

Suggestions in reference to the present cholera epidemic, for the purification of the water supply, and the reclamation of east London : with remarks on the origin of cholera poison, proofs given in facts connected with the sources of water supply in India, with illustrative incidents descriptive of successful preventive measures, and curative efforts / by William Sanderson.

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SUGGESTIONS

IN REFERENCE TO

THE PRESENT CHOLERA EPIDEMIC,

FOR THE PURIFICATION OF

WATER SUPPLY, AND THE RECLAMATION OF EAST LONDON.

WITH REMARKS

ON THE

Origin of Cholera Poison ;

PROOFS GIVEN IN FACTS CONNECTED WITH THE SOURCES OF WATER SUPPLY
IN INDIA.

WITH ILLUSTRATIVE INCIDENTS

DESCRIPTIVE OF SUCCESSFUL PREVENTIVE MEASURES, AND CURATIVE EFFORTS.

BY

WILLIAM SANDERSON, C.E.

LONDON: WILLIAM MACINTOSH,

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1866.

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SUGGESTIONS

THE PRESENT CHOLERA EPIDEMIC



WITH NUMBERS

Origin of the Epidemic

FROM THE LONDON CHOLERA HOSPITAL, AND THE RESULTS OF THE

INVESTIGATION

WITH A HISTORY OF THE DISEASE

AND THE RESULTS OF THE INVESTIGATION, AND THE RESULTS OF THE

WILLIAM SANDERSON, C.E.

LONDON: WILLIAM SANDERSON, C.E.

PREFACE.

THE ideas herein promulgated, having been much discussed since my arrival from India, my mind was prepared with the subject, when by chance I read an article in the "Daily Telegraph," which led me to write this pamphlet. It being my object to show that it is certain that Cholera originated from the pollution of water by decomposing, animalized, and feculent matter (and probably in India), and to give proof in the facts known of the condition of the water supply in Lucknow and in London; and I desired to state what I know and have heard relative to the sources of Cholera poison, and to draw deductions from known facts and discoveries.

I would also suggest the means of purification of the water supply, and give one or two illustrative incidents, referring to Indian sources of water supply, and apply the whole to this country, and especially to the river Lea, the most important stream in connection with the metropolis next to the Thames, and to East London, supplied with water from the Lea for culinary and other domestic purposes.

I have also put forth a crude idea for a scheme for the preservation of the waters of the river Lea from pollution by drainage of surface and cesspools of the houses, villages, and towns upon its banks, or upon any of the feeders of the river from the most minute sources, to the mouth of the river at the Thames.

Another scheme is suggested for the reclamation and purification of East London and the Isle of Dogs, so as to extend the accommodation of the vast number of inhabitants, and to provide more suitable dwellings, and generally to provide for complete drainage,

and a pure water supply ; with wide thoroughfares, thereby vastly increasing the value of property ; raising the social status of the population, and providing a preventive remedy against Cholera which will benefit posterity, and remove the foul blot, the most degrading and most disgraceful state and condition of a portion of this the greatest and the most wealthy city in the world ; the metropolis of the greatest empire ! the centre of the commerce, the science, and the philanthropy of the world. The reclamation of East London has become an imperial necessity, and should be a national work ; and before that necessity, vested interests should be compelled to give way. But I would also provide for the preservation of the value of every privilege, freehold or leasehold, or in connection therewith.

In presuming thus to appear before the public, I am in hopes that men of high standing in the Engineering and other professions, will take up the question ; and that no time may be lost in completing the designs of the scheme for the purification of the water supply, the reclamation of East London, and for stamping out Cholera in the metropolis. God helps those who help themselves.

WILLIAM SANDERSON.

ST. MARGARET'S,

WARE, HERTS.

September 4th, 1866.

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The leader which I make my text however, contains some valuable remarks ; and to do justice I make a more copious extract, including all the points which I have been led to touch upon as follows :—

“ And if we are to be so fortunate as shortly to get rid of the deadly enemy, after an invasion of but eight weeks in all, we shall cling with new confidence to the trust that, even if the type remains the same, each periodical assault does become weaker and weaker, and that Cholera, like other historical scourges, will at last wear itself out. There is little reason, unhappily, to hope that the sad experience of the season has given science any better method of combating the disease ; the ‘ eliminators,’ ‘ stimulators,’ homœopaths, and others, still wrangle over the question of treatment, while Death grimly and impartially snatches his victims from all in turn. Wonderful things are reported from Naples respecting the virtue of spirits of camphor ; yet all such lauded remedies have proved medical mirages, vanishing so soon as investigated. Nevertheless, we have obtained great and notable conclusions ! We have proved the marvellous efficacy of energetic sanitary measures ; we have, thanks to the noble conduct of those officially engaged in the conflict, and the brave spirit of many amateur visitors and helpers, done much to dispel the fear of contagion ; and if we have not found out the direct cause of the plague, its indirect and secondary causes are ascertained beyond all dispute by the remarkable phenomena of the present visitation. There is probably some occult condition of the atmosphere essential to the production of the epidemic—some magnetic or aerial disturbance, of which the ‘ blue mist,’ so much talked about, may be a visible accompaniment. Without such a condition, neither offensive exhalations nor impure water, we imagine, would breed the real plague : because, in a city like London, foul smells are always to be discovered by an adventurous nose, and make the daily breathing-stuff of hundreds ; while as for the water, when was that of London ever pure ? In India almost all the water is got from stagnant tanks. The Hindoos bathe in them, alligators live in them, buffaloes wallow, frogs croak, water-snakes swim, and weeds grow amid them, and filth of all sorts collects under a blazing sun upon their repulsive surface ; yet, if it be not ‘ a cholera season,’ Ramchundra and Gungalace, his wife, say their prayers and drink in peace, without fear and without injury.

“ Impure water cannot, therefore, be the primary cause ; but that, given the existence of a choleraic influence, it is a certain and fatal secondary one, must no longer be doubted. The experience of these terrible weeks is positively overwhelming on the subject. The district of infection in the East of London has been accurately mapped out by the pipes of the Old Ford Company, and it has been ascertained that, to the quarters where a certain supply comes, the Cholera has come too ; where it is exchanged for another source, the Cholera has ceased. Nor can we resist the collateral facts which Dr. Letheby has lately marshalled on the subject. The famous—or infamous—pump in Broadstreet, St. James’s, is what Lord Bacon would have called “ an instance of the lamp ”—a clear light thrown on the entire matter. At West Ham, in 1857, one side only of a street was attacked ; it was found that the people had resorted to one pump, and when it was closed the epidemic ceased. Again, in 1849, southern London suffered severely, and a certain water supply was discovered to be propagating the plague, while the other source in the district had no noxious properties. The pestilence reappeared in 1854, when the old company was furnishing the best, and the new company the worst water ; and on that occasion the district which had originally suffered escaped, while that which had been untouched in the first attack was now smitten. Such records make us tremble at the other revelations of Dr. Letheby. According to his

investigations, all the pumps of the city of London may be fountains of death. Although their water is often bright and pleasant, it is charged with horrid ingredients. Those near Newgate, Aldgate, and Leadenhall reek with the salt and rotten organic matter soaked through the soil from the shambles and meat markets; more disgusting still, the pumps which adjoin the graveyards give water full of nitre and ammonia and worse elements, derived from the decomposing remains of thousands of corpses. There is little hope that pumps outside the city boundaries can be resorted to with much more safety. Sewage percolates into them, and surface drainage poisons them; so that Dr. Letheby earnestly recommends that they should be entirely avoided.

