is 23.2 per cent., found by Matthews and Smith (1919 *a*) in 207 patients in a lunatic asylum.

The figures generally—of which the foregoing are a sample—show such variations that I am in much doubt as to their significance. I have estimated roughly (p. 42) that the total findings indicate that some 6 to 9 per cent. of the British population may harbour this flagellate: but I am not disposed to attach much importance to these figures. The only certain conclusion that emerges from the findings generally is that *Chilomastix* is apparently less common in British residents than in soldiers who have seen service abroad. In such persons I have invariably found a higher rate of infection.

The first British cases of infection with *Chilomastix* were recorded¹ by Yorke, Carter, Mackinnon, Matthews, and Smith (1917). Nothing else regarding this organism seems worthy of special comment here.

(8) *Trichomonas hominis*.—Up to the present this flagellate has been reported in one series of British cases only—the asylum patients examined by Smith (1919) at Rainhill. He found altogether six infected out of a total of 504 examined. Of the members of this series 34 had been abroad: but it appears that at least one of the patients who had never left England (Case J. Ho.) was infected with *Trichomonas*. Whether the other infected cases were 'British' or not is not stated.

In the other series examined by Smith and Matthews, and by the later workers along similar lines, there is not a single case of *Trichomonas* infection reported. None was found by any worker for the War Office Committee, and none by Baylis (1919) in his naval cases, nor by Miss Mackinnon (1918) in her series of 'British' soldiers. It thus seems clear that the flagellate occurs in persons who have never left Britain, though it is uncommon; and at present there are no figures which permit of even an approximate estimate of its frequency.

Trichomonas hominis can, as a rule, be found only in soft or liquid stools, and its cysts are at present unknown. Consequently it is not surprising that it has not been found in a large number of healthy persons with normally formed stools. Its apparent absence cannot, therefore, be taken to prove that it is as uncommon as the findings might at first sight seem to indicate.

¹ Recorded under the name *Tetramitus*.

(9) *Other Protozoa*.—No protozoa other than those just considered have yet been found in the stools of persons who have never left the British Isles. Nevertheless, I think it worth while to point out this obvious fact, as it may direct further attention to the point and possibly induce some workers to bring forward further records or undertake new investigations.

I would particularly emphasize the fact that no infections with intestinal coccidia or with *Balantidium* appear to have been reported in British residents who have never been abroad. As regards the former, it may be noted that there is one British case of supposed coccidiosis of the liver (Silcock, 1890); but this is still somewhat doubtful. I have discussed this case elsewhere, in a review of our knowledge of coccidiosis in man (1919*a*), and need say no more about it here. Since I wrote this paper, no new facts have, to my knowledge, come to light.¹

As regards *Balantidium coli*, I would point out that it is somewhat singular that no British cases of infection with this ciliate appear to have been recorded. It is now generally accepted that *B. coli* is a parasite proper to the pig, from which animal man may occasionally acquire an accidental infection. Swineherds and others particularly associated with pigs are especially liable to balantidiosis. In parts of the British Isles—e.g. in rural Ireland—conditions conducive to infection are apparently not lacking: and one would expect human cases of balantidiosis to occur, from time to time, if the parasite were present in our native pigs. From personal experience I can say confidently that it is. I have, in fact, never examined the faeces of pigs in this country carefully without finding *Balantidium* present, often in large numbers. It seems, therefore, somewhat remarkable that no human cases of balantidiosis are yet on record—so far as I can ascertain.

The other intestinal protozoa described from man are at present too little known or too doubtful to merit special individual mention here.

B. The Spread of Infections in Britain.

Although much information concerning the incidence of protozoal infections in Britain has now been obtained, very little direct evidence is yet available to show how such infections are spread through the community. Such facts as have been elicited may be briefly mentioned here.

All the intestinal protozoa of man—with the possible exceptions of *Trichomonas hominis* and *Dientamoeba*, whose cysts are still unknown—are probably transmitted from man to man in the same manner. The active forms of all these organisms are capable of living in the intestine, where they multiply by fission. Outside the human body, however, they cannot long survive. They have

¹ An English case of intestinal 'coccidiosis' has, however, been recently described by Lockhart-Mummery and Gabriel (1919). Through the kindness of Dr. F. G. Crookshank I was able to examine sections showing the structures interpreted as coccidia, and I have no hesitation in saying that they were neither coccidia nor any other protozoa; and consequently that this case was certainly not one of coccidiosis.

but feeble powers of resistance, and are rapidly killed by drying and all conditions which differ from those under which they normally live in the bowel. If ingested in the active state by a human being they always perish. In other words, the active organisms can live in the intestine only, and are incapable of playing any direct part in the spread of infections from one host to another. But in certain circumstances—which are not yet properly understood—these active organisms can encyst in the bowel and pass out in the form of more or less resistant cysts with the faeces. It is by ingesting such cysts that a new host becomes infected.

