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SCIENCE

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KOCH ON BACTERIOLOGY.

THE *Lancet* of Aug. 16, 1890, gives a summary of the address of Koch at the Tenth International Medical Congress, in which he declared that he had not much that was new to tell, but he would make a preliminary communication regarding the result of important new experiments. This communication, a *résumé* of which is published in the *Medical and Surgical Reporter*, had reference to a remedy for consumption discovered by him, which, however, he would not name till his experiments were ended. The rest of his address was an admirably clear account of the progress of bacteriological research.

Only fifteen years ago one regarded the micro-organisms occasionally observed in the bodies of diseased animals and persons more as curiosities than as things essentially connected with the disease; and, considering the great ignorance of their nature which then prevailed, this could not but be so. There were investigators, for instance, who declared bacteria to be crystalloid bodies, not living organisms. With the perfecting of the magnifying instruments, the application of staining, the propagation of organisms on nutritive media, culminating soon in pure cultivation, a rapid change took place. It became possible to distinguish a number of quite definite sorts with certainty, and to ascertain that they were distinctly connected with the diseases in which they were found. It was further ascertained that one sort of bacteria was not transformed into another; and the remarks of old writers on leprosy and consumption, for instance, even justified the conclusion, that just as certain diseases, presumably caused by micro-organisms, had remained unchanged, their germs also must, on the whole, have retained their old qualities. Within certain limits, indeed, deviations of demeanor had been observed in some bacteria, but that was the case among the higher plants too, without the varieties ceasing to belong to the species. The main gain of this period of research was the recognition of the fact that the thing was to discover as many morphological and biological qualities of a bacterium as possible, so as to be guarded against the danger of confounding various bacteria. There was still a danger of this with certain bacteria.—the typhus and diphtheria bacilli, for example,—whereas it had been removed in the case of the tubercle and cholera bacilli by the very exact investigations of these organisms. In their case too, however, the bacillus must never be determined by one mark alone. He had experienced this in his own case, having for some time taken the bacillus of chicken cholera—for the special study of which he had not had material—for a variety of the bacillus of Asiatic cholera, till a new series of experiments had convinced him of his error. Whether the germ of chicken cholera would have an injurious effect on human beings was still a question, and a question that would not easily be answered, as one could not well make direct experiments on human beings, but must wait to see whether the bacillus of chicken cholera would not one day appear in a human cholera patient.

As to the etiological connection of the noxious bacteria with infectious diseases, general opinion was at first against it, and strict proof was necessary. It was necessary to prove in all cases that the disease and the micro-organism always appear together; that the micro-organism in question does not appear in any other disease; and that the micro-organism, propagated outside of the body through several generations, always produces the

same disease if it gets into the body again. Now that the etiological connection had been proved in this manner in anthrax, tuberculosis, and erysipelas, and the resistance of opponents broken, one might confine one's self in further cases to the two first lines of proof. This proof had still to be given in the case of abdominal typhus, ague, leprosy, diphtheria, and Asiatic cholera; but in the case of the latter it was already generally assumed that the cholera bacillus was the cause of cholera. As subjects of investigation for the immediate future, Koch designated the question whether the pathogenic bacteria live only in the body, or outside of it too, and in the latter case only occasionally get into the body and cause disease; also the manner of getting into the body and their demeanor there.

The next advance in bacteriology was the discovery of the poisons excreted by the bacteria, which were now regarded as the cause of death in fatal bacterial diseases, for the opinion that the white blood-corpuscles resist the bacteria was more and more losing ground. Koch then discussed the spore-formation of some bacteria, and the influences of air, warmth, moisture, and chemicals on bacteria. Direct sunlight quickly killed bacteria; the tubercle bacillus, for instance. Even daylight produces the same effect, though more slowly. Cultivations of the tubercle bacillus, propagated for from five to seven days at a window, died. Moisture was necessary for the growth of bacteria; moisture, however, on the other hand, hindered their spreading. A bacterium never rose: its transmission took place only by the flying of dust, if it remained for some time capable of life in dry air. By means of improved staining methods some knowledge of the inner structure of bacteria had recently been gained. There seemed to be an inner nucleus of plasma with flagella proceeding from it. In certain infectious diseases—measles, scarlet-fever, and small-pox, for instance—the presence of a pathogenic bacterium had not yet been proved. In hydrophobia, influenza, whooping-cough, trachoma, yellow-fever, cattle-plague, and pleuro-pneumonia of cattle, also, no specific bacterium had been discovered, though the infectious nature of these diseases was evident. And perhaps these diseases were caused, not by bacteria, but by organic parasites belonging to quite another group of animated beings. In the blood of malaria patients protozoa had been found, which were now suspected of causing this and other infectious diseases. Whether protozoa, the lowest representatives of the animal world, really deserved this suspicion, would have to be decided by a method analogous to bacteriological pure cultivation.

