A RESUMÉ OF SCIENTIFIC INVESTIGATIONS IN CONNECTION WITH THE MEDICAL DEPARTMENT OF THE LOCAL GOVERNMENT BOARD.*

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PATHOLOGY AND ETIOLOGY OF DIPHTHERIA.

IN continuation of his study of diphtheria, Dr. Klein has commenced investigation from a bacteriological view-point of the relations of that disease and croup. Inquiry in this sense has been the more called for since "croup" is a term of uncertain pathological significance, notwithstanding its abundant employment in registration of cause of death in various parts of the country. Taking the presence of the Klebs-Löffler bacillus (bacillus diphtheriæ) in definite relation with lesion of the mucous membrane, as determining the nature of maladies not considered clinically identical, Dr. Klein has tested one and another throat ailment that offered itself for examination, and with results as follows: He finds, as others have before him, that so-called "scarlatinal diphtheritis" occurring in the early days of scarlet fever attack, is not, judged from the bacteriological standpoint, diphtheria; and, on the other hand, that similar manifestations, whether of diphtheritic or croupy type, occurring in the later stages of and during convalescence from scarlet fever, are almost invariably true diphtheria. But he also finds, in the majority of cases examined by him, that membranous croup of the larynx or trachea, though altogether dissociated clinically from diphtheria, is to be regarded as essentially that disease; indeed, so far he has only met with a single instance of croup not related clinically to diphtheria or to scarlatina, in which he was unable, with the material at his disposal, to demonstrate the presence in the membrane of bacillus diphtheriæ.

CONCURRENT INFECTIONS.

With reference to the influence of one infection upon another, Dr. Klein has, as in former years, studied not only the interrelations within the animal body of different microbic processes, but also the effect therein on the life processes of a given microbe of introduction of the metabolic products of a different micro-organism.

And first, as to erysipelas and vaccinia. He sought to induce in the calf both these diseases. From the ears of a series of rabbits in which he had set up erysipelas, indifferently by inoculation of the raw material of that disease and of culture on gelatine of the streptococcus erysipelatos, he obtained active erysipelas infection in the form of serum expressed from the ears of the inoculated rabbits, as well as in the form of pure culture in gelatine of the erysipelas organism derived from the serum in question. These matters he inoculated—by multiple cutaneous incision of the skin

in the groin and abdomen—into calves; but always with one result, namely, complete failure to induce erysipelas in these animals. He next tried, also in calves, simultaneous inoculation of the above material together with fresh calf lymph, and also inoculation of the one material antecedent to the other. But on each occasion he obtained the following uniform result: vaccinia never failed to take and to run its course in orthodox fashion, whereas his attempts to induce erysipelas along with, or in sequence to, the vaccinia, failed entirely and always. As a result of these experiments, Dr. Klein has come to regard calves as altogether insusceptible to erysipelas disease. His further experiments with living microbes included simultaneous inoculation of: (a) the aerobic bacillus of malignant cedema and the bacillus of grouse disease; (b) the grouse bacillus and the Middlesbrough pneumonia bacillus; (c) the bacillus of mouse septicæmia and bacillus of swine erysipelas; and (d) the bacillus of fowl cholera and the bacillus of fowl enteritis. Mice, pigeons, and fowls were the animals experimented on in these series, but in series (a) alone were positive results of the nature of antagonism between the organisms of experiment obtained. The malignant cedema bacillus and the grouse bacillus when separately injected into mice were almost invariably alike fatal to these animals, and after an equal interval of time. But when cultures of these microbes were mingled together and the mixture injected into mice, the animals thus dealt with, almost without exception, easily survived, indeed, very few of them suffered any illness.

Secondly, as regards the chemical products of bacteria in their inhibitory action within the animal body on the life processes of pathogenic organisms, Dr. Klein has made further study of bacillus pyocyaneus as affecting the development of tubercle. So long ago as the winter of 1889-90—antecedent to the announcement by Professor Koch of "Tuberculin" as a material inhibitory of tuberculosis in the guinea pig—Dr. Klein was seeking to ascertain by experiment how far tuberculosis artificially induced in these animals could be retarded or controlled by subsequent repeated injection of the affected animals with sterilised cultures of the tubercle bacillus. But the results then obtained by him were negative; and, as noted in the report of the medical officer for 1890 (page 8), he was subsequently led to substitute in this connection the chemical products of bacillus pyocyaneus for sterilised culture of the tubercle bacillus. The "expectation that the chemical products of bacillus pyocyaneus will be found to have distinct inhibitory action on the tuberculous process," recorded by the medical officer in his report for 1890 has, as regards guinea-pigs been fully borne out by the experience of 1891-92. Several separate series of these animals were inoculated by Dr. Klein, some with material of human some with material of bovine tubercle, with the effect of producing in each