It is thus evident that the actual source of infection is, in every case, the person who harbours active protozoa in his gut and passes their cysts in his stools: whilst the spread of infection to other persons is brought about by any or every circumstance which insures these cysts being ingested, while still fresh and living, by another individual.

It seems reasonable to assume that infections are usually acquired by swallowing food or drink which has been recently contaminated by fresh human faeces containing cysts. This contamination may conceivably occur in a variety of ways—by the agency of flies, the pollution of water with sewage, or otherwise. The present reports supply no direct evidence bearing on these problems, and it is therefore unnecessary to discuss the various possibilities here. What they do supply, however, is evidence that the contamination of food and drink with fresh human faeces—however it may occur—cannot be uncommon in this country: and it furnishes some suggestive facts which may indicate where the most important foci of infection should be sought. The evidence for the former conclusion is indirect, and is derived from the demonstration that a considerable proportion of the people of this country has actually acquired infection, in some way, with intestinal protozoa: for the latter inference, the evidence is contained in some observations of Matthews and Smith, which will be briefly considered here.

These workers (Matthews and Smith (1919), p. 365) 'in order to obtain a closer insight into the actual process of spread of these protozoal infections . . . singled out certain cases, chiefly those [children] infected with *E. histolytica*, and have examined the whole family of which each one was a member'. They state that 'in only one family' out of seven examined, were they 'able to examine the parents as well as the children and the records in this case (Family I) proved of great interest'. 'In all the other families,' they continue, 'we examined the children only. . . . It is of great importance to keep clearly in mind that these are the results of one examination only. They are therefore minimum results. At least the infections recorded were present; probably, in fact almost certainly, others also.' Their results are recorded in a table (*op. cit.*, Table V, p. 366), which need not be copied here in full. On account of its great interest, however, and as an example of the results obtained, I give below—in a modified form—the findings for Family I.

Protozoal Infections found in Family I.

Protozoa.	Parents		Children					
	J.S.	L.S.	L.S.	F.S.	Ja.S.	J.S.	M.S.	D.S.
<i>Entamoeba histolytica</i> . . .	+	+	+	+	+	...	+	+
<i>E. coli</i> . . . . .	...	+	+	+	+	...	+	...
<i>Endolimax nana</i>	+	+	+	+	+	...	+	+
<i>Giardia intestinalis</i> . . . . .	...	...	...	...	...	...	+	+
<i>Chilomastix mesnili</i> . . . . .	...	...	...	...	...	+	...	...
Ages	41	41	16	13	11	9	7	3

[+ denotes that an infection was found, ... that it was not found during the single examination made.]

Matthews and Smith conclude, from all their observations, 'that within certain families infections are much more common than in the general population of children. This is strikingly seen in Family I, where, in one family only, there are almost as many *E. histolytica* infections as we have found in the 548 cases taken from single members of different families. This applies also to the other infections, particularly to *E. coli* and *E. nana*.'

These authors have remarked further that 'there are at least two possible ways in which this state of affairs may have been brought about. (1) A single member (or some small number of members) of the family has become infected in a way at present unknown and from this source the infection has spread to other members of the family. . . . (2) The whole family, or those members of it who have similar infections, may have been infected simultaneously, for instance by all eating food from the same contaminated source.' Matthews and Smith 'think the former method the more probable': and with reference to the particular families in question they add the following information. 'With regard to the possible source of these protozoal infections it may be recorded that in each of the families investigated, one member—in six of the families the father, in the seventh a brother—had been abroad and had visited the home after going abroad. In five cases this member of the family was a soldier and in two cases a sailor. It is therefore possible that all the infections had their origin abroad. It is not at all necessary to make this supposition however, for protozoal infections, as we have shown (Matthews and Smith, 1919), are sufficiently common in all sections of the population to warrant the belief that they may have existed in this country before the war.'

Attempts were made to determine, by measurements of the cysts, how many races of *E. histolytica* and *E. coli* were present in the members of two families. From the few observations which they were able to make Matthews and Smith concluded that 'the evidence does not go far, but such as it is, it points to one race, and therefore presumably one source of infection, for the *E. histolytica* infection in the two members examined of Family II, and to two sources of infection in the four members of Family I'.

There is but little that can profitably be added to the foregoing observations at the present moment. In this connexion, however,

I would call attention to the similar observations recently made in Holland by Kuenen (1918)—considered more fully on p. 60; and I would emphasize once more two of the important facts which the present reports have revealed. These are, first, that intestinal protozoa are far from uncommon in British children, in whom they occur even in the first year of life. The statement of Matthews and Smith (1919, p. 364 n.) that ‘liability to infection does not appear to occur until the child has entered his second year’ can no longer be regarded as a true proposition (see p. 52); and the possibility of infection at a very early age will in future always have to be considered in any discussion of the means by which intestinal protozoa are disseminated. Secondly, we now know that females are not less subject to infection than males; and that domestic servants, cooks, and other female members of the household may harbour *E. histolytica* and other protozoa.

