

The ages of the patients unfortunately are not recorded with sufficient frequency to allow their influence on the rapidity or otherwise of the development of the disease to be worked out with any degree of accuracy, but six out of ten children under fifteen years, twelve of sixteen adults (mostly conjugal cases) developed the disease within less than three years, against three out of 6 per cent. over thirty years of age, the tendency for early development in the young being in accordance with their greater susceptibility to leprosy.

CONCLUSIONS.

1. There are few cases on record which allow the incubation period of leprosy to be definitely fixed, but in the Cullion settlement children the disease appeared on the average two years after their separation from their leper parents, and if half the average period of their previous exposure to infection be added, the incubation period would average three and a half years and vary between five and a half months and four years.

2. The analysis of eighty-four recorded cases shows that the disease developed in within less than five years after exposure to infection in 92 per cent. of them, while in most of the few with longer periods there had been repeated opportunities for infection, so that they afford no proof of such long incubation periods; and although there are a few cases on record of long period between living in an endemic area and the development of symptoms, they are very rare and the possibility of slight unrecognised earlier symptoms is very difficult to exclude. If such doubtful cases are omitted, the average period between exposure to infection and the development of the disease was only two years and two months.

3. There is a direct relationship between the closeness of contact with the disease and the early development of symptoms, the incubation period in a few cases of direct inoculation being under two years and usually about six months; sleeping with a leper was followed by symptoms in an average of one year and eight months; living in the same house in two years and ten months; and less close association in four years and eleven months. The apparently longer incubation periods are, therefore, more likely to be later infections due to less opportunity for inoculation, and the true incubation period is comparatively short, and probably only exceptionally exceeds three years, and is usually not more than two years, or less than has hitherto been commonly supposed.

If this conclusion is correct, its practical importance in a campaign against leprosy will be evident, for it will clearly be advisable to watch closely all non-healthy contacts of any discovered leper for several years to detect the first, and most easily

curable, signs of the disease now that at last we have effective treatment for such cases. Those who have lived in the same house, and specially any who may have slept in the same bed as a leper, should be carefully examined by an experienced medical man or woman every three months for three or four years after exposure to infection for this purpose, by which means the disease will be detected and effectually treated before it has become actively infectious, and the extension of this terrible affection will be cut short at its source, and future generations spared its ravages.

THE TYPHUS GROUP OF FEVERS.

By J. W. D. MEGAW,

LIEUT.-COLONEL, I.M.S.,

Director and Professor of Tropical Medicine, Calcutta School of Tropical Medicine.

WHEN there is an epidemic of typhus fever, it is usually quite easy to diagnose the cases and to attribute the outbreak to the agency of the louse.

There have been a good many reports of outbreaks of fever which have shown the symptoms of typhus, but which have appeared under conditions in which typhus would not be expected to occur. Cases of "typhus-like fever" occurring under such conditions are often very puzzling, and this paper is an attempt to throw some light on the miscellaneous fevers of this group.

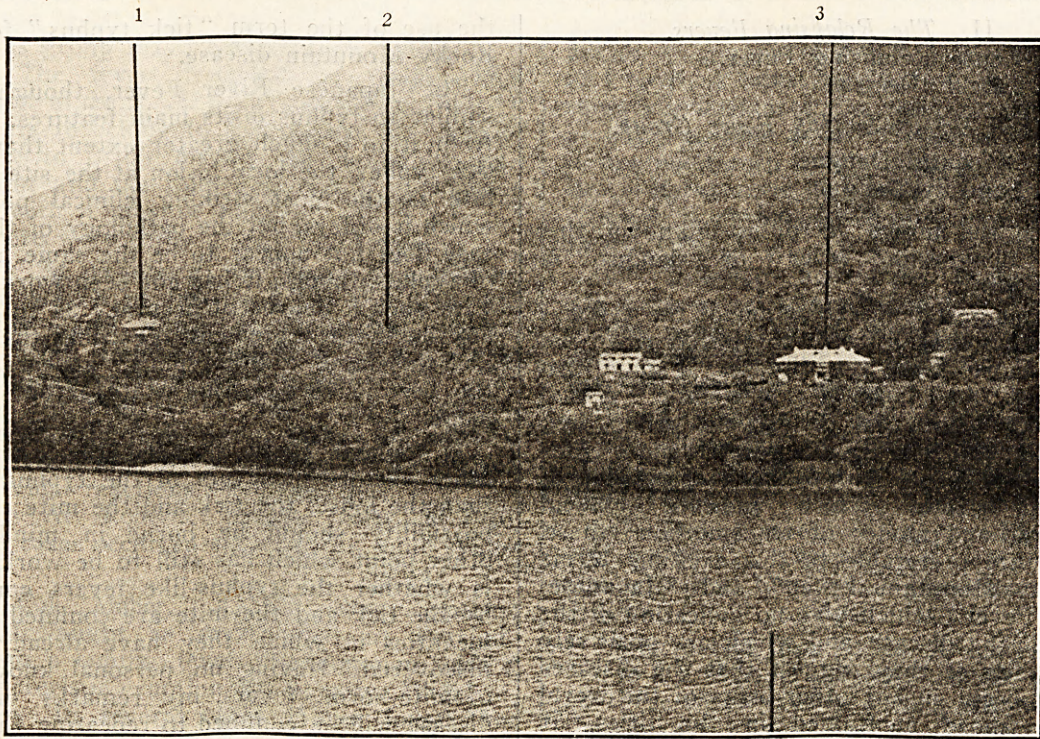
In articles in the *Indian Medical Gazette* in January 1917 (1) and October 1921 (2) I brought forward evidence which suggested that typhus-like fevers, such as those described by McKechnie in the Kumaon Hills, by McNaught in South Africa, by Wynne, Davis and Johnson in Nigeria and by other writers in various parts of the world may be examples of tick-borne typhus fever. I also suggested that it would be better to adopt a classification of the fevers of the typhus group which would indicate their affinities with typhus and would designate the arthropod which is responsible for carrying them to man.

The provisional classification which was suggested by me for the fevers of the typhus group is shown in the table. In this has also been included a classification on the same lines which I have suggested for relapsing fever and the dengue-sandfly fever group.

I. *Typhus Group of Fevers.*

- (a) Louse Typhus (Typhus).
- (b) Tick Typhus (Rocky Mountain Fever).
- (c) Mite Typhus (Japanese River Fever).

