THE CHOLERA BACILLUS

In view of the investigations which are going on at the present time, it will be of interest to our readers to summarise the reasons which Koch gives for his conclusion that the comma-bacilli described by him are the cause of cholera. No doubt can remain in the minds of those who have read his paper on the subject, published in the *Berl. Klin. Wochenschrift*, No. xxxi., 1884, and the discussion thereon, that he has devoted an immense amount of time and labour to the question, and that he has dealt with the subject in a most open-minded and conscientious manner. His known character for accurate observation and care in drawing conclusions lend great weight to his statements. We will give a short sketch of his arguments under a series of headings.

(1) The comma-bacillus is a specific micro-organism having marked characteristics distinguishing it from all other known organisms.

Their length is from half to two-thirds of that of tubercle bacilli, but thicker and slightly curved; this curve is generally not more than that of a comma, but sometimes it may be greater, forming even half a circle. Sometimes several bacilli can stick together end to end, giving rise to the appearance of a spirillum. Koch thinks that this organism stands midway between a bacillus and a spirillum. They grow rapidly in meat infusion. They possess the power of active motion. They also grow well in other fluids, in milk more especially. They increase rapidly in blood serum. A very good medium is Koch's gelatinised infusion (peptone, gelatine, meat infusion, made neutral by carbonate of soda), and its cultivation in this medium "renders its detection easy and very certain." Shaken up with the liquefied gelatine, poured out on a sterilised glass plate, and kept at a temperature at which the gelatine becomes solid, its colonies are very characteristic: when young, they appear as small, very pale drops, not quite round, but more or less irregular and jagged in contour; they also have a granular appearance, and when larger look like a heap of strongly-refracting pieces of glass; the gelatine becomes fluid in the immediate neighbourhood of the colony, the latter sinks into the gelatine, and thus a small funnel-shaped depression is formed, in the middle of which the colony is seen as a small white point. The liquefaction of the gelatine does not extend more than about one centimetre around the colony. If a tube of solid gelatine is inoculated by dipping a needle in the cultivation, and pushing it into the gelatine, the latter becomes fluid first at the point of entrance of the needle; the colony sinks more and more; a funnel-shaped depression is formed with an appearance as if an air-bubble were present at the top. They can also be cultivated in a meat infusion containing peptone, neutralised and rendered solid by agar-agar. They grow on potatoes, forming colonies closely resembling those of the bacillus of gangers, but not so brown as the latter. They grow best at a temperature between 35° and 40° C.; below 16° C. they cease to grow; freezing does not kill them. They only grow in presence of oxygen. They grow very fast; their vegetation rapidly reaches its highest

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point; it remains stationary for a time, and then as rapidly ceases, the bacilli dying. They will not grow in meat infusion or the gelatinised material if it is at all acid. They die very rapidly when dried, not retaining their vitality longer than three hours. They do not form spores, corresponding in this respect with spirilla rather than with bacilli; Koch has made an exhaustive series of investigations to ascertain this point. Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli.

(2) This bacillus is always present in cholera.

Koch states that this bacillus is always present in cases of cholera. He determines its presence not only by microscopic examination, but by cultivation in gelatinised meat infusion. In ten cases in Egypt they were found microscopically (he had not then worked out their characteristics on cultivation). In India he made forty-two post-mortem examinations, and found them in all cases, by cultivation and microscopic examination, in the intestinal canal. The dejections of thirty-two cholera patients were also examined in the same way, and the comma-bacilli were found in all cases; also, in two cases seen in Toulon, and microscopically in sections of the intestinal wall in eight cases sent to him previously from India and Egypt. In almost 100 cases carefully examined these organisms were found, and that in cases occurring in various parts of the world.

(3) It is the only form which is constantly present in this disease.

(4) It is present in greatest numbers in acute and uncomplicated cases.

Koch has found that this is the case, and that on the other hand, in cases which live longer, the bacilli are fewer, and more especially where haemorrhage or other complications have occurred, other bacteria are most numerous.

(5) It is present in the parts most affected.

According to Koch the lower part of the small intestine is that most affected by the disease, and here the bacilli penetrate into the tubular glands and also in part between the epithelium and basement membrane; in some places they penetrated even more deeply into the tissue. Where death of portions of the mucus membrane had occurred, other bacteria were also present in the tissue, but the comma-shaped ones were always deepest, "giving the appearance as if they had prepared the way for the others."

(6) It is never present in other diseases, in healthy persons, nor has it been found outside the body when no cholera was in the neighbourhood.

