PREVENTIVE MEDICINE SINCE 1869.

By Dr. C. J. Martin, F.R.S.

PREVENTIVE medicine is concerned with the application of knowledge to the prevention of disease. To this end all the sciences have been laid under tribute, but physiology, pathology, bacteriology, and epidemiology to the greatest extent, as these have the more immediate bearing.

The rapid progress of preventive medicine during the last half-century is due primarily to the increase of physiological and pathological knowledge, and pre-eminently to the completer understanding of the process of infection which has been acquired during this period. So long as defective development and disease were regarded as wholly constitutional or inherent in the individual, the only prospect of improvement lay in the weeding out of the unfit by the ruthless process of natural selection. A greater hopefulness has, however, arisen as the part played by prejudicial environmental conditions, such as improper feeding and housing, undue fatigue, the abuse of alcohol, and, above all, the invasion of pathogenic agents, was realised.

By the end of the 'sixties the necessity of supposing a *contagium vivum* as the cause of many diseases was fairly generally recognised. Pasteur's researches on fermentation and putrefaction had led him to the opinion that infectious diseases might be interpreted as the result of particular fermentations due to specific microbes, and it was the ambition of his life to substantiate this conception. Lister had launched his antiseptic methods on the basis of Pasteur's work, and these were already beginning to revolutionise surgical practice. Villemin had just demonstrated that tuberculous diseases, hitherto regarded as "constitutional," were due to a common infective agent capable of multiplying indefinitely in the bodies of animals and of being handed on from one animal to another by inoculation. Hitherto, however, although various microscopic organisms had been found to be associated with disease, and indications had been obtained of their ætiological significance, not one of them had been isolated. The causal relationships claimed were thus unproven and much of their life-history unknown.

The first isolation and propagation in pure culture of a pathogenic organism took place in 1876, and was accomplished by Koch in the case of a bacillus derived from cases of splenic fever or anthrax. Inoculations of cultures made *in vitro* into animals reproduced the disease. Progress in bacteriological discovery remained slow until in 1880 more appropriate methods for the isolation of bacteria were derived by Koch. Then followed a period of extraordinary fertility. Within fifteen years the causal agents of cholera, typhoid fever, diphtheria, tuberculosis, various types of suppurative processes, gas gangrene and erysipelas, glanders, gonorrhœa, pneumonia, food poisoning, meningitis, Malta fever, leprosy, and plague, as well as of a larger number of diseases of animals, were discovered.

The discovery of pathogenic agents of another kind soon followed. The association of relapsing fever with the presence of a minute motile spiral organism in the blood was observed by Obermeier in 1873. Later, a number of diseases of man and animals were found to be caused by various spirochætes, most important among them being relapsing fevers, syphilis, yaws, and infective jaundice.

In 1881 Laveran described the parasite of quartan malaria. This observation was followed by the discovery of more than a hundred microparasites belonging to the protozoa which are responsible for diseases in higher animals. The most important human diseases due to protozoan parasites are the three types of malaria, sleeping sickness, and kala azar.

Another class of pathogenic agents which is already known to be responsible for upwards of thirty separate diseases of man and animals remains to be mentioned. These viruses are either on the margin of visibility or invisible with the microscope. They are so small as to pass through biscuit porcelain. The causal agents of infantile paralysis, yellow fever, *molluscum contagiosum*, dengue fever, the three-day fever of the Mediterranean, and typhus fever belong to this category, as well as those of many important animal diseases, as rinderpest, horse sickness, and foot-and-mouth disease, and there are a number of indications that the infective agents of the common exanthemata—measles, scarlet fever, smallpox—are at some period of their life-history so small as to be included amongst the "filter-passers."

Since 1880 the ætiological factor of most human maladies has been brought to light. A correct ætiology is fundamentally necessary, but for preventive measures mere identification of the cause of a disease is not sufficient. The life-history of the parasite within and without its host, and particularly the channels and method of entrance and exit, must be known if a successful attack is to be made upon it. Indeed, some of the most striking triumphs of preventive medicine have been gained in the case of diseases in which the virus had not been seen or isolated (such as hydrophobia, yellow fever, and trench fever), but in which, nevertheless, many properties of the virus and the method whereby it effected entrance and exit had been revealed by experiment.

In the first half of the period under review researches were more particularly directed to the discovery and isolation of the causative factors of disease; the latter half, for the reasons outlined above, has been characterised by the amount of knowledge gained regarding the details of the life-history of various parasitic agencies, the maintenance of the infection in the absence of obvious cases of the malady, and the transmission of the infective agent from one individual to another.

