BERIBERI IN LEBONG.

AN ACCOUNT OF THE STEPS TAKEN TO ERADICATE THE DISEASE DURING 1914.

BY MAJOR J. C. KENNEDY.

Royal Army Medical Corps.

In the year 1911 an epidemic broke out amongst the men of the 3rd Middlesex Regiment stationed at Lebong which presented the symptoms of multiple peripheral neuritis. The disease continued to make its appearance in 1912 and 1913, occasioning much concern, and was the subject of investigation by the sanitary officer of the Division and of reports from the medical officers of the station.

These officers all agreed in being unable to assign any definite cause for the disease, and were able to eliminate such causal agents as alcohol or arsenic.

No record of a similar disease having occurred at Lebong prior to 1911 could be found, and the fact that the regiment affected in that year had come from Singapore in the previous cold weather gave rise to the theory that the disease had been imported and was of an infectious or contagious nature.

In November, 1912, The King's Own Regiment relieved the Middlesex at Lebong. In June, 1913, the disease broke out again, and by the end of November sixty-five cases had occurred.

In consequence, the D.M.S., India, appointed a Committee to investigate the nature and cause of the disease and to report by what means it could be prevented. This Committee, consisting of Major E. D. W. Grieg, I.M.S. (President), Major F. Harvey, R.A.M.C., Captain G. I. Davys, I.M.S., and myself, met towards the end of December, 1913. We were handicapped in our investigations by the fact that the regiment had left Lebong for the Dacca manœuvres, leaving behind only a detachment which consisted chiefly of convalescents and men attending hospital for slight symptoms of the disease. Furthermore, none of the cases in hospital were of recent origin, thus precluding any satisfactory bacteriological or clinical research work. There seemed to be no doubt, however, that the disease was beriberi.

In view, therefore, of the large and ever-accumulating amount of recent research work which points to this disease being due to a deficiency in an element of diet, vitamine, which is essential
for the proper nourishment of nerve tissue, we directed our
attention mainly to the investigation of the dietary of the regiment.
At the same time we endeavoured to keep before us the rival
theory of those who believe that the disease is a specific infection.
It is not within the scope of this paper to relate the details of
our investigations; suffice it to say that in a very short time even
those of us who were the most sceptical of the vitamine theory
had begun to look upon the food of the troops with the gravest
suspicion.
Put very briefly, the conclusions of the Committee were:—
(1) That the disease was beriberi;
(2) That as regards the available clinical material there was no
evidence of a bacterial or protozoal causal agent;
(3) That the food of the troops could only be described as
dangerously lacking in vitamine content;
and they recommended—
(1) That a fixed dietary be laid down;
(2) That the cooking be specially supervised;
(3) That an officer be appointed for a year to supervise the
whole rationing of the troops, including quality of food, preparation,
cooking, serving and all details;
(4) That the troops be regularly weighed and records kept.
The immediate result was that I was ordered to proceed to
Lebong at the end of February to do what was possible to carry
out the recommendations of the Committee. My duties began on
March 1 and finished at the end of October on the departure of the
regiment for England.
My official report was submitted in due course, and this paper
is the result of a request for its publication. The report is a
lengthy one, and I have been requested to present it in an abridged
form suitable for publication.
The points that engaged my attention during the year were
many, and it is necessary, in order to give a lucid account, to place
my observations and record my facts under separate headings.
Table No. 1 gives the monthly incidence during 1914 compared
with previous years and does not include readmissions or relapses.
During 1913, 65 men of the King's Own contracted the disease
at Lebong, and 9 at Barrackpore, making a total of 74. Of this
number 38 continued to require treatment during the early part of
1914 or relapsed during the year. All these men, with the excep-
tion of one who died, were fit when the regiment left Lebong on
October 26.
Beriberi in Lebong

The Incidence of Beriberi in 1914.

Table I.

<table>
<thead>
<tr>
<th>Month</th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
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<td>March</td>
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<td>April</td>
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<td>May</td>
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<td>June</td>
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<td>July</td>
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<tr>
<td>August</td>
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<tr>
<td>September</td>
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<tr>
<td>October</td>
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<tr>
<td>November</td>
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<td></td>
</tr>
<tr>
<td>December</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>26</td>
<td>65</td>
<td>4</td>
</tr>
</tbody>
</table>

Of the 4 cases contracted in 1914, 1 died, 2 were able to proceed home with the regiment, and the fourth was able to join the regiment before it sailed from Bombay. This is a very great contrast to the state of health obtaining in the regiment at the end of 1913.