But now there remained the question as to what had been the practical utility of all these extremely laborious investigations. The investigator indeed, ought not to inquire after the immediate practical utility of his work. In the present case, however, the question was not entirely devoid of justification. Nor was it quite impossible to give it a satisfactory answer. Had not bacteriological investigation alone led to effective methods of disinfection? The value of water-filtration, the question of the filtering qualities of the soil, of the fitness of surface water for use as drinking-water, of the best method of constructing wells, the sterilization of milk (so important especially for the nutrition of infants), the investigation of the air in schoolrooms and in sewers, the proof of the presence of pathogenic bacteria in the soil and in the air, were all bacteriological questions or conquests.

The diagnosis of isolated cases of Asiatic cholera rendered

timely preventive measures, the discovery of tubercle bacilli rendered timely therapeutic measures, possible. Besides these, indeed, only Pasteur's inoculations against hydrophobia, anthrax, symptomatic anthrax, and swine erysipelas, remained to be mentioned; and the first of these probably did not belong to bacteriology at all, though they had grown on its soil. "But," concluded Professor Koch, "it will not always remain so. Therapeutics proper will also derive benefit from bacteriology; hardly, indeed, for diseases of rapid course, in which prevention will remain the main thing, but certainly for slow diseases, such as tuberculosis. Others also, like Billroth, maintain this hope; but the mistake has frequently been committed of beginning the experiment on human subjects. I regard this as wrong, and look upon the alleged successes of various remedies, from benzoate of soda to hot air, as illusory. For years past I have been seeking means for the therapeutic treatment of consumption, but I began with the pure cultivation of the bacillus. I found a number of substances,—etheral oils, tar-pigments, mercurial vapor, salts of gold and silver, especially cyanide of gold, for instance,—some of which, like the last, even when very strongly diluted, prevent the growth of the bacillus, which, of course, suffices to bring the disease to a standstill. All these substances, however, have proved ineffectual when used against the bacillus in the bodies of animals. I continued my search, however, and found what I sought. Susceptible as the guinea-pig is to the tubercle bacillus, it proved non-inoculable when treated with the substances in question, and even when its disease was far advanced it could be brought to a standstill by this means. This fact may give occasion to search for similar effective remedies in other infectious diseases also, and here lies the field for an international contest of the highest and noblest kind."

EXCAVATIONS IN JUDÆA.¹

THE traveller from Hebron to Gaza cannot fail to be struck with the sudden contrast presented by the mountainous country that he leaves behind him, and the long stretch of almost level plain into which he descends. After passing Bêt-Jibrîn, in which some scholars would see the sight of the ancient Gath, he has to wend his way through narrow defiles and precipitous limestone crags until he suddenly finds himself in the rich plain which forms the *Negeb*, or district of "southern" Judæa. On the first occasion on which I traversed it, however, it was not the sharp contrast between mountain and plain that first attracted my attention: it was rather the number of *tels*, or artificial mounds, with which the plain is covered. Each *tel* marks the site of an ancient city or village; and no archæologist could help reflecting, as he gazed upon them, what a rich field must here await the future excavator. Among them I noted two or three of remarkable height and size, and longed for an opportunity of discovering the historical secrets that lay hidden within them. It was more especially on a lofty mound, which my dragoman told me was called Tel 'Ajlân, that I cast covetous eyes.

The curiosity which the site of the mound excited has now been partially gratified. After ten years of patient importunity, the Palestine Exploration Fund succeeded last spring in obtaining permission from the Turkish Government to excavate in the south of Palestine; and Mr. Flinders Petrie, the prince of living excavators, placed his services at the disposal of the fund. In spite of obstacles of every nature, presented by the climate, by Turkish officialism, and by the character of the Bedouin inhabitants of the country, his few weeks of work have produced truly marvellous results. We now know something of the art and building of the Israelites in the period of the Kings, and even of that older Amorite population whom the Israelites conquered. It has become possible to speak of Palestinian archæology, and to determine the age of the pottery and hewn stones which are met with in the country. Where all before was chaos, order at last has begun to reign.

