Congress at Newcastle-upon-Tyne, 1882.

INAUGURAL ADDRESS

BY DOUGLAS GALTON, C.B., HON. D.C.L., F.R.S., &c., &c.

PRESIDENT OF THE CONGRESS.

IN the name of the Sanitary Institute of Great Britain, I beg to thank you, Mr. Mayor, and the Corporation of Newcastle, for the invitation you have given us to visit this important industrial metropolis of the north of England—an invitation which is the more satisfactory to us because Newcastle is advancing in the van of sanitary improvement, and is thus proving the interest of this great city in a subject which is contributing so largely to the material and moral progress of the nation.

I venture to think that of all the definite questions which are made the subject of instruction by Congresses at the present time, there is scarcely one which deserves a greater share of attention than that which calls us together here to-day—I mean the subject of the Public Health.

Within the last half century the whole community has been gradually awakening to the importance of a knowledge of the laws of health; and the energies of some of the ablest intellects, both of this country and of the world, have been employed in investigating the causes of disease, and in endeavouring to solve the problem of the prevention of disease.

There is no doubt much that is still obscure in this very intricate problem, but the new light which is being thrown day by day upon the causes of disease by the careful and exact researches of the chemist and of the physiologist, is gradually tending to explain these causes and to raise the science of

hygiène, which may be translated into the science of the prevention of disease, out of the region of speculation, and thus enable it to take rank as one of the exact sciences.

The sanitarian has known long ago, by the careful observation of facts, that the preservation of health requires certain conditions to be observed in and around our dwellings—conditions which, when neglected, have led to outbreaks of epidemic disease, from the days of Moses to the present time. But whilst the results have long been patent, it is only in recent years that we have obtained a clue to some of the occult conditions in air and water which enable us to distinguish their comparative purity, and which exercise such a powerful influence upon our health.

The researches of Pasteur into the causes of certain forms of disease in French vineyards opened out a fruitful field of enquiry, in the cultivation of which many leading physiologists, chemists, and physicists, are now assiduously occupied; and we have to thank the theories of Dr. Bastian on spontaneous generation for the beautiful series of experiments on bacterian life devised and made by Dr. Tyndall.

In a lecture on fermentation delivered by him not many years ago, he remarked that the researches by means of which science has recently elucidated the causes of fermentation have raised the art of brewing from being an art founded on empirical observation, that is to say on the observation of facts apart from the principles which explain them, into what may be termed an exact science.

In like manner, if recent theories on the propagation of disease by germs, were proved to be correct, and if the laws which govern the propagation or destruction of those germs were known, the art of the physician would be raised from dependance on empirical observation into the position of an exact science.

A large band of the leading scientific men, both in this country and over the whole world, are devoting their energies to a knowledge of these questions; but as yet we stand barely on the threshold.

These researches have shewn us that putrefaction is only another form of organized life. If on a bright day the shutters of a room be closed, and a single ray of light be allowed to penetrate, the ray will reveal the presence in the air of moving particles of fine dust. Dr. Tyndall showed us that germs of the low forms of life, which cause putrefaction, are ever present in this dust; and that they are ready to spring into life and assume activity when a “nidus” is provided which is favourable to the development of the organism.

Lister has turned this knowledge to useful account. In the practice of surgery it was well known that if the skin were cut or broken and the injured tissues underneath exposed to the air, suppuration would ensue; but that when the injury to the tissues occurred under the skin, or if an operation were finished with rapidity, and the wound were sealed so that there could be no access to the air, the injury healed without suppuration.

Lister judged that the suppuration was due to the presence of germs in the air; and in his system of antiseptic treatment he provided for filtering the air through carbolic spray, in order to remove any germs or organisms from that portion of the air of his wards which came in contact with the wounds, and thus to prevent the germs from reaching the wounds, and from developing those organisms whose presence causes what we call suppuration or putrefaction. This treatment has obtained a large degree of success, and has had a very material influence on the art of surgery throughout the world.

The researches of the physiologist have further been directed to ascertaining whether there are not some diseases at least which arise from the presence of minute organisms in the blood. Pasteur has attributed to this cause a certain disease in silkworms. Dr. Davaine asserted that splenic fever in cattle is due to a similar cause. Dr. Klein alleged that pig typhoid arose from an organism which he succeeded in cultivating; and Mr. Toussaint has attributed fowl cholera to a similar cause. Professor Koch, from the light afforded by recent investigations, attributes tubercular disease to specific germs; and Dr. Vandyke Carter has endeavoured to establish the connection between the presence of bacillus spirillum and relapsing fever. Mr. Talamon claims to have discovered that diphtheria is due to an organism by means of which the virus can be conveyed from men to domestic animals, and *vice versa*.

Drs. Klebs and Crudelli allege that malaria fever arises from germs present in the soil and which float in the air over marshes; and that by treating with water the soil of a fever-haunted marsh of the Campagna the germs of this organism could be washed out; and that the water containing the organisms thus obtained, introduced into the circulation of a dog, produced ague more or less rapidly and more or less violent according to the numbers in which the organisms were present in the water.

This theory no doubt agrees with certain well-known facts.

In a tropical climate, if soil which has been long undisturbed, or the soil of marshy ground, be turned up, intermittent fever is almost certain to ensue.

In illustration of this, I recollect that at Hong Kong the troops were unhealthy, and a beautiful position on a peninsula

exposed to the most favourable sea breezes was selected for a new encampment. The troops were encamped upon this spot for some time to test its healthiness, which was found to be all that could be desired. It was then resolved to build barracks—as soon as the foundations were dug, fever broke out.

As an instance of this nearer home I may mention that last winter at Cannes in the south of France, some extensive works adjacent to the town were begun, which required a large quantity of earth to be moved. The weather was exceptionally warm—an outbreak of fever occurred among the workmen, of whom fifteen died: this fever was attributed to the turning up of the soil.

If a strong solution of quinine be let fall in the water containing these organisms, they at once die: the efficacy of quinine as a preventive of this form of fever would therefore not be inconsistent with this theory.

Dr. Sternberg of the United States Army, who made experiments on the soil, water, and air of New Orleans, whilst he is unable to confirm the views of Professors Klebs and Crudelli, admits that there are many circumstances in favour of the hypothesis that the etiology of these fevers is connected, directly or indirectly, with the presence of these organisms or their germs in the air and water of malarial localities.

Sir Joseph Fayrer, whose large experience in India has given him exceptional knowledge of malarial fevers, in speaking of these researches of Klebs and Crudelli, says that the importance of such a discovery, if it were confirmed, could not be over-rated; because if we take the world over, it is probable that some form of malaria is the most fruitful cause of disease; and that this theory offers an explanation which appears to correspond with what we know of the mode of operation of malaria:—First, that it occurs at certain heights, and that it is not necessarily connected with the presence of marshes, ponds, or rivers, nor with admixture of fresh or salt water, nor with the putrefaction of an organic substance. Second, that the production of malaria ceases when the air can no longer act on the soil; for the most pestilential marshes cease to be so when they are covered with water, or when the air is excluded by any interposing substance. Third, that a very moderate degree of humidity will produce malaria. Some malarial soils, innocuous during hot and dry weather, become dangerous after a shower, and so in the case of the upturning of new ground or the cutting down of jungle.

But he adds the following words of caution: “In our natural anxiety to find a particular origin for the poison or germ, we must not overlook the possibility that the results attributed to

the so-called malaria may be due to disturbance of the system caused by gaseous emanations or by some other agencies, in a body predisposed to be so deranged by peculiarity of constitution, climatic or other influence, of the nature of which we are ignorant, though it is conceivable by analogy."

In the case of certain of the diseases mentioned, some very curious and valuable results have been obtained—results analogous to that of vaccination in the case of small-pox.

If the point of a needle be dipped in the blood of a fowl suffering from chicken cholera, and then placed in a vessel containing pure chicken soup, from which care has been taken to exclude all contamination by air-borne germs, and a suitable temperature be maintained, the bacterium or microbe (as M. Pasteur terms it), and cognate organisms which are found in the blood of the diseased fowl, multiply and render the liquid turbid by their presence. If a drop of the contents of this vessel be transferred to another portion of similar chicken soup, it, too, speedily becomes permeated with the organism. The process may be repeated a hundred times; and the result inoculated upon fowls, or given them in their food, will produce the same fatal effects. But if the infected chicken soup be allowed to remain for a few weeks or months, the malignant powers diminish: it becomes, as Pasteur terms it, "attenuated." A given quantity of infected chicken broth, even at the hundredth rapid cultivation, inoculated upon twenty chickens, would probably prove fatal to eighteen of them. If the same infusion were allowed to remain exposed to the air for a month, it would be so far attenuated that it would only prove fatal, say, to ten. Exposure for another month would render it still less virulent, so that it would only prove fatal to two or three; while after exposure for six or eight months it would not prove fatal in a single instance. In its most attenuated form the infusion gives rise only to trifling local symptoms, not at first recognizable as bearing any affinity to the deadly fowl cholera, and consisting of a small local slough. But the valuable fact discovered by M. Pasteur is that the attenuated infusion works upon the system a change protective against subsequent attacks of fowl cholera, exactly similar to that which has been remarked to be enjoyed by fowl that had recovered from the virulent form of the disease. Similar results are obtained in the case of anthrax or splenic fever in cattle.

The practice of mitigating the severity of attacks of disease by producing voluntarily a milder form of the disease is not new. Inoculation for small-pox has been practised in various ways from the most ancient times; because it was known that the occurrence of the disease caused some change in the blood

or in the system of the person suffering from it which prevented the development of the disease a second time, or mitigated the attack.

Jenner showed us that the milder disease of cow-pox caused a change in the system which produced a similar result.

With regard to more recent investigations, the most cautious observers are prepared to admit that in some diseases, such as anthrax, fowl cholera, and in some other diseases, it has been proved that there are certain organisms in the blood, or in the tissues, or in the morbid fluids in animals suffering from disease; that blood or fluids containing the organisms or their spores transmit the disease when inoculated; that when these organisms are absent or artificially separated, inoculation gives no such result; that the organisms can be cultivated outside the animal body, and after ten or fifteen generations the fluid which contains the cultivated organisms can reproduce the original disease when inoculated; and that the method of cultivation can modify or increase at will the virulence of the communicated disease.

There are some other diseases of the zymotic class besides those mentioned above, in which there is a probability that organisms may cause the disease; but experiments have not hitherto absolutely settled the question; and for the present our attitude must be one of reserve, much as we should wish it should prove all true.

When we consider the marvellous facility of reproduction of these various germs, shewn by these discoveries, we wonder how any higher form of life can exist subject to the possibility of invasion by such countless hosts of occult enemies.

