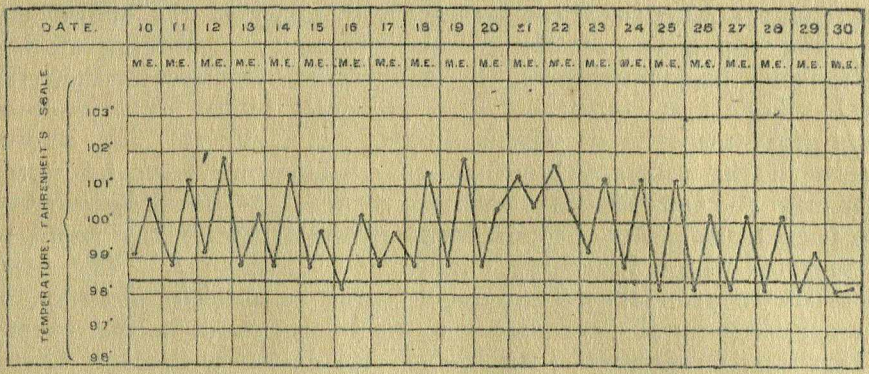
Major Fearnside was formerly personally in control of one of the three jails in which the recent records of Enteric Fever have been high, and he has published in the *Indian Medical Gazette* (April, 1904) some suggestive remarks on the influence of intestinal entozoa in raising the mortality in some of the Madras jails and on the notable effect of anthelmintics in reducing the high death-rates from bowel diseases: dysentery, diarrhœa and catarrhal enteritis. For example, the mortality from bowel diseases during the three years, 1891-3, ranged in one jail (subject in the records to "Enteric Fever") from 33 to 49 *per mille* of the average strength; then with the recognition of the part played by entozoa and the introduction of the treatment by anthelmintics, the death-rate from these disorders fell in 1894 to 10·9, in 1895 to 9·7 and in 1896 to 1·5 *per mille.** His record shows that in one year no less than 2,703 worms, chiefly *ascaris lumbricoides*, were obtained from 255 patients, the prevalence of the round worm being favoured by the moist damp coast climate and by the opportunities afforded, by the habits of the people, for infection and reinfection. Dealing with the symptoms due to the presence of these parasites he refers to headache, faintness, malaise and dyspepsia with abdominal fulness in the first stage, followed by muco-enteritis, vomiting and persistent diarrhœa; the temperature rising to 102° at night with a remission of a degree in the morning. The stools contain much jelly-like mucus, and the conditions may persist for long after the evacuation of the larger worms. The fever may last for weeks and "*simulate exactly enteric fever;* and not only this, but the *post-mortem* appearances are often similar. Pain in the right iliac region is marked (the cæcum being a favourite nidus for the worms) and one not cognizant of the prevalence of *A. lumbricoides* might mistake the whole disease for enteric." Temperature charts are given which fully confirm this statement, and one of these is appended. Finally, a definite dysenteric condition is set up by the continued irritation maintained near the ileo-cæcal valve and the constant passage of mucus and pus, the fever continuing and assuming a more hectic type. Major Fearnside refers the general symptoms, fever, headache, nausea and depression to the toxin excreted by the worms which is probably rendered effective by the enteritis induced by their presence in large numbers. The young nematode bores into the mucous membrane and sets up local inflammation, which often goes on to ulceration, gangrene and emphysema and,

* Similar results have been achieved elsewhere, *Indian Medical Gazette*, July, 1905.

occasionally, to perforation. Cases are quoted which show the destructive effect on the intestinal walls as found on autopsy, one of which was returned as "Simple Continued Fever;"

CHART No. XXIV.



Enteritis caused by *Ascaris Lumbricoides* (Major Fearnside, I.M.S., *Indian Medical Gazette*, April 1904.)

the *post-mortem* disclosed the intestine with thickened coats and superficial ulceration of the ileum, eight ascarides being found in the small intestine. (See also Prof. Blanchard in *Archives de Parasitologie*, t.x., No. 1.) These considerations should be borne in mind and we shall deal later with the evidence of the more or less endemic prevalence of Enteric in this area.

To take one or two examples at random of the *post-mortem* results recorded in jails in Bengal; during the last twelve years (1893-1904), it will be found that out of a total of 180 deaths occurring in the Hughli jail, 154 were submitted to autopsy, but in no case was Enteric Fever diagnosed. There are several examples of well marked and typical dysenteric lesions in which ulceration extended to the ileum, and there were cases of tubercular ulceration of this part of the intestine. There are only two cases examined and reported on by Assistant-Surgeons in the absence of the Superintending Medical Officer (I.M.S.) which might possibly be regarded as of an Enteric nature; one in which "the small intestines presented patches of ulceration, Peyer's patches slightly enlarged"; (no mention of large intestine) and which was returned as "death due to chronic diarrhœa" —duration of illness, one week; the second died after two days' illness from peritonitis due to "a perforation the size of a split pea, about three feet above the ileo-cæcal valve; there were also two small ulcers, size of a pin's head, 3 ins. above the

perforation." Lt.-Colonel Crawford, I.M.S., who sends me these *post-mortem* records, says: "I must have done at least 1,000 autopsies in the jails and in medico-legal cases, and I do not remember ever seeing Enteric lesions save in one case in the Calcutta College Hospital. In medico-legal cases one is not specially looking for these lesions, and many of the bodies are too decomposed to see them even if present." Making all due allowance on this account, the statement is sufficiently remarkable when it is confirmed so abundantly in the experience of the great majority of officers in medical charge of jails, and in view of the statistical and other evidence we have adduced. During the last 20 years out of a total of 154 deaths occurring in the Cuttack jail only six were returned under the head of fevers, of which four were classed as "Remittent." The *post-mortem* records show that one was due to double pleurisy; in two, no intestinal ulceration was discovered, and in the fourth there were dysenteric ulcers in the large bowel with a few ulcers in the cæcum and ileum. This long digression should not be valueless in elucidating the main problem as a complement to the most recent views based on the results of the serum test.

We must devote the remaining space at disposal to a brief review of the facts and opinions derived from experience of hospital and other practice among the general civil population. It must suffice to quote some of the most definite points elicited in the replies to numerous enquiries; at the same time it will be clear to the reader that the record is, by its nature, both incomplete and inconclusive, and that it affords no valid basis for a comparison with that for the Europeans.

PUNJAB.—The Professor of Medicine at the Medical College, Lahore, has kindly furnished the following statement of cases treated at the Mayo Hospital for the last five years 1900-4:

	No. of European patients.	No. of Eurasian patients.	No. of Native patients.	Enteric among Europeans.	Enteric among Eurasians.	Enteric among Natives.
1900	260	143	3,387	9	...	3
1901	197	191	3,483	5	1	3
1902	198	141	3,669	8	1	1
1903 ...	176	182	3,510	6	...	6
1904	174	134	3,427	4	...	...
	1,005	791	17,476	32	2	13

We have already seen that during the previous six years ending 1899 there had been 11 cases among Natives, reported by Colonel Browne, *i.e.*, therefore, a total of 24 cases recognized in this large college hospital in 11 years. Major Sutherland adds that generalizing from his experience, Enteric Fever is very rare among Natives and that when it occurs there is usually some departure from the usual habits of life. "I imagine it to be phenomenally rare among pure vegetarians and that meat-eaters are more subject to attack, but I would not dogmatize from this impression. To the best of my recollection I have never seen a case of Remittent Fever in the Mayo Hospital which, if it failed to show malarial parasites or to yield to quinine, or failed to react to a culture of the Malta fever coccus, did not prove, while under observation, to be due to tuberculosis or other pulmonary affection, or to syphilis or some pyogenic infection." He further holds the opinion that a considerable proportion of cases returned as Enteric Fever should properly be included in the paratyphoid class. "The procedure adopted in all cases of fever is to look carefully for signs of local infection first, and it is astonishing how often it is to be found,—perhaps a bronchial catarrh, a patch of broncho-pneumonia, an adenitis of the mesenteric glands, a bile infection, a urinary infection, and so on. Having found a local trouble, the sputum, urine, etc., is examined microscopically to find the infecting micro-organism, and when found, it is returned as pneumococcal infection (bronchial catarrh, broncho-pneumonia, pyelitis, etc.), and tubercle infections, streptococcal infections and others are returned in the same way. If need be, we make splenic or lumbar puncture for help.

"When there are no local signs we look on the case as possibly malarial, and make a blood film and do a differential leucocyte count. If malarial parasites are found, the case is returned as Malaria, in one or other form depending on the form of parasite found and on the type of fever assumed; and Relapsing fever would go under its own heading in the same way, though it is a very rare fever with us. Should nothing be found in the films, the differential counts may point to malaria infection, pyogenic infection, worm infection, etc., depending on how the mono-nuclears, poly-morphonuclears, eosinophiles, &c., are affected, and we return a fever with mono-nuclear increase which yields to quinine, as malaria, according to the type of fever assumed. If this examination is also negative, and the fever does not subside under 30 grains of quinine daily in a few days, the serum test generally gives positive results, and may show the case to be either Enteric or Malta fever, when it is returned as such. In my experience very few fevers are left over in the end which have to be returned in an uncertain way, like Simple continued Fever, Remittent Fever, Febricula, etc., though I dare say some febriculas get returned as malaria."

It will be allowed that this stringent scientific method of diagnosis renders the evidence in regard to the non-prevalence of Enteric Fever very forcible.

The reports of several Civil Surgeons (I.M.S.) of the largest experience coincide as to the main fact of the rarity of the disease in their experience, but we shall merely quote the remarks of two officers whose status and qualifications are guaranteed by the fact that they have held the important post of Civil Surgeon at Simla. One writes: "My opinion is that Enteric is not nearly as common in the Natives as has recently been believed. I have been constantly on the look-out for it and have sent blood for examination to the Pasteur Institute in every case in which I had the smallest suspicion that the disease was present. During the past three years I have seen four cases (one Eurasian), the diagnosis being

confirmed by the serum test." All were meat-eaters. "Native Assistant Surgeons tell me they meet with cases frequently, but I am doubtful of the diagnosis, for these are just the cases in which the Civil Surgeon would be called in for consultation." The other says: "In my opinion Enteric Fever is very rare in Natives; I have not had more than one dozen cases in my career. In 307 consecutive autopsies as Police Surgeon, Calcutta, there was no case of Enteric ulceration nor of perforation due to enteric ulcers. During 14 years, I have always myself made all the *post-mortems* in jails and have not yet seen typhoid ulcers in a Native."

The writer has been kindly favoured by Dr. Browne, of the Church Missionary Society, with reports from 13 Medical Mission Stations all in charge of highly qualified officers, the results from the stations being omitted where the Missionaries are medically "unqualified." The reports deal generally with the practice of the year 1904 in which about 360,000 patients were under treatment, and among these, 10 cases of Enteric fever were diagnosed. Dr Lankester, Peshawar, while stating that no case occurred among 700 in-patients in 1904, says: "I have had from time to time cases of Enteric among Natives as to which the diagnosis was quite clear, but the disease among them is so very rare that one perhaps naturally hesitates to pronounce a positive diagnosis until the symptoms are quite unmistakeable." Another writes: "Personally I have found it very rare. I have had only two really authentic cases under my own care during my 4 years' experience here." (These cases are included in the total of 10 referred to.) A third says: "No Enteric cases came to us at all this year; in fact we rarely see it among Natives." A fourth believes that "many cases of continued fever with diarrhœa are really typhoid especially amongst children, but personally I have never had a case long enough under observation to make a positive diagnosis." A fifth writes: "I consider typhoid very rare among the Natives; during this last year, we had one typical case in a Brahmin girl, 5 years of age. There were 766 in-patients and 10,023 out-patients; the diagnosis of the latter is of course very uncertain." Miss Church (M.B., Lond.) says: "I have had very few cases under my care; I can only recall one in Lahore,—a Native Christian, aged 14. During the 5 years I had charge of the Scotch Mission Hospital in Madras I think I had one case. During 2 years in Calcutta I had none, but the number of patients was small." Dr. Neve of Srinagar, Kashmir, reports 4 or 5 cases during the year, the number of new patients treated being 16,000 to 17,000. "The disease is not common among Natives; perhaps as quite young children they get it in the form of an obscure fever. I suspect that as against Enteric the tissue resistance is higher." Another writes: "Our new patients numbered 13,201, old cases 25,528; maternity cases, 1,826; visits to houses, 2,733. Judging from the experience of a good many years: "I should say Enteric is rare among non-Christian Native women and children. I have seen typical and undoubted cases in previous years only in Christians." Lastly, it is said by a doctor on the North-West Frontier: "I feel sure that Enteric is not at all uncommon among the native population, but as we hardly ever get *post-mortems* and are unable to do Widal's test, doubtful cases come to be entered as continued or Malarial fever." Another from the same locality writes in similar terms, though no cases were recognized from the end of 1903 to the beginning of 1905.

Dr. Martyn Clark, of Amritsar, whose experience in medical mission work is quite exceptionally great and valuable, informs the writer that, in his opinion, Enteric Fever is commoner among the Natives than formerly, though

this may be only an apparent phenomenon due to better diagnosis and to the greater confidence of the people in British medicine. But for all that, he is inclined to view the result as largely the effect of a change in the habits of the people in the direction of more Western modes of life involving increased liability to new diseases—"a disease of modern introduction which is establishing a foot-hold among the Natives." "As regards Natives I should call the disease neither rare nor prevalent, but increasingly appreciable. It is nothing like the scourge it is among the European population, but without being prevalent, it is there; middle age, early manhood and adolescence are the periods of liability. It occurs equally in urban centres and in villages. It is in no way connected with meat-eating, but rather with milk, and I presume water. It is never epidemic, but always sporadic, an observation I cannot account for. I should not call it prevalent among children any more than among adults,—certainly not so as to confer immunity in later life. I am distinctly of opinion that it exists among Natives in nothing like the amount to account for the alleged infection of European troops in bazaars and Native towns. In towns, it is remarkable to think of the filth, smells and general sanitary vileness, and then to realize the non-prevalence of the disease."

The experience gained in medical mission work is especially valuable as it brings the doctor into very intimate relations with the people, and it has therefore been quoted at length.

CENTRAL INDIA.—The Administrative Medical Officer, Central India, informs the writer that he has met with "several cases of Enteric which were corroborated by Widal's test," but he holds that not all Remittent fevers that give a positive reaction are to be classed as Enteric. "There are many Remittents, not Malarial and not Enteric, which, in many cases I have proved to be Malta fever and which gave the Widal reaction." Malta fever is much more prevalent than is commonly supposed (see reference to recent work of Major Lamb).

A senior officer of great experience of medical work in the Rajputana States makes the following interesting remarks:—

"In 1901 I went to Ajmer, and on looking up the mortality statistics of the Ajmer City I noted that 700 cases of Enteric had occurred during the previous year. This rather staggered me, and I at once instituted enquiries as to localities in which it had been prevalent,—the conditions of sanitation, water-supply, etc.,—and could get no information of any value. No steps seem to have been taken in these directions and I found that there were no special localities to which the disease could be traced, but simply that *all cases of fever lasting over a certain time* were entered as 'typhoid.' I further elicited that there had been a few cases of Enteric, but these had been either in Eurasians or Europeans. Natives suffering from prolonged fever were simply put down as Enteric cases, but no special care seems to have been taken in diagnosis, etc. I then gave orders that *every case* at all simulating 'Typhoid' should be at once reported to me for my personal investigation, and this order I repeated at intervals, but I never saw a single case in a Native during the year I was there." He goes on to refer to a form of Remittent fever ("Motijara") having some of the characteristics of Malta fever: this would seem to present a promising field for research, as it is frequently referred to in the Reports received. The Civil Surgeon of Ajmer, the incumbent at a later date, is strongly of opinion that whatever be the case with "Motijara," many of the cases of Remittent fever in

Native and Eurasian children, often accompanied by obscure abdominal symptoms, are of an enteric nature,—and that to this the immunity of adults is due. Further he furnishes a list of nine cases of Enteric Fever, one of which, in a sepoy, is doubtful, as the *post-mortem* showed acute hepatization of one lung, "slight congestion of Peyer's patches ; no ulceration." The other eight cases occurred among young Rajput chiefs and nobles while at the Mayo College (ages 13 to 18), and three of which were under his care. These cases occurred between 1895 and 1904 inclusive (three in December 1895) ; all recovered, and one, the last, case was confirmed by the Widal test. All but two of the total (9) were meat-eaters. It should be added that the total number of boys at the College during the 10 years in question was 189, which gives a very high attack rate, but the three cases in December 1895 would appear to have had a common simultaneous origin as there were only 10 days between the admission of the first and the third. It need scarcely be pointed out that these young Chiefs observe in many respects (especially as regards diet) European or semi-European customs ; there can be little doubt, so far as clinical symptoms afford a guide, that most, if not all, of these were true cases of Enteric Fever.

Reference may be made at this point to the experience of the well-known Muhammadan Anglo-Oriental College at Aligarh, of which the writer was in medical charge for about seven years (1891-7), during which period no case of Enteric Fever occurred. The following is a statement for the last four years :

Muhammadan Anglo-Oriental College.

Year.	Average number of pupils.	Total cases treated, All Causes.	Cases of Remittent Fever.	Cases of Simple Continued Fever.	Cases of Enteric Fever.
1901	415	2,819	30	21	.....
1902	496	3,048	21	15	.....
1903	531	3,596	15	21	.....
1904	521	4,538	5	16	1
	1,963	14,001	71	73	1 (recovered.)

Note : Boys are not removed from College when ill, but they are sometimes sent home for change after recovery. No one is known to have died at home after illness contracted at the College. There were only two deaths from all causes, one from dysentery and one from cholera, during the four years. The boys have access to a large native town (population 80,000), but the College is well situated in the civil station.

If Enteric Fever were prevalent among Natives we should surely have evidence of it in this admirably conducted Institution to which boys come from all parts of India, with constantly recurring risk of importation every term.

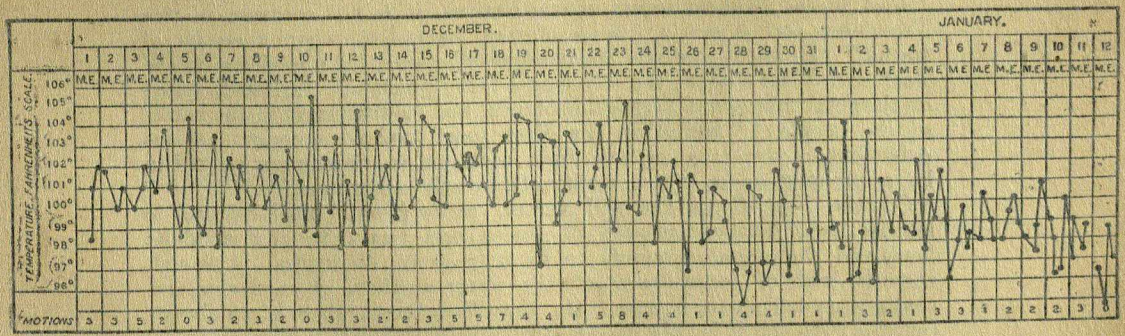
The Civil Surgeon of Agra, one of the largest charges in India, says : "My opinion is that Enteric Fever is very rare among Natives. I see a great many patients in private practice ; cases of Continued fever generally turn out to be tubercular or malarial. I do not think I have seen a single genuine case in jail or police hospital practice.'

The Residency Surgeon at Hyderabad has kindly furnished a report of cases observed in the Chudderghaut and Secunderabad suburbs, showing that 56 cases are on record as occurring during the last 10 or 12 years; of these 5 were in Europeans, 18 in Eurasians and 33 in Natives. Chudderghaut, where 46 of the total number occurred, is near Bolarum, the European cantonment, and it is said that in many cases the infection may have been contracted there, as visits to the cantonment are frequent; but the British soldier rarely visits Chudderghaut, and outbreaks of the disease in the barracks cannot well be ascribed to infection in the civil suburb.

MADRAS—The acting first Physician at the General Hospital, Madras city, informs me that during the past 5 years 177 Europeans and 24 Natives have altogether been treated in his wards for Enteric, about 700 Europeans and between 300 and 400 Natives being admitted annually for all causes. Of course, as has already been pointed out, Enteric Fever among Europeans is far more likely to come under observation than that among Natives. It is said: "One not seldom sees forms of fever, Continued, Remittent or undulant, among Natives which are not malarial and do not conform to the Enteric or paratyphoid type, but which may yet be due to some gastro-intestinal infective process."

The Second Physician, Major Donovan, whose researches in connexion with the Leishman-Donovan body are now well known, "considers the disease rare in Madras City and surroundings; in my wards at the General Hospital during 1903 and 1904 among a total number of 2,500 patients treated, only 5 cases of Enteric were admitted. But in a three years' experience in S. Canara (West Coast) especially of the town of Mangalore, I found Typhoid decidedly common among Natives at certain times of the year. I have been much struck by the close resemblance to Typhoid of what I have called "Human Piroplasmosis" (due to Leishman-Donovan bodies); the pyrexia has closely simulated that of Typhoid, and moreover Widal's reaction has been found positive in a 1 to 20 dilution." A chart appended will illustrate the point as to temperature, and the *post-mortem* records of fatal cases (Madras General Hospital Report, 1903) refer to the intestinal lesions in this disease, which might well be confounded with those of Enteric fever by a casual and inexperienced observer.

CHART No. XXV.



"Piroplasmosis" (Leishman-Donovan.)

Major Donovan's reference to the prevalence of Enteric Fever on the West Coast of the Presidency lends interest to reports from S. Canara and Malabar, kindly furnished by the District Medical Officers. Of the former it is said that the disease is undoubtedly present and is observed chiefly among the middle and upper classes, and that it prevails mostly in the large town of Mangalore situated on the coast. Cases are rare in the villages. The disease appears to be increasing and is most prevalent in the very rainy months of June to September or October, though it also occurs at times in December and January. Native Christians appear to be most liable and at the age of 14 to 30. The disease is attributed to the deposit of fæcal matter and refuse on the soil of the compounds of the homesteads (where also corpses are interred) and the organic matter, under the influence of an enormous rainfall, is washed into the shallow wells, the water-level of which is so high that the housewives can dip their receptacles into the water by hand. Each family has its own shallow well, quite unprotected, and close to the dwelling; the conservancy arrangements are *nil*, save in respect to the services of the pigs which act as scavengers; the disease is observed to cling to certain houses, and no precautionary measures are taken on the occurrence of a case.

The Medical Officer of Malabar furnishes similar but more detailed testimony, and we need only note the points not dealt with in the Canara report. "In the chief town, Calicut (population 76,000), I should say that 20 to 30 cases come under my direct observation every year, but there are undoubtedly a very much greater number in the town who never seek European advice. Some of the cases are very typical, and the diagnosis has been verified by the Widal reaction, and by the discovery of *b. typhosus* in the urine." House epidemics have been noticed. As regards the water-supply and the absence of conservancy the details given are similar to those prevailing in S. Canara. Entozoa are very common indeed, including ankylostoma; catarrhal inflammation of the bowels, as also dysentery and diarrhœa are very rife.

Further inland, where the wells are deeper and fewer and, being common property, are far better conserved, bowel diseases (including Enteric) are certainly far less prevalent.

To this account may be added some remarks by the Sanitary Commissioner of the Madras Presidency, Colonel King, C.I.E., I.M.S., who had a large experience of the disease before entering the service and who has always taken the greatest interest in the subject of its occurrence in this country. After giving instances within his own knowledge, he sums up: "that whilst Typhoid exists among Natives, it is not common in this Presidency and is not a disease of rural tracts but, where it occurs, of towns." He then proceeds to distinguish between the prevalence on the East and West coasts (the whole area being practically seaboard) based on the geographical and physical contrasts, and on differences in the habits of the people: "whilst on the East coast typhoid amongst natives exists but is very rare, on the West coast, it is, though not proved to be a pressing cause of mortality, frequently recognized." * * * "On the East Coast the soil varies greatly (from 'black cotton,' to laterite, with shallow sub-soil of shales and traps, to alluvial delta land) and the rainfall amounts to an average of 46 inches. Although there is lack of conservancy of the water-supplies, gross, direct and continuous defilement is rare. On the West Coast, there is an abrupt contrast; the soil is largely a loose lateritious gravel with a substratum of clay favouring shallow wells; and quite near the sea, the upper soil is mere

sand. The rainfall amounts to 133 inches, and frequently 10 inches fall in one day, so that the probability of transfer to the wells of matters on the surface and *viâ* the rapidly fluctuating ground-water is obvious. * * * Each house stands on its own separate and considerable area of private enclosed ground, so that a village proper may extend to ten to twelve miles, and yet may not contain more than eight or nine thousand people. The consequences of this arrangement are that the compounds (or "parambas" as they are called) are the great dumping ground of all effete matter. For night-soil purposes a shallow pit is dug in the soil, when the compound is small. Over this two planks are placed, and when the pit is full it is filled up. This goes on year after year. In the larger parambas, defæcation proceeds on the soil surface, but chiefly in corners specially devoted to this purpose. The rate at which nitrification proceeds is astonishingly quick, so that what was a mass of fæcal matter becomes unrecognizable from soil within 48 hours of deposit. In non-municipal areas, children are universally buried in the parambas and adults burned or buried as their caste allows. Practically, each paramba has its own water-supply. In the good class of houses, there is a bathing tank besides the usual shallow well which, if possible, immediately adjoins the house, so that the housewife may draw water direct from her window without going into the eternal rain. "The Muhammedans or Moplahs of the West Coast afford in their habits a complete contrast to the Hindus. They are dirty in their persons, live in very over-crowded houses, and do not luxuriate in bathing. They live side by side with their dead. The houses are built round mosques and each mosque compound is an over-crowded graveyard. Fæcal cesspools or shallow pits are also employed for at least the use of females in poor and crowded houses, although removal is practised amongst the better classes. Their water is almost exclusively drawn from wells in the neighbourhood of the churchyards. My theory is that under East Coast conditions fæcal matter reaches water after it has had considerable time under favourable conditions to favour the multiplication of non-pathogenic microbes at the expense of the pathogenic; whereas on the West Coast, year by year, there is risk of a more gross contamination by fæcal matter in a less perfect condition of change; and, moreover, there are the disadvantages, if once a "paramba" is contaminated by typhoid matter, of the continuance of its transmission. On this very theory when last on the West Coast, I made certain enquiries which pointed to the fact that only exceptional houses get attacked, and that, time after time, various members of the family disappear, under the influence of a disease that from its history *might* be typhoid."

* * * "I would state that of the two East Coast towns where typhoid is known, Madras City, although it has a public water-supply (itself open to possible contamination) nevertheless largely uses shallow wells, which are side by side in every house with its latrines; (this language must be regarded as "general" and applicable to certain classes of native houses only). Now as to Nellore, it is the only town where I have seen water exposed to the risk of fresh fæcal contamination to a gross extent on the East Coast, and it is the only town, besides the large City of Madras, where typhoid amongst natives has been recognized." * * * "In the above, all attention is paid to water transmission, and nothing has been said of dust, flies, milk, etc. Of course, transmission by these modes is likely, but it takes little imagination to make the theory fit in also with these modes, having once arrived at conditions which point to the retention of vitality of the microbe."

It has been necessary to quote at length from this statement, not only on account of its intrinsic interest, but because we have in the West Coast of Madras an area which has the unenviable distinction of a reputation for Enteric Fever in the endemic form among the Natives; of no other part of India has this ever been suggested unless we except the recent statements of Rogers in regard to the great City of Calcutta. But then we must hold that the conditions of life of the people, both on the West Coast and in Calcutta and the largest cities, are quite exceptional, if in different ways. But after all, with our knowledge of the habits of the people in every part of India and the gross neglect of conservancy that prevails everywhere, we can scarcely expect to find an explanation of this peculiar local liability in the greater measure of sanitary neglect *per se*. In default of authentic data, it would be unprofitable to pursue the suggestions that occur to one in this connexion; we merely note that all competent to judge, including those officers now serving on the West Coast who have had ample experience in other parts of the Presidency, agree that the prevalence of Enteric Fever in Malabar and S. Canara is quite peculiar to those particular areas, so that the evidence, even if taken without qualification, does not impugn the consensus gathered from experience elsewhere. A glance at the Census Report for 1901, however, shows that the population of the West Coast areas is quite peculiar in its caste-constitution, and that though "Hindus" predominate here as elsewhere, the *castes* of these are special to the area.* We find the distribution given as follows:

	Hindus.	Musalmans.	Native Christians.
Malabar District	1,904,474	832,970	51,493
Calicut Town	42,744	30,158	4,007
S. Canara District	914,163	126,853	84,103
Mangalore Town	25,312	7,149	11,604
Madras Presidency	34,048,082	2,457,088	1,024,071

* See also "Imperial Gazetteer of India," Arts. "Malabar" and "Canara."

Now this statement reveals the fact that while Muhammadans and Native Christians together stand in the ratio of only 1 to 10 of the Hindus in the population of the Presidency, the ratio for S. Canara is as about 1 to 4, and for Malabar as nearly 1 to 2, or five times the proportion for the Presidency. But it is in the large towns that the disease is said to be most prevalent, and we see from the above table, that in Calicut, the Muhammadans and Christians amount to 80 *per cent* of the total of the Hindu population, in Mangalore to 74 *per cent*. Now nothing like this is to be found anywhere else in India save in the scattered hamlets of the extreme west of the Punjab, and we have taken no account of the low and other caste Hindus whose habits (and diet) are assimilated to those of the Muhammadans and Christians. It is notorious that pork is a favourite and frequent element in the dietary of the Christians and lowest castes in this area. Obesrvations in regard to race and caste habits in relation to the incidence of Enteric

Fever are required as a supplement to the peculiar physical conditions set forth by Colonel King with such picturesque force ; and then also we need confirmation of the etiological connexion of the *b. typhosus* with the disease regarded as Enteric, in view of the extracts quoted from *post-mortem* examinations in the Mangalore and Calicut jails, examinations which were not conducted by the Indian Medical Service officers who furnish these reports on the free civil population.

