REPORTS OF THE M. AND H. LABORATORIES DEALING WITH THE DISEASES AFFECTING THE TROOPS IN THE DARDANELLES.

By Captains R. G. ARCHIBALD and G. HADFIELD.
Royal Army Medical Corps.

AND

Lieutenants W. LOGAN and W. CAMPBELL.
Royal Army Medical Corps.

At the instigation of Surgeon-General Babtie, V.C., a field laboratory was established at M. E. in the end of July with the object of providing bacteriological assistance for the stationary and other hospitals located there.

A month later sufficient equipment had arrived to furnish an extension laboratory at W. B., C. H. This extension laboratory was placed in the charge of Lieutenant W. Campbell, R.A.M.C., and was primarily intended to be of service in the event of a cholera outbreak or serious epidemic among the troops on the Peninsula.

Efforts were also made to establish a similar type of laboratory at A., but the scheme was abandoned owing to the difficulty of obtaining a water supply and to the constant and concentrated shell fire existing there.

As a central laboratory for the Peninsula the site at M. was a favourable one, inasmuch as it was only a few hours distant from the Peninsula, and opportunities were thus available for the early clinical study and bacteriological investigation of the various diseases prevalent among the fighting troops and on the lines of communication.

This report deals with the work carried out at M. E. laboratory for a period of five and a half months, dating from August 1, 1915, to January 15, 1916, and also with the investigations of the H. laboratory from September 4 to the time of the evacuation.

Before alluding to the different diseases occurring on the Peninsula and at M. it would be well to refer briefly to the climatic and other prevailing conditions that directly and remotely influenced the disease incidence.

During the months of June, July, August and September there
Reports of the M. and H. Laboratories

was a low rainfall accompanied by a comparatively high temperature and an affluence of flies and dust—in short, an ideal state of things well fitted for the spread of fly- or dust-borne diseases.

In October and the following months the fall in the temperature and the increased rainfall had a determining influence in the diarrhoea and amoebic dysentery incidence. The former practically disappeared, while the latter was almost entirely replaced by the bacillary type of the disease. It was also observed that, coincident with the change in the climatic conditions, there was an increase in the paratyphoid A incidence; indeed, during the months of December and January it had almost entirely taken the place of the paratyphoid B infection.

Source of Material.

Most of the material sent for examination was supplied by the stationary hospitals and the Indian Field Ambulance; some, however, was also obtained from naval and mercantile ships anchored in the harbour. The majority of the cases were illustrative of infections acquired either on the Peninsula or in M. Reference will now be made to the more important diseases investigated clinically and in the laboratory.

The Dysenteries.

During the months of July, August, September and October, the dysentery most prevalent on the Peninsula was undoubtedly amoebic in type. Almost all the cases represented infections with Entamoeba histolytica.

The stools in the majority of instances were typically dysenteric, consisting of blood and mucus with or without faecal material.

A large number of these specimens when examined microscopically contained relatively few organisms, but, as a matter of routine, whether entamoebae were present or absent, a sample of the stools was plated, either on McConkey's bile salt neutral red lactose agar or on Endo's or Drigalski-Conradi's media. By adopting this procedure the risk of missing bacillary or other concomitant infections was minimized.

For the purpose of demonstrating the cytological characters of the causal amoeba, specimens were suitably stained either by iron haematoxylin or Hasting's method.

Pressure of work, however, did not always permit of laborious staining methods being employed, and in such instances the
diagnosis was based on the evidence obtained by direct examination of the entamoeba and its cysts. Entamoebae containing phagocytosed erythrocytes were considered pathogenic and not of the *E. coli* type, a view also held by Wenyon and other protozoologists. In a few instances *E. coli* was found.

Clinically, the cases resembled those of entamoebic dysentery, and in the majority the exhibition of emetine was a therapeutic success provided that a total amount of ten grains had been administered over a short period. Some cases, however, proved fatal, post-mortem evidence showing either the existence of perforations of one of the multiple amoebic ulcers in the colon or the presence of liver abscesses.

**Bacillary Dysentery.**—This type of dysentery was comparatively uncommon in the months of August, September and October. In November, however, the case-incidence increased somewhat, and in the following month it was practically the sole type of dysentery found. Clinically, although never in epidemic form, some of the cases were very severe, but responded in a striking manner to the use of a polyvalent dysentery serum (*vide* chart, fig. 4).

The Shiga group of organisms was more common than the Flexner. In eleven instances bacilli giving the cultural characters of the dysentery group were isolated, but remained unidentified owing to their failure in responding to specific agglutination tests.

The bacillus of Shiga was obtained on thirty-five occasions, that of Flexner on twenty-three. The total number of dysentery organisms isolated, including the unidentified strains, was sixty-nine.

During the five and a half months 1,921 stools were examined; of these 518, or 27 per cent, represented dysenteric stools; of the latter 70 per cent were due to amoebic infections and 13 per cent represented bacillary dysentery infections. In the remaining seventeen per cent no apparent causal organisms were found.

**The Diarrhœas.**

During August, September and October diarrhœa was very prevalent among the troops both on the Peninsula and at M. With the onset of the rains and the cold weather, however, the incidence of this complaint abated in a striking manner. A large number of diarrhoeic stools were examined microscopically and bacteriologically, and the following conclusions arrived at regarding their etiology.

**Sand Diarrhœa.**—When sand-storms were common, the
diarrhoea incidence was high, and sand as a causal factor was considered a probable one, either by its direct irritating effects on the mucosa of the intestinal tract or, as was more likely, by the mechanical transmission of micro-organisms attached to sand particles. It would be difficult, however, to attribute entirely the cause of these diarrhoeas to the effects of sand when another agent and menace—the fly—existed as a serious pest. No stretch of the imagination was required to understand how food could be faecally fouled by the common fly; probably the two factors, flies and dust, were responsible for the greater number of the diarrhoeas.

In a large proportion of these diarrhoeas the predominant organism was a non-lactose-fermenting diplostreptococcus which grew readily on McConkey’s medium in the form of delicate, clear colonies. The preponderance of this organism, as seen in stained preparations of the stools, left little doubt that it was responsible in causing diarrhoea. In 1·5 per cent of cases Morgan’s bacillus was the only known pathogenic organism isolated.