But as we pursue the subject further, we find that the science of the prevention of disease, that is to say the science of hygiene, advances quite as rapidly as our knowledge of the causes of disease.

And even if the views of those who are prepared to accept the germ theory of disease to its fullest extent were shewn to be true, it seems also to be certain that if the invasion of these occult enemies present in the air is undertaken in insufficient force, or upon an animal in sufficiently robust health, they are refused a foothold and expelled; or if they have secured a lodgement in the tissues, they may be, so to speak, laid hold of and absorbed or digested by them. In corroboration of this view Professor Koch and others state that the micro-organisms of tubercular disease do not occur in the tissues of healthy bodies, and that when introduced into a living body their propagation and increase is greatly favoured by a low state of the general health.

The record of facts enunciated by the various scientific en-

quirers into the germ theory of disease affords an interesting contribution to the solution of etiological questions; but these enquirers have not yet given the sanitarian grounds of practical action: and for the present at least sanitary procedure is quite independent of them.

It has been long known, in many of those diseases which we term infectious or contagious, that by separating the individual attacked from the community, we may check the spread of the disease: and this practice has long prevailed.

The recent valuable and interesting report by your able medical officer of health, Dr. Armstrong, illustrates how the spread of scarlet fever and typhus have been checked in this city of Newcastle by the isolation of cases by removing them to hospitals: and how careful and systematic vaccination has secured immunity from the scourge of small-pox.

In some towns the local authorities have obtained power to compel the registration of all cases of infectious diseases within their jurisdiction. But it is very difficult effectively to isolate a patient in his own home; hence the further question arises as to what arrangements should be adopted for ensuring to the public the best means of isolation.

Special hospitals have been the panacea proposed; but a suspicion has recently arisen that if all cases of infectious diseases are concentrated in a special hospital in an inhabited district, this concentration of disease may have tended to intensify the disease and disseminate it in the neighbourhood.

Under the circumstances of the existing law we must mainly trust to voluntary effort to prevent the spread of infectious disease; and I may here quote the experience of a nurse of twenty years' experience in dealing with the most infectious and dangerous of these diseases, viz., scarlet fever. Her chief practice was the common one in respect to all cases of the various epidemics—to isolate the patient in a single room, the upper room if possible, and let no one else enter it; to so arrange as to keep the door and part of the window open in order to let a current of air pass through the room over the patient; to observe all the details of regulations as to the cleanliness of the patient and the articles of clothing and furniture, and the removal of excreta, &c.; and as to her own personal protection, never to drink out of the same vessel that had been used by the patient, and especially to wash from head to foot twice a day with tepid water, and to change her clothes each day: moreover she was careful never to serve in conditions of exhaustion with an empty stomach. With these precautions, she had

never had a single case of the spread of the disease to a member of the family or anyone else during the twenty years; nor had she once contracted the disease herself.

Notwithstanding the numerous experiments and the great efforts which have been made in recent times to endeavour to trace out the origin of disease, the sanitarian has not yet been able to lift up the veil which conceals the causes connected with the occurrence of epidemic diseases.

These diseases come in recurring periods, sometimes at longer, sometimes at shorter intervals. Animals, as well as the human race, are similarly affected by these diseases of periodical recurrence; but why they prevail more in one year than in another, we are entirely ignorant. They appear to be subject to certain aerial or climatic conditions. Cholera affords an illustration of this.

There is a part of India, low-lying, water-logged, near the mouth of the Ganges, where cholera may be said to be endemic. In certain years, but why we know not, it spreads out of this district, and moves westward over the country: the people are sedentary and seldom leave home, but the cholera travels on. At last it arrives on the borders of the desert, where there are no people, and no intercourse, no alvine secretions, and no sewers, yet the statistician sitting in Calcutta can tell almost the day on which the epidemic influence will have crossed the desert. But it exercises discrimination in its attacks. It will visit one town or village, and leave many others in the vicinity untouched. Similarly it will attack one house and leave another. But it has been generally found that the attacked house or village held out a special invitation from its insanitary condition. The same houses or the same localities will be revisited in recurring epidemics, because the conditions remain the same; remove those conditions, and at the next recurrence the locality will escape.

At Malta it was found that the same localities and houses which yielded the majority of plague deaths there in 1813, yielded the majority of the deaths in the cholera epidemics of 1839 and 1867; and that in the intervals the same localities yielded the majority of cases of small-pox, fever and of an anthrax, a very special eruptive epidemic attended by carbuncles.

Hence, whilst we are unable either to account for the cause or to prevent the periodic recurrence of epidemic diseases, the sanitarian has learned that it is possible to mitigate the severity of the visit; and that whether these diseases arise from the

occult causes to which I have alluded or from other causes, pure air and pure water afford almost absolute safeguards against most forms of zymotic disease.

Water has for many years been the subject of careful examination and analysis; indeed in the water supply for our large towns water examination may be said to be an ordinary branch of the service.

So long as the country was sparsely inhabited the question of the pollution of rivers was comparatively unimportant, because when sewage is discharged into running water, provided the primary dilution of the sewage with pure water be sufficient, the removal of the whole of the organic impurity will be effected after the run of a certain number of miles, the precise distance of travel being dependent on several conditions.

Perhaps the most beautiful instance of the self-cleansing power of a river is afforded by the Seine at Paris, where the river, which is black and foul when it leaves the town, becomes comparatively clear and full of water plants and fish at some ten or twelve miles lower down.

But the numerous centres of population in England, and the shortness of the rivers, leave them no time to exercise these self-cleansing processes; and some of the most important sanitary legislation in recent years has been devoted to the preservation of our rivers from pollution.

It is, however, shewn by Dr. Angus Smith's reports, under the Pollution of Rivers Acts, that either by the application of sewage to land, or by some of the methods of defecation which I will not further enter upon here, water from sewage may be so purified as to be placed in a flowing river without mischief.

And although there are many theories as to how far water which has once been contaminated by sewage may again after a time become fit to drink, I am disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly on analysis have condemned the water as an impure source; and it appears probable that, whatever may be the actual cause of certain diseases, *i.e.*, whether germs or chemical poisons, the materies morbi which finds its way into the river at the sewage outfall is destroyed, together with the organic impurity, after a certain length of flow.

Considering the density of population over the whole country, it is to be regretted that so much time has been lost in bringing these Acts into operation; and it is to be hoped that there will be no further delay in strictly enforcing the provisions of the Rivers Pollution Act.

With respect to air the question is somewhat different.

It is nearly fifty years ago since that able sanitarian, Mr. Chadwick, impressed on the community the evils which were caused by the impure condition of the air in our towns, owing to the retention of refuse round our houses.

In considering this question it is necessary to discriminate.

The gases which are the result of putrefaction are offensive to the smell, and some of them, as for instance sulphuretted hydrogen, are dangerous in that they may kill persons outright if they are present in undue proportions in the air; or if air containing smaller proportions of these gases be breathed for a long time the general tone of the individual inhaling them may be lowered, but they do not produce specific diseases. When, however, the putrefaction has gone on for some time, it may result in leading to the development of other conditions which may become the cause of disease, or death.

In connection with this question, M. Gustave Le Bon published recently in the *Comptes Rendus* some experiments relating to the properties and the influence of antiseptics on the volatile products of putrefaction.

He prepared a liquid made up of water and hashed meat. He placed a frog in an enclosure with some of the liquid. When putrefaction first set in, a very fetid odour was produced, and the liquid swarmed with bacteria, and he states that in this condition it is a very virulent poison if injected under the skin of an animal; but the frog merely breathing the effluvia, took no harm. After two months, the strong fetid odour had much diminished; the liquid had ceased to have virulent properties when injected under the skin, but the animal breathing its volatile products was rapidly killed by them. There is thus no parallelism between the virulent power of a substance in putrefaction, and the toxical power of the volatile compounds given off by it, indeed these powers seem to be in an inverse ratio. Moreover the older the putrefaction the weaker is the disinfectant power of any antiseptic over it.

These experiments are consistent with the observation that an offensive smell is often less injurious than the slighter fetid odour from an old drain, and that putrefying matter left for a long time in ashpits or manure heaps may be a source of danger: and it is also consistent with the observation that emanations from decomposing matter in the soil, such as refuse in old cess-pools, or the stagnant deposit of sewage in badly constructed drains, may produce very dangerous results, although the odour is not strongly offensive; and they justify the established axiom that all refuse matter should be removed as rapidly as possible from the vicinity of dwellings.

There is no doubt that in the sewerage of towns want of experience in the construction of the works has in some cases led to deposits in the sewers and to their failure to remove these dangerous gases, and that evil consequences have ensued; but it may be accepted as certain that in every case where the sewerage has been devised on sound principles, and where the works have been carried on under intelligent supervision, a largely reduced death-rate has invariably followed.

The records of your own city afford evidence of this fact.

The quinquennial period beginning in 1868 shewed a death-rate of 27·6, the quinquennial period ending in 1881 shewed a death-rate of 23; whilst the death-rate of 1881 was only 21·7.

At the recent Sanitary Congress at Vienna, some remarkable results of the effects of the sewerage of certain German towns were given, which are very striking.

Munich is the residence of one of the ablest sanitarians of Europe, viz., Dr. Pettenkofer. His admirable illustrations of the effect of the impurities which were accumulated in porous cesspits upon the air of the town and the death-rate of the population, form a text book of sanitary knowledge.

At Munich the enteric fever mortality per 1,000,000 of inhabitants for quinquennial periods was as under:—

1854 to 1859, when there were absolutely no regulations for keeping the soil clean	24·2
1860 to 1865, when reforms were begun by cementing the sides and bottoms of the porous cesspits ...	16·8
1866 to 1873, when there was partial sewerage ...	13·3
1876 to 1880, when the sewerage was complete ...	8·7

Similarly at Frankfort on the Main, the deaths from enteric fever per 10,000 were:—

1854 to 1859, when there was no sewerage	8·7
1875 to 1880, when the sewerage was complete ...	2·4

At Dantzig the figures present some more striking characteristics; the deaths from enteric fever per 100,000 living were as follows:—

1865 to 1869, when there was no sewerage and no proper water supply	108
1871 to 1875, after the introduction of water supply ...	90
1876 to 1880, after the introduction of sewerage ...	18

Hamburg has been drained by Mr. Lindley, and he has stated that in his plans he carefully followed the principles laid down by Mr. Chadwick.