BOMBAY.—We have already referred to the work of Dr. Row (M.D., Lond.) in the elucidation from the bacteriological side of cases of an enteric type which are said to be frequently met with in the city of Bombay. Briefly, his results go to show the important rôle played by *b. coli* and *b. enteritidis* in the etiology of these attacks, only two cases out of 24 in nearly all respects clinically identical, being associated with pure *typhosus* infection.

The Professor of Medicine at the Grant Medical College has most kindly furnished figures of the cases among Natives treated in the Sir J. Jeejeebhoy Hospital during the last fifteen years, and with these are shown the facts as recorded for Europeans admitted into St. George's Hospital.

Enteric Fever. Bombay Hospital Returns.

	St. George's, Europeans.		J. J. Hospital, Natives.			Total cases all causes (medical), treated.
	Ad.	Died.	Ad.	Died.	Otherwise.	Natives.
1891	17	7	1	..	...	3,158
1892	26	6	2	2	...	3,154
1893	29	10	...	...	...	2,809
1894	38	11	3	1	...	3,015
1895	85	19	5	3	...	2,520
1896	39	14	6	3	...	2,565
1897	25	12	4	2	...	2,571
1898	33	9	1	...	...	2,822
1899	47	9	7	4	1	3,156
1900	61	3	8	3	2	3,144
1901	46	12	8	2	1	2,816
1902	60	24	7	5	...	2,528
1903	46	15	3	3	..	2,579
1904	45	7	17	6	3	2,611
Total 14 years ...	597	158	72	34	7	39,436

N. B.—Those discharged "otherwise" possibly went to swell the mortality.

The mean case-mortality *per cent* among the European patients is 26·4, a result almost identical with that obtained among the troops; that of the Natives (without including those discharged "otherwise") works out at 47 *per cent*. It is impossible to draw exact deductions from these figures for reasons previously stated, but the contrast is certainly remarkable as it stands; it will be noted however that the number of cases is much greater in the second half of the period in both cases, especially if the exceptional incidence on Europeans in 1895 be discounted. It is said that, as regards Natives, this is probably due to more exact diagnosis. Major Childe, I.M.S., thinks Enteric a common disease among Natives in Bombay and not rare, as has been stated, and that the well-to-do are more liable than the poor. He thinks the disease must have been confused with Malarial, Remittent and other fevers in the past, and this source of error still exists in less degree. He quotes an experienced Native Physician to the same effect, who in 1879 described three cases he had met with among Parsis. Major Childe has reported several cases met with in practice; in a series of ten, of which seven gave a positive reaction to Widal's test, 2 were Brahmins (one a meat-eater), 2 Muhammadans, 4 Goanese, 1 Eurasian and 1 Parsi. He also supports Dr. Row's observations as to the frequency of "para-colon" or "paratyphoid" infection, and he notes that Malta fever and the Leishman-Donovan disease have been recognized by him in Bombay.

Dr. Powell of Bombay City, a very able observer, with large experience, says: "I do not think Typhoid rare in Natives of India, but still it is much rarer than among Europeans in India. During three and a half years (ending November 1904) we have had 32 cases among the Police; 7 Musalmans in a strength of about 550, and 25 Hindus in a force of about 1,750. There are about 70 Europeans in the force, but they are treated in St. George's Hospital" (figures included in statement given), "and the number of cases among them is not available, but the incidence on this class is certainly greater than on Natives*; their average age on joining the force is 25 or 26, and they are mostly old soldiers, which should render them less liable, both on account of age and of previous attacks. * * * My experience of this city shows that enteric is much more prevalent than in rural areas. As Coroner's Surgeon I occasionally meet with cases of sudden death from rupture of typhoid ulcers. I am sure the case of the Bombay Police is *quite exceptional*, and I am unable to account for the frequency of the disease among them as compared with Native troops. Is not the whole lymphoid tissue of the Native less prone to disease than that of Europeans? How seldom their Peyer's patches, tonsils and vermiform appendix go wrong. Though Tuberculosis is so frequent, that of the lymphatics is proportionately much rarer."

The Civil Surgeon of Poona, who has had a very extensive and varied experience during 22 years and who has constantly had European patients with the disease, is of opinion that the incidence of Enteric on Natives is highest among those whose habits (especially dietetic) approximate to those of Europeans, *e.g.*, low-caste Hindus, Parsis, high-castes who can afford to disregard caste "prejudices," like the young Rajput nobles at the Rajcomar College (as has been seen in connexion with the Mayo College), Muhammadans, and other Hindus (Brahmins and Bunniahs) who have been to Europe or who occasionally take European food.

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*A subsequent report shows that the incidence is four times greater.

Lastly, in connexion with the series of cases in which the diagnosis was confirmed by the serum test by Major Lamb, previously referred to, the remarks of Mr. Bharucha, L.M. & S., a teacher at the Medical School, Poona, and on the staff of the Sassoon Hospital there, are of interest. He believes that Enteric has prevailed among the Natives in Poona for some time past, but that this was formerly not the case to anything like the same extent. It is steadily gaining ground, but has never prevailed in epidemic form as among Europeans. The hospital register gives 34 cases during the four years from 1901 to October 1904, but this does not include cases seen in private practice. It is understood that all these cases were verified by the Widal reaction by Dr. Bharucha himself, save the few submitted to Major Lamb. He says: "I believe the prevalence of typhoid amongst Natives is peculiar to Poona; when working under the careful and able physicians, Dr. Vandyke Carter and Dr. Cook, and during my service of three years in the large Native hospitals of Bombay, I never saw a single case of typhoid fever, real or doubtful. * * * On coming to Poona, I was struck with the peculiar nature of the fever I met with there, and soon suspected that my belief in the absence of the disease would have to be renounced. Enteric runs a very mild course among Natives; diarrhœa occurs in only half the cases. I have seen hæmorrhage in only three or four, and thus I have had no occasion to verify my clinical and bacteriological data by *post-mortem* examinations; I have, up to date, lost only 4 cases, in which one *post-mortem* was performed and ulcer and perforation made out. As Police Surgeon, I must have performed over 300 autopsies during the past four years, but I have never met with a single case of typhoid amongst them. The majority of cases occur at the ages of 18 to 22 years, but I have had cases in children of from 5 to 10 years old. Most of my cases have been students, a large proportion being medical students. Enteric prevails in all classes, but Parsis and Native Christians appear to be most liable, next Hindus and last of all Muhammadans." (This is based on Dr. Bharucha's experience in Poona, where Muhammadans are in a small minority; thus, for the district the census in 1901 gives Hindus, 920,885; Musalmans 45,790; Native Christians, 14,484).

BENGAL.—As we have given a comparative statement of the cases of Enteric Fever treated in the other three large College hospitals, we may as well complete the list for convenience of reference, though here, as elsewhere, the record has only a very small relative value and cannot be held, and certainly is not intended, to exhibit a true and complete record, nor the true relative incidence on the two classes,—Europeans and Natives.

During the decade ending 1903, the records of the Medical College Hospital, Calcutta, give the following numbers of admissions and deaths among three classes, *viz.*, Europeans, 40 and 10; Eurasians, 21 and 5; Natives, 51 and 15, respectively; no less than 39 of the cases with 9 deaths among the Natives were treated during the last 3 years. This information was accompanied by the statement that two or three Natives were admitted for all causes for every European (Europeans being exclusively treated at the "General" Hospital) and that the number of Eurasians admitted exceeds that of Europeans. The great rise in the cases treated among Natives in 1901-1903 is notable: "I think cases among Natives are proved to be commoner than they were believed to be before the use of the Widal test;" evidently in 1901, as may be seen from Captain (now Major) Rogers' work published in the *Indian Medical*

Gazette of January 1902,* which was followed by his paper read before the Medico-Chirurgical Society, London, in May 1903† and published in its Transactions (Volume 86). These papers deserve close consideration, as upon the thesis they sustain depends in largest measure the case for the prevalence of Enteric Fever among Natives in the largest urban centres. It would be unfair to take extracts from the context of these statements, and there is the less necessity for this as everyone interested in the subject is bound to study them carefully for himself‡: we shall therefore merely note a few of the salient considerations and conclusions. Rogers considered that he had established the facts that among the continued and Remittent fevers met with among both Europeans and Natives in the hospitals of Calcutta, only two specific forms exist, *viz.*, typhoid and malarial remittents, and that as regards Natives "upwards of 80 *per cent* of the Remittent fevers encountered, which last three weeks or more, are typhoid fever." (At the same time only 50 of 126 cases "of all kinds" among Europeans in hospital were pronounced after examination to be Enteric, while 46 were Malarial. There is some danger of this being understood as implying that Enteric is proportionately more prevalent among Natives.) "On the other hand, I have not met with any cases of true Enteric in Natives of shorter duration than three weeks (mild or abortive cases), although they may possibly occur, so that my experience, so far, does not point to this fever being especially mild in Natives, but rather the contrary, for the series shows a mortality of 30 per cent, which is only partly accounted for by the late admission of one of the cases. ***Clinically they do not differ from the same disease in Europeans, only they tend to be more severe and fatal on account of the late stage of the disease in which they are commonly admitted." It may be added that up to March 1903, the number of cases of Enteric authenticated among Natives by Rogers had amounted to 26, together with others in different institutions in Calcutta and from various parts of Bengal. If all this be so, we can, on the evidence available, only fall back on Crombie's original suggestion of a form of fever ("urban fever") to which the residents of the great cities are peculiarly liable, for the facts of the clinical and *post-mortem* evidence and of the mortality among the classes of the population under medical control elsewhere cannot be strained to conformity with Rogers' results; for the age incidence as given for his Enteric cases includes a large proportion (over half) at ages at or above 20 years, which are fully represented in the Native army and among the prisoners, as has been shown. He also shows (from his experience) that the age incidence of acute Malarial Remittent is similar to that of Enteric "so that no diagnostic import attaches to the ages of the patients in these two forms of fever." He agrees that the "typhoid state" is commonly met with in Natives suffering from other Continued and Remittent, including true Malarial, fevers, and especially in Pneumonia; he has not met with a case of Malta Fever, but says that Cerebro-spinal fever may sometimes be difficult to differentiate certainly from Enteric when first seen; but here he relies on the presence of leucocytosis in doubtful cases of the former disease. "The chief points in which acute Malarial Remittent differs

*Typhoid as a common continued fever among Natives in Calcutta.

† The differentiation of the Continued and Remittent Fevers of the Tropics by the blood changes.

‡ They should be read with Colonel Crombie's address to the B. M. Association, 1904, entitled the "Fallacy of Finalities" (B. M. J., August 20th, 1904) and with the discussion that followed the reading of the second paper (*Lancet*, May 16th, 1903).

(clinically) from typhoid are mainly of a negative character," but the temperature curve is of great importance, though the Remittent type is commonly seen in both European and Native cases; the rises and falls are much more regular and punctual to the hour in malarial cases, while a more persistent high temperature (continued type) characterizes Enteric. "Of course a similar type is common in pneumonia, but here the presence of leucocytosis will exclude uncomplicated typhoid." Owing probably to the previous exhibition of quinine, parasites were only found in 20·7 *per cent.* of acute Malarial cases, but the failure of the drug, in 30-grain doses by the mouth daily for a week or more, does not preclude a malarial origin as is often fallaciously thought, such cases reacting well to hypodermic administration of the drug.

It will be noted that Rogers' conclusions are largely based on the results of the Widal reaction, and on the increase of the lymphocytes in the diagnosis of Enteric Fever; as to how far these criteria are absolutely reliable in cases among Natives we must leave scientists of equal ability to pronounce. It may, however, be noted that as regards the latter test some question has been raised by men competent to appraise its value (*Lancet*, May 16th, 1903); secondary toxæmias from intestinal affections are common and will alter the normal composition and relations of the blood cells. And as regards the former it appears strange that no evidence of paratyphoid or para-coli infection has been forthcoming, but that all the cases appear to be clinically and etiologically of pure *typhosus* origin and course, and the contrast with Dr. Row's Bombay results is remarkable. We have referred to Crombie's reported results of the application of the serum test in the case of healthy Natives of India residing in England, and who had no history of illness that could be identified with Enteric. A word of caution against a too absolute reliance on the results of this test in different races may not be superfluous and we commend to notice the remarks made by Professor Uhlenhuth (*Deutsch. Med. Wochenschrift*, October 19th, 1905) on "Blood relationship and the Precipitin test." The general conclusion to be drawn from the observations discussed by Uhlenhuth, is that, even in nearly allied animals, important differences must be present in the chemical constituents of the blood. How close the inter-relationship must be before these chemical differences disappear is at present an open question. Occasionally the precipitin test has brought out differences in blood constitution even in animals which are zoologically identical. Thus Schutze prepared a serum by inoculating rabbits with rabbit's blood; this serum he tested against the blood of thirty-two rabbits, and in two instances obtained a precipitate. This rare phenomenon, in Professor Uhlenhuth's opinion, must not be explained by the supposition that an "iso-precipitin" has been formed, but ought rather to be regarded as due to a *racial difference in the blood albumens* of the animals in question. And similarly, he thinks, chemical differences may be present in the blood of various races of mankind.

After all, the established facts do not appear to warrant the assumption that the large class of Continued and Remittent fevers can be differentiated under the two heads—malarial and true Enteric, and that 80 *per cent.* of the whole occurring among Natives, the duration of which exceeds three weeks, belong to the latter category. Such a statement is doubtless a misinterpretation of Rogers' views which were formulated three years ago, and in the remarks which follow, no criticism is implied; we wish merely to indicate the various forms under which so-called "Remittent" and "Continued" fevers may appear. If we set down simply the commonest

forms of disease already known to occur among the Natives we may appreciate at once how much larger is the range of fevers which assume a more or less remittent type, simulating the pyrexia and other clinical signs of Enteric; and these are not occasional curiosities of tropical pathology, but, in many cases, the commonplaces of practice in this country. We have, *e.g.*—

1. True Malarial Remittent, acute and chronic, from which to judge by the returns (admissions *per mille*) a large proportion of the population suffers and which confers no subsequent protection, and must frequently complicate other specific infections. This is frequently attended by "enteric" symptoms in the non-specific sense, by enteritis (Rogers) and by necrotic lesions of the intestine (Vandyke Carter, Murray, Mannaberg, &c). It is also frequently accompanied by low forms of pneumonia and bronchial catarrh.
2. The disease caused by the Leishman-Donovan bodies, the extent and distribution of which is not yet known, but, so far, it has been found to be most prevalent where Enteric is least recognized. Here again we have intestinal implication, and it was long confused with Malarial Remittent of which Rogers himself considered it a special form.
3. Malta Fever, which has recently been shown to be much commoner among Natives than has hitherto been suspected, and this not by the serum test alone, but by the isolation of the specific organism by Lamb from material received from several different places. (Sanitary Commissioner, India, 1904). Here there is enlargement of the spleen as in the two previous instances cited, and "it may be that it only on the *post-mortem* table that we have the assurance, from the absence of ulceration in the ileum, that we have had to deal with a case of Malta Fever" (Manson).
4, 5, 6. Tuberculosis, Pneumonia in various forms, and Dysentery, are all very prevalent, and all may be complicated by Malaria, and in two of these at least there is frequently hæmorrhage from the bowels, along with intestinal lesions, simulating to the casual observer those of Enteric Fever. Chronic Pleurisy also is extraordinarily frequent, generally as a complication of other primary disorders, but when simple, it is often masked by Malaria and overlooked.
7. Cerebro-spinal fever, the similarity of some cases of which to Enteric has been noted by Rogers.
8. Influenza and its complications; and even Dengue may be mentioned.
9. Pyogenic infections, pyelitis; hepatic, cardiac, splenic and meningeal affections; also those of a gonorrhœal origin.
10. Syphilis.
11. The fever induced by entozoa of which a chart has been given, and in which intestinal symptoms and lesions are often present.
12. Various forms septic throat infection; and of entero-sepsis, leading on to appendicitis and to para-typhoid and para-colon infections.

This list written *currente calamo* leaves little room, in a combined death-rate from *all* fevers among the Native troops and prisoners of about 2 *per mille*, for

13. True Enteric Fever, which, to sum up the conclusions we contend for, is undoubtedly present, but is relatively rare, even though it be overlooked to a considerable degree; and it may be granted that the incidence on urban residents is probably comparatively much heavier than on the 90 *per cent.* of the people who live by agriculture in the villages, as conditions of aggregation (involving propagation and dissemination), diet and occupation must

be expected to operate here as elsewhere. It will be granted that general factors which favour the prevalence of the disease among Europeans will also operate in the case of Natives. Major Rogers reports a double rise in the Enteric curve for Natives, while affirming his belief (based on a comparatively few figures) in a single season of prevalence in the case o Europeans, *viz.*, the end of winter and on into the hot weather. If w take the Punjab where the hot weather rise is most definite and exclusive as regards Enteric Fever (see Charts, Chapter IV), and so most accordant with his observations, and if we compare the seasonal incidence with that of the deaths from "fevers" among the Native civil population, we shall not find much indication of an identical etiology, thus :

Deaths from "Fevers" in the Punjab, Native Civil population.

Jan.	Feb.	Mch.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
138,767	103,773	103,369	95,862	107,962	100,775	86,553	85,686	118,495	175,377	197,179	176,896

Thus 54 *per cent.* of the mortality occurs in the five months, September to January, the period of least Enteric among the troops in the same area. There is indeed an increase in the mortality in May and June, but it is far below the monthly mean, and there is the best authority for the attribution of this small rise in the curve in large measure to "Malarial" influences. Captain James, I.M.S., gives a chart in his first Report on the anti-malarial operations at Mian Mir (*Scientific Memoirs*, No. 6) which shows how *anopheles* mosquitoes begin to increase in April and May with a simultaneous rise of malarial fevers among the troops, the curve showing a fall in June and July to rise to its highest point in October. The seasonal curve of Remittent Fever in the same ("continental") area among the Native troops and prisoners follows much the same course, the acme being reached in the autumn. And, in this place, it may be as well to record the fact that the total number of admission to hospital for Remittent Fever in all the jails was 1,422, during the five years ending 1904, the aggregate population at risk being over half a million. Of these 1,422 cases, 462 were admitted in the Bombay Presidency, and 433 of these during 1900-03, the latter being mostly attributable to famine conditions ; and similar instances can be found in other provinces. During the last two years the mean ratios *per mille* of strength of admissions and deaths (jails of India) have been, for Remittent fever, only 2·1 and 0·4 respectively.

An endeavour has been made in the foregoing notes to give the evidence as furnished by those best qualified by their professional status and experience, and as we have reviewed at length the position taken by the foremost advocate for the prevalence of the disease among Natives in Bengal (or rather in Calcutta) it would scarcely serve any useful purpose to extend the references. It may be said, briefly, that several other interesting replies have been received from officers serving in Calcutta and in other parts of Bengal, those working in the capital being in general agreement as to its greater prevalence, though one or two qualify their opinions in a suggestive way. The late Superintendent of the Campbell Medical School and Hospital says : "I am convinced that it is an imported disease, it is rare relative to the entire Native population, and almost unknown in the country districts. Some influence is apparent in the contact in the city with Europeans."

The late pathologist at the Medical College, who was also Police Surgeon, and who performed several *post-mortem* examinations daily, says: "I have come across so very few cases that I hold the disease to be extremely rare among Natives of this part of India. I have seen two or three typical cases in youths of well-to-do Bengali families."

The Professor of Clinical Medicine at the Medical College, who has a large consulting practice, is convinced that "Enteric Fever is one of the commonest diseases amongst Natives * * I look upon Typhoid as just as common amongst all classes of Natives, Eurasians and Europeans as the disease is in Europe." He admits the difficulties of diagnosis from other common fevers "without the aid of the blood test which is rarely obtained," and says "we undoubtedly get cases which fail to show any malarial parasite, fail to react to the Widal test or to that for paratyphoid, and what these cases are I do not know. Clinically I should not hesitate to call them Typhoid, but that repeated Widal's tests fail." In many of these cases there are no intestinal symptoms, and in cases considered to be Enteric, intestinal symptoms are more marked in Europeans and Eurasians than in Natives. "The majority of my cases are in children of both sexes and young adults, but I have seen cases at over 40 years of age."

Dr. Koilos Chunder Bose, C.I.E., who enjoys a large practice in Calcutta, confirms the foregoing statement in many of the main points; but he believes Enteric to be certainly a new development, due to the growth of the population and the increasing congestion of the city site and to the introduction of underground drainage and sewers. It is in the most congested areas and among the well-to-do that he finds his cases, their ages ranging from 7 to 25 years, males predominating. He has not seen a case in the more open suburbs. His experience of the mortality is that it does not exceed 10 *per cent.* "I have tried and often failed to trace the disease to direct infection," a notable point in regard to a disease like Enteric in the most closely congested inhabited site in the world. Lastly, he distinguishes a form of "simple continued fever" which runs a definite course of 7, 14, 21, 28 or 35 days, which he says is easily differentiated from Enteric.

We may conclude this survey with a quotation from the Army Medical Department Report for 1904, which deals with the evidence as regards the prevalence of Enteric Fever among Natives in more or less close contact with the European troops in cantonments. The suggestion that these cases prove the presence of sources of infection for the European troops may be accepted, but it leaves the question of the primary origin of these sources undecided, and it is at least a feasible hypothesis that the European troops themselves may well have been responsible, and that the Natives attacked derived the infection from them in the first instance.

"Colonel Morris, R.A.M.C., reports that at Sialkot one of his officers differentiated Enteric Fever and also Malta Fever in a Native Corps there, which under other circumstances would have been returned as an ordinary malarial attack. Again at Pachmarhi, Major J. Alexander, R.A.M.C., notes he saw in consultation a Native child in the bazar suffering from Enteric Fever, and his Hospital Assistant reported three other cases and doubtless many others occurred and were returned as 'fever.' Again from Kirkee, Major Hale, R.A.M.C., writes—"Natives play a large part in contaminating the ground around barracks and bungalows as there is no doubt they suffer from Enteric Fever as much as Europeans, but up to date it is always looked upon as only being Remittent Fever when they get it. In support of this he notes that three cases which were treated for Enteric Fever in the Native Section

Hospital at Kirkee gave a positive reaction with Widal's test and a fourth case, a native driver who died a few hours after admission, showed *post-mortem* that death was due to hæmorrhage from one of twelve typical enteric ulcers. At Ambala on the contrary after careful enquiries, Lieutenant-Colonel Woodhouse notes that Enteric Fever is extremely rare among the Native population, and Major Morgan, R.A.M.C., who has been two years in charge of the Cantonment General Hospital at the same station, states that during this period he has only met with one case of Enteric Fever amongst his Native patients.

At Fategarh Major Mould, R.A.M.C., draws attention to the prevalence of the disease amongst the Native population, and as there were no cases of Enteric Fever amongst the troops in the previous year, and as far as he could learn no convalescents arrived in the station before the outbreaks, he thinks the presence of infection in the station was originally derived from Native sources. He notes no less than five cases occurred amongst the Natives during the year, four being confirmed by Widal's reaction. If five cases were seen, he thinks the inference may fairly be drawn that very many more were not seen, as comparatively few cases of fever come under the notice of medical officers. Having regard to the habits of the Native as to his evacuations, the infection would be spread broadcast, so it is easy to understand the British soldier contracting the disease notwithstanding all the care devoted to the sanitation of the lines and their vicinity."

Finally, the writer has been favoured with reports from the authorities of a number of the large Colleges and Schools in British Indian territory, but considerations of the space at disposal preclude anything more than a bare summary of the evidence so kindly furnished and for which thanks are tendered. It may merely be mentioned that the replies received from the ten representative Institutions mentioned below, where Native boys and youths are educated, are negative in regard to any history of Enteric Fever, save where noted.

1. C. M. S. High School (Boarding) Calcutta ; one case in nine years.
2. Forman Christian College, Lahore. Dr. Orbison (M.D.) says that during eighteen years' experience, cases have been very rare. Enteric Fever is not nearly so common or so fatal among Natives of India as among Europeans.
3. Rajshahi College ; no case during three years' experience (Dr. H. M. Ghosh).
4. Chapra Boys' School (C. M. S.). Negative.
5. High School, Raipur. No case since the opening, twelve years ago.
6. Jubbulpore College, Male and Female Training Institutions ;—No case during last 10 years.
7. High School, Saugor. No case during 1904, to which period the reply was confined.
8. Central Training College, Lahore. No case during the last four years.
9. Madras Christian College. No records.
10. Muhammadan Anglo-Oriental College (see previous reference). One case (1904) on record. The writer can confirm this statement of the absence of the disease for the period 1891-97.

It is otherwise with regard to half-a-dozen schools at which Europeans and Eurasians only are educated ; *e.g.*,

11. Martiniere College, Lucknow, which has an average establishment of 150 Europeans and 90 Eurasians. There were four cases among the former and three among the latter from the middle of 1898 to the early part of 1904.
12. Diocesan Boys' School, Naini Tal. From 1899 to 1904 the number of pupils has ranged from 60 to 109, fairly equally divided between the two

classes (Europeans and Eurasians). During this time there have been four cases: 2 Eurasians, 1 European and 1 Armenian.

13. Government Schools, Kurseong; present numbers in training, 200 boys and 100 girls. Only four cases during the last ten years; probably imported.

14. Girls' School, Mussoorie; strength not stated. The medical officer reports four cases during the last year, during which alone he held charge. Three of the girls were of pure European parentage, one Eurasian.

15. Lawrence Military Asylum, Sanawar; average strength 380 Europeans and 110 Eurasians, ages ranging from 4 to 17 as a rule. During the period 1898-1904, there are 23 cases on record, of which 16 were in Europeans. The Widal test was employed in 18 cases. In a large number of the cases the infection is believed to have been imported.

16 and 17. Bishop Cotton's School, and the Boarding School at the Convent, Simla. There were fourteen cases in these two institutions in 1904; four in the former, 2 Europeans and 2 Eurasians; 10 in the latter, 6 Europeans and 4 Eurasians.

This completes our survey of the available evidence, and we now sum up briefly some of the provisional conclusions to which it points.

If we assume that the *b. typhosus* is everywhere widespread in the Native environment, we have to explain the fact of the comparative rarity of its reaction on the human host which constitutes the disease we recognize as Enteric Fever, the means of access of the bacillus (if widespread) to the Native host being everywhere exceptionally free and uncontrolled. The only possible explanation is that the soil presented by the human host is unfavourable to the seed, and that is to say, there is a relative and considerable measure of immunity to the attack of the specific micro-organism in question. This immunity may be due to an extensive experience in the past of the individual, or the race, of the effective attacks of the *b. typhosus* or of allied pathogenic organisms; or, possibly, to some subtle properties of the tissues evolved in the race under the conditions of life which mark the civilization in contrast to that of the Northern and Western races. But if we could exclude from account the possibility of the almost universal prevalence of true Enteric among children, it appears doubtful if under such conditions the specific bacillus would maintain its effective viability and ubiquity, for it would probably degenerate into a harmless saprophyte, if it did not disappear altogether; for its maintenance as a "specific" parasite depends on its capacity for setting up a pathogenic reaction in the host. We may assume, at any rate, that this reaction is a necessary condition of its parasitic

existence, if regard be paid only to the enormous multiplication of the species and to the maintenance of its specific virulence, which is involved in the effective attack of the host. But this essential biological condition is apparently lacking or, at most rarely present, if the evidence adduced has any weight. The specific germ, if not constantly re-imported, requires a passage from host to host, unless we assume its evolution from a lowlier and commoner saprophytic form of the same genus.

On the other hand, the facts would also be explained on the hypothesis that the *b. typhosus* is generally absent from the Native environment, and only rarely present and confined for the most part to local (urban) centres where the danger of infection from Europeans is not to be overlooked, and where the environment is a recent development and alien to the great majority. Thus the whole tendency of the evidence is to indicate that one or other of the essential factors is absent or in abeyance, *viz.*, the predisposition of the host or the presence in the environment of the *b. typhosus* as an effective pathogenic agent.

