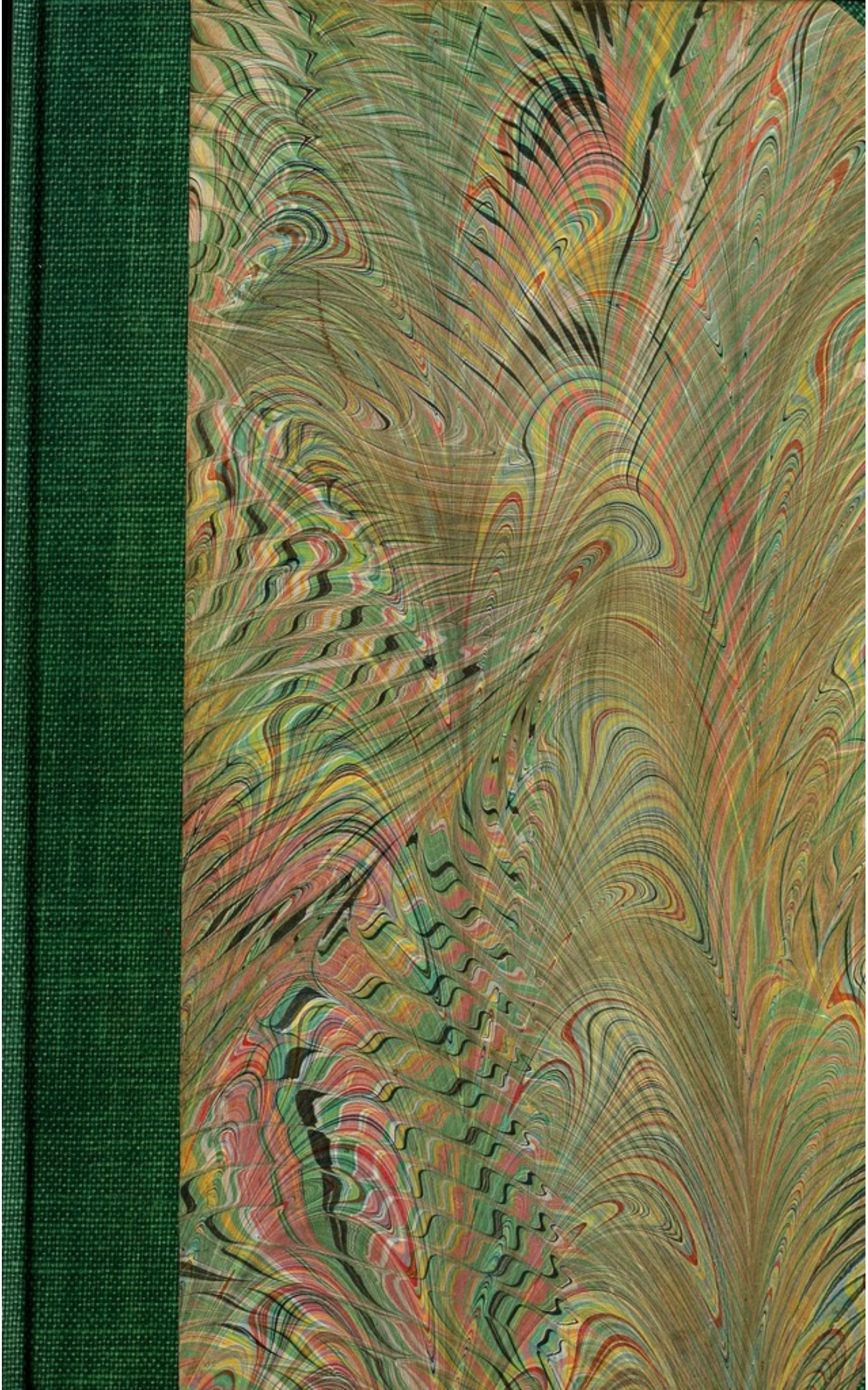
Public health : address / by Edwin Chadwick, as President of the Health Department at the Science Congress held at Aberdeen, Oct. 1877 ; with corrections and additions.



For
Dr Henry L. Bowditch
with the Author's high respects
and acknowledgments.

PUBLIC HEALTH

ADDRESS

BY

EDWIN CHADWICK, C.B.

AS PRESIDENT OF THE HEALTH DEPARTMENT

AT THE

SOCIAL SCIENCE CONGRESS HELD AT ABERDEEN, OCT. 1877

WITH CORRECTIONS AND ADDITIONS

LONDON : 1877

CONTENTS.

May it please you; my Lords, Ladies, and Gentlemen.—

IT will be my duty to submit to you, as well as I may, from my own point of view, the present position of Sanitary Science, for its future practical advancement.

A Stationary Death-rate, with a Largely Increased Population, a Reduced Death-rate.—It has been recently put forward by a gentleman who held this chair at Liverpool, that notwithstanding all the expense incurred by local authorities for sanitary works, there has been little alteration in the death-rate during the last forty years. In great part this is true, and I may show why it is so; but the figures are misleading, for with an increase of the population during that period, from about fifteen to twenty-two millions, with extensive conditions of overcrowding of dwellings of the wage classes, and of cottages which formerly served for one family, but which have now frequently one family to each room, there have been augmentations of death-rates at many points, insufficiently countervailed by reductions at others. It will be found that a stationary death-rate is, relatively a largely increased population, a reduced death-rate. But the statement is, as I shall show, so couched as unjustly to depreciate our increased power of sanitation. Then we have had the doctrines of Malthus raised against us, and it is held forth that by increasing the population we shall by division diminish its subsistence fund and intensify misery. Those doctrines were pressed for application when the population was one-third what it now is. They were again pressed as of increasing necessity, when it was one-half what it now

is. In what comparative condition of comfort would the population now be, and of prosperity and strength would the nation be, if it were now as it then was? In my service in Poor Law administration, I had to deal practically with those doctrines. In one county we at once struck off 10,000 able-bodied men from the pauper roll of out-door relief in aid of wages. The Malthusians declared that wages must be reduced by that measure, and that its working must be horrible. But lo! wages, instead of falling, rose higher than they had ever been before. In the very county where the objection was raised the population has been increased during the last half century from half a million to upwards of two millions, wages have been doubled, and until the late check to manufactures and population—productive population—had become scarce, as I foretold it would be. I might add, that if by sanitation the population were increased to the extent foreboded, why then, as it is estimated, that of the habitable parts of the globe only one-sixth is really believed to be inhabited, we shall have sufficient outlets for the superabundance of a strengthened population. Noting the fact that at the period of the promulgation of the population doctrine, epidemic visitations were regarded as 'positive checks,' absolutely unpreventible and uncontrollable,—I beg to call attention to the progress made in the development of the powers of sanitation in absolute prevention; especially as bearing on those visitations. In our first meeting at Birmingham, in 1857, Lord Stanley, now the Earl of Derby, referred to my official Report of 1842, on the sanitary condition of the labouring population, in terms with which subsequent dedications to me of works on the subject—of which I prize most the dedications by officers who have served with me—have concurred, in accepting that Report as the *Starting-point* of public effort in Sanitation. I therefore propose to submit examples of the development of those powers since that period. Our general death registration is defective in itself; and it is yet more defective for our present purpose, because in the same registration districts houses situate outside sanitary works which have had no amendment are mixed up with others in areas which have been so amended, and it is hence very difficult to obtain distinct and just conclusions in respect to the results of such works. We may, however, see more clearly the operation of principles, and obtain more satisfactory conclusions, by observing their working on similar classes of persons in similar conditions, as in the Army and the Navy; or in public institutions under distinct professional observation and care. It is to such instances that I beg to solicit attention. And, first, as to

the prevention of the greatest sources of preventible diseases, 'the children's diseases' and 'children's epidemics.'

A Norma of Sanitation for the Infantile Stages of Life.—In 1838 there fell to the direct administration of our Poor Law Board, of which I was the Secretary, two large institutions for the care of destitute orphan children, which suffered severely from passing epidemics or typhus fever. In one, at Norwood, containing 700 children, there was a severe outburst of typhus fever, by which more than a third were attacked, and more than 30 were killed. The general declaration of medical men at the time was, that the mortality was occasioned by deficient food. But the food was better and more abundant than the food of the independent wage classes. I got the case examined by the late Dr. Neill Arnott, who was a specialist in one element of sanitation—ventilation. He pronounced the main evil to be not deficiency of food, but deficiency of pure air, and that the remedy was the constant removal of putrifying matter by good drainage, and of foul air by ventilation. This was adopted, with the result of a reduction of the death-rate by about one-third. Next followed the production of clean skins, by regular head to foot ablutions with tepid water;[1] and this was followed by the reduction by about another third of the ordinary death-rates. Other improvements in detail have followed, chiefly in physical training. As sanitary improvement has advanced in these institutions there have been fewer inmates of the sick wards to the extent that not a fourth of the beds provided for sickness are now usually occupied. The particular institution first attacked, and now eight other large orphan institutions, district asylums,—are in fact children's hospitals, where numbers are received only to die. All the inmates as a class are of the most wretched type of children, all weakly and susceptible to disease; but of those who come in without marked disease, there is now an almost absolute immunity from the 'Children's epidemics.' Cases of typhus, at one time scarcely ever absent, have not been seen there for several years. The mean death-rates in these institutions have been steadily reduced to about 3 in 1,000, that is to say to nearly one-fourth of the general death-rate of children of the school ages, including the children of the well-to-do classes of the population. It was recently stated, as evidencing the success of the 'boarding out' system, that the deaths had not exceeded 2 per cent.; and this pro-

[1] On skin cleanliness generally as a factor in sanitation, see an Exposition of mine, made for the Congress on Domestic Economy, held at Birmingham, and published with other Papers by the Society of Arts.

bably may be taken as an average children's death-rate for the cottage;—that is to say, 20 per 1,000, as against 3 per 1,000 in the district orphan institution, with little variation in the separate institutions. Medical officers in charge of them, but who are in private practice, have repeatedly expressed to me their astonishment at these results of sanitation as surprising and wonderful to them. I was lately present at a prize-giving to agricultural labourers by Lord Shaftesbury, where one prize man was a shepherd who out of 100 lambs he had reared had only lost one. Such emulation may well be directed to the preservation of the human. On a visit to one of these orphan institutions, I told the governess of the infants that the Queen of the Belgians had offered a gold medal to whichever manager of such institutions should rear the greatest number of infants, and I asked the governess whether she would compete in conservancy of life against that shepherd with his lambs. She proudly declared that she would do more than that, and with the infants of the ages under her care she really has done more. It is, however, to be noted that the schools are on the half-time principle, which we introduced with the Factory Acts, as preventive of the physical injury done by over-sedentary work in the long-time schools; and I may add that, by a better adjustment of the book teaching to the children's mental powers of receptivity, and by the 'freshening up' of the faculties by brisk gymnastic exercises and the military drill, these children, though naturally of an inferior mental type, are got well through the three R's in less than four years, as against seven in the common elementary schools, and at half their cost for teaching power; and with the economical outcome, that the efficiency of three is imparted to two for industrial occupations. Formerly, very much from bodily inaptitude, not one out of three got good places; now a very small percentage fail to do so. Here then we have a great sanitary norma established with factors that go to the prevention of an annual excess of upwards of 50,000 deaths in the school stages of life, in England and Wales.

A Norma of Sanitation in Adult Stages of Life.—I would now call attention to another norma of sanitation, for adult stages of the population.

It has fallen to my lot in the course of my early service to examine and compare the results of sanitation in our prisons. Prisons, I need not remind you, were in the time of Howard, seats of the reputed special 'gaol fever,' to which not only prisoners, but juries and judges who tried them have heretofore fallen victims. But now, by clean air, clean per-

sons, pure water, and by regulated regimen, prisons are made seats of health, and display the most conspicuous norma to be kept in view of the power of sanitation in adult life. Sir Robert Christison, the distinguished consulting physician on the prisons of Scotland, declares that the general prison of Scotland, that of Perth, is apparently the most healthy place in the world. He states to me: 'The healthiness of the general prison is almost marvellous. I have down to the present time inspected it as Government inspector six times annually for thirteen years past, and have very seldom indeed found more than one man and one woman in bed amongst 750 prisoners—once or twice no one!' In the common condition previously from such a number of prisoners, a large sick ward would be occupied. He is most emphatic in his expressions of astonishment at the result. I have heard similar expressions from prison surgeons in England, and that they are wont to say of patients in their private practice, 'Oh, if I could only have that case in prison, I could save the life.' It may be said that the epidemics which ravage the populations under the rule of Baily bodies, vestries, and the like, do not now touch the populations in the prisons under the care of the State. Epidemics rage around them, but do not enter them, unless it be by some extraordinary accident, or some very culpable negligence.