* From the report of the Medical Officer to the Local Government Board for 1891-92.

guinea-pig thus dealt with definite manifestation of commencing tuberculosis. As soon as tuberculosis was thus established in a series of animals, certain of them were repeatedly injected during successive days now with dilute now with undilute sterilised cultures of bacillus pyocyaneus, while others were kept for control. As a result the control guinea-pigs invariably died in the usual time of their induced tuberculosis, whereas in the guinea-pigs which after their inoculation with tubercle, had been subjected to injection of the products of bacillus pyocyaneus, the tuberculous process was found delayed or even arrested; indeed, so uniformly in this way was definite inhibition of tuberculosis (especially when undiluted culture of bacillus pyocyaneus was injected in considerable amount at frequent intervals) obtained by him, that Dr. Klein sought a further and more satisfactory test of this new method of controlling the development of tubercle. Short of the human subject, the bovine animal seemed to promise the best test in this sense, and accordingly Dr. Klein proceeded to experiment further on cows and calves. Unfortunately, however, Dr. Klein's attempts at setting up, by subcutaneous inoculation of active bovine tuberculous matter, tuberculosis in these animals practically failed in four cows and two calves experimented on by him; and so far he has not been able to make further trial of the inhibitory power of bacillus pyocyaneus in the direction contemplated.

CHEMISTRY OF DIPHTHERIA.

Proceeding on lines indicated by his former inquiry into the chemistry of anthrax, Dr. Sidney Martin, has, in 1891-92, made investigation of the chemical pathology of diphtheria and of infective endocarditis. As will be remembered, Dr. Martin, in his former researches respecting anthrax, ascertained first of all what were the chemical products of bacillus anthracis in an artificial medium of unorganized materials representing as nearly as practicable blood-serum, and then went on to the discovery that identical chemical substances (albumoses and an alkaloid) were obtainable from the tissues of animals dead of anthrax. In 1891-92 he reversed his process of investigation, first inquiring what are the chemical substances abnormal to the tissues which are separable from the blood and spleens of persons dead of a given disease, and what the physiological action of such chemical substances when injected into rodents; afterwards proceeding to ascertain whether identical chemical products, with like physiological action on rodents, are obtainable from artificial media in which the reputed microbe of the particular disease has been under cultivation.

Dealing in this fashion with diphtheria, Dr. Martin obtained alike from the blood and spleens of persons dead of that disease, from the diphtheria membrane of non-fatal cases, and from cultures in beef-broth of the Klebs Löffler bacillus, albumoses

and an organic acid which produced when injected into rodents definite physiological results of a nature parallel with those observed in the human subject attacked by diphtheria. Not least conspicuous among the physiological effects of these albumoses, and the more significant therefore as testimony to their essential "specificity," was the production in Dr. Martin's experimental animals of those nerve lesions which have obtained the name of diphtheria paralyses. And this circumstance has led to the pathological condition of the nervous system in man and in other animals associated with this paralysis, or rather paresis, being examined by Dr. Martin carefully and in much detail. He demonstrates it to be due to degeneration of the peripheral nerves (motor, sensory, and sympathetic), without implication of spinal cord, spinal ganglia, or brain; a degeneration, moreover, which he shows to be an early and direct result of diffusion in the experimental animal of the chemical products of diphtheria.

Of these chemical products Dr. Martin finds the albumoses far more potent physiologically than the organic acid, and it is to the albumoses of diphtheria that he would refer in the main the constitutional and neurotic manifestations of that disease. As to the sources of the poisonous albumoses, Dr. Martin points to some important indications that they, unlike the albumoses of anthrax, are not the direct outcome of the life processes of the bacillus with which they are associated, but are, so to speak, the product of its product. Thus, he found that an "extract of diphtheria membrane" with which he was experimenting, though it contained mere trace only of proto and deuto-albumose, caused when intravenously injected in definite and single doses into rabbits, more profound physiological effect than larger and repeated doses of diphtheria albumoses obtained by him from the blood and spleen. Hence he infers the existence in the diphtheria membrane of a poison associated with, but distinct from, the proteid; a poison which has been, in his view, excreted by the diphtheria bacillus at the seat of its local multiplication in the throat of the affected patient. This poison Dr. Martin regards as in the nature of a ferment, which being absorbed into the system is able to digest the proteids of the body, with the result of production of poisonous albumoses and organic acid, such as were obtained by him from the blood and spleens of diphtheria patients. The ferment in question he would term the "secondary infective agent," in distinction from the primary infective agent which in his view, as in that of others, is the bacillus diphtheriæ.