Several cases of diarrhoea, especially during the month of October, were apparently due to infections with vibrios and spirilla. Most of these vibrios were coarse in type, but in a few instances they morphologically resembled the cholera vibrio, so much so that it was deemed necessary to subject them to crucial cultural and agglutination tests.

Some of the vibrio infections were responsible for a severe and choleraic type of diarrhoea, associated with “cramps.” In no case, however, was a true cholera vibrio isolated.

Trichomonas Diarrhoeas.—Trichomonas intestinalis was observed on fifty-seven occasions, and usually in fluid stools containing bile-stained mucus. These flagellates are apparently capable of causing diarrhoea, particularly when present in large numbers. Little is known regarding their pathogenicity. In guinea-pigs, however, they have been known to set up a severe and fatal enteritis.

Flagellates of the genera Cercomonas and Tetramitus were observed in only a very few cases and require no further comment.

Malaria.

Subtertian parasites were found in two cases, and parasites of the benign tertian type were found in twenty-four. All of the latter had acquired their infection on the Peninsula and chiefly in the vicinity of H., where anopheline mosquitoes had been found breeding by Lieutenant-Colonel Balfour, C.M.G., of the Sanitary Commission.
RELAPSING FEVERS.

Forty-six cases were diagnosed by blood examination. These occurred among the I. troops and men of the E. Labour Corps. In only one instance were spirochætes found in the blood of a British officer, who previously had been in command of the E. Labour Corps.

Some comparative observations were made with the I. and the E. relapsing fever cases, and the evidence collected was in favour of the duality of the species of spirochæte. Unfortunately it was not possible to carry out crucial tests by cross-immunization.

A large number of spirochætes were measured, and the average length of the I. species was 12.56 microns, while the E. measured 16.8 microns. In the former, coils, figures of eight and skein forms were relatively more numerous than in the latter.

Clinically, the E. relapsing fever was more severe, showed more irregularities in temperature and in the intervals of apyrexia, jaundice and liver and splenic enlargement were invariably present, and pulmonary symptoms conspicuous by their absence.

In the I. type the symptoms were less severe, and jaundice and splenic enlargement not common. The average period of apyrexia was seven days. Pulmonary symptoms were usually present. In a few cases epistaxis was noted.

Owing to the early transfer of the cases, no comparative observations could be made to show the number of relapses in the two types of the disease.

As regards the method of transmission, circumstantial evidence has certainly implicated the body-louse, Pediculus corporis.

INFECTIVE JAUNDICE.

Evidence is still lacking to prove whether or not an organism is concerned in the etiology of this condition. Blood cultures have been carried out in different stages of the disease, but the results obtained have been disappointing and indicate that the existence of a bacillæmia is the exception and not the rule.

In one instance Bacillus paratyphosus B was obtained by blood culture, and in another—a fatal case—a similar organism was isolated from the gall-bladder; this viscus showed all the signs of a cholecystitis.

From material representing the syphoned duodenal contents of a case of jaundice under the care of Major Hertz, a Gram-negative diplococcus, probably of intestinal origin, was obtained.
Typhoid and Paratyphoid Fevers.

Bacilli of the typhoid-paratyphoid group were obtained by blood culture from 147 cases; of these 21 were *B. typhosus*, 41 *B. paratyphosus* B, 70 *B. paratyphosus* A; in addition, there were 15 inagglutinable strains of the paratyphoid group, of which 1 resembled *B. paratyphosus* A in type, others *B. paratyphosus* B.

From the stools during the same time 18 strains of *B. typhosus* were obtained, 50 of *B. paratyphosus* B, 11 of *B. paratyphosus* A, while 72 strains were obtained which culturally resembled the paratyphoid group but were not agglutinable by the specific sera. Some of these were probably true paratyphoid, others were probably not.

One *B. paratyphosus* B was obtained post mortem from the gall-bladder of a case which had marked jaundice as a symptom; one *B. typhosus* post mortem from a mesenteric gland, while *B. typhosus* was isolated from the pus of a suppurative osteo-arthritis following frostbite.

Methods.

Blood culture in the first week of the disease being regarded as the ideal method of diagnosis of the enterica, this procedure was adopted whenever possible. The less satisfactory methods of agglutination tests with the patient's serum and examination of the stools were resorted to where request for blood culture in the early stages has not been made or where blood culture had proved negative; in some instances, too, the patients had passed the stage of bacillemia by the time they reached hospital.

Many opportunities of doing blood culture were lost owing to prevailing sand-storms that rendered an aseptic operation in the tents impossible.

A two per cent solution of sodium taurocholate in distilled water was the medium used for blood culture. As a rule, from five to seven cubic centimetres of blood were put into ten cubic centimetres of this medium at the bedside. It is important that the blood and culture fluid should be well mixed by shaking before being placed in the incubator. From this preliminary medium McConkey’s plates were spread daily for four successive days till a growth was evident, when subcultures were made from isolated colonies, tested in lactose, glucose, mannite, dulcite, saccharose, and peptone water, and put up against the agglutinating serum or sera indicated by the cultural reactions.

For faeces McConkey’s plates were used as a routine, with Endo
R. Archibald, G. Hadfield, W. Logan and W. Campbell

and Conradi-Drigalski as an occasional variation. Likely colonies were subcultured, put through the sugars and tested by agglutinating sera, as in the case of the blood cultures. Every stool was examined microscopically for the presence of amoebae, flagellates, etc.

**Clinical Features.**

The onset of illness was in many cases sudden; in others the patient was out of sorts for two or three days before being compelled to go off duty.

In the first stages feverishness, headache, shivering and generalized pains were common to practically all; giddiness was frequently complained of. A furred tongue was almost invariably seen, usually furred and dry, occasionally furred and moist. Abdominal tumidity and tenderness on palpation were common; many cases gave on palpation what may be described as a "doughy" feeling. There was as a rule no palpable enlargement of the spleen until bacilli had disappeared from the blood; exceptionally it was enlarged in the first week, and in one case of \( B. \) *paratyphosus* A infection it was definitely enlarged on the third day of illness. Spots were not as a rule present in the first week, but appeared irregularly in the majority of cases during the course of illness.