Table II.

<table>
<thead>
<tr>
<th>Incidence by Companies</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1913</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>18</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>1914</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
</tr>
</tbody>
</table>

Table III.

<table>
<thead>
<tr>
<th>Incidence by Bungalow No.</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>1913</td>
<td>—</td>
<td>2</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>—</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1914</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td></td>
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</tr>
</tbody>
</table>

Referring to Tables II and III, I would draw attention to the point that 3 of the 4 cases in 1914 came from "A" Company, occupying bungalows 18 and 21. These bungalows, along with 19 and 20, are situated at the lowest and remotest part of the cantonment (vide plan) and in 1913 provided 28 out of 65 cases and, with bungalows 16 and 17, which are just as badly situated, 40 cases. Later, I venture to suggest an explanation of this fact.

It is of importance to study the history of each case, and I give the particulars in full.

Case 1.—Private P., aged 24, one year and three-quarters in India, "G" Company, admitted June 22 from dormitory 2, bungalow 5, which he had occupied for the last six months. In 1913 there was 1 case in the same bungalow but none in his dormitory. There were 9 "contacts" (men occupying the same dormitory). None of
these "contacts" had had beriberi and none showed signs of the disease, but 5 of them had lost five pounds weight or more up to June 13. During the period April 25 to June 13 it had been noted that 13 men of "G" Company had lost five pounds or more in weight and 6 of them (including Private P.) lived in this dormitory. It was found that 3 had suffered or were still suffering from gastric trouble and diarrhoea, the other 2 seemed quite fit but complained of their food—that they could not eat the meat and did not get enough variety. These "contacts" were kept under observation and remained fit, though 1 required treatment for indigestion and loss of appetite.

**Personal Particulars.**—Not a beer-drinker, a very moderate smoker, not an athlete, but was not in the habit of sleeping in the afternoons; lost five pounds weight in a month.

**Previous History.**—In hospital from March 16 to April 20 with sprained ankle and eczema. Ever since his discharge from hospital he had not felt fit and lost his appetite. In the beginning of June he had diarrhoea for about ten days, and while on company training got very wet three days in succession. From this time he began to suffer from pains in his legs and felt breathless. On June 10 he began physical training and after a day or two his legs got swollen, painful and weak, and on the day of his admission to hospital he could barely walk.

**Progress of Case.**—This was a mild case and did not develop acute symptoms. He had loss of knee-jerks, weakness of leg muscles but no actual paralysis, patches of anaesthesia, and, later on, some cardiac dilatation.

**Case 2.**—Private B., aged 24, two and three-quarter years in India, "A" Company, admitted July 21 from dormitory 4, bungalow 18, which he had occupied for the last six months. In 1913 there were 6 cases in the same bungalow and 3 in the same dormitory. There were 15 "contacts." One had had beriberi in 1913 but was a mild case and had been doing full duty since March 16. Two had been admitted to hospital some weeks previously with swollen legs, due in one case to valvular disease of the heart, and in the other to severe eczema with debility and disordered action of the heart.

**Personal Particulars.**—Not a beer-drinker, a moderate smoker, athletic; lost five pounds weight.

**Previous History.**—He suffered from malaria at Barrackpore in 1913. His first symptoms appeared on July 5, when he reported sick with diarrhoea and vomiting and attended hospital for treatment till July 20, when he was admitted to hospital. Under
treatment the vomiting stopped at once and the diarrhoea in a few
days, but he continued to be debilitated, and when allowed up
developed disordered action of the heart. About August 10 he
complained of pains and stiffness in his legs, and the knee-jerks
were found to be absent.

Progress of Case.—Acute symptoms of the disease very rapidly
appeared in spite of all treatment and culminated in acute dilatation
of the heart. He died on September 19.

Case 3.—Private D., aged 22, three years in India, “A”
Company, admitted September 5 from dormitory 3, bungalow 21,
which he had occupied for the last six months. In 1913 there were
four cases in the same bungalow and one in the same dormitory.

There were ten “contacts.” None of them had had beriberi and
all were fit.

