

**The defecation and utilization of the sewage stream : a lecture to the Framlingham Farmers' Club / by J.H. Groome.**

**Contributors**

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Royal College of Surgeons of England

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SECOND EDITION.

The Defecation and Utilization  
OF THE  
Sewage Stream.

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A LECTURE  
TO THE  
FRAMLINGHAM FARMERS' CLUB

BY  
The Rev. J. H. GROOME, M.A.,

*Rector of Earl Soham.*

MAY 30th, 1866.

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### AVVISO.

The intention of the following pages is to get, if possible, a thorough sifting of the subject in all its bearings. It is not simply a question of the success or non-success of the Stroud experiment ; but of that which is of the utmost urgency now, the possible fallacy, both *a priori* and *a posteriori*, of the defecation of the sewage stream by the irrigation plan. Its universal adoption implies unbounded expense, and, in case of failure, irretrievable loss. May it be added without offence ? scientific men are not necessarily practical farmers, nor is the money-value near London or any great town a true criterion of the intrinsic value of an over-stimulated grass crop. It may be superfluous, perhaps even impertinent, to add that the writer of these pages has no other interest in the subject of them than the general weal and a desire to make a useful discovery known.



LECTURE  
ON  
The Defecation and Utilization  
OF THE  
Sewage Stream.

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MR. PRESIDENT AND GENTLEMEN,

The singular subject on which, considering my position, I am about to address you this evening, seems to require some preliminary explanations on my part. In the first place, let me premise, I do not pretend to give the subject before us a scientific exposition, as, by so doing, I should lay myself open to a charge of presumption and only expose my own incompetence; but still I hope to describe to you a most remarkable discovery in the treatment of Town Sewage, which is of equal value, as it regards on the one hand the necessities of Towns, as on the other the interests of Agriculture. I shall try to bring before you facts and not theories, leaving you to form your own conclusions as to their practical value. But before proceeding even to this part of the question, I will, as far as personal matters are concerned, state thus much, that in consequence of being interested in the value of Cheltenham property, I was led to take part in the discussions, which were rife in that town in 1864 and 1865, on the defective supply of water, and the means of remedying it on the one hand, and on the difficulty of getting rid of it on the other; or, in other words, on the management and disposal of the offensive matters, with which it had become charged and converted into that, which we now so well know about—Town Sewage; for at Cheltenham, as elsewhere, it is a problem necessary to be solved, while it is at the same time most difficult of solution.

The Author's  
interest in this  
question.



These inquiries brought me into contact with Dr. H. Bird, of Berkley Street, Cheltenham, and from him I learned the particulars of an experiment he was making with the town sewage of Stroud, the well known clothing town in Gloucestershire, and at his kind request I visited the works. This was in May, 1865, and what I there saw was, to my unscientific perceptions, so admirably perfect in its results, that I could but say, "Dr. Bird, "you have got everything or nothing, there is no medium; "unless all my organs of smell and taste and sight are deceived, "you have met the great social physical evil of the age—the pollution of the streams and rivers by the excreta of the indefinitely increasing towns." How far these conclusions can be justified will be shown by my following statements, which I conscientiously believe to be at once accurate and real. The reality of the existing evil is patent to all, and it seems to me to have grown to its present pitch from the very excess of our precautions against the necessary consequences of any large encampment of men within a limited space, viz., the supersaturation of the soil with their excreta, as well as those of the various animals necessary for their use and sustenance, not to speak of the immense amount of matter more or less noxious to life arising from the processes of art and manufacture, when left to accumulate above or below the soil not entirely or only partially removed.\*

Sewage — its antiquity and difficulty.

We know that, from the earliest antiquity, men have recognised the necessity of this removal, and that in all the cities of past time, cloacæ, common shores, &c., were part of the public constructions of Government, so that the impurities of the towns

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\* It is impossible for any one to read in the most cursory manner the reports by Dr. Letheby, Mr. Simon, and the Registrar General; the accounts given by London Clergymen, City Missionaries, and the Correspondents of the *Pall Mall Gazette*; the reports in the *Times* of the state of the Lea and the Limehouse basin; together with the almost daily proceedings in the Courts of Law in regard to river pollution, and to doubt for a moment that "the Health of Towns" is the most vital question of our day. But no one has more thoroughly exhausted the subject or thrown a more searching light into the abyss of physical and moral misery arising from overcrowding and unremoved filth than Dr. Trench in his able and philosophical reports and evidence on the "Health of Liverpool and causes of the excessive mortality in the Borough." All extremes meet, and Goldsmith's words lose none of their force when applied to the effects of excessive instead of diminished population:—

"Ill fares the land, to hastening ills a prey,  
"Where wealth accumulates and men decay."