We have seen also (p. 45) that the purveyors of food for domestic consumption—such as butchers and bakers—are also sometimes infected with *E. histolytica* and other intestinal protozoa, and they can certainly acquire such organisms without going abroad. There is also some evidence that people who are closely associated for considerable periods, and under conditions which are not sanitarily perfect, are apparently apt to acquire infections from one another. At all events, the high rates of infection found among colliers (see p. 45) and the inmates of lunatic asylums (p. 46) appear to point in this direction.

It appears more than probable that all the common intestinal protozoa of man occur indigenously in Britain; and with obvious sources of contagion close at hand it thus appears no longer necessary to seek a foreign origin for every case of protozoal infection found in this country.

CHAPTER V. RECENT OBSERVATIONS ON THE OCCURRENCE OF *E. HISTOLYTICA* IN FRANCE, HOLLAND, AND GERMANY.

A DISCUSSION of the occurrence of *E. histolytica* and the other intestinal protozoa of man in Europe generally, does not properly come within the scope of the present Report. But since Britain is a part of Europe, and since the British findings are of more than local interest, it seems to me desirable to consider, before I end, some comparable findings which have been recorded by our nearest European neighbours. I shall therefore give here, as briefly as possible, the recent results obtained, along similar lines, by workers in France, Holland, and Germany—these being the only adjacent countries from which, so far as I am aware, any information is yet available.

No comprehensive survey of the intestinal protozoa harboured by the native population appears to have been yet attempted in any European country save Britain; and it has seemed to me

unnecessary to collect, at the present moment, all the scraps of information previously published which appear to indicate that most of the common intestinal protozoa of man are indigenous in Europe generally. But the large number of native British infections with *E. histolytica* revealed in the present Reports must be considered in relation to the incidence of infection with this parasite in the world at large—else we may form a very erroneous opinion of its significance. The other intestinal protozoa found in Britain should also, of course, be considered in a similar manner: but as *E. histolytica* is, for practical reasons, more important, and as information about the others is even more scanty, I shall here leave them out of account.

The notes which follow are merely notes, and make no pretensions to being an exhaustive survey of the literature.

The Occurrence of E. histolytica in France.—There is now evidence to prove that *E. histolytica* occurs indigenously in the population of France. The evidence is chiefly derived from records of sporadic cases of amoebic dysentery and liver abscess in persons who have never left France.

Galliard and Brumpt (1912) have published the results of a careful study of an indigenous case of amoebic dysentery. Their patient was a young male Parisian, aged 25, suffering from acute dysentery and passing numerous amoebae in his stools. The observations and experiments of these workers show conclusively that the amoeba found was *E. histolytica*. In a brief survey of the literature, the authors were able to find five earlier recorded cases which, in their opinion, are to be interpreted as indigenous French cases of disease due to *E. histolytica* (by these authors called '*Amoeba dysenteriae*').

In the following year Paviot and Garin (1913) reported another indigenous case of amoebic dysentery observed at Lyons. The amoebae found in their patient—who died of the disease—appear to have been undoubtedly *E. histolytica*. (I assume that some of the authors' observations were inexact.) These authors also refer to a number of apparently similar previous cases.

A little later Landouzy and Debré (1914) described an indigenous fatal case of amoebic abscess of the liver, following dysentery. The patient was a bargee who had never left France. The clinical and *post-mortem* findings leave no doubt that this also was a case of *E. histolytica* infection. In a useful table the authors summarize previously published observations on 13 apparently similar indigenous cases of *E. histolytica* infection recorded in France. They also add a warning of the danger which may threaten the community as a result of the importation of large bodies of colonial troops, infected with the parasite, into France during the War.

Some interesting observations were recorded two years later by Ravaut and Krolunitski (1916). They stated—but without giving details—that since the outbreak of the War they had found 25 cases of *E. histolytica* infection 'of indisputably indi-

genous origin'. (They call the parasites, however, '*Amoeba histolytica*' or 'A. H.'). This large number of French cases was discovered within the limits of only a 'small area' and 'in the space of several weeks'. These authors carried out an investigation of the stools of certain 'individuals who did not show, at the time of examination, any dysenteric symptoms'. They examined, in all, 200 such persons, with the following results:

Of 72 orderlies in Hospital S. (which had received many cases of dysentery), 10 were found to be passing cysts of *E. histolytica*. Out of these 10 cases, only 4 had a previous history of having suffered from intestinal ailments.

Of 32 orderlies in Hospital G. (in which dysentery cases had been 'relatively very rare'), 2 showed cysts of *E. histolytica* in their stools. Only 1 of these had a previous history of dysentery.

Of 96 soldiers, who were in these two hospitals for various ailments, 22 showed *E. histolytica* cysts. A dysenteric history was elicited for 19 of these cases.