SUSCEPTIBILITY AND INSUSCEPTIBILITY.

Dr. Hamer, in continuation of his investigation of the chemistry of susceptibility and insusceptibility, has given attention to certain ferments

proper to the animal body, with reference to their power of retarding or inhibiting multiplication of different microbes. He experimented first with human saliva, and he found that a weak solution of this saliva, provided it be not boiled, may, notwithstanding it has been inoculated with bacillus subtilis, be incubated almost indefinitely and yet remain free from growth of that organism; and on the other hand, he found that a similar solution dealt with in like manner, but after boiling, quickly develops abundant growth of bacillus subtilis. Next he obtained, by macerating a dog's pancreas in glycerine, a pancreatic extract, which he added to different culture media in a series of test tubes, and incubated the latter, after inoculation with various kinds of bacteria, at suitable temperatures. In this series, however, no definite restraining influence of the ferment on the growth of the bacteria was observable, and a like negative result was obtained in similar experiments with the blood-ferment. Incidentally in the course of his experiments, Dr. Hamer obtained a pancreatic extract, which though proved absolutely sterile by independent tests, nevertheless liquefied gelatine without development of scum, or turbidity, or flocculent material such as is usually associated with the growth of bacteria. The experience of a material capable of exhibiting ferment powers altogether apart from coincident growth and development in it of micro-organisms may, Dr. Hamer notes, prove of service in the study of the action of unorganised as contrasted with that of organised ferments.

ORGANISMS AND SUPURATIVE PROCESSES.

The last paper of the series gives account by Dr. Andrewes of observation of pus in its effect on the vitality of bacteria. He sought to ascertain with respect to certain pathogenic and saprophytic micro-organisms how far pus is, as a culture medium, favourable or hostile to their life and multiplication. The samples of pus employed by him were from abscesses both acute and chronic; some samples contained, some did not contain, streptococcus; some had been sterilised by heat, others had not been sterilised; some were acid, and some were feebly alkaline. And the micro-organisms of experiment were the bacilli of anthrax and diphtheria, the hay bacillus, the proteus bacillus, bacillus prodigiosus, and staphylococcus aureus. These several microbes exhibited very different behaviour in pus as a culture medium, but for the most part they failed to multiply there. Among the pathogenic species, bacillus anthracis and bacillus diphtheriæ were found to be at opposite poles in this respect; the former, whether or not containing spores, failed under all conditions to multiply in pus, and, indeed, soon died out in that medium; whereas bacillus diphtheriæ not only maintained its vitality but actually multiplied in the pus into which it was introduced.]

QUALITY OF THE WATER SUPPLIED TO LONDON.*

THE quality of the London water in relation to the propagation of disease is a subject that may be examined either from the standpoint of theory or from that of experience, and it will be well to look at it from each point of view separately, so far as such separation is possible.

(1) *Theoretical Considerations.*—Whenever there are aggregations of human beings living in the neighbourhood of rivers, and discharging their sewage into the stream, there is manifestly a possibility, or indeed a practical certainty, that some, at any rate, of the pathogenic bacteria given off by the sick members of such communities will find their way into the water, and it is consequently held by some persons, and has been strongly urged upon the Commission by some of the witnesses that have appeared before it, that all water that has been liable to such contamination should be held as totally unfit for drinking purposes, and that no water should be deemed potable excepting such as has been collected from uninhabited and uncultivated, and therefore unmanured, ground; for that water, when once polluted in the way described, will remain so for an indefinitely long period, and that no subsequent treatment by filtration or otherwise can be trusted to free it from the pathogenic organisms that have once got into it.

In reply to this argument it is said that, though it is undeniable that some of the infective substances given off by persons suffering from zymotic diseases may and do find their way into the rivers, the amount of such substances that thus enter the Thames and the Lea is extremely small, and indeed infinitesimal in proportion to the enormous bulk of water with which it is then mixed; that there are moreover numerous conditions which lead to the destruction or elimination of the pathogenic bacteria during the flow down the stream, and afterwards during the sojourn of the water in the subsidence tanks and during the process of filtration; so that it is extremely doubtful, to say the least, whether a single one of these pathogenic bacteria will remain in the water as delivered to the consumer, or even in the unfiltered river water itself; that in spite of frequent examinations none have ever been detected in it; and that, even on the probable assumption that some few might exceptionally pass through the successive barriers to their entrance into the service pipes, they could not possibly be there in such number as to give rise to disease, which, according to all bacteriological researches, requires a certain quantity of such bacteria for its production.

Let us examine the evidence on which the successive allegations in this statement are based; and, in so doing, it will be best to confine our-

* From the Report of the Royal Commission on the Water Supply of the Metropolis.