In the series of cases from which paratyphoid bacilli were obtained from the blood, forty-eight per cent of the *B. paratyphosus* A cases and thirty-five per cent of the *B. paratyphosus* B showed diarrhoea as a marked symptom. In the same series vomiting was present in the initial stage of thirty-one per cent of the *B. paratyphosus* A cases and in nineteen per cent of the *B. paratyphosus* B.

Constipation was present at some time of the illness in many of the cases, and epistaxis was present in a small proportion.

The duration of temperature varied in these positive cases from a week to a month, being on the average longer in *B. paratyphosus* A infections than in the other.

There was no doubt that in this series the *B. paratyphosus* A infections were the more severe of the two.

**Duration of the Bacillema.**

An average of the duration of illness at the time of blood culture gives the following results (positive cases only) :-
All cases, including typhoids and infections by inagglutinable paratyphoid-like bacilli

- \( B. \text{paratyphosus} \) B infections
- \( B. \text{paratyphosus} \) A infections
- \( B. \text{typhosus} \) infections
- \( B. \text{paratyphosus} \) (inagglutinable infections)

were obtained on the tenth day of illness or later. \( B. \text{paratyphosus} \) B was obtained on one occasion on the tenth day. \( B. \text{paratyphosus} \) A was obtained three times on the tenth day of illness, once on the eleventh, and once on the fourteenth. These figures are exclusive of cases of true relapse where there is a fresh flooding of the blood by bacilli.

There appeared, therefore, to be a longer bacillæmia in the \( B. \text{paratyphosus} \) A infections than in the \( B. \text{paratyphosus} \) B, with the \( B. \text{typhosus} \) infections longer than either. The nine days' average duration in cases where an inagglutinable paratyphoid bacillus was obtained is striking, and it is a matter for speculation whether there is any connexion between the inagglutinability of the organism and its length of duration in the blood.

These facts go to emphasize the necessity of making blood cultures in the first week from all patients showing a sudden or moderately sudden illness with rise of temperature, headache, shivering, generalized pains, and a furred tongue. The disadvantage of doing a blood culture on a patient who ultimately proves not to be paratyphoid is small compared with the danger of having a paratyphoid patient labelled P.U.O. or influenza, and acting as a focus of infection for all around. It is frequently a fortnight from the commencement of illness before agglutinins have formed in sufficient quantities to give a positive agglutination reaction with strains of paratyphoid bacilli, while the uncertainty of isolating the bacillus from the stools is well known.

CHARACTERS OF THE BACILLI.

The cultural differences between our strains of \( B. \text{paratyphosus} \) A and \( B. \text{paratyphosus} \) B are very striking in organisms which produce clinical conditions so similar. Morphologically the A type is more consistent in its characters than the B; it is a small, short, rather squat coccobacillus of active mobility, and in hanging-drop preparations shows a typical globular appearance, due to the small bacilli searching the upper reaches of the fluid and impinging on the under surface of the cover-glass. The B type shows greater pleomorphism, but as a rule is more bacillary in form than the A.
Its mobility also varies more, and it is not uncommon to find strains of *B. paratyphosus* B which show practically no mobility in saline emulsions of twenty-four hours' agar-slope cultures.

A noticeable characteristic of *B. paratyphosus* A is its behaviour while agglutinating under the influence of the specific serum. After the organisms have lost their power of progressive movement they retain a twirling rotatory movement. One frequently sees a whole clump of agglutinated bacilli, eight to twelve in number, spinning round.

In sugars in peptone water the two varieties exhibited a marked difference. *B. paratyphosus* B showed, as a rule, strong acid and gas production at the end of twenty-four hours in glucose and mannite, in dulcite a commencing acid reaction and a small bubble of gas, while in lactose and saccharose there was no change. At the end of forty-eight hours the change in dulcite was slightly more marked. There were strains of *B. paratyphosus* B, however, both from blood culture and from stools, which produced no change in dulcite even after four days' incubation, and also two strains, one from the blood and one from the stools, which fermented glucose, mannite, and saccharose but not dulcite; these were definitely agglutinated by the serum. Our sample of dulcite, unfortunately, was not so far above suspicion as to lead one to lay much stress on this delayed or absent dulcite fermentation.

The strains of *B. paratyphosus* A showed very typical and consistent reactions in the sugars. At the end of twenty-four hours there was an acid reaction with a small bubble of gas in glucose, an acid reaction only in mannite, while the other sugars showed no change. In forty-eight hours there was gas formation in mannite also, while in from three to five days the dulcite showed slight fermentation with a small bubble of gas. The amount of gas production by *B. paratyphosus* A was very small compared with that of *B. paratyphosus* B.

On McConkey's plates the paratyphoid A colonies were very small and delicate at the end of twenty-four hours' growth; in forty-eight hours they were slightly larger, but never so large that one could mistake them for the larger colonies of *B. paratyphosus* B. The latter varied considerably in size even on a twenty-four hours' plate; but on a portion of the medium where colonies were few were about twice the size of a *paratyphosus* A colony of the same age and under the same conditions. On agar slopes the organisms showed no resemblance one to the other. The A exhibited a delicate growth difficult to distinguish from a *B. typhosus* ; the B a relatively heavy, often slightly viscid, growth.
The serum used for agglutination tests was, for the *B. paratyphosus* B, a Lister Institute stock. The strains of *B. paratyphosus* A did not always agglutinate satisfactorily with the Lister A serum, possibly because of a non-specificity for the strain of *B. paratyphosus* A prevalent in these parts, but agglutinated well with the Pasteur Institute A serum. It is probable that the non-agglutinable strains of A type obtained from the blood during early autumn would have proved agglutinable had the Pasteur Institute serum been then available.