One cardinal fact, not to be ignored, is the absence of *epidemic* outbreaks in which all observers, whatever their views on the main point, agree ; and, moreover, it is clear that if there were no natural immunity, cases when they do occur—and no one can doubt their occurrence—would prove almost invariably fatal. A survey of the evidence on this point indicates that the case-mortality is certainly not notably higher than that observed among the European troops, taking all the considerations into account:—the natural resistance to specific bowel diseases and the resources of medical treatment and nursing in the two classes respectively ; it cannot be doubted that a proportion of attacks evades recognition and many capable observers maintain that the case-mortality is much lower. On a review of all the considerations (including the low combined "fever" mortality), the writer is compelled to affirm his opinion, in the present stage of knowledge, that we have in the evidence good grounds for the belief that the disease stands on an altogether different plane as regards Natives in comparison with Europeans ; and that the contrast involves essential differences in the factors, the interaction of which connotes what we term Enteric Fever, which in itself can no longer be considered a true specific pathological entity. Thus we are led to the conclusion of a decided measure of immunity on the one hand, and

to the rarity in the Native environment of the true and effective *b. typhosus* on the other hand, while, at the same time we must recognize the influence of other parasites, facultative or other, having racial and biological affinities and, possibly, an identical ultimate origin. It may be that Natives are, as it were, on the way to a susceptibility to true Enteric while now subject to the pathogenic influences of the other micro-organisms of the Typho-Coli group, including the agent of Dysentery, or it may be that these latter infections exclude the former. The conditions of life, of diet and metabolism, of climate and of a most insanitary environment are all influences which may determine the issue in a direction contrary to what might well be expected, *viz.*, to an evolution of a greater resistance against the operation of the more common and lowly or primitive members of the series, for it is difficult to account for an immunity from the effective attack of *typhosus* by past experience thereof, with the retention of the susceptibility to *b. coli* and the intermediate organisms.

But in all this we trench on the province of exact research which, while following up the way opened by the work of Rogers, Row, Lamb, and Sutherland, must make the effective bacillus or bacilli its final objective, in all cases of Remittent and Continued fever that cannot be proved to belong to the other categories we have cited. And, fortunately, we have not to confine ourselves to fatal cases, the excreta affording ample material for this purpose. Attention must be directed to the bowel diseases of children, and having regard to the excessive liability to lung diseases, these offer a field for research in this connexion which must be cultivated. We shall then be in a better position to estimate the true nature and prevalence of the disease and of its relation to the Enteric of Europeans, and further, the measure, the quality and the basis of the immunity which the evidence appears to demonstrate. (See Summary at end of Chap. VIII.)

The hope of contributing a few facts to the elucidation of the questions at issue, and which may serve to direct the enquiries of scientific research, may perhaps justify this long dissertation.

We may now conclude with the briefest possible survey of the records of the disease among Natives of other tropical and sub-tropical regions, passing as consistently as possible from West to East. At the same time we shall make no attempt to appraise the value of this evidence, our aim being rather

to complete the record and to exhibit the present state of opinion on the subject with a view to facilitating further research.

America.

We have already referred to the view expressed by Munson that "Negroes and other coloured races undoubtedly possess an immunity to Typhoid Fever" and we have given the facts from American army experience on which this is based : thus

United States Army.

	White Troops.	Coloured.	Indians.
1887-1896 ...	5·93	2·43	0·47

the figures representing the ratios of admissions *per mille*. By the courtesy of the Surgeon-General, U. S. Army, I am enabled to give the incidence of morbidity and mortality for the last 7 years (ending 1903) in continuation of Munson's record.

Enteric Fever. Mean Ratios per mille of strength.

	White Troops.		Coloured.	
	A.	D	A	D
1897-1903 ...	44·4	4·7	8·5	1·9

This period included the operations in connexion with the Spanish war (1898) in which the ratios were, for White troops, 147·5 and 15·26, and for Coloured troops, 27·97 and 6·7, respectively, "in spite of the fact that the Negro regiments saw harder service."

Phillippines.

For the Filipino troops in 1902-03, the average annual strength of which was 4,800, the mean rates per 1,000, were 1·4 and ·21, for admissions and deaths, respectively.

West Indies.

The opinions of medical officers in practice in British Guiana and the Bermudas, in favour of a relatively large measure immunity from the disease on the part of the Natives have already been given. During the period 1898-1902 the British Troops in Bermuda suffered at the rate of 17·8 and 1·96 *per mille*, admissions and deaths respectively, while there was only one case recorded among the Natives, giving a mean admission rate of ·5. In Barbados, during the same period there were no cases among the Non-European troops. In Jamaica the following is the record :—

	European Troops.		Natives.	
	A.	D.	A.	D.
1898-1902 ...	8·4	2·2	3·4	1·35

Malta.

Crossing to the Mediterranean, we come to Malta, the record for which is :—

	European Troops.		Royal Malta Artillery (Maltese).	
	A.	D.	A.	D.
1898-1902 ...	7·9	2·32	0·8	—

Algiers-Tunis.

The facts as to the immunity of the Arabs and Natives of North Africa as shown in the experience of the French army of occupation have already been detailed, as also the observations of Professor Vincent in this connexion (see Chapters V and VIII). It may be mentioned that Brault (of the Algiers School of Medicine) has confirmed Vincent's results, and in order to determine the question of immunity acquired in childhood, he applied the Widal test to the blood of 40 children (from 4 to 14 years of age) with the results that 34 gave an entirely negative reaction; in 4 cases it was doubtful, and in only 2 positive. He concludes that the immunity of the Arabs and other Natives of Algiers-Tunis, is natural (innate) and not the result of a previous attack in infancy. (Soc. Medicale de Gand.)

We shall merely give the briefest summary of the facts on official record for the whole French army of occupation (Algiers-Tunis) for the 5 years ending 1902. In many of the 22 units located in the Colony, Natives and Frenchmen are mixed in uncertain and varying proportions; we shall therefore take the corps in which "black" troops alone are on the rolls and compare the incidence on them with that on the whole army of occupation (Native and European) :—

Ratios per mille of strength.

	1898.		1899.		1900.		1901.		1902.	
	A.	D.	A.	D.	A.	D.	A.	D.	A.	D.
Tirailleurs Algeriens*	4·4	0·82	8·70	1·02	6·49	1·33	3·67	0·68	2·05	0·54
Spahis*	10·26	1·47	15·37	2·61	6·73	1·96	7·46	—	5·79	1·38
Army as a whole ...	23·47	3·57	32·07	4·43	23·92	4·95	21·55	3·56	17·80	2·88

* "Black" Troops.

Of course, the contrast would be still more striking if the results for the "black" regiments were separated from those for the army of occupation as a whole.

Egypt and Soudan.

To the case of Egypt we have referred more than once; here are the figures and the comparison given by Sandwith, whose conclusions have been quoted at length (Chapter VIII) :

		Average Strength.	Average cases of Enteric annually.	Ratios *per mille.*
English Army in Egypt	1888-1902	4,045	105	25·9
Egyptian Army in Egypt	1892-1902	2,837	5·8	2·0
Egyptian Army in Soudan	1892-1902	15,323	32·6	2·1

The incidence on the Natives is, therefore, less than one-twelfth of that suffered by the Europeans.

For the Soudan there is the testimony of Caldwell already quoted (Chapter V), which is confirmed by Dr. A. Balfour, Director of the Research Laboratories and M. O. H. Khartoum (see his report 1904, page 55), "Enteric Fever—Natives

apparently unaffected. The disease is rare." He kindly adds in a letter to the writer: "There is of course Enteric in Egypt and we get 'birds of passage' developing it here, but we have never had an epidemic, and considering our present water-supply (the river bank being fouled by excreta) we should have been scourged ere now, if the disease were at all "common." And, again, "I have not seen a single case in the civil hospitals at Khartoum and Omdurman."

The Prinicpal Medical Officer at Khartoum has most kindly furnished a statement of the record of cases amongst Egyptian and Soudanese troops during the last four years, of which the following is a summary :—

Enteric Fever admissions among Native Egyptian and Soudanese Troops at all Stations,
1900-04.

Station.	Total cases.
Cairo ...	21
Assuan ...	5
Wadyhalfa ...	3
Dongola ...	7
Khartoum ...	13
Omdurman ...	15
Kassala	7
El Duem ...	1
El Obeid ...	2
Berber ...	3
Shendi ...	2
Sennar ...	1
Total	80

This gives an average of 16 cases *per annum*; the average strength in Egypt and the Soudan is said to be about 17,000 to 18,000.

The P. M. O. adds: "Egyptians and Soudanese are not nearly so subject to Enteric as Europeans. During an experience of 13 years I have never seen a serious outbreak amongst the Egyptian or Soudanese troops either in Egypt or the Soudan. Enteric Fever occurs throughout the Soudan *especially in the large towns*, but the cases reported are very few (see table). During the last two years the ratio of admissions *per mille* of strength of the troops, has been ·8 (1903) and ·6 (1904), and most of the cases occurred at Cairo."

South Africa.

In regard to South Africa, the writer has received most generous replies to enquiries from Dr. Turner (Census Commissioner, and formerly M. O. H., Transvaal) and from Dr. Hill, M. O. H. of Natal, but the results are so inconclusive, owing to defective Census data and to defective notification of disease and registration of deaths among the white and indigenous populations, that any attempt at a summary would be dangerous and misleading. It may be noted merely that on the *recorded* facts for Natal, both Asiatic immigrants and S. African Natives are far less subject to the disease than Europeans. Dr. Hill's report deserves quotation at length, but as space forbids this, I shall merely note that he points to the probability of the inclusion of Paratyphoid fever in the returns and, further, he remarks that the recent Boer war was responsible for the propagation of the disease, owing to the fact that Natives employed with European troops contracted the infection in the field, and on return to their home, communicated it to their families or to other Natives with whom they stayed *en route*. We must turn to the records of the Zulu war (1879) for the most authentic evidence of the relative immunity of Natives, in the case of the "Black Irregulars" (operating with the English troops) which was cited in Chapter V.

We pass next to the region intervening between Africa and India and including Persia, Turkish Arabia and the Persian Gulf, the information being derived from the few stations at which officers of the Indian Medical Service are posted. From the nature of their duties, which are semi-political, and the comparative brief periods of their service in these remote places where the civilization does not include vital statistics and registration among its fruits, it is not

to be expected that the evidence based on hospital practice (which is in the early stages, and carried on under considerable difficulties) will be very conclusive.

Meshed and Baghdad. There is a general agreement that the Turkish "hakims" have nothing to say on the subject for the very cogent reason that they do not recognize the existence of the disease, but devote their talents to a whole-hearted endeavour to suppress the most prominent symptom in any case that falls into their hands, by the use of drugs. They have no "how" nor "why" in their philosophy, and the traditions of Alhazen and Avicenna do not disturb their mediæval attitude. At Meshed (Persia) and Baghdad (Turkish Arabia) little or no effort is made in the direction of public sanitation; nearly every house has its uncemented cesspits which receive all the waste-water and refuse; the latrines are separate and are "cleaned" out from time to time, and the excreta are either thrown into the river Tigris (in the case of Baghdad) or dumped upon the desert. At Meshed, the Dispensary records are valueless; at Baghdad, the Residency Surgeon has treated 7 cases during the eight months ending January 1905. One was a European adult; one a Native Christian child; two Muhammadans, one child and one woman; three Jews, all women. Among the British community, numbering about 25 persons, there have been 5 cases during the last three years. There is no record of the disease in the Indian Sepoy escort. "Enteric fever hardly seems to exist among the wandering Arabs; it occurs only in towns or large villages."

Muskat. The Agency Surgeon, Muskat, says that during his 20 months' experience of the place he has not met with a case either in hospital or private practice. The hospital records for several years were searched, but gave no evidence of the disease among Natives, but there are 3 cases on record among blue-jackets who were landed for treatment from one of H. M. ships. The population consists chiefly of Arabs, Biluchis, Persians, Afghans and Natives of India.

Bushire. The Residency Surgeon at Bushire (3 years' experience) had not seen "any well-marked case of Enteric Fever", until the autumn of 1905, when "4 severe cases of the Typho-malarial type were treated by him, one European child and three Natives"; two of the latter died on 20th and 31st day of illness respectively. He further gives a list of 24 cases among Natives treated in the Dispensary during 13 years, 1891 to 1904, the average number of Natives treated annually (all causes) being about 7,000. "The Persians who come into this list do not represent all the cases which occurred in Bushire during the period. They are a few of the more enlightened people who came under the notice of the Residency Surgeon." He encloses a letter from a French physician, who had served in the Army and had practised for 18 months in Bushire, who states that in his experience there and in the French tropical colonies, the disease is very rare among the Natives.

Bahrein, Bussorah. From Bahrein, Dr. Patterson reports that the experience of six years' medical work in which two European physicians have been engaged, has been negative in respect of Enteric Fever among the Natives until the summer of 1904, when a Syrian boy (10 years), whose people had been in close association with Europeans, was believed to have been attacked. As for Bussorah, one case has been diagnosed in an Arab during 10 years' work carried on by two English doctors, one of whom has special experience of practice among the women and children without encountering a case among them.

Ceylon. The physician in charge of the General Hospital, Colombo, who has many years' experience of medical work in Ceylon, says "I have always held the opinion formed from a very large experience of Enteric in Ceylon, that the coolies from Malabar (S. India)

enjoy an immunity from the disease. I cannot recall a single instance of it among them. As regards the other races, Europeans seem most liable,—young men just out from Europe. The indigenous population suffer a good deal from it; —they live in very insanitary surroundings." He adds as evidence against the theory of the immunity of the Malabaris being acquired by previous attack in infancy, that the children born of these immigrants on the island also enjoy the immunity. The population of Ceylon amounts to 3¾ millions, and the Reports of Sir Allan Perry show the following numbers of cases and deaths *recorded* during three recent years: 1899, 170 and 61; 1902, 243 and 63; 1903, 358 and 71, respectively. Of course, notification and registration is far from complete. It is recognized that the disease is often imported from ships entering this busy port.

Bangkok, Siam.

Dr. Campbell Highet, of Bangkok, kindly informs me that he is accustomed to see cases regularly among the Siamese inhabitants of the city, and he summarises his experience as follows: young Europeans newly arrived are most susceptible; the Native of Bangkok itself is not so apt to contract the disease as a countryman who comes in to join the Police, the Army or Navy, &c.; and, finally, Europeans are more susceptible than Natives, as "I have as many cases amongst a few hundred Europeans as amongst as many thousand Natives."

Straits Settlements.

Dr. Brown, of Penang, whose experience of this region is unrivalled and who has devoted special study to the subject, is good enough to offer the following interesting observations: "Excluding Malaria (and the blood of all cases was systematically examined for parasites) the usual fever from which the Natives suffer is one with a typhoid temperature, tongue and spleen, but no diarrhœa, no spots nor hæmorrhage from the bowels. It is prevalent during the hot dry weather among all races. True Enteric with spots, diarrhœa, &c., is common among Europeans and especially in children. In the first-named fever I have not been able to find parasites nor spirilla; nothing abnormal obtained by Spleen puncture. In 1897, I found that most (not all) of these cases reacted to Widal's test, and I concluded that they were Enteric after all. Further experience of that test and the use of controls, have taught me, that valuable as it is, it must be used in the tropics with even more discrimination and care than in Europe. The fact is that many healthy adult Chinese in the Straits give a positive serum reaction again and again if tested at intervals of six months. The only conclusion I have been able to form is that the immunity is acquired in childhood and is more persistent than in Europe. But though I have tested many cases (about 150) I have never known any patient showing a positive reaction to acquire a serious infection of fever. If there is evidence that the Widal test is doubtful because many healthy persons give a positive reaction, there is also evidence that it is only persons who are negative thereto who become ill. On the whole, I agree with the general opinion in the Tropics, that Natives are as adults almost immune to Enteric, and that immunity has been acquired by attacks in childhood." Dr. Brown adds that his cases were distributed proportionately as follows:—well-to-do Chinese, one half the whole; Europeans, merchants and miners, one-fourth; Malays and Southern Indians, one-fourth. It is probable that we may see in this account evidence of Paratyphoid infections among the Natives.

Malay Peninsula.

From the Institute for Medical Research, Kwala Lumpur, the Director, Dr. Daniels, kindly sends a few notes of the opinions of some of the State Surgeons. One Surgeon knows of 3 cases only (Europeans and Eurasians):—"amongst the Malays it is said not to occur in the Native villages, but occasionally it does occur in the vicinity of

European Stations. No *post-mortems* are allowed on Malays. In 7 out .of 400 autopsies on Chinese (who are immigrants) Enteric lesions were found. Amongst Europeans, especially in the towns, it is commonly diagnosed, and some of the cases, but by no means all, give the Widal reaction."

Dr. Travers, of Selangor, very kindly informs me that any record of cases outside the Government hospitals is valueless, because the registration agency is quite untrained (Malays or Sikh police). "I can only state from personal experience during the last 17 years that I should say Enteric is extremely rare among the Malays and very uncommon among the other nationalities." He gives a statement of the cases treated in the State hospitals, which is reproduced, and as regards which he lays stress on the reliability of the records of the General and District Hospitals (Kwala Lumpur) as being the results of diagnosis by English Surgeons; six of the cases were confirmed by *post-mortem* examination.

Enteric Fever in Selangor for three years, 1902-1904.

	Cases of Enteric.	Total cases treated (all causes).
*General Hospital (Kwala Lumpur)	22	6,721
*District Hospital (Kwala Lumpur) ...	31	12,941
†All State Hospitals (Selangor)	83	46,917
Total Natives ..	136	66,579
*Population of town, Kwala Lumpur ...	... ...	23,381
†Total population of State (1901)	... ...	168,302

During the same period 5 cases of Enteric in Europeans were treated in the hospitals, the number admitted for all other causes being 136; the European population at the Census (1901) was 487.

Singapore.

The case as regards Singapore is stated by Dr. Galloway, whose experience goes back to 1884, and who is good enough to give the following interesting remarks:

"With a plethora of fevers of all kinds and in the absence of any diagnostic test (at that time) I certainly met with but few cases which filled my concept of Typhoid fever, but an unexpected light was thrown on these by the occurrence of an outbreak of a continued fever in the Jail, all the fatal cases of which shewed, *post-mortem*, true typhoid lesions. From a study of the clinical features of that outbreak we were able to know that many of these cases of continued fever, which had previously escaped notice, were really Typhoid. Now with the aid of Widal's test all uncertainty is past, and we have learned that Typhoid is not at all rare and that natives are the chief sufferers. The age of incidence is in the second decade of life, and my strong impression is that, with the growth of the city, the type is becoming more severe and more akin to the classical. As to the particular query as to whether the occurrence of typhoid has any relation to contact with Europeans I think that can be met by a decided negative. Typhoid among Europeans is rare or, at least, not common, and Singapore is peculiar in that the European and Native quarters are quite distinct as to drainage and, until recently, water-supply. It is impossible to state whether it owes its introduction to European influence, but I should think it unlikely in view of the

TABLE XV.

ENTERIC FEVER, EUROPEAN TROOPS, 1903, BY AGE AND SERVICE IN INDIA.

Age	1st Month.	2nd Month.	3rd Month.	4th Month.	5th Month.	6th Month.	7th Month.	8th Month.	9th Month.	10th Month.	11th Month.	12th Month.	13th Month.	14th Month.	15th Month.	16th Month.	17th Month.	18th Month.	19th Month.	20th Month.	21st Month.	22nd Month.	23rd Month.	24th Month.	25th Month.	26th Month.	27th Month.	28th Month.	29th Month.	30th Month.	31st Month.	32nd Month.	33rd Month.	34th Month.	35th Month.	36th Month.	1st Year.	2nd Year.	3rd Year.	4th Year.	5th Year.	6th Year.	7th Year.	8th Year.	9th Year.	10th Year.	Over 10 years.	Not classified.	Total.	Ages.
14	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	14
15	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	15
16	1	...	...	1	2	...	...	1	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	16
17	...	1	2	3	1	1	1	1	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	17
18	...	...	1	1	2	1	...	1	2	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	12	18
19	3	...	1	1	2	1	...	...	...	...	...	1	2	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	15	19
20	21	22	13	14	15	12	7	4	7	7	3	2	2	...	5	2	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	140	20
21	19	39	12	14	22	32	16	12	10	12	8	8	6	2	2	...	7	3	2	2	...	1	1	1	...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	5	240	21
22	17	19	17	17	15	31	10	21	18	12	8	14	11	8	6	3	2	9	3	3	4	6	3	1	2	...	...	2	...	1	...	4	...	2	2	1	4	2	...	...	...	...	...	...	...	...	...	...	2	276	22
23	15	13	7	10	6	11	4	8	5	9	8	8	6	4	5	6	7	5	1	5	7	2	1	3	3	1	5	1	1	2	1	1	2	1	2	...	5	3	...	...	...	...	...	...	...	...	...	...	...	184	23
24	4	8	8	7	2	9	8	3	6	2	1	3	3	3	1	1	5	3	1	1	3	2	...	1	2	3	2	4	...	2	...	...	...	3	1	2	13	24	4	...	1	...	...	...	...	...	...	...	...	146	24
25	3	3	3	2	6	3	1	1	2	1	4	2	5	4	1	1	2	1	...	1	...	2	...	...	...	1	1	3	1	...	...	1	1	...	...	...	9	20	10	3	1	...	...	...	...	...	...	...	99	25
26	1	5	2	2	3	4	1	2	...	2	2	3	...	1	2	...	...	1	...	...	...	...	3	1	...	...	1	1	1	...	...	...	...	...	...	...	...	13	13	7	1	1	...	...	1	...	...	74	26
27	1	2	...	...	...	...	...	...	...	2	...	...	2	...	...	...	...	...	...	...	...	2	1	...	...	...	...	...	...	...	1	...	...	...	...	2	8	7	9	2	...	...	...	...	...	...	...	39	27
28	...	1	1	1	...	1	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	3	3	8	3	2	1	...	...	...	...	...	...	...	29	28
29	1	...	1	...	1	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	1	1	...	...	...	...	...	...	...	...	1	2	4	5	6	7	3	...	1	...	...	...	...	38	29
30	...	...	...	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3	...	1	2	2	2	...	...	...	...	15	30
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32	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	2	2	...	...	...	...	...	7	32
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34	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	4	34
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42	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	42
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Total	87	115	68	76	79	107	48	56	52	47	35	43	37	21	22	15	23	23	8	12	17	18	10	7	8	6	11	11	3	5	2	7	3	7	6	4	43	70	52	29	17	17	6	12	12	1,366		
	1st 6 months=532						1st year=813								2nd year=213										3rd year=73																										
	Av. strength, 18,625 R. per mille, 43·6														Str., 10,238 R. per mille, 20·8										Str., 7,940 R. per mille, 9·2																									
																																					43	70	52	29	17	17	6	12				
																																					Str., 6,233 8·9	Str., 7,987 9·8	Str., 11,901 10·1				Str., 3,268 3·6					

Str., 3,104 / 592·2

Str., 32,029 / 30·7

Str., 29,893 / 12·1

Str., 6,946 / 5·9

1,883 / 3·7

Str., 405 / 2·4

R. per mille.

R. per mille.

prevalence of Typhoid in Native cities in China from which most of our immigrants come."

Dutch Navy. In an account of the vital statistics of the Dutch Navy for 1897, it is stated that the *personnel* exposed numbered 17,254 Europeans, 32,833 Asiatics and 80 Africans; there were only 37 cases of Enteric Fever recorded, of which 29 occurred among the Europeans. (*Lancet*, January 27, 1900.)

Hong-Kong and China. For the facts and opinions regarding the prevalence of the disease in Hong-Kong, we may refer to Dr. Cantlie's article in the *Practitioner*, January 1904, and to the full extract given in Chapter VIII from Dr. Hunter's Report for 1904. Cantlie sums up as follows: "Typhoid is rare among the Chinese. Chinese children are liable to Typhoid, even more so than European children." In support of the latter opinion he cites an instance of six cases occurring in a Home in Hong-Kong, into which the infection was imported by a German pastor who came from the interior of China suffering from the disease; "after his death 6 children ranging from six to seventeen years of age, contracted the disease, showing that Chinese children are as liable, if not more liable, to Typhoid than are Europeans of the same age. This case supplies food for argument in two directions: first it shows the liability of Chinese children to the disease, and, *therefore* (our italics) "that the apparent immunity of the adult is due to child infection. Second, seeing that Chinese children are so liable to the disease, the typhoid germ cannot be very prevalent in China, or more children would be found suffering from the disease". We cannot follow this logic; if adult immunity (as to which his paper is full of testimony so far as the evidence is available) is due to "child infection", it would seem to follow that most children are attacked and that therefore the germ must be very prevalent, which however he concludes is not the case, because so few children suffer from the disease. The statements on page 38 and on pages 42 to 44 (*Practitioner*) give a good summary of the available evidence and of the prevailing opinion on the question of the relative prevalence of the disease among the Chinese, which is summed up in the statement that "amongst the Chinese, typhoid is a rare complaint anywhere"; and "all reports seem to point to the European's liability to the disease, and in some places to 'ten times the extent' of its prevalence in Britain".

Dr. Maxwell has contributed an instructive paper on "Typhoid Fever among the Natives of Southern China" (Amoy) of which the conclusions may be summarised: (1) Typhoid occurs sporadically, or may spread to the members of a household, but is unknown in epidemic form in China. (2) It is uncommon amongst Chinese children (Maxwell has met with no cases). (3) The symptoms conform to those generally met with in Europe, but, as a rule, they are less pronounced. (4) The disease is attended by a not-insignificant death-rate. In a series of 55 cases observed by him and a fellow-practitioner, the case-mortality was 20 *per cent.* During the same period there were 26 cases among the small European community with 4 deaths, equal to 15·4 *per cent.* Dr. Maxwell has observed only one case of "paratyphoid." (*Journ. Trop. Med.*, June 15th, 1903).

The writer has to express his hearty acknowledgments to several officers of the Indian Medical Service now, or recently, in medical charge of the Indian Force in occupation since the advance of the Allies on Peking in 1903, for much information collected from medical men practising in various parts of the country; and his thanks are especially due to Major Westropp-White and to Major Ozzard in this connexion, who were able to obtain statements of the experiences and the opinions of many observers of high repute. Lack of space precludes more than a bare summary of the more important facts elicited. The general consensus gleaned from more than a dozen letters on the subject supports the

view that Enteric Fever is frequently recognized among the Chinese, but that it is relatively rare in comparison with European experience, although all the conditions in which the Natives live are favourable in the highest degree to the prevalence of the infection. Dr. Moorhead, of Tongshan, whose professional attainments are widely recognized and highly esteemed and whose experience is probably unrivalled, (as he is in charge of the Chinese hospitals attached to the Mines and other Engineering undertakings in which upwards of 100,000 men are employed and who, in case of illness necessitating absence from their duties must obtain a certificate from one of the hospital staff stating the nature of their complaint in order to obtain their pay and escape fine) remarks :—"I am therefore able to say that among the adult working males Enteric is a rare disease." His opinions have such unquestionable weight that some of the most important, from an epidemiological point of view, may be quoted.

"Enteric is not so prevalent among Chinese as among an equal number of Europeans. It is not nearly so prevalent a disease in China as in Ireland. It attacks Chinese as in the case of Europeans principally between 18 and 25 years of age. It is more prevalent in autumn than in spring, and I have seen it only during September, October, November, March, April and May; the climatic conditions during these months resembling our mild autumns at home. The disease is usually mild though severe cases do occur. I think it is the exception rather than the rule for ulceration to occur. I have seen only two cases with severe intestinal hæmorrhage, and one case in which there was perforation—due to gross dietetic indiscretion." (In most other clinical features, and in respect of its course, relapses, complications and sequelæ, the disease is as a rule in all respects much less severe and fatal than in Europeans). "I am aware that it is generally believed that the rarity of enteric among Chinese adults is due to protection by the disease acquired in childhood. I can find no facts to support this and it is contrary to my experience. I do not find the disease very prevalent among children. It may be that children suffer from it in so mild a form that they are not brought to the doctor, and the cases I do see are generally mild."

The following statement gives the results of four years' hospital experience :

1901-1904 (*inclusive*).

	Cases.
Total patients treated (all causes)	147,367
Total medical cases	58,138
Trivial ailments	11,725
Medical cases among adults (exclusive of trivial ailments)	18,089
Ditto, under 5 years of age	8,324

Enteric Fever.

Adults	20 cases	Certain.
Under 5 years	3 „	
Adults	41 „	Probable.
Under 5 years	7 „	
Adults	139 „	Doubtful.
Under 5 years	23 „	

The 23 cases in the first category (Certain) were established by Widal's test; the 48 "probable" cases were such as did not react to the Widal test, or where this was not employed, but in which the clinical symptoms (except the rash) were unmistakeable. The "doubtful" cases are more open to question, but still the symptoms were more or less pathognomonic.

The testimony of medical missionaries in various more or less remote parts of the country is, as a rule, even more negative in its character, but statistics are not forthcoming owing to the destruction of hospital records in the Boxer rising in 1900.

Finally, the writer has good reason to believe that the Chinese Coolie Emigration officers, through whose hands many thousands of men (at the early adult age) have recently passed after undergoing a scrupulous medical examination, could testify to a remarkable absence of the disease among them. It would be interesting to hear what the medical officers in the Transvaal mining camps have to say upon the subject, but so far, it is believed that the usual experiences attending such aggregations in the case of Europeans, have not been forthcoming.

We may commend to the reader an able summary of an article in the *Revue d'Hygiene* from the pen of Dr. Brunet on the influence of diet in China on Natives and Europeans. (*B. M. J.*, July 1st, 1905). To quote:—

> "In the country the diet of the labouring classes is almost exclusively vegetarian (Millet) and in those public institutions, such as orphanages, prisons and hospitals, which are under European management and where a proper account of the dietary is kept, meat only plays a small part in the bill of fare and may even be absent. But Dr. Brunet finds that the Chinaman thrives remarkably well, in spite of the absence of meat from his food. The country labourers have exceptional powers of resisting fatigue, although experience has not taught them the value they might derive from sugar as an adjunct to their vegetarian diet. He adds, what is well known, that the Chinaman never drinks plain fresh water, but almost always submits it to boiling first. Then "there is a great variety of animal food, almost every sort of mammal, bird, fish or shell-fish being utilized for culinary purposes."

