already complaining of the large amount of work and the large number of committees which they are expected to attend.

The advocates for placing all sanitary matters under the county councils would have us believe that the members of these councils have a much higher sense of duty than the members of rural district councils, but this certainly cannot apply to all county councils, as, notwithstanding the permission given in the Local Government Act of 1888 to appoint medical officers of health, a certain proportion of county councils did not avail themselves of this privilege, and, indeed, only grudgingly appointed such officers when compelled to by the Housing and Town Planning Act of 1909.

DEFORMITIES.—When not due to tuberculosis serious deformities are generally the result of infantile paralysis. The newer methods of modern surgery, such as muscle grafting, nerve grafting, and tendon transplantation have extended the field of treatment of paralysis and deformities, and in experienced hands often yield brilliant results. Unfortunately, only a small percentage of crippled children at present can obtain admission into orthopædic hospitals. The after cure of these cases is beset with numerous difficulties, walking or other apparatus is frequently needed. It is as a rule costly to obtain, and under the wear and tear of school life is apt to get out of order, and as growth proceeds not infrequently becomes useless. It is clear that crippled children require more supervision and after-care than can be bestowed under the present conditions. They are in many instances anæmic, weakly, ill-fed, and badly clothed, an easy prey to the first serious illness which may attack them. On leaving school, cast on the world without a trade, shut out from the ranks of unskilled labour by their physical inability to compete with the able-bodied, left to themselves they go to swell the ranks of the unemployed and destitute. On the other hand, with proper treatment of the defect, and efficient after-care, they may become highly skilled workmen and valuable members of society. —*Joseph Cates, M.D., D.P.H., Annual Report, Medical Officer of Health, Lancaster.*

APPOINTMENTS.

JOHN DEAN BUCHANAN, M.B., B.Ch., B.A.O.R.U.I., D.P.H., Viet., has been appointed medical officer of health of Lancaster.

WILLIAM ARNOTT DICKSON, M.D., Ch.B., St. And., F.R.C.S., Edin., D.P.H., has been appointed tuberculosis officer for Gloucestershire.

ANDREW LESLIE DYKES, M.D. Edin., D.P.H. Lond., has been appointed assistant medical officer of health of the County Borough of Oldham.

RORY MCLAREN, M.D., D.P.H., has been appointed assistant county medical officer of health for Dorset.

THOMAS HENRY PEYTON, M.D., B.Ch., B.A.O. Dub., D.P.H., has been appointed tuberculosis officer for Cheshire.

Wigan Education Authority have unanimously decided to appoint MRS. ALICE STALKER, M.B., Ch.B., D.P.H., to the position of assistant school medical officer and assistant tuberculosis officer.

"THE EVOLUTION OF EPIDEMICS"*

BY J. T. C. NASH, M.D. (Edin.), D.P.H. (Camb.).
(President of the Eastern Branch of the Society of Medical Officers of Health.)

Being a brief epitome or précis of Chadwick Trust Lectures I., II. and III., on the Evolution of Epidemics.

THE evolution of disease implies and involves the evolution of *ideas* of disease as well as of causes—the resultants being the labelled phenomena. Hence the importance of careful observation of phenomena objective and subjective, and of subsequent philosophic reasoning concerning such phenomena before pronouncing a judgment. The *history* of disease should be traced back to broaden the outlook and engender liberality of sentiment.

Neither Chadwick nor Pasteur were medical men, but both played great pioneer parts in preventive medicine, both making and recording observations and then applying philosophical induction.