This is the keystone of the research, and naturally Dr. Koch has devoted great attention to this point. All his investigations in this direction have been carried out by his usual methods—chiefly by cultivation, aided also by the use of the microscope. He has thoroughly examined thirty bodies of patients who had died of dysentery, intestinal catarrh, "biliary typhoid," one case of ordinary typhoid fever, and several cases where ulceration of the intestines has been present. In none of these did he find comma-bacilli. He failed to find them in a number of cases where he examined the dejections of patients
suffering from dysentery, also in diarrhoea of children, in animals poisoned by arsenic, in impure water from various parts around Calcutta, indeed wherever he met with a fluid containing bacteria he examined it for comma-bacilli, without however finding any (except in one instance, see No. 8). He specially mentions that he has tested saliva and the material on the teeth and tongue, which is always full of bacteria, but always with a negative result. He further refers to his own previous large experience in the cultivation of bacteria, and that of others who have worked at cultivation, this experience being against the presence of this organism, except in cholera. From these facts he feels himself warranted in stating that "the comma-bacilli constantly accompany cholera, and are never found elsewhere."

(7) No other conclusion can be arrived at than that these bacilli are the cause of cholera.

(a) It might be said that the choleric process merely favours the growth of this bacillus. But on this supposition every one must have comma-bacilli in his body, because they are present in cases of cholera occurring in widely-separated parts of the world. This, however, is not the case (No. 6).

(b) As the result of the disease, conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli. There is no evidence of such rapid transformation of one form of bacterium into another. The only known case of alteration in the properties of these bodies is the attenuation of anthrax bacilli, &c., but this is merely an alteration in pathogenic action; their form and mode of growth remain unaltered. Outside the body Koch has not, during the course of his investigations, got the slightest evidence of any change in these bacilli.

(c) The only conclusion which remains is that the cholera process and these bacilli stand in close relation to each other—in a relation of cause and effect.

(8) Although by experiments on animals direct evidence that the comma-bacillus is the cause of cholera has not been obtained, there are various observations which are almost as good as experiments on man.

In one case in a village near Calcutta Koch examined the water of a tank which supplied the inhabitants with drinking-water, &c. A number of cases of cholera had occurred, and when the water was examined the epidemic was at its height. Comma-bacilli were found in the water in considerable numbers. At a later period, when there were only a few cases of illness, the comma-bacilli were few in number, and only found at one part of the tank. This was the only instance in which Koch found these bacilli outside the body. He further refers to the occurrence of disease in washerwomen, and infection from clothing soiled with cholera dejecta.

(9) The natural history of the disease corresponds with the various characteristics of this organism.

The bacilli grow rapidly, soon reach their highest point of development, and then die; this corresponds to what occurs in the intestinal canal. Under ordinary circumstances these bacilli are destroyed in the healthy stomach. This corresponds to the clinical facts of cholera, for, of a given number of individuals exposed to cholera, only some are taken ill, and those almost all suffer from disturbance of digestion—either catarrh of the stomach or intestine, or overloading of the stomach, &c., with indigestible food. The disease dies out in places where the conditions for its continuance are unfavourable: the bacilli have no spores.

These are the facts on which Koch's views are based; lately, however, two researches have been published which strike at the root of the theory, and which try to show that these bacilli are not peculiar to cholera. Dr. Koch has also published a reply.

The first of these researches is that of Dr. Lewis, who finds bacilli in the mouth microscopically identical with the comma-bacilli. Koch's reply (Deutsche Med. Wochenschrift, No. 45, 1884) is that he is well aware of the fact that organisms somewhat resembling the cholera bacillus are present in saliva, but that he does not diagnose these bacilli by microscopical characters alone, that if these bacilli are cultivated they will be found to be quite different from those present in cholera. For instance, they will not grow at all in the neutralised cultivating gelatine in which the cholera bacilli grow rapidly. The other research is by Finkler and Prior, who stated that they had found the comma-bacillus in cases of cholera nostras, and who further described spore-formation in them. Koch succeeded in obtaining a specimen of their "pure" cultivations, and found, on shaking up a minute quantity with the liquefied gelatine and pouring it out on a glass plate, that they had a mixture of four different bacilli, and that none of them were the comma-bacilli described by him.

Koch further adds the interesting fact that he has again taken up the experiments on the lower animals (presumably, from the context, on dogs and guinea-pigs), and that by injecting minimal quantities (as little as the 100th of a drop) of the cultivations of comma-bacilli into the small intestine, the animals have as a rule died in one and a half to three days, and the post-mortem appearances of the intestine were the same as in acute cases of cholera, the fluid in the intestine also containing enormous numbers of comma-bacilli.

In two cases of cholera nostras, and in a diseased bee, the writer found bacilli which microscopically closely resembled the comma-bacilli, but it was found that they did not grow in the neutralised gelatinised material, and were therefore not the same organism.

THE HAYTIAN NEGROES


Whatever theory may be adopted regarding the fundamental equality or disparity of the human races, a truthful and unbiased account of the present social condition of the Haytians, by a competent observer, must necessarily prove a valuable contribution to the study of psychological anthropology. These conditions are eminently satisfied in the work before us, written as it is by a man personally above suspicion of any unworthy motive, by a statesman who has associated for some five-and-thirty years with every variety of coloured peoples, by a distinguished diplomatist, who, as British Minister and Consul-General, has resided for twelve years in Hayti itself. On the other hand, no more favourable field could be selected for a study of the negro race than this western and smaller division of this large West Indian island,