But though not expressly affirmed, the latter statement must refer to the towns and the coast, and it is possible that in the local contrast of the staple dietary we may find a clue to the differences of opinion which have been expressed as regards the incidence of Enteric Fever, and we might expect the crowded towns and ports (where animal food is largely consumed) to be associated with a greater prevalence of the disease. Intestinal disorders are rife as in India, but Dr. Brunet remarks on the extreme rarity of appendicitis among other diseases.

The whole tendency of the available evidence is to indicate that the Chinese are certainly liable to Enteric Fever but to a much smaller extent than modern Western communities, and that, in view of Dr. Hunter's results (quoted) derived from a large series of autopsies, any special immunity that can be

ascribed to the race is not due solely to more frequent attacks in childhood; further, here as in India, there is an almost total lack of evidence of epidemic prevalence. Beyond this, we may not overlook the probability that to paratyphoid infection is due a large part of the results as hitherto disclosed.

Japan.

In conclusion, one small contribution to the statistics of the subject in the Far East is available from a Report on the medical aspects of the naval operations in the war between Japan and China in 1894-95. During 18 months the total casualties (excluding killed and injured in battle) in the Japanese Navy amounted to 7,106 cases, of which 215 were fatal; Enteric Fever accounted for 131 cases and 24 deaths. (*Lancet*, Oct, 16, 1897).

As to the immunity of the Polynesian Islanders (Fiji, etc.) the testimony of Sir W. Macgregor, M.D., has already been cited.

It remains to be noted that the incidence on British troops serving in China, Japan and the Straits is altogether incomparably less than that suffered by their comrades in India and Egypt; this can be only partly due to the elimination of susceptible subjects in other tropical and sub-tropical garrisons before arrival in the Far East. At the same time it cannot afford any true measure of the prevalence of the disease among the Natives of these respective countries, for, on the whole, Enteric and the allied infections appear to be more prevalent among the Natives of the Far East, especially when compared with Egyptian experience. The conclusion of the whole matter must be, then, as contended on other grounds, that we must look to the conditions inherent in the *personnel* of the British army on foreign service, rather than to the presence or absence of infection in the native environment, to explain the epidemiological facts.

CHAPTER X.

Conclusions and Indications. Prophylaxis and Suppression.

In offering the following remarks on the practical indications which may be deduced from the whole body of evidence presented in the foregoing pages, the writer would disclaim the intention of affording more than a suggestive treatment of this aspect of the subject. He has endeavoured to review the facts impartially, and while conscious that he has not risen to the height of his argument, he regards his specific task as completed at this point, for the rest depends mainly upon the judgment to be awarded to his interpretation of the evidence. Moreover the essential principles of prophylaxis are now well-established, and it is only in their rational application and direction that we are called upon to revise our methods if it be demonstrated that the current conceptions of the etiology are partial and inadequate and disproportionate to the weight of the evidence. No one can doubt, for instance, that the infection of Enteric Fever is frequently conveyed by specifically polluted water, nor again, that the Natives of India are liable to the disease, but as a basis for a complete working hypothesis these facts are totally inadequate alike to explain the epidemiology and to indicate successful preventive measures. Indeed, on the contrary, they have proved a stumbling-block. With the advance of knowledge there is an irony in the fate that makes one established truth the enemy of another and a greater, but "truth is truth in each degree," and the scientific method must adjust values if we are to escape the most blinding form of error—partial truth. The aim pursued in the foregoing exposition has been to re-examine the evidence critically from all sides, to readjust the weight of its components in relation to the whole, and so to arrive at a juster conception of its bearing on the practical problem. If this has been attained, the actual working details of a rational prophylaxis need no laboured discussion, for they emerge as logical deductions of the thesis and it only remains to readjust

our efforts in accordance with the altered conception. But with readjustment must go concentration of effort, clearly directed by the etiological indications; to the promotion of the natural resistance of the host, to the destruction of the infective agent and to the rupture of the chain of infection.

We may set forth as briefly as possible the essential considerations on which the plan of campaign must be constructed. These fall naturally under the three main heads of the human organism exposed to risk, the chief sources and means of infection and the environment, as to each of which our remarks may take the form of a summary of some of the more salient points brought out in the previous discussion in so far as they bear directly on the practical problem.

In dealing, first, with the *personnel*, it will be convenient to include the indications to which the chief considerations give rise, in so far as they provide a basis for prophylaxis in the earliest stages, *i.e.*, up to the time of the arrival of the men in India. This will clear the way for the discussion of the task that awaits us in cantonments. It is well established that the liability of European soldiers to contract the infection of Enteric Fever stands in inverse relation to the length of time they have been exposed to the Indian environment, and further that this liability is definitely associated with certain age periods on which the morbid incidence is greatest everywhere. If then we can effectively check or minimise the risk of infection of men under 25 years of age and of all during the first two years of service, we shall cut at the very root of the evil. The danger lies in the "predisposition" of the tissues of the raw individual born and bred in Great Britain when first exposed to the influence of the Indian environment, which operates not only generally to lower resistance, but to provide abundant sources of infection. The physical and mental characteristics of the raw material out of which the British soldier is evolved have been sufficiently indicated in Chapter I., where also the notable changes which have marked the *personnel* as a body were graphically depicted. We recognize, further, that health is a question of due adaptation, that the necessary physiological adjustment is the resultant of the interaction of the extrinsic forces (climate, food, occupation) and of the inherent constitutional qualities with which each man is endowed at birth in varying measure, and that any great change in either direction will upset the balance. But in the case of the modern soldier transported direct from his natural habitat to the tropics a double

disability is incurred: the predisposition of the last generation has been increased by non-elimination of the most susceptible as a result of the great advance in all measures affecting the public health, and especially in regard to conservancy, and by the effects of the short service system in lowering the age and in necessitating a larger annual supply of drafts to maintain the strength. And, on the other hand, there is the strain imposed by the sudden and extraordinary change in the environment taken in its widest sense. We have to regard the striking phenomena of the deadly effects of exposure thereto during the first few months, along with those which are connoted by the term "acclimatization"; our object must therefore be to pursue the indications to which these converse phenomena provide the key. That some of the factors are beyond our direct control may be conceded, but this fact should stimulate vigilance and resource in the application of indirect measures against the root elements of the evil—the predisposing conditions,—in addition to the concentration of our forces where both predisposing and exciting causes are open to a front attack.

So far as the *personnel* is concerned, such measures must take account of all the factors in operation, both general and special, to which attention has been directed, and they must be based from the outset on a comprehensive view of the whole problem: the physical and mental character of the raw material—the recruit—the conditions of service, the effects of long and short service respectively, of first exposure to an alien environment and, conversely, of previous experience. They will strive to make the imperial responsibilities of the army subserve the end in view while minimising the risks these involve, by attention to the details of the system of reliefs and drafts, by precautions on the voyage and on arrival, including the season of arrival and the distribution of the men to their final destinations.

In the application of these indications one of the first and most important steps is to secure the intelligent co-operation of both officers and men by systematic education in the essential elements of hygiene, specially directed to the simple service each man owes to his own body as well as to his duty to the community under the conditions of service at home and abroad. The subject, including its historical aspect, should be given its proper place in the curriculum of the military schools, and officers would then be prepared to co-operate with the medical staff in bringing the best influence to bear upon their men which

would reinforce the instruction which should form part of the training of the recruit.

Systematic instruction of selected non-commissioned officers and men should certainly be instituted. If this is held to be necessary in the subjects of agriculture and dairy-farming, the case is far stronger for a new departure on similar lines in the matter of training in the essentials of practical hygiene. Sanitary reform can only be accomplished by the establishment of a subordinate staff competent to maintain a high standard in the details of the work. Let liberal inducements be offered in the way of staff allowances, etc., and then secure the services of competent men of high character by the test of examination after careful instruction, and no more promising investment of public funds could possibly be made. The excellence of the papers submitted by many of the quartermasters at the examinations of the National Health Society just before the South African war, showed the interest taken by them in the subject, and in view of the duties of the quartermaster there can be no question of the value of such training which should be systematized and extended to both officers and rank and file. The modern soldier will readily respond to the claims of some intellectual interest that is presented in a sympathetic and practical form and which will enlarge his narrow view of his functions and incite or rehabilitate his sense of responsibility. The results achieved by the Army Temperance Association afford a good augury of success, while the history of the past sufficiently proves the futility of the best measures applied from outside when opposed by ignorance and indifference. We must substitute for this, which at best rises to a perfunctory blind obedience under supervision, a willing spirit of co-operation, a sanitary conscience and a will, —in short, a healthy sense of personal responsibility and a higher standard of public opinion. But to this end we must be leaders and emulate the wisdom of the greatest soldier, of whom it was said: he had never an "ito" in his commands, but only a "veni." (Cicero on Julius Cæsar). An old tradition dies hard, and though we have progressed very far from the state of opinion to which expression was given in the monstrous dictum of Lord Melville, in the House of Lords in 1808, that "the worst men make the best soldiers," we have still to recognize fully our responsibilities on the true and opposite view and the power which this would give us.

The evidence in favour of the utilization of some of our sub-tropical possessions, and notably of the high veldt of South

Africa, as acclimatization grounds, has been discussed (Chapter II.) and, for the rest, we need only emphasize the need of proper care to preclude as far as possible the embarkation of infected men and to secure them against the risks of infection *en route*. The arrangements on troopships must be directed by scrupulous regard to hygiene with special reference to the conditions of aggregation and of the disposal of excreta,—common dormitories, refectories and latrines. The writer was once in medical charge of a transport, a converted "liner," in which 400 invalids with women and children were conveyed from Bombay to Plymouth. The passage was made during the monsoon, all hatches being battened down for six days, and the conditions set up among this seething mass of humanity are indescribable. The sick and convalescent lay huddled together in their blankets on the deck in darkness, without a possibility of ventilation, and many cases of dysentery were not discovered till a late stage as the patients were too apathetic from misery to call for aid. By good fortune we emerged from a terrible experience without loss of life and, doubtless, all the arrangements are now infinitely better ordered, but it is for others to say if they are perfect, specially in respect of a properly adjusted diet and to systematic exercise. We may, however, call attention to the risks involved in the transport of sick and convalescents along with the healthy, or even in the same ships as those used for the conveyance of outward bound drafts and reliefs, without radical measures of disinfection between the services. There are also the risks incurred by visits paid, and by the embarkation of drafts, at the ports of call along the route, as well as from the food and fruit, etc., supplied by bumboat hawkers. The same considerations are still more applicable to the journey across India after arrival, for it must be remembered that the annual stream of arrivals is equalled by that of the departures, and that both flow along the same routes. The sanitary arrangements (in their widest sense) of troop-trains may be susceptible of improvement, and the abolition of the system of daily halts at rest-camps *en route* is a measure which has too long been delayed. It should be possible to provide sidings for the troop-trains apart from the public stations, along the main lines, where every provision should be made for the necessary supplies and which would prevent the risks attendant on resort to latrines, water-supplies and restaurants open to the general public. The troop-trains should possess their own cooking equipment, and be dependent on the sidings merely for

supplementary food and water-supplies and for latrine accommodation. But there should, of course, be no facilities offered by the arrangements for the possible infection of the healthy new-comers by the time-expired men and invalids despatched along the same routes in the reverse direction. In addition to these efforts, nothing can be of more practical importance than the judicious employment of a measure of quarantine for all troops on arrival, and it is only a question as to where and how this can best be carried out; whether at Bombay or Karachi (where the disease is at a minimum), at some selected site upon the Western Ghats, at one or more convenient places in the lower Himalayas (for the Northern and Eastern Commands) or eventually at the cantonments of destination. Nothing is more clearly demonstrated than the facts of importation of the infection unless it be the futility of measures (*e.g.*, removal to the Hill Stations) taken after the new men have mingled with their comrades in rest camps or cantonments. In deciding this question much will depend on the view taken of the effect of first exposure to the tropical environment in predisposing to infection, and of the value of the power of acclimatization. If this be given its due weight (in the writer's opinion) the men should not be allowed to enter their allotted cantonments in the plains until after a sojourn in the Hills to which they should be despatched direct, and with the utmost expedition, from the port of arrival. Indeed, the whole question of the judicious utilization of the resources we possess in the Hills appears to need reconsideration, now that the principle is accepted that one paramount function of the army in India—the maintenance of internal peace—may be deputed largely, if not entirely, to the civil powers, and now that under the scheme for the redistribution of the forces, a far larger number will be massed on the strategic lines in proximity to the Himalayas. There would seem to be no insuperable difficulty in raising the number of men so disposed during the period from March to October, from the present average total of 13,000 to twice the sum, and so securing that all under 25 years of age and with less than two years' service should have the benefit of one of the finest climates in the world. And if we could reduce the Enteric Fever mortality to its minimum, we should wipe off nearly half the loss due to deaths from all causes, and about one fourth of that arising from sickness, with a larger proportion of the consequent invaliding. This calculation is based on data already given (Chapter II.) but the results would be even more

striking if the arrangement were carried out systematically year by year in regard to all the younger and newly-arrived men. The experience gained as to the extraordinary vigour and health acquired by the men when employed on road-making in the Hills in 1863-72 is very pertinent in this connexion (Chapter V., page 253) and may point to the way to similar employment in future.

Although it is anticipating the order of our discussion, it may be said here that the principles laid down should be enforced practically to control the risks arising from interstation movements, and from the aggregation of different corps units on mobilization for manœuvres and campaigns. We have seen the lamentable results following the movements of infected corps units ; a regiment leaves a local centre of infection and will often propagate the disease along its course, sometimes without giving evidence of its fatal influence among its own men ; but other bodies with which it comes into contact, direct or indirect by association or by following in its track, will suffer. Such a sequence of events may well provide an epidemiological "mystery," and baffle detection of the source of infection.

With these broad indications of a policy of prophylaxis based upon the host factor we may pass on to a closer analysis of the local sources of infection which will provide the key to the plan of campaign for the concentration of our forces against the more immediate dangers. But it is perhaps necessary to observe, both in regard to what has been said and what is to follow, that success will largely depend upon the local knowledge and on continuity of effort on the part of the medical staff to whom the work is committed. Frequent changes of the medical *personnel* are greatly to be deprecated ; and as regards the numerous expeditions that have marked the history of the last century, it has too often happened that medical officers have been drafted away to leave large cantonments inadequately served, the sanitation being the first of the responsibilities to suffer. This has doubtless been inevitable and the remedy is a larger reserve of officers for war, with an adequate peace establishment for all purposes which should be left intact on mobilization when perfect organisation is most necessary. If there be neglect at such times or a break in the sanitary service for any considerable period, the best methods and most assiduous care previously employed are largely thrown away.

We need not recapitulate *seriatim* the various sources and means of infection which were fully discussed in Chapter III. *et seq.* ; for our present purpose the main problem is to get into

closest touch with them that we may attack them at their origin, and to this end we have to decide, in the first place, where the chief danger lies. Briefly, are we to look for this within or without cantonment limits,—to the immediate environment of the men themselves, or to the surroundings in which the native population supply the sources of infection? And if to both, can we discriminate between the extent of the danger inherent in each?

As regards cantonments can it be reaffirmed that they merit the estimation in which they have been held as "oases of purity in a desert of filth"? Is this, or is it not, a dangerous rhetorical fallacy based on the partial truth? It is submitted that there can be no possible doubt of the answer we must give to these questions in the light of the evidence before us. Enteric Fever is essentially a "filth" disease directly dependent on faulty conservancy, whereby the soil, the water and the air are subject to fæcal pollution, and to which young adults in aggregation are specially liable on first exposure to an alien environment, especially under the conditions of a primitive or improvised system of conservancy and water-supply. We have seen how we stand in regard to all these conditions and responsibilities: a steadily increasing number of men at the most susceptible age, renewed every year in larger proportion to the total strength; these in close aggregation, the danger of which is enhanced by common resort to latrines, lavatories, and hospitals, in refectories and dormitories, and by the prolonged occupation of certain sites under conditions which approximate to those of permanent camps; and with all this we have the evidence of a gradual rise in the prevalence of the disease in spite of all sanitary efforts put forth. The evil has stolen upon us unaware, and for long was entirely overlooked and denied; when recognized, it was only in the most typical and striking cases, and the conceptions of the etiology current in Europe under totally different conditions long governed the measures taken to meet it and were mostly confined to purely clinical treatment of cases in the advanced stages. There was no isolation of the sick, the roughest nursing and little if any attempt at disinfection; a large proportion of the infected were never detected and it was never suspected that the periods of greatest danger to the community were those preceding and following the disabling illness.

Such are the salient facts, the conditions thus set up gathering force by the vicious circle maintained by the multiplication and constant renewal of the sources of infection; the

most serious results could only have been expected under the best ordered arrangements for the removal and disposal of excreta, the nidus of infection. But what are we to say of these arrangements? Scarcely less than that they could not have been better devised and carried out to give every facility to the evil we deplore. A picture of the typical latrine and of the methods employed in disposal as they exist to-day has been given from the hand of one of the best and most unbiassed of authorities and endorsed by the Director-General of the Medical Department (Chapter III.). If further and fuller evidence be required it will be found in the following extract from the A.M.D. Report for 1904.

"Experience is daily proving that the method of treating excreta with dry earth and removing it in receptacles or carts for disposal in trenches is not only offensive and unsuitable but is also fraught with very real danger to the health of troops. The latrines are cumbrous structures with earthen floors and in not a few instances have been erected within ten yards of a cook-house. The seats are unprovided with covers, the pans are not protected from the ingress of flies, often do not fit sufficiently closely to the seat and so pollution of the ground with urine is frequently unavoidable. Dry earth is not, usually, immediately applied to the dejecta by the men and the pans frequently remain for some time unemptied by the sweepers. Soiling of the ground behind the latrine is not infrequent when the pans are being emptied into receptacles and is almost unavoidable when the latter are being emptied into the filth carts. The sweepers too have a practice of rinsing out the commode pan with water and throwing it over the ground, which contaminates it. The ground around the urinals and latrines in barracks is much the same and must get contaminated by men in the early stages of enteric before they report sick. At the urinals pollution of the earthen floor under the trough is common, and so is pollution of the ground outside the shelters when the urine receptacles are being emptied into the filth carts. We have now certain areas of ground, in and about latrines and urinals in barracks, which are always more or less polluted with possibly infected excreta, not to mention the pollution of the soil that occurs in the neighbourhood of barrack rooms, regimental institutes and canteens as a result of indiscriminate micturition by the men. Since it has been proved that the enteric bacillus can be recovered from Indian dust five days after it was infected and from the same after three days, when it had been exposed for nearly 24 hours to the rays of a tropical sun, it is quite evident what danger spots these polluted areas may prove when the blasts and whirls of the wind raise and carry away the infected upper layers of dust and deposit it on uncovered articles of food or even in the throats of human beings. But the risk of infection through this system of conservancy does not stop at the barracks. As the filth and receptacle carts rock along the roads some of their contents very frequently shake out, soiling both cart and ground. Efficient disinfection of the filth receptacles is not carried out at the trenches and they are often returned to cantonments in almost as dangerous a condition as when they left it. The filth carts

can be neither properly emptied nor cleaned and they always carry back with them swarms of fæcal fed flies that forthwith proceed to distribute themselves about the barracks and officers' bungalows.'' (It should be noted that each battalion of Infantry is provided with no less than 23 latrines, to which these remarks apply in a greater or less degree.)

"The present method of disposal of excreta is also objectionable and insanitary. At some stations what is known as the Allahabad shallow trench system is in vogue. In this, the top soil is scraped off a rectangular space (16 feet × 5 feet) for a depth of three inches and the bottom soil is loosened for another six inches. Into this space the contents (60 gallons) of a filth cart are tipped, spread evenly over its bottom and then covered with the earth that had been removed. Heavy rain often washes the contents of these shallow trenches on to the surrounding ground. The tropical sun dries the covering of earth to the consistency of dust and the wind and flies carry the possibly infected excretal matters far and wide. No more dangerous system of disposal could be adopted in the vicinity of a cantonment, though it certainly works well on sites far-removed from all habitations.

In some stations, however, excreta are disposed of in trenches one foot wide and nine inches deep, being deposited along the bottom to a depth of three inches and then covered in with earth. With this method the excreta is less likely to be exposed by rain and wind, but the trenches are still too shallow. Urine is deposited in separate trenches about six inches deep. At any trenching ground dogs, kites and crows may be observed scratching up the newly buried ordure in search of chance pieces of food, and the excretal matter thus exposed remains uncovered to dry and be converted into dust or carried away on the feet of flies. It is evident that shallow trenching affords every assistance to the spread of infectious disease. After a certain period (one to three months) at a suitable season the trenched ground is supposed to be cropped, but this is not always done, as it is often impossible from want of water.''

The problem is to deal effectively with the discharges, alvine and urinary, of (1) recognized sufferers, (2) of those in the early and later stages of the disease, ambulants and convalescents, (3) of unrecognized cases that may never come under observation, and (4) of those whose systems are successfully resisting the infective agents,—it may be because these are few in number or lacking in virulence which, however, they may gradually attain. The indication is, surely, that the only safe plan is to treat the sewage of the whole community as if it contained the specific germ. It may be claimed that the general system of disposal now in vogue, *viz.*, by surface trenching, has much to recommend it both on scientific and practical grounds; the *rationale* of immediate earth disposal and the disadvantages of water-carriage are now sufficiently well understood and recognized, and we need not recapitulate the facts. But after all it is our

business to apply our scientific knowledge with common sense to the circumstances of each case, and in this question far too little attention has been paid to the special conditions of the Indian soil and climate, to the infective qualities of the excreta, to the character of the community, to the resources at our disposal and to the methods employed. Tested by any one of these considerations we should find good reason to question the justification of the present practice, but in their combined force they bring it into condemnation that admits of no appeal, when applied everywhere without due regard to local conditions. Too often the sewage is deposited in soil on which it is impossible or difficult to raise a crop during the greater part of the year, and which is at one time exposed to sun and wind and so situated that clouds of infected dust are carried back to the cantonment; while, at other times, the monsoon deluge renders the trenching ground a swamp and scours the surface or carries pollution downwards to within the range of influence of the rising ground water. And this must often occur under the best ordered arrangements, but all the risks are multiplied by the ill-adapted resources for removal (the pail and cart system) and by the ignorant and careless practices of the native menial staff, *e.g.*, by the utilization of the infected soil of the trenching plot for the "dry earth" required in the latrines, and, as we have already seen, there are many other ways leading to failure of removal of the infective excreta from the site, or to their return from the place of deposit by foul carts, dust, flies and the persons of the staff and animals employed. There is always sufficient moisture in the soil at a depth of six inches to maintain the viability of the bacillus, which may well be favoured also by storage in the damp and shady annexe of the latrine, while at the same time, and under similar conditions, the more delicate cholera vibrio may find its quietus.

On the other hand, the evidence presented has demonstrated the extraordinary effect of light and intermittent rainfall in determining a break in the prevalence of the disease, the infective agents being thereby anchored to the soil by moisture and by the resulting vegetation. And these facts surely provide a clue to one solution of the problem, which will take account of all the risks encountered from the time and place of deposit in the latrines to the stage of final disposal: these indications are met by water-carriage, starting with an automatic flush to a properly adapted apparatus for

mineralization by biological agency, and by final disposal of the effluent by irrigation and cultivation of suitable soil. But before discussing this in detail we may dwell further but briefly on the actual conditions set up by the present arrangements.

We have not far to look for abundant sources of specific infection in the inhabited site, centering in and radiating from latrines and trenching grounds, but which is scarcely free from pollution anywhere owing to the careless practice of urination in which the men indulge. It is easy to see how hospitals, barracks and kitchens are linked up with the more immediate foci, by means of traffic, dust and flies, the danger extending to the water-supplies in a measure depending on the circumstances of time and place. This is sufficiently indicated by the nature and extent of their micro-organic content, apart from the questionable isolation of the specific germ, and is brought about doubtless at one time by the access of polluted dust and flies, at another by the combined movements of the rainfall and the ground water.

Contributory factors in soil pollution and its results in favouring the viability and transport of the bacillus are the defective surface drainage, the lack of subsoil drainage and of arrangements for the effective disposal of sullage water, garbage and rubbish, and we have already seen how all these conditions co-operate to link up the chain of infections, and, in a word, to induce endemicity. Abundant confirmation is derived from the experience in regard to endemic Typhoid in all parts of the world; we find Osler explaining that the provision of good water-supplies is not always sufficient to banish the disease from a community in the absence of effective drainage and removal of refuse, and that no fact is better established than the intimate association between a sewage-polluted soil and Enteric Fever; while endemicity is due to persistent fæcal pollution of the soil. This writer also gives charts which demonstrate comparatively the enormous disadvantage in respect to the persistent prevalence of the disease which badly sewered communities suffer. Liebermeister says: "The disposition of any locality to Enteric depends largely on the extent to which the inhabitants breathe, eat or drink the contents of their privies; the greater the chances of this, the greater the danger of an imported case producing an epidemic." The experience of the city of Munich in the great decline of the disease, subsequent to the abolition of the numerous cesspools from the site, is one of many cases in point; and, again, the evidence

of the definite association of the greatest incidence and of the endemic prevalence of the disease, on sections of a community dependent on privy middens, and similar arrangements for the retention of fæcal filth upon and within the site, is conclusively established. It is not only that the conditions thus set up provide a favourable nidus for the viability of the bacillus when introduced, but that they connote a radically defective conservancy in its widest sense which the best efforts in other directions fail to counteract; the first essential precaution is neglected, the predisposing conditions are ever present and constantly active, and every facility is provided for the dissemination of the virus. Long before the true etiology was elucidated by the efforts of bacteriologists, it was clear to acute observers that the secret of the suppression of the disease lay in the maintenance of a pure soil and surroundings, with the consequent prevention of pollution of the atmosphere and water in intimate relation therewith; and in pursuing the indications thus provided the greatest success has been achieved, *viz.*, by the abolition of cesspools and privy middens and the like, supplemented by drainage. (Buchanan, Boobyer, Pettenkofer, etc.). It may be admitted freely that the water-supplies have also been the objects of a vast amount of care and attention, but it must be maintained that this has been mainly effectual by obviating the risk of contact with the immediate sources of infection, by the removal of the latter; failing this, the purest water from outside will operate only to limit the extension of an outbreak. And it is to be noted that while the course of the disease among modern civilized communities has declined generally, but in the closer and more direct relation to improvements in conservancy, drainage and removal of refuse, than to improvements in the water-supply, where these measures can be distinguished in their operation, our public hygienic efforts as a whole have involved special dangers to the community in the provision of common sewerage and water-supplies with the risks of pollution of the latter by the former. The disease has, nevertheless, declined steadily; and as a further result its most striking manifestations are now afforded in its epidemic form which has coloured and distorted the etiological conceptions of observers, who would look to water-borne infection to explain all manifestations. The prejudice engendered by this experience, and fostered by school and text-book teaching in the West, has necessarily dominated opinion and practice in India, where the medical officers serve

for a short term and are replaced by others. We see the results throughout the record in the constant endeavour to implicate the water-supplies in theory and in practice, and in the mass of contradictory evidence which is born of the assumption. This evidence has been reviewed at length (Chapter III.), and we have only been able to give it a qualified assent; where the sources of infection are so numerous and constantly present, water could not fail to play its part as a vehicle under the conditions to which it is subject, but it is submitted that this part is relatively subordinate when due regard is paid to the other avenues of infection. The futility of the efforts directed to the sterilization of the water in all cantonments during the last 8 or 10 years is a constant theme of despairing comment and of reproach; it is even contended by many, and not without reasonable grounds, that these efforts have added to the risks of pollution. We find officers enquiring pathetically whether, "if Enteric Fever be not usually water-borne we have not ourselves been unconscious agents in its dissemination by the very means taken to prevent it." "It seems unlikely that good measures enforced simultaneously throughout the cantonments in India should have everywhere been mismanaged and should, after years of efforts, have produced absolutely no good effect." "Either the measures were not of a kind to do good, or being good, they were not applied to the cause of the evil." (Sanitary Commissioner, India, 1897.)

And when we look to the usual sources of supply we can confidently pronounce them to be, in certain essential respects, beyond reproach, and it is only in the treatment to which we subject them that the danger lies. The essential default lies in the conversion of the soil in which the water stands into a reservoir for filth of all kinds which is largely infected with the specific germ, and beyond this, in the partial and often misdirected efforts to redeem the situation thus created: the use of multiple sources of varying degrees of purity for the same or for different purposes, with the risks of pollution at various points by the means adopted for drawing, distribution, "purification" and storage. The history of our efforts in these respects would afford a melancholy satire on good intentions misdirected, and on ingenuity perverted. We shall have a few remarks to offer later, on the practical application of the indications for obtaining and safeguarding a pure water-supply, but we may pass on now to note how the position described has diverted the true course of observation and

fostered the theory of bazaar infection, which has held the field so long.