In that town the deaths from enteric fever per 1000 of total deaths were from 1838 to 1844, before the commencement of the construction of any sewerage works 48·5

From 1871 to 1880, after the completion of the sewerage works 13·3

During the time that the works were in progress, viz., from 1872 to 1874, the mortality from enteric fever per 10,000 living was—

In the unsewered districts 40·0

In the districts for the most part sewerred 32·0

And in the fully sewerred districts 26·8

These results illustrate the effect of purifying the air of towns by the rapid abstraction of refuse matter, so as to prevent it from remaining and putrefying in and upon the ground.

But whilst the retention of refuse is probably the most fertile cause of mischief, there are other questions connected with the purity of air to which it is useful to direct our attention.

Dr. Angus Smith has given us very valuable information on this subject in his "*Contributions to the Beginnings of a Chemical Climatology*." He shews that the air in the middle of the Atlantic ocean, on the sea shore, and on uncontaminated open spaces, commands the greatest amount of oxygen; that at the tops of hills the air contains more oxygen than at the bottom; and that places where putrefaction may be supposed to exist are subject to a diminution of oxygen. For instance, a diminution of oxygen and an increase of carbonic acid is decidedly apparent in crowded rooms, theatres, cowhouses, and stables. It is well known that oxygen over putrid substances is absorbed, whilst carbonic acid and other gases take its place; and hence all places near or in our houses which contain impurities diminish the oxygen of the air.

Let me explain to you what this diminution of oxygen means.

The average quantity of oxygen in pure air amounts to 21 parts out of 100.

In impure places, such for instance, as in a sleeping room where the windows had been shut all night, or in a lecture theatre after a lecture, or in a close stable, the oxygen has been found to be reduced to as little as 20 parts in 100. That is to say, a man breathing pure air obtains, and he requires, 2,164 grains of oxygen per hour. In bad air he would, if breathing at the same rate, get little over 2,000 grains of oxygen an hour, that is a loss of about eight per cent.; and this diminished quantity of oxygen is replaced with other, and in almost all cases, pernicious matters.

The oxygen is the hard-working, active substance that keeps up the fire, cooks the food, and purifies the blood; and, of course, as the proportion of oxygen in the air breathed diminishes, the lungs must exert themselves more to obtain the necessary quantity of oxygen for carrying on the functions of

life. If the air is loaded with impurities, the lungs get clogged, and their power of absorbing the oxygen that is present in the air is diminished.

An individual breathing this impure air must therefore do less work; or, if he does the same amount of work, it is at a greater expense to his system.

In towns, the impurity of air arises chiefly from dust of refuse, mostly horse manure, as well as from smoke, and other products of combustion.

The influence of smoky town air on health is to some extent illustrated by the fact that the death rate of twenty-three manufacturing towns, selected chiefly for their smoky character, averaged 21·9 per 1,000 in 1880; whilst the rural districts in the counties of Wilts, Dorset, and Devon, excluding large towns, averaged 17·7 per 1,000; and the deaths from the principal zymotic diseases in the towns were more than double those in the rural districts.

Mr. Aitken, of Edinburgh, has made some very interesting experiments, showing that visible fog is due to particles of foreign matter floating in the air. He showed that the vapour of water injected into air, from which particles had been strained out, was not visible; whereas, as soon as foreign matter, such as dust, or smoke, or fumes, and especially fumes of sulphur, were introduced, the aqueous vapour condensed on the particles, and became visible as fog.

He showed that some kinds of dust have such an affinity for water, that they determine the condensation of vapour in unsaturated air, whilst other kinds of dust only form nuclei when the air is supersaturated; and that dry fogs are produced by those dust particles whose affinity for water vapour enables them to condense vapour in unsaturated air. Amongst this class of dust may be instanced chloride of sodium or salt, which largely pervades the atmosphere, and is probably derived from sea spray; also ammonia, which is present in town air, and may be largely due to the manure. In towns where the streets are paved with stone, asphalt, or wood, and even where the surface is of macadam composed of granite, the chief part of the mud and dust consists of horse manure, which continually gives off the fumes of ammonia; and this substance when mixed with fumes of sulphur has a greater power of condensing aqueous vapour than the products of combustion of pure coal, and gives rise to a very fine textured dry fog.

The conclusions which may be drawn from these experiments are: 1st, That when water vapour condenses in the atmosphere, it always does so on some solid nucleus; 2nd, That the dust particles in the air form the nuclei on which it condenses; 3rd,

If there was no dust in the air there would be no fogs, no clouds, no mists, and probably no rain; but when the air got into the condition in which rain falls—that is, burdened with supersaturated vapour—it would convert everything on the surface of the earth into a condenser, on which it would deposit itself. Every blade of grass, and every branch of tree would drip with moisture deposited by the passing air; our dresses would become wet and dripping, and umbrellas useless; but our miseries would not end here. The inside of our houses would become wet; the walls and every object in the room would run with moisture.

Hence we have in this fine dust a most beautiful illustration of how the little things in this world work great and useful effects in virtue of their numbers.

This dust pervades the air everywhere. The haze in the air on a summer's day is caused by dust, which is probably largely composed of the pollen of flowers. This dust appears to occupy the lower strata of air, for in the valleys on the South or Italian side of the Alps a blue haze mellows the view; but this is passed through after a little hill-climbing, and the atmosphere becomes clearer.

The theory is not inconsistent with the formation of the loftiest clouds, because dust does not only pervade the lower region of the atmosphere.

Mr. Langley was making observations last autumn on the spectrum of the sun on Mount Whitney, which is within some 300 miles north of the Mexican frontier, and about 200 miles from the Pacific Ocean. When at a height of 13,000 feet above the sea, he observed dust in the atmosphere between him and the sun. He computed that this dust was at a height of from 1,000 to 1,500 feet above the elevation at which he was placed; that is to say, at a total height of from 14,000 to 15,000 feet above the sea. It has been suggested that this dust might have been carried by the prevailing winds from the plains composed of loess in China.

There is, however, another source whence dust in the air at higher altitudes may be derived; for recent investigations shew that appreciable quantities of meteoric dust are being constantly brought into our atmosphere from interplanetary space.

In our towns the dust is more plentiful, but there also it diminishes with elevation.

The clumsy and barbarous method which we adopt for burning coal in this country adds to the dust the fumes which necessarily result from combustion, as well as a quantity of soot and tarry matter from the imperfect combustion of coal.

Mr. Chandler Roberts, who made experiments on the question of the amount of soot from different forms of grates for the

Smoke Abatement Society, found the quantity of soot to vary from about one per cent. in most furnaces, to as much, in some instances, as three per cent. of the fuel consumed in domestic fire places; that is to say, the imperfect combustion causes from one to three cwt. of soot for every five tons of coal consumed.

This soot assists in forming the black canopy which it is fashion in England to consider the proper attribute of a large town.

Dr. Frankland and Dr. Russell have shewn that the tarry matter which arises from the combustion of coal, coats over the water resulting from the aqueous vapour thus condensed upon the particles of dust, and considerably delays their re-evaporation; consequently whilst the atmosphere of large towns is more favourable to the development of fog, the fogs prevailing over large towns are more persistent in their character than in the open country. Moreover, the fumes from combustion contain substances, and especially sulphur, which appear to be more favourable to the formation of fogs than any other form of dust; and, therefore, even if whilst continuing to burn coal in our towns we get rid of smoke, we should still have products of combustion, which would favour the occurrence of fogs; but they would be fogs of lighter colour and less persistency than our ordinary London smoke fog.

The conclusions at which Mr. Aitken has arrived from his experiments are well illustrated by a fact of every day experience. A heavy fall of rain washes the particles of dust out of the air, and after rain the fog is often removed, and the air of a town is much clearer.

But in addition to the chemical and inorganic constituents of air which have been generally taken as a measure of its purity, recent researches have divulged to us the character of some of its organic impurities.

Dr. Tyndall has shewn us, by passing a ray of light through a space otherwise dark, that all air is more or less filled with dust; that this dust is destroyed by incineration, and that it is therefore chiefly organic; and his experiments, made with infusions previously freed from all possibility of containing germs in the infusion, or as he terms it sterilized, demonstrated that this dust contains germs which are always ready to spring into life when a congenial medium for their development is at hand.

He shows that if the air of a room be left absolutely undisturbed for some time, this dust is more rapidly deposited than in moving air. Thus in a sheltered and quiescent position in a room, flasks filled with various infusions developed organisms more rapidly than those placed in the more open parts of the room.

Dr. Tyndall has also shewn by similar experiments that these sterilized infusions did not develop organisms when exposed to the clear mountain air on the Bel Alp in Switzerland, whilst the air of a hay-loft near the glacier developed organisms in 90 per cent. of the flasks containing sterilized infusions.

M. Marie Davy, of the Montsouris Observatory of Paris, tells us that the air near to the Hotel Dieu in the centre of Paris and near an opening to a sewer, is more prolific in causing the development of bacteria and similar organisms, in prepared sterilized infusions, than air in the more open space near the Montsouris Observatory; and that the latter is more prolific than air on the plateau of Gravelle near Paris.

M. Davy also tells us that the air in rainy weather is less prolific in producing bacteria; that it becomes more prolific during the drying up of the rain; but becomes less prolific again in drought and in sunshine. Similarly, the numbers of bacteria are very small in winter; they increase during the spring; attain their maximum in autumn; and then decrease with the rain and cold weather on the approach of winter. The cold of a Parisian winter is inimical to them, and so is dry hot weather, and especially sunshine.

It is not alleged that those various organisms are all productive of disease or injurious to the higher forms of life. Some are no doubt productive of what we term putrefaction; others may be productive of disease; but some may possibly afford nourishment.

It is, however, noteworthy that those observations which shew the presence and absence of organisms in certain localities and in certain conditions of the atmosphere, seem to present coincidences with other observations on the prevalence of certain diseases, which at least make it desirable that the enquiries should be further pursued.

For instance, in the Punjab the mortality from fever deaths in each of three consecutive years, 1872-73-74, when food was cheap and when there was no extraordinary occurrence to affect the ordinary relations between fever and rainfall, the fever deaths only began to rise after the rainfall had attained its maximum and had begun to decrease, and the deaths from fever attained their maximum soon after the rainy season came to an end, during the drying up of the ground, after which they decreased.

In Bombay the registered fever deaths on a mean of fourteen years shows a minimum of fever deaths during the hot, bright, and dry season.

It is also noteworthy, more especially in hot climates, that those rooms of a house into which sunshine can penetrate are

healthy, whereas rooms where no sunshine can penetrate are unhealthy.

In our present knowledge, it would be premature to draw any conclusions from these various researches; but they open out an interesting field of enquiry which it is not presumptuous to think may possibly have some bearing on the prevalence of disease.