My first lecture embraced a brief historical survey of some of the more remarkable epidemics of the Middle Ages, obtained chiefly from the writings of Hecker and Creighton. There is almost total lack of contemporary expert information—the medical men of the day being apparently galenically hide-bound and lacking in independent philosophy. But from ecclesiastical, municipal and other records we gather the striking fact that the Middle Ages were years of great human misery and of cataclysmic natural phenomena, such as earthquake and flood. The lower classes were extremely indigent and their dwellings were in a frightful condition of concentrated filth, as recorded by Erasmus. The mud floors were strewn with rushes, which, when impregnated with all manner of putrefying filth, were simply covered over with fresh rushes—covering over, *but not removing, the ghastly mass of decomposing filth already there.* In Britain, after "The Great Plague of Cadwallader's time" in the middle of the 7th century (the exact nature of which is uncertain), the pestilences for the next seven centuries appear to be, according to Creighton, mainly the results of famine; but various periodical, sudden and fatal outbreaks, affecting monastic communities, were probably fresh outbreaks of genuine plague. The feudal system was responsible for much misery. It is stated that in the reign of William Rufus the incubus of excessive tribute apparently led to famine through no less remarkable a cause than a refusal to cultivate the land. Such times of

* President's Address at Annual Meeting of the Eastern Counties Branch of the Society of Medical Officers of Health.

misery and lawlessness, with barbarous invasions by Scots and Celts, civil wars, baronial cruelties and predations, all contributed to the dire famine of 1143, when people ate the flesh of dogs and even the raw garbage of herbs and roots. Better times followed in the reign of Henry II. A five years' famine in 1193-97 was accompanied by a pestilential fever; and famine and pestilence prevailed again in 1203 and after the hard frosts of 1205. In 1256-59 famine was accompanied by remarkable scarceness of money, owing to the exactions of King and Pope, so that even men of good position felt the pinch of hunger. The last of the great famines was in 1315. A new chapter in the history of English epidemics was opened by the advent of the Black Death in 1348. England was, however, singularly free from the epidemics of "ergotism" which raged in France in the 14th century, probably due to rye-bread being but little eaten in England as compared with France.

Let us for a moment refer to the astonishing psycho-pathies or neurotic epidemics of the Middle Ages, more particularly the dancing manias, which illustrate how, in crowds, "ideas, sentiments, emotions, and beliefs possess a contagious power as intense as that of microbes" (Le Bon, "The Crowd," p. 128). "The convulsions in the most extraordinary manner infuriated the human frame, and excited the astonishment of contemporaries for more than two centuries" (Hecker). Something of the sort may still be seen in connection with devil worship or other heathen rites. Wretchedness and want, combined with superstition and unusual excitement, had apparently much to do with these extraordinary disorders, which gradually became mitigated under military conditions. Apart from superstition, however, men's minds were everywhere morbidly sensitive through frightful calamities and pestilences of a magnitude rarely known in these days. Even decided sceptics were so vulnerable to these influences that they were subdued by a poison, the effects of which they had ridiculed, and which was in itself inert. Hysterias were common, and women (especially in Italy) led idle, lonely and miserable lives, and so were peculiarly susceptible to ecstatic attacks excited by the delights of music, which furnished a magical means of exorcising their melancholy.

From the preceding remarks, it becomes evident that a knowledge of contemporary circumstances which attended the development of visitations of disease which in the course of ages have appeared in divers forms, renders clearer our insight into the nature of disease. We are, therefore, naturally in a better position to trace evolutionary factors than our predecessors, though our successors again will have the advantage of us.

In the evolution of medical science two distinct tendencies diametrically opposite are in evidence:—

(1) A tendency to differentiate as distinct affections diseases which had been included under one common designation;

(2) A tendency to determine a persistency of type running through a long series of disorders of various designations.

Variation in the birth-rate and death-rate is only the most obvious and numerically precise of a whole series of variations in vital phenomena, such, for instance, as the apparition and vanishing of leprosy in mediæval Europe. Comparisons may be drawn between leprosy and pellagra—another disease with profound disorder of the nerves—and as regards the causation of both these diseases there are two camps of opinion, according as to whether it is held that the cause of each is something noxious in the dietary or not.

It is conceivable that a common saprophyte may, under different evolutionary conditions, such as semi-putrid fish on the one hand or semi-putrid vegetable on the other, under varying conditions of season and light, become a lepra bacillus in the one case or a pellagra micro-organism in the other. It is, however, equally likely that the somewhat similar nervous symptoms in leprosy and pellagra may be the results of interaction between susceptible tissues and two quite distinct organisms. Recent research suggests that both leprosy and pellagra are insect-borne diseases. Ravbitschek's and Charlton Bastian's observations illustrate the enormous evolutionary importance of light and heat in the production of primordial life.