I once met a prison surgeon of our Model Prison at Pentonville, who appeared to be in trouble of mind. I asked him if anything had happened? He had got a case of small-pox in the prison! The disease was then ravaging the courts and alleys in the vicinity of the prison, where as many as a third of the wage classes in some of them were attacked. But this by no means consoled him; a case had no business to be in his prison. A case of cholera occurred in one of the Scotch prisons, and there was a serious consultation about it, and an elaborate speculative report as to how such an extraordinary event could have occurred there. We heard at the Board of Health that there was an attack of dysentery in a prison, and on hearing of it we were perfectly certain that there was misfeasance or culpability somewhere. On inquiry it turned out that an ill-constructed prison drain had burst into the prison well, from which the prisoners were supplied with drinking water. In the Millbank Prison cases of typhoid fever were at one time frequent, which was traced to sewer-tainted water from the Thames. For the protection of the prison population, this source of supply, to a large proportion of the outside population, was stopped, and spring sources, such as

we recommended for the metropolis, were resorted to with the result that typhoid fever, which continued to prevail amongst the general population of the metropolis, has been long extinguished amongst the population of the prison. In another prison an outbreak of typhoid fever took place, which was found to have arisen from the overflow pipes being connected direct with the main sewer, which conveyed the gas from the sewer to the prison water-tank, so that those gases were absorbed by the water which the prisoners drank. This connection was severed, and the prisoners were restored to their superior health. But in the metropolis, and other large cities, from the work of ignorant plumbers, to whom is left the uncontrolled internal distribution of water, the like connections are made by waste or overflow pipes opening into the common sewers, whence the sewer gases of ill-constructed sewers of deposit and consequent putridity are led into the cisterns of the houses under vestral rule,—with the continued consequences to the general population from which the population under State sanitary rule are protected. Temperance, or the enforced exclusion from alcoholic drinks (as well as from tobacco) may, it is observed, have claims as factors in the great sanitary results; but to what extent the prison surgeons I have consulted cannot determine, for they have observed similarly good results manifested in the health of female prisoners who have not been gin or beer drinkers, but chiefly tea drinkers.

To prisons, then, we should accustom the health authorities to look as strongholds of attained, and attainable, sanitation. About two-thirds of the prisoners, as appears in Scotland, enter the prisons with disease upon them, often in advanced stages. Eliminating these cases, we may get a measure of progress from the military prisoners whose death-rates as outsiders we know. Men have been taken from the ranks, where the death-rates were 17 in 1,000, and put into the prisons where the death-rates were only 3 in 1,000. I am led to consider, from various evidences, that a death-rate of 3 in 1,000 may be taken as an attained normal death-rate for the adult stages of the life of the ages of the prison populations.

Here, then, we have two great sanitary normas—one of a death-rate of little more than a fourth of the common death-rate in the infantile and juvenile stages of life, and the other of the like proportion in the adult stages. These results of sanitation in the exemptions from ordinary as well as extra-ordinary epidemics excite the astonishment of the professors of the curative service. Yet these results are obtained by very

rudimentary means applied, especially in the juvenile stages, by agencies for which high refinement cannot be claimed. On examining these same results it is evident that they are yet susceptible of further advances. Undivided professional attention (which is frustrated by the administrative arrangement which necessitates anxious attention to private practice), and close observation of the comparative experience of several of such establishments, would evolve important contributions to sanitary science. Thus the effects of sanitation, under different conditions of climate, have yet to be observed and discriminated. In one children's institution at Calcutta, similar to those instances cited near the metropolis, a death-rate of about 7 in 1,000—not of a fourth— but of one-half the ordinary death-rate here, has been obtained, which gives good promise of the practicability of rearing children Indian born of British residents, and so establishing succession in our Indian dominions.

Different Species of Disease attendant on Different Doses of Aërial Impurity —I obtained observations of one large prison, that of the French prisoners of war in this country, who were confined on the high and fine site for air, the granite of Dartmoor. As the number of prisoners, and the crowding of the prison, was increased, and in the then ignorance of the principles and means of sanitation, typhus became rife and dreadfully predominant. As the numbers of the prisoners were reduced by exchanges, typhus was reduced, and finally disappeared; yet phthisis remained, and was prominent, but when the number of prisoners was still further reduced, phthisis was reduced, and on the prison being further thinned finally disappeared. The apparent immunity from phthisis amongst the reduced numbers of the prisoners attracted the attention of a physician who was a very good observer (the father of the late Dr. Hunt), who applied the fact successfully in his practice. He was wont to send patients who were smitten with consumption up to Dartmoor, and to provide that they should be kept alone in rooms carefully aërated. Cases occurred of whole families in lower sites smitten with phthisis, of whom he could persuade only one to take the remedy of pure aëration, and that one recovered, whilst the rest who remained fell one after another. This great prison presented an example on a large scale of the deterioration of the finest air and water by insanitary treatment; and, moreover, of another important subject needing further observation—the production of different orders of disease in the same air, by different doses of aërial impurity on the same sites and under the same atmospheric conditions

Progress of Sanitation in the Army.—I now beg leave to submit to your attention the progress of the principles of sanitation under public treatment and collective observation—namely, of our military forces at home and abroad. On the outbreak of the Crimean War I went myself, as the chief executive officer of the first general Board of Health, to the War Office, and ventured to express my doubts as to the sufficiency, not of the medical or curative, but of the preventive service. I was met by assurances of perfect confidence in the completeness of all preparations. In result, however, a victorious army fell, not by the sword of the enemy, but by insanitary administration. The first outcry was to charge the disaster upon the insufficiency of the rations to sustain force. A Commission was sent out, and the rations were amended. But good food does not suffice against bad air; the food was improved, but sickness of the troops continued. Independent remonstrances were made by Lord Shaftesbury and others, and by myself in a pamphlet I wrote on the subject for Lord Palmerston.[1] A Royal Commission, formed of the Chief Staff of trained Officers of our Board, was sent out, and as a result of the sanitary measures proper, as was declared by the then War Minister, Lord Panmure, the second army was saved, and returned in a better condition of health than the army at home. It marks the antipathy, or at least the apathy, with which sanitation has to contend,—of which other large examples may be adduced,—that whilst every official through whose misfeasance the first army was lost, was decorated, not one of those through whose sanitary science the second army was declared to have been saved received then or since the slightest notice for the achievement. Chiefly, at the instance of Lord Herbert, under the influence of structural improvements advised by the Army

[1] *See* 'Life of Lord Palmerston,' vol. ii. pp. 81–82. On February 22, 1855, the late Lord Palmerston wrote:—'My dear Lord Raglan,—This will be given to you by Dr. Sutherland, Dr. Gavin, and Mr. R. Rawlinson, whom we send out to put the hospitals, the port, and the camp into a less unhealthy condition than has hitherto existed; and I request that you will give them every assistance and support in your power. They will, of course, be opposed and thwarted by the medical officers, by the men who have charge of the port arrangements, and by those who have the cleaning of the camp. Their mission will be ridiculed, and their recommendations and directions set aside, unless enforced by the peremptory exercise of your authority. But that authority I must request you to exert in the most peremptory manner for the immediate and exact carrying into execution whatever changes of arrangement they may recommend; for these are matters on which depend the health and lives of many hundreds of men—I may indeed say of thousands.' The Commissioners landed in Constantinople on March 6, and immediately commenced cleansing operations in the large hospitals at Scutari, with results fully set forth in their Report.

Sanitary Commission, army sanitation has advanced, under more or less perfect provisions, from a death-rate of 17·5 in the year 1858 to a death-rate of 9·06 for the whole army in 1875. The death-rate of the Foot Guards was in 1858 20·4 per 1,000.[1] It was last year 7·72. The deaths amongst them from continued fevers have been reduced from 2·45 to 0·44, and of tubercular diseases from 12·53 to 1·69 per 1,000 of mean strength. New hospital accommodation, provided on the old experience of the curative service of a constant bed-lying sickness of 100 per 1,000 of force, has been found to be in excess to more than the double of what is now required. The effects of sanitation in the army have been progressively manifested in the army on foreign stations, in some instances to a considerable degree, of which I will mention one—the instance of Gibraltar, where from 1818 to 1836 there was a death-rate of 21·4 per 1,000. Progressive reductions have followed barrack improvements, general drainage, water supply, and other sanitary works there until 1875, when the death-rate was 5·50 per 1,000, and the place is made the most healthy spot out of England for troops. I may here state that at our meeting at Liverpool in 1858, I read a Paper demonstrative of the importance of the application of sanitary science to the protection of the Indian Army. The representations then made met with concurrent support, and were followed by the appointment of a competent and efficient Royal Commission of enquiry into the state of the Indian Army, in 1859. The Report of this Commission stated that the death-rate of the British soldier since the first occupation of the country has oscillated round 69 per 1,000. Dr. Cunningham gives the present death-rates among the British troops in India at 17·48. The average rate of the preceding four years has been 17·65, though 1875 was a great choleraic epidemic

[1] It is due to state that Lord Fortescue, in 1856, gave notice of four resolutions, on Army Sanitary Reforms, of which the first was, 'That the continued excessive mortality of the British army has been mainly caused by the bad sanitary condition of the barrack accommodation'; and the last was, 'That in the opinion of the House such increase and improvement of the barrack accommodation are imperatively called for not less by good policy and true economy than by justice and humanity.' In collecting materials for his speech he visited many barracks and military hospitals; and only a week before the motion was to come on Lord Fortescue caught the ophthalmia in one of the hospitals, by which he lost the use of one eye. Whilst on a sick bed, he was gratified to hear that a Royal Commission had been issued to inquire into the subject, which presented a very able Report, drawn up by its chairman, Mr. Sydney Herbert, before Lord Fortescue was able to make the motion which had been standing *in extenso* on the notice paper before he was taken ill in 1856. That Report led to great improvements being at once made by Lord Derby's Government in 1858, which was followed up by subsequent Governments; and on May 11, 1858, Lord Fortescue moved and carried without a division the four resolutions which he had given notice of in 1856.

year. These are the death-rates in India, but as some die on the voyage home and others at Netley, the total death-rate has been 18·52. On a threatened invasion of our West Indian possessions by cholera, we were called upon at the General Board of Health to organise a Sanitary Commission for defence. One result of that examination, chiefly conducted by Dr. Gavin Milroy, was to show that the excessive ordinary death-rates there (50 in 1,000), and the assumed impossibility for the white races to live and have succession there, were mainly the results of insanitary conditions. The army sanitary statistics are confirmatory of that view. In the Leeward command the death-rate was from 1819 to 1836 no less than 96 per 1,000. Great improvements have been made at all the stations of late years, and the management of white troops has been much improved. In 1875 the death-rate was 5·98 per 1,000. As in the prisons so in the barracks, it may now almost be said that epidemics are not permitted there. Whensoever any occur there an inquiry is made as to the causes with a view to their removal, whilst epidemics carry away thousands of the civil population, the industrial forces of the country, without any proper inquiry whatsoever.

Shortcomings in Army Sanitation.—The foregoing results may be accepted as great and telling demonstrations of the power of sanitation, but in the service of this science, we should reckon nothing done whilst aught remains to do. For sound fault-finding is promotive of further progress, and with our knowledge of the subject, we should change our aspect of felicitation to an aspect of severe discontent with the shortcomings of the administration. It may be demanded why the death-rate of the Foot Guards should be 7·72! why should it be above that much exposed service, the police, which has now a death-rate of only 5 in 1,000, instead of 11 as formerly? Why should the death-rate of the Foot Guards be above Gibraltar, which was 5·50. There are yet fevers in the barracks combined with other diseases, which ought not to be there any more than in the prison—there are some 50 per 1,000 constantly sick amongst the selected strong lives of the barrack, and not above 10 per cent. amongst the unselected and low and bad lives of the prison, even with the diseases brought with them. Then we have yet a death-rate of 9·36 for the whole of the home army! such a contrast to Gibraltar—strong selected lives, a death-rate, even threefold greater than the wretched population of the prisons! This, surely, ought not to be, and with due support to the sanitary administration, which has done so much, it would not be.