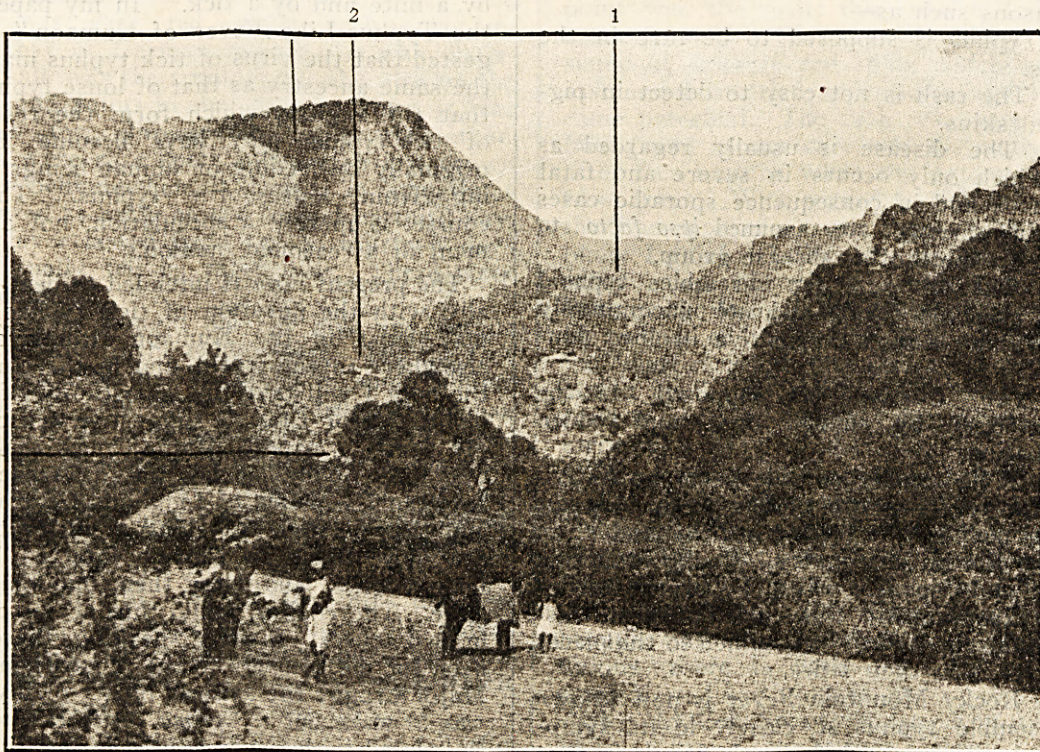
When the insect vector is unknown the term "typhus-like fever" will be employed.



BHIM TAL.

View of Western side of Lake.

1. Col. McKechnie's house. 2. Dense Jungle. 3. Hotel.



SAT TAL.

1. Upper houses. 2. Lower houses (Miss M. lived in the one indicated). 3. Position of Lake.

II. *The Relapsing Fevers.*

- (a) Louse Relapsing Fever.
- (b) Sandfly Dengue.

III. *Dengue-Sandfly Fever Group.*

- (a) Mosquito Dengue.
- (b) Sand-fly Dengue.

When the insect vector is unknown the term "dengue-like fever" or "dengue" is appropriate.

The suggested classification of the typhus-like fevers may have to be altered when we know more about the diseases, it may turn out that the Japanese mite-borne disease does not belong to the typhus group, but until the evidence on this point is more complete there is no objection to employing provisional names which indicate clinical affinities and modes of transmission: these names are preferable to the existing terms "Rocky Mountain Fever" and "Japanese River Fever" which give no indication of the type of the disease and which are positively misleading as they suggest that the diseases cannot occur in any other parts of the world besides those mentioned in the titles. It would be absurd for example to refer to a fever of India as "Rocky Mountain Fever." The table on p. 78 shows some of the most striking features of the fevers of the typhus group to which reference is made in this paper.

Fevers of the typhus group have been wrongly diagnosed in the past for a variety of reasons such as—

I. Typhus is supposed to be rare in the tropics.

II. The rash is not easy to detect in pigmented skins.

III. The disease is usually regarded as one which only occurs in severe and fatal epidemics and in consequence sporadic cases of slight severity are assumed *ipso facto* to belong to some other disease group.

IV. The disease often resembles typhoid or paratyphoid fever, and not uncommonly the Widal reaction is positive in low dilutions.

V. The disease is supposed to be characterised by sudden onset and sudden termination.

VI. It is usually considered to be impossible for fevers of the typhus group to occur among people who lead a healthy and clean outdoor life in the country. Rocky Mountain Fever, and Japanese River Fever are recognised exceptions to this rule, but these diseases are supposed to be confined to the places referred to in their titles.

The Rocky Mountain Fever is now known to resemble typhus so closely in its symptomatology and pathology that it is almost impossible to distinguish between the two diseases except on epidemiological grounds, for this reason there can be no objection to

the use of the term "tick typhus" for the Rocky Mountain disease.

The Japanese River Fever, though very similar to typhus in its main features, differs from it to a much greater extent than does tick typhus, the local lesion at the site of the bite is the most striking clinical point in which it differs, but the pathology of the disease does not appear to be the same as that of typhus, though it has not been worked out with such a degree of accuracy as to justify any dogmatic statement regarding the point, and the name "mite typhus" appears to be the best in the existing state of our knowledge.

It remains to be seen whether there are other vectors of fevers of the typhus group than the louse, the tick and the mite; such a possibility should be borne in mind. Another point which has still to be worked out is whether the typhus-like fevers conveyed by the tick and the mite are confined to the localities in which they have already been discovered. Having no personal knowledge of mite-borne fevers, my remarks on that disease will be confined to repeating the suggestion already made by others as well as by myself that Schueffner's pseudo-typhus of Sumatra, Mossman Fever, and the Adelaide Fever described by Hone may possibly be examples of mite typhus. Schueffner makes the interesting suggestion that the Sumatra Fever may be carried both by a mite and by a tick. In my paper "On the Typhus-Like Fever of Kumaon" I suggested that the virus of tick typhus may have the same ancestry as that of louse typhus and that the animals which form the reservoirs of tick typhus may have become infected originally by feeding on human beings suffering from louse-borne typhus. This, of course, is merely a speculation, not a statement of a reasoned opinion.

The present note is intended to deal especially with the question of tick typhus which may exist in the Kumaon Himalayas and elsewhere in the world, and in the course of the note I will take the opportunity of replying to Major Cragg's suggestive criticism of my previous paper. Major Cragg (3) points out that Bhim Tal lies on the trade route between the plains of India and Central Asia, and that persons travelling along that route are quite likely to become infected by lice from coolies who carry them and their luggage. The coolies would thus act as carriers in two senses. Strictly speaking, there is no need for me to reply to the remarks made by Major Cragg: the avowed object of my paper was to make out a "*prima facie* case against the tick" with a view to ensuring that the possible role of the tick should not continue to be ignored in connection with the Kumaon fever and other similar fevers.