But whatever may be the influence which such organisms or germs exert on the production of zymotic diseases, the sanitarian has attained to the absolute certainty that the number of persons who are attacked by this class of diseases can be increased or diminished in proportion to the defects or the excellence of the hygienic conditions under which they are living.

I have already mentioned to you the effects of sewerage on the mortality of towns.

On the general effect of sanitary conditions upon health, the experience of the Indian army is very striking.

Periodic fevers occur everywhere in India, and there arise extra vicissitudes of temperature and endemic causes of dangerous disease. Yet there, even under these circumstances, sanitary work, by removing preventible causes of disease, has reduced the death-rate of the European Army in India from 60 per 1,000 to 16 per 1,000, and is gradually diminishing the death-rate of the civil population.

Perhaps one of the most conclusive examples of the effect of sanitary observances is that furnished by fairs and religious festivals in India. These assemblies bring together many thousands of persons, sometimes even as many as 100,000 persons, together with numerous horses and cattle. They form a huge encampment lasting for many days, sometimes for weeks. A very few years ago there was no care taken to prevent the fouling of wells and water-courses, or to regulate the disposal of the refuse which was scattered all over the surface of the ground where this multitude encamped. These fairs and festivals were therefore almost invariably foci for the spread of cholera and other diseases. Now this is changed. Stringent regulations preserve the wells and water-courses from pollution, and compel the people to deposit all refuse in prepared places. All the rest of the ground in the vicinity of the encampment is kept scrupulously clean. Since this has been done, many festivals and fairs have been held in districts where cholera has been prevalent, but yet, owing to these stringent regulations, no cases of cholera have occurred amongst the persons attending the fairs and festivals.

We may find, perhaps, more striking results from the influence of sanitary work in India or in a tropical climate than

elsewhere; but still we are surrounded by numerous examples of the effect of sanitary work at home.

In the Foot Guards in London, the deaths from tubercular disease used to be 10 per 1,000—in fact equal in amount to the total deaths which now occur in the Army in peace time.

The improvements in the hygienic conditions under which soldiers live, which were introduced into the Army in consequence of the recommendation of the Royal Commission on the Sanitary State of the Army and the Barrack and Hospital Commission, have reduced this death-rate from tubercular disease to about 3 per 1,000. This is one of the diseases which it is now alleged can be or is propagated by germs; and it is to this point that I desire especially to call attention, viz., that whatever be the manner in which these zymotic diseases are propagated, the death-rate and consequent sickness may be diminished or increased according to the sanitary conditions in which a population lives.

In this city of Newcastle the number of deaths per 1,000 was 25·4 in 1870, 26·1 in 1875, 23·5 in 1879, 22·8 in 1880, and in 1881 it was 21·8 per 1,000.

We are accustomed to speak of a death-rate of so many per 1,000 in a great city—we ought at the same time to recollect that this death-rate is made up of many details. For instance, in 1875, the death-rate for the entire City of Newcastle was 26·1 per 1,000; but there was a group of buildings, called the old Pandon group, since pulled down, in which the death-rate was 40 per 1,000, and in parts of that group of buildings the death-rate amounted to 54 per 1,000.

It is very difficult to obtain the death-rate of a limited area; but I will give you some instances from districts in London where the figures have been stated in the evidence given to the Select Committee of the House of Commons on the Artizans' and Labourers' Dwellings Act.

These districts were condemned by the medical officers chiefly by reason of the closeness, narrowness, and bad arrangement of streets, courts, and alleys.

In Limehouse, whilst the average death-rate of the population of the district was 23·9, the death-rate of a special part of the district was 50 per 1,000. The population on this part of the district was 514 per acre.

In Whitechapel and Aldgate there was a district of six acres which had 625 persons per acre, the death-rate in that part being 50 per cent. above the death-rate of the district. In some parts of the area there were 1,423 persons per acre.

In St. Giles, whilst the death-rate of the Northern district was 21·82 per 1,000, that of the Southern portion was 33·16 per

1,000. In parts of this district the area was covered with very narrow courts and alleys, with badly ventilated and dilapidated houses, many of them without back yards, and the rears almost touching each other. In this area the death-rate was 40 per 1,000, as against 25 per 1,000 for the whole district, and 17 per 1,000 for St. George's, Bloomsbury, which is close by.

Parts of these districts have been cleared under the Artizans' and Labourers' Dwellings Act, and new dwellings have been constructed by the Peabody Trustees and by various Companies formed in London for providing improved dwellings.

These improved dwellings are built in several stories one above the other. They afford accommodation to a population per acre as dense as, and in most cases even denser than, that afforded by the buildings which they replaced.

Within limits it is not the density of population which regulates the health. But if a dense population is spread over the surface, or close to the surface of the ground, by which means all movement of air is prevented, and if there are numerous corners in which refuse is accumulated, it will be difficult to prevent disease.

Dr. Angus Smith's experiments shew that whilst there is less oxygen and more carbonic acid in the eastern and in the more crowded parts of London, yet, that in open spaces the amount of oxygen rises and the carbonic acid diminishes very considerably; and that we are exposed to distinct currents of good air in the worst, and equally to currents of bad air in the best atmosphere, in towns like Manchester.

Dr. Tyndall shewed that where there is quiescence in the air the tendency of his sterilized infusions to produce organisms was increased.

The conclusion from all these experiments is to show the importance of laying out the general plan of dwellings in a town, so that currents of air shall be able to flow on all sides with as little impediment as possible, by which means the air will be continually liable to renewal by purer air.

The dwellings which have been constructed in the place of the very defective dwellings condemned by the Medical Officers of Health in various parts of London, specially illustrate the importance of this question of the circulation of air.

These dwellings replace those in which the normal mortality was as much as 33, 44, and 50 per 1,000.

But these improved dwellings provide ample space all round the blocks of building, so that air can flow round and through them in every direction, and so that there are no narrow courts and hidden corners for the accumulation of refuse. In some cases these dwellings accommodate above 1,100 persons per acre.

The mortality in the new dwellings is as low as 13 per 1,000 in some, and does not rise above 20 per 1,000 in any of them, and upon an average of years it may be taken at from 14 to 16 per 1,000.

It is to this point that I specially desire to draw your attention, viz.: that these facts prove the possibility of bringing down the death-rate of the class of population which inhabits this sort of accommodation to rates varying from 15 to 16 per 1,000. I say of the class of population because habits and mode of life have an important influence on health and on longevity.

Mr. Chadwick and Dr. Richardson obtained some statistics for Westminster, for the use of a Committee of the Society of Arts, which indicate the very different conditions of health to which the different classes of population are subject (Appendix A, p. 55). The divisions they adopted were as follows:—

First, the class of professional persons, or of those classed as gentry; secondly, the salaried classes, clerks and mechanics, and wholesale dealers; thirdly, the general classes of retail traders or shopkeepers; fourthly, the wage classes, artizans and labourers; and fifthly, domestic servants.

Each of these classes, it will be seen, represents very distinct sanitary conditions as to streets, houses, room space, overcrowding, and filth.

It appeared from these statistics that out of 100 deaths of the first class, or gentry, six were those of children in their first year, and nine of children within their fifth year; whilst out of 100 deaths of the wage classes 22 are those of children in their first year, and 39 within their fifth year.

If we take the average duration of life of all who have died of the first class, men, women, and children, we find that they have had an average of 55 years and 8 months of life; whilst of the wage classes they have had a mean of only 28 years and 9 months.

And if we take the average duration of life of those who have escaped the earlier ravages of death up to 20 years of age, the males who have died of the first class have had 61 years of life, whilst of the wage class the males have had only 47 years and 7 months. Moreover, of the first class in Westminster, the proportion who have attained to old age, and died of natural causes, is 3·27 per cent., but of the wage classes only a fraction, or $\frac{2}{3}$ per cent. did so.

I have obtained similar returns for this city (Appendix B, p. 56).

It was considered desirable, for the purpose of this return, to divide the population into the following five classes—

First, Gentry and Professional men; Second, Tradesmen and Shopkeepers; Third, Shipwrights, Chain and Anchor Smiths, Iron Forge Labourers, &c.; Fourth, Seamen, Watermen,

Fishermen, &c.; Fifth, Other Wage Classes and Artizans; and each of these classes represents distinct sanitary conditions and habits of life.

The healthiest class is that of the seamen, watermen, and fishermen. The mean age at death of all who died of that class, men, women, and children, is 37 years; as compared with 35 years for gentry and professional men; whilst the mean age of shipwrights, chain and anchor makers, and iron forge labourers, is only 22 years.

A further examination of this table shews that this great difference in the average length of life arises from the great excess of deaths in childhood of the wage classes above those of either the seamen and watermen class or the gentry and professional class; the proportion per cent. of deaths of children under five years of age to total deaths is in the class of shipwrights and iron forge labourers, &c., 47·96, in the wages classes 41·52, in the class of gentry and professional men 33·93, and in the fisherman class 26·77: and the mean duration of life of the males who had survived the period of youth, that is to say, of those above 20 years of age, was for the gentry class 53 years, for the tradesmen 54 years, for the seamen and fishermen class 52 years, for the shipwright class 46½ years, and for the other wage classes 49·9 years.

I have also obtained for comparison returns from the borough of Dover (Appendix C, p. 57), which is a sea-port town with what may be called a favourable mortality, viz., an average death-rate of 16·7 per 1,000.

In that town the mean duration of life in the wage class, artizans, &c., of all who died, is 33½ years; and of those who died over 20 it is 55 years; and the proportion of deaths of children under 5 years of age is 36 per cent. of the total deaths, instead of the 48 per cent. of deaths in the shipwright class in Newcastle.

As a contrast to the returns for the City of Newcastle, I have obtained information respecting certain rural parishes in Northumberland. These parishes are comprised in the registration districts of Bellingham and Rothbury, together with the sub-districts of Islandshire and Norhamshire, in the parish of Chatton (Appendix D, p. 58).

In this return the population is divided into the following classes:—First, Gentry, Professional men, &c.; Secondly, Farmers; Thirdly, Tradesmen, Shopkeepers, &c.; Fourthly, Wage Classes, Artizans, &c.; Fifthly, Agricultural Labourers.

Although the average mortality of the districts is 15·3 per 1,000, as compared with 21·8 per 1,000 for Newcastle, the proportion of zymotic diseases shews that these districts cannot be considered to be in very favourable conditions of health.

A comparison of these returns affords much food for reflection, and makes us regret that the returns of the Registrar-General do not afford us more information upon the relative health of the different classes of the community.