This brings us to a crucial issue in the problem, *viz.*, the relative importance of *intra-* and *extra-*cantonment sources of infection and the relation of the one to the other; and it is clear that a conclusive judgment is not only the necessary preliminary to practical measures, but that it must have the most direct and important influence on their nature and direction. The question is: Are we to look outside cantonments for the chief and omnipresent sources of infection, or are we to regard the men themselves and their immediate surroundings as the centres of the evil? It is obvious that these views are irreconcileable, and that they vary diametrically in their logical indications. We have, at various points in the course of the discussion, endeavoured to indicate the bearing of the evidence on this question, and more particularly in Chapter VII., to which the reader is referred, and we shall abstain from drawing any inference from the facts and opinions presented in Chapters VIII. and IX. One consideration must be constantly borne in mind even when the evidence of bazaar or outside infection is most incontrovertible, and that is the possibility, the probability, of its indirect derivation from a previous case which had its origin within cantonments. In so far as bazaars and other outside resorts are, to all intents and purposes, adjuncts and extensions of the cantonments, where sanitary appliances and precautions are either totally lacking or less under control, it is only to be expected that they should be centres of infection which are set up in the same way as those in cantonments, *i.e.*, by the men themselves; there is certainly no need to postulate an indigenous origin of the infection.

Then let the evidence as set forth on all aspects of the subject be tested by the alternatives: the changes in the constitution of the *personnel*; the course, rise and decline of the disease during the 35 years of the record, with the evidence of a real increase and of its original absence in certain localities where it has since become endemic—and this taken along with the marked decline in the prevalence of other indigenous infections to which the native population is notoriously susceptible; the history of importation, most strikingly illustrated in connexion with the Boer prisoners of war, but established as constantly derived from forces in the field and transported from one cantonment to another, of which the experience of the Hill stations affords the clearest example; the evidence

from camps and campaigns ; the characteristic features of the local and seasonal incidence ; and, lastly, the indications derived from our study of the incidence on the different arms and classes (officers, women and children, separately, and when compared *inter se* and with the rank and file) and from the closer analysis of corps unit and company infections. And in forming a judgment on this issue due regard must be paid to the evidence derived from the experience of the disease in other countries, where the question of the "saturation of the Natives with Enteric Fever" does not arise ; and we may point to the history of the mobilization camps in America in 1898 as specially pertinent.

There is one additional consideration which deserves more than a passing allusion. Medical Officers have found support for the theory of bazaar infection in the fact that men admitted to hospital for Venereal disease have frequently developed Enteric Fever, and as there can be no doubt of the place of origin of the one affection, it is plausible, *primâ facie*, to connect the other therewith.

Now, in the first place, it must be noted that all the circumstances render the men under 25 years of age and those in the earlier period of their service specially liable to both affections, and the test thus presented may be deemed peculiarly valid and conclusive, so far as the facts are to be relied on. It is, however, overlooked that fully one-third of the total admissions for all causes is due to Venereal disease, and the proportion to the total at the most susceptible age for Enteric Fever must be much higher ; during the quinquennium ending 1899, the average number of men constantly in hospital on this account (Venereal) was 2,880, and the average period of detention for each case was 32·5 days, while the average number constantly sick from *all* other causes was 3,445. This shows clearly that an enormous proportion of the most susceptible subjects is exposed to risk in the bazaars,—and also in the hospitals. It is, therefore, only to be expected that when, probably, two-thirds of the younger men pass four and a half weeks in hospital every year for Venereal disease a considerable number should develope the other infection in the course of their detention ; and this without taking into account the risks of infection in hospital, and the fact that the incubation period does not often exceed 10 to 14 days, and may be less. Of 301 cases noted as developing in hospital during ten years (1891-1900), 108 occurred among patients admitted for Venereal

disease, 102 among other patients, and 91 among attendants, and it is submitted that in view of the foregoing facts and considerations, this does not disclose any excessive proportional liability on Venereal patients beyond that due to age and early service; it may be added that such patients are only rarely confined to bed and most of them "have the run" of the hospital and may even attend on Enteric cases, though doubtless this is not sanctioned. Even if it could be demonstrated that the Enteric infection in these cases was actually derived from the bazaar along with the Venereal infection, we should still leave the question of the original source of the infection in doubt, but it is certain that ambulant and early cases of the disease and convalescents must contribute largely to its dissemination in the brothels and the bazaar haunts where sanitary arrangements and all prudential considerations are equally lacking.

Now both Enteric Fever and Venereal disease increased, *pari passu*, to their maximum prevalence in the year 1898, which might, again, be taken by the casual observer to indicate a common origin in place and time, but when we examine the respective geographical and seasonal incidence of the two affections, the most definite contrasts are exhibited, thus:—

INCIDENCE OF ENTERIC FEVER AND VENEREAL DISEASES ON THE DIFFERENT GEOGRAPHICAL GROUPS.

Admissions per 1000 *of strength*, 1891—1900.

ENTERIC FEVER.		VENEREAL DISEASES.	
Groups.	Ratio per mille.	Groups.	Ratio per mille.
1. Hill Stations (XII a)	33·8	1. Gangetic Plain (V)	539
2. S. E. Rajputana and Central India (VIII) ...	32·2	2. S. E. Rajputana and Central India (VIII) ...	504
3. Gangetic Plain (V)	30·2	3. Burma Coast (I)	496
4. Upper Sub Himalaya (VI) ...	27·0	4. Deccan (IX)	484
5. Deccan (IX)	21·5	5. Burma Inland (II)	481
6. N.-W. Frontier, Indus Valley (VII)	19·5	6. Southern India (XI)	458
7. Southern India (XI)	16·9	7. Bengal-Orissa (IV)	447
8. Hill Convalescent Depôts (XII b)	15·8	8. Upper Sub-Himalaya (VI) ...	428
9. Bengal-Orissa (IV)	11·1	9. Western Coast (X)	426
10. Burma Coast (I)	8·4	10. Hill Stations (XII a)	355
11. Western Coast (X)	7·3	11. ,, Convalescent Depôts (XII b)	351
12. Burma Inland (II)	4·7	12. N.-W. Frontier, Indus Valley (VII)	316
INDIA	24·2	INDIA	431

In the period 1901-03 the order of prevalence among the Groups was as follows, from greatest to least:

Enteric ... VIII, VI, V, IX, XII a, XII b, VII, XI, IV, II, I, X.
Venereal ... I, IV, IX, XI, VIII, II, X, V, VI, XII b, VII, XII a.

If we analyse next the incidence on the various cantonments the contrast is brought out still more forcibly. Space is not available to give lists comparing the places in which the two infections were respectively most prevalent, but it will be found that whereas Venereal disease gives the highest ratios in the stations which are situated in the peninsular (Southern) and coast areas, including the sea-ports, Enteric Fever is at its maximum in the continental (Northern) and inland regions.

The following statement will, however, exhibit the main facts in a condensed form; it shows the distribution by Commands of the thirty stations which stood highest on the lists for Enteric Fever and Venereal diseases during the four years 1900-03, the total number of cantonments, with an average strength of over 100 men, being 95:—

Command.	No. of stations altogether, in Command.	Enteric Fever. Distribution of the 30 stations highest on list 1900-03.	Venereal Disease. Distribution of 30 stations standing highest on list 1900-03.
Bengal ...	31 (124)	46	34
Punjab ...	27 (108)	38	7
Madras & Burma ...	18 (72)	7	39
Bombay ...	19 (76)	29	40
Total ...	95 (380)	120	120

Note.—The figures in brackets represent the number of stations exposed during the four years.

We need offer no comment on these facts, for it is clear that there is rather an inverse than a direct relation between the endemic foci of the two diseases. But we may emphasize the conclusion by glancing at the relative incidence on corps units

in 1903 for which the records are available. We take the 20 regiments standing highest on the Venereal list, with ratios of admissions ranging from 302 to 885 *per mille* of strength, and for comparison the 20 corps at the bottom of the Venereal list, the range being from 75 to 230 *per mille*. Of the former series no less than 8 were newly arrived regiments, *i.e.*, they had landed in India during the last trooping season, 1902-03, or subsequently, while of the latter series only six regiments were in like case, and 11 had been over five years in the country. Nevertheless, the incidence of Enteric Fever was 50 *per cent* higher on the latter body of men than on the former, *i.e.*, for the 20 corps with the enormous Venereal ratios, the Enteric rate was 15·1 *per mille*, against 22·8 *per mille* for the corps with less than half the amount of Venereal disease.

Lastly as regards the seasonal incidence, it will suffice to say that the period of greatest prevalence of Enteric Fever, *viz.*, April to September, is precisely that when the admissions for Venereal disease fall to the minimum, though it is true that the month of April shows a comparatively high number for the latter affections. Forty *per cent* of the total Venereal sickness is returned during the first four months of the year (33 *per cent* of time), a gradual increment being observed from the onset of the cold weather (October), due probably to the arrival of drafts and reliefs and to the greater vigour and activity of the men during the winter.

We have quoted the results of an enquiry into the prevalence of Venereal disease which showed that 71 *per cent* of the force present in 1894 had been admitted to hospital on this account since the arrival of the men in India : this certainly indicates that very few—a negligible minority—avoid the risks of bazaar infection to the fullest extent to which they prevail. The facts set forth, however, are not to be reconciled with the easy assumption of widespread sources of infection in the bazaars and other extra-cantonment resorts to which the prime and chief danger may be traced, but, on the contrary, they lend a special force to the contention that, in so far as these sources exist, they are derived from the men themselves. And for the rest it may be affirmed that scarcely one prominent feature of the epidemiology requires the invocation of external sources of infection, while, on the other hand, the various problems are at once elucidated when we regard the soldier and his immediate surroundings as the *fons et origo mali*. This is not to deny the necessity of all measures of sanitary amelioration

that can be applied to these resorts, if only on the ground that they are *de facto* extensions of the cantonment, but it is obvious that our charity must begin at home—that we must set our own house in order—that the problem must be attacked at its root, whereas, hitherto we have sown the noxious tree and exhausted energy in lopping its branches.

Having now seen how we stand in regard to our obligations, we are face to face with the question of the essential features of a policy of reform. The remarks which follow must be taken merely as suggestions with a wide general application and as representing the results of individual cogitation which claims no special authority ; the conditions of each community and locality must necessarily be studied by those primarily responsible and the measures must be adapted thereto. Our object may be said, in the words of Simon, to be "the perfect adaptation of drainage, water-supply and scavenage to the purpose of carrying away, inoffensively, all refuse materials of life from the person, the house and the environment so soon as possible after their formation, and with as near an approach as possible to one continuous current of removal", and with this, their speedy, safe and economical disposal. The subject claims a few observations under the following heads : (1) removal of excreta and polluted waste water ; (2) disposal ; (3) water-supplies ; (4) general remarks on the hygiene of the soldier and his surroundings.

In regard to the first two questions, the writer desires to urge the claims of the water-carriage system of removal with subsequent disposal by what are well-known as "biological" methods, the *rationale* of which and their adaptability to cantonment conditions in India were discussed by him in a contribution to the "*Scientific Memoirs by Medical Officers of the Army of India*," Part XII, 1901.

The objections that have been raised in this country against the more artificial biological methods, and which at present appear to stand in the way of their adoption, are—

"Want of more extended experience of the system ; the necessity for an abundant and cheap supply of water for purposes of dilution."*

The doubt as to the passage through the apparatus of pathogenic germs.

Difficulties in the way of water-carriage due to the character of the site; and the prime cost.

* See letter of Quarter Master General to L. G. Cs. of 29th June, 1900.

As regards the first, it may be said that experiments already made in India have put the question beyond doubt, as far as the main issue is concerned, even if details vary and require elaboration in minor points (see reports from Bombay, Poona, Calcutta, Simla and elsewhere.) Experiments in India have fully demonstrated the capacity of the biological methods to deal with the excrement of natives which averages 10 oz. for each person, with all its undigested food residue and large excess of cellulose, with a dilution of 4* gallons per head, and it is certain that the European adult average excrement of 5 oz. could be submitted to the process with equally good results when diluted with 3 gallons of water, because of the relative diminution in quantity and of the comparative absence of undigested residues.

Does the European soldier receive, for ablutionary and culinary purposes, less than 3 gallons of water per diem? If he does, the difficulty of supplementing the supply to reach this amount is surely not insuperable; but is it too much to ask that this amount of fresh water should be set aside for the purpose of diluting the excreta? One of the objections raised against trenching-grounds is the lack of irrigation water for cultivation; the intermittent bestowal of a "purified" effluent from a "biological" installation not only returns the necessary nitrogen to the soil for manurial purposes for raising crops of vegetables, but it brings at the same time the required supply of moisture, while it relieves the inhabited site of so much stagnant waste.

As for the second objection, there is certainly no intention on the writer's part to minimise its importance, but, first, it must be noted that it is hypothetic and inferential. If pathogenic germs be contained in the solid and liquid excreta—and it may be taken as certain that they do—what are we to say of the present arrangements? The fact forms the most damning indictment of these arrangements, and one might be content to rest the case for the prosecution on this alone. Given a damp polluted soil upon which contaminated fæces and urine are constantly deposited, and add to this the faulty latrine system, and we have abundant foci of infection provided before we get to the trenching-ground. Let us, however, look at what we actually know as regards the biological methods of which an adequate system of *removal* must form an integral part. It is proved to demonstration that where a proper water closet and drainage system is in use, there Enteric Fever

* Three gallons in some of the Calcutta experiments.

is enormously reduced, if not altogether abolished. (Boobyer, Osler; Bermuda; American Camps.) We may, however, admit that while the chemical qualities of a sewage effluent can be controlled by biological methods to any extent and to any desired standard, yet the evidence, so far available, appears to point to the fact that in some forms which these methods take, there is no large detention or destruction of the characteristic flora of sewage. Organisms, not indeed ranked as pathogenic, if highly suspect—*e.g.*, *B. coli*,—are found in practically the same abundance in a chemically pure effluent as in the original raw sewage, after passage through downward filtration beds, or after "contact" in aërating "filters." (Clowes and Houston; L. C. C. Reports.) The importance of this fact is not to be underestimated, but it may be pointed out that the prospects of those methods which include an anaërobic stage are manifestly brighter than those which rely on "aëration" pure and simple, and for these reasons. The pathogenic organisms of water-borne diseases are aërobes even if we allow them a facultative existence where free oxygen is at a minimum; they are by far the most fastidious and the least robust in the struggle for life when confined under the conditions which obtain in a septic tank or bed, which is swarming with anaërobes, and with saprophytic and putrefactive rivals. We know that even among these latter the tide of victory rises and falls, with the extermination of the least fit at each stage of the battle, and these are favoured by all the conditions of a natural habitat. It must go much harder with a *parasite* and an aërobe; the absence of free oxygen, the conditions of temperature and the fluctuations in reaction are inimical to fastidious parasites, even if they had the field to themselves. The "germs" of typhoid and cholera are particularly fastidious in these respects, and it is probable that both lose infective virulence during their passage through the human organism which they only regain after exposure to air; and as they are believed not to form spores, they are deprived of their best chance of survival until the conditions become more favourable. It is not strange, on the contrary that *B. coli* and *B. enteriditis sporogenes*, which are universally present in the environment, and which are normal habitants of the intestinal tract where putrefactive processes are initiated under anaërobic conditions, should find the conditions more propitious.

What we can say amounts to this, that the sojourn of fastidious parasites in an anaërobic tank exposes them to such

unfavourable conditions, mechanical, (from sedimentation and a course of upward and downward filtration), chemical and biological, that the chances of ultimate survival in the final effluent are exceedingly poor and doubtful. The fate of pathogenic organisms in the dead animal body under anaërobic conditions affords striking testimony in favour of this view. (Klein. L.G.B. Report, 1898-99). These are some of the first general considerations which, indeed, are far from conclusive, but the results of more recent experiments directed to a solution of the question go far to justify confidence in the ultimate results.

The Committee recently appointed by the Government of Bengal to study the question of the purification of the septic tank effluents from certain installations provided for the large mills on the banks of the Hooghly have reported remarkable results from the use of chlorinated lime (33 *per cent* of available chlorine). It has been found that when this substance is mixed with the effluent in the proportion of 5 grains to the gallon, the latter is rendered virtually sterile and certainly much purer (bacteriologically) than the filtered drinking-water of Calcutta. Repeated examinations, confirmed independently, failed to demonstrate the presence of *b. coli* or of *b. enteritidis* in cultures made from the effluent after this lime treatment, the cost of which does not exceed Rs. 10—15 a month, for an installation adapted to deal with the excreta of 2,000 persons. The bactericidal action is, moreover, complete within the first hour. It may be well to add that the installations in these cases (*i.e.* for Natives) are arranged in the form of a series of latrines (W. Cs.) on the top of the septic tank and that a flush of 4 gallons of water (actuated by pedals) is provided for each user, the excreta being washed at once into the tank. The water, raised by pump, is stored on the roof; the capacity of the septic tank is arranged to accommodate from 2½ to 3 days' sewage, and the resulting effluent even before passing into the aeration beds must be described as very good. One example is given in the margin.

Kanchrapara Latrine

	Parts per 100,000
Chlorine ...	2·41
Free Ammonia ...	1·275
Albuminoid Do. ...	·19
Nitrates ...	·07
O. absorbed (10 minutes) ...	·6
Do. (4 hours) ...	1·06

Into the details and technique of disposal by "biological" methods we do not propose to enter; the system has emerged successfully from the stage of probation both in England and India, and every scheme must receive separate consideration

by Medical Officers and Engineers qualified for the work, the main lines of which have now been sufficiently established. We shall merely affirm as the result of personal practical experience, that, in view of the comparatively concentrated nature of the sewage owing to the low measure of dilution ordinarily available, installations must be constructed for the double process of preliminary hydrolysis and subsequent aeration, *i.e.*, for a septic tank or upward "filtration" followed by a passage of the first effluent through porous beds arranged for intermittent "contact" or downward filtration. The measure of concentration of the sewage will determine the required capacity of the former to ensure full hydrolysis by the necessary length of sojourn in the tank, the capacity of the filters being adjusted to accommodate the actual amount of the effluent.

But it may be said that for a body of 1,000 Europeans with a water-supply of 3 gals. per head, a septic tank of the capacity 6,000 to 9,000 gals. would be required, according as a 2 or 3 days' sojourn of the sewage in the tank be found necessary; probably the former period would be ample. This involves 960 cubic feet of space and as the most suitable depth is 6 feet the other dimensions of the tank would be 8 feet by 20 feet. The subsequent process of aeration would require arrangements for a charge of 4,000 gals. daily (allowing for alternation in use and the rest of one "filter" at intervals) and for this, 4 beds, each of 280 cubic feet capacity, would suffice, after the introduction of the filtering material. If the results of the lime treatment be substantiated, one of the gravest difficulties, *viz.*, that of removal of the sewage from the site to the installation at an inconvenient distance, where the gradients are inadequate, will be largely obviated. And when the effluent is disposed of on light, porous soil which should be systematically cultivated, it will be admitted that the possible danger bears an altogether insignificant proportion to that incurred in the methods at present in use.

The apparently insuperable difficulty of obtaining adequate supervision, absolutely essential for carrying out trenching, is minimised, and with a proper integral system of removal, is almost entirely obviated, while the risks to health, to some extent incumbent on all methods, are largely discounted. In larger communities installations can be established at suitable points, and so save the cost of costly schemes for the devolution of all the sewage to a common outfall; smaller communities

need not wait for the comprehensive schemes required by towns in or near which they are situated. As regards the final disposal of the effluent, the question of its discharge into a stream or natural drainage channel, will rarely arise in the cantonment problem, for it is to be remembered that in the endemic area of Enteric Fever, the conditions of soil and climate are such as to require moisture by irrigation for 8 or 9 months of the year; the effluent is entirely absorbed or evaporated, and no question of its final disposal, or of deep drainage, arises. A few suggestions may now be offered on the practical aspects.

Removal.—It will be seen that the key to the situation is the prompt and complete removal of refuse, with as near an approach as possible to automatic action to the place of "purification," whereby we obviate pollution of the soil of the site and of the water-supplies; given a successful solution of the first problem, the other results naturally follow, though certain additional precautions will be indicated as regards the water-supply from wells.

The first essential is the total abolition of the present latrine system, with the filth-sodden floors and sites, the retention of filth, the "dry-earth" nuisance, the multiple manipulations from receptacle to pail and from pail to filth-cart, and the unscrupulous *mehter*. We must treat each barrack as a unit in the scheme and utilize the waste water, which at present is not properly disposed of, as our motive power for immediate removal, while at the same time we secure its safe disposal. How are we to effect this? The means and the circumstances will vary, but a little judgment and engineering skill will, in most cases, solve the problem. In the case of hill cantonments we shall have no difficulty, as we may take full advantage of the site and gravitation. The ablution water and other waste can be run from the barracks to detached water-closet latrines on a lower level, where a flush is secured and the excremental refuse will be carried automatically to the biological installation at a lower level, and the effluent be conducted thence by pipes to the arable land. These considerations provide an additional inducement to carry out the policy recommended of a completer utilization of Hill sites for the cantonment of troops on first arrival in India, and for the retention thereon of all the younger men during the first two years of their sojourn.

In the Plains difficulties in regard to the necessary gradients must often be encountered; a great deal obviously depends on

the natural levels of the site ; in some cases it may be said that the whole arrangement is a plumber's job ; where gradients are less favourable, we shall have to resort to expedients to overcome the difficulties. The first consideration is, then, the survey of the ground of the cantonment, to indicate the most favourable levels ; on the one side between the latrine and lavatory sites and the biological installation, and on the other side, between the latter and the ground to which the effluent is to flow for final disposal. This indeed is the crux of the problem of perfectly efficient removal, and it is one that must receive the most careful attention in the first place. Much will depend on the arrangement of the barracks and their affiliated latrines and lavatories on the site, *i. e.*, whether in extended line or whether in square or parallelogram, as regards the most economical laying of the latrine drain pipes and their linking up into a larger connecting drain which will conduct to the installation ; but given a sufficient natural fall in the ground this is a matter of detail presenting little or no difficulty.

Take the case of the ordinary company-barrack, to each of which is attached, ordinarily, two latrines and a lavatory. The present pan arrangements of the former should be dismantled ; the flooring within, and the soil around, the latrine should be removed, renewed and asphalted and the whole site and structure be thoroughly disinfected. It should then be fitted with automatic flush W. C's. which should be raised to a sufficient height above the floor level to provide an adequate fall for the soil pipe which should run from end to end of the latrine, receiving the discharges of the series of W. C's., to convey them to the connecting drain. If, for example, the closets are raised some 4 feet above ground-level, we at once secure a gradient of 1 in 30 for the first 40 yards of the system, that is, until the connecting drain is reached, which may therefore take-off at surface level and still have the whole of the natural gradient available.

For the supply of flushing water two sources are available, *viz.*, that from the lavatory and the swimming bath and a separate supply of fresh water, which would only amount to some 300-350 gallons per company, and which, as in the present case of the lavatories, would have to be conveyed by pump to a reservoir placed at a higher level (7 or 8 feet) than the W. C.'s ; if water can be conveyed to a tank in the lavatories, there can surely be no difficulty about the latrine

supply. With this separate supply of 3 gallons per head for the W. C.'s, the whole of the lavatory and bath waste could be utilized for flushing purposes, by being conducted to a siphon flush tank discharging at the head of the main drain, or at proper intervals along its course, according to the circumstances of the site and the arrangement of the main drains, the flushing tanks being of from 100 to 300-gallon capacity according to the length of sewer to be flushed. In regard to the arrangement and course of the main drain everything will depend upon the number and position of the W. C. latrines to be connected and upon the natural gradients to be obtained. It is believed that, in general, a fall all over of 1 in 100,—or 15 feet in the course of 500 yards,—will be ample to ensure self-cleansing with the flushing arrangements as suggested. The kitchen waste-water should of course be diverted to the drain at the nearest convenient point. If the necessary gradient be not naturally available, it may be increased easily by depressing the "biological" tank below ground level to the required extent. The effluent would be discharged into a tank from which it would be necessary to raise it by means of an ordinary Persian wheel worked by a bullock, or by a pump, in order to provide the requisite fall to the ground set apart for irrigation.

To recommend such a system of removal may be deemed a counsel of perfection, but it is surely feasible in many, if not all, of the cantonments, and half-hearted and partial methods in dealing with a situation which is the legacy of forty years of failure and compromise will be found far more costly in the long run. A proposal recently sanctioned to try the effects of special measures of disinfection in latrines will cost at least £100 *per annum* in the case of each regiment, a sum which may be taken to represent the interest on a capital of £3,300, and without discounting the results, one may fairly assume that financial considerations can scarcely be urged in favour of the present policy. Enough has been said to make it clear that the present latrine system and the methods employed in the removal of the excreta are the essential, the prime and the chief sources of the evil, compared with which all other factors are secondary and on which other factors are dependant; compromise in the way of efforts directed against the latter are foredoomed to failure. In one way or another the solution of the problem should not be beyond our resources: if an organic drainage system be found impracticable we must turn to some

modification, such as W. C. latrines with automatic flush, the soil-pipe of which will be adjusted by screw joint at some distance to a sealed car tank with non-absorbent lining, which will retain the excreta of a day or more and then be run on well-laid tram-lines to a "biological" installation where it would be thoroughly flushed out; its place while in transit would be taken immediately by a similar tank. We may also refer incidentally to the Neilson system of disposal by cesspool tanks, which are reported to have yielded very good results in the City of Florence, (see *Lancet*, May 20th, 1905, p. 1373).

Considering the great danger arising from the long-continued infectiveness of urine in Enteric Fever cases and convalescents, the present arrangements for urinaries demand attention. These are lightly built and cheap structures, the abandonment of which would not involve much monetary loss; on the other hand, the immediate and complete removal of this, perhaps the most dangerous of the excreta, would be a great gain. The precise details are a matter for consideration, and present no great difficulties, provided it be conceded that a W. C. and drainage system are essential to adequate sanitation. Some forms of flush W. C.'s can be used as urinaries; in other cases, it is merely a question of providing non-absorbent receptacles or channels at the top end of the latrine and arranging for an occasional flush from the latrine tank; or the urinary might be placed next to the lavatory, the waste of which, on its passage to the automatic flush tank at the head of the drain, could be directed to flush the urinary.

As regards urinaries for night use in barracks, the arrangements should include a receptacle for the ground floor, instead of as formerly for the upper stories only. Men in the former will utilize the nearest open ground, at night, instead of resorting to the urinary. These barrack conveniences should properly be connected with the nearest latrine drain, although it may be admitted that there are difficulties in providing the necessary flushing; but if water be laid on to the barracks, as it should be, these would not prove insuperable. Leaving flush tanks out of the question, a pail of water discharged into each receptacle every morning would serve the purpose.

In connexion with the automatic arrangements for flushing the W. C. pans, it would certainly be well if the British soldier could be induced to adopt the physiological attitude in defæcation, *i.e.* squatting. This would involve far less danger

from contact of body and clothes with the structure of the latrine and it would secure a completer evacuation of the bowels. It should be noted that intestinal hernia is just four times more frequent among European troops than among Native troops and prisoners.

The case for improving the conditions of the removal and disposal of the excreta of Native troops, is little less urgent, where Europeans and Natives are cantoned together. Difficulties there are in the way of a perfect scheme which one need scarcely anticipate in the case of European troops, and especially in the supply of the necessary water for dilution and removal. But at the same time the whole problem is simplified, if we abandon the system of removal by drainage, which alone necessitates a fairly large supply of water as the motive power. If natives can be compelled to walk (as they now do to the trenching grounds) to the site of an installation, two or more being provided at suitable points to divide up the distance to be traversed, it would appear from experiments that a dilution of the excreta with two gallons in excess of the ablution water in customary use, would be perfectly adequately transformed in an apparatus, the first upward bed or septic tank of which was sufficiently large to secure the retention of each day's sewage for some 4 to 6 days, and this is only providing structurally for a daily quantity of excreta with a dilution per head of 4 to 6 gallons. Here we should escape the drainage difficulties with the flushing requirements, and the men would deposit their excreta in a flush latrine above the septic tank, and water to the extent of two gallons per head could be provided in the latrine flush. This would entirely meet the water difficulty, and involve no more expense in construction, as although the septic tank would have to be slightly larger, to ensure a due sojourn therein for thorough hydrolysis, it would be more than compensated by the decrease in the size of the subsequent downward filtration area, which would only need to accommodate a body of sewage made up of about 2½ gallons per head. The sewage of a bazaar affiliated to a cantonment could be dealt with in the same manner.