Personal Particulars.—Not a beer-drinker, a non-smoker, not
athletic, but not indolent in habits; lost eighteen pounds in weight.

Previous History.—In hospital for malaria, April 21 to May 4,
and June 20 to June 30. After discharge from hospital he attended
for quinine and then joined his company at physical training during
the latter three weeks of July. He states that he found the course
rather a strain and had to fall out on occasions. On July 29 he
began company training, and after doing about two weeks of this he
got diarrhoea and began to feel seedy. He got worse, feeling faint
and giddy and vomiting at times, and reported sick. He attended
hospital, but as he did not improve was admitted on September 5.

Progress of Case.—The vomiting was very persistent about the
time of his admission and was not controlled for some days. Slight
symptoms of the disease developed, affecting the legs chiefly and to
a lesser degree the heart. He made a good recovery.

Case 4.—Private A., aged 26, three and a half years in
India, “A” Company, admitted September 27 from dormitory 2,
bungalow 18, in which he had lived for the last six months. One
case occurred in this dormitory in 1913.

There were eight “contacts.” None had beriberi and all
were fit.

Personal Particulars.—Not a beer-drinker, a moderate smoker,
not an athlete and occasionally indolent, well developed physically,
and had lost sixteen pounds weight.

Previous History.—Had pneumonia at Dacca in December, 1913.
About the end of August, while on company training he began
to feel ill. He lost his appetite, sometimes vomited, suffered from
cough at night, and complained of tightness in his chest. He,
J. C. Kennedy

reported sick and was admitted to hospital and diagnosed bronchial catarrh. After his discharge on September 16 he felt all right for two or three days, but as soon as he attempted full duty his legs began to get painful and swollen. On his admission to hospital on September 27 his legs were oedematous and there were patches of anaesthesia, and the knee-jerks were absent.

*Progress of Case.*—The case did not develop further, and made a rapid recovery.

**The Dietary.**

In view of the findings of the Beriberi Committee, my duty was obviously to see what could be done by thorough supervision of the dietary of the regiment.

The British soldier in India receives from Government a ration consisting of meat, bread and potatoes one pound of each, rice and flour two ounces of each, and some sugar and tea. As a rule only three-quarters of a pound of potatoes is drawn from the commissariat and for the other quarter a quantity of mixed vegetables of the same value, and consequently varying in amount according to the market prices. This item is of importance and should always receive careful attention. He also receives a messing allowance of two and a quarter annas a day, and in addition it may be reckoned that he gets a grant of at least one pice a day from the president of the regimental institutes.

The messing is run generally on the company system and can be done well and economically in the Plains.

In the hills, however, and particularly at Lebong, the messing cannot be run either so economically or so efficiently, because the rations are not as a rule so good, and the extras which are required to supplement the rations are more difficult to obtain and much more expensive.

For instance, the meat ration at Lebong is distinctly poor. The cattle (which the Indian does not breed for food) have to be driven some hundred miles from the Plains to the foot of the Hills and then a further forty miles into the Hills. When slaughtered they are, as a rule, in miserable condition, although they are allowed a rest of a fortnight at the foot of the Hills and are not supposed to be killed for some days after arriving at Darjeeling. They are not grain-fed and the pasturage is poor. The meat is deficient in fat, tough, and has an excess of bone. There is no doubt that the vitamine value of such meat must be low.

Again, such supplementary articles of food as fresh milk and
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eggs, important for their vitamine value, were almost entirely lacking in the men's dietary. Fresh milk, on account of the difficulty of obtaining it in sufficient quantity and its expense, was replaced by tinned milk, an article of no vitamine value. Eggs were bad, unless a price was paid that was prohibitive for the men.

Furthermore, an examination of the messing books revealed the fact that the men's taste did not lie in the direction of such articles as oatmeal, peas, lentils, or barley—all valuable supplementary foods, especially where the meat ration is of poor quality.

Lastly, there was an undoubted tendency to monotony in the diet. This fact and the poor quality of the meat had a depressing effect on the appetite.

During 1914 there was a distinct improvement in the quality of the rations supplied to the troops, but the raising of the standard of the messing to that desired by the Beriberi Committee was a matter of considerable difficulty.