Among these 200 persons there were thus, in all, 34 individuals infected with *E. histolytica*. Of these, 24 had a dysenteric history, while 10 had apparently shown no symptoms due to their infections—i.e. were 'healthy' contact carriers. From these findings Ravaut and Krolunitski drew the conclusion that as many as 5 per cent. of healthy persons, in the region studied, are infected with *E. histolytica*. Although this conclusion has been copied—and apparently accepted—by some reviewers of these results, it is evident that the findings recorded do not warrant such a deduction. They are of considerable interest; but obviously they do not indicate what percentage of healthy persons, with no history of dysentery, is infected with *E. histolytica*: and the authors' comparison of these findings with the results of Mathis—who found 8 per cent. of such persons infected in Tonkin—is hardly possible. It should be added that the histories of the individuals in these series are not recorded, so that it is not possible to state how many—if any—of them can be regarded as indigenous cases of *E. histolytica* infection.

Labbé (1919) has recently recorded 8 cases of 'amoebic dysentery' which he has observed in Paris. (The author refers to the finding of 'amoebae' and 'cysts' in the stools, but does not mention the species to which they belonged.) He states that 'sometimes the disease might have been contracted during a sojourn outside of France', but 'sometimes the amoebiasis was contracted in France—even in Paris'. Though his cases may be cases of amoebic dysentery which occurred in France, the particulars recorded do not show how many of the patients studied had really acquired their infections in that country. (Only one case is definitely stated never to have been abroad, and at least two appear to have contracted their dysentery in the tropics.)

The Occurrence of E. histolytica in Holland.—About two years

ago some interesting observations were made and recorded in Holland by Kuenen (1918). As practically no notice has hitherto been taken of his work, I propose to summarize it here.

Kuenen, who appears to have been unaware of the observations made in this country, is already known for his careful work on amoebiasis in the Dutch East Indies. Having there studied the intestinal protozoa of Europeans and natives, it occurred to him, on his return to Holland, that similar investigations carried out at home might yield interesting results. He therefore began to study the stools of certain hospital patients in Amsterdam. Before long he found some who were passing cysts of *E. histolytica*, and although some of these carriers were found—as was to be expected—to be persons who had been in the tropics and there suffered from dysentery, he also, to his surprise, found several cases of *E. histolytica* infection in Dutch residents who had never been abroad. The following is a short summary of the indigenous cases recorded.

Case 1.—A dock-worker. Though *E. histolytica* cysts were repeatedly found in his stools, he showed no symptoms referable to his infection during his stay in hospital. He had never been abroad, but had worked on board ships plying between Holland and the Indies, and had therefore very probably been in contact with colonial carriers of the parasite.

Case 2.—A military patient—a miner by calling. No intestinal symptoms could be elicited, and no history of association with friends or relatives who had been in the Dutch Indies. *E. histolytica* cysts were present in the stools.

Case 3.—A boy of 12, from Amsterdam. He had been suffering from dysentery, with intermissions and relapses, for 8 months. Typical *E. histolytica* amoebae were found in the bloody mucous stools.

Case 4.—Another boy of 12, also from Amsterdam. Had suffered from diarrhoea or dysentery, with intermissions, for 5 months. At different times he passed typical adult, precystic, and encysted forms of *E. histolytica* in his stools.

The last two patients (Cases 3 and 4) had scarcely ever spent a single day out of their native city. They were unrelated and unacquainted with one another. The stools of all the other members of their families were examined, but none of them found infected with *E. histolytica*. The father of Case 3 had spent 3 weeks in the Indies some 20 years previously; but apart from this no indications of a possible colonial contamination through other members of the two families could be discovered. Both patients were treated with emetine hydrochloride hypodermically, and were cured of their symptoms but remained carriers of the parasite.

Case 5.—A married Amsterdam woman of 32. Since 18 years old she had had attacks of diarrhoea, sometimes with blood and mucus. Many cysts and precystic forms of *E. histolytica* were found in her loose stools. No contact with relatives from the Indies could be established. The husband and two daughters of

this patient were also examined. The husband was apparently free: the children were, however, both infected (Cases 6 and 7).

Case 6.—Daughter of preceding. She had occasionally suffered from bowel trouble, and had passed some blood and slime in the previous year. Typical *E. histolytica* cysts were present in the stools.

Case 7.—Daughter of Case 5. No symptoms of intestinal trouble. A few *E. histolytica* cysts found in the stools.

Case 8.—A married woman, aged 32, a native of Wormerveer, now living at Haarlem. Since the age of 18 she had suffered from occasional severe attacks of diarrhoea. Large numbers of *E. histolytica* cysts were found in her stools. The husband and the son of this patient were also examined, but not found to be infected.

Kuenen discusses these cases at some length; but I will merely note here that he concludes—in my opinion very properly—that it is a mistake to regard *E. histolytica* as a parasite peculiar to the tropics, and to seek an imported origin for all infections discovered in Holland. *E. histolytica* probably occurs indigenously in that country; and if, as Kuenen believes, Case 5 contaminated her two children (Cases 6 and 7), infection can evidently be spread there without foreign intervention.