A Norma of General Sanitation in a Tropical Climate.—In respect to the sanitation of the Indian army, I may present one norma for use. Some time ago I was informed of an example of the power of sanitation on a tract of land in Algeria, which it was necessary to occupy, and, if possible, to colonise for stratagetical purposes; where, however, three sets of colonists had been swept away, and three sets of military force dislodged by a death-rate higher than the worst that ever prevailed amongst our army in India. Subsequently the place was skilfully drained, supplied with water, and appropriately cultivated, with the result that the malaria and the malarial fevers were nearly abolished, and the birth-rate made as good as in a rural district in France, and, indeed, to exceed the death-rate of the colonists; and the death-rate of the soldiers was reduced to about 13 in 1,000. At my instance, our then Minister of War, Lord Ripon, directed the place to be visited and the work to be examined by a special Commission, on which were Dr. John Sutherland, Lieut.-Col. Ewart, R.E., Dr. Paynter, and Mr. Robert Ellis, C.B., of the Sanitary Commission of Madras. But that I was prevented by illness, I deemed the example so important, that I should have accompanied them. By them the results were verified, and pronounced to be generally applicable to India. It showed that for the protection of soldiers, sanitation must extend beyond the four walls of the barracks to the cantonments and to the habitations of the connected populations.

To go with an army under insanitary commands is to incur threefold greater danger of death from disease than from the sword. To go with a working army, for settlement under sound sanitary commands, is for the settler to go with threefold greater security for himself and family against disease, —tropical disease—than if he went alone.

Not solely by the one recited norma of sanitation, but on other evidence too long to recite, I believe that the death-rate of the Indian army and its sickness-rate are yet at least full one-third higher than it ought to be, or will be hereafter under a good administration. The present loss from defective army sanitation amounts to between four to five hundred deaths annually, and the preventible sickness of some 1,600 or more of our small and valuable force. Added to these are the enormous losses of civil population from the dereliction of governmental duty in respect to them, and the inaction arising from administrative ignorance and apathy, which has its pretext for inaction in the assumed difficulty of overcoming the habits of the population, and the ignoble assumption that ignorance is impregnable.

Economics from Past Army Sanitation.—All the shortcomings may be treated as waste of military as well as of civil force, which have to be measured by the gains derived from past sanitation. Let me state some of the gains of military force so obtained, as indications of future practical economy from sound sanitary administration.

The death-rate of the home army was 17 per 1,000 up to 1857. This, on a man-strength of 88,147 men, gives 1,840 deaths. But the actual deaths were only 870, showing a saving of 670 men—a battalion nearly. At 100*l.* per man this represents a saving of 67,000*l.* per annum in the home army. As to the Indian army, the latest return shows that it amounts in round numbers to 60,000 men. A death-rate of 69 per 1,000 implies 4,140 deaths per annum; but at the present rate, all told, at 18 per 1,000 per annum, there would be required only 1,080, or 3,660 fewer deaths than under the old death-rate, and on the calculation of the Royal Commission this gives an annual saving of 366,000*l.* per annum, which ought to be half a million under effective sanitary administration. The army was smaller, but under the old insanitary, and merely curative rule, there would have been 10 per cent. of sick, that is to say, 6,000 men out of an army of 60,000 always in hospital. At present the numbers are 3,360, too many by one half, but it shows nevertheless three battalions of men more in the effective of the army than would have been the case formerly with an army of the present strength.

Progress of Sanitation in the Royal Navy.—I now advert to the progress of sanitation in the Royal Navy. Dr. Johnson, now just a century ago, thus spoke of it: 'As to the sailor, when you look down from the quarter-deck to the space below, you see the utmost extremity of human misery; such crowding, such filth, such stench. A ship is a prison with the chance of being drowned; it is worse, worse in every respect; worse air, worse food, worse company.' This, which was said of the Royal Navy then, may be said of the Mercantile Marine now. Such events as occurred in Anson's time may be stated to be impossible in the Royal Navy, in which now the death-rate from disease alone in the total force was, according to the last report, 6·9 per 1,000. This is little more than one-half the death-rate prevalent amongst the men of the same ages of the civil population. Nevertheless, it appears to me that the progress of sanitation in the navy is yet unsatisfactory. It was 6 per 1,000 as early as 1830. In 1835 it had been got down to 4·9. Some observation in experience of the preventive vigilance exercised in the transport of pauper emigrants when payments were made only on the numbers landed alive, and a

consideration of the species of disease yet too prevalent in the Royal Navy,—under former conditions denoted by Dr. Johnson's expression, the mortality on board transport ships was terrific. The Indian Government have now, however, sanitary troopships for the outward voyage in which the death-rate from disease is under 3·0 per 1,000. Indeed, the transport returns for 1876–7 show a death-rate of 2·6 per 1000—that is to say, about the same death-rate as in the best-ordered prison on shore, and less than half the death-rate in barracks;—less than a third of the death-rates of the wage classes under corporate rule, and this with no greater than 50 cubic feet of space. Of course enforced temperance in the floating prison, as in the stationary prison on shore, has much to do with this; but there are no epidemic outbreaks in these ships. On the return voyage many of the men who are sent home, as invalids or on sick leave, land quite recovered. Making all allowances for differences of exposure to external contagion;—the death-rate and the sickness-rate prevalent amongst the selected population of the movable prisons afloat ought, I consider, to be brought much nearer to the normal sickness and death-rates of the unselected, primarily diseased and altogether inferior populations of the fixed prisons on shore. With assured normas for his guidance, a Minister of Health would require 'explanations,' and it might be, and I have no doubt that it would be found in some instances, the defaults of sanitation were not with the ships but with the ports.

State of Sanitation in the Mercantile Marine as Affecting Quarantines.—But what is the state of sanitation for the conservancy of force, for the maintenance of our great Mercantile Marine, in its competition with the mercantile navies of the world, of the total tonnage of which, according to the last returns (whilst only 2·57 was Dutch, 5·51 French, 6·30 German, 15·03 American,) not less than 37·51 was British, worked by 200,000 seamen, of whom about 10 per cent. were foreigners? What, since 1849, when at the General Board of Health examining for the settlement of the question of quarantines, we found our Mercantile Marine subject to frequent outbursts of epidemic diseases on long voyages, amongst animals as well as human beings, long after reputed periods of incubation and under conditions sufficient, apparently, for spontaneous generation of the diseases assumed to have been introduced and conveyed from far distant land sources. What in these states of things have been the advances made, and the sanitary normas obtained—if any—in this great field for sanitation? The only answer that statistics give is the continuance of a nearly threefold death-rate beyond that in the

Royal Navy, and the continued prevalence of diseases banished thence in the Mercantile Marine. Our Report was translated into French and Italian, and our evidence was examined and discussed, and its sanitary application to ships was finally adopted, by a congress of the consular and sanitary officers of twelve of the States of Europe in 1851, when Dr. J. Sutherland appeared as representing our principles. Since then a reactionary movement took place in support of the hypothesis of the exclusive propagation of disease, from person to person by human intercourse, and for prevention, not by sanitation, by the cleansing of places or persons on shipboard or on shore, but mainly by checking that intercourse, by quarantines, by burning clothes, by disinfecting goods, and by destroying germs, the assumed agents of contagion. Subsequently, however, it has been seen that human intercourse on shipboard has been speeded by steam, and on shore by railway transit of people in masses, unrestrained by any quarantines; yet the spread of pestilence has not been proportionately speeded and spread as it should have been, according to the contagionist theory. On shipboard in large transports, we have seen that the passengers have been conveyed with as much safety from epidemic attacks almost as if they had been in a well-managed prison. On shore, I remember the time, when in a town in the most insanitary condition, even a medical officer has ascribed an outburst of an epidemic to its introduction by a tramp from a common lodging-house where it first appeared. Here in Scotland people and police, on the alarm of a coming visitation have given their whole attention to keeping out tramps. Now, as I may show, well-regulated common lodging-houses have almost an immunity from epidemic attacks, and the tramp's superior security will be in not going to an ill-regulated place, or into any dwelling in a low neighbourhood occupied by the wage classes. In India it has always been held that pestilence has been carried about and introduced by pilgrimages, verified, as is natural, by the disease being rife amongst the moving masses, and the remedy was, if possible, to arrest them; but Mr. Robert Ellis, C.B., a sanitary commissioner of Madras, who unfortunately for our cause has been suddenly removed from amongst us, attacked with sanitary regulations one of them which had been the source of frightful epidemics, and ensured protection and freedom to the moving masses. Even in France no better views have obtained until lately. It was a belief that the King Louis Philippe conveyed typhus about; for was it not seen that year after year, so sure as he went to Versailles, there was an outbreak of typhus! as there

certainly was under the common military insanitary commands, until a medical officer, conversant with sanitation, pointed out that the evil was due to the overcrowding of the barracks by a double population, composed of the King's band and *entourage*, and other conditions, which, being amended, the accustomed visitation of fever was prevented, and health was maintained. We know too well the losses incurred in the movement of military forces under insanitary commands in tropical climates. On the announcement of the visit of the Prince of Wales to India, serious apprehensions were entertained, which were well founded (under the common conditions of such a progress under which seasoned men have suffered) until it appeared that a good sanitary body guard and a sanitary escort were provided for his security, and that a sanitary force prepared the way for him; and as the event proved gave to him and his *entourage* security against dangers, which the strongest merely military or insanitary escort of infantry, cavalry, and artillery would in all probability have aggravated.[1] It is observed that by the application of sanitary principles, on the occasion of the Prince's visit to Calcutta, when there was an immense influx of foreign population into that city, such as to have engendered an epidemic outburst under insanitary conditions, the public health in no way suffered. Continued observation of the movement of cholera, in its great source and constant seat, have negatived distinctly the reactionary hypotheses, and maintained our conclusions. Amongst other points it is shown that cholera passes over wide tracts almost desert and with sparse population quite away from all highways of intercourse. Closely quarantined districts there have suffered severely from the epidemics, whilst unquarantined districts have suffered little. The Commissioners state in their last Report 'that facts regarding the movement of cholera show that, whether or not cordons be drawn round stations, no dependence can be placed on them as a protection against cholera, while the employment of troops may be a direct

[1] By sanitary commands every arrangement was made for his passage through highly dangerous districts before a tent was pitched. 'Camps fell into their places in perfect order, and surplus animals were removed to the open country. There was no over-crowding anywhere. Surface sweepings were at once buried in shallow pits. The trench system of latrines with the immediate burial of the sewage under a covering of dry earth was resorted to, and officers were told off to see that no nuisances were anywhere permitted. Wells for drinking water were marked by flags and care was taken that no other water was drawn for the purpose. Two temporary hospitals were provided, and provisions made for immediately reporting all cases of sickness. The consequence was that not a single case of any epidemic disease occurred in the camp:—that the daily sick lists contained reports of trivial cases of sickness or accident only, and were blank for many days.' —Indian Sanitary Reports for 1877, p. 210.

means of augmenting the mortality.' They say that 'the entire chain of facts shows the necessity of coping with the disease in the localities themselves, for upon the continued progress of sanitary improvement, especially in the purity of drinking water and of the atmosphere, cleanliness, surface-drainage, &c., in the towns and villages of India, it depends whether the intensity of each succeeding epidemic shall be less or greater than that which has preceded it; so far, at least, as past experience enables us to judge.' Of minor subsequent observations, confirmatory of the declaration that in none of the quarantine stations was there an instance of the propagation of the plague by goods, it was shown in the Rivers Pollution Enquiry, that upwards of 70,000,000 pounds of woollen rags are annually imported largely from districts where plague, fever, small-pox, and loathsome diseases prevail, and that these uncleansed rags are there (in Yorkshire) sorted by human fingers, before being placed in machines which tear and separate and cleanse the fibre for manufacture into 'shoddy,' and that for fifty years the manipulation has not been found injurious to the health of those engaged in it. A similar enquiry made at Paris amongst the paper manufacturers, with a view to ascertain the propagation of small-pox by unclean cotton and flax rags, was attended by similar results. These facts are stated simply as confirmatory of our conclusion, that, be it as it might with any other means of transmitting disease, there was no justification for staying the transit of manufactured goods, from any infested place at one of them. Of the means proposed for prevention by disinfectants, as they are assumed to be, we had strong evidence that they were only deodorants. Powdered charcoal was put forth as a powerful disinfectant. The crew of a ship loaded with it for the Crimea were severely attacked by cholera, when the blue stages of the disease were almost marked by the charcoal-powder on their faces. One inventor of a preparation of acetate of lead, who almost threatened us with condemnation for manslaughter if we did not exercise our authority to en force its general use, died from the epidemic, poor man, amidst a magazine of his confidently declared infallible preventive. Admitting fully the infectiousness of certain febrile diseases, it would be unjustifiable to trust to any supposed disinfectants for protection. But nature has given us the means always at hand, without cost or difficulty, of perfect safety: of complete personal cleanliness of clothing as well as of persons, abundance of water, and by replacing the foul infected air round the sick by dilution in the boundless external atmosphere. In the words of Miss Nightingale, 'cleanliness and fresh air are the

only protection which a nurse requires.' 'True nursing (she says), knows nothing of infection except to prevent it. Cleanliness and fresh air from open windows are the only defences a true nurse either asks or needs.' What is true of a sick room or a hospital is equally true of all sources of infection. Clean skins, clean clothes, clean ships, clean houses, and clean air are the only disinfectants, because they prevent infection. The special commission appointed in France to determine what course should be taken for its protection against cholera, after reciting our statements with approbation, say: 'Ce sont les vues et les pratiques en Angleterre dans ces matières, vues bien fondées, pratiques parfaitement rationnelles, que le General Board of Health s'efforce de faire prévaloir, et qui, il faut le croire, deviendront la base de tout système sanitaire.' The sum of the observation of facts has been a re-vindication of the general conclusion of our Report as regards shipping, viz., 'that the substitution of general sanitary regulations of ships in port for the existing quarantine regulations would far more effectually extinguish epidemic disease, and afford better protection to the uninfected on shipboard, whilst it would relieve passengers and crews from grievous inconvenience, abate the motives to concealment of sickness and to false representations as to its nature, greatly lessen commercial expenses, and remove obstructions to the free transit of goods and uninfected persons, which the existing system of quarantine occasions. It follows that we propose the entire discontinuance of the existing quarantine establishments in this country, and the substitution of sanitary regulations.' At a late Congress it was found necessary to abate reactionary measures and return towards our doctrine.