"Another fact comes out with equal force, namely, that working people pay dearly for the miserable quarters in which they consent to live. They can do something to sweeten the water by boiling it; but if Cholera finds them out in the dismal and fetid holes where they live, they must die, and they do die, like rotten sheep. Surely, with the cruel evidence of Bethnal-green, Mile-end, Whitechapel, and such parishes, before us, the disgrace and danger of these poor districts in London will be dealt with at last. If the task of reforming the slums of a metropolis were simply one of charity and Imperial taste, it would require an *edile* like M. Haussmann, and despotic power like the French Emperor's. But the work is different; it affords a field for large and legitimate profit, while it would confer the greatest benefit upon every class of the community by humanising an immense section of the people. One of the heaviest penalties paid for the gross political duplicity of last session, and for the Cabinet which now "stops the way," was and is the loss of Mr. Torrens's wise and salutary bill, which would have enabled parishes to destroy and rebuild on a grand and sweeping scale. The working people must see that the vast question does not sink out of sight; healthy and decent houses, having all the modern improvements, can be erected where now stand those dens and rookeries which fatten landlords with weekly rents; or, better still, industrial suburbs can be created outside the metropolis—railways at the same time bringing in the working people at a nominal cost. The necessity for such dwellings we regard as the sternest and most urgent warning which the awful pestilence has brought. The liveliest charity, the most English liberality, is also needed to strengthen Mrs. Gladstone's hands, in order that provision may be made for the orphans of those who have fallen victims to the disgraceful want of sanitary arrangements in this great city. The public is but beginning to learn the heartrending state of things produced by foul water, and houses where fresh air cannot come. Nor is the fault that of the victims, for they had no other homes. The fault is the nation's, with its slow legislation and Adulamite lethargy of belief and action. To-day our duty is to help those who have suffered; by-and-bye we must deal with the evil itself by wholesale measures if we would avoid the annual visitation of a pestilence."

After reading this leader, I immediately took my pen to address the Editor, to assert that, There can be no doubt that impure water is the primary cause, that is as far as the source of water supply goes,—to go further back to original causes we must conclude that neglect of surface cleansing, or the removal of the cause of that impurity, is the primary cause of the malady. My object in commencing this paper, has carried me beyond the limits of a newspaper column, because I have been led, in seeking proof of my assertion, to refer to observations made in India, where I have sojourned many years, and where I had many opportunities of

observing the progress of the malady, and of which I have had much sad experience ; and acting on the desire to make a communication to the public, I do not presume to appear in the character of a member of the grand fraternity of the *literati* of this age and day, but humbly to "say my say," and leave it to work its effect if it has any weight : with this deprecativè remark I proceed, by repeating that there is no doubt that Cholera is caused by polluted water, but it depends upon the matter by which it is rendered impure, and then to adduce proof from record, tradition, and experience in India.

CHAPTER I.

CHOLERA is known to have originated in India, which has long been well populated, even in the prehistoric period.

Cholera could *originate* only in dense masses of population depositing excreta and other animalized matter over surfaces, from which it is carried by the percolation of the rainfall to the sources of the water supply, and in a measure by surface drainage into the rivers and reservoirs natural and artificial.

From the prehistoric period the populations of India have been constantly congregated in and around large armies. Cholera was first known to Europeans in the eighteenth century in Indian armies ; but the malady had devastated various parts of India for centuries, returning at various periods. The Indian name for Cholera, "Murree," meaning "The death," is found in some of the puranas, or theological writings of a later date than the Brahminical Shastur ; the word is not derived from the Sanscrit, and although adopted and used by Brahminical Hindoos, is derived from a primitive language ; uncouth dialects of which are spoken by the Tharoos and the Booksthes of the Turai, the Bhils and Ghonds, of Central India, and the various aboriginal tribes scattered over the more inaccessible portions of the mountain and the Ghaut districts of India generally.

A little more than a century before the Greek invasion of India, Budha, the great reformer of the Brahminical religion, appeared, and devoted his life to the instruction of the people, and the introduction of a new system, with a view of lessening the power of the priesthood. One of the disciples of that great reformer departing from the simplicity of his doctrine and manner of dealing, sought to lower the priesthood by detraction, and seizing upon the dread "Murree" as a subject, he caused to be cut in the stone or Monolith before a temple, *then* ancient, near Vizianuggur, a distich

which was copied into a parana, and is known to many Hindoos, and sung or recited at their poojahs in deprecation of the wrath of the God who brings the scourge. Sir William Jones attributes it to a goosain, who accompanied the earliest armies of the Mahrattahs, but the ancient monolith proves its great age. The distich is as follows, a free translation :—

“ His snaky fingers probed
 With claw-like nails,
 The cavities of the abdomen, the hidden
 Muscles and fibres in the limbs of the strong ;
 As by fire the limbs are curled up.
 His breath is on the warrior's face,
 Whose lips are blue,
 Whose eyes are sunk,
 Whose face is shrivelled,
 And writhing, prone, knotted, and cramped,
 He dies, cursed by the offended Siva,
 Who sent the priest
 To afflict with Murree the righteous brave.”

This distich was composed in an endeavour to rouse the people to rebel against the priests by an insinuation that the degenerate Brahmin priests brought “ Murree ” (Cholera) upon them by unholy incantation ; the only use, however, of the attempts of Budha's disciple at detraction, is the proof it gives in this day of the ancient presence of the dread malady which is so graphically described in the delineation of the contortions of the dying warrior.

Much as we pride ourselves on the deep research and great knowledge of the sciences, that of medicine is very little more advanced than in India many centuries ago ; and the religious laws of the founders of Brahminism (which was originally pure Deism) were dictated with regard to sanitary measures, after the manner of the patriarch who dictated laws to the Israelites, and many of the peculiar customs and singular superstitions of the Hindoos of the present day originated in a wise effort to preserve the health of the people ; they have lost their value now because of the corruption of human nature, leading to a departure from the wise and simple laws of the great legislators, who founded communities, and who provided those laws, which in their days were always, as among the ancient Hebrews, inseparably connected with their religion.

Cholera has always followed the great increase of populations. The black death which occasionally ravages the dense populations of China, is undoubtedly choleraic, and was known in the days of Confucius. In China the polluted waters produce something more than microscopic infusoria. In that country there is in addition the poisonous fly, whose sting produces mortification, and

is probably the result of a condition under which it is surprising that the population is maintained without decrease ; certainly we should consider that under the more favorable conditions of the greater enlightenment and civilisation of Europe, China would not hold the redundant population, without energetic sanitary means.