Some fevers which may belong to the tick typhus group may be referred to briefly.

I. The fever described by Major McNaught in the *R. A. M. C. Journal* in 1911(4) appears to belong to this group, its resemblance to Brill's disease was noted by McNaught and the following points in connection with it may be noted.

There were three groups of cases—

(a) At Wynberg; the onset was sudden, there was a profuse rash on the fifth day leaving stains which lasted several weeks. The fever lasted from two to three weeks, the Widal reactions were negative.

(b) At Pretoria in 1909 there were ten cases, mostly from one company of soldiers, the fever lasted from one to two weeks and the Widal reactions were negative.

(c) At Roberts' Heights early in 1910, some cases occurred showing the same symptoms.

Lt.-Col. Maher, R.A.M.C., was reported by McNaught as saying that at Potchefstroom a similar fever was common with a characteristic eruption and negative Widal reaction. In several cases Maher found that patients had been bitten by ticks two or three days before the onset, and he suggested that the ticks may have conveyed the infection.

The description of the fever leaves no room for doubt as to its belonging to the typhus group. The onset was sudden with severe headache, pains in the back and limbs, injected conjunctivæ and suffused eyes. The rash was dark red, maculo-papular, not unlike that of German measles, it was distributed all over the trunk and limbs, also on the soles and palms in the cases in which it was looked for. Interspersed with the other spots were rose spots. The rash left brown stains behind when it faded, it sometimes appeared as early as the second or third day. The fever lasted from ten to fourteen days and usually fell by rapid lysis. There were no deaths.

Major McNaught did not give any details with regard to the epidemiology, but the fact that tick bites had occurred in some similar cases and were suspected of being the cause of the fever, and that the groups of cases occurred in widely separated areas suggests that the victims were exposed to bites by insects in the open country. The incubation period of two or three days suggested by Col. Maher is too short for a typhus fever, but the interval between the bites and the onset may not have been accurately noted, also it is possible that earlier bites by ticks may have occurred as well as those which were referred to.

II. The Nigerian Fever recorded by Wynne, Davies and Johnson as "anomalous dengue" (5) obviously belongs to the same group of fevers. The cases occurred in widely

separated places, there was no evidence of person to person infection, cattle farming is an important industry in the locality and under these circumstances tick infection appears to be quite possible as an explanation, though it is not mentioned by the authors. The similarity of the fever to that seen in Bhim Tal, Kumaon is obvious from the curves shown in Chart II (p. 73).

III. Mossman Fever and Adelaide Fever are much more suggestive of tick or mite infection than of louse infection. Schueffner also mentions ticks as possible vectors of the Deli Fever in Sumatra.

IV. The following cases were reported to me in personal communications after the appearance of my paper on Kumaon typhus-like fever.

(a) Three cases of typhus-like fever reported by Col. Chapman, I.M.S., from Nagpur in Central India. Col. Chapman wrote as follows:—

"I have had three cases of spotted fever, one in a European, the other two in Bengalis, all three cases exactly correspond with your description in the *Indian Medical Gazette*. One case gave a positive Widal, very slight about the 12th day, the others were negative, there were no changes in the blood counts.

"In none of the cases was the patient really seriously ill. There was nothing approaching a typhoid condition and there were no abdominal symptoms, the most remarkable point was the rash; this was profuse, most marked on the lower extremities. It consisted of discrete red spots which gradually assumed a mottled appearance and then became petechial. The rash was very slow in fading and in one case was distinctly visible after two months when the patient returned from leave. With regard to tick infection, in the European case such a possibility is unlikely I think. I am not so sure about the other cases but there is no history of it. Both of the Bengali patients were out in huts on account of plague and both used to lie on the same *charpoy*, they contracted the disease almost on the same date. This would I think, point to lice or bugs as the more probable carriers."

These cases, undoubtedly, belong to the typhus group, they show that a typhus-like fever occurs in Nagpur, but apart from the curious fact that two of the fevers were contracted when the patients were living in plague huts in which they were probably brought into close contact with jungle conditions there is little evidence as to the carrier.

(b) Lt.-Col. Sprawson, F.R.C.P., I.M.S. wrote to me from recollection about a case which he saw in Hyderabad shortly after seeing me while I was suffering from an attack of the typhus-like fever. "The patient was

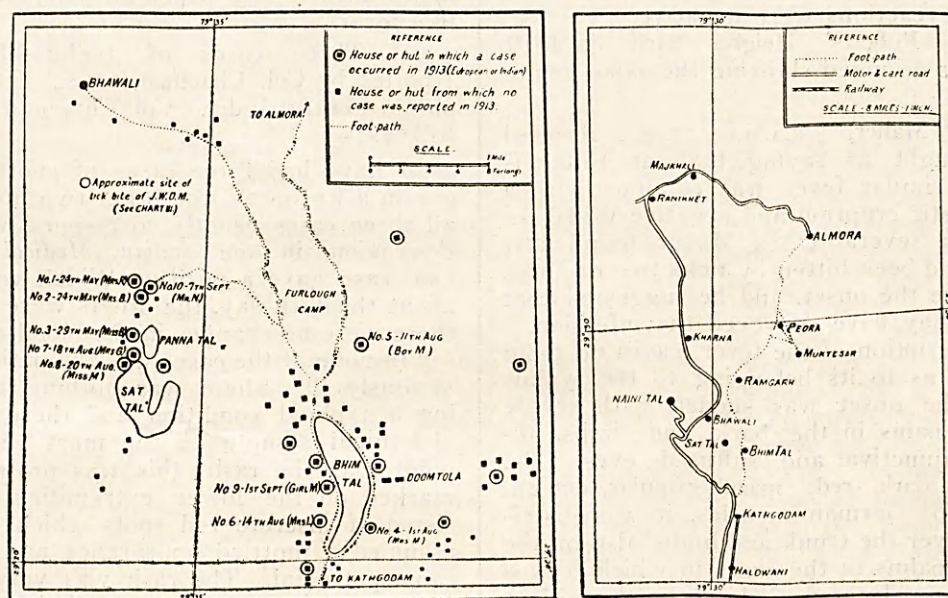
Mrs. G. I only saw her once, I asked her husband whether she had been bitten by a tick recently, because her rash was so like yours. He said she had removed from herself a tick presumed to have come from her dog between a fortnight and a month previously. At least I think that is the period so far as my memory goes. As I compare her rash and yours, with what I saw in Mesopotamia, I see many differences. My experience with typhus may not be the usual one, I saw less than a dozen cases in Europeans, but many in Persians, Turks and Indians. In

Mrs. G. is the wife of a high European official, and louse infection was very unlikely. Major Brodribb, I.M.S., told Col. Sprawson that he had seen a similar case in a General in the same locality three years previously.