The evils of unfounded hypotheses in the maintenance and propagating of disease—amongst others, in directing exclusive attention to minor means of security and in diverting attention from the proved means of security, by sanitation—have operated most injuriously in the maintenance of the comparatively low condition of our great Mercantile Marine. The elements of efficient sanitation—cleanliness, good dieting, good clothing, and care for their regular and orderly application—tend to comfort, to sobriety, and security, and altogether constitute in sanitation a factor opposed to drunkenness, disorder, and insecurity, and the waste of property as well as the waste of life and of force. The statistics for one year will serve to indicate the conditions of our Mercantile Marine in respect to the waste of life and force as well as the waste of property. Of the total number of persons in the Mercantile Marine (203,000) there died 2,700, being a death-rate from

disease of about 13 per 1,000, as against 6 per 1,000 in the Royal Navy. An excessive proportion of the deaths in the Mercantile Marine were from the preventible foul-air diseases—fevers, cholera, dysentery, diarrhœa. The total deaths from all causes were 4,076, the rest of the deaths being about two-thirds from shipwreck, and about one-third from violence and accidents. The mean death-rate of seamen in the Mercantile Navy, on the returns of the last three years, appears to be about 20 per 1,000 from all causes, as against 8 per 1,000 from all causes in the Royal Navy; but these rates for seamen in the Mercantile Marine do not include the deaths of passengers, who, so far as may be distinguished in an average of eight years and a half would be one-third more, making up the total death-rate of the Mercantile Navy to three-fold that of the Royal Navy. It may be mentioned, as indicating the state of moral and economical disorder of the Mercantile Marine, that the total number of desertions within the year (1875) was 28,800, that 3,700 were imprisoned, that 23,900 were discharged, and that a total of 60,000 left before the period for which they had signed articles, and that 49,600 were engaged subsequently to the commencement, apparently to make up for the desertions.

The contemplation of such results, with knowledge of the insanitary conditions, and of the economical and other conditions involved in them, is very painful, and on my appointment as a political economist to preside at the Department of Economy and Trade at our meeting at Sheffield in 1866, I could not help making the losses of life and property at sea the subject of my address, especially to call attention to the economical aspect of the great waste involved, and particularly to the lethal influence of full insurance in reducing responsibilities for ignorance in the commands, and the bad conditions of the crews. I believe that Mr. Plimsoll was of our audience. The facts were well known to the officers of the Department, who were aggrieved at their failure to gain attention to them and action upon them from their changing political chiefs; and I was not more successful. But where quiet but strong and earnest remonstrance failed, passionate sympathy has succeeded in getting public and legislative attention to the tragical losses by shipwreck and to some of the grievances of the men. There has not been time yet to judge of the results of the measures obtained, and statistics show as yet no reduction of these casualties. Nevertheless, the hulls of vile craft are now to be seen rotting in ports, that but for the measures already taken would have been at sea,

to the destruction of life by disease as well as by disaster with fully insured cargoes, but for the recent measures. I hope and believe that a reduction of the losses on the coast have been materially reduced by them.

But the death-rates continue to show that the great insanitary evils remain in almost unmitigated force in our Mercantile Marine. I do not advance the normal death-rate of the Royal Marine as immediately and strictly applicable to the Mercantile Marine. The Mercantile Marine has, I believe, normas within itself which I had not the means of eliminating. Indeed, ships of those great and grand mercantile organisations, the Cunard Line, which has never lost a ship or a passenger; the Peninsular and Oriental Company; and the Royal Mail Companies' fleet, which become our maritime position, may well compete in sanitation as well as general security with the best of the Royal Navy. I believe that other less public mercantile organisations may rank with them. But the elimination of these important instances only make the common death-rates the heavier and the preventible causes of evil the more gross. The continued evil of the Mercantile Marine and the great obstruction to its sanitation is the ignorance of its commands. When we were charged with the sanitation for the prevention of cholera, measures for the provision of protection of persons on shipboard, we sent inspectors and transmitted instructions to our Consuls at the chief foreign ports to communicate them to ship-captains for execution. We were then told in despair by the Consuls that we should be surprised if we had their experience of the ignorance, ruffianism, and recklessness, of much of our mercantile commands. This corresponded with what I learned in our inquiry under the Constabulary Force Commission into the practice of wrecking on our coasts. The extensive continuance of such conditions, notwithstanding such measures as have been taken to ensure fitting qualifications for command, is displayed by the results of the most recent inquiries into the causes of wrecks, a large proportion of which are proved to have been occasioned by culpable recklessness or incapacity. A late statement by our Consul at Pernambuco of his observations of the mercantile commands may be cited as corroborative of our earlier information on the topic. He states that 'numbers of British shipmasters are no better than ignorant, pugnacious, and obdurate seamen,' and that to their unfitness to be placed in charge of men and property the loss of many lives and a large quantity of property annually must be attributed; and he quotes an illustrative instance of disorder

from the log-book of a vessel which left the Mersey with all the crew except two boys in a state of intoxication, 'with a crew in a condition in which a cabdriver would not be allowed to proceed along a street.' A fact came to my knowledge which is pregnant with large promise for the future for sanitation and for economical results, namely, in practical training on the half-time school principle. In some of those distinct half-time schools to which I have referred as primary normas of sanitation, the boys have much of their requisite physical training at the mast. Those at the Limehouse school were orphans and destitute children of the very scum of the port, which supplies material such as we see for the Merchant Navy. They were free to choose their course. Many had tempting offers of good wages on board Merchant vessels, but the great majority of those who were bodily fit volunteered for the Royal Navy. I inquired why they did so. Was it the martial glare of the Royal Navy that affected the imaginations of these boys? No, their choice was deliberate. The general ground assigned for the rejection of the Mercantile Marine was, 'that it was so dirty and so disorderly.' This was from boys the children of parents the scum of the streets.

The practical outcome from the mixed physical and mental training in a high order of sanitation on the half-time principle (some of which we have had the pleasure of seeing in Sheriff Watson's school and the training ship at Aberdeen), in begetting a repugnance to filth and disorder, and a preference, even at a pecuniary sacrifice, for cleanliness and order, is an outcome for national exertion to make generally prevalent amongst the whole population. I reserve it, to submit it, as a foremost topic for the special attention of the Section of Education.

I could not but inquire what sort of owners they were of these merchant ships who could appoint such commands, so dangerous and so wasteful of the capital embarked in them. They were, so far as was known, chiefly small shopkeepers in the ports, people of the smallest means as capitalists, and of very narrow views. It would be well if this smaller service of single ships could be superseded by collectivity, in joint-stock organisation, such as that of the great companies to which I have adverted, by which alone existing evils must be abated. I shall not be understood as assuming that the smaller craft of the Mercantile Marine may be brought up to the sanitary condition of the Royal Navy. Nevertheless, some observations which I made on the transport of pauper emigrants under the authority of our first Poor Law Board, warrant a confident

expectation that far greater sanitary as well as other beneficent results are obtainable than may be readily imagined, under the operation of the great master principle of administration to which I have adverted of making interest coincident with duty—by only paying for results. In the first voyages of transport ships the skippers were paid per head on the numbers embarked, and the explosions of epidemic and the losses of life on some of the long voyages were terrific. By a happy and simple change of the terms of the contract, they were paid only per head on the numbers landed alive, and to the terms on this principle we adhered. On going on board one of the first pauper emigrant ships under this form of contract, I was charmed by the way in which I was received by the skipper; he was so desirous, so pressingly anxious to receive any suggestion for the improvement of the sanitary condition of the ship. Of their own accord the skippers under this form of contract engaged ship surgeons for the care of the passengers, and transferred to these surgeons, medical officers of health, the pressing responsibilities of the contract, by making their emoluments dependent solely on the number of the passengers landed alive. The working of the principle was excellent. I was otherwise occupied and obtained no statistical evidence; but my belief is, that the sanitary condition of the floating prison was brought very close to the norma I have adduced of the stationary prison, and I am very certain that there were no longer any epidemic visitations upon the passengers. The perceptions and observations of points of sanitation by the ship surgeons acting under these conditions, were acute, original, and highly instructive. Moreover, under these conditions, without benevolence and with the common everyday principle of interest, we did the work of uncommon, active, and enlightened benevolence. We at all events secured for every lone emigrant, who might after all be lost, at least one sincere mourner. If we could get the Legislature or local authorities to appreciate and apply the principle of the payment for results, and augment the salaries of officers in proportion to the reduction of death-rates, we should only have an advance in sanitation, that to the public would be wonderful.

In tracing, as I have endeavoured to do, the advance of sanitation for the protection of the population on the sea, and also for the protection of moving populations on land, although we may not at present develop distinct normas specially applicable to them, as in the instances of the Army and of the Royal Navy, yet we have established the power of giving full protection to those moving populations, and of advancing the security of

transit and the freedom of trade. To this end it is proved that efficient measures may be taken to remove the remaining obstructions created by reactionism on false and pernicious hypotheses.

Normas of Sanitation obtained by Improved Civic and Private Constructions.—I now proceed to notice the normas of sanitation evolved by local or private effort for the protection of civic populations.

In about thirty of the smaller towns sanitary works were attempted by local authorities on lines adopted by our first General Board of Health, for systematic sanitation, namely, by the removal of damp by the drainage of sites with permeable agricultural drains,—by pure supplies of water, if possible from spring sources, delivered direct into houses on the constant system of supply, without cisterns and without waste,—by the constant removal from within the house of all putrescible or fœcal matter by the water-closet, together with all the fouled water from the kitchen or the laundry, from the house, through self-cleansing house drains,—by the constant removal of such matter from beneath the site of the town through self-cleansing sewers, and by the constant and direct application of all such foul or waste matter as was removable in a liquefied form (perfectly fresh) or free from advanced decomposition, as manure on to the land for agricultural production. There was to be no stagnation anywhere, no time given for advanced decomposition, and no production of putrid-sewer gases to be discharged either into the houses or into the streets, or above them into the general atmosphere. Normas of the self-cleansing sewers, and of the application of the sewage to the land, were separately considered, and separately established at great pains. Trial works were got, as to the forms, sizes, and inclinations of channels, that should be self-cleansing with the least quantity of water. Our objective points of sanitation were, first the house, next the street, then the town area, and last of all the river. It was established, that as a rule pure supplies of water could be brought to the door for rates amounting to a penny per week, and carried into the house for another penny per week; and the waste water of the scullery or the laundry removed for another penny; and the cesspit abolished and the water-closet added for another halfpenny, or in the whole threepence-halfpenny per week, or a halfpenny per diem, for a complete system, in which there should be no putrid-sewer gases, and in which you might test the competency of the sanitary engineer by the smell. We showed that three houses and three towns could be sewered well at the cost heretofore incurred for draining one town ill on the old plan of brick

drains of deposit and large man-sized sewers of deposit, which were only extended cesspools for the generation of putrid-sewer gases.[1] At these prices works were done then, and allowing for the advanced price of labour, may be done under competent administration now. To this work for the removal of putrescible matter from within houses and from beneath streets and towns, was added the covering of footways and the roadways of streets with some impermeable surface, and the cleansing of it by a jet of water, from a hose and hydrant, to be used on occasions for the extinction of fires. In blocks of houses and whole towns cesspools have been removed, and water-carriage through the water-closet, with self-cleansing drains and self-cleansing sewers have been substituted. Physicians in practice in such localities have testified, on their experience, that house to house as the improvements were completed, and the atmosphere of the house was altered, low headaches were removed, the appetites improved, and the symptoms premonitory of advanced disease were abated, and that their practice was largely affected. But it is difficult to get satisfactory statistical estimates of the results, because they have not been appreciated or regarded by the ignorant local authorities, and the returns are not available distinctly for the houses where sufferings have been alleviated, and even in respect to the towns where such works have been effected, the registration includes outlying houses and undrained detached villages, which are unimproved. Nevertheless, in the statistics for the places where the works have been carried out in principle, even in a rudimentary manner, reductions of death-rates by one-fourth, and even by one-third are frequently shown. In 1866, an examination of 25 of these towns was made by the Medical Department of the Privy Council, but without a due knowledge, as it appeared to me, of the nature of the works or of what was to be expected from them, or of their defects. It came to my knowledge subsequently that the works of some of them were grossly defective, and wretched houses, rooms, and room-tenements had remained unimproved. Nevertheless, the