CHAPTER II.

HAVING shown that Cholera was known to the people of India long previous to our historic period, I would draw attention to the assertion on page 10, that Cholera could only originate in dense masses of population, and I will refer to the city of Lucknow in Oude, as affording an instance of the condition and circumstances in which Cholera originated there.

Lucknow, a large city of modern date, suddenly rose from an insignificant village to the huge place it was under the last king of Oude. As a large and populous city, its existence cannot date further back than the middle of the last century ; before the Indian Mutiny, and the annexation of Oude, it had a fluctuating population of one or two millions. The city stands upon a plain of alluvial deposit, on the right bank of the river Goomtee, one of the principal rivers which water the plain running parallel to the Ganges. The plain stretches from the Ganges to the Himalayan Turai, and has a formation of vegetable soil and alluvial deposit, resting on a bed of clayey sand containing in large proportion nodules of carbonate of lime.

The extent of the city caused the inhabitants to change from their primitive habits of depositing excreta on the open plain, and they constructed cesspools and drains, generally open and offensive ; the richer inhabitants, however, covered their cesspools and drains. In the superstratum were sunk innumerable wells, from which water was lifted by ropes, pumps being unknown. There is no basin, as under the city of London, and there is no impermeable formation for a great depth, and the strata from the depth of 50 feet below the surface of the soil, may be considered as thoroughly saturated.

There was formerly no attempt at drainage beyond the open channels ; consequently the water of the wells in the immediate vicinity of the cesspools of the wealthier classes was more or less polluted in proportion to the scantiness or abundance of the rainfall ; and towards the end of the hot season, when the level of

the saturation was lowered, the appearance of Cholera has been regular; but the intensity was confined to the parts where the cesspools were covered, and the disease was always more manageable according to the distance from the places where the water was corrupted by the closed cesspools; and further distant from that centre it did not appear, or, at least it was understood by the inhabitants of Sirtheera, Mundeegoon, Futteegunge, and other adjacent villages, that the victims of Cholera, if any, brought the malady from the city.

The account of Lucknow, its geological bed, water supply and corruption of its sources, will enable us to see more clearly the terrible extent to which we have carried the pollution of our water supply in this metropolis. The city of Lucknow stands on a site capable of natural drainage; let us contemplate a picture of the reverse.

It is well known that London stands over a bed of solid clay, which covers the hollow or concave bed called the London Basin, and having the same degree of concavity, but which is filled up by a superstratum of dislocated clay, gravel, alluvial soil, and débris, varying from 40 to 70 feet in depth. It is this superstratum of recent formation in which all the sewers were built, and in which all the cesspools and wells are sunk, the former contaminating the latter; and until within the last fifty or sixty years, the cesspools had no communication with the sewers, but these malformations are now however allowed to receive the overflowing of the cesspools and the discharge from the waterclosets, which either lodge on the way or pass into the Thames, whose waters thus poisoned are again pumped up for culinary and other domestic purposes.

The London Basin has been gradually converted into an immense cesspool, the bottom of which is a few feet lower than the bed of the Thames; and there is no possibility of a complete and constant natural drainage. It may be assumed that the bottom of this recently formed superstratum, is about 25 feet below the level of low water in the river, and that the impermeable beds of the London and plastic clay are together about 100 feet deep. Below these is found a stratum of sand 20 feet thick; below that the upper chalk formation, having a thickness of at least 300 feet, containing flints, and resting on the lower chalk formation, which has no flints.

From the upper chalk formation is obtained the Artesian supply of pure water at a depth of 350 to 400 feet. This supply of pure water is supposed to be unlimited, except by the expense of providing a sufficient number of Artesian wells so built, and protected against contamination by the pollution held in recent formation, to

the level of the bottom of which the Artesian well water will spontaneously rise.

Dr. Letheby says, he "thinks he may say," that not only himself, but all the officers of health of the metropolis, are of opinion that bad water is the frequent cause of disease, and that there is no doubt it aggravates some of the diseases; and that decomposing organic matter in certain conditions of decay in the alimentary canal is sufficient, without any other agency whatever, to cause disease; and that next to impure air he would rank it as one of the most powerful causes of disease. But I would add to Dr. Letheby's remark, that impure air is the consequence of impure water; and whether the pollutions of the water sources poison the blood through the alimentary channel or the lungs, the result amounts to the same thing for suffering humanity.

During all great epidemics, popular opinion has pointed out the state of the water as one of the chief causes of the pestilence; and modern experience has confirmed this by minute statistical inquiry. The disease to which bad water peculiarly predisposes is Cholera.

During the Cholera epidemic of 1848-49, several instances occurred in which nearly every person using water from particular wells was affected with Diarrhœa or Cholera, and of the Cholera cases nearly all died.

During the epidemic of 1854, of seventy-three persons who died in a certain street in the metropolis, sixty-one had drunk water from a pump polluted by sewerage. A vessel of this water was sent to a lady at Hampstead; she was attacked, and died of Cholera; the water on being analysed, was found to contain 92 grains of solid matter in the gallon, of which 7·8 grains were organic matter. During the same epidemic, the populations of Southwark and Lambeth suffered severely from Cholera, which was attributed to the state of the water supply. The affected district was supplied by two companies, one of which gave a comparatively pure water, and the other a very impure one, containing sewage matter from the Thames. The deaths from Cholera in the houses supplied by the purer water were in ratio of 37 in 10,000, while the ratio among those supplied with impure water was 130 in 10,000. This special case was the subject of elaborate statistical inquiries made by the Registrar-General's Department. Referring to these facts, he says, "Therefore I conclude that there were 'destroyed by the Southwark and Vauxhall Company (whose 'water was at that time impure) 2,500 persons.'"

The further evidence which was brought before the Commissioners appointed to inquire into the sanitary state of the army in India, proves the necessity of careful chemical investigation; and

as an illustration of the beneficial result thereof, it may be stated
 “that the impure water sources of the metropolis were abandoned
 “and better water provided, with marked improvement in the health
 “of the population; that a proposal to supply the city of Glasgow
 “with well water was rejected after chemical analysis, and at a great
 “expense the people obtained a supply, the total impurities in
 “which amount to 2·35 grains per gallon, of which only 0·605 grains
 “consist of organic. If the chemical constitution of this water be
 “compared with that of the supply of Serunderabad, already men-
 “tioned, a clear idea will be obtained of the great importance of
 “chemical inquiry on such subjects.