It was obvious from the first that it would be quite impossible to raise the standard of the messing without increasing the expenditure. The messing money was quite inadequate. With the aid of the master cook I drew out a specimen diet on the lines of that laid down by the Beriberi Committee, economizing where possible, and making alterations to suit the taste of the men. It was found that such a diet would cost at least four annas per man per day. The commanding officer went into the matter very carefully, and, at a meeting representative of the regiment, it was decided to raise the messing contribution for each man to four annas per day. This, along with a grant from the president of the regimental institutes, brought the sum available for messing to four and a quarter annas per man per day. By means of lectures, commanding officer's orders, and personal supervision, the company messing committees were instructed how to draw up their weekly diet sheets, which had to be approved by the commanding officer. At the end of each week the actual daily menu of each company was submitted to me, and I drew the attention of the commanding officer to any deficiencies or suggested further improvements.

The attention of the messing committees was directed to the following points: Fresh milk to be used instead of tinned. A different dinner to be given each day. Full use to be made of bones for stock, and soups to be given as often as possible. Sweet puddings three or four times a week. Full use to be made of the
flour ration in making dumplings and pies. (A large proportion of the rice and flour ration used to be sold.) As much use as possible to be made of the following articles: eggs, moong dhal, oatmeal. Extras to be provided for tea; advantage to be taken of the heart, liver, tails, brains, &c., of ration animals. The tea hour was changed from 4.30 to 6 o'clock, and a substantial meal provided. Formerly nothing was provided beyond tea and dry bread between midday dinner one day and breakfast the next day. "Chota hazri" was also insisted on before early morning parade.

The cooking was very carefully supervised, and every endeavour was made to make the meals appetising. Owing to the inferiority of the rations, it was found that a very large proportion of the meat was thrown away unless it was served up in some form of mince.

The new dietary was, on the whole, appreciated by the men, but, of course, there was grumbling at the extra expense. Under the old system many men, probably the majority, bought suppers for themselves at night, but the new scheme relieved them of this, and at the same time assured that every man had a substantial meal in the evening. In this connection an important point should be noted, viz., the peculiar conformation of the cantonment and the relation of the various bungalows to the coffee-shop. The lowest bungalows (vide plan) are a considerable distance from the coffee-shop, and not many men would take the trouble to climb three hundred feet to buy their suppers, especially if at the same time they ran the risk of being soaked to the skin. This difficulty had been recognized by the regimental authorities, and the men had been permitted to cook their suppers in their own rooms. The objections to such a practice will be evident.

In September the Government of India sanctioned the issue to the British troops in Lebong of the extra articles of diet recommended by the Beriberi Committee and ordered the scales and issues to be fixed by the local medical authorities. Thereupon a requisition was made for the supply of the following articles:—

Moong dhal to be issued four times a week; dripping or suet, daily; cocoa, twice a week; jam, twice a week; oatmeal, twice a week; split peas, once a week; barley, once a week; blue peas, once a week; mutton, twice instead of once a week; whole-meal bread, twice a week as an experiment; vegetables, a fixed ration of 7 oz. in addition to 12 oz. of potatoes; meat, 20 oz. ration (as ration meat contains about 30 per cent bone).

This order came too late to benefit The King's Own Regiment, but it is hoped that the arrangements will be completed for the troops this year.
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I should at this point like to say how much I appreciated the hearty co-operation of the regiment, from the colonel downwards, in carrying out the work, which entailed on them no little pecuniary sacrifice.

Appended are two actual weeks' diet sheets as samples of the messing during 1913 and 1914 respectively:

"E" COMPANY, FROM JULY 1 TO JULY 7, 1913.

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Cheese &amp; onion</th>
<th>Meat &amp; salad</th>
<th>Bacon &amp; tomatoes</th>
<th>Steak &amp; onions</th>
<th>Bacon &amp; onions</th>
<th>Butter</th>
<th>Cheese &amp; onions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soup</td>
<td>Roast</td>
<td>Stew</td>
<td>Roast</td>
<td>Roast</td>
<td>Stew</td>
<td>Roast</td>
<td>Stew</td>
</tr>
<tr>
<td>Meat</td>
<td>Roast</td>
<td>Stew</td>
<td>Roast</td>
<td>Stew</td>
<td>Roast</td>
<td>Roast</td>
<td>Stewed peaches</td>
</tr>
<tr>
<td>Pudding</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Tea</td>
<td>.</td>
<td>Tea and bread; no extras.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
</tbody>
</table>

"A" COMPANY, FROM AUGUST 2 TO AUGUST 8, 1914.