[1] Some of the principles were first developed under the Metropolitan Sanitary Commission, 1648, and in trial works carried out in that and the next year under the Metropolitan Sanitary Commission. As to the principles of water supply they were expounded, in the Report on the Supply of Water to the Metropolis in 1850; next, in the 'Minutes of information on the drainage of land forming the sites of towns, in the drainage of suburban land, and on road drainage, issued by the General Board of Health in 1852, also 'Minutes of information on the removal of soil water and the drainage of dwelling-houses,' and 'Minutes of information on the practical application of sewer water to agricultural production,' issued by that Board during the same year.

general results obtained were reductions of the general death-rates (after excluding small-pox and infantine epidemics) about 12 per cent., of typhus fever 41 per cent., of phthisis in a number of cases more than 40 per cent., and of diarrhœa a mean of 18 per cent., and a reduction of the general death-rate of more than 9 per cent. The commentary by Mr. Simon on these results, was that 'they may serve to fulfil very important provisional uses, not only to confute persons who have despaired or affected to despair of any great preventibility of disease; but still more to justify in the public eye, and to encourage in some of the noblest of human labours, those who for long weary years have been spending their powers in this endeavour, and to whom it will be the best of rewards, to see the demonstration of the good they have wrought.'

More is to be lamented for the good that has been frustrated, than is to be rejoiced at for the shortcomings obtained, and it will be proper, in the interest of the future, to display hereafter the obstructions continued against the complete and extended applications of settled principles of sanitation. But for the present I must confine myself to the showing the progress of the power of sanitation, and the demonstrations of such distinct normas as have been got. For the reasons heretofore stated, I deem the available statistical evidence derivable from the experience of whole, even of improved towns, at present insufficient to display the full power of sanitation. In my experience, however, the statistics may be inferred from the aspects of the places, and from the aspects of the people. After traversing different districts and observing the difference of their conditions as to cleanliness, drainage, and other sanitary points, when I have been enabled to get out the statistics of the death-rates street by street, I have found they have corresponded closely to what might have been anticipated from their relative conditions. Nay, from the contrasts of the classes of destitute orphan children in the district half-time schools, I could anticipate, where there were marked contrasts in their conditions, very much of the different death-rates of the places whence they came. And here I would mention an experience from my own observation. I have been in the habit of visiting those institutions at long intervals of time. At a late visit to one of them, I was struck with the improvement of the type of the children. I observed to the manager, 'Why you have a different class of children to those I last saw here. Where do they come from?' The answer was, 'They come from the same districts, the lower districts, but since sanitary improvements have

been made in those districts, we are getting a different type of children, as you see.' I found that the medical officers, as well as managers of other institutions, confirmed these observations by similar experiences. Others than myself have made the observation that since the clearances of bad dwellings, and the wider spreading of the habitations of the wage classes in Paris, that they are changing that leathery complexion—so much like the inner soles of old shoes,—which they formerly had, for one clearer and fresher. Such changes are in accordance with our anticipations, and it is satisfactory to observe distinct appearances of their realisation for future promise of large improvements in the types of populations.

I should anticipate with confidence, from such appearances, a reduction of the death-rates to be marked by statistics if they were got out. The blocks of model dwellings in London, erected by voluntary associations, present better observed and clearer instances, serving to some extent as normas of the preventive power of sanitation. In these the death-rates range separately from 14 to 17 per 1,000. I assume that in the metropolis 16 per 1,000 may be taken as the mean death-rate of similar improved habitations; that, I need not say, is an important advance upon the general death-rate of 23 in 1,000. But a death-rate, which is a mean of the deaths of a large city, is almost always a delusive misrepresentation, especially of the extremes. Thus we have part of a sub-district in London, comprising houses in good condition, where the death-rate does not exceed 10 in 1,000, whilst there are adjacent dwellings chiefly occupied by the wage classes, where the death-rates from year to year keep up to the extent of 38 per 1,000. Important returns, with which I am favoured by Dr. Russell, the medical officer of health of Glasgow, show, for the last year, a range of death-rates, from one district at 15 in 1,000, to another district at 40 in 1,000. Now, a mean of these two, or the general routine mean (25 in 1,000, with sub-districts of 17 in 1,000, 24, 26, and 33 in 1,000) is a misrepresentation of each. It has lately been proved that in some of the dwellings condemned under Mr. Cross's Act, the death-rates were as high as 50 and 60 in 1,000. It has been objected to the conclusions from the lower death-rates in the model dwellings that the people living there are generally of a better class in position and habits. The answer is, that if the same people were taken into the inferior tenements their habits would deteriorate, as the habits of artisan families from the rural districts deteriorate, whatsoever may be the increased amount of wages they obtain. But the power of sanitation is displayed upon people of the lowest condition and habits

in the metropolis—namely, the tramps who occupy the common lodging-houses, regulated under Lord Shaftesbury's Act. These places were formerly distinguished for the first outbreaks of typhus and epidemic diseases. Drainage, water supply, and the means of cleanliness and ventilation are now enforced, and overcrowding is prevented in them, and they are now distinguished by an immunity from common epidemics. Medical officers of the districts, where these lodging-houses are situated, have testified to the better sanitary condition of their occupants than of the wage classes dwelling under the jurisdiction of the common vestries. Dr. Russell states to me that 'in the large model lodging-houses of the Corporation a case of fever is the greatest rarity, and it never spreads. In the common lodging-houses belonging to private individuals, we have fever oftener, but there again it never spreads'—that is to say, as it does in defective houses of the wage classes. 'We are informed of a case at once, and remove it immediately to the hospital. Fever of any kind never spreads in any of our institutions where I can do as I please to cut it short.' Why should not similar protection be extended to the wage classes? Accepting my norma of sanitation in the prison, Dr. Russell says:—'If I had perfect command over all the Irish in Glasgow, as the governor of a prison, I would reduce the death-rate one-half in five years,' and in less time than that I expect. On the whole, death-rates in the model dwellings may be fairly placed in opposition to the common death-rates prevalent amongst the wage classes of the metropolis, where it is upwards of 30 in 1,000; or, as an example, of a gain of one-half upon that special death-rate by the power of sanitation. His Majesty the King of the Belgians has offered an international prize which is calculated to be of high service, as conducing to a better determination of the power of sanitation, and its vindication before Europe. He offers 'a gold cup of the value of 5,000 francs to that municipal or local authority, or private association, which shall, by an improvement of the dwellings of the wage classes, effect the greatest reduction of their death-rates at the lowest cost.' I have been informed of instances of model dwellings on the Continent where a lower death-rate has been attained than of those in London. But an instance is stated by Dr. Tatham, the medical officer of Salford, which, if correct, would gain the cup for England. It is of a block of model cottages, a model village, erected for the work-people of Messrs. Price & Co., near Liverpool, where the average death-rate for the last five years has been 8 in 1,000.

On a review of the facts I have adduced, I think I have

proved that by sanitary measures under such regulations it is quite possible considerably to reduce the common death-rates. I state that we can so arrange common conditions to multiply the most fatal orders of disease, and that we can command conditions to induce them as effectually as to prevent them. If I might resort to the Hindu mythology, as formulating or embodying maleficent and beneficent principles, I may say that if 'Siva the Destroyer' were to require it, we could certainly build a city in which we could ensure a death-rate of 40 per 1,000, or far more than double the general mortality of the country. For that purpose we should copy literally and closely the old parts of Whitehaven, those of Newcastle-upon-Tyne, and the wynds of Glasgow and of Edinburgh, which I have heretofore traversed, and some edifices in Paris and Berlin, and some tenement-houses and crowded slums reported of in New York and Boston. We can reproduce conditions of damp and of filth, and of darkness and of confined stagnant air, and induce the specific diseases found in those conditions. I have asked relieving officers in London whether they could take a dozen cabs and fill them with fever cases, of which particular cases of which they had received no notice. Yes, they replied; they could readily find enough, though they might not be quite sure of the sort: the cases might be of typhus, they might be scarlet fever, they might be measles, they might be small-pox. But some cases of the eruptive diseases they were sure to find. Let those places be looked to and copied. There were instances even of particular houses, which the medical officers were sure would be the first to be attacked on any renewed epidemic visitation. There was one house, or street, in York, of which we were informed by tradition, was the first attacked by the great sweating sickness; then the first by the great plague, and lastly the place which cholera selected on its first visitation to this country. On the second visitation during my service we had an outlook whether the place would be true to its traditions, and it was so! Let that be copied. As a short cut to get at the places for sanitation, I have instructed sanitary inspectors to go into the primary schools, to put aside the most squalid and inferior children, ascertain their residences, and examine them. They have done so, and as a class they have found the most wretched tenements to be the fever-nests of the city. I remember that Dr. Lyon Playfair, then a pupil in sanitation, told me that he had with other visitors acted on this suggestion, and noted amongst the class of squalid children two whose faces were blotched from disease. They

found that their habitation was over the confluence of a discharge of putrid-sewage. Let such places, too, be included. By copying these places and repeating these conditions with fidelity, we may ensure with certainty that more than half those born shall be in their graves by the fifth year, and that those who survive shall be stunted, squalid, irritable, and weakly. We may, by such insanitary conditions, reduce the proportion of the aged and of the middle-aged and of persons of mature experience, and increase the proportions of the young and of persons of immature experience to the rest of the community. We may reduce the steadying influence of experience and augment the preponderance of passion and of blind impulse. We may, by the excessive sickness and death-rates, produce a sense of the shortness of life of its pains, and its worthlessness, and generate a reckless avidity for immediate gratification; such as that which characterises inferior soldiers in time of war. We may, indeed, compound a 'hell broth' of 'powerful trouble' to the police, as well as to the administrators of relief to human misery. We may produce such results; for they are produced from such conditions, and are displayed in outbursts that alarm and endanger the negligent administrations under which they have arisen.

On the other hand, if the beneficent principle worshipped as 'Vishnu the Preserver' should command, we can undertake to erect a city which shall in time be the reverse of all this, and in which the death-rate shall not exceed 10 in 1,000, or one-half of the general average of sickness and mortality, a city which shall be as fever-proof as we have made our orphan half-time asylums and our prisons, without, indeed, materially altering the popular habits, except as to overcrowding; with houses freed from the cesspool smell, from the bad drain and the sewer gases, from the damp wall and from the foul wall smell, and from wall vermin, from stagnant and vitiated air, and from the too prevalent exclusion from sunlight—houses that should, by their construction, be cool in summer and warm in winter, with good water supplies undeteriorated by bad modes of delivery.[1] I say with confidence that we might ensure an advance upon the hitherto normal death-rate of 15 or 16 in 1,000 of the present model dwellings; because those dwellings are in my view not yet up to the principles of construction, as the Prince Consort's model dwellings were, in some important points.

[1] *Vide* for particular exemplification my Report 'on the dwellings characterised by cheapness, combined with conditions necessary for health and comfort,' as displayed at the International Exhibition of 1867, at Paris, presented to Parliament, 1868, vol. 2.

Moreover that reduced death-rate of 16 in 1,000, as against 30 or more, good though it is, must be considerably affected by the condition of the general urban atmosphere in which they are situate, as well as by particular insanitary conditions. As to the general urban atmosphere surgeons will be well aware that if an accident requiring a serious operation were to occur to the occupier of any of those urban dwellings, his chances of recovery would be considerably improved by removal into a purer suburban atmosphere. With respect to the conditions of urban and country hospitals, a celebrated physician remarked: 'In the city hospital-ward the most expert surgeon cannot cure; whilst in the country hospital-ward the greatest bungler cannot kill.' Of the particular insanitary conditions to which the occupiers of these urban model sanitary dwellings are mostly exposed, are air tainted with sewage gas from bad general drainage, and indeed much sewer-tainted water by the dung-dust of ill-cleansed streets, befouling skins and clothes,—the children being compelled to go to long-time schools, and to be massed together with filthy-skinned children, the centres of children's epidemics, and by the adults being compelled to labour in ill-conditioned workshops not under the Factories Regulation Act. By the elimination of these insanitary conditions, a reduction of the death-rates of the model dwellings by full one-third may be confidently assured. It might indeed be anticipated, that some approach might be made as to children to the condition of the half-time schools, or as to the adults to the sanitary conditions of those great normas of sanitation, our prisons;—that is to say, a condition in which two years out of every three there should be, as it were a sanitary jubilee, in which there should be no disease, and no death; a condition under which all men shall attain the promised term of threescore years and ten.