The inagglutinable strains of paratyphoid-like bacilli isolated from the stools require mention. During August, 1 strain was isolated, during September 5, during October 19, during November 37, and during December 5. These were definitely not *B. paratyphosus* A, but approximated in cultural characters to the B type. Thirteen of these fermented glucose, mannite, and saccharose, and would have been definitely put outside the paratyphoid group had it not been for the two similar strains already referred to, which were agglutinated by paratyphoid B serum. It is probable that the majority at least were not true paratyphoid organisms.

Of the remaining fifty-four strains, five showed rapid dulcite fermentation, in addition to the fermentation of glucose and mannite. Ten strains were left in the incubator for one week, and at the end of that time showed no change in dulcite. Many of these inagglutinable strains gave a heavier growth on agar, and rather larger colonies on McConkey's medium than did any of the agglutinable strains of *B. paratyphosus* B. The majority were obtained from the stools of patients clinically diagnosed as paratyphoid, but a certain number were obtained from cases which were suffering from diarrhoea or dysentery, and which had had no symptoms of paratyphoid. In this connexion it is interesting to note that in one case a *B. paratyphosus* B, and in two cases inagglutinable paratyphoid-like bacilli, were isolated from patients then suffering from diarrhoea without temperature, who a few days later developed paratyphoid fever.

In two cases the serum of the patient was tested against the inagglutinable strain isolated from his stool, but with negative results. Only one strain was agglutinated by Gaertner serum. A small number were also tested against Aertrycke serum with negative results.

There was therefore some difficulty as to how to regard these organisms. With a limited equipment and lack of animals for experiment, it was not possible to come to a conclusion as regards
their pathogenicity, and it was therefore judged well to err on the safe side and regard them as possible sources of infection. The large number of organisms of this type prevalent in the stools in November when the *B. paratyphosus* B epidemic was on the wane—as shown by blood cultures—is a matter of interest, but one can only speculate as to the significance. A number of strains have been kept, and it is hoped that an opportunity may be found later of working them out more fully.

**Preventive Inoculation.**

Reliable histories as to previous inoculation were obtained from fourteen of the cases from whom *B. typhosus* was isolated. Of these five, or 35.7 per cent, had been previously inoculated against typhoid, while nine, or 64.28 per cent, had not been inoculated.

It was noteworthy that one at least of the inoculated cases ran such a mild course that there was little resemblance clinically to true typhoid.

Out of 126 cases of paratyphoid from which the bacillus was obtained by blood culture, 109, or 86.5 per cent, had been inoculated against typhoid, while 17, or 5.8 per cent, had not been inoculated; none had been inoculated against paratyphoid.

These figures and those previously given, showing the very low relative incidence of true typhoid, demonstrate the efficacy of antityphoid inoculation against typhoid fever, but they also show that antityphoid inoculation produces no protection against paratyphoid.

Antiparatyphoid inoculation, to be effective, must be against both A and B, and, while it is important that the vaccine should contain a mixture of strains of each, it is still more important that local strains from the locality to which the inoculated man is about to proceed should be included.

**The Course of the Epidemic.**

The accompanying chart (fig. 1) shows the relative proportions of the three main types of enterica prevalent at M. during the months August to January. No inagglutinable strains and no cases diagnosed by agglutination tests with the patients' serum are included. The figures represent the number of *B. typhosus*, *B. paratyphosus* B, and *B. paratyphosus* A obtained from patients during each month in the Laboratory, calculated as a percentage of the total number isolated each month of the three combined.

The striking feature is the change in the type of the enterica
prevalent during these months. In August typhoid led the field. The majority of these cases were almost all uninoculated, but unfortunately accurate records of inoculation in these early cases were not kept; the percentage of typhoid in inoculated men already given is therefore higher than it actually should be.

In September and October the paratyphoid B steadily rose, while the typhoid and paratyphoid A fell to a negligible amount. During this time and during the first half of November paratyphoid B was the type which filled the enteric division in the 15th Stationary Hospital.

About the middle of November, with almost startling suddenness, the paratyphoid A shot up, while the paratyphoid B fell. The typhoid, as before, remained low.

Many of these cases had acquired the disease locally at M., others on the Peninsula. The figures obtained indicated that, so far as the Peninsula was concerned, paratyphoid A was more common at S. and A. than at H.

It was not possible to come to a definite conclusion as to the origin of these epidemics.

**OTHER ORGANISMS IN THE BLOOD.**

In several cases, clinically resembling paratyphoid, a diplostreptococcus was obtained in blood culture. This coccus grew well in taurocholate solution and on McConkey's medium. It was usually obtained in pure culture and as a rule during relapse. The delicate nature of the organism and the conditions under which it was obtained supported the view that it came from the blood and was not a contamination.

This organism was apparently the same as that already described in cases of diarrhoea, and corresponded in many ways to the enterococcus of Thiercelin. It grew, however, more easily on bile salt media than the enterococcus is wont to do. The conclusion was come to that this organism was probably of intestinal origin, and that it might be a cause of secondary rises of temperature in cases of true paratyphoid.

**CONCOMITANT INFECTIONS.**

It was common, particularly during the earlier months, for a patient to be suffering from a second infection in addition to his paratyphoid. Several patients came in with paratyphoid and developed amoebic dysentery during their illness (*vide* chart, fig. 7).
R. Archibald, G. Hadfield, W. Logan and W. Campbell

Still more came in with dysentery and contracted paratyphoid. It is not possible to give exact figures of the number of these cases in this report. The following figures show mixed infections found at a single examination of a patient's stool. The table could be greatly enlarged if the results of more than one bacteriological examination of one patient were included:

<table>
<thead>
<tr>
<th>Entamoeba</th>
<th>Trichomonas</th>
<th>Vibrios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhoid</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Para B</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Para A</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Below is appended a table giving the total figures of typhoid and paratyphoid cases bacteriologically diagnosed, agglutination tests being included:

<table>
<thead>
<tr>
<th>Blood culture</th>
<th>Stools, urines, etc.</th>
<th>Agglutination tests</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. typhosus</strong></td>
<td>21</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td><strong>B. paratyphosus A</strong></td>
<td>70</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td><strong>B. paratyphosus B</strong></td>
<td>41</td>
<td>123</td>
<td>29</td>
</tr>
</tbody>
</table>

(Including inagglutinable paratyphoid strains)

| Inagglutinable para. typhoids | 15 | - | - | 15 |

**Summary of Examinations, with Results Obtained.**

Total number of stools examined 1,921

Dysentery stools 518: (a) Amoebic 362 (B. Shiga 39), (b) Bacillary 69 (B. Flexner 23, unidentified 11).