It may be added that Nolen (1918) was reminded, by Kuenen's paper, of a case which he studied in 1908. His patient was a Dutch fisherman, aged 42, belonging to Vlaardingen, who had suffered for 2 years from dysentery. In his bloody mucous stools numerous active amoebae containing red blood corpuscles were found. This was doubtless, therefore, a case of true amoebic dysentery. Its interest lies in the circumstance that the patient had never been, in the exercise of his calling, further afield than England. He had never been in the tropics or in Eastern Europe, and must therefore have contracted his infection either in Holland or in England.

The Occurrence of E. histolytica in Germany.—In a recent paper Fischer (1920) has recorded several cases of indigenously amoebic dysentery in Germany. This observer—who has had experience of amoebic dysentery in China—appears to be unaware of the work already accomplished in England, France, and Holland: and it is clear from his paper that he is not abreast of the present state of knowledge of the amoebae of man. His findings, in so far as they are of interest in this connexion, are briefly as follows:

The author has examined the stools of 120 patients, suffering from various complaints (mostly stomach and bowel affections) in a hospital at Göttingen. He found *E. histolytica* in 2 (or 3?) cases, and other intestinal protozoa in several others. The positive cases were the following:

Case 1.—A young woman of 18, with clinical dysentery. In the bloody mucous stools amoebae containing red blood corpuscles were found, but no cysts. They were diagnosed as *E. histolytica*.

It is stated that this is an 'autochthonous' case of amoebic dysentery, but details of previous history are not given; it being merely noted that 'contact with amoebic dysentery patients could not be established'. The administration of emetine appears to have had no curative effect.

Case 2.—A 'young' man (no age stated) who had suffered from clinical dysentery in the army. He had had frequent stools—sometimes containing mucus, but no blood—accompanied by tenesmus, for a year and a half. Amoebae (none containing red blood corpuscles) and cysts measuring 10–12 μ in diameter were found in the stools, and identified as those of *E. histolytica*. No other essential facts are recorded.

Case 3.—Regarded by the author as doubtful. A man, aged 24, suffering from 'colitis'. He had served in the army from 1914 to 1918. In his stools 'a few amoebae with phagocytized red blood corpuscles' were found—also, it may be noted, macrophages containing the same inclusions. No cysts were found, and no other essential details are given.

Although Fischer calls all these cases indigenous, and says they prove that there are 'actually autochthonous cases of amoebic dysentery in Germany', no proof of these statements is supplied in the present paper. The author merely records cases of amoebic dysentery, or amoebic infection, detected in Germany. Further evidence is necessary to establish the fact that the infections were contracted in that country. The author does not allude to any earlier observations bearing upon this subject, but I may mention that at least one indigenous case appears to have been previously recorded. For Jürgens (1906) states that he performed a *post-mortem* examination on a boy of 16, at the Charité Hospital (Berlin), who had lived in Germany all his life but presented, notwithstanding, typical lesions of amoebic dysentery.

The foregoing observations, while they show the necessity of further work along similar lines, make it clear, I believe, that *E. histolytica* occurs indigenously in France, Holland, and Germany. They supply no exact figures for comparison with those now available for Britain, but they indicate clearly that the conditions found in this country are not peculiar. Indeed, they make it highly probable that the incidence of infection with *E. histolytica*—and other intestinal protozoa—within our shores is not greater, nor the occurrence of amoebic diseases commoner, than in the countries inhabited by our nearest neighbours in Europe.

CHAPTER VI. CONCLUDING REMARKS.

THE observations recorded in foregoing chapters have demonstrated conclusively that all the commoner intestinal protozoa of man occur now in the population of the British Isles. The species actually recorded, up to the present moment, are the following:

RHIZOPODA (Amoebæa)	}	1. <i>Entamoeba histolytica</i> .
		2. <i>Entamoeba coli</i> .
		3. <i>Endolimax nana</i> .
		4. <i>Iodamoeba bütschlii</i> .
		5. <i>Dientamoeba fragilis</i> .
MASTIGOPHORA (Flagellata)	}	6. <i>Giardia intestinalis</i> .
		7. <i>Chilomastix mesnili</i> .
		8. <i>Trichomonas hominis</i> .

Infections with organisms belonging to the other main subdivisions of the Protozoa—the Sporozoa (e.g. Coccidia) and Ciliophora (e.g. *Balantidium*)—have not yet been recorded.

The probable frequency with which the above protozoa occur in Britain has been discussed in Chapter IV, and need not be considered again here. I would only remark that the estimates at which I have arrived are based upon the results of an examination of the stools of over 3,000 British residents, of all ages and both sexes, who had never left these islands. They therefore have a substantial basis.

From a practical standpoint, the most important figures are those relating to the incidence of infection with *Entamoeba histolytica*—the 'dysentery amoeba'. It has been demonstrated that not less than 3.4 per cent. of the persons already examined harbour this parasite; and it is probable that this figure—which represents an absolute minimum—indicates that the true rate of infection is of the order of 7 to 10 per cent.