When studying the history of plague in England I remarked that the 15th century theory that bubo-plague was due to a cadaveric poison fitted in with both Pettenkofe's ground water fluctuation influences and the most recent rat theories, as regards the causation of plague. Plague came in Europe in the age of feudalism and of walled towns with a cramped unwholesome manner of life and inhabited spots of ground choked with the waste matters of generations. Plague as an entity was

endemic in Britain for more than 300 years, although probably all the records of "pestes" were not outbreaks of bubonic plague. After 1420 it became more and more a disease of the towns. Parliament was frequently adjourned from Westminster on account of the infection in London. "Change of air" meant more than it means now.

Between 1500 and 1521 plague appears to have been regularly prevalent in London, especially severe in 1513-15. Yearly references occur again from 1526-1532. The first known reference to the London Bills of Mortality is made in 1532, the first weekly bill showing 99 deaths in the City from plague, and 27 deaths from other causes. In 1539, parish registers of the births, marriages and deaths began to be kept. By this means we can henceforth trace the existence of epidemic disease which might not have been suspected. Curiously, the reigns of Edward VI. and Mary, full of trouble as they were in other ways, furnish hardly a single record of plague; but a very severe epidemic occurred in London in 1563, more particularly in the latter half of the year, reaching an average of 1,350 deaths a week from plague in September—the total mortality in 33 weeks was 16,586, or an average of abont 500 deaths a week. The most probable determining factor of this sharp outbreak was the re-accumulation of a susceptible population during a non-epidemic interval of a dozen years, the incidence rate rapidly falling when once this non-immune pabulum was exhausted, but never quite disappearing. Very little sanitary provision was made, until in 1518 a quaint form of notification was required in Oxford. The first plague order of which the text is extant was issued in the thirty-fifth of Henry VIII. (1543), and provided for notification, quarantine, destruction of infected straw, etc. A clause provided for the cleansing of streets, etc., and there were special clauses relating to dogs and beggars. In the light of present-day knowledge we may surmise that dogs and beggars harboured infected fleas.

Queen Elizabeth ordered bonfires in the streets in the evening to consume "the corrupt airs." An unfortunate order, dated September 30th, 1563, attempted to shut up the foul air of infected houses. This was apparently revoked in January, 1564, when a more sensible order required a general cleansing and airing of houses, bedding and the like. A most essential means for controlling plague was the institution of "searchers" for cases and contacts. These "searchers" became a regular institution in 1578.

One thing, however, that was not touched by the sanitary policy of the day was the disposal of the dead, and the old city churchyards became scandalously overcrowded and the earth incapable of effecting oxidation of the bodies.

Plague was prevalent both in Scotland and Ireland also throughout the Tudor period, which closed with a severe epidemic at Stamford, which began in 1602. A severe outbreak in Scotland in 1568 gave occasion to the first treatise in English upon the subject by a Dr. Skene of Aberdeen.

The last period of plague in England, from 1603 to its extinction in 1666, was as fatal as any known.

In my second Chadwick Lecture I suggested that in comparing the "sweating sickness" of the later Middle Ages with modern influenza we gain an insight into evolution in thoughts and ideas as well as in actual disease processes. The "sweat" type of disease was first recorded in England in 1485, and the attacks were of dramatic suddenness and fatality; the progress of the "sweat" in 1529 was noted as "like an influenza, reversing the order of its usual direction."

Its first introduction into England was supposed to be through the mercenary troops from Rouen who accompanied Henry VII. They were natives of a region in which a sweating sickness had long been indigenous. Influenza is essentially a protean disease, showing changes of type, which gave rise to many different titles at different times, including "stop gallant," "new acquaintance," "jolly rant," "la grippe," "hot ague," "catarrh," etc.