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Cold pork &amp; sauce</th>
<th>Porridge &amp; butter</th>
<th>Steak &amp; onions</th>
<th>Bacon &amp; onions</th>
<th>Eggs &amp; butter</th>
<th>Porridge &amp; cutlet</th>
<th>Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soup</td>
<td>Dhal</td>
<td>Brown stew</td>
<td>Roast</td>
<td>Irish stew</td>
<td>.</td>
<td>Irish stew</td>
<td>.</td>
</tr>
<tr>
<td>Meat</td>
<td>Roast</td>
<td>Hotpot</td>
<td></td>
<td></td>
<td>.</td>
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<td>.</td>
</tr>
<tr>
<td>Pudding</td>
<td>Current</td>
<td></td>
<td></td>
<td></td>
<td>.</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Tea</td>
<td>Potato cutlets</td>
<td>Eggs &amp; butter</td>
<td>Sausage tomato</td>
<td>Cold meat &amp; salad</td>
<td>Potato pie</td>
<td>Butter</td>
<td>Meat rissoles.</td>
</tr>
</tbody>
</table>

ACCOMMODATION AND HYGIENIC CONDITIONS.

The accompanying plan of the Lebong Cantonment shows the disposition of the bungalows and their heights above sea-level. Bungalows 11, 12 and 13 are situated on the ridge of the spur of Lebong, the others lie on the slope on either side. Owing to the steepness of the mountain side these latter have been built parallel instead of at right angles to the side of the mountain, consequently they are all more or less overhung. This fact interferes with efficient ventilation and in the rainy season renders them very damp. The bungalows on the western slope suffer most from this disability and are also more exposed to the prevailing damp winds. The dampness of these bungalows was clearly demonstrated when
I took up the flooring of one of the rooms (4 Bungalow 20). The majority of the men in this room were suffering from some ailment such as sore throat or diarrhoea and complained of a smell. The earth underneath the flooring was damp and mouldy, and the musty odour was simply overpowering. The investigation resulted in my contracting a severe sore throat.

To put it mildly, there is no doubt that such a condition must have a depressing effect on the health of the men, and it has been strongly recommended that the bungalows should have a concrete basement and thorough ventilation between the basement and the flooring. It is interesting to note that two of the bungalows (Nos. 6 and 7) already have concrete basements and that no case of beri-beri occurred in either of them in 1913.

Rough plan of Lebong Cantonment, showing the altitude of each bungalow, thus [5950], in feet above sea-level.

Distances: From Bungalow 20 to the coffee-shop is about 730 yards by a steep winding path. From the coffee-shop to the Parade Ground is 660 yards.

I have already referred to the fact that the six bungalows Nos. 16 to 21 with a nominal accommodation of 338 out of a total of 890 provided 30 out of 60 cases in 1913, and 3 out of 4 in 1914. I am inclined to believe that a partial explanation may be found in the great distance between these bungalows and the parade ground and the difference in altitude. A man living in No. 20 has to go three-quarters of a mile (reckoned on the level) and climb a height of 425 feet. He probably does this before breakfast, and at least once between breakfast and dinner. Then again, the canteen and coffee-shop are 730 yards distant and 375 feet higher up. I feel sure that these facts should be borne in mind
when regulating the training of the men, especially when we consider the altitude and the effect of the climate on the general health.

The accommodation was found to be deficient. By reason of the bungalows being only 20 feet broad instead of 22 feet, each man had 6 square feet of floor space or 60 cubic feet less than the regulation. As soon as this was appreciated the number of men in each room was readjusted and it was found necessary to send about 100 surplus men to Barrackpore.

Throughout the year two rooms were set apart for the segregation of those men still attending hospital for beriberi contracted in 1913, and four rooms were kept vacant for the reception of "contacts" of fresh cases. As soon as a fresh case occurred the room was vacated and disinfected and the "contacts" were sent to a vacant room and kept under observation.

**Loss of Weight.**

As I have already pointed out, all the 1914 cases of beriberi suffered considerable loss of weight. Loss of weight is an important prodromal of beriberi, therefore the regular weighing of the troops should be of great assistance in the early detection of the disease.