If the infective agent is present in a superficial lesion, as in smallpox, syphilis, diphtheria, or pneumonia, or passes out with the excreta, as in cholera and typhoid fever, more or less direct transmission can occur, but in the case of a parasite situated only in the blood or internal organs it was for long a mystery how the disease was transmitted. The secret was revealed by the discoveries of Manson, Smith, and Bruce on filariasis, red-water fever, and Nagana, showing that in these diseases mosquitoes, ticks, and tsetse-flies respectively acted as transmitters. These observations were soon followed by those of Ross on the transmission by mosquitoes of malaria, and afterwards it was shown by the American Commission that yellow fever also was transmitted by a particular species of mosquito.

Relapsing fever, sleeping sickness, and bubonic plague were also found to be spread by the agency of insects; ticks or lice in the first case, a tsetse-fly in the second, and fleas in the last, and the most recent addition to the list is trench fever, which has been proved to be louse-borne.

The dependence of these maladies for their dissemination upon particular species of insects has afforded a long-looked-for explanation of their distribution—*e.g.* sleeping sickness, yellow fever, and dengue—and the very extensive investigations into the life-history of the parasites and their insect hosts has enabled the sanitarian to choose the stage in the cycle most convenient for attack. He could strike at the enemy whilst it was resident in either host or indirectly by preventing the insect from biting the patient and other individuals until in course of time the infection died out. By netting-in patients suffering from yellow fever so that mosquitoes could not attack them, and at the same time insisting on the removal of all small collections of water in the neighbourhood of habitations in which these insects were wont to lay their eggs, Gorgas rid the city of Havana of yellow fever. By a campaign on similar lines against malaria-bearing species of mosquitoes, the Isthmus of Panama was converted into a health resort. Equally satisfactory results have followed elsewhere when it has been possible to institute equally thorough measures.

Before leaving the subject of infection, I must not omit to mention that biological discoveries regarding the life-history of the parasitic worms —*e.g.* the hookworms and Bilharzia—have shown how diseases caused by this class of parasites could be successfully controlled.

It has not often been found possible to eliminate the cause of a disease. In some cases knowledge has not been sufficiently complete. In others its application has been too difficult, and it has been found impracticable sufficiently to control the lives of the population. In many such cases, however, preventive medicine has another arrow in her quiver. This is aimed at reducing the susceptibility of a population to a particular infection by protective inoculation. The earliest effort of preventive medicine along these lines was that of inoculation against smallpox practised in Asia for some centuries and introduced into England in 1721 by Lady Mary Montagu. Cutaneous inoculation of smallpox usually produces a local and comparatively mild illness, but the method suffers from the disadvantage that it propagates the virus of the disease. Jenner's vaccination with cow-pox—a modified virus—obviated this disadvantage.

With the discovery of the microbial origin of disease, Pasteur saw that the principle of Jennerian vaccination might be further exploited, and in 1881 successfully employed attenuated cultures of the microbes of splenic fever and chicken cholera to protect flocks and poultry against the depredations of these diseases.

In the case of man, the possible danger from the employment of living cultures of the germs of fatal diseases led to researches to determine whether the injection of the microbes which had been killed by heat or chemical agents also induced some measure of protection against a subsequent inoculation with living virulent organisms. By experiments on animals this was found to be the case, and the use of such bacterial "vaccines" was employed by Haffkine to protect man against cholera and plague. Shortly afterwards Wright and Semple elaborated a similar method of protective inoculation against typhoid fever. Anti-typhoid inoculation has been extensively used. The experience in the British and American Armies during the last fifteen years has been that a material reduction in the incidence of the disease has occurred amongst inoculated troops.

The greatest triumph of preventive medicine during the late war was the comparative rarity of typhoid fever amongst our troops. This was the case not only in France, but also in military operations in other areas, where the conditions were such that satisfactory hygienic measures could not be carried out. No other explanation of this freedom from enteric is forthcoming other than the periodic prophylactic inoculations to which our armies were subjected.

So far I have dealt exclusively with infection by living pathogenic agents. I make no apology for so doing, for the great developments in preventive medicine throughout the world which are characteristic of this period have been due to the impetus given by the conceptions of Pasteur and the methods of Koch.