The firman granted by the Porte allowed excavations to be conducted over an area of 9½ square kilometres in the neighborhood of Khurbet 'Ajlân, but enjoined that all objects found, including

even duplicates, should be handed over to a Turkish commissioner specially appointed to oversee the work. When, however, Mr. Petrie arrived in Jerusalem at the beginning of March, he found, that, owing to a trifling error of description, the firman was detained in Constantinople; and it did not reach Jerusalem, where Mr. Petrie was awaiting it in the midst of violent storms and penetrating cold, until the very end of the month. At last it came, but, in spite of the courtesy and assistance of the enlightened Pacha of Jerusalem, further delays were interposed by the Turkish commissioner; and it was not until April 14 that work could be commenced, one week only before Ramadan. What Ramadan means is known too well to those who have lived in the Mohammedan East. An unbroken fast throughout the day, followed by feasting at night, renders even the most industrious disinclined for work. And Mr. Petrie had to deal with a population naturally disposed to steal rather than to work, and who had never tried their hands at excavating before. It was no wonder that the excavator from time to time thought regretfully of the industrious and intelligent *fellahin* he had left behind in Egypt, and longed to see the "savages" who now squat on the fertile plain of Judæa swept back into their ancestral desert homes.

Mr. Petrie began with some preparatory digging at a place known to the geographers as Umm el-Laqlis, which has been supposed to be the site of the once important fortress of Lachish. The first time I visited the spot I was told that the real name of the hill-slope was Umm el-Latîs; and three years ago, when I visited it for a second time, I satisfied myself that it represented nothing more than the site of a village of the Roman age. Mr. Petrie's excavations have abundantly confirmed my conclusion. The site, he found, was covered with only six to eight feet of artificial earth, which was filled with fragments of Roman pottery, and in one place a worn coin of Maximian Hercules was disinterred two feet above the virgin soil. Accordingly, he soon moved with his workmen to the *tel*, which formed the most prominent object in the district where he was permitted to dig.

The *tel* is about six miles from the village of Burêr, and near the site of a Roman hamlet which goes by the name of Khurbet 'Ajlân, or "Ruin of Eglon." It proves not to be called Tel el-'Ajlân, "the mound of the Eglonite," as my dragoman informed me, but Tel el-Hesey, apparently from a spring of water which flows past the eastern face of the mound. The spring is the only source of fresh water that exists for many miles around, and falls into a brackish brook which trickles from the neighboring Tel en-Nejîleh, the united stream being subsequently swallowed up in a stony *wadi* a few hundred yards lower down. Mr. Petrie is doubtless right in thinking that it was to this spring that the city now represented by the Tel el-Hesey owed its importance. The spring would have borne the same relation to the old town that the spring of the Virgin bore, and still bears, to Jerusalem. When swollen by rain, the stream is capable of doing a considerable amount of mischief. It has washed away a large portion of the eastern and south-eastern sides of the mound, thus laying bare a section of the *tel* from its top to the bottom. This has proved, however, of invaluable service to the explorer, as the time at his disposal would never have allowed him to uncover a tenth part of the soil which has been removed by the water. Another season of work would have been needed before the lowest part of the *tel* could have been reached, and the history of the mound revealed, together with that of the pottery which is embedded in it. The kindly assistance of the water was the one piece of good fortune that fell to Mr. Petrie's lot, and he knew how to make the most of it.

On the southern and western sides of the *tel* is an enclosure, about thirty acres square, which is surrounded by a "clay rampart" still seven feet high in certain parts, and in one place by a brick wall. As there is but a slight deposit of earth within the enclosure, while nothing was found in it, Mr. Petrie is doubtless right in holding that it was intended to shelter cattle in case of an invasion. It probably belongs to the later period of the city to which it was attached.

The city is represented by the *tel* or mound. This rises to a height of no less than sixty feet, formed by the accumulated ruins of successive towns, the lowest of which stood on a platform of

¹ Article by A. H. Sayce, in *The Contemporary Review* for September.