The mean duration of life of all who died was 42·3 years as compared with 29·4 years in Newcastle, and of those who had survived the period of youth and reached the age of 20, the mean age at death of the males was 60·9 years, as compared with 51·9 years in Newcastle. For the Wage and Artizans class in the rural parishes the mean age at death of all who died was 35·4 years, and for the Agricultural Labourers, &c., 42·2 years, as compared with 22·3 years for the Shipwrights, &c., class, and 27·0 years for the other wage classes in Newcastle; whilst for the males who had survived the period of youth and attained the age of 20, in the rural districts the mean age at death was 56·0 for the Wage and Artizans' class, and 63·7 for the Agricultural labourers, as compared with 46·6 for the Shipwrights, &c., class, and 49·9 for the other wage classes in Newcastle.

I may also instance the rural district of Utttoxeter, where the mean age at death of all who died of the wage class, including agricultural labourers, was 39 years, whilst that of the agricultural labourers alone was 40 years; and the mean age of those who died over 20 was 62 years; yet this is not a particularly healthy rural district, since the proportion of deaths from epidemic disease to the total deaths was 26·5.

Thus the parallel classes in the rural districts enjoy at least 10 years more life than those in Newcastle, and yet it will be observed that the proportion of deaths from the principal zymotic diseases (excluding diarrhœa) in the rural districts is less favourable than in Newcastle.

In contrast with these rural districts, and as an illustration of the effect of insanitary surroundings on health, it may be mentioned that on the experience of a decade in a district in Ireland, situated in Connaught, where there was a large proportion of mud hovels having only one room, the mean age of all who died was only 26·8 years as compared with 42·3 years in the rural districts of Northumberland; and the proportion of deaths from epidemic diseases to total deaths was 47·8 per cent. The occupiers were chiefly peasant proprietors.*

* It is interesting to mention, in connection with this question of the relative death-rate, that the wages of the agricultural labourers in the rural parishes of Northumberland may be assumed to be for the men from 18s. to 20s. a week; the wife or daughter may earn 7s. 6d. a week, and for about

A low standard for the mean duration of life in the wage class is not a necessity. It is controllable by the surroundings in which they live; and the fact of how largely the death-rate is influenced by these surroundings is evidenced by the condition of health in Improved Industrial Dwellings.

Mr. Gatliff shews that the death-rate over a series of years in the buildings of the Metropolitan Association for Improving the Dwellings of the Labouring Classes, varied from 14 per 1,000 to 17 per 1,000; and in the buildings of the Improved Industrial Dwellings Company, under Sir Sydney Waterlow, the mortality during a period of over 16 years has been 16·2 per 1,000.

Similar results are obtained in the Improved Industrial Dwellings in Newcastle. The able manager of this property, Mr. Price, will, I believe, furnish a full account of these dwellings to the meeting. I would therefore only mention that Mr. Price informs me that in these dwellings are accommodated 108 families or 450 persons. The death-rate for the year ending June 30, 1882, has only been at the rate of 12 in the 1,000, whilst the rest of the city of Newcastle shews an average of 21·6. This result must be considered the more satisfactory when it is remembered that these buildings are tenanted by the lowest wage-earning class. Out of the 108 tenants there are only two who earn 30s. per week, the majority being labourers averaging 21s. per week, and several less than that sum.

The effect of the sanitary conditions under which people live is further well illustrated by comparing the condition of health enjoyed by those who may be assumed to have been removed from unhealthy influences in their ordinary life, and placed in healthy surroundings.

I have obtained, through the courtesy of Mr. Hardcastle, a return from the Prison at Newcastle-upon-Tyne, shewing the health condition of prisoners who entered the prison without any disease.

From this it appears that during the five years ended June, 1882, nearly 20,000 prisoners passed through the prison, and that during the whole of that time there was no death from zymotic disease in the prison, although during that period there were epidemics of Scarlatina, Typhus, and Small-pox in the

three weeks in harvest time probably 10s. 6d. per week extra, say from £46 to £65 a year. Mr. Murphy, Professor of Agriculture in Ireland, in a work on a Model Farm, estimates that the outcome in wages of the work of a peasant proprietor and his wife and child on his farm, of eight acres, is only £25 a year. Also Mr. Jenkins, the Secretary to the Royal Agricultural Society, states that he examined the outcome of the peasants' earnings in Belgium and France, and that he could not make out that the tenant's profit on ten acres came to more than £30 a year.

Borough. Moreover, during three of the five years, there were no deaths at all of prisoners admitted without previous disease; whilst in 1879 the deaths in this class amounted to $\cdot 027$ per 1,000, and in 1881 to $\cdot 025$ per 1,000.

After commenting upon the good sanitary state of the Prison, Mr. Hardcastle makes the following suggestive remark:—
“There is not the slightest doubt that if my private patients lived under similar conditions they would enjoy better health.”

In considering how far it can be hoped that the death-rate of the wage classes can be permanently reduced to that of the more fortunate classes, there have to be considered the questions of the occupation of the members of the classes when out of their homes.

If we take the professional and merchant class who attend at their offices during the day time, we may be sure that, as a rule, they are placed in unhealthy surroundings during that time, and in many cases have to breathe, during their hours of work, as bad an atmosphere as that in which the wage classes work.

The great mortality of the tradesmen class shewn in Mr. Chadwick's return for Westminster was explained by him to arise from the fact that the best rooms of the houses in which they live are let for lodgings, and that they often live in the basements or back premises, which are frequently unhealthy. Whilst we may anticipate great improvements in the health of the wage classes by the construction of improved dwellings, these must be supplemented by healthy arrangements in the pursuit of their daily avocations. Indeed in many cases education is required to teach workmen to attend to precautions devised for their health; they often look upon ill health as a matter of course.

The deaths of children, who are the most influenced by the conditions of air, and the least by occupations and by migration, especially those under one year, are regarded foremost exponents of sanitary conditions.

The tables in Appendix E and F (p. 59), shew the annual rate of mortality per 1,000 of population; the mean age at death; and the expectation of life, at several ages, for the City of Newcastle for 1881, and for Dover in 1880.

In the City of Newcastle, the annual rate of mortality per 1,000 for all ages was for males 23·15, and for females 20·13, whilst for children under five years it was 66·19 for males and 54·77 for females. In Dover, whilst the mortality per 1,000 of all classes was for males 18·13 and for females 15·37, it was for children under five years 62·61 for males and 44·47 for females.

The very marked difference, shewn in the returns I have spoken of, in the mean duration of life of the wage classes as

compared with the well to do class, is no doubt largely attributable to the deaths of the young.

The large death-rate of children and of young persons arises from a variety of causes which it may be difficult entirely to remove; it must, to some extent, be dependent on the health of the parents, but it is often the result of improper food.

An instance, from your own town, illustrates this point.

The Reverend Mr. Lintott, who manages the Northern Counties Orphan Institution, informs me that the children there have been singularly free, during the eighteen years the Institution has been in existence, from children's disorders.

Each child has a pint of new milk every day. Some years ago milk was very dear, and for three months the children received half the quantity, weak tea for the evening meal being substituted. During the latter part of that time, the number of the children who were unwell, from various causes, was greater than it had been for years; the milk was restored, and the Orphanage became as free as ever from the usual disorders of children.

But the condition of the surroundings, in which children are placed, also materially influences their death-rate. If the choice lay between giving young children plenty of food whilst they were exposed to bad air, or giving them little food whilst they were placed in pure air, it would be preferable for their health to select the latter alternative.

Some evidence of the effect of pure air on children is afforded by comparing the table of mortuary statistics of Newcastle with that of the rural parishes of Northumberland. The proportion per cent. of deaths of children under five years to total deaths in the class of tradesmen and shopkeepers in Newcastle is 37, as against 20·48 for the same class in the rural parishes; whilst for the shipwrights, smiths, and forge labourers class it is 47·96; and for the other wage and artizans class it is 41·52 in Newcastle, as compared with 28·72 for the wage and artizans class, and 22·59 for agricultural labourers in the rural parishes. On the other hand for the seamen and fishermen class in Newcastle, the proportion is 26·77. It would be interesting to trace out the reason why the proportion of children's deaths in this class differs so materially from that of the other wage classes in Newcastle, and so nearly coincides with that of the wage classes and agricultural labourers in the rural district.

In further evidence of the effect of the surroundings on the health of children, it may be mentioned that whilst the mortality of children under 10 in the Metropolis generally was 47·66 per 1,000, that of children in the Improved Dwellings was 24·04 per 1,000, or less than one half.

Moreover, in the buildings of the Improved Industrial Dwell-

lings Company, during a period of 16 years, the death-rate per 1,000 of persons over one year of age was only 10·35 in the Company's Dwellings, whilst it was 17 in the Metropolis.

The death-rate of infants under one year of age was even more favourable; for although the birth-rate was 5 in a 1,000 more in the Company's Dwellings than in the Metropolis generally, the death-rate of infants was only 1·7 higher in the Improved Dwellings than in the Metropolis, thus shewing that the conditions of occupancy in these dwellings are as favourable for infants as they are for persons of riper years.

The other Companies who have built improved dwellings can shew equally favourable results.

We have done much for the health of young people by the Factory Acts in regulating their labour; and we have made stringent rules to compel their attendance at School; but in these latter regulations it is to be feared that the health of the children has been too little considered.

Mr. Chadwick and Dr. Richardson have long pressed upon the consideration of the public the defects of the elementary school system, first as to the insanitary conditions of the rooms in which most of the school work is performed, and secondly as to the advantages which have been found to result from making physical training a portion of ordinary school work.

Dr. Richardson shews that the long hours spent in school do not produce results commensurate with their length. That is to say, he shews that in those schools where half the time is allotted to physical training, the children learn quite as much as in schools where the whole time is devoted to study; that the children are brighter, and that they are eventually turned out of the school better qualified to take up the avocations of daily life.

On the other hand, the condition of the children is an important factor in the ventilation of a school room. With children who are not washed all over daily, the skin and the clothes assist in producing a foul atmosphere; and the rooms crowded with children in that condition require special means of ventilation. Unless this is provided the atmosphere is injurious. But as a rule the children are not thoroughly washed every day, nor are exceptional means of ventilation provided.

From some recent statistics it appears that the death-rate of elementary school teachers amounts to as much as 20 per 1,000, which is more than double that of soldiers on home service, and about four times that of the police or of sailors, in which forces, apart from deaths from accident or violence incurred in their profession, it amounts to about 5 per 1,000. It is even from five, six, to seven times greater than that of those criminals who are imprisoned who have no specific disease, amongst whom, when they

enter a well-conditioned prison, the death-rate does not exceed 3 per 1,000. The sickness will be proportioned to the death-rates; and there can be no question but that the high death-rate is largely due to the unhealthy atmosphere in which their work is performed.