At the same time, knowledge in all departments of physiology and pathology has steadily, though less dramatically, progressed. The increased understanding of animal nutrition must, owing to its important bearing upon the maintenance of the health of the peoples, be briefly referred to.

Before the period under review Pettenkofer and Voit had been able to strike a balance-sheet of the net in-goings and output of matter by the animal body. Within the last fifty years the applicability of the principle of conservation of energy to animals has been established by Rubner. The energy-value of the important foodstuffs has been ascertained, and the requirements of the human body under various conditions of age, climate, and occupation have been determined.

This knowledge has been inadequately exploited because everyone prefers to be a law unto himself in the matter of food intake. It has served as a basis for the rationing of armies and for the construction of institutional dietaries. During recent years, however, it has become increasingly apparent that man cannot live on protein, fat, and carbohydrate alone, but that a diet must contain in addition small quantities of what, until they can be isolated and identified, have been designated "accessory food factors." The best example of these is the for long recognised anti-scorbutic substance in fresh vegetables and fruits. The existence of at least three accessory food substances has been since established. For all of these the animal is dependent directly or indirectly upon the vegetable kingdom. An insufficient supply of any one of these leads to trouble. If one of them is inadequate, scurvy results; deficiency of another leads to the disease beri-beri; and if deprived of the third an animal fails to grow. There appears also to be no doubt that rickets in children is due to a similar cause.

This knowledge has for long been utilised to prevent scurvy. Where it has been intelligently applied it has eliminated beri-beri from coolie-camps, the population of jails, and industrial communities of the Far East, and if it is utilised in the efforts to feed the famished population of the unfortunate countries of Eastern Europe it will be the means of saving thousands of young lives during the ensuing winter.

Science has also been successfully applied in recent years to the diminution of the dangers incident upon certain industrial occupations, such as mining, caisson working, and deep-sea diving. During the last ten years, too, the influence of industrial fatigue, alcohol, improper atmospheric conditions in workshops, etc., upon the health and efficiency of the worker has been seriously studied. In these inquiries America has shown the greatest energy, but in Britain the subject is beginning tc receive the attention its importance demands.

It is impossible to assess the effect of preventive medicine and improved hygienic surroundings upon the health and happiness of mankind; but the influence upon longevity can, in the case of civilised communities, be determined. During the last fifty years upwards of ten years have been added to the mean expectation of life of a child born in Britain or in the United States of America. An increase of 25 per cent. in so short a time is cause for congratulation, but, on the other hand, the fact that a million young men were found unfit for active service indicates that all is not well with Britain.

We are still far from the possession of sufficient knowledge to regulate satisfactorily our environment or to avoid all noxious influences, but owing to lack of power, money, or sometimes sense, we apply far less than we possess.

THE ANTIQUITY OF MAN

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AT the beginning of the Tertiary period, when mammals began to spread widely over the world, they were all very small and so uniform in character that it is scarcely possible to classify them into groups or orders. They all had a comparatively small brain of a simple kind, and as in course of time they became gradually subdivided into the groups with which we are now familiar, the brain increased both in size and effectiveness, while many of the animals themselves grew larger. In the middle and towards the end of the earliest Tertiary (Eocene) epoch some of the low-brained hoofed mammals attained their greatest size and then became extinct. Next in the Oligocene another group with somewhat improved brain grew even larger just before extermination.

In the following Miocene epoch several groups that had by that time acquired a still more efficient brain, such as rhinoceroses, horses, certain carnivores, and primitive elephants, attained a comparatively large size and soon reached their maximum in the Pliocene. About the middle and towards the end of the Miocene epoch true apes, with a higher development of brain than any mammal up to that time had acquired, also began to grow to as large a size as most of the apes of the present day. It may therefore be predicted that the earliest remains of the largest members of the ape-series, with a truly overgrown brain—the great ground-apes which were the immediate forerunners of man—will not be found in rocks of older date than the Pliocene, and probably not in any but the latest of this epoch. For other reasons Sir William Boyd Dawkins came to the same conclusion so long ago as 1880, and as discoveries progress it becomes increasingly clear that true man, of the family Hominidæ, cannot be earlier than late Pliocene or the dawn of the Pleistocene.

So few fragments of apes and man have hitherto been met with that it is difficult to decide upon the region of the world that may be most hopefully searched. If, however, conclusions may be drawn merely from teeth, the most promising field at present seems to be south-central Asia. By the discovery of such teeth, Dr. Pilgrim has