The evidence now obtained appears to show clearly that *E. histolytica*—as well as many other intestinal protozoa—occurs indigenously in Britain. It has been suggested, however, that the occurrence of large numbers of carriers of this parasite among our home population at the present day is a consequence of the War. There is, indeed, good evidence to prove that our troops returning from the tropics, and other places where *E. histolytica* is known to be endemic, were often heavily infected; and it is true that an extensive infection of the resident civil population of Britain has been demonstrated only since the outbreak of the War. Consequently, the present state of affairs may be due to the contamination of the civil population by an infected soldiery returning home. This conclusion is, I believe, unjustifiable and almost certainly incorrect. All the evidence is against it. We know—from the early records considered in Chapter II—that long before the War *E. histolytica* occurred in British residents

who had never been abroad. We know that the parasite occurs in widely separated parts of the country, and is comparatively common. We know that it occurs at the present time in every part of the world where it has been sought; and from its relative harmlessness to human beings it seems probable that its association with mankind is no new thing. The very fact that *E. histolytica* is now comparatively common in persons who have never left the country, whilst amoebic diseases are uncommon, argues a degree of tolerance in the community such as is inconsistent with the supposition of its recent importation. Finally, it has not been possible, in those cases where careful inquiries have been made, to establish any direct connexion between the native cases of infection and carriers returning from abroad.

The proof that *E. histolytica* and other intestinal protozoa occur not uncommonly in the resident civil population of these islands offers a wide and somewhat novel prospect for contemplation by the British physician. The organisms themselves are—save to those who have studied tropical medicine—comparatively unfamiliar, and consequently apt to be regarded with suspicion. Medical practitioners in this country will therefore desire some further information concerning the protozoa in question, and will naturally ask what all the figures in this Report really mean—whether they have any practical importance, and, if so, what it is. To answer such questions finally is hardly possible at the present moment. Nevertheless, approximate answers can, I think, even now be found; and in the remainder of this chapter I propose to give my own general conclusions from the findings before us, and to discuss very briefly certain problems and points of interest which they suggest.

In the first place, the figures mean—and to my mind this is their worst meaning—that the inhabitants of Britain must frequently consume food and drink which has been exposed to gross contamination with fresh human faeces. The findings demonstrate this conclusively. Of the protozoa here considered, not one lives—so far as we know at present—anywhere but in the human bowel. The cysts of all are discharged in human faeces only; they cannot long survive outside the human body; and they cannot withstand drying. Infection can only be acquired, in natural conditions, by swallowing fresh, undried cysts derived from the faeces of a human being. Consequently, when we find persons infected with intestinal protozoa we must conclude that they have previously swallowed particles of the fairly fresh and damp excrement of other persons; and when we find many people presenting such evidence of pollution, we can only conclude that the disposal of human faeces has not yet been brought generally to that pitch of perfection which seems desirable.

The exact mechanism by which *E. histolytica* and other intestinal protozoa are spread through the community is not yet fully understood; but from the facts now available it is clear that in the past we have been too prone to lay stress upon foreign sources of infection. We have ignored the fact that we ourselves harbour,

and have probably for centuries harboured, an abundance of protozoa. If, at the present moment, a case of amoebic dysentery were discovered in a British household, it is probable that an attempt would be made to trace the origin of the infection to some male member of the family who happened to have been abroad—especially if he had served in the Army and there suffered from ‘dysentery’. But it must, in future, be realized that the source of infection is not necessarily the soldier son, returned from foreign parts. It may equally well be the mother of the family, who has never been abroad; it may be the nursemaid or the cook—with no signs of dysentery about them; it may be the greengrocer who handles the uncooked vegetables and fruit consumed by the family. All these hitherto unsuspected persons may be passing cysts of *E. histolytica* and other protozoa by thousands every day. Certain vocations, sojourn abroad, and some other obvious factors are no doubt rightly regarded with suspicion when considering possible sources of infection: but in future suspicion will also fall upon the home circle, and the mere circumstances that a man lives at home, does not work in the sewers, has not had dysentery, and has never been abroad, can hardly be regarded as sound reasons for believing that he is, therefore, *not* infected with *E. histolytica*.

The foregoing points are chiefly for the consideration of the sanitarian, but there is another which is worthy of notice by the statistician also. This is that the figures now obtained offer us a means of checking and correcting certain others which have been previously arrived at. If a body of troops returning home is subjected to protozoological examination, the results obtained can now be more accurately interpreted than has been possible hitherto. For example, if, in such troops, it is found that some 10 per cent. are infected with *E. histolytica*, it is no longer easy to argue that they have become contaminated abroad; or that they are importing foreign parasites and thereby threatening danger to the rest of the community. Such a figure would, indeed, be almost devoid of significance, since we now have evidence that the men concerned might have been already infected to a similar extent before ever they set out from home. The earlier records of the incidence of protozoal infections in our returning troops will all have to be reinterpreted in the light of the new observations.