Water-supply.—A few remarks may next be offered in regard to the water-supply. Given an unpolluted soil, there is probably no safer nor more economical source than the ground water tapped by means of properly protected wells. There is abundant evidence of the dangers to which gravitation supplies from rivers, tanks and surface wells and springs are open,

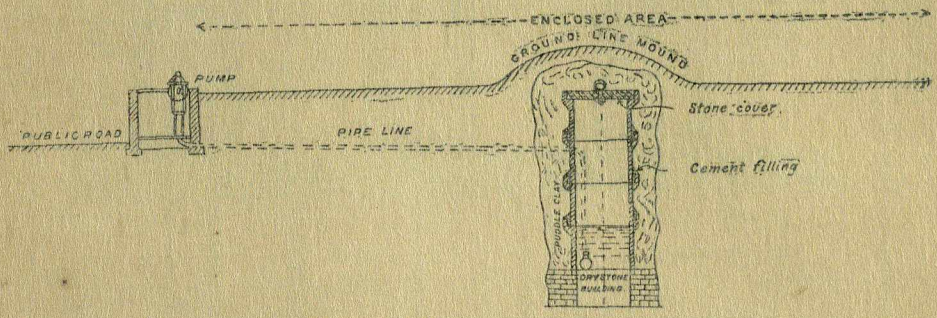
and no filtration process of a polluted supply can be held to justify its use save under exceptional circumstances, of which the most valid is that there is no choice.* Wells must be chosen or made, with due regard to the surroundings and the natural flow of the ground-water, and after adequate protection in their course through the soil, they should be provided with pump-tubes and hermetically sealed by masonry covers; the tube should be conducted through the lining below the parapet to some distance from the well mouth, where it will join the pump, so that no pumping is done over the well mouth. The ground around the well should be laid out in grass and the whole area fenced-off to obviate all access by man or beast. A force-pump should be used to raise the water to a proper covered receptacle at a height sufficient to give a fall to the barrack, hospital and kitchen, where it should be accessible by means of brass taps on the verandahs; the pipes must not stop short of the points of consumption. The chief points to be observed are the choice of the well in unpolluted ground; the protection of the well both as regards its lining and its cover, which latter *must* be dust and water proof; the reservation of the area around, and the provision of the pump outside the reservation; the complete distribution by pipes to the barracks, hospital, etc. We have not dealt fairly with our wells in India; we cannot expect pure water from a high and fluctuating ground water, which washes a polluted soil and which is often tapped in ground below the level of a neighbouring native village or bazaar. Beyond this, we find a good well often fails to yield a sufficient quantity in the dry months, and is condemned as useless, when deeper boring would tap the permanent supply, and not the fluctuating "drainage" level. In view of the considerations adduced in a former chapter as to the retentive properties of clay for all foul organic matters and their concomitants, no question is of more practical importance than that of deep boring in order to avoid the polluted water near the surface which is retained *in situ* by a comparatively superficial stratum of clay which, at the same time, protects the water in the sand and gravel beneath it. The indication is therefore plain, *viz.* to take advantage of the first clay stratum by tapping the water at the lower level, and fortunately, this

* See remarks by the Bacteriologist, North Western Provinces and Oudh, as to the relative purity of filtered river-water and the supply from wells at Agra.—Report of Sanitary Commissioner (India) for 1899, p. 49; also Dr. Thresh on the safety of rural well-water-supplies, *Lancet*, April 15, 1905.

can be done, in many cases by a simple expedient applied to the wells at present in use.

An iron pipe, 3 or 4 inches in diameter, may be sunk through the bottom of the well, as in ordinary boring, until the supply of purer water, below the clay, is struck, and this water will rise into the well in ample quantity. But, at the same time, the bottom of the well must be plugged with a floor of masonry in concrete to prevent the access of the water from the upper layers of the soil. A narrow cylinder of larger diameter may replace the iron pipe where larger quantities of

DIAGRAM No. XXVI.



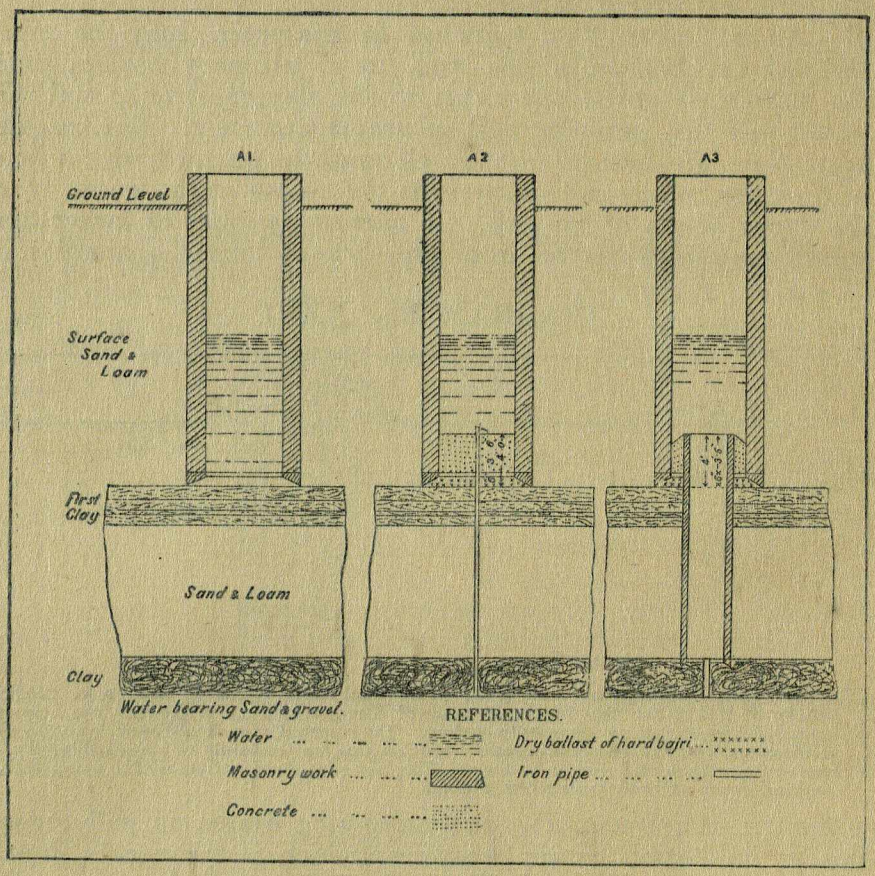
Scale 8 *Ft.* = 1 *Inch.*

A safe form of well, devised and used by R. W. D. MacMartin Cameron, M.D., D.Sc., Medical Officer of Health for the County Councils of Kircudbright and Wigtown. The arrangement and the advantages are equally obvious. The reserved area should be at least 20 yards in diameter, with the well in the centre; but this area may certainly be increased largely, if deemed necessary, to ¼ or even ½ an acre. The lead pipe running from well to pump should be fitted to the latter by brass screw joining.

water are required. The accompanying diagrams will give a clearer indication of the position, which is frequently found in the plains of Upper India, and of the methods suggested; they are taken with slight alteration from Bulletin No. 20 of the Department of Land Records and Agriculture of the United Provinces, the author being Mr. Moreland, C.I.E., the Director. A 1 shows an ordinary well-cylinder resting on the first clay layer and drawing its water thence; A 2 and A 3 the same well altered by provision of bore pipe and inner cylinder respectively. (See next page.)

By such simple measures, the necessary quantity of water may be obtained, as to the quality of which there need be little doubt; and for the rest, all unnecessary interference and manipulation should be scrupulously interdicted and indeed obviated by abolishing the various risks in the chain of supply by human agency, any one of which may introduce pollution

DIAGRAM No. XXVII.



Slightly altered from Bulletin No. 20, Dept Land Records, United Provinces. (Mr. Moreland, C. I. E.)

Systematic bacterioscopic examinations of the water should be instituted at all centres, and these should include comparative observations in regard to the normal or predominant flora of the soil of the drainage areas of the wells. Such observations carried on in a large number of places, differing in their geological and climatological characteristics, throughout the seasons and for a sufficient time, would, if supplemented by exact meteorological observations, be of immense value. The epidemiology of many diseases would doubtless be elucidated; as it is, our knowledge of the seasonal variations of the bacterial flora of soil and water is very defective. If, however, the

precautions we have indicated are maintained, we need have no fear of direct or indirect contamination of the wells. But, however good the sources, we cannot expect to secure safety if they are open to pollution by dust or by the methods still in vogue in many places for drawing, distributing and storing the water by hand in all sorts of receptacles; the whole procedure involves a series of risky compromises, one directed to nullify the results of another, and our efforts themselves contribute to our defeat. Again, where the methods in use are better calculated to fulfil the requirements laid down, they are too often partial and stop short of systematic completeness at one point or another; this involves the dangers of multiple sources of varying degrees of purity, of storage to complete the chain of supply and of reliance on faulty measures of purification.

Aerated waters are consumed in large quantities and the authorities are fully alive to the necessity for scrupulous care in all details of their preparation; here the use of the Pasteur-Chamberland filter is amply justified with the supervision that can be given to prevent abuse. It would be a good investment to provide a liberal supply of these waters from regimental factories free of charge, and in every cantonment bazaar a branch of the regimental institute should be established for the provision of simple refreshments. Special care should of course be exercised to ensure a supply of good water at rifle ranges and wherever the men are called on extra-cantonment duty.

In regard to other measures of conservancy, we need only refer to the necessity of the complete and expeditious removal and destruction of all garbage, manure and refuse of every description, which replenish the soil with organic matter and favour the breeding of flies; incineration, which may provide steam power for pumping or other purposes, is clearly indicated. The prompt disposal of kitchen waste and sullage is equally important and has been referred to in connection with the sewage arrangements.

It is open to question whether measures are practicable for the suppression of the dust nuisance in this country, but it should be possible to minimise its worst effects by providing screens to the barrack verandahs and venetian blinds to the upper story windows. Paving of the site around barracks and latrines and the cultivation of trees and grass are measures which demand consideration. The danger that is incurred from dust in riding schools may be obviated by a careful choice

and preparation of the ground, and by watering or oiling. Nose-breathing should be inculcated and also the routine practice of rinsing out the mouth and gargling before drinking.

Systematic measures of conservancy will tend to mitigate *pro tanto* the plague of flies and a study of the natural history of these pests will doubtless provide indications for a more direct campaign of suppression. We have seen (Chap. VII.) that biological methods of sewage-disposal have a special justification in this connexion.

In concluding this section on prophylaxis, a few remarks may be offered on some points connected with the domestic economy of the soldier's life : the food supplies and cooking arrangements, clothing and personal hygiene in general. Much has been done, and more is in contemplation, for the improvement of the authorized rations, in regard to quality, variety, sources of supply and preparation. It is proposed to establish central dining halls for companies when barracks are constructed on the new and revised plan, and these halls will be provided with cupboards for such supplementary food supplies as the soldier affects and which have now to be kept in his kit-box. Dairy farms have been instituted in some stations, and in many others there are regimental dairies and aërated water factories where all the arrangements are made on, and maintained at, a high sanitary standard. A great deal of care has been bestowed on the kitchens, which, however, by their structure, position and arrangements are altogether ill-adapted to respond to these efforts ; they have, in the past, been relegated to the ignorant low-caste native servants, who could not be expected to live up to responsibilities they do not recognize, and whose primitive habits are reflected in their surroundings. The kitchen in India has everywhere been cut off from the house and become the stronghold of the native cook and his satellites with disastrous results : the majority of housekeepers, who may be scrupulous in the care they bestow on bed-room and sitting-room, are strangers to their kitchen, where, generally, their presence would be resented. The folly of this ostrich-like policy is now becoming recognized and nowhere more clearly than in the army, and a radical alteration in theory and practice cannot be carried out too soon. Already a great advance has been made in many regiments in the way of training the men themselves to prepare their own food in regard to all the manipulations required, and the system must be extended till it prevails exclusively. But with this, every facility must be given for

the hygienic conduct of the difficult and delicate work; labour and money would be lost by endeavouring to palliate the present arrangements in most cases, and reform should not stop short of new structures with all the necessary equipment on modern lines, including proper ranges, and separate scullery and sink with immediate covered drainage to the place of disposal. The kitchen will, of course, be removed from contiguity with the latrine, and it would be well to make it an annexe of the dining hall or, better still, to locate it above the latter, a lift being provided to obviate human traffic between the two. There is no obvious reason for the employment of natives in any capacity in the kitchens, and it is least desirable in the hot weather when Enteric Fever is most likely to occur; the fact that Europeans pass long hours on duty as engine drivers in the hottest season provides a good precedent for this most necessary service. So much depends on conscientious care in details, and domestic economy is so peculiarly a woman's province, that it becomes a practical question whether it would not be well to confide the general management and supervision of the kitchen operations to educated women (as in the case of the Nursing Service), or to qualified stewards selected from the ranks: this, of course, should not involve any delegation or diminution of the Medical Officer's responsibility or authority. For it is just in these details of domestic hygiene that we may reap the fruit of bacteriological knowledge, not in the hunting down of particular germ pests, but in the refined sense of order and cleanliness it evolves and educates. In regard to all measures of conservancy (including that of the water-supply) and of food supplies and kitchen service a cardinal element in success is to eliminate the native as far as possible; camp followers have always been the bane of an army, and the ideal soldier is he who can dispense with these dangerous allies, who, indeed, are enemies within the camp. It is, doubtless, one secret of Japanese efficiency in the field, that the men depend upon their own resources, and nearer home, the soldier may find a worthy example in the proverbial "handiness" of the British seaman.

Under the improved organization and supervision suggested, much may be done in the way of improving the quality and variety of the rations and of adjusting them to physiological requirements. The following statement is extracted from the weekly letter of the army correspondent of a leading Indian newspaper, in which, however, in the writer's opinion,

the choice of meat dishes is needlessly embarrassing to both mind and stomach and would not represent the ideal for India.*

"The restaurant system of messing is being tried on an extensive scale at the Rifle Depôt, Winchester, and the variety of *menu* shows what can be done with a soldier's rations in the hands of an experienced cook, with the ordinary accommodation met with in barracks. The old method of drawing company rations and taking them to the cookhouse is dispensed with, for the company's kitchen is now converted into a restaurant, and a large blackboard fixed near the entrance contains a chalked statement of the day's *menu* prepared for the soldier. The following is one of the dinners, a fair example of the new style :—

Soups—Thick, clear.
Joints—Hot : roast or boiled beef, boiled mutton ; cold : roast or boiled beef.
Entrees—Mutton chops and tomatoes, meat pies, curry, stew, and rice.
Vegetables—Potatoes, cabbages, turnips, parsnips, beans and peas.
Sweets—Currant roll, date pudding, boiled rice and currants.
Cheese and pickles.

The bill of fare is drawn up by the Master Cook of the depôt, and submitted to the Quartermaster, who approves, after satisfying himself that the men's messing account is on the safe financial side. The meat ration is arranged with the contractor at the rate of $\frac{3}{4}$ lb. per man in mess, and the other edibles required to complete the day's messing are procured locally each day, and the cost borne by a charge of $3\frac{1}{2}d.$ *per diem* set aside from each man's pay. The men go to their kitchen, select their dishes and repair to the barrack room with them. Extras are also forthcoming for breakfast in the shape of liver and bacon, fish, jam, eggs, and butter or dripping for tea ; and there is often a basin of soup for supper, and sometimes bread and cheese. The residue of the day's dinner-fare is distributed after the tea bugle has sounded, and the soldier has no reason to spend his pay in the coffee bars or institutions usually made attractive as supper bars, since his rapacious appetite can be satisfied at all times from his own company's kitchen. Winchester is not alone in the experiment of combined messing, which is being carried out successfully at Aldershot, Shorncliffe, and other stations. In some cases separate rooms are set apart for dining purposes, and in one instance a pint bottle of ale is procurable by the men in their dining-room for twopence under arrangements made with

* The institution of scientific experiments to determine the dietetic requirements of the soldier in India is a matter of most urgent importance ; see Chittenden's remarkable work in America, which necessitates a revision of all our ideas and standards.

the local brewery. Crime has diminished at stations where the soldier's food has been improved, and such is the success of restaurant messing that the authorities are likely to give the increased accommodation so badly wanted in many cases, which at present hampers its introduction."

The scullery and pantry accommodation and equipment is of the first importance; they must be separate alike from each other and from the kitchen. If water be laid on to the former with simple means of heating it, and if racks for utensils and a sink and proper drains be provided, a whole series of mischances will be obviated. In the pantry, which like the scullery should be tiled, all food must be stored in wire safes, or, in the case of milk, in locked cans provided with taps.

The special dangers attending the consumption of raw foods needs no emphasis, and an adequate supply of vegetables and fruit should be provided under regimental auspices, so that the men may have no excuse for resorting to the bazaar or to casual hawkers, who must be strictly excluded from cantonments. Regimental gardens may well be instituted for the supply of vegetables; many of the difficulties would be overcome with a water-carriage system of removal with disposal by "biological" methods. All these internal resources, with greater variety and due delicacy in the cooking and serving of the food, will tend to remove the chief inducement to resort to the bazaar eating houses, and these could reasonably be placed out of bounds or be registered for inspection and supervision as in the case of lodging-houses. There should certainly be co-operation to this end with the authorities responsible for the various soldiers' homes and other similar agencies.

In regard to clothing the modern soldier is at a great advantage as compared with his predecessor, but here too much is left to his own scanty resources (see Chapter III.), especially in the way of underclothing and in view of the necessity for its more frequent change in this climate. Experiments are required to determine the most suitable colour and texture of the fabric worn beneath the white drill in the hot weather, and indeed at all times and in all places where the sun's rays are exceptionally powerful. In this respect we need to apply the indications derived from nature's provision of pigment in the case of natives.

The methods hitherto in vogue for cleansing clothing and bedding and all kitchen and scullery cloths present another example of our dependence on the natives and their primitive

resources, and it is fully recognized that a properly-equipped laundry is an essential adjunct to every well-ordered cantonment to supplement the arrangements for disinfection. Apart from the obvious necessity of this provision on its own merits it will foster a higher standard of personal cleanliness in all other respects, for which more systematic arrangements must also be made in the way of additional under-clothing and of hot-water baths, the value of which will be enhanced by the routine scrubbing of the integument with soap; the toilet of the mouth and teeth must be inculcated to prevent oral sepsis. There is good reason for suspecting the ordinary plunge-bath in common use of a rôle in the communication of specific bowel infections.

Judicious precautions must be observed to prevent the exposure of the younger men especially, to the effects of excessive bodily exertion under a tropical sun, such as is frequently involved in marches, musketry practice and in the riding schools. The intelligence of the men must be enlisted against the dangers of dietetic follies and excesses, in the matter both of eating and drinking, than which no more potent predisposing causes of disease and of mental and physical inefficiency prevail, especially in combination with the physiological depression and embarrassment induced by "fatigue." Properly adjusted and regular exercises and diet, which connote what is recognized in empirical experience as "training"—not over-training—are at once the best preventives of disease and the best preparation for the duties demanded of the soldier.

All these matters may be regarded as trifling details, but apart from their individual and intrinsic importance they subserve the whole end in view, and they will yield results beyond their application to the prevention of Enteric Fever. They have their place in a scientific and comprehensive scheme of prophylaxis, and to neglect them is to jeopardise the results of more imposing measures.

One fundamental consideration must be faced, and that is the necessity for a wisely liberal financial policy. The course of endeavour in the past has been strewn with stumbling blocks due to a neglect to apprehend and act upon this principle. In the last A. M. D. Report (1904), we find it stated that "impermeable floors will be provided for latrines and urinals *as funds allow*," and this is but one of many similar evidences of short-sighted extravagance masquerading in the guise of economy which the records furnish. Meanwhile

partial expedients and experiments, which in the aggregate cost large sums, are sanctioned; "they have their little day and cease to be." There is a middle-way between a wholesale whoring after new inventions and a policy of *fainéance* or compromise; that way is now sufficiently clear before us, and what may stand as excuse in the past will justify the greater condemnation in the future if we evade it.

In consonance with the view of extra-cantonment sources of infection, so largely held by medical officers, it is not strange that there is a strong consensus that in the present state of the sanitation or insanitation of the affiliated bazaars, they should be put "out of bounds" for the troops. The Cantonment Code which came into force only in October 1899, is a belated attempt to deal with this difficult problem, and Major (now Lieutenant-Colonel) Firth, R.A.M.C., late Special Sanitary Officer of the Rawal Pindi District and now Professor of Hygiene at Netley, offered some strong but judicious criticism of the Code in his report for 1899-1900, which the authorities would do well to consider. The Cantonment Magistrates are the Executive Sanitary Officers, and these are supposed to get their technical advice from the "Sanitary Officer," who is a member of the Cantonment Committee. In the majority of cantonments no specially qualified Health Officer had then been appointed, and the sanitary adviser was practically the senior executive medical officer in the station. Work of this kind involving special knowledge and training in a science that is making great strides yearly, if not almost monthly, can only be expected of an expert. Again, of the Cantonment Committees, Major Firth says: "I fear but few Cantonment Committees will rise to a sufficient appreciation of their powers and responsibilities." He points to the apathy engendered during the hot and rainy months (the period of danger), when everyone is inclined to let abuses stand over for attention till the next cold season. There is a most undesirable lack of continuity in the administration, and "it comes to this that in nine cases out of ten, the activity, zeal and initiative of the Magistrate are the true measure of the efficiency of the local sanitary authority." The provisions under the Code as to bye-laws are too lax and permissive, and this particularly with regard to the control of trades, etc., from which most of the danger to the troops is considered to arise; and "the multiplication of sanitary officers will, and can do nothing if the law allows any loophole for escaping conformity with sanitary requirements." In the important matter

of conserving a pure water-supply, we find it enacted that "no person shall, without permission, place any latrine, cesspool, urinal or drain, or use for the deposit of offensive matter or rubbish, any place within fifty feet of any source of public water-supply." Any "person" may, it would seem, put his latrine at a distance of fifty feet, or nearer "with permission." Again, the provisions laid down (sections 73 and 76) as regards latrines, are not calculated to arouse the enthusiasm of the most lukewarm sanitary reformer. Major Firth concludes by saying that "we can only hope for very gradual improvements, as a result of a judicious combination of cajoling and menace on the part of officials," "but success in this direction is purely that of the individual and not of the administration." It must be affirmed that neither the specific provisions of the Code, nor the authority to which their execution is entrusted (with the large amount of judicial and office work this individual has to perform) provide a basis for sanguine anticipation; menace and cajolery are feeble agents to depend on. By the time the ground has been covered at infinite trouble those who were first cajoled into some reform have relapsed, and so the work goes on *da capo*. For ignorant people it must be made as easy to do well as to do ill, and nothing will avail but radical reforms in all the practical measures by which a community can live cleanly and righteously in a sanitary sense.

These considerations have an obvious application to cantonments themselves, including those parts of the site in contiguity which are occupied by the dwellings of officers and civilians, the conservancy arrangements for which are too often neglected for lack of a systematic and comprehensive sanitary organization with adequate resources and control. While endeavouring to secure the first essentials of a pure-water supply and the complete removal and disposal of excreta and refuse in these affiliated areas, the accurate registration of all deaths and their causes is a measure, the importance of which can scarcely be exaggerated. In a word, organization and authority must be extended and co-ordinated in control of the dangerous zone that intervenes between the general native population and the troops in cantonments.

A considerable, if uncertain, proportion of Enteric Fever infections are contracted on journeys by road and rail; the neglect of the commonest sanitary arrangements in railway refreshment rooms and dâk bungalows is a crying scandal. If we cannot reform those sloughs of despond known as hotels, it is

certainly incumbent on the authorities to put the former, which are State institutions, under strict sanitary discipline, and this can only be effected by general ordinance giving the necessary powers and providing penalties for default.

This leads us to the question of the sanitation of troops on the march and in camp. The annals of route-marching in India, involving frequently the use of the same camping site by successive regiments at short intervals, are rich in records of epidemics. In these camps we have every source of pollution of the soil, by badly arranged and badly conserved latrines, by want of care in trenching, by accumulation of waste liquids and decaying organic matter. If we look at the medical history of the campaign in South Africa, all this and its results are brought home to us in the terrible figures of mortality and sickness from Enteric Fever and other bowel diseases. If we wish for peace we must prepare for war, and to be ready for war we must prepare in time of peace ; moreover, with regard to Enteric Fever we may not maintain two attitudes, one only being possible, *viz.*, that of war. Camping sites along the main routes and those subject to repeated occupation must be brought under ordered control, provided with the necessary arrangements and strictly conserved at all times, and not merely subjected to hasty intermittent efforts which at best assume the nature of compromises at the time of occupation, and for which the individual corps unit is responsible. But in all cases, we must expect more from our medical officers than valour in the front line and surgical skill in the field and base hospitals ; each regimental unit must have its sanitary preventive patrol or vedette, which should be mounted, and to this end some of the more intelligent men must be trained in peace. Part of this sanitary guard should precede the regiment on the march, and part should follow after taking all measures to conserve and disinfect the camp. The Medical Service should have an independent transport entirely at its disposal. The whole problem is beset by difficulties when forced marches in a campaign have to be undertaken, but that is no reason why they should be shirked, and this matter is one of the most pressing in the whole question of military reform. The Japanese in the recent war have furnished a striking object-lesson of the results of preparation and organization in this direction, and it must be insisted that this training and organization can be instituted successfully only during peace, and that combatant officers and men must co-operate to the end in view.

We have now to summarize as briefly as possible the general principles that should guide us, and the practical measures thereby indicated, in combating an actual outbreak of Enteric Fever.

Starting with a due appreciation of the parasitic faculty of the bacillus, the fundamental principle of action must be the definite identification of its presence with the aim to its destruction, and the prevention of its propagation and dissemination ; this identification may (and must often) fall short of positive demonstration of the bacillus itself, and we must then fall back on the more indirect evidence, which, in the last resort, is derived from the clinical symptoms. The failure of our efforts in the past has, however, been due largely to our dependance on this last resource ; the protean features of the malady and the established fact of the frequent infection of the apparently healthy, has rendered exact bacteriological methods indispensable, and the success and economy of our efforts will be proportionate to the skill and energy displayed in their application. Outbreaks are always and everywhere the result of the effective access of the bacilli derived from previous cases from which they obtain passage directly in the excreta (fæces, urine, sputa) or indirectly by articles contaminated thereby (clothing, vessels, food, &c.) ; the danger is *ceteris paribus* in proportion to the extent of the susceptible population exposed, of its close aggregation and use of common resorts and common services. While in the active combat with an outbreak every possible means of transmission is to be taken into account, it is often impossible to mark down each and every *fomes* in detail ; and when infection is present in a community, constant and cumbrous precautions against all indirect modes of transmission are sooner or later as futile as they are exacting. The cardinal indication is, therefore, to attack the evil at its origin—the infected host—while maintaining a high standard of public and personal hygiene. At the same time investigation must be directed to trace each case backward to its source and then to determine the area of influence of the infection. We may thus hope to secure the identification of all who are infected and to determine the duration of their infectiveness.

These ends can only be achieved successfully and economically with the skilled resources of bacteriology which must be made available by the institution of laboratories for the work of investigation and diagnosis at the hands of traine

experts, whose primary function must be the examination of all suspected materials. Their results along with the information supplied by the medical officers on the spot will secure the "intelligence" by which active measures must be directed, a Register being maintained at each centre for the record of all the essential facts elucidated : name of patient, date of illness, age, service, corps unit, barrack, bed, mess, latrine, etc., with a statement of any (and what) connexion with previous cases or centres of the disease, and the nature of the material examined and the results, whether blood reaction, positive find of bacilli, etc. Outline maps of the cantonment, showing dormitories, latrines, wells, etc., must be spotted (with numbers and dates) to exhibit the local and time relation of the cases. The ensuing investigation should be pursued upon the spot and embrace enquiries as to the source and means of the infection, and be directed primarily to determine the questions of importation, of water or food or more direct contact infection. It should then extend to the men living in the same dormitory or barrack, and to those resorting to the same mess or latrine as the patient, recent visitors thereto from other units not being overlooked ; and it should take strict account of all forms of febrile illness or bowel disturbance however slight.

The procedure laid down by the German Imperial Board of Health for the diagnosis of the disease and for the examination of suspected materials may be given in brief outline as follows: the details are extracted from the official Memorandum on "*Measures for combating Typhoid Fever*" issued in 1903.

The substances sent to the laboratory for examination should be :—

(1) Fæcal matters : 50 to 100 c.c. if liquid ; of the size of a nut if solid.

(2) Urine, 500 c.c.

(3) Blood, taken by scarification of rose spots.

(4) Expectoration from the lung.

(5) Pus, or inflammatory exudations.

(6). Blood, taken (*a*) by puncture of an arm vein (2 or 3 c.c.) (*b*) from the lobule of the ear.

(7). Soiled linen.

(8). From a dead body ; intestinal contents taken from above the ileo-cæcal valve, portion of spleen and lung; some bile, contents of abscess; pulmonary secretion.

(9). Well-water, after the well has been stirred up, from 3 to 5 litres.

The operations to be performed are: cultivations, agglutination test, Pfeiffer's test.

(1) *Cultivations.*

(*a*). Substances 1, 4, 5, 7 and 8. At least two series of large Petri dishes are plated with Drigalski-Conradi medium, and incubated at 37° C. for eighteen to twenty-four hours.

(*b*). Urine—Centrifugalise and cultivate from the deposit as (*a*).

(*c*). Blood.—Inoculate into alkaline peptone bouillon, using 10 c.c. tubes for No. 3, and 150 c.c. flasks for No. 6. Incubate at 37° C for twenty hours, and sow into Petri dishes as (*a*).

(*d*). Water.—Place in a 2-litre flask. Add (for 2 litres of water) 20 c.c. sterilised solution (7.75 p.c.) of hyposulphite of soda (German Pharmacopœia). Mix. Add 20 c.c. sterilized solution (10 p. c.) of nitrate of lead. A deposit is obtained, either by centrifuge or by sedimentation for twenty-four hours: pour off supernatant water, add to the deposit 14 c.c. sterilized solution (100 p. c.) of hyposulphite of soda, shake, and decant into a small sterilised tube; allow the insoluble matters to settle. With the liquid portion, prepare Petri plates (2 to 5 cc. in each) as with fæcal matters. Colonies are examined with the naked eye by daylight, as to their size, colour and transparency; those suspected of being B. typhosus (which are small, transparent blue-violet in colour) are examined microscopically afterwards under a low power, as to their behaviour in the presence of a strongly agglutinating serum. Pure cultures are then made on sloped agar.

The final determination is made (A) by examining the shape and motility of the organism; (B) cultivation in glucose agar; (C) in litmus whey; (D) on potato; (E) on gelatine; (F) agglutination test microscopically; and (G) by Pfeiffer's test.