The persistency of fundamental types in disease, in spite of well-marked variations—the evolutionary results of environment—is really remarkable. A noteworthy peculiarity of influenza is its tendency to relapse, thus differentiating it from the majority of well-defined infectious diseases, where one attack confers, as a rule, a high degree of immunity against further attack. In March, 1906, in a paper on "Evolution in Relation to Disease," I suggested that some well-recognised diseases had become largely specialised types, through evolutionary factors on certain fairly definite lines (fairly defined for each special type) gradually influencing the life processes of some common ancestral saprophytic organism, more particularly in its environmental relation to man in various countries. In this way specialised varieties of a common ancestral protoplasm,

or germ, would be evolved, and under similar environmental conditions would naturally tend to breed pure, and produce fairly specific toxins giving rise to fairly specific reactive phenomena in human animal tissues, rendering diagnosis simple.

Two diseases of very stable specific type, viz., measles and smallpox, illustrate what is meant by specific disease, but, strange to say, although measles is so constantly with us, and smallpox is generally so distinctive, and is yet common enough in various parts of the world, no causal germ has yet been definitely recognised for either disease. Certain other "specific" diseases have been found to be due to the life-processes within the blood and tissues of higher forms of life than mere bacteria. I need only mention malaria as an example of such. As regards smallpox it appears to have been known in China since 1200 B.C., and in Europe since the 6th century. Until recent times it was characterised by the enormous areas affected and the malignant type of the disease. One of the oldest known medical works on the subject is by an Arabian physician —Rhazes—in the 10th century, who quotes extracts from an Egyptian physician who practised in the 7th century. In the same century smallpox appears to have been known in Ireland, but not to have been recognised in England until the 10th century. The first known English work on smallpox dates only from the end of the 16th century. In pre-vaccination days smallpox in Great Britain showed a periodic intensity of prevalence every three, four, or five years, but during the latter half of the 19th century, since vaccination was made compulsory in 1851, only one wide-spread epidemic occurred in 1871-72, when smallpox overran Europe and America; but it must be clearly remembered that vaccination was not the only measure in force, and compulsory notification, disinfection, isolation, "following up" of contacts throughout the incubation of the disease, all assisted in limiting the spread of infection and widening out the inter-epidemic periods.

The striking resemblance in many of the phenomena of smallpox and of measles make the latter disease one of peculiar interest at this juncture, and it is not outside the bounds of possibility that an original saprophyte evolutionised on different lines, tending specifically to measles on the one hand and to smallpox on the other. Such diseases as rubella, the so-called "Fourth disease," and the so-called "Dunn's disease," may be further evolutionised forms of reactive phenomena due to special environmental conditions. The old term "morbilli," or "measles," covered, no doubt, what is now differentiated as scarlet fever and diphtheria. In 1906 I referred to certain bacteriological evidence suggesting that both scarlet fever and diphtheria may be fairly specifically evolutionised conditions arising from one common parental saprophyte under slight variations in environment. As regards measles, undoubted restraining influence can be exercised on the disease by steps taken by the education and health authorities acting in close conjunction, preferably through one common medical officer versed in public health and state or preventive medicine, as well as in general medicine. The diagram on the wall shows clearly the control obtained over measles in Southend-on-Sea since 1912, when I acquired early school notification of measles, which has ever since been kept up.

In the course of the 19th century public opinion gradually became intolerant of overcrowding and the grosser insanitary conditions of towns. Towns and villages entered on a period of unparalleled growth to meet the new industrial conditions which followed the introduction of factories, and the country districts sent the best of their young manhood into the towns to meet the demands for labour. People had not yet learnt the dangers of aggregation and the consequent soil-polluting, water-polluting, atmosphere-deteriorating and insect-contaminating collections of refuse. These conditions bred sickness and consequent poverty, and sanitary administration was evolved from an enquiry into these conditions.

In Norfolk, a sparsely populated county, one wonders why, with so much available space, villages should have their cottages crowded together with inadequate yard or garden space. The cure of such faults transmitted from our ancestors will naturally take time, public energy, and public thought. Medical officers of health need the unstinted support of public opinion in order to propose the strong and radical measures necessary to deal with the evils so clamant.