“It may be useful to state briefly the nature of the improved
 “water sources, together with the methods of distribution which
 “have been adopted of late years in this country. The purest
 “waters are those derived from mountain springs or streams,
 “collected and stored either in large artificial reservoirs in upland
 “valleys, such, for example, as those for Manchester and Liver-
 “pool, or in natural mountain lakes, such as Loch Katrine, from
 “which Glasgow derives its water. We have already noticed the
 “small amount of impurity in the Glasgow water. Manchester
 “water, obtained from a hilly district, contains 3·33 grains of im-
 “purity per gallon, of which ·680 is organic, chiefly peat. It is found
 “highly advantageous in these cases to bring the water a distance of
 “30 or 40 miles in iron pipes; and as the reservoirs are at a con-
 “siderable elevation, the water is discharged by head pressure, and
 “can be delivered by gravitation all over the towns for which it is
 “intended.” This is the best method of securing a good water
 supply; but there are no such mountain heights as Woodhead, such
 favorable localities for the construction of reservoirs, such deep
 ravine-like valleys, as that of the river Eethro. The water of the
 metropolis, obtained from rivers, cannot be pure until the sewage
 of the various towns and hamlets is cut off, and even then the
 drainage by percolation will bring much impurity from the over-
 manured fields. The total impurities of the Thames waters may
 taken at 20 grains per gallon, of which 2 grains are organic and
 animalized matter.

CHAPTER III.

WE have an account of two cities: London standing upon a
 loose formation, the strata of which holds the water source of a
 large population, and which is saturated with impurity, the
 whole filling up a basin in the chalk which cannot be naturally

drained,—Lucknow, standing upon permeable strata, and capable of natural drainage by percolation. In London, Cholera has always been, as it is now, traced to the effect of polluted water. In Lucknow the natives rightly attributed the spread of the disease to the use of the water in the heart of the city; and the wealthy classes drew their supplies for culinary purposes from the suburban villages.

From this account of the geological formation, and water supply of the two cities, with the statistics of the periods of the epidemic, we may safely infer that Cholera originates generally, and is always spread by contagion where the water is corrupted by feculent matter. I use this term *feculent*, advisedly, because the impurities of Indian tank and some river water arising from decomposed vegetable matter do not originate Cholera or Dysentery, but though the consumers of such water are not thereby liable to be attacked by the dread malady, they are subject to a disease equally as terrible in the extent of its destruction of human life, if not so in its action upon the victims. People in India die with much less pain and anguish from remittent fever than from Cholera.

I would correct the writer of the article which is my "*text*," wherein he says, "In India almost all the water is got from stagnant tanks," etc. With the exception of a small extent in Southern India and on the Eastern coast, the inhabitants of that vast country are supplied from wells and rivers. I would refer to a Report of the Commissioners appointed to inquire into the sanitary state of the army in India in support of my assertion, that wells are the main source of supply, rivers next. With the exception of certain localities where the cause of impurity is known, as in large towns, well water throughout India is generally pure.

We are helped to a reply to the question as to whether or not Cholera is produced and fostered by polluted water, by the statistics of the extent and virulence of that disease in India, which vast area offering for inspection and investigation various conditions under which water is obtained, in connection with the above statistics—brings conviction to the mind that Asiatic Cholera is produced by the pollution of the sources by feculent matter.

After many years' sojourn in various parts of India, I am prepared to assert,

That Cholera is caused and originated by the decomposition of animalised and feculent matter, which, in the alimentary canal, is sufficient to cause disease, without any other agency whatever; but the most certain agency is its diffusion in the sources of water supply.

Impure water is therefore the primary cause, and no *occult* condition of the atmosphere is essential to the production of the Cholera epidemic. Certain known conditions of the atmosphere may be necessary to change the pollution in the water to an aerial poison.

The malady, as is well-known in India, will follow the course of a river, if it has broken out in a dense population on its banks. The disease always spreads downwards, carried by the additionally poisoned stream. The choleraic poison is also carried along the great routes, mostly by pilgrims, who are constantly moving in large bodies throughout the country. If a much frequented route follows the banks of a river, the disease may be carried up the stream, by travellers who throw the bodies of the victims to Cholera into the river, carrying away the polluted clothing, and wearing it without sufficient washing.

That Cholera has been produced and originated by the pollution of wells from cesspools, without any "*occult*" condition of the atmosphere having been essential, I can adduce some well-known cases from Ajmere and Jeypoor, from Delhi, and from Barielly, in that garden of India, Rohileund.

I also assert that Cholera is not produced by the impurity of water arising from the decomposition of vegetable matter. The natives of India are so well acquainted with this fact that they will desert a clean-looking well, protected from surface drainage and other pollution within a populous village, for a stagnant-looking tank, or jheel.

I cannot admit the accuracy of the following from my text:—
 "In India almost all the water is got from stagnant tanks. The
 "Hindoos bathe in them, alligators live in them, buffaloes wallow,
 "frogs croak, water-snakes swim, and weeds grow amid them, and
 "filth of all sorts collects under a blazing sun upon their repulsive
 "surface."

How loathsome a picture! but, happily, how utterly inaccurate. There are such dismal spots—such horrible places of stagnant water and all its dreadful concomitants, but at such places there will be found no Hindoos bathing; Ramchundra and Gungabhaee will not be seen near, because there they know they must meet death, whether it be the "Cholera season" or not. As I write, my recollections of pleasant far away talaos (*Anglice*, tanks, meaning small natural or artificial lakes) bring back to my mind moments of exquisite enjoyment, when, after a long hard ride across a burning plain—when hour after hour, riding through the blaze of the glowing sun, I have looked with longing impatience for the distant grove—I have found myself in the shade of the burgad, the peepul, and the mangoe—the choumeilah and the Indian jessamine filling up

the spaces, and loading the air with sweet perfume,—on the banks of a little lake, whose pellucid waters were undisturbed by any foul thing, and its surface dotted with the lotus, the great lily, and other aquatic plants. “Weeds,” says the writer, “weeds are noxious plants;” The luxuriant and gorgeous vegetation of the tropics exhibits a large variety of beautiful and useful spontaneous production. Pleasant reminiscences are awakened of rest and thankfulness, in some sweet spots called “Indian tanks,” and my pen shall run on, following those “sunny memories.” The Indian talao is generally the result of some pious and long defunct Hindoo devotee, who, may be a thousand years ago, caused the little streamlet to be arrested by an earthen dam, with rude engineering provision for the escape of superabundant waters on the higher land on which the ends of the embankment rested. The “bund,” or dam, was planted with forest and fruit trees, and in a generation delicious shade was there by the side of sweet pellucid water, and for many after generations was ensured rest, shelter, and exquisite enjoyment to the panting wayfarer, who revelled in the deep shade, the quiet coolness, and the clear bright water which assuaged his thirst. Such a spot is even better than the scriptural illustration of “the shadow of a great rock in a weary land.”

In such a spot I have rested; mayhap have seen a “muggur” (crocodile) make a dive and a splash from the opposite bank, and have seen the buffaloes, too, “wallowing,”—at any rate below the surface, with just their nostrils above, and in the shade of a burgad, the cows and oxen standing knee-deep, ruminating in silence, lazily brushing the flies with an occasional switch of the tail. And as evening came on, and my tent was pitched, and I felt “at home,” I have heard the frog croak also; and if perchance I should look too intently into the little cleared spaces, where the water looked so cool and bright, I might have seen things not pleasant to see, such as the “bich cobra,” the “jhul samp” (*Anglice* a lizard and a snake), make a dart across into the thicket of water-plants. The alligator and smaller reptiles, the water-plants and the insects, have their uses.