In spite of the improvement in the dietary of the regiment there was a general loss of weight during the year, and for this I have endeavoured to find some reason. To this end the weighings were taken as far as possible at the beginning and end of the different courses of training.

The accompanying chart shows the average loss or gain in pounds per man of six companies for six months. Only the men who have been weighed regularly are included in the calculation. Those who were absent from one of the weighings, attending hospital or for other reasons, have been excluded. Therefore we are dealing with the more healthy portion of each company. The total loss or gain at each weighing has been divided by the number of men weighed. The normal line is fixed by the first weighing, and along this line is shown the period during which the company was engaged in Physical Training and Gymnasium (P. T.), Company and Field Training (C. T.), and Musketry (M.). During the rest of the period the companies were doing ordinary duty, guards, parades, physical exercises two mornings a week and a weekly route march.

At the foot of the chart is the curve of the rainfall of Lebong during 1914. For the uncharted portion of the year the rainfall
is negligible, and during the month of October the weather was delightful.

The principal feature of the curves of weight is the very definite fall in July and August, and in every case the September weight is the lowest. I have not the least hesitation in attributing this to the climate, in other words to the rainfall. Conclusive evidence is afforded by the universal increase of weight in October, and by the great improvement in general health and appearance of the men during that month. I have no doubt that had it been possible to continue the observations the curves would have regained the normal line during the next few months.

It will be noticed that "E" Company's curve differs from the rest in showing a rise to the end of June. This may be explained by the fact that this company returned to Lebong on relief from Barrackpore towards the end of May. A number of "E" Company come under the same category.

Another point that will be noticed is the fall of "A" and "B" Companies' curves in April which is quite different from the others. These Companies occupied the lowest bungalows.

The Effect of Physical Training and Exercise.—Up to July 10. the course of Physical Training and Gymnasium (lasting three weeks) consisted of three parades a day, one three-quarters of an hour before breakfast and two three-quarters of an hour between breakfast and dinner. Acting on my recommendation the Commanding Officer reduced this by abolishing the early morning parade. Apart from the fact that the course is no doubt a strenuous one at such an altitude, I had two main reasons for my recommendation: —

1) The distance between the bungalows and the parade ground. This particularly affected "A" and "B" Companies. The time between the first and second parades was just sufficient to allow these men to go down to their bungalows, snatch a hurried breakfast, and get back.

2) The prevalence at that season of digestive troubles, chiefly a more or less mild form of diarrhoea, which tended to become chronic and had the character of hill diarrhoea.

For instance, during the physical training of "C" Company, 11 men lost over 5 lb. in weight, viz.: 6, lost 6 lb.; 1, 7 lb.; 3, 8 lb.; and 1, 9 lb. Seven of these had definitely been suffering from diarrhoea, 1 had an attack of colic, and 1 had a sore throat and some bronchial trouble. Only 5 of them had reported sick.

"A," "B," "E," and "H" Companies, therefore, had a modified
course, "C" and "D" Companies and also "D" Company (May 2 to 19) had the full course. Of the four companies who did the modified course, 48 per cent lost weight and 46 per cent gained, and the average per man was a gain of 0.65 lb. Of the three other companies 54 per cent lost and 27 per cent gained, and the average per man was a loss of 0.95 lb. Though I am loth to place much value on these figures, I am inclined to think that the original course of physical training was rather strenuous. The balance in favour of the modified course is more evident when we remember the climate conditions before and after July 10.

As regards Company and Field Training there is no evidence from these weights that by itself the training has any bad effect. On the other hand, it serves to accentuate the point that the greatest effect is produced by the climate. There is no doubt that Company Training can be made very strenuous, as the only available training ground is up and down the khud, and it has been necessary to issue a caution on the occasion of a number of men falling out or coming sick directly as the result of a hard day's work.

It was the custom in 1913 to hold Running Parades during the rains. These consisted in alternately a double, a quick-time march, and a walk up the cart road for about one and a half miles. From what I gathered from the men I judged that these were the most trying of all their exercises. These parades were stopped in 1914.

The Route Marches in 1914 were considerably reduced in distance and the custom of marching the battalion straight up the short cut to Darjeeling was stopped.