It is not, however, necessary to wait for the construction of Hygeias, to make large advances in urban sanitation. What has already been done in old cities, such as Salisbury, where the death-rate has been reduced from some 28 in 1,000 to 17 and 18 per 1,000; what has been done with the common lodging-houses; what has been done with blocks of buildings in the metropolis and in Glasgow; warrants the conclusion, that specialists as sanitary engineers might now contract for the attainment of important sanitary results. I am confident that data might be given for the reduction of the death-rate of the metropolis, from 22 to at the most 17 in 1,000, and for the reduction of the death-rates of provincial

cities in the manufacturing districts in yet greater proportion. I am confirmed, in this anticipation, by the facts obtained from recent returns from Glasgow, where efficient sanitation has lately been applied, and where in one well-to-do district, an urban death-rate of 23 in 1,000, or about the mean of the Metropolis in 1871, has been reduced to 17 in 1,000 in 1876. In another district the death-rate has been reduced from 29 to 26; in a third from 35 to 26; and in the worst district from 44 to 33: the mean reduction in that city being from 33 to 25 within that period. I am nevertheless of opinion, that by vigorous and complete sanitation, a further reduction of 9 deaths to 17 per 1,000 is practicable in that city. Aberdeen, with a death-rate of 20 in 1,000, is in the fore of Scotch cities; but I believe the death-rate to be reducible there, by complete sanitation, to 14 in 1,000.

Excessive sickness involves premature working disability as premature mortality and excessive pain and misery involve definite pecuniary loss which the political economist may estimate. On definite data, I have heretofore estimated, the money loss from insanitary conditions at about 15,000,000*l.* sterling per annum. It must, however, be much more than that. Happily, this sum capitalised would, under economic rule, amply suffice, in most cities, to defray the expenses of proper works by which the existing insanitary conditions might be removed and a pecuniary gain in productive power effected.

Normal Examples of Agricultural Production obtainable from Town Sewage or Liquefied Manure Culture.—It will serve to show the sorts of intelligences that have to be dealt with, if I now state to you the normas obtained for the application of the excretory matter of towns to agricultural production, and the sanitary relations of those normas.

With long labour the experience of all Europe was sedulously collected on this subject, and not only agriculturists, but horticulturists, such as Sir Joseph Paxton, skilled in plant-feeding, were consulted upon it. The axiom was adopted of the foremost vegetable physiologist of the last century, Decandolle, 'that the future of agriculture would be in giving food and water at the same time.' Trial works were obtained on this principle. I persuaded the late Emperor of the French to direct trial works to be made with the sewage of Paris, and those as made by specialists (Professor Moll, of the Conservatoire des Arts et Métiers, and Mons. Mille) were in my opinion the best that have been made hitherto. We got out, at our Board of Health, a manual expository of all the expe-

riences collected, which we issued for the instruction and guidance of local authorities. I have recently visited, with a sanitary officer of the King of the Belgians, some of our towns, where the principle has been moderately well applied, and I may state the normal results verified there and elsewhere. You may be aware that the highest agricultural results in weight of produce obtained over a given area is by garden, market-garden culture, with the most active tillage and the heaviest doses of manure;—almost invariably with solid manure. The common yield from that culture is more than threefold the yield of ordinary good agricultural tillage. But the sewage or the liquefied manure culture for various reasons stated in the manual to which I refer, everywhere exceeds the best solid manure culture, in quality, as well as in weight of produce. The normal results obtained, stand thus:—where the common agricultural yield is as one, the market-garden culture is as three and a half, and the liquefied manure or sewage culture is as five. Where the best of the ordinary pasture land carries one cow, the liquefied manure farms carry five, and the milk yielded is of superior quality. To give an extreme case. The sewage farm of Aldershot is on a close quartz sand, ten acres of which would not have kept one animal alive;—but under Mr. James Blackburn it now keeps four cows in milk and one growing animal. Mr. W. Hope, V.C., states to me that the ordinary allowance of land in Gloucestershire and Cheshire is from 2 to 3 acres to keep each cow the whole year, and he says 'one year I kept in capital condition, between 60 and 70 head of horned cattle and 14 horses for three months upon 7 acres of sewaged Italian rye-grass.' He estimates that each human being represents not less than 1,000 lbs. of possible rye-grass per annum, and that 'each human being represents 85 quarts of milk.' He states in answer to my question, as to the waste of manure going on at present in London (and more or less in all our large towns),—'that taking the population of London at 4,000,000, they (the representatives of the vestries) are at present injuring the oyster and other fisheries at an expenditure of 340,000,000 quarts of milk yearly. But I give you this calculation purposely as greatly within the truth. Yet taking only one penny per quart of milk as due to the grass, *i.e.* to the sewage, and allowing as much more for the land, the farmer, and the cow, we have an annual preventible waste of manure that can be realised amounting to no less than 1,411,111*l.*, and again I say this credit of oru penny is too little, I believe it will be found that this estimate is substantially correct.' But there arises some important

sanitary conditions, in connection with the external agricultural economies of the question. Between sewage manure that is fresh or undecomposed, and sewage that is putrid from having been retained in a state of decomposition, in cesspools, or in drains of deposit, for weeks, or months, or years until it is flushed out artificially or by storm,—there is generally a difference of at least one-third. Putrid decomposition of sewage in ordinary weather in England I have ascertained begins in about four days; and discharged into rivers in that condition it kills fish; but when discharged from towns that have been water-closeted, through self-cleansing drains and sewers, that is to say immediately, before decomposition begins, it feeds fish, and increases their number and improves their qualities. The finest fish have been caught at the mouths of sewers of towns drained with self-cleansing channels, and where from administrative incapacity they have not tried or have not succeeded in getting the sewage applied to the land. A case for litigation as stated to me illustrates the position of the sewage farmer in relation to the sanitary condition and the administration of the town. A farmer, contracted with a town, which had been newly water-closeted and drained, for the whole of its excretory matter. On that contract he invested his capital in laying out a farm with appropriate farm buildings. But when he came to the application, he found that the whole of the town had not been sewered as represented; and that much of it was badly drained, and that as a consequence he has had a less quantity of manure than he had contracted for, and that manure of an inferior quality. He has brought an action to recover damages, and, assuming the case to be as stated, he is justly entitled to them. The case is important, as showing the interests of agriculture in complete sanitation. But it is to be observed that the inhabitants, at the same time, have their injuries from the sewer gases generated and distributed into their houses from unskilful drainage. I recently visited Croydon, with a sanitary officer sent by the King of Belgium, and asked: Were the 16,000 houses there all water-closeted?—Yes, they were. Were all the sewers self-cleansing and free from smells?—Not all:—some were sewers of deposit. How so?—They had in one quarter of the town been badly jointed by the contractor. The sewage leaked out at the joints and permeated the site, and the flow being diminished, deposit was occasioned, and putrefaction and sewer gases generated, and outcries raised for sewer ventilation. Dr. Alfred Carpenter, a distinguished physician and member of the local sanitary authority there, and the engineer stated that, as a rule, the fever cases in the

town occur in the district of the defective works, where the common putrescent sewage of deposit generates sewer gases and foul smells—this interior injury to the health of the population having its exterior injury to the sewage farm in the reduction of the quality, the quantity, and the value of the produce. On visiting the sewer farm of the Camp of Aldershot, I went at once to the outfall, and said, 'Why, this camp is badly drained?' 'Had I seen the plan of the drainage works?'—No, but I said: 'I smelt that it was badly drained, for the smell at the outfall was the smell of putrefaction—the old sewer smell of the sewers under the jurisdiction of the London vestries.' And it was so. It was the farmer's grievance that the sewers had been made large enough to receive extraordinary storm waters. As a consequence, the ordinary sewage, instead of being concentrated for a quick discharge, which, with properly arranged works, carries any gas with it from the friction of the water on the air in the pipe—has a retarded flow which occasions deposit, and hence decomposition, and waste, and deterioration of the manure. Moreover, the deteriorated manure was at times brought down on that farm in such flushes, and so excessively diluted as greatly to encumber the farmer's operations. I have found that from the defective engineering this is a prevalent defect complained of by sewage farmers, that will necessitate laying down separate and smaller sewers in conformity with the first principles enunciated. I may mention, *en passant*, another peculiar grievance of the farmer of the sewage of the Camp at Aldershot, as it elicited a strong illustration of the value of the manure. When he took the farm and executed his works for the reception of the sewage, the camp was a stationary camp of some 8,000 men. But since then the autumn manœuvres occurred, taking away the manure of his farm just at the time he most wanted it, and he bewails the departure in each man of his equivalent of the 85 quarts of milk, and of the 'awful' expense to which he is put for artificial manures to avert the consequences of their absence. Added to the cause of irregularity and inferiority in the quality of the sewage from the admission of water which is not due to the field, but to the river, there is another and large cause of deterioration in towns by excessive dilution from the waste water from the house service-pipes. The common practice has been for the engineer to carry the water in the mains only to the doors of houses, and to leave the house services to be put in by common plumbers, without system and without supervision, and, as a consequence, with every variety of defect. We ascertained by gaugings, that the waste of water in the

metropolis was full three-fifths of the water pumped in. In part this waste, supersaturates the soil, and through defective drains and sewers makes it sodden with excrementitious matter; and in part it adds to the deterioration of the manure by excessive dilution. From these causes many a cry is raised that 'sewage is worthless as a manure, as it is declared to be not worth more than a halfpenny a ton.'

Putridity of sewer manure, the spoiled manure, assumed to be a constant, is used as a pretext for the refusal of land for it in the vicinity of towns, and for the exaction of excessive rents for land anywhere for its use as being injurious to the land as well as offensive to neighbourhoods. Plain water irrigation, by the method of stagnant submersion, is, however, productive of fever and ague. Fresh sewage manure if mismanged so as to supersaturate the land and produce surface decomposition by stagnation, may be made highly injurious. But high culture, market-garden culture, with heavy top-dressings of solid manure, almost of necessity kept during long periods in states of decomposition before it can be absorbed by the soil, sanitarians know very well are injurious and unfit for the close vicinity of habitations. The way to prevent injury to the public health from such dressings with solid manure, and at the same time to augment its productive power, is to liquefy it, and apply it in the liquefied form in quantities adapted to the receptivity of the soil and of the vegetation, as horticulturists and the growers of prize fruits are skilled in doing. Examples were adduced, where, by this process, more than a double fertilising power was imparted to a given quantity of solid manure. The common waste of the farmyard manures and of solid manures generally in common agriculture throughout the land, was estimated by the late Mr. Smith of Deanston, a distinguished agriculturist, as equivalent to an additional rental. At a time when town sewage was only known in its then condition of putridity—the condition in which even medical officers in old urban districts only know of it now—I got trials made on a small scale of a method of subterranean distribution through permeable agricultural drain-pipes. I got Sir Joseph Paxton to make trials of this method, and they were very successful. They, however, required great skill, and were comparatively very expensive. But the discovery that the condition of putridity was not a necessity, and demonstration of the comparative freshness of the condition of the sewage from self-cleansing house drains and sewers, and of the inoffensiveness and the convenience and greater cheapness of surface-distribution, led me to desist from the prosecution of

the method of subterranean distribution. Nevertheless, this method has been independently prosecuted with much success by the late Mons. Charpentier, a vine-grower of Bordeaux, and I consider that it will be found to be eligible under certain conditions, especially for the culture of fruit trees and of ornamental timber near cities.