To Chadwick, as a pioneer in recognising that overcrowding is the greatest factor in the evolution of epidemic diseases, we owe a boundless debt of gratitude.

I dealt in my third Chadwick Lecture with the present-day scientific evidences of evolution. Many medical scientists who do not profess to

believe in the special creation of ordinary animal genera and species each after his kind, as suggested in the First Book of Moses, yet paradoxically believe in the absolute specificity of epidemic diseases, and disease germs, as descending from, and always reproducing their like, in unchanged form.

A considerable minority have expressed a more philosophical breadth of view, insisting on the application of the laws of evolution to disease processes. The present lecturer also can claim to have made several contributions on evolution in relation to disease and disease germs since 1901; and Professor R. T. Hewlett was one of the earliest of bacteriologists to trace biological affinities between two forms of bacteria which are looked upon by the specificists as absolutely distinct and unconnected with each other. I refer here to what are known as Klebi-Löffler and Hoffman bacilli.

The present-day scientific evidences of evolution in relation to disease may be gathered from:—

(a) Field work epidemiology—based on painstaking investigation and accurate clinical observation apart from laboratory aid.

(b) Systematic, day-to-day bacteriological observations in the laboratory from infected mucous membranes, or discharges, or the blood, or otherwise; not neglecting, as is too often the case, the study of natural conditions and symbiotic relationships.

(c) Philosophical logical deductions based on (a) and (b).

Two important phenomena stand out and mark the evolution of the organic world: One is the actual existence of different species, their differentiation in groups, the increasing complexity of organisms, their evolution from the lowest to the highest forms—the other is the adaptation of living things to the conditions and necessities of their environment.

No biologist will ever again consider natural selection as the only factor. Roux's theory of functional stimulation beginning with embryonic life in more highly organised creatures, affords a solution of the difficulties which exist in explaining the hereditary transmission of acquired characters in higher forms of life.

As regards bacteria, however, I wrote in 1901 that "organisms of the most primitive type pass through many generations in the course of a few hours, so that a few days or a week of ordinary time might in the life history of a bacillus correspond in generations to a geological epoch in the history of the human race," and pointed out that experiments proved that as regards *environment* in the matter of temperature, atmosphere, pabulum, and other physical conditions, minute *micro-organisms are exquisitely sensitive* to changes of a degree so slight, that they are inappreciable to more highly-organised—that is more specialised—creatures. Sir W. J. Collins, in his paper on "Specificity and Evolution in Disease" many years previously, had remarked, "It is reasonable to believe that in organisms whose cycle may be less than an hour, and whose rate of propagation is incalculable, that evolution must be powerfully at work." Remy expressed in 1900 his conclusions from a large number of experiments, that the difficulty of isolating the typhoid bacillus from fluids in which it had been existing with bacillus coli was not due to the disappearance of the typhoid bacillus, but to modifications in biological characters. When a specific bacillus is pushed too far by the absolute specificist, he has to invent new names for bacteria giving rise to symptoms almost, or quite, alike, but differing slightly in some one or two chemico-physical properties.

Baerthlein's recent experiments show that bacterial mutations occur regularly, but suddenly, under defined environment; the changes being transmitted to following generations under the same conditions—the mutations affecting the morphological, biological, and serological relations of the bacteria. Some bacteria, such as B. typhosus, have several mutative forms—but all such forms tend to return to the original form when the biological environment is made as like the original conditions as possible.

Drs. Thiele and Embleton concluded from a number of experiments that the pathogenicity of bacteria is largely an evolutionary process, due to environmental conditions in the tissues of a susceptible animal.

Mr. Sidney Turner, M.R.C.S., F.L.Z., in 1894 tersely defined zymotic disease in general as *life in the wrong place*.

In dealing with biological problems we have to do with complicated *historical* processes related to a far-reaching past, and hence only to be *approximately* estimated. Hence we have to proceed by *induction*, with proportionate confidence from the accumulation of detailed observations. The figures given by individual observers are too few to permit of general conclusions from them. Those given by the

Registrar-General are perhaps of sufficient magnitude to enable allowances to be made for errors of observation, etc., and yet to allow of broad inferences being drawn. These show that in each succeeding decade the population is becoming more able to resist tuberculosis, an evolutionary factor of much importance. Sir Hugh Beevor, Bart., in 1900, showed so regular a general diminution in rural phthisis as to cause him to state that it was cogent evidence of the insignificance of case-to-case infection.