Finally, as regards the effect of physical training, it is interesting to note that three of the four cases of beriberi came from "A" Company. Now it will be asked how can the total absence of the disease from "B" Company be explained, since two companies lived side by side in the group of four bungalows at the lowest and remotest part of the Cantonment, had practically the same food and went through the course of Physical Training together? The only explanation I can offer is that on the completion of their Physical Training at the end of July "B" Company had a month's rest, whereas "A" Company went straight on to Company Training, which lasted the whole of August, the most depressing season of the year.

Diarrhoea.—One very important cause of the loss of weight is the prevalence of digestive troubles, particularly diarrhoea, which presents the symptoms and characters of hill diarrhoea. This disease tends to become chronic, with two or three putty-coloured
J. C Kennedy

stools first thing in the morning. It was rarely of a severe nature, and many of those attacked did not report sick and only a small proportion required admission to hospital. I have given above an

<table>
<thead>
<tr>
<th>APRIL</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUG.</th>
<th>SEPT.</th>
<th>OCT.</th>
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<tr>
<td>C&quot;COMPANY</td>
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<td>P.T.</td>
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instance of the loss of weight produced in the persons of seven men of " C" Company and also amongst the "contacts."

The following tables, dealing as they do with the more severe cases only, give some idea of the prevalence of this disorder.
Table IV brings out the fact that "A" Company suffered most while "B" Company was nearly as bad.

Table IV.—Cases of diarrhœa by companies for each month of 1914.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
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<tr>
<td>February</td>
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<td></td>
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<td>March</td>
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<td>April</td>
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<td>1</td>
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<tr>
<td>May</td>
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<tr>
<td>June</td>
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<td>2</td>
<td>1</td>
<td></td>
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<tr>
<td>July</td>
<td>12</td>
<td>11</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>August</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
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<tr>
<td>October</td>
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</tr>
</tbody>
</table>

Number: 19 17 7 3 12 7

Note.—"F" and 1/2 "D" went to Barrackpore.

Table V.—Monthly incidence of diarrhœa during the years 1911-1914.

<table>
<thead>
<tr>
<th></th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
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<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td>March</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td></td>
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<tr>
<td>April</td>
<td></td>
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<tr>
<td>May</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>June</td>
<td>7</td>
<td>14</td>
<td>5</td>
<td>8</td>
<td>105</td>
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<td>10</td>
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</tr>
<tr>
<td>September</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td></td>
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<tr>
<td>November</td>
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<tr>
<td>December</td>
<td></td>
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</tbody>
</table>

Number: 124 46 48 65 283

Table V shows the monthly incidence to be highest in June and July, and it is interesting to compare these figures with the beriberi figures in Table I. At first sight there seems to be a relationship between the two, but after a closer study and reference to statistics for previous years I think the relation is more apparent than real. However that may be, there is no doubt that we must reckon with this diarrhœa as an important cause of loss of weight, and therefore as a factor to be reckoned with as a predisposing cause of beriberi.

Judging from my own experience and that of other officers who have suffered from this complaint, the effects are very great. There is great debility, loss of weight (one officer lost eighteen pounds in a very short time) and impairment of digestion, only the lightest diet of milk and eggs being tolerated.

In the case of the men it is not by any means the rule for them
to report sick; they have two or three motions in the morning and then feel better and are just able to carry on for the rest of the day. At the same time their ordinary diet serves only to aggravate the symptoms and is not digested. This state of affairs may last some time, and the man loses weight and becomes debilitated and all exercise becomes an effort. Then one day being called upon to do a little more strenuous work such as a route march or an "attack" up the khud, he breaks down. When brought to hospital such a man will describe how he felt dizzy and breathless and felt his legs getting weak, and then he vomited.

On examination no symptoms beyond the diarrhea and vomiting may be present, and with careful treatment and rest the patient may recover without any further developments. On the other hand, the knee-jerks may be absent or may disappear later, and there may be pain and tenderness of the calves and pain on pressure over the epigastrium. Even then no further symptoms may develop under appropriate treatment, but possibly in time undoubted symptoms of beriberi made their appearance.

The conclusions I would draw from these observations are:

1. That loss of weight is the rule during the summer and is directly the result of the rains.
2. That with the advent of the rains digestive disorders become prevalent and have a very depressing influence.
3. That physical exercise if regulated to suit the altitude is not in itself harmful, but may easily be overdone in the presence of (1) and (2).
4. That consequently by the operation of (1), (2) and (3) we have a condition produced which predisposes to the development of symptoms of beriberi.