(c) Lt.-Col. Hardy, R.A.M.C., who had previous experience of the typhus-like fever of South Africa, saw a similar case in a European soldier in Cawnpore in 1912, but unfortunately it was not possible to obtain any information as to the conditions under which the disease was contracted after so long a period of time had elapsed. The man

CHART I.

European cases of Typhus-like Fever Reported by Major McKechnie in 1913.



Data—Total number of cases in Europeans ..	..	..	..	10
in Indians ..	..	..	..	20
Total number of cases ..	..	..	..	30

In 13 houses there was only one case in each ..	..	..	..	13
In 4 houses there were two cases in each ..	..	..	..	8
In 1 house there were three cases ..	..	..	..	3
In 1 house there were six cases ..	..	..	..	6
In 19 houses ..	..	..	..	30
Cases	..	..	..	30

these the rash was not so prominent and often was confined to the flanks of the chest only, with perhaps some spots on the inner surfaces of the upper arm. The rash in Mrs. G.'s case was distributed all over the body and was much brighter and pinker. I remember several spots on her legs and some on your wrists which I should not expect to see in typhus. Then the skin was cleaner, i.e., no mottling as one would expect to see with that extent of rash in typhus.

"It was in September when I saw Mrs. G., the typhus in Mesopotamia was a cold weather disease."

might even have come recently from some other station.

(d) Dr. Mitra of Howrah, in a lecture at the Calcutta School of Tropical Medicine, described several isolated cases of typhus-like fever which he met with in his practice, which may possibly have belonged to this group.

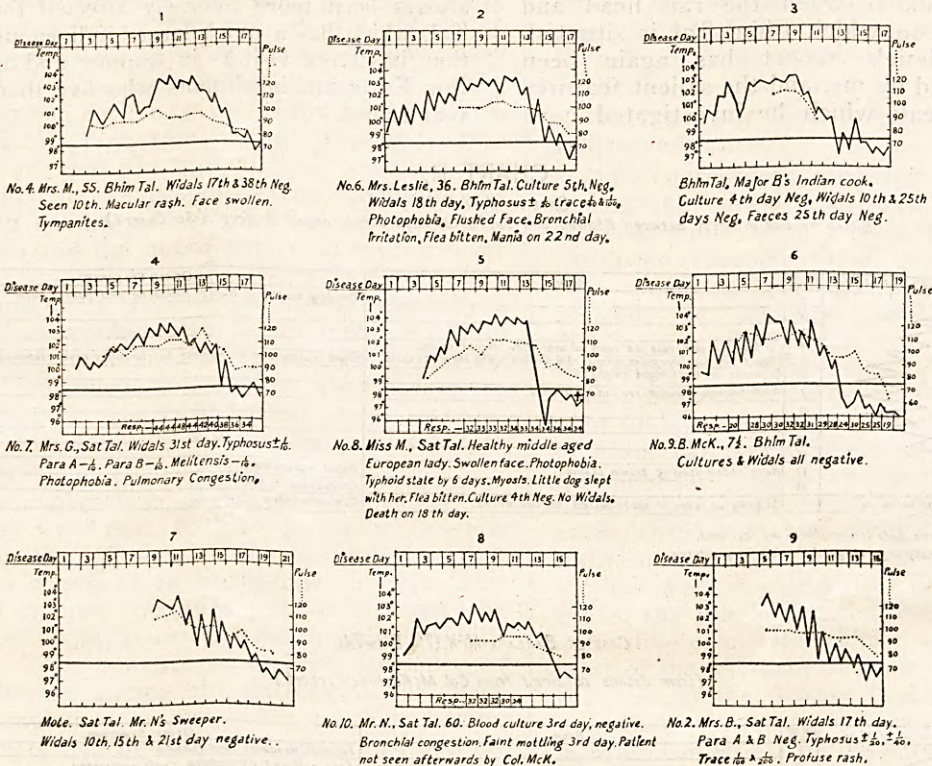
(e) My own personal experience of an attack of typhus-like fever from which I suffered after being bitten by a tick in the jungle near Sat Tal is of special interest, and the conditions under which it occurred may

again be summarised briefly (see Charts I and III).

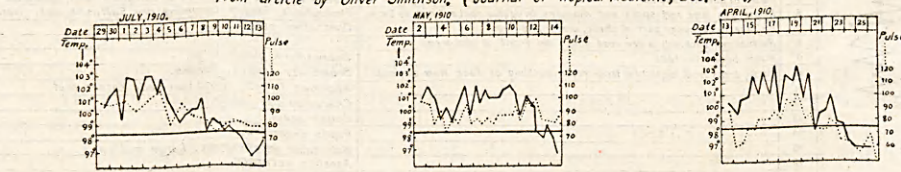
I was bitten by a tick which must have attacked me while sitting in the jungle about half way between Bhawali and Sat Tal on the 30th of June, 1916. The tick was not detected till 12 hours later, but there was no other

College, Lucknow. The course of the disease is shown in Chart III. The long incubation period is well within the limits of experimental typhus, and the chances of the infection being acquired elsewhere than in the notoriously infective area of Sat Tal are exceedingly remote. There was no contact

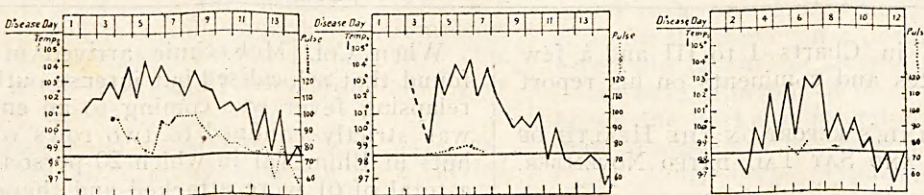
CHART II.
BHIM TAL FEVER (From Lt. Col. McKechnie's report.)



MOSSMAN FEVER.
From article by Oliver Smithson, (Journal of Tropical Medicine, Dec. 1910.)