The clinician will probably be more concerned with knowing whether intestinal protozoa cause diseases, and if so, whether these are sufficiently serious to be worthy of his attention. Fortunately, our present knowledge, though imperfect, is able to supply fairly satisfactory answers to these questions. It has now been proved that two of the intestinal protozoa of man are facultatively pathogenic—namely, *Entamoeba histolytica* and *Balantidium coli*. The latter has not yet been found in man in Britain (i. e. as an indigenous infection): the former has, however, been shown to be fairly common in these islands; and as it can—in certain circumstances—cause dysentery, liver abscess, and other diseases,

it obviously merits very careful attention. There is as yet no conclusive evidence to prove that any of the other intestinal protozoa of man are pathogenic; while there is much evidence, on the other hand, to show that they are, in the majority of cases, harmless. As possible causes of human disease they may, therefore, all be left out of account for the present.

As regards *E. histolytica*, the evidence clearly shows that this parasite is not responsible for any considerable proportion of the disease of this country, though it shows equally clearly that it is responsible for a small number of cases. This statement is, however, in all probability applicable to all other countries where the parasite is known to occur. Britain is not in a peculiar position in this respect.

The fact that the majority of indigenous infections with *E. histolytica* have been found in comparatively healthy individuals, with no past or present symptoms of dysentery or liver abscess, has led some people to wonder whether the '*E. histolytica*' of natives of Great Britain is, after all, the real *E. histolytica* of the tropics—the amoeba which causes amoebic dysentery and other diseases. There is, however, no longer any room for doubt on this subject. It can be confidently asserted that the British parasite is of the same species as the amoeba of tropical amoebic dysentery. It is morphologically indistinguishable; and it is similarly a facultatively pathogenic parasite—as the indigenous human cases of amoebic dysentery and liver abscess indicate, and as its transmission from healthy human carriers to the cat confirms. In this animal the organism causes acute amoebic dysentery indistinguishable from that produced by tropical strains of the parasite.

Although there can be no doubt as to the identity of the British parasite, there is possibly still room for wonder at the fact that, although some 7 to 10 per cent. of the population is infected, yet amoebic dysentery and liver abscess are rarities in this country. But in contemplating this apparent discrepancy the following points have been all too often overlooked. First, infection with *E. histolytica* does not invariably, or even usually, result in dysentery—even in the tropics or other places where 'amoebiasis' is reputed to be 'endemic'. The belief that it does was based upon faulty knowledge of the life-history of the parasite and its relations to its host,¹ and it is now certain that it is the exception, and not the rule, for *E. histolytica* to cause dysentery or liver abscess in human beings. (This does not mean, of course, that it does not usually cause ulceration or erosion of its host's intestine. It must always do this, as it is an obligatory tissue-parasite: but the injury of the intestine is not usually sufficient to give rise to any clinically recognizable symptoms.) The conditions observed in England are thus not really peculiar. They merely illustrate a special instance of a general phenomenon.

¹ I need not labour the point here. The facts now are, or should be, well known. The reader who seeks further information on the subject will find it in my book on the amoebae of man (1919).

In the second place, it must be remembered that it has not yet been proved that amoebic diseases are so excessively rare in Britain as they are usually assumed to be. We know from the observations of Dickinson, Moore, Saundby and Miller, Marshall, and Worster-Drought and Rosewarne, that both amoebic dysentery and liver abscess occur in persons who have never left this country.¹ We can hardly doubt, from the more recent observations of Laidlaw (1918), that British cases of amoebic disease will be found to be more frequent when they are more frequently and carefully looked for. The work of Bartlett (1917), Laidlaw (1918), and others, suggests that some at least of the cases hitherto diagnosed as 'ulcerative colitis' by British physicians may be really caused by *E. histolytica*. It is, indeed, almost impossible to read such works as those of Gemmel (1898) or Hawkins (1909) without suspecting that some of their patients suffered, though they did not realize it, from amoebic dysentery. What other conclusion can we draw, for example, from Gemmel's 80 autopsies on cases of 'idiopathic ulcerative colitis'—containing two dysenteric patients displaying ulcerated large intestines coupled with abscesses in their livers? Furthermore, intestinal disturbances, such as constipation and diarrhoea, are the commonest symptoms of infection with *E. histolytica*; and few practitioners will be prepared to prove that among their patients suffering from these everyday complaints there are none whose symptoms are due to amoebic infection. Again, from the recent observations of Smith (1919) it appears probable that some of the 'asylum dysentery' in England may be amoebic²—though from the work of Gettings and others it seems probable that the proportion is inconsiderable.

It thus seems reasonable to conclude that amoebic diseases are rare in Britain, as they probably are everywhere else in the world—rare, that is to say, in proportion to the number of persons infected with the parasite which 'causes' them—yet not so extremely rare as defective observations and inadequate statistics might lead one, at first sight, to suppose.

Thirdly, there is another point which should not be overlooked. Although it now appears certain that 'pathogenic' and 'non-pathogenic' strains of *E. histolytica* do not exist³—all strains of the species being tissue-parasites and consequently capable of being 'pathogenic' to a susceptible host—nevertheless it does not follow that all strains are equally 'harmless' to all hosts. Amoebic dysentery is the consequence of an incompatibility between the amoebae and their host: it is an abnormal or 'diseased' condition for both. The carrier of the parasite is a compatible host—one adapted to life with the amoebae, and one to whom the amoebae themselves are adapted. Now it appears probable that *E. histolytica* has parasitized man for a very long time. This is indicated by its geographical distribu-

¹ See Chapter II.