Dr. Carpenter says in his work on "Human Physiology," that the "purity of the atmosphere habitually respired is essential to the maintenance of that power of resisting disease which, even more than the ordinary state of health, is a measure of the real vigour of the system. For, owing to the extraordinary capability which the human body possesses of accommodating itself to circumstances, it not unfrequently happens that individuals continue for years to breathe a most unwholesome atmosphere without apparently suffering from it; and thus when they at last succumb to some epidemic disease their death is attributed solely to the latter, the previous preparation of their bodies for the reception and development of the zymotic poison being altogether overlooked."

It is not so many years ago that the death-rate of the Army at home nearly equalled that now prevailing among the elementary school teachers. The large army death-rate was shewn to arise from defective ventilation and want of other sanitary arrangements. These were remedied, and the Army death-rate was reduced to from 8 to 11 per 1,000; and there can be no doubt that if the same care were bestowed upon the purity of air in and around our schoolrooms as is bestowed upon our barrack rooms and prison cells, the health of school teachers and of the children would be materially benefited.

The following extract from a paper by Mr. Chadwick sums up this experience:—

"In one orphan institution the progress made by the application of sanitary factors was thus denoted. The death-rate amongst the children was twelve in a thousand. The impurity of the air was removed by better drainage, and the death-rate reduced to eight in a thousand. A further advance was made by regular head-to-foot ablutions of the children with tepid water, and a complete skin cleanliness maintained, when the death-rate was reduced to four in a thousand. In the district half-time schools near London, where the sanitation is the best advanced, they receive children of the lowest condition and type, and may be said to be children's hospitals; but of those who come in without any developed disease, the death-rates from disease of spontaneous origin do not exceed three in a thousand, or one-third of those of children in the Board or common schools. I deduce from experience that skin cleanliness and clothes cleanliness is a factor of prevention of the

common death-rates amongst dirty children in crowds or in schools by one-third."

Mr. Chadwick further dwells on the economy of cleanliness. He states that it has been ascertained that pigs that are washed put on one-fourth more flesh from the same quantity of food than do pigs that are unwashed. The food that would be required for four children that are unwashed would serve for five children that are washed. A general whose army was hemmed in and put upon short rations encouraged his men to bathe daily; he said that by that means he kept his men in as good condition and force as another division of the army that was on full rations but unwashed.

I am informed by colliery proprietors that horses in a colliery which are well groomed do more work and look better than badly groomed horses with an equal amount of food. And there is a German proverb which may be translated: "Well washed is half the feeding."

My object in presenting to you these facts is to show you that you must not be satisfied with an average death-rate in your towns of 21·8 per 1,000, but that you should investigate the death-rate in each part of your town, and in each class of your population at several ages, and ascertain where it is in excess and what are the causes of the excess, and then do your utmost to remove those causes.

For the death-rate is an indication of the degree of wasted force in the country.

Let us consider for a moment the losses to the country which are evidenced by a high death-rate.

Take a professional man who has accumulated a large amount of knowledge, and what is better, of experience; or take an artisan who is a skilful craftsman. They die in the prime of life when they are most fitted to use these qualities; the knowledge, experience, and skill, which have required many years and much labour and expense to accumulate, all go with them, before the crop of usefulness, in the cultivation of which so much has been expended, has ripened and been gathered.

But there is also to be considered the loss by sickness.

The death-rate affords to some extent an index of the disease rate in the community. It is, however, very difficult to ascertain with any degree of accuracy the disease rate of a community, as compared with the death-rate.

If we take the Army as a criterion, it would seem that there are more than 100 men admitted to hospital to one death, whilst the number constantly sick averages from four to six times the number of deaths. No doubt in the Army many an ailment has to be treated in hospital which in ordinary life would allow the sufferer still to pursue his avocations.

The sickness of the population is not registered, and it is very difficult to obtain any data respecting it. It has been generally stated that there are on an average 20 cases of sickness to one of death, of which 4 cases out of 5 are those of children. I find, however, from a return of an unsanitary district in St. George's-in-the-East, that with a death-rate of 31 per 1,000, the sickness rate was 270 per 1,000, or 9 cases of sickness to one death. But in the worst parts of the same district the sickness rate amounted to 620 per 1,000, which gives 20 cases of sickness to one death.

Mr. Neison, who has recently examined the records of the Ancient Order of Foresters, shews that at 35 years of age there are on an average 22 cases of sickness to one death, and that is in a body of men which it must be borne in mind are selected men so far as health is concerned. From the same record we find that at 20 years of age the loss of time from sickness amounts to 1·5 per cent. of the whole time; and at 40 years of age it amounts to 2·6 per cent.

The value of a single premium paid at 20 years old, (calculated on the 3 per cent. tables) to insure £1 a week during sickness, for the whole life, is £40.

I sought, but failed to obtain, definite statistics on this subject from some of those who are working amongst the poor, both in the east and west end of London.

An east-end clergyman remarked that "the poor go on *living* wonderfully in wretched places, but that they have so much *ill-health*. They are perpetually on the trudge to the Hospitals with their bad chests and bad legs, and get patched up again and again, and live on."

Our London Hospitals and Dispensaries cost, according to Mr. Burdett's statistics, nearly £600,000 annually to administer. The average number of out-patients treated at the various institutions in a year is about 1,000,000—that is to say, more than one out of every four inhabitants of the Metropolis becomes an out-patient in the course of the year.

This expenditure is incurred mainly for the purpose of patching up the wretched poor, who have been injured by bad drainage, want of ventilation, darkness, &c. Though drink may be one of the immediate causes of many hospital cases, yet the tendency to drink is created and fostered by the wretched dwellings of the very poor. But besides the time lost by the sickness itself, there is the large amount of time wasted by the poor in going to and waiting at hospitals, which would be spent by healthy poor in labour.

There is, moreover, the great amount of lassitude and idleness in the low-class poor, which Dr. Richardson traces to want of ventilation, in their own and former generations.

I think we may safely assume that if you can, by preventive arrangements, bring down the death-rate of the wage class to the standard afforded in good sanitation, you would reduce the sickness rate in a similar proportion at least. By means of this item alone the wage earning power of the industrious classes would be enlarged by some millions of pounds, and their comfort correspondingly increased.

You would effect, in addition to the savings under this head, certain other distinct economies. For instance, it is certain that the need for much of the accommodation in our prisons, reformatories, and workhouses arises from evils incident to unhealthy circumstances and crowded dwellings.

We shall probably be led to appreciate more fully the advantages of good sanitation if we can arrive at putting a money value upon some of the more direct results of sanitary improvements.

In the first place the community derives a direct advantage from adopting such a system for the removal of refuse as will enable it to be applied directly to improving the cultivation of land. For whilst on the one hand the rapid removal of refuse from the neighbourhood of dwellings by the efficient sewerage of towns results in improved health, the application of sewage to land by the irrigation of growing crops affords both a means of fertilizing the land, and of cleansing the fluid, so as to place it in a fit condition to pass into the streams.

My friend Mr. Chadwick asserts that where the sewage is undiluted with rain-water, and where it is utilized at once, and carefully applied under favourable conditions, an acre of land ought to absorb the sewage of 100 persons, and that the crops on this area should feed five cows; or, if put in another way, that the produce of ordinary cultivation being represented by 1, and market garden produce by $3\frac{1}{2}$, the produce of sewage cultivation should be represented by 5.

I have obtained some recent facts on the direct application of sewage to land which, although they do not show such high results, deserve attention.

Mr. Brundell, who has the management of the Doncaster Sewage Farm, states that during nine years he has never applied any other manure than sewage. That this year the crops are the heaviest that have been produced, and the land remains just as capable of receiving the sewage as it ever was, and does not "tire." Mr. Collett, of the Bedford Farm, says that their produce is generally much above the average of the neighbourhood, and that the crops are as good or better than they were seven or eight years ago; and the land under sewage treatment has improved in quality.

Mr. Champion informs me that at Reading, with sewage irrigation, they cut the Italian rye grass six and seven times in the season, as compared with two crops without sewage; that man-golds grown with sewage produce from 15 to 20 tons per acre more than when grown in the usual way: that their oat crop this year yielded from 14 to 15 quarters per acre, the straw being from 7 to 8 feet high, and remarkably stout and stiff.

Colonel Jones, of Wrexham, tells me that "having farmed many hundred acres during the last three years for the land-owners who had farms thrown on their hands, I have had some opportunity of comparing actual results of farming with and without the resource to be derived from a town sewer, and I have no hesitation in saying that produce may easily be doubled per acre by the proper use of sewage as regards *any crop*, and that four or five times the weight of grass is a certainty in any season; and it is simply a question of management and market whether or not a sewage farm can be made to pay."

There are occasionally, no doubt, difficulties to be overcome in the application of sewage to land, and some eminent advocates of the conversion of sewage into manure have said that if the sea is at hand it is better to throw sewage into the sea than to utilize it. But that is not the language used in speaking of the manure of an ordinary farm; yet the one is, in its way, and under its own conditions of use, as valuable for improving crops as the other. Farmers say that one of the best ways of obtaining manure for the land is not to buy artificial manure, but to buy oil cake or other suitable food, and to feed sheep and cattle upon that; and land is largely manured by means of oil cake and Indian corn imported from abroad as food for domestic animals. A recent investigation showed that one-third of the food which is consumed by the people of this country comes from abroad; and, therefore, if we applied the sewage of our population to our land, we should enrich the land by the millions of quarters of foreign corn and the thousands of tons of foreign meat which are imported and consumed in the country; and, so far from the land of England deteriorating under such conditions, it ought to become richer year by year by these enormous importations of food. Therefore, whatever may be the trouble and expense in individual cases of applying the sewage to the land, the application, so far as the interests of the community are concerned, must add to the stored-up wealth of the country.

In the next place the diminished death and sickness rates and the greater length of life entailed by good sanitation afford direct pecuniary advantages.

Let us apply this reasoning to the population of the Improved Artizans' Dwellings in London. These now accommodate about 11,000 families.

In many of the districts which are now covered by these improved dwellings, the death-rate in the wretched homes which have been removed varied, as I have told you, from 35 to 40 and even 50 per 1,000. Mr. Gatliff shews that there are nearly five in a family on an average in Model Lodging Houses. There has thus been a saving of life to the extent of at least 20 per 1,000, by the erection of these dwellings, on the 50,000 persons inhabiting them, or about 1000 deaths annually. And if we take the estimate of sickness which I arrived at above, there would be a reduction in the number of cases of sickness which occur in the population of these dwellings of at least from 15,000 to 20,000.