The alligator keeps down the redundancy of fish; the fish prevent too large an increase of insects; the lizard and the snake subsist on the small animals we call “vermin,” and on the productions of decaying and changing vegetable matter.

Animal and vegetable *life* do not pollute; the instinct, by which animals, reptiles, and insects prey upon each other, or consume the living or decaying vegetation, or, as scavengers—like the millions of water-beetle—remove animal excreta and corrupting matter generally, under the allwise provision of the Creator, preserves it all “good.”

Still carrying back my associations with the past, I will tell how a beautiful and pleasant halting-place was turned into a place of corruption and death, and illustrating most clearly my theory, that decomposed animal matter in water or air is the choleraic poison.

"Once upon a time" a Mahomedan, with his servants, traversed a torrid plain, and came to a sweet spot, such as I have endeavoured to conjure up from pleasant memories; and the Mahomedan rode on an elephant—his retainers on horseback. After their noontide rest these persons wandered about on the shady banks, and the "malik" had knelt with his face to Mecca, and after the formula, "Allah il Allah Mahom'd rasool oolah," and the prescribed genuflexions, had risen to receive from his serving-man some "pansooparee," that is, areca nut, with a clove and a little lime in a leaf, to masticate. He put one in his mouth, and tucked the remainder in his extensive and splendid turban, and then sauntered to the elephant, which was flapping its ears, tearing bark from some peepul branches, and occasionally putting one foot forward and from the ground, knowingly lashed it with some leaves or branches held in the extremity of his trunk, as preparatory to curling up the latter to put the "morsel" in his mouth; but elephants are fond of bright colors, and also of "pansooparee," and as the "amir" approached the huge animal extended his trunk in a curve, and in a manner peculiarly "elephantine" expressed his satisfaction. The "amir" stood near the elephant, contemplating the clear water, and the elephant was gently touching him with the tip of his trunk, when he smelt the "pansooparee," and in the act of extracting the delicacy, he unfortunately tipped the Mahomedan's splendid "puggree" into the water, and the unreasonable, ill-tempered, savage wretch, in a moment plucked out his sword, and in his fury struck the poor elephant a "drawing cut" on his proboscis, half severing it. The poor docile beast was left behind when his "master" proceeded on his journey in the morning, and died from the effects of the cruel sword cut, when standing deep in the water of the beautiful and pleasant halting-place, and the carcase, sinking in the soft bed, disappeared from view below the surface.

The monsoon came, the country was impassable, and the talao remained in its solitary beauty, till the delightful season of travel came again, and an English surgeon, his wife and three children, with the usual number of servants, encamped one day and night on its banks, and the next day, at the end of the day's journey, the Englishman and his wife and children were buried; they died of cholera. The inhabitants near said Mahadeo had avenged the intrusion of the Pariahs, but the servants died one by one on the long journey which their master would have made, and only the

khansamah and the bheestie survived to arrive at the end thereof and to tell the sad tale.

Also Brahmins, and Souars, and Hindoos of lower caste came and cooked their bread under the shade of the beautiful trees on the banks of that talao, and drank its crystal waters, and went their way, and they also died of Cholera. Then the inhabitants in the vicinity said that Siva was there under some form, and from distant Hindoo temples and pleasant villages, the goosain, the purbhut, the cultivators and their families, the men with their heads covered with the "chuddur," the women carrying offerings of rice, and clarified butter and sweets, and milk, the children tripping prettily and gaily, unoppressed by superstition and untouched by care, tripped along as the little ones only know how.

And with discordant bray from uncouth instruments, the form of which may have been handed down from the days of king David's shawms and trumpets "making a noise," the motley processions moved across the burning plain through the "blazing" sunshine to remove the grasp of Siva the Destroyer from their rahdharia, their travellers' rest, their beautiful gem of lotus flowers. With all their superstition, there was a purpose of usefulness, and under the command of their priest leader, they opened the ancient dam and let the waters out, and "lo and behold," the huge bones of the elephant, the immense quantity of flesh from its gigantic carcase, had been sufficient to pollute the waters of that little lake, and the animal *life* therein had been insufficient to remove the effects of animal *death*. And the priest passed sentence on the talao, that it was not to hold water for the weary traveller until it had been purified—and how? There was no "flushing" that lake bed, there was no drainage thereof, but the gap was left in the earthen dam, and the remains of the huge thing were carried off by countless myriads of insects, and by reptiles, the blazing sun by his own grand chemistry separated the impalpable and the unseen, which become under the Creator, animal organisation, and the bed of that little lake dried up, and divided by deep cracks and fissures into an intricate mosaic, purified by the alchemy of Nature "as by fire," was again made to hold its waters by the closing of the gap in its dam by the docile and devout Hindoos, men, women, and children, who had been led by a Hindoo priest, guided by a humiliating superstition, to perform a noble sanitary act, for it was only to supply the wayworn traveller with shelter and good water that the pretty "Chushmee Bhag" was restored to its purity.

CHAPTER IV.

I HAVE said that Cholera is produced solely by the corruption of water by animal matter, but the poison can be disseminated by the suffering victims, and sources of water supply polluted by carelessness.

Through the length and breadth of India the excreta of the multitudes are exposed to the action of the tropical sun, except in a few large cities; and in new camping grounds, the hot season is generally the healthiest; but if rain should break out unseasonably, as in March and April, Cholera is certain to break out in large villages and towns, especially on the banks of rivers, and is accounted for by the theory that feculent matter reduced by intense heat and atmospheric action to impalpable powder, impregnates the soil which receives the rainfall until absorption is complete, and the soil can retain no more, when the polluted surface drainage falls into the rivers whence the inhabitants draw their supplies of water.

In 1863, such an unseasonable fall of rain caused Cholera to a frightful extent in a district where the writer was located. I had caused myself to be elected a member of the municipal Board of a village or town of 5000 inhabitants, and I was also an honorary magistrate, which gave me power, and I proposed to the municipal board that in addition to efficient drainage, the wells should be lined to a certain depth, and that all wells not lined in the following April should be closed. As a magistrate I enforced this rule, and in eight or nine months three public wells and several which were private property were lined with brick and mortar down to the trap rock. The geological formation in the part where that town stood; was black vegetable mould lying on a bed of disintegrated trap 30 feet thick; below this a bed of trap rock 7 feet thick, to clayey sand with nodules of trap 10 feet thick lying on the bed of trap depth unknown, but in fissures, water bearing. A well sunk to this lower bed of trap would yield a very small supply of extremely pure water; but the clayey sand between the beds of trap also supplies good water in sufficient proportion, so that wells sunk to this bed and protected against impurities by brick and mortar lining to the upper surface of the upper bed of trap may be resorted to without fear. I also prevented the use of the water in a small rivulet running by, and enforced certain other very necessary sanitary measures; and in 1864, when Cholera came, and scourged the country over an area of 40,000 square miles, nearly in the middle of which was the point of my operations, not being

on any main route, nor being on the banks of a polluted river, having suffered terribly from the malady previously, I had a fair opportunity of judging whether or not the shutting off the former water supply of the upper stratum, would prevent the spread of the malady. I called meetings of the natives in their public places and circulated scraps printed in Mahratta and Rungree, containing information relative to the cause and spread of Cholera, advising them not to drink water except in their own wells, to avoid going far from their homes, and if unhappily the scourge appeared, to have the patient placed immediately in a place I had prepared as a hospital, and to destroy by fire all clothing worn by the patient, whether recovered or not. And the result bore testimony to the accuracy of my views and conclusions. There was not one victim out of that body of 5000 inhabitants, except a few persons who obstinately rejected the advice given, and went to a large city 30 miles off, and to other places where Cholera raged, and died away from their homes.