² The observations of Gemmel (1898)—alluded to above—also seem to point to the same conclusion.

³ Cf. Dobell (1919), p. 58 *et seq.*

tion—apparently world-wide; by its frequency—a considerable percentage of every race of man properly studied having been found infected; and by the fact that its normal host is the ‘healthy’ carrier. In the course of ages *E. histolytica* has become well adapted to man, and man well adapted to *E. histolytica*. But there are many races of Man, and there are probably many races of *E. histolytica*—some of these, indeed, being already easily recognizable by the dimensions of their cysts. On analogy with other protozoa it is probable that there are also many physiologically different races—at present indistinguishable. It is therefore by no means an extravagant hypothesis to suppose that, in the course of time, particular races of amoebae have become specially adapted to particular races of human beings. The races of *E. histolytica* occurring in Britain may well be peculiarly suited to a life in Britons: the races in Africa to African natives. But if the Briton goes to Africa, or if the African comes to Britain, and acquires the parasite indigenous to the country, it is possible that these new combinations might produce a different result. It is possible that African strains of amoebae may be unsuited to a life in British bowels, and may in this abnormal environment give rise to dysentery more readily than they do in their native habitation in the negro. I will not assert that this is the correct or complete explanation of what appear at present to be the facts regarding the incidence of amoebic diseases; but I think that some such hypothesis as the foregoing offers the most plausible line of interpretation, and I know of no other which is consistent with all the established facts—many of which are very curious and, at first sight, contradictory.

I would emphasize here once more that the observations already made in Britain, in France, in Holland, and in adjacent European countries, all tend to show most clearly that *E. histolytica* is as much at home in Western Europe as it is in the tropics. The distribution of this amoeba is almost certainly world-wide. It probably occurs now wherever there are men, and has so occurred from time immemorial. *E. histolytica*, like the eagle of Prometheus, preys upon the perpetually regenerated flesh of the human body; and in the words quoted by ‘the beloved Physician’, ‘Where-soever the body is, thither will the eagles be gathered together.’

In conclusion, I will sum up in a few words the present position with regard to *E. histolytica*—as I conceive it—in so far as it concerns the population and practitioners of this country.

Entamoeba histolytica is, or may be, a ‘cause’ of human disease; but usually it is comparatively harmless to the persons it inhabits—at all events, in a population in which it has been long established. The parasite occurs commonly in Britain, in the resident native population, but to the majority of its hosts it causes little or no inconvenience. It is probably not a new or recently imported parasite, but at least as old an inhabitant of these islands as the British nation. It has apparently caused but little trouble in the past, and is not likely to cause more in the

future. Its prevalence, therefore, need not be regarded with alarm. Nevertheless, the frequency with which it still occurs indicates that conditions are still suitable for its dispersal; and as these conditions imply personal uncleanliness or faulty sanitation, it is clear that, as a nation, we still have much to learn about individual and communal hygiene.

Moreover, though *E. histolytica* is often comparatively innocuous, it is harmful and even dangerous to certain abnormally susceptible individuals; and if such persons are rare, they are, nevertheless, not negligible. Consequently, it will be necessary in future for British physicians to remember *E. histolytica* when they are called upon to treat cases of dysentery, chronic diarrhoea, 'ulcerative colitis', or other intestinal ailments which may possibly be due to this parasite; and to remember it also when they encounter patients displaying symptoms of hepatitis, hepatic abscess, and similar disorders, in the causation of which *E. histolytica* plays a part. Amoebic dysentery is a disease which, if promptly and properly treated, is usually amenable to specific therapy; but one which, when neglected or mistreated, often becomes chronic, leads to much misery and unnecessary suffering, and frequently terminates fatally.

Fortunately, modern methods of diagnosis have made it possible to recognize the amoebic diseases with certainty; and if they have also revealed possibilities of trouble which have lain hitherto unsuspected, they have at the same time put our knowledge of both the cause and the cure of these diseases on a sound scientific foundation. Therefore, let the British physician grieve not, nor be filled with forebodings at the outcome of the work chronicled in these pages: but let him rather rejoice that it gives him new light and new weapons—if he will but use them—for his fight against disease and death.

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¹ This name is misprinted as 'Taylor' in the original.

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The following were published under the direction of the Medical Research Committee :

Milk and its Hygienic Relations, by Janet E. Lane-Clayton, M.D., D.Sc. (Lond.). Price 9s.net. [Longmans, Green & Co.]

The Amoebae living in Man, by Clifford Dobell, F.R.S. Price 7s. 6d. net. [Bale, Sons & Danielsson, Ltd.]

In addition to the publications contained in the list given above, numerous memoirs upon work aided by the Medical Research Council have appeared in Scientific Journals.

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