Scientific Memoirs by Medical Officers of the Army of India. Edited by B. Simpson, M.D., Surgeon-General with the Government of India. (Part I., 1884). (1) On the relation of cholera to Schyzomycete organisms, by D. D. Cunningham. (2) On the presence of peculiar parasitic organisms in the tissue of a specimen of Delhi boil, by D. D. Cunningham. (Calcutta, 1885).

IN the first of these memoirs Dr. Cunningham makes some interesting additions to our knowledge of the presence and distribution of comma bacilli in the intestinal contents in cases of Asiatic cholera; on the occurrence of peculiar comma bacilli associated with the scum formed on tank water by Euglenæ; and on certain modifications in morphological and other characters in artificial cultivations of the choleraic comma bacilli.

The second memoir gives a minute description of the anatomical nature of the skin disease known as "Oriental sore" or "Delhi boil." This description is the more valuable as it is the first accurate account that we possess of the minute anatomy of this interesting malady. The value is enhanced by the discovery by Dr. Cunningham in the diseased tissue of a peculiar fungus bearing the characters of Mycetozoa or Myxomycetes, more especially of the subdivision of the Monadinæ; the distribution of this fungus is such that a causal relation of it to the disease process becomes highly probable.

The memoir is illustrated by numerous fine lithographs, many of them coloured. E. KLEIN

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Thomson Effect as Expounded by Prof. Tait

AMONG modern expositions of the subject of thermo-electricity there is none so full, and on the whole so instructive to students, as that contained in Prof. Tait's "Heat." It is therefore the more important to call attention to what appears to me to be, to say the least, a very questionable statement there made. It refers to the Thomson effect.

Thomson's experiments were of the following nature. A metallic bar was surrounded with a hot-water jacket in the middle and with cold-water jackets at the ends, and there were two holes sunk in it for the insertion of thermometers, midway between the hot jacket and the two cold jackets. When the flow of heat had become nearly steady, a steady current of electricity was sent through the bar; and, after it had flowed for several minutes in one direction, it was reversed; then, after the same number of minutes, it was again reversed, and so on several times. It was thus found that, when the bar was of copper, the current made the temperature of the further thermometer higher than that of the near one (the words *far* and *near* being used with reference to the end at which the current entered). When the bar was of iron, the current made the temperature of the near thermometer higher than that of the further one.

Seeing that a current may be regarded at pleasure as the flow of vitreous electricity in the nominal direction of the current, or as the flow of resinous electricity in the opposite direction, Thomson summed up his results by saying that "the vitreous electricity carries heat with it" in copper, and "the resinous electricity carries heat with it" in iron. He also gave the name of "electric convection of heat" to the effect thus detected. It has since been called by others "the Thomson effect."

The experiments were instituted to test the truth of a conclusion of which he had previously given a theoretical proof—the conclusion that "in one or other of the metals, and most probably in both, there must be a thermal effect due to the passage of electricity through a non-uniformly heated portion of it, which must be an absorption of heat [a cooling] or an evolution of heat [a warming], according to the direction of the current between the hot and cold parts."

It may be taken to be an established fact that, in a uniform linear conductor along which a current is flowing, there is, in addition to the frictional heating, which is proportional to the square of the current, a warming or cooling effect proportional (at given temperature) to the steepness of the thermometric gradient at the point which is warmed or cooled, changing sign with the gradient, and vanishing at points of maximum or minimum temperature, where the gradient vanishes.

Now compare these effects with what happens when a stream of liquid flows through a pipe surrounded at alternate points in its length with hot and cold jackets, the average temperature of the water being the same as the average temperature of the pipe. It will carry heat from the hotter to the colder portions, thus cooling the hottest parts, warming the coldest parts, and at the same time carrying forward the points of maximum and minimum temperature. If, at each point of the pipe (supposed straight and horizontal), we erect an ordinate to represent its temperature, and call the curve of which they are the ordinates "the temperature curve," the effect of the flow of liquid on this curve will be twofold: (1) it will carry the temperature curve forward; (2) it will make the temperature curve flatter.

Thomson's experiments show that an electric current carries the temperature curve forward in copper, and backward in iron; but I am not aware of any evidence to show that it makes the temperature curve flatter.

The analogy between the Thomson effect and convection of heat by a liquid in a pipe therefore does not run on all fours, and must be used with caution.

Maxwell says ("Elec. and Mag.," p. 343, second edition), "positive electricity in copper, and negative electricity in iron, carry heat with them from hot to cold." The words "from hot to cold" are here added to Thomson's original phrase "carries heat with it," and the addition thus made is not in accordance with facts, for it implies that heat is taken away from the hot parts and given to the cold parts; whereas the fact is that heat is taken from parts where the temperature gradient is in one direction, and heat is given to parts where the gradient is in the opposite direction. If the statement be altered by a little transposition, so as to make it stand thus, "positive electricity in copper, and negative electricity in iron, going from hot to cold, carry heat with them," it will be scarcely distinguishable from Thomson's original statement.

Prof. Tait goes further, and says ("Heat," p. 170):—"After a series of elaborate experiments (described in the *Phil. Trans.* for 1855) [it should be 1856] Thomson found that:—

"*An electric current in an unequally heated copper conductor behaves as a real fluid would do,* i.e. *it tends to reduce differences of temperature. In iron it tends to exaggerate them.*"

The italics are Prof. Tait's.

I can find nothing in Thomson's paper to support the assertion that in copper an electric current tends to reduce differences of temperature, though the idea that it does so is naturally suggested by the analogy implied in the phrase "electrical convection of heat."

The statement that in iron the current tends to exaggerate differences of temperature, seems to be completely original on the part of Prof. Tait. It does not arise naturally out of Thomson's dictum, "resinous electricity carries heat with it in iron"; for if we think of resinous electricity as a real fluid flowing through iron, it would tend to equalise differences of temperature in that metal.

The two statements taken together suggest the following line of reasoning as conclusive against them both:—

Let there be the same initial distribution of temperature in a copper and in an iron bar, and currents in the same direction through both. Then the alterations of temperature at corresponding points in the two bars will have opposite signs. Any one who maintains that the warmest parts of the copper are cooled is therefore bound to maintain that the warmest parts of the iron are warmed. But there is precisely the same ground for maintaining that the warmest parts of the iron are cooled, and therefore the warmest parts of the copper warmed. Whatever vitreous electicity can do in copper, resinous electricity can do in iron. We are thus involved in a contradiction if we assume any finite heating or cooling at the hottest parts. And similar reasoning disproves any finite heating or cooling at the coldest parts.

The following formal investigation confirms the view which I have above expressed.