TWELVE DAY FEVER OF NIGERIA — WYNNE DAVIES AND JOHNSON.
(Journal of Tropical Medicine and Hygiene — July 15, 1921.)



known exposure to conditions in which tick bite was likely. Unfortunately the tick was not preserved or identified as the possibility of disease being conveyed to man by ticks in India did not occur to me at the time. The incubation period was 21 days; of this period one day was spent in motoring to Lucknow and the rest in my house at the Medical

with coolies or other people living in Sat Tal, and my nearest approach to Sat Tal was when I sat in the grass of the jungle about a mile and a half from that place.

The odds in favour of the infection being contracted from the tick which bit me then appear to me to be many thousands to one.

After this experience my attention was directed to the possibility of the occurrence of a tick-borne typhus in the Kumaon Hills, and I managed to secure a copy of Col. McKechnie's valuable unpublished report on the typhus-like fevers of Bhim Tal to which I have already referred in my previous articles.

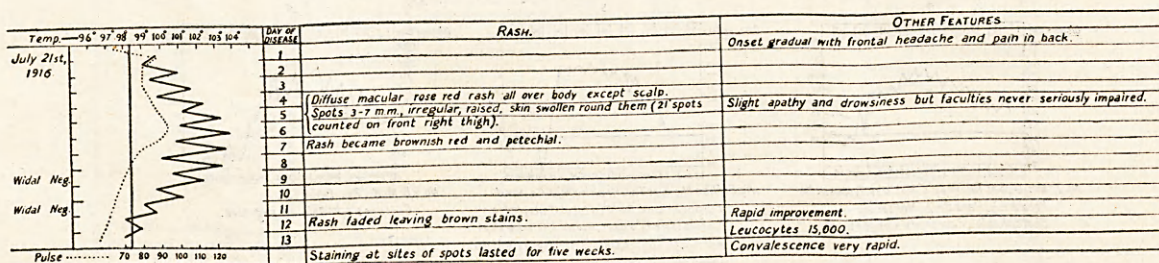
In view of the suggestion by Major Cragg that louse-borne typhus is quite likely to be endemic in the Kumaon Hills, especially along the trade track between the rail head and Central Asia on which Bhim Tal is situated. Col. McKechnie's report has again been closely studied by me, and the salient features of the outbreak which he investigated have

Kumaon Himalayas. The notorious prevalence of severe fevers in places which appeared to be especially intended by nature as ideal health resorts, led the Government of the United Provinces to depute Col. McKechnie to investigate the nature and cause of the fevers. Sat Tal, which is about two miles off the beaten track and which has hardly any permanent population excepting a very small number of Indians living in isolated huts, had always been more intensely affected than Bhim Tal, which has a much larger indigenous population, has more visitors in summer and also has a few European inhabitants who live there all the year round.

CHART III.

CASE OF J. W. D. M.

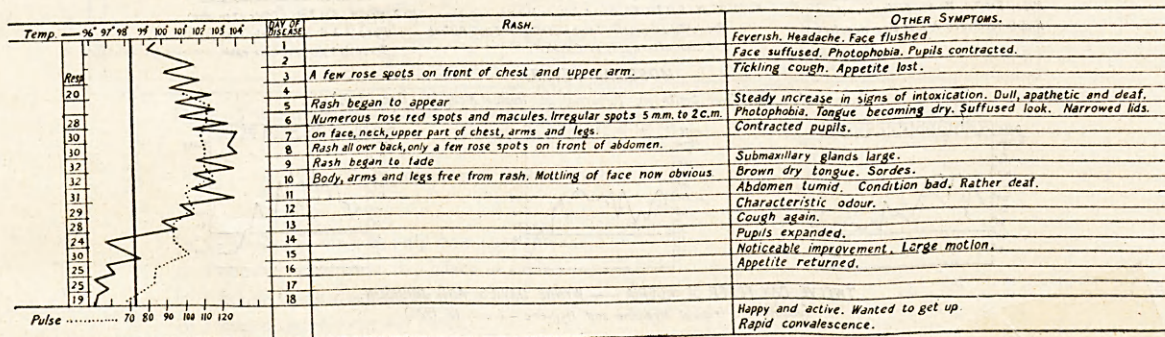
Bitten by tick in forest between Bhawali and Sat Tal 20 days before onset of fever. (See CHART I.)



Note that the extreme daily temperatures are recorded.
Hence the exceptionally large range of the daily temperatures.

CASE OF BARBARA MCK. (7½) BHIM TAL.

(From details obtained from Col. McKechnie's report.)



been collated in Charts I to III and a few additional notes and comments on his report are added.

COL. MCKECHNIE'S REPORT ON THE HEALTH OF BHIM TAL AND SAT TAL, DATED NOVEMBER, 1913.

This deals with an investigation of cases of typhus-like fever studied by Col. McKechnie from July to October, 1913.

A fever which had been regarded as typhoid or paratyphoid had been prevalent year after year among European visitors to Bhim Tal and Sat Tal, which are small pleasant summer resorts situated by the sides of lakes at a height of about 4,500 feet in the

When Col. McKechnie arrived in July he found that a localised but intense outbreak of relapsing fever was coming to an end. This was strictly confined to two rows of Indian huts in Bhim Tal in which 20 persons out of a total of 61 were attacked and there were 6 deaths. The origin of the outbreak was traced to an old woman who had contracted the infection in the plains about 12 miles away; the epidemic lasted about two months and then died out, when it had exhausted the available material in the rows of huts. The huts affected are marked "Doom Tola" in the map. This outbreak showed clearly the possibility of the occurrence of louse-borne

disease in the locality, but on the other hand it was a striking example of the usual behaviour of a louse-borne epidemic when introduced among a susceptible population. There was no spread beyond the immediate focus either to the European or Indian population in spite of the large number of people who were affected. In this connection reference may be made to the interesting outbreak of typhus fever reported by Major Phipson, I.M.S., in the January 1924 number of the *Indian Medical Gazette*. All the cases occurred in members of the same family group who were living in close association with each other. During the earlier period of his investigations Col. McKechnie was strongly predisposed to the view that the special fever of the place belonged to the typhoid group, owing to his finding conditions suitable for the spread of typhoid and the improbability of typhus fever occurring in Europeans living in cottages in the jungle. His view was strengthened by a mistaken reading of a Widal report early in the investigation, but towards the end he was compelled to regard the disease as typhus. The charts and descriptions leave no room for doubt as to his being justified in this opinion.

His explanation of the prevalence of the disease was that it was probably endemic among the hill men of the locality, and that it was conveyed to Europeans through their down country servants who contracted the disease from association with infected hillmen. The absence of striking evidence of the disease among the natives of the place was explained as being due to their having contracted it in childhood and thus become immune. Fleas which are plentiful were especially suspected as vectors, bugs and mosquitoes are also mentioned. Lice are referred to in the discussion, but Col. McKechnie does not state that he found any evidence of their existence among the affected persons, though his reference to the work of Nicolle on the experimental transmission of typhus by lice shows that he was familiar with the fact that the louse is of importance in connection with the disease. Ticks are not referred to at all, though the significant statement is made "For all I know *Jhar* (the fever in question) and Rocky Mountain Fever may be the same."