Research Work.

Owing to my many other duties I was unable to carry out any elaborate research, and my efforts were limited to an endeavour to find a causal organism.

Two post-mortems provided me with material. The first case contracted the disease in 1913 and relapsed in 1914 and died of acute dilatation and failure of the heart. The second contracted the disease in 1914 and has been reported above (Case 2).

With material from these post-mortems four monkeys (M. rhesus) were inoculated: three received into the peritoneum cerebrospinal fluid, saline emulsion of the medulla and emulsion of the mesenteric glands respectively, the fourth had fifteen minims of cerebro-spinal fluid injected into the spinal column by lumbar puncture.
All the animals showed some loss of weight, but this may have been due to the advent of a cold spell of weather, and one lost appetite and had diarrhoea for a short time; otherwise they remained perfectly well, and a short time after I left Lebong they were allowed to regain their freedom.

Further bacteriological examination of these two cases gave negative results. The microscopic examination of the blood, bile, cerebrospinal fluid, spleen and mesenteric glands revealed nothing. Likewise the cultures remained sterile or showed a few intestinal contaminations.

The pathological findings in each case were entirely those depending on the mechanical effects produced by dilatation of the heart. In the second case the whole of the intestines showed a fine arborescent injection and the mesenteric glands were prominent. Cultures from these glands produced only some common intestinal organisms.

From the vomit of a beriberi patient three bacilli were isolated on a McConkey plate, viz.:—

1. A non-lactose fermenter turning glucose acid without gas and rendering the media fluorescent.

2. A non-lactose fermenter and motile, in its reactions corresponding to *faecalis alkaligenes* and agglutinated up to one in twenty dilutions of the patient’s serum.

3. A bacillus fermenting lactose, glucose, and mannite with gas (dulcite was not available).

I was struck with the large number of the chronic cases that suffered from bad teeth and pyorrhoea alveolaris; one case, a relapse from 1913, had this condition particularly well marked. He was one of the worst of the 1913 cases and had to be readmitted during 1914 with persistent vomiting. Microscopic examination of the vomit revealed quantities of saliva with threads of pus. When the mouth condition was energetically treated the vomiting ceased at once. In many of these cases there was present in the pus a very large bacillus, sometimes segmented and suggesting the mycelium of a fungus, but it was not by any means a constant feature.

Therefore, so far as these observations go, there was no indication of a causal organism, and this was to be expected if we were dealing with true beriberi. The object of the animal experiments detailed above was to eliminate the presence of a “filter passcr,” but of course the susceptibility of the monkey to the disease is an unknown quantity.
The dogs at Lebong suffer from a curious disease, the symptoms being fever, pains in the back and limbs, weakness of the legs and partial paralysis and loss of weight. Many develop cerebral symptoms and some cases have been mistaken for rabies. I had the opportunity of doing a post-mortem on one such dog, and found acute meningitis. The causal organism was a small streptococcus which grew very slowly and delicately on ordinary media. The dogs which I afterwards treated all recovered under the administration of calomel and a course of liq. hydrarg. perchlor. I mention this disease of dogs because it had been noted by former medical officers and mentioned in their reports as bearing some resemblance to beriberi.

CONCLUSIONS.

I think that it may be very fairly concluded—
(1) That the disease is beriberi.
(2) That no evidence of a specific organism has been obtained and there is no evidence that the disease is infectious or contagious.
(3) That the steps taken to prevent the disease at Lebong during 1914 have had a gratifying result. The regiment did not leave behind a single man on account of beriberi when it sailed for England.
(4) That the result has been attained in the first and foremost place by the improvement in the dietary, but also in no small degree by the attention paid to general health, hygienic surroundings and physical exercise.
(5) That climate, climatic diseases (diarrhoea) and physical exercise which is not regulated to meet the conditions obtained at Lebong are important factors in predisposing to beriberi.

Rules and recommendations have been drawn up for the future guidance of the troops at Lebong and it will be very interesting to see the result.

I desire to express my indebtedness to Lieutenant-Colonel J. C. Prettie Perry, R.A.M.C., the S.M.O. of the Station, for his hearty co-operation in the work and for his assistance and his many valuable suggestions, without which it would not have been possible to have brought the work to such a successful issue.

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