Stools with Morgan's No. 1 bacillus 21

| Trichomonas infections | 57 |
| Cercomonas | 3 |
| Tetramitus mesnil | 4 |
| Vibrio diarrheas | 47 |
| Relapsing fever | 46 |
| Malaria | 26 |
| Diplostreptococcal septicemias | 10 |
| B. coli septicaemia | 1 |
| B. Gaertner infections | 1 |

- **B. typhosus** 40: (a) Blood culture 21 (b) Stools, &c. 18 (c) Agglutination tests 1
- **B. paratyphosus A** 101: (a) Blood cultures 70 (b) Stools, &c. 11 (c) Agglutination tests 20
- **B. paratyphosus B** 193: (a) Blood culture 41 (b) Stools, &c. 123 (c) Agglutination tests 29
- Inagglutinable paratyphoids - (a) Blood culture 15

Water tests 14

Other examinations 491
SUMMARY.

In recapitulation, the following points are emphasized:

(1) The total typhoid incidence was very low.

(2) The results showed the efficacy of typhoid inoculation against typhoid fever and its inefficacy against paratyphoid.
R. Archibald, G. Hadfield, W. Logan and W. Campbell 709

(3) Blood cultures should always be done in the first week in cases with the symptom group already described.

(4) Attention is drawn to the epidemic of paratyphoid B fever during September and October and the first half of November, and its sudden substitution then onwards by paratyphoid A fever.

NOTES FROM THE CAPE H. LABORATORY BY LIEUTENANT W. CAMPBELL, R.A.M.C.

These notes are intended to indicate in a general manner the results obtained at the Cape H. Laboratory. Unfortunately the bulk of the records were lost during the evacuation, but, while it is now impossible in many instances to give exact figures, the writer still hopes to recover the records eventually, as several interesting details will thereby become available.

**Water Supplies.**

Under all circumstances, but especially where an outbreak of cholera is a possibility, the purity of water supplied to an army is a *sine qua non*. For this reason much time was spent at the H. Laboratory in the bacteriological examination of water samples.

Chemical analysis was not possible, and reliance had therefore to be placed entirely on the bacteriological examination and inspection of the source of the water and the immediate surroundings of the wells; the results of each of these, on which independent opinions were formed by the bacteriological and by the various sanitary officers, were found to correspond in practically every instance.

In view of the large *B. coli* content of most of the samples examined, this coincidence of opinion is interesting, and will be readily understood when the following facts are explained: The wells at H. were essentially "shallow" wells; the gathering grounds were invariably much polluted by the excreta of horses and mules; the water percolating from these gathering grounds had frequently to pass through a screen of latrine areas on its way through the soil to the wells; in some cases troops had been encamped or entrenched for months close to the mouths of the wells; finally, during the rains surface ground water so overflowed through the mouths of some of the wells in the hollow that the wells had to be pumped free of this water, which was little else than surface washings, before they could be used again.
Having stated these facts, one may proceed to say of unchlorinated samples (i.e., raw water) that in only one case was \( B. \text{coli} \) absent from ten cubic centimetres and smaller amounts of the sample; in a few cases the same organism was present in five cubic centimetres of samples and absent from smaller quantities; in the vast majority of samples, however, \( B. \text{coli communis} \) was recovered from 0.01 cubic centimetre of specimen. The samples were examined immediately they were received at the laboratory, and, usually within two hours of their being taken from the wells.

The cultural characters of an organism having the usual morphological appearances, staining reactions, and cultural features of \( B. \text{coli} \), had to include the "flagin" group before it was accepted as an "excretal" \( B. \text{coli} \). As milk was not obtainable, a "flagin" instead of a "flaginac" organism had to be recognized; for the same reason \( B. \text{enteritidis sporogenes} \) was not sought for. On the other hand, the presence of streptococci in some samples decided the question of their potability.

The "total count" by means of gelatine and of agar plates was so high in all the waters that it was found to be of comparatively little help in deciding between one sample and another, and was latterly given up; it was, however, of value in determining whether the process of chlorination as a protective measure had been efficiently carried out.

A keen watch was kept for \( V. \text{choleræ asiaticæ} \); in no case was it found in any of the samples examined. \( B. \text{paratyphosus B} \) was isolated from one shallow well, within ten yards of which was an old latrine pit. This finding points to the possible water carriage of paratyphoid infections.

Sediments from the bottom of several wells were examined for pathogenic protozoa, parasitic ova, etc., mostly with negative results; but in two instances flagellates with the characters of \( T \text{richomonas} \) were found once in a sediment and once in the slime obtained by scraping the wooden beams supporting the sides of a well; flagellates of the type of \( T \text{ercomonas} \) were found in sediments from three wells.

**Note on the Chlorination of Water.**

While chlorination was never performed at less than one part per million (available chlorine), chlorination at four parts per million gave the best results, though the water had a decidedly unpleasant taste when chlorine was present in this amount.
Sedimentation (alum five grains to gallon) of some waters followed by chlorination (one part per million), as carried out by Captain W. Egan, R.A.M.C., gave very satisfactory results.

Only four samples of chlorinated water giving bad laboratory results were encountered, and in those the hypochlorite of lime was at fault in not containing the proper amount of available chlorine.

The experience at H. has shown that there can be no question regarding the value of chlorinating doubtful or bad water supplies.

Amybic Dysentery.

The prevalence of diarrhoeal diseases formed one of the largest problems on the Peninsula, and it is no exaggeration to say that Cape H. will ever be associated in the minds of those who were there during the warm weather with the “red flux” of dysentery. Whether or not amebic dysentery was endemic at Cape H. before its occupation by our troops is not known; even presuming that it had been, it is quite clear that the source of infection must have been considerably augmented by “ameba carriers” amongst those troops which came from E., where amebic dysentery is endemic.