There were fifty-seven cases of cholera, travellers who had been attacked elsewhere. These were received in a shed provided immediately without the town: I had no medical assistance, having been refused by Government on several previous applications, but I obtained the services of a dismissed "hospital apprentice," who came to me about six months before this outbreak in a starving condition. He was a native Christian and a convert; his teachers had helped him to a knowledge of writing and accounts, and to the post of hospital apprentice; but having put off the restraints of his old religious faith, he became lewd and drunken, and was cast adrift, and thus found his way to me. With his aid I hired three other Madrassesees and two sweepers, with a water-carrier, and my establishment was complete; and during the short period of eight days the fifty-seven Cholera patients were treated. Of these, thirteen died, and the remainder left in various states of convalescence, as they were able to resume the labours of travel. With reference to the treatment of these patients, it was the same that had been adopted in former emergencies, and at the end I will describe it in the relation of the facts connected with the successful treatment of a Cholera case, an Englishman now at home.

The bodies of the victims, with all clothing which had been worn by any of the patients, were carefully burned, and the convalescents were supplied with clothing from the native looms, and with turban and shoes at the expense of the municipal fund, to which the inhabitants subscribed liberally, in addition to their octroi payments, which formed the basis of the fund. Thus the said town was saved from Cholera by preserving the water from the pollution by percolation of rain water charged with decomposed

animalized and feculent matter, always in abundance on the surface, and in the superstratum on the sites of old towns.

Cholera has always followed the great increase of populations. The "black death" which constantly ravages the dense populations of China, is undoubtedly choleraic, and was known in the days of Confucius. In China the extent of decomposing animal matter in the water everywhere, in addition to the subtile "Cholera poison," produces flying insects, whose sting is followed rapidly by mortification, spreading so rapidly that death follows in a few hours; death among the Chinese is so extensive in every form, at all ages, from all kinds of disease, that the people are absolutely utterly reckless, and without fear of death. What is it that is reducing the once redundant population of China? Emigration, rebellions, wars, do much, but the most active agent is choleraic disease, caused by the dreadful extent of the pollution of their water sources.

It has been shown that in India the water supply is derived from lakes, wells, and rivers. In low, flat countries, and in deltas, artificial lakes are chiefly relied on; they are made by throwing up an embankment on three sides of a space which is excavated to supply the requisite material, the fourth side being left open to receive the surface drainage. Or, where the locality is favourable, a dam is thrown across from one minor watershed to another; or, again, the bed of a river which in the rainy season holds a torrent, and in the hot season is dry, is crossed by a dam from bank to bank.

River water is used where a river happens to be the most abundant and accessible source; elsewhere, except in the low plains and deltas, the supply is derived from wells 20 or 30 feet deep.

Natural and artificial lakes or ponds (tanks?) where distant from populated places, are not charged with Cholera poison, but those receiving the drainage of forests, charged with a large quantity of vegetable decomposition, cause remittent fever, enlargement of glands, mesenteric disease, with enlargement of the spleen.

River water is the most pure until it passes large populations; the polluted superstrata do not affect flowing rivers, the Cholera poison carried by its waters is thrown in by the surface drainage of the habitations of diseased populations.

The report of the commissioners appointed to enquire into the sanitary state of the army in India, contains much valuable information connected with the various conditions of its water supply, and proving incontestibly that Cholera has in every locality where searching enquiry has been made, been traced to the use of water poisoned by decomposed animal and excrementitious matter. Some of the communications are evidently by men, who though in authority, and possessing every means of thorough investigation,

have not given the subject sufficient thought. One states that certain wells in old sites contain a large amount of salts, and a similar excess of saline matter is found in tanks, rivers, etc., in dry weather, and that the locality of such tainted waters should be avoided as dangerous. Why the natives themselves know better from actual experiment; and a tyro in chemistry will know that nothing further can be done by nature herself, decomposition having finally resolved and restored the various constituents of animal matter to their primitive and innocuous forms. The site of Tooglukabad is covered with masonry-built tanks, whose water is saline, "Kurooah," as the natives say, when drawing up a report of the state of the ancient reservoirs of Tooglukabad (the ancient city of Delhi). I suggested the selection of that locality for a station, and the utilization of a vast number of old massive stone buildings, tombs, and shrines, and mosques, and temples, whose former frequenters in untold myriads have long ago been resolved into the original simple elements, and made the waters savour of salt. The chemistry of the elements has in long time completed the transformation; and Tooglukabad, at a very slight expense, might be made into a noble, healthy station for an army. The remark of the doctors in high authority was, that the saline matter in the water proved the presence formerly of organic matter, *therefore* Tooglukabad must be considered an unhealthy locality!*

The object of the foregoing remarks and references to countries rightly adjudged as the cradle of the dread malady, is to show that it really arises from the polluted waters of the superstratum on which stand the cities and towns of the constantly and rapidly increasing population of this country; and that the greatest efforts of health officers, sanitary commissioners, municipal boards, etc., should be directed to the prevention of the consumption of the waters held by the polluted superstratum. But before the existing source of water supply can be closed, another should be opened, and wherever the borings give a favourable locality, the first attempt at the opening of a new source should be the construction of an artesian well: the next work should be to shut off the surface drainage of populated sites from the streamlets and rivers; finally the storage of spring water on the uplands wherever it can be effected; with the increase of population will be the increase of pollution. If we commence the work of carrying off the polluting elements, and prevent the continuance of pollution of the superstrata, posterity a few generations hence may reap the benefit when the result of decomposition is complete and final.

* That was in 1850, much has been learnt since. What an immense advantage would have been derived at the period of the siege of Delhi, in 1857, from the occupation of Tooglukabad.

CHAPTER V.