*Deserted Village*



found their way then as now into the rivers; and it would seem by no means improbable that one of the secondary causes of the downfall and gradual decay of the enormous cities of old may have been not only the saturation of the soil on which they stood, but also the pollution of the rivers (that ran through them like the Yellow Tiber through Rome) with those excreta, which are so fertile (when in excess) of malaria and its innumerable consequences of fever in all its shapes, from the actual plague of Egypt to the cholera of the East Indies, and the scarcely less deadly typhus and typhoidal fever of the filthy dens and uncleaned cellars of London, Manchester, or Liverpool. The various modes in which this evil has been met, the deposit in the streets and its removal in the early morning by scavengers' carts, the constructions of cess-pits more or less connected with the houses (and every one who has visited Continental towns will understand what I mean) need not be described. They have been found failures, either from filling the houses with the effluvia of disease or saturating the soil, till even our wells, the tapplings of the subterraneous rivers, have become poisoned; and, if we may believe scientific men, not the less so when the brilliancy, freshness, and sweetness of the water have but masked the atoms of death.\* About sixty years ago began the great sanitary move-From 1806.ment. Water closets were contrived and relieved the house; then within the last few years cess-pits have been generally abolished, and a system, so to speak, of arterial drainage introduced (it may be called venous and arterial) each water closet, each drain from a slaughter-house, from every factory, offensive or not, is joined to the public sewers; these again to the main sewer, and this in its turn emptied into the clear running river that reflects the town from its translucent breast; or, into the health-giving brine, in which the visitor at Brighton and elsewhere, seeks vigour and delight. *Hinc illæ lacrymæ.* For a while all went well. Theories of oxydation removed all fear, and our rivers were supposed to be capable of receiving indefinitely the streams redolent neither of violets nor roses; and so no one cared about it, till one fine day not a window of our glorious Houses of Parliament could be opened on the side of the muddy, seething, filthy Thames (the silver Thames of our fathers), because our Governors were strangled with all the death-giving abominations of the Metropolis.

\* See the grievous report of Dr. Letheby in the *Times*, August 27th, on the universal pollution of the London wells.



Its present  
magnitude.

Ever since then the evil has gone on increasing; towns have been sewered, and the rivers poisoned. The Court of Chancery has intervened, and Corporations and Town Councils have been driven to despair having got their municipal abomination concentrated in tanks, whence they are not permitted either to cast it into the flowing river, or in many cases to spread it over the land, a remedy much boasted of, but which is unconfirmed by experience, and which certainly does not obviate one nuisance—*stench*.

Questio crucis. Here, then, is the problem to be solved. Is it possible by any method, chemical or mechanical, so to “defecate,” viz., to cleanse the sewage stream either by filtering or precipitation, so that freed from its organic pollutions it may either pass into the rivers without rendering them foul, without destroying animal life, without being injurious to the cattle that drink of them, or be diffused over the land as a useful and yet inoffensive irrigant? This problem, which so many have failed in (I venture to say), has been successfully solved by Dr. Bird. I hope to shew that the sewage stream of Stroud is so defecated by his process of precipitation as to be approximately pure: and that it does pass into the river Froome without nuisance and without injury to anything, while at the same time, the resulting material, which he obtains, is in itself *per se* a valuable fertilizer, and even still more valuable as a basis for a highly powerful and scientifically formed manure. The solution of the problem in this manner is surely all the more important, when the two processes—defecation by irrigation and defecation by precipitation (Bird’s process)—are contrasted one with the other. The first (not to mention that it is in many cases simply impossible, and except where the position is favourable for the operation, so as to dispense with towers, pumping apparatus, &c., of enormous cost),\* is from the very nature of the case limited in its application, the limit being the area greater or less over which the sewage stream can be spread; while the time of irrigation is practically unlimited; a fixed quantity on the one side and a constantly increasing one on the other; so that, if we may use the expression, you have an action in the *inverse ratio*, and there is if not a certainty at least a very high probability, that in process of time, allowing for the variation in the permeability of the soil and other circumstances more