At all events, one occasionally saw patients who stated that they had suffered from dysentery in E. before coming to the Peninsula, and that they had been treated there by hypodermic injections—presumably by emetine. Whatever may have been the original focus of infection, troops coming direct from England to Cape H. developed amebic dysentery.

Working with over 150 cases of dysentery during the months of September and October, one found sixty-five per cent of stools with blood and mucus to contain entamoebae. A detailed description of the morphology of these entamoebae would occupy too much space, and an entry into the question of their classification is beyond the scope of this paper. One may say here, however, that as a general rule the ectoplasm of the entamoebae found was more highly refractile than, and consequently defined from, the endoplasm; the nucleus was exceedingly poor in chromatin and difficult to stain; at times phagocytosis of red blood corpuscles or of bacteria, or of both, was noted; from time to time, cysts definitely with the characters of those of Entamoeba tetragena were observed. Entamoebae were also found in some diarrhoeic stools in which neither blood nor mucus was present; but rarely in such profusion as in the more typical muco-sanguineous stools of dysentery.

Post-mortem examination of one case, where the patient had
never previously been abroad and had come direct from England to the Peninsula, revealed extensive ulcerative colitis, with the morbid appearances of the type found in amebic dysentery, together with secondary liver abscess formation—two abscesses being present, one in the right lobe and another, the larger, in the left lobe of the liver; portions of the tissues from this case were sent to Professor J. Lorrain Smith, M.D., F.R.S., for histological examination, and his report stated that the sections showed amebae in large numbers.

Bacillary Dysentery.

True bacillary dysentery was rare at Cape H. Plate cultivations succeeded in the recovery of \textit{B. dysenteriae} (Shiga) from no more than five cases of dysentery; one of these was drawn from S. and so cannot be accounted to Cape H. In one case only was \textit{B. dysenteriae} (Flexner) isolated.

The cases of bacillary dysentery at Cape H. were sporadic, having no relation to each other either in time or as regards the immediate locality in which they occurred. Further, no epidemic occurred in which the cases were like bacillary dysentery either in their clinical aspects or in their bacteriological findings.

Flagellate Diarrhæas.

Flagellates were found in the stools of a few diarrhœal cases. As they were never found in solid motions this fact would appear to indicate that flagellates were sometimes the cause of diarrhœa. They were at times associated in dysenteric cases with entamoebae; in one specimen entamoeba, \textit{Trichomonas hominis} and \textit{B. paratyphosus} \textit{B} were found in conjunction.

At H. \textit{Cercomonas hominis} and \textit{Trichomonas hominis} were the flagellates more commonly found, Cercomonas rather more often than \textit{Trichomonas}.

In uncomplicated flagellate diarrhœas, \textit{Trichomonas} was found to be the responsible agent in eight instances; one case only was due to infection with \textit{Lamblia intestinalis}. Presence of blood in the stools of these cases was the exception and not the rule, blood being found on no more than two occasions, in each case associated with the presence of \textit{Trichomonas}. The stools of cases suffering from flagellate infections were generally large, watery, diarrhœic stools, containing much fecal material, and frequently bile, the consistence most often resembling that of thin gruel.

The flagellate diarrhœas were treated with success by the
method recommended by Captain R. G. Archibald, R.A.M.C.; this method consists in the exhibition of a solution of potassium permanganate and in the administration of rectal injections of quinine (strength 1 in 5,000). In two cases where the potassium permanganate was administered in the form of keratin-coated pills and the quinine injections were omitted, very satisfactory results were obtained; this may mean that the permanganate is the agent of chief value.

Typhoid and Paratyphoid Fevers.

(1) Typhoid Fever.—Only three patients with true typhoid fever were encountered; in two instances the patient had not been inoculated against B. typhosus, while in the third case, where the infection occurred in an inoculated patient, the fever ran a short and abortive course.

There can be no doubt after the H. experience that the practice of antityphoid inoculation has absolutely justified itself.

(2) The Paratyphoid Fevers.—In paratyphoid fever one found blood culture between the second and sixth days of the fever to be par excellence the best means of diagnosis; of the later stages of the illness one cannot speak, because patients were always removed to the hospital ships as soon as possible and could not therefore be kept under observation by the writer.

Since the thirty cases or so of paratyphoid fever yielding a positive result by blood culture represented approximately fifty per cent of all the cases of P.U.O., thought to be possibly enteric fever, one may conclude, in the first place, that the bacillemia in paratyphoid fever takes place early, and in the second, that owing to the protection given by antityphoid inoculations, paratyphoid infections are now of greater importance than true typhoid fever as a cause of invaliding amongst the troops.

At H. most of the paratyphoid fever was due to B. para-

B. paratyphosus B. B. paratyphosus A and inagglutinable strains were found in a few cases. The inagglutinable strains of paratyphoid bacilli were obtained as follows: once from an ulcer of the ileum and twice from the blood of patients suffering from "jaundice with pyrexia."

B. paratyphosus B was also obtained from the blood of five patients with jaundice; this organism was in another case recovered from the bile of a patient found at operation to be suffering from gangrenous cholecystitis.
Catarrhal jaundice formed the greater portion of the so-called "epidemic jaundice." In view of the prevalence of diarrhoeal diseases during the summer months, the relationship between the incidence of these and that of jaundice is interesting; the chart (fig. 3), illustrates this relationship and, for the figures from which he was able to construct it, the writer wishes to acknowledge his indebtedness to Captain MacGregor, R.A.M.C.

Blood cultures were made from sixty-four cases of jaundice; most of these were cases of catarrhal jaundice with slow pulse and normal or subnormal temperature; all of these gave negative results. Cases of jaundice with pyrexia were less frequent, but nine of them gave a positive result, B. paratyphosus B being found in five cases an inagglutinable strain of B. paratyphosus in two cases, and Gram-negative motile non-lactose-fermenters (which could not be worked out owing to the evacuation) in two cases. One of the last-mentioned organisms gave the cultural reactions of B. paratyphosus, but for the reason above stated, the agglutination tests against the paratyphoid anti-sera could not be carried through.