A QUESTION arising out of the foregoing, and one which has absorbed the attention of the highest medical authorities is, as to the nature and form of the Choleraic poison. The great advance in scientific research, and especially in chemistry, has carried the minds of men beyond the simplicity of the question, and led to much discussion on the condition of the atmosphere, which is supposed by some to be impregnated with something, by others to be deficient of something, so the writer of the article which is our text says, "There is probably some occult condition of the atmosphere essential to the production of the epidemic, some magnetic or ærial disturbance, of which the 'blue mist,' so much talked about, may be a visible accompaniment." To the most advanced of scientific men all the operations of nature are occult; and it is worth asking, "what is the real value of the learning" of this day and age? the results are brilliant; steam, electricity, chemistry, meteorology, and geology have enabled the restless people of this island to flock to distant places with ease and facility most agreeable; to communicate with lightning rapidity all over the world; to apply those substances most conducive to the restoration of the productive powers of an exhausted soil, to provide means of cleanliness and light, and of the resolution of natural substances into useful matter and form; to take measures of protection against a coming storm, and to find the shortest way for our sails across the great oceans; and lastly, to attain at the smallest cost of labour the riches stored up by the Creator for the use of His creatures in due time. But how much of the wonderful discovery and startling advance in science, as applied to invention of the past two generations, is due to the so-called men of "scientific education?"

Neither Watt nor Stephenson knew much of mathematics; and of the host of inventors, how many were armed with the possession of "learning" for their onward fight and struggle? *In mediotutissimus ibis*, we may become too scientific, and mount so high on the hill of knowledge as to overlook the simple matters which call for our most serious attention. We know that nature is ever changing, ever changeable; and it is a beautiful discovery to have made, that in the lapse of time the revolting state of the decomposition of our departed loved ones shall have been changed to a state of purity; and if we could discover, and collect all that once went to a beloved form from the realms of space, it would be beautiful and pure; perhaps not in the same meaning, but singularly in

accordance with St. Paul's, "For th's corruptible must put
"on incorruption."

This idea of some "occult condition of the atmosphere" is incomprehensible, except by the most profoundly learned, connected with electricity. Dr. Honigberger, a Prussian, and for many years physician to the late "Lion of the Punjaub," a man of patient research, but from his long isolation from the congregation of busy men, rather inclined to be empirical, affirms that the poison producing Cholera exists in the form of infusoria, that is, microscopic organic matter, which, when diffused through the atmosphere, enters the system as an ærial poison by absorption, either through the mucous membranes of the eyes, ears, nose, or mouth, on which it attaches itself, or more probably that those minims of animalcules, by our breathing, find their way through the capillaries of the lungs to the bloodvessels, where they, whenever a certain Choleraic predisposition exists, produce the malady. And other theories have been put forth, but this question has not been satisfactorily settled, nor ever will be. The question affecting people generally, is how to prevent the malady; still, for those unfortunates who may have to suffer, it might be of some use to say what has been the experience of one who has been in the midst of Cholera, and been compelled to act without the aid of a medical man; and I will single out one case, and relate proceedings and results.

In April, 1864, an English "navvy" entered my bungalow hastily, and said, "Pleese sirr, my master is very ill," and on being questioned, added, "he's gotten t'cholurick." It was but a short ride to the house of his master, a civil engineer, in the employment of Messrs. Lee, Watson, and Aiton, on the Nagpoor Extension of the Great Indian Peninsula Railway. He was a young man of about twenty-five, active, spare, and irascible, and most zealous and energetic; a large eye and other peculiarities showed a sensitive temperament. I gave him 30 drops of Dr. Brown's Chlorodyne; and after seeing him a little easier, I left the phial with the navvy, and told him when to give another dose. After two hours I returned to my patient, found the "navvy" intoxicated, and the only phial of chlorodyne to be had *broken*, and the patient apparently in despair. I told him that under Providence I would save him by a medicine I had frequently administered to natives, and that I would not leave his bedside till the cure was effected. The following extract from a diary will show how serious was the case, and the treatment adopted:—

"* * * When I returned to T—— at 5 P.M. I found him
"suffering from violent vomiting, he was also purged, the evacua-

"tion *without* odour and like water; his face, especially the lips,
 "bluish; his eye intensely bright and dilated. A quarter of an
 "hour after my return to him he had cramps, commencing in the
 "calves of his legs and passing upwards. I got in three horse-
 "keepers and the house servants, and got them to rub his legs and
 "arms, applying brandy and salt; I set them the example, and they
 "attended very willingly and patiently to my directions. In the
 "absence of chlorodyne I gave the patient a pill, containing
 "half a grain of sugar of lead, and half a grain of opium, and in
 "half an hour, this seeming to have no effect in reducing the
 "vomiting and purging, I repeated the dose, and again in another
 "half hour. At half past six the distressing symptoms had
 "decreased, but I thought he was dying; the countenance became
 "more cadaverous, the eye glazed, and I thought the opium was
 "in excess, and gave him two grains of calomel, and watched the
 "result till eight, when he seemed still suffering from opium, and
 "I gave him three grains of calomel; in the mean time I gave him to
 "drink rice water as cold as we could make it, and cold chicken
 "broth, which I made in a preserve jar with a clamped stopper,
 "a very certain method of extracting the animal juices; a little
 "salt to make it palatable was all the seasoning, and I gave him a
 "table spoon of the soup or broth frequently. At nine o'clock the
 "effect of the calomel could be seen in the evacuations, small quan-
 "tities of fæces in the watery matter, containing bile, showing the
 "liver was acting.

"At midnight the Cholera symptoms returned with all their
 "force; vomiting, purging, cramps, and then collapse. I gave
 "him the same doses of sugar of lead and opium at the same intervals,
 "and apparently with exactly similar result, and again gave him
 "calomel with the same result, except that the presence of natural
 "fæces was greater, and at three in the morning the face had lost
 "the cadaverous hue, and an appearance of hopeful animation
 "cheered me. After that he slept, and, wearied by much exertion
 "previous to my being called to him, I fell asleep in the chair by
 "his bedside, and was awakened at daylight by his attempt to get
 "from his bed, which I fortunately prevented. At six I gave him
 "some cold strong tea, sweetened, and when next he craved some-
 "thing I gave him a cup of strong chicken broth, and at eight in
 "the morning, after fifteen hours at his bedside, I left him with a
 "feeling of devout thankfulness for his safety."

Now not being a "medical man," I do not presume to say that
 sugar of lead and opium, with an alternation of calomel, is a
 panacea, but simply that in treating a large number of cases

among the natives of India, and in the above case, the patient being an Englishman, I have been singularly successful.

Doctor Honigberger suggested inoculation with quassia, the bitter principle of the *quassia amara* wood, and according to his own account he has been very successful ; but for my part, not being sufficiently acquainted with the mysterious connection of that wonderful thing the animal frame, in its various parts, I should desire something to act more directly on the stomach, and on the channels by which we convey nutrition to the body, and unhappily receive that which is destructive to health and life. Yet, on the *similia similibus curantur* principle, quassia and sugar of lead may be valuable as a remedy, introduced, the one directly by an opened vein, and the other by the alimentary canal, as both, when so introduced in a healthy subject, produce choleraic symptoms, and both are "insect poisons." If, therefore, the theory that the poison enters the system with the water we drink, or in the form of an aerial poison, as microscopic infusoria be correct, quassia and the acetate of lead introduced as separately directed, may be considered as the antidotes of that poison.

CHAPTER VI.