Typhoid and paratyphoid fever were excluded by blood cultures, which were carried out under conditions which would have made the finding of the typhoid bacillus almost absolutely certain if it had been present. The Widal reactions gave findings strongly opposed to the cases being typhoid, but there were a few feeble reactions such as usually occur in typhus outbreaks.

Chart I shows the dates and places of occurrence of the cases of typhus-like fever

in Europeans recorded by Col. McKechnie during the hot and rainy season of 1913. The cases in Indians are not included as they were less closely observed. Temperature curves of several of the European cases are shown in Chart II, also curves of cases of Mossman Fever and Nigerian typhus-like fever. In Chart III are shown some details of one case recorded by Col. McKechnie and of my own case to which reference has already been made. The surroundings of some of the cottages in which cases occurred are shown in the photographs which are taken from Col. McKechnie's report.

The important facts in connection with the Indian cases are—

(1) There were probably about 20 cases during the period dealt with in the report, most of these were among the servants of European visitors, these cases occurred in the servants' quarters of the European residents for the most part, they showed a distribution of the same type as that seen in the European cases.

(2) Seven cases were seen among permanent Indian residents of the neighbourhood of Bhim Tal, four of these patients were little girls and all of them were isolated cases with no observed relationship in time or place to each other or to any other known case. In most or all of these it was likely that the victims were brought into contact with the life of the jungle (herding cattle, etc.). It is quite likely, as McKechnie points out, that most of the villagers of Bhim Tal and Sat Tal suffer from the disease in childhood, in this way their apparent immunity to the disease in after life would be explained.

(3) The five cases occurring among Col. McKechnie's servants within about a month constitute the only approach to an epidemic that was observed. Unless it is assumed that the servants were brought into exceptionally close contact with a jungle infection, these cases would strongly suggest louse infection, but as two of the victims were *saises* (grooms) and two were sweepers it is quite likely that they may have been very much exposed to a "place infection," and the conditions for the conveyance of this may have been especially favourable at the time.

The case in favour of the disease as a whole being one of louse infection, conveyed from man to man, may be stated as follows:—

(1) Louse-borne typhus is *prima facie* likely to occur as an endemic disease in a population living in the Himalayas under the conditions of dirt and crowding which undoubtedly exist. The disease is known to occur in the hill men of Simla and other places in the Himalayas where the conditions of life are very similar to those of Bhim Tal, but on the other hand it has never been reported to have been communicated to the

European population of Simla or any other part of India. The freedom of Europeans from relapsing fever is also a striking circumstance.

(2) Some of the European victims appear to have lived in exceptionally close association with their Indian servants from whom they might have contracted the infection. The plains servants might have contracted the infection from association with the people of the endemic area, and some cases in which the infection could readily have been explained on this hypothesis are recorded by Col. McKechnie.

(3) It is suggested that in Bhim Tal and Sat Tal the European residents were often compelled to employ hill men as servants, owing to the reluctance of the plains servants to stay in places which are notoriously unhealthy.

(4) The sharp epidemic in Col. McKechnie's household in which six persons (five Indians and one European) out of a small establishment were affected is the one outstanding example which is in favour of infection by close personal contact. The occurrence of six cases within a short space of time is very suggestive of the spread of infection by personal contact. If this example stood alone it would be almost unnecessary to suggest any other hypothesis, but we must remember that altogether there were 13 houses or huts in Bhim Tal and Sat Tal in each of which only one case occurred although there were several inhabitants in each dwelling.

Is it possible that lice contracted the infection from a patient who was suffering from a tick-borne infection and then conveyed the infection to these five persons? Such an occurrence would be almost unprecedented in connection with typhus or other insect-borne disease, but on the other hand it is not by any means an incredible supposition. Schueffner is reported as thinking that both ticks and mites are concerned in the spread of the Sumatra typhus-like fever, and the possibility of one virus being conveyed by two or more insects has not yet received sufficient consideration. It is usually assumed that when one vector is found the whole problem is solved and no other vector is looked for. I have already raised this question in connection with the dengue group of fevers, but must leave the suggestion as a surmise in favour of which I cannot offer any positive evidence.

On the other hand it is quite possible that the infected ticks near Col. McKechnie's house may have been particularly active at the period when his household became infected, and the victims, including his own daughter, were certainly exposed to the bite of ticks to an exceptional degree. The house

stands amid dense jungle which comes close up to its doors (see photograph A).

(5) The fact emphasised by Major Cragg that Bhim Tal and Sat Tal are situated on the main trade route to Central Asia, and that in consequence the baggage carriers and dandy bearers employed by the visitors are likely to be infected and to convey their infection by means of lice is in favour of louse infection. This point will be dealt with in the next section.

(6) There is no authentic previous record of a tick-borne typhus-like fever having occurred in India.

Altogether it is possible to make out a plausible case in favour of the view that lice are probable transmitters. The points which are in favour of transmission by the tick or other biting arthropod from a local animal reservoir are—

(1) The pronounced tendency of the disease to attack single individuals in each dwelling, even when there were a good many inhabitants in each. The disease as a whole does not behave in the manner which our experience of louse-borne typhus would lead us to expect. When the incidence of the disease was exceptionally heavy, as it was for part of the time during which Col. McKechnie was making his enquiry, a large proportion of the inhabitants being affected within a short period, person to person infection would appear at first sight to be a likely explanation, but taking the disease as a whole and considering that, during 1912 and 1913 "in every one of the eight cottages of Sat Tal which were let to visitors, one or more cases occurred" as dropping cases, it can safely be stated that nothing like this has ever been recorded in connection with a louse-borne disease in India. So far as the evidence goes, it appears that during these years the chances of becoming infected were very great in the case of every European who occupied one of these cottages, even if it had remained unoccupied for a considerable time previously; it must be remembered that all the cottages were empty during the winter. This evidence is far more in favour of a place infection than of a person to person infection.

(2) The singular persistence of the disease confined to one small area over a period of several years is against louse transmission. It appears that dropping cases of the fever occurred among European visitors without any discoverable tendency to spread from one person to another. The similarity of the disease to tick relapsing fever in this respect as contrasted with "louse relapsing fever" is very striking.