In these cases of positive blood culture one gained the impression that the jaundice and the paratyphoid fever were concomitant infections; further, no evidence was obtained of the jaundice being due to a specific micro-organism.

Simple Diarrhoeas.

Lienteric diarrhoeas unattended by pyrexia or, as in a few cases, associated with an elevation of temperature not exceeding two degrees above normal, in which many large watery motions containing neither blood nor mucus were passed per diem, were present at H. in the warm weather; these diarrhoeas became suddenly rare early in October when the days became colder.

Although a quickened pulse-rate was common, the simple diarrhoeas were not, as a rule, accompanied by any further symptoms other than occasional colic; for this reason they gave little rise for anxiety except, perhaps, as possible predisposing causes for dysentery and cholera. These diarrhoeas usually lasted ten days, with an average duration of three to five days.

In a group of twenty cases which were examined bacteriologically there was in no case any infection with bacilli of the dysenteric or typhoid groups of micro-organisms, nor with entamoebae, flagellates, or spirochaetes.
R. Archibald, G. Hadfield, W. Logan and W. Campbell

Compared with films from normal faeces and with similar films from cases of dysentery, direct preparations from the stools in the simple diarrhoeas revealed a remarkably heavy organismal infection, not due to any of the micro-organisms usually recognized as capable of producing diarrhoea.

In one exceptional case with choleraic symptoms, vibrios were noted, but these did not prove to be V. asiatica cholerae.

In two cases a diplococcus was found to be the predominating organism, and, on plating out the specimens, colonies of this organism, whose growth was not inhibited by either McConkey's or Endo's medium, greatly outnumbered the colonies of all other organisms, present; on further examination, the organism was found to correspond with the diplo-streptococcus already referred to above. A similar organism was also encountered during the month of December in a more chronic case of diarrhoea, where the patient had suffered from diarrhoea at frequent intervals for several months but had never passed blood or mucus; and where no cause, except the diplostreptococcus, could be found on bacteriological examination of several specimens of the stool. Some believe the acute simple diarrhoeas to have been due to the mechanical action of sand in the intestine. The writer was informed by one regimental medical officer that he had observed after each sand-storm an apparent increase in the number of diarrhoeal cases with which he had to deal; this, however, was not the experience of others.

Sand per se, either taken in the food or swallowed directly during a sand-storm, can be accepted as an important factor in the causation of the simple diarrhoeas. More positive evidence is required of its presence in intimate mixture with the faeces, because sand particles are not an uncommon form of adventitious contamination of specimens of faeces sent to a laboratory during a sand-storm.

In some cases where the patients had been on the Peninsula for no more than two days, and that in non-windy weather, sand could not have been a serious aetiological factor. Further, if the diarrhoeas were caused so largely by sand, one would have expected colic to have been a more prominent feature of them.

While the purely irritative action of sand may be regarded as a somewhat doubtful adjuvant in the production of diarrhoea, the question of micro-organismal infection conveyed indirectly to the patient by means of soiled sand used in cleaning out mess-tins, etc., is quite another matter; it is common knowledge that epidemics of camp diarrhoeas have been caused in this manner.
With other causal factors apparently constant, the remarkable coincidence of a marked diminished incidence of the diarrhoeal diseases with a sudden fall in the temperature and an arrest of the fly-plague was striking and serves to show that the relationship existing between them was very real. At the latrines flies formed a perfect plague, and it was no difficult matter to understand how noxious material could be carried by them from the latrine to food; the latter was frequently covered by flies to such an extent that it became a veritable black mass of living things. Aided by the warm weather, this would result in a multiplication many times over of the original organismal infection of the food. It would seem that most of the simple diarrhoeas were due to a "mass infection" obtained in this way—a mass infection probably capable of producing diarrhoea although the individual strains of organisms concerned need not necessarily have had a specific pathogenic action.

This is borne out by the heavy organismal infection found in the stools of these cases, by the absence of specific infection by dysenteric or typhoid organisms, and, if the analogy of summer diarrhoea in children be taken by its consonance with certain investigations in America, where it was shown that a massive infection conveyed by means of milk could in the ordinary way inevitably produce diarrhoea, although of 200 strains of organisms isolated from the same milk none had by itself a specific pathogenic function.

While this opinion is expressed, an open mind must be kept as regards the rôle of vibrios and of the diplostreptococci already referred to; these may play a more important part in the production of such diarrhoeas as were common during the hot weather than the limited number of examinations carried through at H. might indicate.

Malaria.

Patients suffering from malarial fever were met with from time to time. Of these, four cases had undoubtedly become infected (benign tertian) at Cape H., a fact which is interesting in view of Lieutenant-Colonel Balfour's discovery of Anopheles there.

Diphtheria.

This disease was not unfrequently met with. The most noteworthy facts are these:

(1) The open-air life rendered the disease a mild type clinically.
(2) One case of exceptionally mild sore throat bacteriologically diagnosed as, but clinically unlike, diphtheria, revealed its true clinical position at a later date by the development of neuro-cardial paralysis.

(3) The disease was apparently spread by "carriers." Two "diphtheria-carriers" were detected; their isolation was followed by a diminished incidence of the disease amongst the troops of the regiment from which they came.

(4) As no raw milk was used by the troops—tinned milk only being made use of—this article of diet could be excluded as a means of spreading the disease, a fact which emphasizes the importance of the "carrier."

**Pneumococcal Throat.**

While ordinary septic throats and diphtheria were the most common throat conditions, mention should be made of the fact that, with the sudden advent of a short period of cold, damp weather, numerous cases of tonsillitis and pharyngitis occurred.

In these cases the temperature continued high for several days, and, while no suppuration occurred, the effect of this variety of sore throat upon the patient's general condition was more profound than might have been expected from the appearance of the local lesion.

The pneumococcal throat is a specific entity, and the likelihood of its occurrence should be borne in mind, particularly when the weather conditions are changing from warm to cold and damp.

To assist in its bacteriological investigation it would be well to employ blood agar for the primary cultures in addition to the routine blood serum or egg medium.