It will naturally be asked how, with such a cheaper method of removal and conservation of the manure than all others —that by water-carriage—and with such cheap and convenient methods of application to the soil, and with such rich yields, exceeding the highest of common market-garden production, sewage farms seldom pay, and are generally attended with loss to the towns? In part this is explained by the mismanagement I have stated. Moreover, sewage farming does not pay when the Legislature sanctions, as it has done, exactions of fivefold values for land: sewage farming does not pay when a town is put to as much expense for obtaining a local Act as would suffice for the construction of a first-class farm-steading; or when a town has been subjected to a Parliamentary conflict, and to such expenses as 10,000*l.*, to which Birmingham has, I understand, been subjected—a sum sufficient to have defrayed the expenses of preparing more than 1,000 acres of ordinary land: it does not pay when the engineering expenses belonging to the internal works of a town, such as the pumping works for carrying away the sewage, which would have to be paid if it were thrown into the river, are charged to the farm: it does not pay for works of the ordinary scale of works of engineers who are not agriculturists, and not conversant with the necessities of agricultural economy: it does not pay when, to use the expression of Lieut-Colonel Jones, of the Wrexham Sewage Farm, in reference to so many examples 'scattered over the country of sewage farms with massive vaults for tanks, and permanent carriers in places where they only encumber the ground and stop the plough, as well as of bad subsoil laid bare in ruthless levelling; when farming considerations are less regarded than the execution of those great engineering works laid out on the understanding that something solid was required by the ratepayers for their money, and that their engineers should be paid by a percentage on the cost of the works to be executed.' Neither do sewage farms pay when they are subjected to the scales of expenses of municipal officers for unskilled service, or for inferior service that is not special, as 'that of a common farm bailiff, at 25*s.* a week, to please some fifteen or twenty masters, Town Councillors, who have no experience in agricultural pur-

suits, but who must all have a vote, on entirely new and difficult farm management.' But they do and will pay, as stated by Mr. Robert Rawlinson and by Mr. Clare Sewell Read, himself a successful farmer, in the conclusion of their report on an examination of all the present methods of disposing of town sewage—'Where a fair rent is charged for suitable land, the sewage is regularly delivered, and a good market is close at hand, there is no reason to doubt that the return for capital judiciously expended upon sewage farms will produce a higher rate of interest than the money invested by the majority of tillage farmers throughout the country.' It was not within their province, or those two able and practical men might easily have shown the conditions in which, after so much had been done to make the sewage of little worth, localities had been led by railway or other insanitary engineers who know nothing of agriculture —to give no trouble about it, and to allow the construction of great tunnel sewers, to throw their manurial matter into the sea, at manyfold the expense that would have sufficed to effect superior applications of it for the production of food and the advancement of agriculture.

Market-garden farmers admit that sewage farms have great advantage over their culture, in being supported by the constant regulated supply of water to the city, and in being protected from droughts and the irregularities of rainfalls. It may be added, that the sewer manure farms have a peculiar advantage over the market-garden farms as well as ordinary farms, in the ready and superior means of feeding the plants by liquefied as compared with the common feeding by the solid manures. I have known a liquid manure farmer who regulated his plant-feeding as he wanted woody fibre, the leaf or the fruit developed, and who at will could change the colour of the leaves in twenty-four hours. This could not be accomplished with solid manures. By the liquefied manure culture the character of the produce is largely changed: there is a larger production of farinaceous and saccharine matter. The liquefied manure culture converts some plants almost into new ones. The sewaged rhubarbs have been sought for their excellence to make champagne or a superior still hock. The finest perfumes known are yielded for the boudoir of fashion from what would be the odious stench of the wynds or alleys. It may be hoped that this liquefied manure culture will develop and accustom the people to new and superior edibles as common food, to give relief from the terrible consequences of main dependence on single crops—an evil against which the increasing insect visitations are giving additional national warnings. This liquefied

manure culture, with the excreta of cities, when perfected, will, I consider, be an advance of what I have heretofore contended for, as a principle of agricultural economy, the economy of what I have called 'intensive' culture and food manufacture in narrow areas, as against extensive or thin culture over wide areas. For if we obtain, as has been shown by the established normas, a fivefold yield on the same area, there will be required only one-fifth of the extent of drainage for the removal of surplus moisture, one-fifth of roading, one-fifth of the space for the removal of crops, and one-fifth of the hedging or the outer fencing of farms. On the principle of intensive culture a higher order of works and of machinery may be afforded for food manufactures. In this view well-cultivated sewer farms may be made subjects of superior national agricultural instruction.

A metropolis, as the centre of science of an empire, with endowments from common funds for common benefit, may be expected to take the lead in the practical applications of science for the advantage in guidance of provincial cities. This becoming position Paris has maintained in what is called the 'sewage difficulty.' It has referred the subject to superior scientists and practitioners, who have expounded it in able and guiding reports for the information and guidance of the provincial cities of the Empire. The French Commission has set aside at once the preposterous notion, got from the representatives of the vestries of London, of carrying the sewage of the metropolis to the sea. It rejects the principle of collection and removal of the excreta by the pail, of which Paris has had too long experience, and will proceed to substitute water carriage as soon as it is deemed practicable. It rejects all plans of intermediate precipitation, of solidification, of chemical treatment, of disinfection, and of the manufacture of patent manures, such as are in conflict in England, having had long experience of the inconveniences and the little advantage of the declining manufacture of *poudrette* in Paris. Having examined these projects in principle and in detail, it concludes by the affirmation of our principle of the uninterrupted and constant conveyance of all excretory matter possible by water-carriage direct to the land, and it has set the practical example of it, close to Paris, where, but for the interruptions of the war of 1870, it would now have been largely and systematically developed on a scale of agricultural grandeur. At present the applications have been chiefly by small farmers, and consequently in rude methods. But I trust that by the next year the sewage farming of Paris will have its place as

an important adjunct to the International Exhibition. Dr. Folsom, Secretary of the State Board of Health of Massachusetts, has visited the chief sanitary works in Europe, and has presented a Report upon his examinations, very much in accordance with the conclusions of the French Commission as to the superiority of the direct sewage applications.

There is one practice in cities passed by as a detail of no great importance in sanitation to which I beg to call attention. We found in London that at least 1,000 loads of horse-dung were daily deposited from the traffic on the streets. The interest of agriculture is that this mass of valuable fertilising matter—some 350,000 loads a year—should be carefully preserved. But it is spread about, triturated, and a large proportion of its finest constituents lost by the evaporation which makes the streets at times smell like ill-kept stable-yards. So much of the street-mud, of which it is the chief constituent, as can be gathered up by hand-labour is removed, at intervals, by the expensive method of cartage, so that the waste is very considerable. But the sanitary interest of the population is that the removal of it, as a source of the pollution of the air they breathe, should be accomplished as quickly as possible, and that they should not be obliged to breathe pulverised horse-dung, as they are, which forms by analysis the greater proportion of the mud and dust of the streets that so befouls the skin and the clothes as to require continual extra washing and labour to maintain cleanliness. The injurious effects of London street mud may be inferred from the experience of Mr. H. Graves, the print publisher, who states that an engraving may be cleaned from ink or from oil, but not from London mud. Now, the most effectual mode of street cleansing is by water power—by the jet from the hose and hydrant. We had complete trial works of this mode of cleansing, and found that whilst it was more rapid and effectual than cleansing by the broom, it was not half so expensive. It partakes in principle of the removal by the water-closet, and of the direct conveyance of the manurial matter to the land in the quickest manner, and placing it in immediate chemical combination with the soil, with the least loss. We also recommended the system for the collateral purpose of fire prevention, by having an apparatus available for the purpose always ready. Paris has adopted the method propounded, as did Hamburgh long before, with a large reduction of its fires; and as to that matter, I beg to mention, by the way, so has Manchester, Liverpool, and Glasgow, as to fire prevention, with a reduction of their previous losses by fire by two-thirds.

By this method of cleansing an appropriate impermeable pavement Paris has acquired the name of 'clean-streeted Paris.' And it is noted by French sanitary authorities that marked improvements in the health of the inhabitants have followed the extension of the improved impermeable paving and of this mode of surface-cleansing.

Mons. Mille, the engineer-in-chief of Paris, has made a Report on the works of sanitation for the metropolis of the German Empire, Berlin, and he points out that they are on principle derived from the report inspired by myself. We might claim as due the acknowledgment of some principles and details of our original elaboration, that have been adopted in Paris, beyond those I have stated, as the abandonment of river supplies for spring supplies, a measure in which Paris is in advance of London.

Our plan for the sanitation of London was first to put the whole of the water supplies under unity of management on a public footing. Successive Royal Commissions have re-enforced that conclusion. We next proposed to abandon river sources of supplies, as of unavoidably inferior quality, if not from the sewage of towns which might be diverted from the surface washing of lands which could not be diverted, and we prepared to resort to spring supplies, of which we found in the Surrey sands springs of soft water of double the then actual consumption of the metropolis. Whether they would now suffice for the increased population, and what assistance would be needed and available from other sources, would be matter of inquiry. But the delivery of these spring sources would have been constant and direct to the house, without the intervention of any external subsidence or filtration reservoirs, or any stagnation in internal cisterns which would be unneeded and detrimental. The fouled water, with all excretory matter, would have been in course of constant removal through self-cleansing impermeable drains from beneath the sites of houses, and through self-cleansing sewers from beneath the streets and the site of the metropolis. By steam-power mostly, such as that by which the fresh water was carried into the houses, the fouled water would have been carried from them, and be distributed in several directions on to land fitted for its reception. We prepared for the agricultural treatment of the sewage of the metropolis in at least four sections, pumping backwards to the S.W. as well as to the N.W. By the concentration in pumps for sectional distribution, we should have increased falls and the rapidity of the discharge, and we were perfectly confident that as a general result there would be no

stagnant fœcal matter in the metropolis, and that the whole of the fouled water would be deposited as manurial matter—not in suspension but in chemical combination—in the soil within the day. Of the interruption of our preparations and expositions by an epidemic visitation of cholera with which we were charged to attend, and of the working in Parliament of the opposing sinister interests, it may be useful for public instruction to give an account hereafter. But it is for the immediate purpose of the advancement of sanitary science to state that the German engineers have (as stated by M. Mille), upon a study of our principles, adopted them, and are closely applying them for the sanitation of Berlin. The river Spree is perhaps one of the least objectionable of river sources, but collections of waters are now being made from beneath the sands near Berlin in close analogy with the proposed spring collection of water near London. These sands near Berlin, uncultivated and almost barren, constitute superior natural filters even of the rainfall, and the water so collected is delivered direct, on the constant system, to every house in that metropolis. A new and self-cleansing system of sewers is in formation, and house drains are in course of construction and connection with them, for the constant removal of all excreta as sewage, and for its direct application to the land. The German metropolis is for this purpose treated in five sections, with a main pumping station for each; and the sewage will be pumped out by two lines of mains to two large farms on sandy land like that of Aldershot, one farm north and one south, for which altogether about 4,000 acres of land have been provided. The house connections are not yet completed with closets, but one farm of about 400 acres is already in operation, and one crop has been taken from it, demonstrating the extraordinary development of productive power by liquefied manure.

On the occasion of a visit to Berlin, the Governor did me the honour to ask my opinion of the plan for its sanitation, and I could not do otherwise than express my gratification at the affirmation they gave of our principles, and my confidence that if they were applied with completeness in the details, Berlin, from being the lowest in sanitary position, would be raised to the highest of any capital in Europe, and be made the worthy seat of the great German Empire.

The old city of Dantzig has been made a sort of trial work of the principle of venous and arterial circulation. Water-carriage has been introduced there for a large proportion of the houses, and a direct application of the sewage to the land made by M. Von Weibe, the engineer, and Mr. Aird,

the contractor, with complete success. A material reduction of an excessively heavy death-rate has followed the introduction of the system of water-carriage from the houses, and crops such as have never been obtained before from any culture have been raised from the adjacent lands. At Hamburgh, where I was credited by Mr. W. Lindley, the engineer, with the principles of sanitation applied to the houses, and at Dantzig as well as at Berlin, the practicability of the system of water-carriage during long severe frosts has been established. At Dantzig, and subsequently at Berlin, the practicability of the regular distribution of the sewage to the land underneath the ice and snow, has also been demonstrated, and the necessity of large storage reservoirs of sewage during the winter obviated. From His Excellency the Governor of Dantzig, Von Winter, I have received a very gratifying account of the public appreciation of the work of sanitation, marked by the increased application for houses where the works have been completed.

As far as my observation goes, in England, as a rule, the sewage of about 100 persons may be utilised on an acre of ordinary land. Local conditions differ materially, and at Berlin Mr. Holbrecht anticipates that he may be able to utilise the sewage of about half more of the population on that area. But he is of opinion that for efficiency and profit, a smaller number will probably be found to be better.

On the whole, I submit, from such evidences, derived from increasing practice, that the venous and arterial system of sanitation for the protection of urban populations is safe for eventual general adoption with the progress of science, in respect to economy as well as for health.