(3) Col. McKechnie was well aware of the importance of lice in transmitting typhus fever, but he does not mention having found

lice on any of the patients, though he mentions fleas as being abundant, and he also refers specifically to bugs and mosquitoes as possible vectors. He refers casually to lice among other insects in his general instructions for the prevention of the disease, but does not mention them in his discussion of the possible insect carriers.

(4) The liability to contract infection appears to have been directly in proportion to the degree in which the residents were compelled to live in association with the life of the jungle. Sat Tal and the heavily wooded part of Bhim Tal were affected far more severely than the cleared and open parts of Bhim Tal. The cottages in the affected parts are situated in the heart of the forest, so that the occupiers to all intents and purposes live in the jungle; when they go out they have to walk in narrow forest paths, if they sit down to rest or to fish in the lake they have to do so in the grass and undergrowth of the forest and so are exceptionally exposed to bites by ticks, etc.

(5) The freedom of other hill stations in the Kumaon Hills, such as Naini Tal, Almora and Ranikhet is hard to account for on the louse-borne hypothesis. In these large stations the visitors are far more numerous than in Bhim Tal and Sat Tal, they are also brought constantly into close association with the hill men who act as dandy bearers, baggage coolies, wood and water carriers, etc. Taking the other hill stations and the isolated European residents on fruit farms and cottages in Kumaon in the aggregate, the points of contact between the European population and the dirty hill men are infinitely more numerous than is the case in the affected places. Taking the point emphasised by Major Cragg, that lice are likely to be transferred from dandy and baggage coolies to European visitors, it is well known that visitors and their baggage are carried to Almora and other hill stations by the same coolies who serve the visitors to Bhim Tal, and as the latter place is only one stage from the rail head while Almora is four stages, it is clear that the people who travel to Bhim Tal are relatively little exposed to this possible means of infection. Almora also is on the trade route to Central Asia, so that Bhim Tal is not more likely to be supplied with infection by traders.

Having spent about eight months in the Kumaon Hills at various times and having done at least a hundred daily marches with my wife who was carried by casual hill coolies, and having been served for the most part by hill servants during our stay in the hills, it has been a matter of surprise to me that we have never once found that lice have been conveyed to our bedding or clothing from the coolies.

The experience of all the residents and visitors to the hills with whom I have discussed this matter shows that the transfer of lice from coolies is an extremely rare occurrence though its possibility must be admitted. That all the 10 affected Europeans in 1913 should have been attacked by infected lice is exceedingly improbable.

(6) The persistence of the place infection in Bhim Tal and Sat Tal is more in keeping with the tick-borne view than with the louse-borne. Both places are situated on the wooded sides of lakes at a height of 4,500 feet, whereas the only other important hill station which is situated by the side of a lake (Naini Tal) is at a height of 6,500 feet and is much more highly developed than Bhim Tal and Sat Tal. The site of Naini Tal is cleared, it has wide roads and cattle do not roam about in the woods close to the houses to any great extent.

There are thus several factors any one of which may account for the special persistence of the disease in Bhim Tal and Sat Tal. Altitude may influence the fauna of the place, as well as the development of the virus in the animal reservoir and in the vector, and it appears to be possible that the combination of forest and lake at a certain altitude, together with intimate association of the visitors with the life of the jungle may be the combination of circumstances to which Bhim Tal and Sat Tal owe their unenviable monopoly of the typhus-like fever of the Kumaon Hills. The general appearance of the cottages in which cases of the disease occurred is shown in the photographs.

(7) The seasonal distribution of the disease is much more in keeping with the tick-borne view than with the louse-borne view.

(8) My own personal experience of the disease, following on the bite by a tick in the forest near the Sat Tal, naturally made a great impression on my mind, especially as it was followed up so soon by the report from Col. Sprawson who encountered a similar case in South India in which a tick was a possible vector.

(9) The other recorded outbreaks in South Africa, Nigeria and Australia are all suggestive of infection conveyed by ticks or other biting arthropods from an animal reservoir, and there is certainly enough evidence to justify a strong suspicion that a tick-borne typhus fever may not be confined to the Rocky Mountains of America, but may have a very wide distribution.

(10) There is no record of any medical man or sick attendant having contracted the disease from a patient in Bhim Tal or Sat Tal though no precautions against lice were taken.

The question of the probability of being bitten by ticks in the affected locality is one

TABLE I.

	FEVERS OF TYPHUS GROUP WHOSE VECTORS ARE KNOWN.			SOME TYPHUS-LIKE FEVERS WHOSE VECTORS ARE DOUBTFUL OR UNKNOWN.					
	Louse typhus.	Tick typhus.	Mite typhus.	Kumaon typhus-like fever.	South African typhus-like fever.	Nigerian typhus-like fever.	Mossman typhus-like fever.	Adelaide typhus-like fever.	Typhus-like fever of Sumatra.
Synonyms ..	Typhus exanthematicus.	Spotted fever of the Rocky Mountains.	Japanese River fever or tsutsugamushi disease.		(Anomalous paratyphoid),	(Twelve-day fever of dengue group.)	(Mossman fever) Oliver		(Pseudo Typhus)
Source of information ..	....	....	....	Megaw, I.M.G., Oct. 1921.	McNaught, R. A. M. C. Journal, 1911.	Wynne, Davies and Johnson, Journ. Trop. Med. and Hyg., 1921.	Smithson, Journ. Trop. Med. and Hyg., Dec. 1910 and private communication.	Hone, Med. Journ. Australia, Jan. 1922 and April 1923.	Schueffner, Trop. Dis. Bull., 1915.
Distribution ..	Wide. Less common in tropics.	Rocky Mountains, U. S. A.	North Japan and Formosa.	Bhim Tal and Sat Tal in Himalayas.	Wynberg, Pretoria, etc.	North Nigeria	N. Queensland. Mossman district.	Adelaide.	Deli in Sumatra.
Epidemiology and ætiology ..	Epidemics associated with crowding and dirt.	Local outbreaks in spring months in dwellers in the open country and forests.	Flooded areas. Local outbreaks in summer.	Cottages in jungle by side of lakes at height of 4,500 feet.	In British troops in camp.	July to Oct. Rainy season. Scattered cases in agricultural area.	Scrub and cane cutters chiefly affected. Strictly local. Women rarely affected.	Workers in wheat flour often affected. Not epidemic.	June to Aug. and Nov. to Jan.
Virus ..	Probably <i>Rickettsia prowazeki</i> .	Probably a rickettsia body.	Organism Unknown.	Unknown.	Unknown.	Unknown.	Unknown. Blood sterile.	Unknown.	Unknown.
Vector ..	Louse.	<i>Dermacentor venustus</i> .	Larva of Mite, <i>Trombicula akamushi</i> .	Possibly tick.	Possibly tick.	Unknown.	? Some insect in sugarcane, or scrub.	Strong suggests a mite found in corn.	Possibly tick or mite.
Animal reservoir ..	Man.	Rodents and possibly domestic animals	Rodents of the country. (Vole and rats.)	Possibly jungle rodents.	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Duration of fever	10-16 days.	Usually longer than typhus.	10-15 days; may be 3 weeks.	12-16 days.	10-14 days.	10-13 days	10-21 days.	About 14 days.	
Day of appearance of rash ..	4th to 5th day.	3rd to 5th day.	Appears during first few days, most profuse after 7 days.	4th to 5th day.	Sometimes on 2nd or 3rd day.	4th to 6th day.	?	4th to 7th day.	2nd or 3rd day.
Characters of rash	Typhus rash. Trunk, arms and legs. First on trunk. Staining often persists.	First on wrists, ankles and back; last on abdomen typhus-like. Persistent staining.	Typhus-like.	Like typhus, appears early on extremities. Staining persists.	Like typhus, profuse all over body including palms and soles. Staining lasted several weeks.	Profuse rubecular all over body including hands and feet. Visible though faded for several weeks.	Macular or roseolar in cases of long duration. In 60% of cases.	Typhus like.	Roseola all over body especially on trunk. Sometimes hæmorrhagic.
Other features ..	....	Slightly marked icterus. Spleen enlarged.	Spleen enlarged. Local sore at site of bite by mite. Leucopenia.	....	"Not contagious."	"Evidence of direct contagion slight." Albuminuria.	Femoral and axillary glands enlarged.	Positive Weil Felix in most cases. "But little infectious."	Necrosis at site of bite. Lymphangitis and lymphadenitis.
Mortality ..	Very variable 3-6%	Very variable 5-75%	15-50%	About 3-6%	Nil.	Nil.	Under 5%	About 5%	3%