(2) *Agglutination Tests.*

For the determination of a suspected colony or pure culture, these are carried out (*a*) in hanging-drop with direct addition of serum; and (*b*) in dilutions of $\frac{1}{50}$, $\frac{1}{100}$, $\frac{1}{500}$, $\frac{1}{1000}$ and $\frac{1}{2000}$, each experiment being repeated with the same culture and the same dilutions, and with a known typhoid culture of the same age and the control serum. For the examination of the blood, a microscopic test is made with $\frac{1}{50}$ and $\frac{1}{100}$ of the suspected serum and a forty-eight-hour typhoid culture; microscopic examination is also made in conical tubes, left for three

hours at 37° C. If $\frac{1}{50}$ gives positive reaction and $\frac{1}{100}$ negative, the case is doubtful, and the test should be repeated a few days later.

(3) Pfeiffer's Test.

The serum employed must have a strong agglutinating power. Four guinea-pigs are taken: A receives a fivefold immunising dose; B a tenfold dose; C is a control, receiving a fiftyfold dose of normal serum; these animals are injected with doses of serum containing a loop of the culture to be examined (eighteen hours on agar, and then diluted with one c.c. bouillon). D receives an injection of a quarter of a loop of the culture simply, this serves as a test for its virulence. The peritoneal exudation is examined in hanging drop under a high power from twenty minutes to one or two hours after the injection. In A and B the bacilli should be dissolved or transformed into granules; in C and D a large number of bacteria should be quite motile and retain their characteristic form.

In the application of the campaign against typhoid to military practice, the examination of water supplies is not to be omitted. This mode of infection may be obviated in some degree if a bacterioscopic water examination is made at regular intervals, not to discover the enteric bacillus, which practically is never found there, but to ascertain the presence and amount of colon bacilli, which are the proof of fæcal pollution and an indication of possible contamination by Eberth's bacillus. In Koch's opinion, no filter can safeguard against this danger of infection by water; sterilisation is the only method to employ.

The essential end to which the procedure is directed is the rapid identification of the infective agent by one or other of the processes according to the circumstances of the case, and this has been facilitated by the special culture medium introduced by von Drigalski and Conradi mentioned above, which consists of lactose litmus agar containing crystal-violet. This differentiates the colonies of *B. coli* which are coloured red, from those of *B. typhosus* which remain translucent and bluish, and can thus be picked out and identified by the agglutination and other tests, the diagnosis being completed in from 24 to 48 hours. It is probable that finality has not been attained in this matter of technique which demands considerable skill and experience in its employment, but that it marks a great advance to a practicable solution of the difficulties, there can

be no doubt. More recently, Lentz and Tietz and Endo have introduced to notice selective media of a similar kind, in essential principles, which would appear to have a sphere of usefulness in examinations of the fæces, possibly as supplements or complements to the Drigalski-Conradi process, but experience alone can decide as to their relative advantages in different cases. In this connexion we may not omit mention of the procedure elaborated by Hoffman and Ficker for the detection of *B. typhosus* in water, in which similar materials are employed but with a special adaptation to the exceptionally difficult problem, and which has been attended with striking success (see v. Jaksch, *Contralblatt fur Bakteriologie, Orig.*, XXXVI., No. 4, 1904).

A few words may be added on the present position, legitimate indications and the requirements in practice, of the Gruber-Widal serum test. It is not denied by any competent observer that it is certainly a valuable aid to diagnosis, that it is, indeed, indispensable; and we may hope that with the advance of our knowledge of the biochemical forces in action we may find in its very limitations surer evidence of its true worth. Failure has often been due to the use of haphazard methods and to a lack of appreciation of the obscure differences that mark different strains of the same micro-organism obtained from different sources and cultivated under varying conditions in the laboratory. And to this must be added the variations in the reaction of the tissues of the organism which provide the conditions for agglutination, and in the personal equation of different observers. It may be concluded that while in the laboratory we can control, more or less, the factors in operation, the clinical problem may be complicated by the individuality of the case; that no single test or symptom can be relied on exclusively, but that the Gruber-Widal reaction will maintain its value when its results are read in the light of all the clinical syndromata, and beyond this, it will, in the majority of cases, render a relative service to the patient, the clinician and the epidemiologist by furnishing evidence of specific infection, past or present. In using it, any idea of obtaining indications from arbitrarily fixed dilutions must be abandoned; in each case the observer must exhaust the limits of the reaction of the serum on the different micro-organisms of authentic identity and origin which may have a possible etiological connexion with the case, and so refer not to "positive" or "negative" results, but state the facts. Any simplification of the test that

does not involve loss of accuracy would prove more profitable than an ever-increasing complexity of technique, with its tax on the judgment of the observer. From the consensus of a large and increasing number of reliable authorities who have used it in comparative tests with the Gruber-Widal procedure, it would appear that Ficker's so-called "diagnosticum" fulfils this demand. Along with the abundant testimony to its delicacy and reliability, it is recommended for its simplicity and its availability to the clinician in the absence of laboratory resources, and as altogether specially adapted to the conditions of military hospital practice.

From this sketch of the scope and functions of the intelligence department we may proceed to summarize the measures to which the striking and defensive forces are to be devoted; the plan of campaign is that elaborated by the German Imperial Board of Health and is the outcome of the results of the scientific Commission organized by Koch for the suppression of endemic Enteric Fever in the villages of the Hochwald in 1901, which were confirmed by the success of the operations subsequently carried out in Saarbruck, Treves, Metz and Strasburg by von Drigalski and Frosch. (Talayrach, "*Archiv. Med. et Pharm. Militaires*", No. 11, November 1903.) The general principles of action may be referred to under the following heads: (1) Notification; (2) Investigation and Diagnosis; (3) Isolation and segregation (evacuation); (4) Disinfection; (5) Instruction.

Of the first two, the requirements and scope have already been indicated; the importance of the earliest possible recognition of all cases, whether typical or suspect, has been amply demonstrated in the facts adduced as regards the average duration of treatment in our Indian hospitals, and we must no longer be content to refer the responsibility to the disinclination of the men to "report sick." Reference has been made to the necessity of enlisting the intelligent co-operation of the men by all the means which come under the head of Instruction; and for the rest we must depend on systematic supervision and investigation, to which the Register and Spot maps are indispensable aids and which, at all times, may be guided by the indications derived from the observations in hospital (daily sick state and admissions). Frequent and regular examinations of the men will come into this category. When diagnosis is established, notification should extend to neighbouring stations and especially to those upon a line of march or in

direct communication. There should also be interchange of notification between the civil and military authorities of the same cantonment; advice to the local authorities in advance of projected movements from an infected place, which will apply to departures to the hills, and to convalescents proceeding on leave; and the notification of cases that exhibit infection on return from leave, or from duty in other stations, to the Senior Medical Officer of such stations.

As regards (2) *Diagnosis*, nothing need be added to the statement of the procedure to be followed, beyond urging the adoption of a more vigorous and systematic policy in providing and using the necessary resources. Out of 1,397 admissions for the disease in India during 1904 there is a record of only 749 individual cases submitted to the serum reaction, of which 526 were declared "positive," 198 "negative" and 25 "doubtful." In only 50 of the 86 stations in which Enteric Fever was recorded was the blood test employed as a routine procedure. In all other directions concerning the identification of the specific bacillus or its allies the record for the year is blank (save as regards its detection in the urine in several cases), and only occasional attempts have been made to isolate the micro-organism from the tissues *post-mortem*, and so to confirm the positive pronouncement of Fischer (Kiel) as to its specific identity, which was made in 1890, from specimens submitted to his judgment. The work of Captain Blake-Knox on Typhoid bacilluria was conducted at Netley and furnishes a good example of the observations demanded. It need scarcely be pointed out that a systematic utilization of our scientific resources will contribute materially to the elucidation of the pathology and etiology of other diseases, and especially of the fevers and bowel diseases which are a reproach alike to our nosology and to our preventive efforts. And it is clear that with the concentration of the forces under the new reorganization scheme, there will not only be a more imperative demand for laboratory provision, but also less need of dissipation of the resources in that respect, and this, in any case, is a comparatively trifling matter in view of the issues at stake,—the essential element of success being the men to be entrusted with the work. With diagnosis, investigation of the sources and area of infection should go hand in hand, and this of course, as already stated, will take account of the more dangerous, because more occult, forms of infection in cases before and after the clinical symptoms are manifest, and also of the direct and

indirect means of dissemination ; and this again, will naturally lead to the necessary measures, *e.g.* the exclusion from access to the implicated focus, well, cook-house, latrine, bath, riding school, or barrack, etc.

(3) *Isolation and segregation.* Allusion has been made to the necessity of a precautionary measure of quarantine to be applied to drafts on first arrival and of bodies of men arriving from a centre where the disease exists or has recently existed. This applies to the annual movements in relief, of those to the hills and of those of time-expired men. Inter-station transfers should be avoided as far as possible at the seasons of notable prevalence, and it is obvious that the greatest care must be exercised in regard to the aggregation of corps units from different places in camps, and to the movements and communications involved thereby. These inalienable conditions of army life and function render a perfect integral organization for sanitary purposes an essential part of the equipment and establishment of each corps unit, apart from the general organization which controls the whole : each unit must be equipped and responsible for its sanitary service, otherwise aggregation must always introduce special dangers.

On the occurrence of an outbreak the sufferers must of course be removed to isolation wards set apart and adapted for their treatment, while suspected cases and contacts must be segregated also for a period of observation of three weeks, in special quarters provided for the purpose. In regard to cases established by diagnosis which end in recovery, the ideal to be aimed at is to prevent a return to association until the period of infectiveness has ceased ; this can only be adequately secured by a resort to routine bacteriological examinations of the excreta, two consecutive negative results at weekly intervals being decisive. The alternative is prolonged isolation or banishment to a station set apart for convalescents, which is obviously costly in the loss of effective service involved and affords no guarantee of safety in the end. To sum up ; when a case appears in a barrack, it is advisable to cut off from use the attached mess and latrine, and to institute the mess in spare quarters. The patient is to be removed to the isolation ward, while the other men previously in association, and now under observation, take their meals and exercise and use a latrine apart from the rest for a period of at least three weeks ; suspicious cases of fever, diarrhœa, etc., should further be isolated from the contacts in question and the resources of

bacteriology applied to the blood and excreta for the identification of the specific infection. Such measures are doubtless exacting, but that they are reasonable and practicable has been already proved by their success in cutting short an epidemic of Paratyphoid in the garrison at Saarbruck in 1902; and it must be noted that the whole aim is to discover the beginnings of evil, and that the success achieved will be in direct proportion to the provision made beforehand and to the promptness and energy displayed at the outset. The aim in view is to cut the channels of communication between the sick and the more indirect sources of infection and the healthy;—by removal and isolation of the former and of others possibly infected; by the destruction of the virus; by the prevention of subsequent intercommunication during the period of infection (as by nurses, attendants, visitors, flies and dust); and by the abrogation of common services (water and food) and resorts (latrines and messes) which may have been previously infected.

4. *Evacuation and movement* is a measure which is obviously included by implication in the previous category, and merely deserves separate mention for the proof it has afforded by its success of the danger of the indirect sources of infection, when an outbreak is widespread and has defied half measures. It is, in fact, a wholesale form of segregation from multiple sources of infection which are present in barracks, latrines, messes, the soil of the site, the water and food supplies; but while it serves to establish the etiological connexion with these sources, it is, in itself, a partial and blind expedient unless employed as preliminary and ancillary to a more definite and comprehensive plan of campaign; it is at present our chief resource against plague in the native civil population, as for long it availed us against cholera among the troops, in regard to which we have advanced to a stronger and more offensive position.

5. *Disinfection.* The foregoing measures all lead up to the prompt and complete destruction of the infective agent, on which, indeed, their justification and success depends, the object being to arrest and destroy the virus at its prime source, and, failing this, in all secondary foci in which it has found more or less temporary conditions for viability. Premising that when a case is admitted to hospital with ill-defined symptoms which, in the absence of a positive diagnosis, arouse suspicion of the possibility of Enteric Fever, he should be placed in an observation ward set apart for doubtful cases and all precautions

taken as for the established disease, we have to take account of the following sources and means of infection.

1. The patient and his excreta : Fæces, Urine, Sputa, Vomit, Person.
2. The more immediate environment of the patient, including all articles and places with which he is brought into direct contact before admission and during the period of infection : clothing, bed and bedding ; vessels and utensils of all kinds, including those in use for food, drink and medicine, as well as bed-pans, urinals, etc., and the food itself ; all materials used in the nursing service, towels, soap, swabs, etc., the washing and bathing waste-water and all refuse, sullage, etc.; the walls, floor and furniture of the ward.

Into this category come also the barrack-room, dormitory or tent occupied previous to admission ; the latrine and urinal and mess-room resorted to, as well as the immediate site and open ground surrounding these ; the ambulance or public carriage, if any, occupied by the patient.

3. Other individuals in association with the patient : contacts, doctors, nurses and visitors to the wards.
4. In fatal cases, the corpse and *post-mortem* tissues and fluids.
5. Convalescents.

1. Patients should never be allowed to resort to latrines or closets in common use. All excreta from bowels, bladder or stomach should be caught and retained in easily cleansed vessels with an impermeable and indestructible surface, and which are charged beforehand with a quantity of fluid disinfectant equal to the average of the excreta. The mixture is to be removed from the ward at once and after thorough stirring, it may be allowed to remain in the vessel for an hour before disposal by burning or boiling in a suitable apparatus. Urinals and bed-pans must be cleaned with disinfectant immediately after use and stored in a covered box till next required. Spittoons must always contain disinfectant and be emptied and disinfected frequently and regularly ; their contents should be disposed of as in the case of the other excreta. Swabs of cotton gauze which are used for wiping the patient's mouth, nose or nates, should be deposited in a vessel containing disinfectant and removed at once for burning. The personal toilet of the patient will of course receive scrupulous attention, his hands and nails and nates being regularly cleansed with disinfectant.

All washable clothing, such as body or bed linen should be removed from the ward in a bag which has been wrung out in disinfectant, and should be deposited for one or two hours in a receptacle containing disinfectant in which it may be subsequently boiled, and then finally rinsed in plain fresh water : blankets and woollen articles should not be boiled. Articles of clothing that cannot be washed, and mattresses, carpets, etc.,

should be disinfected by steam in suitable apparatus under competent supervision. Articles of leather, wood and the metallic parts of furniture, and similar objects soiled by the patient's excreta, should be carefully and repeatedly rubbed with rags moistened in disinfectant, the rags being subsequently burnt.

All feeding utensils should, after use, be thoroughly cleansed with hot solution of soda, or with disinfectant, and subsequently cleansed in the ordinary way. Dusters and other service cloths in use should be treated as infected. No food should be allowed in the ward at other than meal times; it should never be left exposed or uncovered, and all fragments or portions left over should be destroyed.

Washing and bath-water after use and all sullage must be treated as infected, and rendered innocuous by the addition of sufficient chloride of lime, the mixture being well stirred and retained for one hour before disposal. The walls and floor of the ward and its furniture should be systematically scrubbed with hot disinfectant, particular attention being paid to crevices and corners and to the immediate neighbourhood of the patient's bed; the rags used being burnt and the brushes disinfected.

Every endeavour must be made to exclude flies from the wards and from the various offices of the hospital, and all intercommunication with other wards must be scrupulously interdicted, save only in the case of the medical officers, who should wear a linen outer-garment in the Enteric ward and disinfect their hands before leaving.

2. It is unnecessary to enter into similar details as regards the disinfection of the patient's environment before admission to hospital: the same principles apply and demand similar measures. When new barracks and dormitories are to be constructed it is to be hoped that in addition to improved arrangements as regards dining halls and kitchens and sanitary equipment in general, special attention will be paid to the materials and structure of walls and floors, to minimise the lodgment of dust and dirt and to facilitate disinfection; absorbent plaster walls and rough plank floors can never be kept truly clean. The introduction of a water-carriage system of sewage removal, with W. C. latrines, would facilitate greatly the task of disinfecting the latter structures, which, under the present arrangements, must tax the best efforts and resources to a hopeless degree. On the occurrence of a case and the removal of the patient to hospital, all his ordinary regimental clothing, barrack bedding, etc., which must be entirely separate from and surplus to the hospital

equipment in these respects, require disinfection in the manner described, a measure which must be extended, according to circumstances, to the dormitory and its furniture and to the clothing and bedding of immediate contacts. The floor and soil of the site contaminated by the excreta of the sick, as well as pavements, gutters, drains and refuse heaps may be disinfected by the application of chloride of lime or slaked lime.

3. Nurses and orderlies entrusted with the care of Enteric patients should wear easily washable outer-garments, or aprons covering the entire front of the body, which should be reserved for ward duty. After contact with the patient or his body or bed linen, the nurse's hands must be thoroughly cleansed with soap, hot water and nail-brush, and then disinfected with a special solution set apart for the purpose, hot water and disinfectant being "laid on" to a lavatory in the ward, with proper automatic drainage. Caution must be exercised in washing and bathing the patient to avoid splashing. Nurses are to be specially warned against touching food before disinfecting the hands; they should never take meals in the ward, where also smoking (in the case of orderlies) should be strictly prohibited. The precautions as to disinfection apply equally to medical officers, chaplains and visitors. It is reported (A. M. D. Report, 1904) that, in spite of regulations and instruction, nursing orderlies are frequently most careless of the risks of infection, in neglecting to wash their hands before leaving the wards, and in the use of the patient's drinking vessels. These men when they themselves escape, may also be a means of the dissemination of the infection among others with whom they associate when off ward duty; if it is essential that they should continue to be so employed, they should, of course, undergo special training and be provided with special quarters including messing arrangements, and all intercourse with the corps or garrison at large should be interdicted during an outbreak; short spells of duty and plenty of open-air exercise must, however, be provided for. The new nursing service composed of trained women will, it is to be hoped, be organized and extended to obviate the necessity of employing orderlies from among the men, save perhaps, as a small auxiliary corps set apart for the purpose and to meet the requirements of field service.

4. Corpses of Enteric Fever patients are infectious and they should be wrapped in a sheet wrung out in disinfectant and removed to the mortuary as soon as possible. The greatest

care should be exercised as to the disinfection and disposal of all *post-mortem* fluids and material including the water employed during the examination and in the cleansing of the room, the furniture and instruments; open, outside drains or catch-pits are in this connexion, specially dangerous, and the access of flies must be absolutely prevented. The corpse must be enclosed in an air-tight coffin, the bottom of which is covered with a plentiful layer of sawdust or some absorbent material, and it should be conveyed to the cemetery on a carriage which is to be subsequently disinfected.

5. As already stated convalescents must be segregated after discharge from hospital during the period of infection, which can only be safely and accurately determined by bacteriological tests. They will ordinarily be sent to the Hills or to some central depôt where they can associate with others in like case, and be under supervision and control, and the greatest care must be taken to prevent the dissemination of infection *en route*, arrangements being made for the reception, disinfection and disposal of their excreta. The greatest danger at this stage is now known to arise from the elimination of the bacilli in the urine, in which they rarely appear until the end of the second week of the illness, but in which they may, and often do, persist for weeks and even for many months, if untreated. Fortunately, we have in urotropine a remedy which is of proved efficacy in disinfecting the urinary passages and excretion, and Blake-Knox, who has made valuable observations on the subject of Enteric bacilluria generally and of the use of urotropine in particular, has found the best results to follow the administration of the drug in 10 grain doses three times a day given, preferably, from the onset of convalescence, or previously if obvious signs of bacilluria (turbidity) are present. He advises its administration in milk and soda-water (half a pint) or in lemonade made from fresh lemons, "until the urine clears and keeps clear"; it should, however, be noted that this result is generally attained after a short course of the drug and that the bacilluria may return if the course be suspended prematurely. The recourse to bacteriological tests is here again obviously indicated. It need scarcely be added that the disinfection and effective disposal of the alvine excreta are not to be neglected. The personal effects of convalescents must of course be thoroughly disinfected finally before they are allowed to return to the community. The case of convalescents proceeding on furlough requires special consideration and precautionary measures, and

it is essential that they should be excluded from camps and campaign service until they have been proved free from infection. Lastly, troop-trains, tents and ambulances of all kinds must not be overlooked in connexion with the efforts made to destroy the virus in all probable and possible places and objects exposed to the risk of infection.

These, then, are the measures which are indicated by the cardinal fact that the human host is the prime and essential source of infection, and that his every excretion may contain the virus at some time or another during the course of the disease, and that everything with which he is brought into contact may sooner or later be specifically contaminated. This provides the key to what may, at first sight, appear a most complicated and exhausting procedure, but which is indeed simple and feasible when the clue is grasped and followed with ordinary intelligence, though here as in other matters scientific methods in alliance will economize and co-ordinate efforts.

As regards the materials and agents to be depended on for effective disinfection little need be said in this place; the subject is one which has an extensive literature of its own, and there is no lack of competent guidance in all essentials. In the case before us our resources may be summarised as:—

(*a*) Dry heat, including incineration by fire, and also sunlight and ventilation, as to which the special and general applications need no further indication.

(*b*) Moist heat, by steam in special apparatus devised for the purpose, and by boiling. As regards the former all apparatus are not of equal value, the three essential conditions of efficiency being, that the steam shall be saturated, that it shall reach a temperature of at least 212° Fahr., and that the articles submitted to its action shall not be damaged. Every steam disinfector requires skilled and trustworthy handling by a competent subordinate and careful supervision by the medical officer. The expense of this apparatus should certainly not be allowed to stand in the way of its provision in all cantonments, but where it is not available a boiler of some kind must be used, and even for the use of this rules should be prescribed. The vessel employed should be covered, and it should be remembered that the temperature of the fluid will be lowered, whenever a fresh article is plunged therein. It is necessary that everything submitted to disinfection by boiling should be completely immersed and exposed to the boiling temperature for not less than 15 to 30 minutes.

(*c*) Lastly, we rely on chemicals of infinite variety, and of the two or three most generally useful, *viz.*, perchloride of mercury, carbolic acid and chloride of lime, it is most important to secure their purity and adequate strength in solution.

Of these chemical solutions which have a wide and important application in the case of Enteric Fever we may merely refer to a few of the most generally useful, effective and economical. These are the acid perchloride of mercury, 1 in 1,000, hot or cold; the cold non-acidulated solution of the same, of double the strength (1 in 500), for woollen shrinkable fabrics; carbolic acid solution in the proportion of 1 part (weight) of the liquid acid to 20 to 30 parts (weight) of water; the diluted cresole solution recommended by the German Imperial Board of Health, 1 part (weight) of *Liquor cresoli saponatus* (G. P.) mixed with 19 parts (weight) of water, the solution containing 2·5 *per cent* of crude cresole. In addition to these a special application, which need not be indicated in detail, is found for freshly-prepared chloride of lime to be used in a mixture of 1 in 50 of the waste-water or sullage, etc., to be disinfected; and for potash soap (soft, green or black soap) in the proportion of 3 parts (weight) to 100 parts (weight) of boiling water, to be used hot

Lastly, in the general disinfection of wards and barracks, the preliminary use of Formaldehyd may find useful applications.

Anti-Typhoid Inoculation.

It will have been noticed that, so far, no reference has been made to the subject of anti-typhoid inoculation, and this is certainly not because its importance as a prophylactic and sanitary measure is ignored or depreciated. On the contrary, the writer believes firmly that its position in these respects is fully established, though the foremost workers in the field are the first to admit that there are still practical problems to be solved before the sphere and extent of its usefulness can be definitely settled. The scientific committee recently appointed by the Prussian Government, which included Professors Koch, Kolle, Donitz, Kirchner and Gaffky, have stated with all the authority that attaches to their opinion, that the subject is one of national moment. It is recognized that while the incidence of Enteric Fever is, in time of peace, very light, the disease would come to be an all-important factor in regard to the efficiency of the army in the event of a European war, and a

still more important factor in a campaign conducted in tropical or subtropical countries. Such considerations have manifestly a far more direct and urgent claim on the attention of the authorities of this country, especially in view of the responsibilities which have constantly to be met in connexion with service abroad and of the eventualities, actual and prospective, which are thereby involved, in peace and war. On the main question of the possibility of successful inoculation, the committee gives its verdict as follows: "On a survey of the scientific observations conducted on animals and men and the practical experience which has already been gained in the case of men, it is impossible, even when proceeding with the greatest caution, to doubt that inoculation can confer a certain measure of protection, and that it is urgently desirable to seek for further information based as far as possible upon absolutely trustworthy data, with regard to the degree and duration of this protection." It is further affirmed that under proper conduct of the process there is no risk of permanent injury to health. These conclusions have not been allowed to die the death of pious opinions of merely academic interest, but have been followed up by an energetic prosecution of practical experiment and of application in the case of the troops despatched to the seat of the war in South-West Africa, no less than 2,000 inoculations having been carried out up to April 1905, in addition to the operations performed among the white and coloured populations on the spot. From a critical survey of the latest results, Kolle has arrived at the conclusion that the inoculation of dead phenolized agar cultures in doses as large as is compatible with safety, affords the best prospect of attaining a protracted period of immunity; the operation should be performed on three successive occasions, at intervals of 8 to 10 days, with increasing doses, from 2 mg. rising to 6 mg., or to 10 mg., if after the second inoculation there is a complete absence of general reaction; these doses are very large, but smaller ones are not, in Kolle's judgment, to be recommended. In view of the prevalence of paratyphoid and of mixed infections in India, the indications are obviously in favour of the use of a polyvalent "vaccine," in place of one composed of a pure *typhosus* culture; the secret of past failure and of future success may lie in the practical appreciation of this suggestion.

Some readers who have followed to this point may look for a separate discussion of the all-important subject of the prevention of Enteric Fever among armies in the field. If this be

indeed necessary, after what has been said in regard to principles and practice, the labour of both writer and reader has been in vain ; moreover, the actual details of the measures which are indicated are, at present, the constant subject of discussion in the medical and lay press, the dire experience of the South African war in contrast with the more recent achievements of the Japanese in Manchuria, having provided a fertile text for reformers of more than one faith.

If the principles which have been advocated in the foregoing pages are adequately applied, one source of infection, of a notable but uncertain extent, should be obviated in a very considerable measure if not altogether excluded, *viz.*, its importation from cantonments into the concentration camps and thence along the lines of communication into the field. Too often when mobilization is ordered all the arrangements for sanitary purposes in cantonments and along the line of march are allowed to fall into abeyance, largely due to the fact that, hitherto, the sanitary and purely medical departments of the medical service have not been distinct in their organization, and that again is due to the inadequacy of the cadre at disposal. In plain terms it is impossible to meet the urgent demands for war (which constantly increase with the drain involved in active service) from a cadre that may be expected to barely fulfil the conditions in peace and which is not adequately organized for war. When war breaks out there is a helter-skelter rush to the front and the devil frequently takes the hindmost in their passage along the line previously occupied by their forerunners. It is at this stage that precautions are most necessary, and obviously the necessary organization cannot be improvised at such a time but must be perfected beforehand ; as regards India the circumstances are specially favourable to such precautionary organization, at any rate so far as the strategic lines to the Frontier are concerned. It will begin with the careful selection of the men, with more close and direct application of the regulations to the elimination of all who may harbour infection. It may be impossible to fix a standard of age below which men should not be sent straight away to the field, but those having less than one year's service should be excluded. The training received by officers and men in the principles of sanitation may, at this stage, be expected to bear fruit and to supplement the efforts of the sanitary and medical staffs, and special instructions should be issued to emphasize the particular dangers likely to be incurred and thus to ensure co-operation.

The food and water-supplies demand the most careful attention. Wellington boasted with proper pride, that whatever his merits as a General, he was a good commissariat officer, and to this fact he attributed his successes. An instance of the danger and loss involved in the provision of bad food—in this case mouldy bread—was recently furnished by the plight of the Russian army in Manchuria, which was stricken with enteritis, dysentery and Enteric Fever as a result of its consumption on several occasions. Other radical and sudden changes in the diet, notably the reliance on tinned meats, have been proved to be a fertile source of bowel complaints. The importance of gastro-intestinal disorders as a premonitory sign of an Enteric invasion (and as indication of faulty hygiene in a force) is established beyond all question in the records of campaigns, and, indeed, in the annals of civil communities. Medical officers in India learnt this lesson in the days of Cholera outbreaks, and the same indications should be followed in the attempt to mark down the sources of infection in Enteric Fever. The earliest possible recognition of the milder disorders must be secured and followed by segregation and disinfection, and special supervision of "contacts." The greater care spent on early and apparently trivial bowel disorders and fevers will be well repaid in the prevention of serious outbreaks and in the general maintenance of the health of the whole body. Let it be remembered then that outbreaks of Enteric Fever among troops on field service in the tropics have invariably been preceded by the notable prevalence of "fevers" (generally called "Simple Continued") and of gastro-intestinal disorders, and the experiences of the American concentration camps and of European campaigns all enforce the lesson and its indications.