Generally speaking, I consider that the history of phthisis prevalence shows for tuberculosis, as for infective diseases as a whole, evidence that when a disease has been endemic in a community for a considerable period of years, it tends to lose its virulence and becomes of a milder type. Sir Douglas-Powell believes the infection is a distributed one rather than a person-to-person contagion, and thinks, as I also do, that the tubercle bacillus is evolutionised from a saprophytic streptothrix.

As regards the present-day scientific evidences of evolution, the facts gathered from (a) field-work epidemiological observation were cautiously stated by Sir R. Thorne-Thorne in April, 1878. His observations were chiefly in connection with diphtheria outbreaks, and led him, by induction, to conclude that the facts appeared to indicate *a progressive development of the property of infectiousness.* Dr. Roberts and Dr. Hubert Airy, about the same time, pointed out that the laws of variation seemed to apply in a curiously exact manner to many of the phenomena of infectious diseases, and Dr. Airy, from a Darwinian point of view, insisted that all forms of life, including disease-producing bacteria, are undergoing slow but perpetual changes in coaptation with the peripheral changes of the complex scenery of their existence.

In 1881 Sir William Collins urged the importance of applying the doctrine of evolution to the elucidation of the nature and origin of specific diseases. In 1891 Colonel A. M. Davies, R.A.M.C., showed that Murchison's theory of the pythogenic or "de novo" origin of typhoid fever could be explained on the hypothesis of evolution of pathogenic properties on the part of a previously saprophytic organism; and in the discussion on my paper on "Evolution in Relation to Disease," in 1906, Col. Davies gave several instances from *vegetable pathology* (in which the surrounding conditions are more under control than in the case of man) which served to corroborate the evolution of pathogenic properties in micro-organisms, which constituted the thesis of my paper.

As regards scientific evidences of evolution from the bacteriological or laboratory side, Professor Greenfield observed an evolutionary phase—in the modification of virulence of the anthrax bacillus—which he communicated to the Royal Society in 1880. Ten years later, Professor Sims Woodhead stated that pathogenic bacteria, grown under unusual conditions, underwent changes either in the direction of losing power of developing in living tissues, or of developing a virulent specific poison. He stated that modification of function, due to delicate metabolic changes, would sooner be in evidence than coarser morphological modifications.

In a long series of experiments, Prof. Hewlett and Miss Knight obtained connecting links between the Klebs-Löffler bacillus of diphtheria and the pseudo-diphtheria bacillus.

In 1906 I was able to state, from a large clinical, epidemiological and bacteriological investigation of diphtheria between 1899 and 1906, that from my own observations with frequent swabbings from numerous diphtheric cases at various stages of the disease under daily observation, even morphological modifications were often detectable in the course of a few days (representing, of course, innumerable generations of the organisms).

Sir William Collins, in his paper entitled "Man *v.* the Microbe," gave quotations from that most eminent of bacteriologists—the late Professor Robert Koch—that to combat pestilences successfully we must strike at the root of the evil, and direct sanitary measures to the *environment* of mankind, such as the destruction of vermin, the purification of water, the prevention of contact between the infected and the sound, to make our practice accord with the latest discoveries of science, thus completely justifying "the sanitary idea" of Chadwick, Benjamin Ward Richardson, Alfred Carpenter, and other of the older pioneers in public sanitation.

DIPHTHERIA IN ABERDEEN.—Referring to a recent return showing an increase in the notifications of diphtheria Dr. Matthew Hay, the medical officer, states that no definite reason can be assigned for the outbreak, which is not confined to Aberdeen. In every part of Scotland diphtheria is prevalent, and has been so for the past few years. The only explanation that can be advanced is that some unknown condition favourable to the epidemic is at present being experienced.