\* In a neighbouring city it is proposed, for the purpose of irrigation, to carry the sewage stream by an intercepting sewer and by a syphon under a river to a given point, where a tower 80 feet high is to be built, to the top of which it is to be pumped, so that it may be then distributed over land at that level, certainly a mile at least distant from the pumping station!



or less favourable, you will sooner or later (as is the case with the rivers) arrive at the saturation point, when the soil can receive no more with advantage, when the herbage will become rank, and both injurious and offensive to your stock, your corn crops light and puffy in the straw, and your fields will stink, and changed into artificial swamps will give out *malaria* and death.\* While, on the other hand, if we establish our case, we send a water into the streams approximately pure, we furnish you with an unlimited supply of a portable manure valuable in itself, still more valuable as a basis for higher composts, while we do not ask you to change your system of farming, or grow artificial grasses of uncertain value, and we give you also, where required, a fertilizing and inoffensive irrigant. For it has been proved by experiment, that the water from the tanks, in its defecated and cleansed state, still contains in itself sufficient fertilizing power to render it very valuable for all lands, which require irrigation, as water meadows, &c.

That irrigation with sewage proper is offensive stands to reason. I know it is so at Arle below Cheltenham, where I have examined it myself; and from most independent testimony I have it that the much boasted irrigation of the Leith sands at Edinburgh is abominable. I place upon the table a very able précis of the evidence on this point given by my friend Mr. Bacon in the *Norwich Mercury* of the 28th of April last; I would most willingly insert it entire, but that it would cause my lecture to extend far beyond its fair limit. The gist of it, however, is this: Dr. Littlejohn, the Officer to the Board of Health in that city, utterly condemns it in a sanitary point of view. Speaking of the Leith meadows he says, "Edinburgh, from its situation, is peculiarly exposed to suffer from the effects of the emanations from these meadows. The Easterly are our most prevailing winds, which pass across these meadows before they sweep over the new and more elevated portions of the old town. And it has been plausibly conjectured that the insalubrity of these winds depends largely upon this contamination. But at any rate a city surrounded with swamps cannot be regarded as in a sound sanitary condition; and it is highly probable that a greater part of the mortality of the Abbey and some of the poorer districts of the Old Town, is in a great measure owing to the unhealthy

Sewage irrigation ordinary: the objections to it.

\*It is not presumptuous, I trust, in me to point out to the learned reader, how Time and Space (Raum und Zeit) are mutual conditions the one of the other.



“character of these breezes, which blow so continuously during many months. It is difficult otherwise to account for the high death rate of the district of the Abbey, in which there is little over-crowding, and where only a small proportion of the population can be said to belong to the poorest class.”\* Here are certainly some remarkable and somewhat unfavourable statements. As to the produce, you will see it stated that the grass is useless except it be cut green for cows, and that then it will only make what is called “city milk,” the quality of which is so poor that it will neither make healthy flesh nor good butter. They cannot make it into hay; and if they do, horses will not eat it. The Engineer in charge of the drains strongly condemns them, whilst the Corporation, merely to abate the nuisance, have ordered a large sum (£24,000) to be spent to take the sewage away in a covered passage, after leaving the Murray meadows, and only regret they could not “take it away before it went to the fields at all.” I also place on the table a very able letter from Mr. Joseph Barker, Jun., and you will see that his account of the irrigation at Croydon quite corresponds with the evidence from Edinburgh; the same stench, when the wind blows over the irrigated land; the same belief in the minds of many, that it makes the town unhealthy; the same poor, valueless grass crops; in the opinion of a stock-keeper unwholesome for cows, coarse