of some importance. Apart from my experience of being bitten by a tick during a stay of about two hours in the Sat Tal jungle and having subsequently suffered from typhus-like fever, I have had a further experience of interest.

In July 1923 I spent a night in the hotel at Bhim Tal, and after dark I sat for about half an hour by the roadside close to the hotel. On returning to my room I found that a tick had begun to fasten itself on my leg. This tick was preserved and was identified by the kindness of Dr. Strickland, Professor of Entomology at the Calcutta School of Tropical Medicine as *Rhipicephalus sanguineus* (fem.), identified by Mr. C. Warburton of Cambridge.* One swallow does not make a summer, but from enquiries made in Bhim Tal from the local doctor I find that it is very common for people who walk in the woods to be bitten by ticks; this doctor has seen one case of the typhus-like fever in a relative of his own who had been bitten by a tick about ten days previously. Doubtless the tick has been overlooked in the past because it is not supposed to be a disease carrier in India, but all the evidence which is available goes to show that tick bite is a common occurrence in Europeans in the affected places, whereas louse bite is of rare occurrence among them.

The relationship between tick-borne typhus and louse-borne typhus has not been completely worked out, their possible common ancestry and the possibility of ticks and lice serving as vectors of the same virus from man to animal, from animal to man and from man to man is an interesting problem.

Summary.

The available evidence strongly suggests that the typhus-like fever of the Kumaon Hills may be a tick-borne disease whose reservoir is in the animals of the jungle. There is also good reason to suspect that the typhus-like fevers of many places in widely separated parts of the world may also be conveyed from an animal reservoir to man by means of ticks, mites or other biting arthropods.

In all cases of typhus-like fever in which louse conveyance from man to man is unlikely it is desirable that medical men should take into account the possibility of ticks or mites being responsible, and should make enquiries for the purpose of obtaining fresh evidence on the question.

The use of names which suggest that a disease is confined to one locality is likely to prevent medical men from regarding the disease as a possibility if it occurs in other parts of the world, hence the classification "louse

typhus," "tick typhus" and "mite typhus" is suggested as being suitable in the present state of our knowledge.

Fevers of the typhus group are very likely to be overlooked unless medical men are aware of the great variations which exist in the symptomatology and severity of the disease and of the possibility of other vectors besides lice being capable of conveying the disease.

I am indebted to Dr. Strickland for helpful expert criticism regarding the entomological aspect of the Bhim Tal fever and for obtaining additional information from a private source about Mossman fever.

REFERENCES.

- (1) Megaw, J. W. D.—"A case of fever resembling Brill's disease." *I. M. G.*, Vol. LII, 1917.
- (2) Megaw, J. W. D.—"A Typhus-like fever in India, possibly transmitted by ticks." *I. M. G.*, Vol. LVI, 1921.
- (3) Cragg, F. W.—"Remarks on the Typhus Fever of Kumaon and on the suggestion that it is transmitted by a tick." *I. M. G.*, Vol. LVII, 1922.
- (4) McNaught, J. G.—"Continued fevers in South Africa." *Jl. R. A. M. C.*, Vol. XVI, Jan.-June 1911.
- (5) Davies L., Wynne, M. D., and Johnson, W. B.—"Notes upon the occurrence of a Twelve-day fever of dengue group in Nigeria." *Jl. Trop. Med. and Hygiene*, Vol. XXIV, 1921.

REPORT ON 69 CASES OF NON-VENEREAL ULCERS TREATED BY INTRAVENOUS INJECTION OF A SOLUTION OF TARTAR EMETIC.

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THE solution used was a 2 per cent sterilised solution of tartar emetic, with 1 per cent. carbolic acid in distilled water.

With the usual aseptic precautions, 2 c.c. of this solution was injected intravenously. Four days later 2.5 c.c. was injected, and four days later 3 c.c. No cases received more than three injections. The total number of injections given was 196.

All patients showed a negative Wassermann reaction before treatment was begun.

General results.—Usually after the second injection the dirty, sloughing ulcer had discarded its slough, and showed a characteristic intensely red base, and edges. No further benefit was observed from subsequent injections after this stage had been reached; on the contrary subsequent injections delayed healing.

Effects observed on various ulcers:—

(1) Large sloughing, dirty ulcers.

Number treated 45. Number markedly improved after two or three injections 25. Number slightly improved 17. Number discharged cured 3.

The benefit obtained is really more than would appear from above results, because of the difficulty of persuading the average patient to remain in hospital long enough for

*The tick which bit me in 1916 was probably the same; the remark made in the paper of January 1917 was: "The tick was not identified, but it was probably *Rhipicephalus sanguineus* or *Hyalomma aegypticum*."