The Powers of Sanitation available for Colonial and Indian Cities.—The principles so tried, examined, and sanctioned, will be found by competent authorities to be peculiarly adapted for the sanitation of Colonial, and especially for Indian, cities. A lady traveller stated, that in travelling through India she knew at night that they had come to an Indian city from being awakened by its stink. This fact would denote to the sanitary scientist that she was awakened by the waste of manure—the horrible waste by evaporation of the finest elements of vegetable production for the sustentation of a famine and fever scourged population. You may now test a condition of civilisation of a legislature, and of an administration central as well as local by the smell. On such experience as I have cited the waste of manure in famine-stricken Madras would suffice to sustain some 20,000 head of cattle, and the equivalent of food for the population ; and double that in Bombay. A friend, an

Engineer officer, Capt. Baird Smith, when he was at home on leave, asked my advice, for the occupation of his time in professional study for use in India. I advised that he could not do better than study the irrigation works of Northern Italy. He did so, and published a book about it for his brother Engineer officers in 1852. Sir Arthur Cotton had long demonstrated to an extent of which I was unaware, the policy and profit of irrigation works. If that policy had been pursued, and if we had given the people water (even plain water), we should not now have to be giving them bread. Of late, however, instead of carefully collecting and carrying to the East the latest improvements in science, and especially this new science, as I may call it, the new power of giving to plants food and water, and also at the same time relieving cities of the causes of depression, sanitary engineers have been carrying to the East the oldest and most expensive errors of the West. As an example. A local plan for the drainage of Cawnpore was referred to me for my observations, from the Works Department of the Indian Government. I found it to be a plan mainly for the construction of sewers of enormous size to receive and carry away extraordinary quantities of storm water, which might well have gone direct to the river, whilst the expense would have sufficed for the proper drainage of the houses. On this scheme I wrote a paper expository of our tried and proved principles of water carriage as applicable to Indian cities. The Duke of Argyll approved of this exposition, and directed the attention of the Governor-General and of the local officers of works to it. The objection those officers raised to it was mainly that the system of water carriage was incompatible with the habits of the natives. This is the same objection that was at first raised to the system of water carriage here. Local authorities, vestrymen, generally small landlords, who from an ignorant dislike of the expense of altering their tenements, insisted that a water-closet was utterly unsuited to the habits of the people; and that the tub system of removal, which required no immediate outlay to them (the landlords), and the working expenses of which were to be paid out of the rate, was the proper practical system. We set aside these ignorant and selfish pretexts, and water-closets have now been brought into systematic use for masses of the population, comprising classes as low as the lowest of any of the most barbarous classes in Indian cities, and in a very little time it is found to be satisfactory in its working, and the objections as baseless here, as under good rule they will be proved to be

in the Indian cities. The expense of the bad imperfect system of removal in the tub system in Bombay, even by the cheapest Indian labour, appears to be double the expense of water carriage in England. I grant that a daily removal by the tub system is better than removal to sewers of deposit.[1] If, however, it passes the skill of the insanitary engineers to construct no other than extended cesspools, let them, for the safety of life, give place to competent specialists. But the first advance in sanitation by water carriage may be in relation to the economy and application of the manure of the Indian cities, where the waste, by burning and throwing it into streams is enormous and most reprehensible. Even the solid animal matters may be made to feed edible plants, instead of dogs and vultures. The introduction of liquefied manure farms, to receive and apply at once the excreta of cities, would have the peculiar advantage for India as serving as great trial works, for the instruction of the people in new cultures, in the introduction of new foods, and relieving them from the lazy, dangerous, and total dependence on one. The irrigation with the liquefied manures of cities would moreover have the great advantage, as a culture, of the freedom, experienced here, from the irregularities of rainfall and from droughts, by storage of water reservoirs and the works for ensuring the regularity of the supply of water to the populations of the cities. In some districts of India, as I am informed, the natives have great skill in irrigation, in water leading with plain water, by methods, some of which might be copied at home for leading liquefied manure. It may be mentioned, as illustrative of the working of the pernicious working of the population check, and of the beneficent counter principle of saving life instead of destroying it, that the great obstacle to the progress of the new cultures we are meritoriously introducing into India of coffee, tea, and others, is the want of hands, and yet they die of hunger by thousands!

[1] When in epidemic periods we had authority under the Public Health, we directed that the removal of excretory matter from urban districts should be effected daily. The putrid decomposition of such matter when received in water, and kept stagnant in tanks or sewers, is fully developed in about four days in ordinary weather. But when kept undiluted in tubs or in pails putrid decomposition is much more rapid. In the towns where the tub system is adopted in England the practice is to remove it weekly, and the cost of such removal by hand labour and cartage is never less than double, and often five or six times greater, than the system of removal by water carriage from the premises in about a minute! It is, however, a mistake to assume that for the system of water carriage, the English water-closet with the seat and its machinery is necessary in all cases. The system may be applied without seats, by latrines, and in various methods.

On the general question of the sanitation of Indian cities, it is to be admitted that according to the descriptions given of some of them, they are so hopelessly bad in the sites and in the surrounding areas, amidst extensive marshes, and in the construction of the houses, that the cheapest course will be one of removal and of reconstructions. When the powers of sanitation, as recited, become known and understood, the like course will be taken with old western cities. We may indeed be said to be beginning already in the like course with bits and blocks of our old towns. But if we are to hold India it may be submitted that it should be for the Indians, and for their protection against pestilences, as may well be done by utilising trained, working military force. In that policy we should keep in view the important example I have cited from Algeria. The Indian military service of the scientific corps have, it is due to mention, afforded instances of great administrators, but little known here, whose achievements not being of battle or of bloodshed, of 'Siva the Destroyer,' but of 'Vishnu the Preserver,' are ungazetted, but who have shown in how short a time the conditions of populations may be beneficially transformed, and who have been positively deified by the poor natives who came under their rule. Let me mention one who, if he had the special light of sanitary science, would have done his work probably even more completely than he did. Major Dixon, of the Bengal Artillery, was sent with a brigade or force to keep in check a robber tribe in the Mairwarra, a hill district about as large as the Highlands of Scotland. He found that from the want of water and the failure of crops they were obliged to make forays on the lowlands for subsistence. He raised capital, made storage-reservoirs, cleared jungles, founded 130 villages, and so engaged that population in productive occupation, that they could not afford to rob. To dispose of the produce raised it was necessary to have a market, and to found a town, and we may be sure that neither town nor villages were fever-nests. Instead of spending a revenue, he raised a revenue from that non-productive population; instead of occupying a brigade of force with it, he raised a brigade of force from it, and that brigade was loyal to us at the Mutiny, before which, having completed his good work, he unfortunately died. India has now an incipient sanitary organisation, comprising able officers who have already rendered good services discovering and displaying the sources of epidemics, and correcting pernicious home errors, as to their rise and spread and the means of their prevention. It would follow that the present declared and accepted policy of the Premier, that the health of the people is the first object of good government, surely that

policy should have commensurate application for the protection of our most afflicted and depressed fellow-subjects of the Indian Empire, that they should be rescued from the ravages of the destroyer, and be made to feel that in being brought under the sway of their Empress our Queen, they are brought under the sway of the preserver.

I beg now to submit a *Summary of the chief results* obtained of the progress of the power of sanitation, deducible from the normal instances I have adduced, or of which, from want of space, I have been obliged to content myself with giving indications for examination:—

1. That we have gained the power of reducing the sickness and death-rates in most old cities by at least one-third; or, as a rule, of reducing the death-rates in old British urban districts to 16 or 17 in 1,000.

2. That in new districts, on sites apart from old urban sites, we may, with a complete arterial system of water supply and surface-cleansing—including measures for the prevention of overcrowding—ensure reduction of death-rates to less than one-half, or to a mean rate of 10 in 1,000, and the sickness in the like proportion.

3. That in well-provided and well-regulated institutions for children from 3 to 15 years of age we may secure them an immunity from the common children's epidemics and reduce the death-rates to a mean of about 3 in 1,000, or to less by two-thirds of the death-rates prevalent amongst childrren of those ages in the general population.

4. That in prisons and places under effective sanitary control the death-rates (from disease) have been reduced amongst persons from the school ages and upwards to about 3 in 1,000, or to one-third of the death-rates prevalent amongst the general population of the same ages.

5. That to the persons in such institutions an immunity may be given as against all ordinary epidemics, typhus and the eruptive diseases, diarrhœa and dysentery, which ravage the general population.

6. That amongst the general population a reduction by full one-half of the diseases of the respiratory organs may be effected by general public sanitation.

7. That complete habits of skin cleanliness, alone and apart from general structural arrangements, or alterations of habits in other respects, constitute a factor of about one-third of the power of sanitation.

8. That, by a proper selection and a due sanitation of sites in tropical climates, and the sanitary care of the population, the birth-rates may be made to exceed the death-rates, and a healthy

succession, for colonisation, for people of the British or of the white races.

9. That by the increased health and strength imparted by improved physical training under sanitary conditions, on the half-school-time principle, in the infantile and juvenile stages, the efficiency of three for productive occupation may be imparted to every two of the most depressed classes of the population.

10. That the death-rates from disease in the Mercantile Marine may, by the exercise of the like powers of sanitation that are exercised in the Royal Navy, be reduced by two-thirds, or to the general death-rate now prevalent in the Royal Navy, namely, of about 6 in 1,000.

11. That—as indicated by existing normas—the greatly reduced death-rates in the Army at home and abroad, admit of important further reductions, by a more complete application of tried and approved means of sanitation.

12. That by efficient sanitation, the transit of persons from infected places may be most safely effected, and the freedom of trade, including the transit of goods, may be relieved from the obstructions and expensive and vexatious delays of quarantines.

13. That the venous and arterial system for the sanitation of cities is fully demonstrated by varied increasing practice.

That all this may be done admits of more abundant proof than in this Address I have been able to adduce on the present occasion; that all this has been done under conditions that admit of more complete and efficient repetition. On the whole, it will be found to justify the recent most important declaration of the Prime Minister to a greater extent than he has had time or opportunity to be made aware of. I cannot do better than repeat here the terms in which the declaration was made, the highest that has yet come from the head of any Government:—'I have touched upon the health of the people, and I know there are many who look upon that as an amiable, but merely philanthropic subject to dwell upon; but the truth is, that the question is much deeper than it appears upon the surface. The health of the people is really the foundation upon which all their happiness and all their power as a State depend. It is quite possible for a kingdom to be inhabited by an able and active population; you may have skilful manufactures, and you may have a productive agriculture; the arts may flourish, architecture may cover your lands with temples and palaces; you may have even material power to defend and support all these acquisitions; you may have arms of precision

and fleets of fish torpedoes, but if the population of that country is stationary or yearly diminishes, if, while it diminishes in number, it diminishes also in stature and in strength, that country is ultimately doomed. And, speaking to those who, I hope, are not ashamed to say that they are proud of the empire to which they belong, and which their ancestors created, I recommend to them, by all the means in their power, to assist the movement that is now prevalent in the country for improving the condition of the people by ameliorating the dwellings in which they live. The health of the people is, in my opinion, therefore, the first duty of a statesman.' [1]

From what is known, I may venture to express a belief, that this declaration is in perfect accordance with the deepest feelings and wishes of Her Majesty the Queen.

General Stages of Progress.—Sanitary science has had for its first stage simple ignorance and apathy, to which the Premier adverts; next its stage of empiricism and half-knowledge, in which stage it is very much at present; with the common result of expensive, misfitting, inefficient, and wasteful works, with water distributions which make good supplies bad and bad supplies worse; with water carried into houses without the means of removing fouled and waste water, aggravating the evils of damp and of excrement sodden sites,—sewers, without adjustment to the house drains, intended arteries without relation to the capillaries of the system, leaving undiminished death-rates, serving to encourage the sinister objections that sanitation is of no avail; and, lastly, it has the stage of science, of complete knowledge, of unity, efficiency, and economy, tested by reduced death-rates. On these stages I might further dilate. Corresponding with these stages of works are stages of empirical and hasty legislation, of defective administrative organisation, which require distinct exposition as a cause of disaster and waste of money, without equivalent results;—and next we must look to more advanced, scentific, and efficient legislation,—the outcome due from that study of the means of protecting the health of the people which the Premier has repeatedly declared to be the first duty of a statesman. This of legislation is a topic of large and distinct consideration. I have confined myself to the exposition of the established normas of sanitary power, which are available for an advanced legislation and administration to apply. In the support of that advanced legislation we have new agencies, for the formation and guidance of an advanced public

[1] Opening of the new buildings of the Victoria Dwellings Association, June 23, 1877.

opinion. In alliance with our Association we have the British Medical Association, with an effective joint committee, specially directed to the consideration of the improvement of the local and central organisation of the public health service. Beside these, we have new and zealous voluntary associations established in the metropolis, and in the course of formation in the provincial cities. We have, moreover, new journals ably and earnestly devoted to the advancement of the public health. The like Governmental organisations and voluntary associations are in course of formation and advancement in the United States, in France, Belgium, and Germany. It will be my consolation and reward if the normal examples I have adduced shall serve to give increased confidence and encouragement to our fellow-labourers, for the reduction of the greatest afflictions of our fellow-creatures.

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