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\* In remarkable agreement with this statement, as well as with the further fact in the *Norwich Mercury*, that gentlemen riding by the irrigated meadows have, even when no offensive smell was perceptible, become sensible of a certain tightness about the forehead and of a nausea that affects the appetite, is the interpretation given by Dureau de la Malle, in his work “*Economie Politique des Romains*, Liv. iii., Chap. iii.. Tom. ii. 1840. *Histoire d’insalubrité*, to the Plumbeus Auster of Horace, usually explained as the Scirocco. He writes, “Frontinus, who lived in the reign of Trajan tells us, “that without police regulations as to cleanliness the air of Rome would have been very bad in his time. Then it was that the injurious effects of “the South wind, called Plumbeus (lead) Auster by Horace, began to be felt. Then were developed the febrile diseases the scourge of the modern Romans, while recurring fever (la fièvre double tierce) had already become endemic in Rome, in the second century of our era, as we learn from the “commentary by Galienus on the treatise of Hippocrates upon popular diseases and the periods of their recurrence.” Thus identifying the Plumbeus Auster of Horace, the grave Cœlum of Columella, the Aria cattiva of modern Rome, the Intemperie of Sardinia, with each other, and as alike having the same cause as the ill wind of Edinburgh, namely, the exhalations arising from putrescible and putrefying organic matter unappropriated by the soil upon which it is deposited. The same evil is insisted on in the able pamphlets by Dr. Norman Chevers on the conditions of the public health of Calcutta: like causes producing like effects all the world over.



like the rank grass in the Framlingham mere;\* and you will notice that he sees the same difficulty, as I do, when he says; "I cannot foresee, what may be the ultimate result of thus flooding the land for years in succession." Gentlemen; I cannot speak too highly of your townsman's sensible and business like letter. That all landowners do not quite recognize the Mechian value of sewage flooding is proved by this fact, that one landowner at this present moment charges the Town Commissioners of Cheltenham £100 a-year for the mere permission to carry their sewage pipes across his property; and as a climax to my argument, let me draw your attention to this fact, that with the sewage most scientifically arranged by Mr. Rawlinson for the late Duke of Northumberland, and to be had merely for the expense of working the steam engine and pumping it, the tenants on the ducal estate around Alnwick at the end of two years declined to go even to that expense, and would have no more of it. I give as my authority an able paper in Dickens' "All the Year Round" for March, 1865. This is (it must be allowed), something like a condemnation of the plan, but as the strength of a chain is measured by the link that breaks; only one month's disease breeding stench in the height of summer is fatal to it.†

\* Seeing how essentially valuable to grass feeding animals are the finer and more delicate grasses, surely it must be a great economical error to so enormously increase the force of Darwin's law of "natural selection or struggle for life;" in virtue of which the stronger growths, animal or vegetable, invariably push out their feebler compeers from the circle of existence. Thus far, at all events, in this much vexed question every thoughtful man will go: it is only to the last great leap into the abysmal mystery of primæval generation that we demur.

† The question of the profitable application of sewage pure to the land must be an open one (*adhuc sub judice lis est*). More than twenty years ago the late Mr. Holmes, of Gawdy Hall, Norfolk, irrigated his park with the sewage of his house in a most ingenious manner. The soil of the park is clay, and the house in such a position that the sewage was distributed by gravity, and for a year or two the yield of grass was enormous; but then it became rank and sour, the sewage stank, and the whole thing was given up. The same plan was tried in the same county on a larger scale, at the seat of a nobleman of great wealth and power, with the same result of failure from over-saturation. In the neighbourhood of Glasgow, where the irrigation of farms, within its reach, by sewage or liquid manure, has been carried on for 17 or 18 years, it has, I understand, disappeared in those cases in which it was applied by pumping, and remains only where it can be distributed by gravity. At first pipes were laid over whole farms, so that the liquid could be applied over all parts of them, and be used for any crop, but this was found not to answer, and so eventually it was restricted to Italian rye grass and given in very large quantities. Certainly a disadvantageous limitation of a fertilizing agent to one special crop and one special locality, unless it can be proved



The evil of  
river pollution  
exemplified in  
the Severn.

The extent of the evil of river pollution cannot be better illustrated, than by a quotation from the article on Water Supply from the Edinburgh Review for April last. "The Severn, it is stated, " in its course receives the drainage of Newtown in Montgomery-shire, of Welshpool, Shrewsbury, Ironbridge, Bridgenorth, Bewdley, and Kidderminster; indirectly through the Staffordshire and " Worcestershire Canal, that of Stourport, Worcester, and Upton; " what must be its impurity after receiving the drainage of all these " Towns? It is in fact the main arterial sewer for the whole district of its watershed and its tributaries above Tewkesbury. The " extent of this district is estimated as nearly approaching 6,000 " square miles, while the population within it is estimated at " about 950,000 persons. Here, then, is a great river into which " eight tributaries enter above Tewkesbury; each of these eight " having six or seven emptying themselves into it, and the whole " pouring themselves unitedly into a vast main arterial district " sewer for nearly a million of people dwelling all around this system of rivers. Is it possible that any great towns can drink of " this river?" They do; because they must. Nor is the Thames above London better. Can it be of this polluted Severn, that Milton speaks so sweetly?—