ALL remarks on India, the cause of pollution of water sources, the manner of dissemination of disease, the action of flowing streams, and moving multitudes, apply equally to this country, especially in reference to the sites of large towns and to rivers and other streams. The metropolis having the largest population, both resident and fluctuating, should have the first attention. Admitted that great efforts are now being made in the Thames Embankment and in the grand systems of sewage, yet a vast amount remains to be done, and the first act of authority should be to effectually close all wells sunk in the recent formation, and at various points sink shafts for artesian wells to the upper chalk stratum. Twenty years ago the "United Kingdom Artesian Water Company" asserted that pure water could be supplied at ten shillings per house, and that the chalk bed under the London clay having an area of 1,000 square miles, will yield as much water as could be needed by a population of twenty millions. It is estimated that the outlay for a sufficient number of artesian wells for the metropolis would be £3,000,000 ; even at that cost it would pay, if 300,000 dwellings could be supplied at ten shillings ; however it is an "Imperial necessity," and should be an enforced national work.

With regard to rivers, the commission appointed to enquire into the cause of the pollution thereof, should also have the power to design a remedy, and should deal first with the rivers and streamlets affecting the metropolis. As the population increases the difficulty will be greater, the vast numbers residing in the Eastern districts especially will still further increase, and the present difficulty still more serious. If it is generally regretted that Sir Christopher Wren was prevented by vested interests from using the opportunity offered by the clearance by the Great Fire; and if it is thoroughly understood by all classes that authoritative legislation is required to remove the horrible and disgraceful state of one third of this great metropolis, who stops the way? What is the obstacle? Vested interests? property rights? Then remove the obstacle, take the polluted part of London as mapped out by the water mains of the New River Company and the banks of the river Lea. And let the Commissioners take up the subject of the cleansing of that river first, and of the drainage and purification of that part affected by its waters. This itself is a sufficient subject for a thick volume, let alone a mere hastily written pamphlet; but as it is the point to which to apply all the foregoing remarks, the subject should not be left untouched. Referring to the necessity of chemical investigation, I would ask has any been made into the state of the waters of the River Lea, as taken up above Amwell, by the New River Company.

Chemical investigation however is essential only where the sources of the water supply are unknown. The surface of the County of Herts is known thoroughly, the gushing springs of the Lea and the New River are well known, and are pure; and it only remains to act so as to cut off the drainage of sewage into the river, of Stevenage, Luton, Hondon, Dunstable, Hertford and Ware, from all which towns, besides from numerous villages, hamlets, and solitary dwellings, the drainage from overflowing cesspools, from water-closets, and from many other nuisances before the Lea water is pumped into the New River above Amwell. And in addition to this drainage of overflow and surface, the waters of the Lea receive by percolation all that has been stored in the alluvial deposit upon which these towns and hamlets stand.

I would suggest a scheme by which the various streamlets entering into the river Lea system should be protected from pollution by the interception of drainage, beginning at the first cottage on the bank of each stream. The sewer should be carried along the bank and carried under by syphon, or through by an iron pipe, all the streamlets running into the river Lea.

This river-protecting sewer could be constructed in the rural districts, of earthenware pipes, and each streamlet should be so

dealt with, arrangements being made at proper intervals to receive a sufficient quantity of the surface drainage of rainfall into the sewer-pipes. The sewage of small hamlets having been brought down to a town, and a larger quantity to be received, I would make the sewer of cast iron, oval in section; and for a town of 2,000 houses with a sectional area of three feet, adding a foot for each additional 800 houses; the capacity thus increased would probably require a sectional area of forty feet below Ware.

This scheme would require a complete system of sewerage on each side of the river where the population of the parts drained is 50,000; but in the beginning the small streams could be sufficiently protected at very little expense, and the land owners might be compelled to absorb or utilize the sewer accumulations of solitary houses or small hamlets.

The existing works for the drainage of north London should be constructed and arranged to receive the drainage of the river Lea. Were such works not in progress, I would have suggested the construction of an intercepting sewer commencing in Bridge Street, Blackfriars, and carried along Earl street, by the east end of Thames Street, the low part of Tower Hill, East Smithfield, Ratcliffe Highway, Shadwell High Street, by the bottom of Schoolhouse Lane, under the Blackwall Railway, up White Horse Street, under Regent's Canal and the River Lea at that bend which is nearly opposite to the workmen's gate of the Dockyard. At this point of the river Lea I would bring the sewerage drainage from Hertfordshire and from Blackfriars to the level of the low water in the Thames; and the same means of interception should be preserved on the north bank of the Thames. However, the River Lea is our theme at present.

I would suggest the embankment of the river Lea on both sides, from Lea Bridge, and continue the embankment eastwards on the Thames for a mile, and westwards to the end of the embankment at present under construction. The main intercepting sewer, and all the feeders and branches leading thereto, should be so constructed as to be flushed when necessary, and to receive a portion of the surface drainage of the rainfall.

The New River Company should be compelled under any design for the preservation of the waters of the River Lea, to pump their additional supplies at the nearest above Ware, and as much beyond as engineering capabilities will admit.

And the waters of the Lea having been so far purified, any property holder of the locality of either bank should have the privilege under certain rules of lifting water for the supply of the immediate vicinity,—a public company would be the best.

The waters of the River Lea having been purified, I would

direct attention to the reclamation of that part of the Metropolis, which has been abandoned to a state far worse than an Indian jungle—that part which takes its water from the River Lea. Say that the boundaries shall be Bishopsgate Street, Shore-ditch, Hackney Road, Victoria Park, the River Lea, and the Thames up to London Bridge. This district, which has been abandoned to such a desperate state by too carefully respecting vested and property right, I would map out, and lay down new streets of proper width, in such direction that all good and new buildings, public buildings, churches, etc., should remain untouched, and judiciously brought into the new system of streets.

Having mapped out this district, I would set apart all the docks and the buildings connected, all public buildings, and all new ranges of new offices and warehouses, and all good property consisting of well built houses with basement at a proper level; and the property etc. thus set apart, the remainder, including the Isle of Dogs, should be valued and divided into £5 shares, and all property taken into the scheme should be valued, and such possession declared to be worth so many shares. To the amount of the property thus valued should be added double as much capital, and the whole district should be rebuilt at a proper level for the drainage. The embankment round the Isle of Dogs should be carried at the same level as that now in construction, and the land in the Isle of Dogs raised to corresponding level; and the whole area of this property laid out in building plots, having especial regard to the requirements of the working class.

Some effort must be made to remove the loathsome and dangerously unhealthy assemblage of hovels and decaying houses, and nothing less than legislative action will overcome the obstacles which would at every step be thrown in the way. The Metropolitan and other railway companies can seize and level property wherever found in the way of their schemes; and if for the pecuniary advantage of a railway company Parliament will so readily grant the powers asked for, surely for a work which should be considered national, and the object of which is to aid a population of half-a-million or more to escape the foul and noisome nests of Cholera, there ought to be no difficulty.

No effectual scheme embracing drainage, lines of communication, decent dwellings, supply of water and gas, can be laid out without powers to take up the property.

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