Allusion has been made previously to the precautions necessary along the routes to the main points of concentration where standing camps are occupied and the army falls into fighting order, to proceed on radiating lines to the front. It is impossible to exaggerate the importance of all sanitary measures at this stage before the army enters the field, and where valuable object lessons may be presented to officers and men for their guidance under the conditions they will encounter subsequently, when each unit will depend on its own sanitary staff to a greater or less extent. The exigencies of the military situation must vary in every campaign, but the salient fact for the soldier and sanitarian alike is the danger of disorderly aggregation of large numbers of corps units from different places. When concentration

involves the crowding together of a very large body of men, so that the number occupying an acre exceeds that of the most congested areas of the London slums, and where there is no water-supply nor sewage system which alone make these slums habitable; where every man is a law unto himself and all the worst defects of cantonment conservancy are allowed to prevail, the result can only fail to be disastrous by virtue of happy chance; and the penalty in these cases is too often only deferred. With the extended use of the telephone it is probable that one great necessity for close aggregation will disappear, but the sanitary ideal to be aimed at under all circumstances, must be adequate space and integration of units for sanitary purposes with due regard to the interests of the whole body. And this also involves considerations of great difficulty with regard to the space and accommodation at the disposal of the individual—the size of tents and the number of men allotted to each. In the same connexion it would seem wise to provide on all survey and intelligence maps, indications as to sites for camps and as to the water-supplies available; the first hurried arrival in a strange country, even though, as must be the case, the sanitary staff precedes the troops, must lead to ventures that ought not to be incurred and might be avoided. And this is the more necessary, as when proper sanitary provision is made in standing camps along the lines of communication, there will be economy of resources, and the observance of the difficult rule to avoid previously-occupied sites may be modified according to circumstances. Each standing camp must have its own permanent sanitary staff and police, working on approved lines to secure uniformity of procedure to which the men become accustomed to conform; in any other case confusion and lack of continuity of policy must ensue.

In regard to the details of that policy a volume might be written, of which, however, the first and last consideration would ever be that of the prevention of the access of the excretory products of man to man; and the difficulties of this task will always be in proportion to the neglect of all the other measures of a complete scheme of hygiene. If anything has emerged clearly from the controversy, it is certainly this, that no one measure, however thoroughly carried out, will secure immunity from the fevers and bowel diseases which disable a force in the field; and this applies equally to water-boiling and to protective inoculation. The key to the problem is, after all, perfect sanitation in all its connotations, and no single device will avail; this alone is the

royal road, and there are no short cuts to the end in view. Effective removal and disposal of excreta and refuse products of all kinds, the protection and purification of water-supplies, are the first essentials, the former being at the same time the most effective means of minimising the vehicles of access of the infection, mediately, from man to man. Along with this, and never in default of this, come the organized efforts for the early detection and destruction of infection whether at its original source or in the local *foci* deriving therefrom. Nothing need be added as to the course of procedure in regard to this second line of defence, the recognition and suppression of the disease, which has an indispensable value in supplementing and directing the first, or preventive, measures. To secure the effective disposal of excreta and purity of the water-supplies must, indeed, often tax the resources of the sanitary staff to the utmost, for at every stage of the work everything may be said to depend on human agency which requires not only constant vigilance and supervision, but the intelligent co-operation of the combatant officers and men, both as individuals and as a body imbued with a sense of corporate responsibility. But it is to be remembered that, hitherto, the measures adopted have generally been planned on the worst forms of cantonment methods, which when at their best, as we have seen, are open to damning criticism, and the conditions of a well-organized camp may even favour the abolition of some stages in the process that make for failure, *e.g.*, the standing latrine and the methods of removal in vogue. If it could be ensured that the soldier proceed direct to the place of disposal, the rest would depend on the efficiency of the staff employed at the trenches and this is merely a matter of a trained staff under constant supervision. As between the latrine and pail system (which can only be organized in permanent camps, and which involves all the added risks of subsequent removal and disposal) and the simple trench system, by which disposal is effected at the same time, there can, in the writer's opinion, be little question of the relative advantages, though, indeed, each case must be judged on a careful consideration of the special local circumstances. No one would think of using shallow trenches in this connexion, for apart from the risk of the transport of excreta by the boots and person, the prevention of the transport by dust and of the propagation by flies has to be secured (see remarks on this subject, Chapter VII.). The trenches may well be from 4 feet to 6 feet deep, small planks which can easily be disinfected being supplied for foot-hold, for it is desirable to dispense

with seats of any kind, the proper physiological attitude in defæcation, *viz.*, squatting, being adopted for its other obvious advantages in minimising the risk of contact with the excreta. Screens should, of course, be improvised of material capable of ready replacement and re-adjustment, not only to secure privacy but to obviate the transporting effects of wind on any dried excreta that may escape burial, and on paper, etc. The native *mehters* should be on duty behind the trenches which may be arranged back to back in lines to economize space, labour and supervision ; these men should patrol a given length of the trenches, one to each double line, and they should immediately cover the excreta after deposit with a layer of earth sufficient to ensure burial ; if necessary a simple arrangement for signalling the deposit by the men using the trench could be adopted, and each should be held responsible that the toilet of the trench is duly carried out so far as he is concerned. All trenching sites must be patrolled by an efficient subordinate of the sanitary staff (a trustworthy non-commissioned officer) and be visited regularly by a responsible sanitary officer. Trenches when two-thirds full will, of course, be properly filled in and the earth rammed down and the area marked off or enclosed. It need not be added that every facility should be afforded for access to the trenches both by day and night, the passages thereto being marked and lighted. There is of course nothing new in all this, save as regards the specification of the spirit of vigilance and efficiency which must be brought to its working details,—but that is everything, and no system applicable to field conditions will succeed without it; at the same time all the advantages of simplicity and finality are secured by means with which the men and the staff are well acquainted.

In dealing with excreta and waste which are known, or reasonably believed, to be infective, *i.e.*, from Enteric and Dysentery wards, etc., probably nothing better need be desired than the disinfecting apparatus of Major Cummins, C.M.G., who proved its efficacy in South Africa. It is estimated to be capable of dealing with the excreta, slops, bedpans, etc., of about 100 cases of Enteric Fever or Dysentery during 24 hours ; its weight is just under 3 cwt., and, therefore, portable ; it requires ordinarily from 50—60 lbs. of coal for a working day of eight hours, a quantity which must be raised to 80 lbs. in windy weather ; wood fuel may be used in place of coal. There is evidently scope for the use of fire in other directions and a good apparatus would soon demonstrate its value.

All other refuse, including offal, cooking-waste, and rubbish of all kinds must be collected daily and destroyed by fire ; some may be disposed of on the kitchen fires, the rest should be burnt in rubbish pits set apart in proper places ; carcases of animals must be removed immediately and buried deeply. There should be nothing impracticable in the foregoing suggestions when camp life is exchanged for bivouacs, though modifications in detail may be necessitated.

That the provision of a perfectly pure and palatable water-supply is an ideal to the attainment of which every effort should be exerted no one will deny, but the means thereto are less susceptible of a simple and inclusive definition, unless we regard all water as dangerous without distinction of circumstances. In the latter case a scheme for the systematic sterilization of all drinking-water, and for putting it at the disposal of the men at all times, has much to commend it. Such a scheme has been formulated and advocated with prophetic zeal by Dr. Leigh Canney, and inasmuch as the military medical authorities maintain in practice the necessity of boiling the drinking-water in cantonments, they would apparently have no logical objection to seeing it adopted in the field, provided it be practicable, a matter for careful experiment to decide. We may not overlook the fact in this connexion that, in similar circumstances, sterilization by chemical means may prove its advantages in simplicity and readiness of application ; of these perhaps the most promising are the chlorine and sulphite of soda and the iodine and sulphite of soda methods of Lieutenant Nesfield, I.M.S., as demonstrated at the last Congress of the Royal Institute of Public Health. The protection of the troops when actually engaged in more or less prolonged manœuvres in the field, where the fighting-line extends over several miles and the majority have to depend on their own initiative, calls for special measures in one or other of these directions, if only because the sources of infection among both opposing forces, who may bivouac alternately on the same sites, cannot be known or controlled by the sanitary staff.

In standing camps, the problem is less difficult, the essential aims being to secure a good source and to prevent its contamination, deep-driven artesian wells with distribution by pipes being resorted to where possible ; much might be done by sinking pipes through the bottoms of shallow wells and the requisite apparatus should aways be available. Where more doubtful and dangerous sources of supply have to be depended on (shallow

wells, rivers, etc.) they must be protected from encroachment and scrupulously policed, the water being boiled and, whenever possible, served as tea. After all, save in the case of a river, where the men are likely to bathe and the conservancy of which cannot be controlled beyond a short distance, reliance must be placed, not solely but in the first place, on the measures of general sanitation previously alluded to and, in particular, on those which secure the effective removal and disposal of human excreta. In this security the water-supply will share, and where the sanitary control is inadequate, pure water will but cut off one possible avenue of infection, and that not the most important save in very occasional and unusual circumstances. The questions involved in the supply of pure water to the Army in the field are understood to be at present occupying the attention of the highest military authorities who can no longer be in doubt as to their importance; the guiding principles having been discussed, there is the less need to enter into details and our main object is served by entering a *caveat* against the assumption that in securing this one end, the hydra-headed problem of the prevention of Enteric Fever will be solved.

A word in conclusion: recent events have called the nation to a new and clearer view of its responsibilities in respect to all matters that involve the well-being and efficiency of the armed forces of the Empire. Amidst the clamour of discussion which has raged round what most soldiers and politicians deem to be the more important issues,—recruitment, re-organization, re-armament,—one paramount consideration, is too apt to be overlooked. The new order, which public opinion demands, must be founded on a recognition of the facts of our shortcomings in the past, and of the price we have had to pay for them, and no clearer lesson emerges from experience than that which is brought home to all in the record of sickness and mortality which is so largely preventible and which demonstrates the success of our most remorseless foe. In open war we are perfectly familiar with the fact that the losses inflicted by the enemy are trifling compared with those arising from sickness and death, and this among the flower of the nation's manhood and from causes over which we have control. But we are only occasionally at war, and the record in peace from year to year is, in the aggregate, still more accusing and inexcusable; from the purely economic point of view our policy is that of a blind bankrupt, struggling on from day to

day and squandering his resources which are ever getting narrower.

The new order, for which we are in travail, must, therefore, recognize that the *prevention* of disease is the primary function of the medical service of the Army, and this involves an almost complete reversal of the policy of the controlling authorities. The page of history is adorned with the names of medical officers who have striven to improve the conditions of the soldier's (and the sailor's) lot and who have so utilized their special opportunities as to confer the greatest benefits on mankind at large, for with them the honour rests of laying the foundations of public hygiene. But this was the fruit of individual talent and energy of the highest order, together with the circumstances in which their lot was cast: it was not due to an organized policy emanating from statesmen responsible to the nation. Such workers are doubtless still available, and are working according to their means, but the conditions are altered in important respects, notably in regard to the complexity and difficulty of the problems which remain to be solved after the first great impression has been made upon the public health by the formulation and recognition of the first principles of hygiene, and by the rise in the standard of living due to economic causes. Moreover, the whole subject has become specialized so that many more labourers are required to cultivate the different fields that now lie open, to co-ordinate the results and to apply them practically. All this demands a recognition of the value, and of the difficulties of the work; more men with special training and a tactical redisposition and re-organization of forces. The position hitherto may be fairly summed up as allowing our men to get sick and keeping a large staff of physicians to cure them—as far as they can; tactics which do not need an epithet to reveal their quality; it is to open your square and ask Fuzzy-Wuzzy to walk in.

It need scarcely be said that the gain will not be confined to the diminution or suppression of any one disease; in attacking the causes of Enteric Fever we are cutting at the root of a noxious growth with many branches. And the gain will not cease with the sphere of the specific infections, for the other categories of disablement, *viz.*, purely functional and degenerative disorders, the predispositions and the penalties, must certainly be affected to our advantage. We need only allude to the benefit which will accrue at the outset from study directed to the differentiation of the "fevers," a "jungle," into which pathways are already being cut.

Large sums of money are being spent on the medical equipment of hospitals—*i.e.*, on the second line of defence—and the doctors' hands are full of cases which reproach our science. This is perhaps more clearly evident in the costly provision rendered necessary for war, which includes a marvellous array of pharmacopæal and other remedies (one had almost written toilet luxuries) and which can hardly be deemed superfluous under present conditions, when, as Sir F. Treves puts it, "we intend to have our 10 *per cent* sick, and we get it." If swords are not to be beaten into plough-shares, it will at least be some consolation to see these huge chemists' shops transformed into receptacles for bandages and first field dressings, and then with a sufficiency of transport we shall be able to dispense with pharmaceutical refinements until the men arrive at the base. We need organized sanitation in the field and an adequate supply of officers to deal with the casualties of pure warfare in the simple preliminary way that has so recently commended itself at the hands of the Japanese surgeons; and with this an efficient transport service. All else is beside the mark at which we ought to aim, but the day for this has yet to dawn. Sir Ian Hamilton (in "*A Staff-Officer's Scrap-Book*") makes some suggestive remarks, in this connexion, which we may ponder with advantage. "In the estimation of the First Army of Japan, England seems absolutely nowhere. Where the officers are at all touched by foreign influence, that influence is either German or French." In the same way we are told that all the army doctors are German by training. "The Japanese invariably adopt the German method instead of the British method whenever there is a difference;" and he adds, "whatever the cause may be, the fact is indisputable that, despite all their wealth and title and British prestige, our doctors have been handsomely worsted in that open-world competition of the nations, where Japan crowns the victor with sincerest flattery." The value of the criticism of our allies is clearly perceived, and however annoying it may be to him to find English ideas slighted, Sir Ian insists vigorously on the significance of such neglect. "The Island Empire," he declares, "offers us a mirror if we would only have the courage to look into it, where we may all see ourselves. Any people who are copied by the Japanese in any department of life may feel fairly secure of being momentarily near the top of the tree in that particular." Accordingly, if we find ourselves not copied, but, on the contrary, carefully neglected, it is a pretty sure indication that there is something amiss with our methods;

and, as we are aware, the Japanese are fully alive to the virtues of our Navy, which renders their discrimination the more valuable in its indications.

After all, it was not a soldier, not a doctor, but a statesman who declared :—"*La bonne santé d'une armée est la première condition de sa puissance.*"

APPENDIX TO CHAPTER X.

CAPTAIN GREIG, I.M.S., who was deputed by the Secretary of State for India to visit Germany at the end of 1905, in order to study the various methods employed in the campaign against Enteric Fever in that country, has furnished a valuable Report, from which the following verbatim extract has been made, regarding the *technique* now in use for the examination of materials received at the Bacteriological Institutes from suspected cases of the disease. This account may be accepted as the latest and most authoritative statement of the methods of diagnosis which have been developed by long experience in the hands of the most competent experts :—

(1) *Blood.*—The usual Widal reaction, carried out both microscopically and macroscopically. The test is made both with typhoid and paratyphoid B. bacilli. It may be observed that a positive Widal reaction is no proof that the present illness of the patient is typhoid fever, but a reaction which is at first negative, and then becomes positive, is absolute proof.

(2) *Fæces and Urine.*—The examination of these for the presence of *B. typhosus* and *paratyphosus* is all important. Unfortunately we have not yet discovered an ideal method for the detection of *B. typhosus* in fæces ; its recovery from the urine is a simpler matter. We have not got an "enriching" process similar to the peptone water for the detection of the vibrio of cholera. The newer methods, however, are a distinct advance on our older methods, and no doubt further advances will be made.

The following are the methods used :—v. Drigalski and Conradi[1]. Malachite green method of Lentz[2]. Fuchsin agar method of Endo[3]. Caffeïne-fuchsin agar method of Gaehtgens[4].

In the Institutes visited, either the Drigalski-Conradi method alone was employed or in combination with the malachite green method. The Endo method was employed in Diedenhofen, as well as the others. Each method has its advantages and disadvantages, but it is quite certain that rapidity in detecting the typhoid colonies

is largely a matter of experience and practice, and an observer who is accustomed to recognise it on one medium may fail to do so on another. The details of the mode of preparation of each of these are given.

(1) *Drigalski-Conradi.—Preparation of medium.*—(i) *Agar preparation:* To three pounds of finely cut horse-flesh add two litres of water. Allow it to stand till next day. The expressed meat juice is boiled for one hour and filtered. Add 20·0 gr. peptone sicca, Witte, 20·0 gr. nutrose, 10·0 gr. NaCl; boil one hour, now add 70 gr. bar agar, then boil three hours (or one hour in autoclave), render slightly alkaline (indicator litmus paper). Filter, boil half an hour. (ii) *Litmus solution:* Litmus solution (Kubel and Tieman) 260·0 ccm., boil for ten minutes, add milk sugar (chemically pure) 30·0 grm. Boil fifteen minutes. (iii) Add the hot litmus-milk-sugar solution to the liquid agar solution cooled to 60° C. Shake well. Render it again faintly alkaline. The colour of the froth is a good indicator. Add then 2·0 ccm. of a hot sterile solution of 10 per cent. water-free soda, further add 20 ccm. of a freshly prepared solution of 0·1 gr. crystall violet B. (Höchst) in 100·0 ccm. warm water (distilled).

One has now a meat-water peptone-nutrose agar with 13 per cent. litmus and 0·01 per mille crystall violet. This can be poured directly into plates and the remainder kept in 200 ccm. flasks.

(2) *The malachite green "enriching" method of Lentz.—Preparation of the medium.*—The proper preparation to use in malachitgrün (crystall) (Höchst) dilution 1-22,000. Preparation: Three pounds fat-free flesh (oxen), finely divided, macerated with two litres of water for sixteen hours. The extract is expressed, boiled for half an hour, filtered, then 3 per cent. agar added and boiled for three hours; add to the agar 1 per cent. peptoned 0·5 NaCl, and 1 per cent. nutrose (this may be omitted). This is brought to the litmus neutral point by soda solution with Duplitest paper. Boiled one hour, filtered through linen. The reaction of the finished agar is sometimes distinctly acid. It is filtered into small flasks of 100—200 ccm.

Before the addition of the malachite green, the hot agar is tested by Duplitest paper and so far alkalised with sterile soda solution until the red strip is distinctly red-violet. This reaction point corresponds in agar, without nutrose, to an alkalescent degree of 1·8 per cent. normal soda below the phenolphthalein-neutral point; if the agar contains nutrose, which remains neutral towards litmus and bacteria, then the alkaline reaction corresponds to 3·5 per cent. normal soda solution below the phenolphthalein point.

To 100 ccm. of the hot agar 1 ccm. of a 1-220 solution malachite green (the solution keeps good for ten days) is added, *i.e.*, agar contains 1-22,000. By this concentration of malachite green (crystall) the growth of the usual kinds of *B. coli.* as well as many alkali-forming organisms, is greatly diminished and practically prevented. The *B. typhosus* growth is also diminished, but only so far that after twenty-four hours the colony can be recognised with the naked eye, the size of a particle of sand, whilst, after a longer period in the incubator, in two to four days, larger, stronger colonies appear which colour the agar yellow.

The finished agar is poured at once into Petri dishes in 2 mm. thick layers. The dishes are well dried.

(3) *The fuchsin agar method of Endo.—Preparation of the medium.*—In an enamel pot put two litres of water (tap), 20·0 gr. Liebig's meat extract, 20 gr. peptone sicca, Witte, 10·0 NaCl, and 80 gr. bar agar. Boil, filter, neutralise. Add 10 gr. *chemically pure* milk sugar and 10 ccm. of 10 per cent. crystallised fuchsin in 96 per cent. alcohol. Then the medium becomes dark red in colour. Now add 25 ccm. of a 10 per cent. sodium sulphite solution. The medium becomes gradually discoloured, but only completely so when the agar is stiff. Sterilise in small tubes for thirty minutes. Pour into plates.

4. *The caffeïne fuchsin agar method of Gaehtgens.—Preparation of the medium.*—As a result of his experiments, he found that an addition of 0·33 per cent. chemically pure caffeïne to Endo's medium (*vide* previous preparation), which had an alkalinity equal to 1·5 per cent. normal KOH below the neutral point of phenolphthalein, markedly increased the value of the medium as a means of detecting *B. typhosus* in the stool.

Endo medium, prepared in exactly the same way as described by himself, is liquified, made alkaline to the required degree, and the required amount of caffeïne added.

In all these methods attempts are made, with more or less success, to check the growth of members of the coli group, and to encourage the development of the *B. typhosus* and *para-typhosus*. In the Drigalski and Conradi method crystall violet is used; in the Lentz method, malachite green; in the Endo, fuchsin; and Gaehtgens, caffeïne. At the same time, the typhoid colonies are differentiated from the coli group by a colour reaction. In Drigalski the typhoid colonies are blue and the coli red. In the Endo the coli colonies turn bright red, whilst the typhoid colonies are colourless. In both cases the fact that *B. coli* produces acid in presence of milk sugar is made use of by in the

one case, litmus, and the other, decolourised fuchsin, a colour reaction being thus obtained in both cases.

Malachite green checks the growth of both coli and typhoid very markedly, but more especially coli. Accordingly, when a stool is planted out on such an agar plate, it may not be possible at the end of twenty-four hours to detect any colonies of typhoid. Lentz has found, however, that if such a plate is flooded with normal salt solution and gently rocked and then allowed to stand for a few minutes, the delicate typhoid colonies diffuse themselves in the solution, whilst the solid coli colonies sink to the bottom, so that if a little of this fluid is plated out on Drigalski plates, practically a pure growth of *B. typhosus* or *para-typhosus* may be obtained. In practice, it is found that the *B. para-typhosus* is readily "enriched" in this way, but the *B. typhosus* not to the same extent.

Having thus seen the method of preparation of the different culture media and principles of their use, it is next necessary to consider the method of preparation and insemination of the plates with the fæces and urine. The following are the steps :—

(1) *The preparation of the plates.*—In this investigation it is more convenient to use a larger size of Petri dish than that generally used. It should be from 15 to 20 centimetres in diameter. About 20 to 25 cubic centimetres of the medium is poured into each plate. The plates are allowed to remain open until all the steam has evaporated and the agar is quite stiff. It is essential that the surface of the plates should be quite dry and firm. Contamination by air-organisms does not occur on account of the aniline dye present in the culture media.

(2) *The preparation of the fæces.*—The fæces are thoroughly mixed with a small quantity of sterile normal salt solution. Then, when one malachite green plate is used in combination with two Drigalski plates, about 0·5 ccm. of the mixture is placed on a green plate. This amount may also be used with the caffeine-Endo, but with the Drigalski plates alone a much smaller amount, about one or two loopfuls, is sufficient.

In the case of urine, several drops are placed on the green plates, on the Drigalski plates one drop is sufficient.

Having thus got the prepared material on the first plate, the next step is the smearing. This is done in the same way, whether green and blue, or all blue, plates are used.

(3) *Smearing of the plates.*—A sterile glass rod (spatula), bent at right angles, is used.

The material on the first plate is thoroughly smeared by rubbing the glass spatula, as it is called, in all directions over the surface of the agar. Then, without sterilising it, the same spatula is rubbed over the surface of a second plate, and then over a third and fourth. After the smearing, the plates are allowed to stand open till quite dry. The plates are then placed in the incubator at 37° C., and left there for twenty to twenty-four hours. At the end of this period the next step is—

The examination of the colonies.—It will be convenient to state briefly the characters of the colonies on the different media already mentioned.

(1) *Drigalski-Conradi.*—By this method the first plate is so overgrown, that it is useless for further examination. The second, third, and fourth, however, are carefully inspected. It is very desirable to use a hand lens for this purpose; also to direct the plate, so that the light falls from a wall, not directly from the window, as a better contrast between the colonies is obtained. After a good deal of practice, it is possible to recognise immediately a colony of *B. typhosus* on the plate even if only a single one exists, but, at first, it takes a considerable amount of time, because a large number of colonies are found which closely resemble those of *B. typhosus*, and it is, therefore, necessary to test each of them according to the methods described later. Broadly stated, the *B. coli* colonies are more or less red in colour, not transparent, and from 2—6 millimetres in diameter, whilst the *B. typhosus* colonies have a diameter of from 1—2 millimetres. The colour is blue with a dash of violet; they resemble dew drops.

(2) *Combined malachite green and Drigalski method.*—As will be remembered, the first plate in this method was malachite green agar, and the second and third Drigalski Conradi. At the end of twenty hours the second and third plates are examined, and present the same characters as noted above. If typhoid colonies are found on these plates then the investigation is finished, but if they are not, it is possible by a further procedure to detect them, and this is the special merit claimed for this method. The procedure is this: the green plate is flooded with sterile normal saline and gently rocked, and then allowed to stand for a few minutes. By this means it is found that the more delicate typhoid and para-typhoid colonies readily diffuse themselves in the liquid whilst the heavier coli colonies, whose growth has been remarkably inhibited by the malachite green, sink to the bottom. The glass spatula is then dipped in the salt solution and rubbed on one or two Drigalski-Conradi plates, which are placed in the incubator at 37° C. for

twenty hours, and are then examined in the usual manner. This method of "enriching" gives very good results with *B. paratyphosus*; the *B. typhosus* is not "enriched" to the same extent, but still it is an additional means of detecting this organism, and in the hands of Lentz has yielded good results

(3) *Endo method.*—Here all the coli colonies are bright red at the end of twenty hours, and, therefore, very easily separated. The typhoid colonies are colourless and very transparent. A stool plated on this medium gives a very striking picture, and the use of this method does not strain the eyes to the same extent as the blue plates. If a very large number of coli organisms are present the plate is liable to become entirely red, and this interferes with the examination of the typhoid colonies. On the whole, this medium appears a very useful one for the separation of *B. coli* and *typhosus*.

(4) *Gaehtgens caffeine-fuchsinn agar.* The appearance is essentially the same as that on the Endo plates, but the growth of *B. coli* is markedly inhibited.

Having thus seen the general appearance of the colonies, the next step is :—

The identification of suspected typhoid colonies.—In practice, this is done as follows :—(1) A portion of the colony is touched with a very fine platinum needle and placed in a drop of highly active serum, in dilution 1—100, on a slide and carefully mixed; at the same time a control should be made with a drop of normal saline solution placed alongside. The agglutination, if it occurs, may be observed with a hand lens or low power of the microscope. Both typhoid and para-typhoid sera are used. In this way a large number of colonies can be rapidly examined. Should complete agglutination occur, then the remainder of the colony is inoculated into tubes containing various nutrient media. From the academic point of view, a considerable number of these are required, but, in practice, it is found that about three amply meet all the necessities, of which ordinary agar slope, litmus whey, and neutral red agar, or grape sugar, are most commonly used.

The following is a complete list of the different media with the methods of preparation :—

(*a*) *Barsikow milk sugar.*—Made thus: (i) 1 gr. nutrose, 0·5 gr. NaCl, aqua distill. 100 cc. Sterilise; filter several times to clarify. (ii) 5 cc. litmus solution (Kubel and Tieman), 1 gr. milk sugar or grape sugar or mannite, maltose, etc. Sterilise six to eight minutes. Cool to 60. C. Mix (i) and (ii). Sterilise for ten minutes on three successive days. (*b*) *Mannite*, as above. (*c*)

Barsikow's grape sugar, as above. (*d*) *Litmus whey*: 500 cc. milk; add 10 to 12 ccm. N/1 solution HCl to precipitate casein. Neutralise with soda solution. Boil one to two hours. Let the precipitate fall to the bottom. Take 100 ccm. of fluid and add 5 ccm. litmus solution. Place in tubes, sterilise two to three hours at 100. C. (*e*) *Neutral roth agar*: agar 2 per cent., grape sugar 0·3 per cent., neutral roth solution 1 ccm. (saturated watery solution of Ehrlich's neutral roth). Mix; sterilise.

The following table shows the effects of growth of *B. typhosus*, *B. coli com.*, *B. para-typhosus*, A. and B., *B. dysentery* (Shiga), and *B. Gaertneri* in various media :—

—	Bouillon Gas tubes.	Mannite Bouillon.	Milk.	Barsikow's Milk Sugar.	Barsikow's Grape Sugar.	Litmus Whey.	Neutral Red Agar.
Control ...	No gas ...	Blue ...	Unaltered	Blue ...	Blue ...	Violet ...	Dark red. No gas.
B. Typhosus ...	No gas ...	Red. No gas.	Unaltered	Unaltered.	Red ...	Slightly red.	No change. No gas.
B. Coli Com....	Gas ...	Red. Gas	Coagulated	Red. Coagulated.	Red. Coagulated.	Red ...	Fluorescent Gas.
B. Paratyph. A.	Gas ...	Less gas. Red.	Unaltered	Unaltered.	Slight red. Coagulated.	Slight red.	Fluorescent Gas. Less than paratyphoid B.
B. Paratyph. B.	Gas, slight	Less gas. Red.	After some weeks becomes yellow and strongly alkaline.	Unaltered.	Slightly red. Coagulated.	After 14 days forms a blue scum.	Ditto.
B. Shiga Dysentery.	No gas ...	No gas. Blue.	Unaltered	Unaltered.	Bright red.	Unaltered.	Unaltered.
B. Gaertneri...	Gas, slight	Red. Gas	Unaltered	Slight red.	Red. Coagulated.	Unaltered.	Gas. Fluorescent.

Should the agglutination be positive in 1—100 dilution of serum, and the organism give characteristic reactions in the various media, the diagnosis of typhoid or paratyphoid, as the case may be, can then be made. Only in exceptional cases is it necessary to perform the Pfeiffer experiment.

The above is a description of the routine examinations made at the Institutes. In addition to the urine and fæces it may, occasionally, be necessary to examine expectoration from the lungs, pus, and *post-mortem* material. The procedure is exactly similar to that adopted in the examination of fæces.

To determine the presence of typhoid bacilli in the blood, it is necessary to take about 5 cc. from a vein and add to it a large quantity of sterile bouillon to neutralise the bactericidal substances present in the blood.

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