The cost of the Improved dwellings appears to have averaged a little over £170 each, or about £1,900,000 for the 11,000 families.

By the light of these various data we may obtain some idea of the actual pecuniary advantage to the community which results from the improved health of the occupants of such dwellings. The cost of funerals has been stated to average £5 apiece. Under this head, therefore, the saving may be taken to average £5,000 a year; the diminished loss of the sickness of the 11,000 heads of families alone may be assumed to average another £5,000 a year; and in addition to this there would be the saving in time and money, in seeking medical attendance, of the wives and children who make up the remaining population of the dwellings, as well as the increased power of earning wages afforded to the mothers of families from the diminished sickness of the children.

Hence the money benefit to the community thus made up, which is caused by the diminished death-rate and sickness-rate, would form an appreciable item in the percentage of interest paid on the £1,900,000 capital expended in the construction of the dwellings.

But there is another way in which we may estimate the economy to the community resulting from the increased health which has been obtained in these dwellings.

The analysis of the mortuary rates for Westminster shewed that the mean age at death of the males of the wage classes in Westminster, who had survived the period of youth, and died after 20 was 47·6 years.

The rate of mortality in the Improved Dwellings is from 14 to 16 per 1,000. The rate of mortality in the rural parishes of Northumberland above mentioned, in the years 1877-81, was 15·3 per 1,000; and in Dover in 1880, it was 16·7 per 1,000. It will not be unfair therefore to take the mean age at death of the males who died over 20 in the rural parishes of Northumber-

land and in Dover as a standard, which may be reasonably expected, for the duration of life of the males who die over 20 years of age in the Improved Dwellings. This was, for the rural parishes of Northumberland 60·9 years, and for Dover it was 57·8 years. That is to say, from 10·2 to 12·3 years, or a mean of 11 years additional duration of life may be expected for the heads of families occupying the Improved Dwellings, beyond that enjoyed by the wage classes who do not live in such favorable surroundings.

Therefore we may assume as a profit to the community the increased earning power of the occupants of these dwellings, due to this increased expectation of life. It would appear from Mr. Neissons tables that 6 per cent. would be a full average deduction for sick time between 47 and 58 years of age; and we may therefore safely take the increased earning power as that due to an additional 10·4 years of life.

If, in order to form a rough estimate of the money value of this, we assume that each of the heads of the 11,000 families receives as a present on his admission to the dwellings a grant of ten years more life, and calculate its money value on the earnings of only £1 a week, we find that upon a four per cent. table the present value of ten years of increased wage earning power at £1 per week would be for 11,000 heads of families £4,640,000, or nearly two and a half times the cost of the property.

By considering the question in this way, we arrive at an understanding of some of the direct pecuniary advantages which accrue to the nation from those sanitary improvements which lead to a decreased death-rate and sickness-rate; and we see that however large may be the cost of the removal of bad dwellings, and the substitution in their place of healthy well-planned dwellings, the actual money gain to the community far exceeds the expenditure in money.

But it is not as a money saving alone that the question must be considered. Its social and political bearings are even more important.

The nation is made up of individual items. The goodness and the happiness of the nation depend upon the individual. Well-regulated family life does more to make up individual happiness than any other form of life. But family life is impossible in the wretched homes which have been permitted to exist in most of our large towns, and many of our rural parishes. These wretched homes drive the population into the streets, and into the gin palaces, and into the public houses. They engender sickness, which entails poverty, and they foster crime.

The improved dwellings, on the other hand, ensure im-

proved health; and by thus affording a security for the more continuous earning of wages, create the possibility of a comfortable home. I was much struck, when in the United States of America, with the fact that the artizan and wage classes, in many manufacturing towns, lived in very comfortable houses, in which each family had their parlour with appropriate furniture, pictures, and often their piano. They had come to look upon these things as a necessity; and this is an evidence of the general civilization which pervades American society. By civilization I mean the education and the general well being of all classes.

In this country our most advanced sanitarians have long endeavoured to impress these doctrines on the public, and I am happy to think that at last they are beginning to bear some fruit; for in order to develop morality, contentment, and happiness among a people, it is essential that they should be provided with healthy and comfortable homes.

The MAYOR said he was quite sure that the meeting would agree with him that the important, interesting, and useful address which had been delivered by Captain Galton deserved their most hearty thanks. People seemed to be living in a state of considerable ignorance as to what was necessary for the promotion of their health, and the information which had been given in the early part of Captain Galton's address should result in very great benefit to the public at large. The latter part of the address was full of very interesting facts which had rather an important relation to the health of the working classes. He hoped that the spirit of advancement which he believed had been going on for some time in connection with matters of general health would be accelerated by the address they had heard that night. He had great pleasure in asking them, without making any further remarks, to give Captain Galton a very hearty vote of thanks for the valuable and interesting address he had just read.

Mr. ALDERMAN WILSON said he had great pleasure in seconding the proposal which the Mayor had made to them. It was undoubtedly a very valuable address, and he hoped that it would be profited by in every possible way. If at any future time it should occur that this valuable Institute should come among them again, he hoped that they would find that a very satisfactory state of things, in regard to the matter of health, existed in Newcastle-on-Tyne. They would find, at all events, that their death rate would be very much diminished. He had very great pleasure in seconding the motion.

Captain DOUGLAS GALTON said he was extremely obliged to those assembled for the extremely hearty manner in which they had carried the resolution. He had now formally to announce that the meeting was adjourned.

The meeting then adjourned.

Classes of the Population.	Proportion of Deaths from the Undermentioned Causes to 100 Deaths from all Causes.						Mean Age at Death of all who died; men, women, and children.	Mean Age at Death of all who died above 20 years of age.
	Diseases of the Respiratory Organs (including Phthisis.)			Deaths from Zymotic Diseases.		Total per cent. of Deaths of each class of Zymotic Diseases, and Mean of all classes.	Diseases of the Nervous System.	Senectus.
	Proportion per cent. of Total Deaths of each Class.	Diseases of the Respiratory Organs (including Phthisis.)	Enteric Fever.	Diarrhoea.	Other Zymotic Diseases.			
Gentry, Professional Men, &c. :—								
Males.....	54.45	29.88	...	3.27	5.88	9.15	11.76	3.27
Females.....	45.55	25.78	0.78	1.56	1.56	3.80	16.41	3.91
Children under 1 year.....	6.41	11.11	...	27.78	5.66	23.34	11.11	...
Children under 5 years.....	9.96	10.71	...	17.86	7.14	23.00	10.71	...
Salaried Classes, Commercial Clerks, and Merchants :—								
Males.....	61.59	28.82	2.35	1.76	4.29	9.80	10.59	3.53
Females.....	38.41	30.91	2.83	3.77	6.60	13.20	8.49	1.89
Children under 1 year.....	15.94	18.18	...	11.36	9.09	20.45	15.91	...
Children under 5 years.....	27.54	21.05	...	9.21	19.74	28.96	9.21	...
Tradesmen, Shopkeepers, &c. :—								
Males.....	51.27	32.52	1.48	3.14	7.15	11.77	10.64	1.05
Females.....	48.73	33.39	0.73	2.75	9.36	12.84	10.55	2.66
Children under 1 year.....	21.90	24.49	0.20	9.59	9.69	19.38	11.84	...
Children under 5 years.....	38.44	26.98	0.35	6.63	18.95	25.93	10.23	...
Wage Classes—Artizans, &c. :—								
Males.....	54.94	36.42	1.35	3.06	5.85	10.26	9.26	0.72
Females.....	45.06	33.55	0.88	3.62	10.09	14.59	10.76	2.41
Children under 1 year.....	22.63	28.17	0.22	11.35	9.17	20.74	11.79	...
Children under 5 years.....	39.03	28.73	0.38	8.35	17.09	25.82	10.51	...
Domestic Servants, &c. :—								
Males.....	47.04	32.62	0.92	4.29	4.00	9.81	8.28	0.61
Females.....	52.96	32.15	2.45	14.56	5.54	10.35	9.64	4.09
Children under 1 year.....	26.35	21.99	...	5.60	7.80	23.40	10.64	...
Children under 5 years.....	30.88	23.70	0.93	12.62	10.28	23.83	11.21	...
Mean of all Classes :—								
Males.....	52.77	33.29	1.34	3.16	6.19	10.69	9.90	1.13
Females.....	47.23	32.77	1.11	3.27	8.30	12.68	10.68	2.80
Children under 1 year.....	20.69	25.20	0.17	11.38	9.12	20.97	11.82	...
Children under 5 years.....	35.71	37.08	0.41	8.23	17.12	25.76	10.42	...

NOTE.—The figures in this Table refer to the three Registration districts of St. George, Hanover Square, Westminster, and the Strand; whose population is very nearly the same as that of Westminster Borough. Thus the population of the Borough, in 1871 was 245,606, while the Registration district had a population of 248,456, or 1,850 in excess. Total deaths in 1878 in the three Registration districts—Males, 2,908 Females, 2,603—5,511. Proportion of deaths to the population, 22.7.

APPENDIX B.—CITY OF NEWCASTLE-UPON-TYNE, 1881.

56

INAUGURAL ADDRESS.