**Gallipoli Sore.**

The so-called Gallipoli sore was that variety of septic or trench sore which was common amongst the troops on the Peninsula. The lesions were divisible into primary and secondary—the primary being traumatic ulcers and the secondary being vesicles, which later developed into ulcers simulating those of the primary lesions. The favourite sites of the primary lesions were the posterior aspects of the fingers and the dorsal metacarpal areas of the hands; while those of the secondary lesions were both aspects of the forearms and hands, though the upper arms and the lips were by no means immune.
Patients commonly described a slight injury to the skin occurring during trenching operations as the cause of the primary lesion or lesions, though this history was not obtained invariably, some patients believing that they owed the condition to bites from flies; in most cases the history of traumatism was clear.

In the majority of cases the primary lesions—indolent ulcers, taking anything between two weeks and three months to heal—were followed intermittently by the appearance of vesicles (the early secondary lesions) on the hands and arms. These vesicles generally contained a serous exudate, though some vesicles with sero-purulent or with sero-sanguineous contents could often be found; if protected from injury the vesicles occasionally terminated by simple resolution. Their usual termination, however, was rupture by traumatism during washing or in some such way, and when this happened a superficial ulcer was formed, the base of which sloughed off within the next day or two, leaving an indolent ulcer similar in characters to that of the well-developed primary lesion. Lymphangitis and lymphadenitis were rare, only being seen in those infrequent cases where an acute septic infection arose as a complication.

The only organism constantly present in the lesions was a Gram-positive diplococcus which could always be obtained on culture as well as demonstrated in direct preparations from the sores and vesicles. In the open lesions this organism was associated with one or more of the following: Staphylococcus pyogenes albus and aureus, streptococci, diphtheroid bacilli, leptotheicci, aspergillus and other hyphomycetes, Bacillus subtilis; but from the closed lesions (vesicles) properly taken material yielded only the Gram-positive diplococcus. For this reason the diplococcus is regarded as the essential factor in the causation of Gallipoli sore. In films taken from vesicles within the first three days of their development the diplococci were both intracellular and extracellular, while in films from vesicles of longer standing they were usually extracellular. No capsules could be demonstrated, although in some preparations occasional diplococci were seen to be definitely aureolated.

On culture, these diplococci grew best on blood agar, forming small greyish colonies with smooth margins; most strains had no haemolytic action, but in one or two instances the organism did possess feeble haemolytic powers. In direct films and in preparations from young cultures the typical organism was seen to be made up of two elongated, somewhat reniform cocci, which had their opposed edges flattened, on culture however, involution
occurred readily, the flattened cocci becoming swollen and spherical—the component parts of the diplococcus sometimes swelling unequally; similarly, after cultivation of the organism for forty-eight hours or longer, short streptococcal forms were frequently seen—but since in the unbroken vesicles the only forms found were diplococcal, the term "streptococcal dermatitis," as applied by some to the condition, does not fairly describe "Gallipoli sore" in so far as its aetiology is concerned.

The main points referred to in the reports may be briefly summarized:

(1) The type of dysentery most prevalent among the troops in the Dardanelles in August, September and October was amoebic; only a few cases of bacillary infections occurred during these months.

In November, December and January, amoebic dysentery entirely disappeared, and the incidence of the bacillary type of the disease increased.

(2) The diarrhoea incidence was greatest during the months when dust and flies were prevalent. Many cases apparently were not due to any specific organism, but resulted from a "mass infection" of micro-organisms in the intestinal tract.

Diplo-streptococci, vibrios, Morgan's No. 1 bacillus and T. intestinalis appeared to be causal agents in a certain percentage of cases.

(3) The typhoid incidence among the troops was very low, the majority of the enterica infections being represented by fevers of the paratyphoid group.

Paratyphoid B was more prevalent in September and October, whereas in the following months paratyphoid A was more commonly met with.

There can be little doubt that the "carrier" plays an important part in the dissemination of paratyphoid fever, assisted probably by such agents as flies and dust. At the same time the possibility of its being a water-borne disease should also be considered. Antityphoid inoculation apparently confers no immunity against paratyphoid.

(4) Relapsing fever was found affecting chiefly I. troops and men of the E. Labour Corps. Clinical and laboratory observations indicate that two distinct species of spirochaete were concerned, and that the body-louse was apparently the transmitting agent.

(5) No conclusions were arrived at regarding the aetiology of epidemic jaundice. In apyrexial cases blood cultures yielded
negative results, whereas in cases associated with pyrexia *B. para-
typhosus* B was occasionally present in the blood, probably as a concomitant infection.

![Graph](chart.png)

**Fig. 2.**—Chart showing the incidence-rate of epidemic jaundice and diarrhoeal diseases per 1,000 troops in one division for period August 7 to December 19, 1915.

**ACKNOWLEDGMENTS.**

Thanks are due to Lieutenant-Colonel Willcox, R.A.M.C., and to the O.C.'s and officers of — stationery hospitals and field ambulance, and medical officers of the E. Labour Corps for kindly assisting the laboratories in obtaining pathological material.
<table>
<thead>
<tr>
<th>DATE</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
<th>29</th>
<th>30</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>F°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>98°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 3.—Amobic dysentery treated with emetine.**

| DATE | 25 | 26 | 27 | 28 | 29 | 30 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| F°   |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 101° |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 100° |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 99°  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 98°  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

**Fig. 4.—Bacillary dysentery (B. Flexner).** This case was treated with emetine prior to bacteriological investigation. On the thirteenth day B. Flexner was isolated from the stools and serum treatment was employed with striking success.
Fig. 5.—Chart of paratyphoid A fever.

Fig. 6.—Chart of paratyphoid B fever.
Fig. 7.—Chart of paratyphoid B fever complicated by amebic dysentery.

Fig. 8.—Relapsing fever (Indian).
FIG. 9.—Fatal case of relapsing fever (Egyptian).

FIG. 10.—Case of frostbite complicated with typhoid. *B. typhosus* was obtained from the local lesions in the right foot, where a suppurative osteo-arthritis had occurred.