Classes of the Population.	Proportion per cent. of Total Deaths of each Class.	Proportion of Deaths from the Undermentioned Causes to 100 Deaths from all Causes.						Mean Age at Death.	
		Diseases of the Organs (including Respiratory Phthisis).	Zymotic Diseases.			Diseases of the Nervous System.	Sexectus.	Of all who died: Men, Women, and Children.	Of all who died above 20 years of age.
			Enteric Fever.	Diarrhoea.	Other principal Zymotic Diseases.				
All Classes:—									
Males.....	51.83	25.76	1.15	5.71	6.01	14.46	2.98	29.4	{ 51.9 55.1 ... }
Females.....	48.17	23.53	1.37	4.44	7.06	14.38	6.36		
Children under 1 year.....	25.62	12.65	0.12	10.93	4.55	19.78	...		
Children under 5 years.....	39.26	16.76	0.24	9.06	11.71	17.80	...		
1. Gentry, Professional Men, &c.:—									
Males.....	54.91	26.02	2.44	4.07	4.88	14.63	3.25	35.5	{ 53.2 57.1 ... }
Females.....	45.09	15.84	...	3.96	6.93	14.85	3.96		
Children under 1 year.....	23.66	5.66	...	11.32	1.89	18.87	...		
Children under 5 years.....	33.93	11.84	...	7.90	11.84	14.47	...		
2. Tradesmen, Shopkeepers, &c.:—									
Males.....	51.92	30.30	1.42	4.55	4.84	14.22	2.70	31.6	{ 54.0 56.9 ... }
Females.....	48.08	26.27	1.38	3.69	6.30	16.44	6.30		
Children under 1 year.....	22.82	15.83	0.32	9.90	2.27	18.12	...		
Children under 5 years.....	37.00	19.96	0.60	6.79	11.33	17.76	...		
3. Shipwrights, Chain and Anchor Smiths, Iron Forge Labourers, &c.:—									
Males.....	50.00	25.51	0.51	5.61	9.18	10.20	2.04	22.3	{ 46.6 50.9 ... }
Females.....	50.00	16.33	1.02	6.63	3.57	9.69	3.57		
Children under 1 year.....	32.40	8.66	...	11.02	6.30	20.47	...		
Children under 5 years.....	47.96	14.89	...	10.64	9.97	15.96	...		
4. Seamen, Watermen, Fishermen, &c.:—									
Males.....	55.12	21.43	...	7.14	2.86	12.86	2.86	37.1	{ 52.4 57.4 ... }
Females.....	44.88	22.81	...	3.51	5.26	12.28	7.02		
Children under 1 year.....	18.90	8.33	...	4.17	12.50	29.17	...		
Children under 5 years.....	26.77	11.76	...	8.82	14.71	26.47	...		
5. Other Wage Classes—Artizans, &c.:—									
Males.....	51.34	20.58	0.90	7.40	7.04	16.43	3.61	27.0	{ 49.9 53.4 ... }
Females.....	48.66	24.38	1.90	4.76	9.52	13.72	4.95		
Children under 1 year.....	27.90	12.96	...	12.96	5.98	20.60	...		
Children under 5 years.....	41.52	15.18	...	11.16	12.72	18.53	...		

APPENDIX C.—BOROUGH OF DOVER, 1880.

DOUGLAS GALTON.

57

Classes of the Population.	Proportion per cent. of Total Deaths of each Class.	Proportion of Deaths from the Undermentioned Causes to 100 Deaths from all Causes.					Mean Age at Death.	
		Diseases of the Organs (including Respiratory Phthisis.	Zymotic Diseases.			Senectus.	Of all who died; Men, Women, and Children.	Of all who died above 20 years of age.
			Enteric Fever.	Diarthra.	Other Zymotic Diseases.			
All Classes:—								
Males.....	52.43	30.74	0.74	7.76	1.85	11.85	7.41	{ 57.8
Females.....	47.57	21.43	1.63	6.94	3.67	15.10	8.57	{ 59.6
Children under 1 year.....	26.59	20.86	...	19.42	0.72	14.39	...	{ ...
Children under 5 years.....	37.28	25.52	...	16.67	5.21	13.02	...	{ ...
Gentry Professional Men, &c.:—								
Males.....	43.94	17.24	6.90	13.79	...	17.24	10.34	{ 64.7
Females.....	56.06	21.62	8.11	5.41	5.40	18.92	16.22	{ 64.9
Children under 1 year.....	13.64	11.11	...	65.56	...	11.11	...	{ ...
Children under 5 years.....	25.76	17.65	...	29.41	5.88	17.65	...	{ ...
Tradesmen, Shopkeepers, &c.:—								
Males.....	48.66	31.87	...	6.59	...	14.29	5.50	{ 61.0
Females.....	51.34	33.33	...	7.29	6.95	16.67	4.17	{ 53.4
Children under 1 year.....	27.27	19.61	...	17.65	1.86	17.65	...	{ ...
Children under 5 years.....	40.64	23.68	...	14.47	7.39	13.79	...	{ ...
Wage Classes—Artizans, &c.:—								
Males.....	58.01	34.62	...	7.69	3.85	9.23	8.46	{ 55.0
Females.....	41.98	35.11	1.06	8.51	...	12.77	6.38	{ 60.1
Children under 1 year.....	29.46	25.76	...	18.18	...	12.12	...	{ ...
Children under 5 years.....	36.16	30.86	...	18.52	2.47	9.88	...	{ ...
Seamen, Boatmen, Pilots, &c.:—								
Males.....	52.63	20.00	...	5.00	...	10.00	5.00	{ 52.5
Females.....	47.37	22.22	...	...	5.56	11.11	27.78	{ 78.0
Children under 1 year.....	34.21	7.69	...	7.69	...	15.38	...	{ ...
Children under 5 years.....	47.37	16.67	...	5.56	5.56	11.11	...	{ ...

Total Deaths 515 {Males 270.
Females 245.

Annual Rate of Mortality per 1,000 of Population in 1880 167.

APPENDIX D.—RURAL PARISHES OF NORTHUMBERLAND, 1877—81.

Deaths in the five years 1877—81, in parishes comprised in the Registration Districts of Bellingham and Rothbury, and in the Sub-districts of Islandshire and Northshire, in the parish of Chilton.

Classes of the Population.	Proportion of Deaths from the Undermentioned Causes to 100 Deaths from all Causes.					Mean Age at Death.	
	Proportion per cent. of Total Deaths of each Class.	Principal Zymotic Diseases.			Diseases of the Nervous System.	Sexectus.	Of all who died; Men, Women, and Children.
		Diseases of the Respiratory Organs (including Phthisis).	Enteric Fever.	Diarrhoea.	Other principal Zymotic Diseases.		
All Classes:—							
Males	50.43	19.51	1.84	1.84	6.50	12.03	(80.9
Females	49.57	23.35	1.50	2.25	7.62	12.61	59.9
Children under 1 year	15.72	13.78	0.55	5.12	6.69	...	...
Children under 5 years	22.46	13.22	...	4.13	16.53	...	...
Gentry, Professional Men, &c.:—							
Males	44.83	11.54	3.85	...	3.85	15.39	(35.5
Females	55.17	25.60	...	...	...	15.75	70.8
Children under 1 year	8.62	40.00	...	...	20.00	...	...
Children under 5 years	10.34	33.33	...	...	16.67	...	...
Farmers, &c.:—							
Males	60.00	19.30	1.75	0.88	3.51	9.65	(88.1
Females	40.00	23.68	1.32	2.63	5.26	10.53	88.8
Children under 1 year	10.00	15.79	...	...	5.26	...	...
Children under 5 years	14.74	17.86	...	3.57	10.71	3.57	...
Tradesmen, Shopkeepers, &c.:—							
Males	51.20	21.70	2.98	0.85	5.96	16.17	(59.2
Females	48.80	21.43	...	1.34	10.71	15.63	60.4
Children under 1 year	13.07	13.33	...	1.67	13.33	11.67	...
Children under 5 years	20.48	11.70	...	1.06	24.47	10.64	...
Wage Classes—Artizans, &c.:—							
Males	46.49	19.11	0.80	3.56	7.56	11.11	(58.0
Females	53.51	21.24	1.93	2.70	8.49	12.36	57.3
Children under 1 year	21.49	14.44	...	9.62	1.92	4.81	...
Children under 5 years	28.72	12.23	0.72	7.91	14.39	6.47	...
Agricultural Labourers, &c.:—							
Males	50.59	18.60	1.40	1.86	7.91	9.30	(63.7
Females	49.41	27.62	2.86	2.46	5.24	9.52	57.7
Children under 1 year	15.53	10.61	...	3.03	7.58	4.55	...
Children under 5 years	22.59	13.54	1.04	2.08	13.54	4.17	...
Gentry, &c.	58	Wage Classes	484	(815 Males.	Population 1871...23,139.	Population 1881...20,666.	

APPENDIX E.—Annual rate of mortality per 1,000 of population at several ages in the City of Newcastle-upon-Tyne during the year 1881, and in the Borough of Dover in the year 1880.

Ages.	Newcastle-upon-Tyne, 1881.		Dover, 1880.	
	1881.		1880.	
	Males.	Females.	Males.	Females.
All Ages.	23-16	20-60	18-13	15-37
0 — 5	66-19	54-77	62-64	44-43
5 — 10	8-84	7-36	3-88	1-80
10 — 15	4-35	3-79	7-06	2-68
15 — 20	5-08	5-10	4-09	4-08
20 — 25	6-00	6-82	6-07	4-98
25 — 35	10-67	8-95	6-20	5-07
35 — 45	17-71	14-88	9-42	10-07
45 — 55	27-11	17-05	12-11	10-02
55 — 65	44-89	32-81	31-91	25-41
65 — 75	88-97	80-72	53-31	42-11
75 — 85	206-01	177-48	183-65	117-72
85 and upwards.	276-90	215-83	430-63	190-89

NOTE.—The numbers of the population at the various ages as enumerated at the Census of 1881, are not yet available. For the purposes of the above table it has been assumed that the distribution of the population over the several ages was relatively the same in 1881 as in 1871.

APPENDIX F.—Mean age at death and mean after life-time or expectation of life, at several ages, deduced from the estimated mortality of the City of Newcastle-upon-Tyne in the year 1881, and of the Borough of Dover in the year 1880. The expectation of life by the English Life Table is added for comparison.

Ages.	Newcastle-upon-Tyne, 1881.				Dover, 1880.				By the English Life Table.	
	Mean age at death.		Mean after life-time.		Mean age at death.		Mean after life-time.			
	Males.		Fe- males.		Males.		Fe- males.			
	Males, males.		Fe- males.		Males, males.		Fe- males.		Males, males.	
	Fe- males.		Males, males.		Fe- males.		Males, males.		Fe- males.	
0	39-1	43-7	39-1	43-7	44-5	52-1	44-5	62-1	39-9	41-9
5	52-6	55-9	47-6	50-9	59-9	63-9	54-9	58-9	49-7	50-3
10	54-7	57-8	44-7	47-8	60-8	64-5	50-8	54-5	47-1	47-7
15	55-6	58-6	40-6	43-6	62-6	65-2	47-6	50-2	43-2	43-9
20	56-6	59-7	36-6	39-7	63-5	66-1	43-5	46-1	39-5	40-3
25	57-6	61-0	32-6	36-0	64-8	67-2	39-8	42-2	36-1	37-0
35	60-7	63-9	25-7	28-9	67-0	69-2	32-0	34-2	29-7	30-6
45	64-8	67-7	19-8	22-7	69-7	72-3	24-7	27-3	22-8	24-1
55	69-3	71-0	14-3	16-0	72-2	74-6	17-2	19-6	16-5	17-4
65	74-6	75-3	9-6	10-3	76-8	78-9	11-8	13-9	10-8	11-5
75	81-3	81-8	6-3	6-8	81-6	83-5	6-6	8-5	6-5	6-9
85	90-5	90-1	5-5	5-1	90-1	91-5	5-1	6-5	3-7	4-0