There is a gentle Nymph not far from hence  
That with moist curb sways the smooth Severn stream,  
Sabrina is her name, a virgin pure—  
Whilom she was the daughter of Locrine  
That had the sceptre from his father Brute.  
She, guiltless damsel, flying the mad pursuit  
Of her enragéd stepdame Guendolen  
Commended her fair innocence to the flood  
That staid her flight with his cross flowing course.  
The Water Nymphs, that in the bottom played,

that no other mode of utilizing it is possible. There are quite two opinions as to the results of the Tiptree Hall farm, both as to agricultural success, and as to freedom from foul smells; and Mr. Hale, the Chairman of the Tottenham Local Board of Health, in a letter in the *Times*, August 9th, says "The banks of the Lea may have been occasionally invaded by foul smells " from *irrigating the grass* with sewage: but this sewage has been suspended " and is now confined to the arable only." The milk also from cows fed on the over stimulated grass produced by sewage irrigation gives little or no cream. Surely with such opposing facts as these, as well as those in the text, Corporations, Town Councils, and Town Commissioners may well pause, before they incur unknown and unascertainable expenses in order to *adapt land* for the purposes of an irrigation, which has so often ended in agricultural failure, and may possibly give rise to most "insanitary" results.



Held up their pearléd wrists and took her in  
 Bearing her strait to aged Nereus' hall ;  
 Who piteous of her woes, reared her lank head,  
 And gave her to his daughters to imbathe  
 In nectar'd lavers strewed with asphodel ;  
 And through the porch and inlet of each sense,  
 Dropp'd in ambrosial oils, till she revived  
 And underwent a quick immortal change  
 Made goddess of the river !

*Comus.*

To what goddess throned in Severn deeps could now-a-days  
 the strongest poetic fancy address the adjuration prayer ?

Sabrina fair  
 Listen were thou art sitting  
 Under the glassy, cool translucent wave,  
 In twisted braids of lilies knitting  
 The loose train of thy amber-dropping hair ;  
 Listen for dear honour's sake  
 Goddess of the silver lake ;  
 Listen and save.

Well, in truth, *yn wir*, as the dwellers around Plynlimmon,  
 the head of Severn, would say. He was right amongst our Poets,  
 who wrote—

God made the Country ; and Man made the Town.

Pardon, Gentlemen, this slight digression from our subject,  
 but in this practical age the ideal sometimes is as bracing to the  
 intellect as the plunge in the clean fresh running river to the  
 strong swimmer. You will not then, I trust, think me beating  
 about the bush before coming to particulars, but it seems to me  
 necessary to go into these preliminary remarks, in order that we  
 may have a clear conception of the problem before us, the diffi-  
 culty of solving it, and yet at the same time the absolute  
 necessity of so doing ; and therefore by way of inference my  
 own justification in venturing upon the arduous and somewhat  
 perilous task of bringing before you Dr. Bird's simple yet true  
 process with its twofold and complete success. One word more and  
 I proceed to business. Bear in mind, Gentlemen, that a little  
 steam moving the lid of a teakettle has brought the ends of the  
 earth together ; a little coal burned in a retort has turned  
 civilized night into *quasi* day ; and the slight attraction of amber  
 under friction for feathers and bits of hair has led to the dis-



The two-fold  
nature of the  
work.

covery of a power, which flashes our words along the wire almost as fast as light can travel. The truth is the greater the simplicity of a process; the more is it in accordance with God's laws in nature, the higher is the probability of its truth. Before however, I proceed to description, let me once more beg you to keep strictly in view the twofold nature of the work to be done, and that it cannot be fairly judged of unless both parts of it have their true value given. It is surely absolutely necessary in point of public health (if possible) to defecate the sewage stream; and if this be done, so as to produce from the organic and inorganic matter in suspension and even in partial or feeble solution a fertilizing power, we may then fairly say, that success is attained; and in estimating the value of Dr. Bird's process, we are justified in asserting, that it does not altogether hang upon the completeness of the last result, viz., upon the plus or minus quantities of ammonia and phosphate; which give (as I am informed) the measure of commercial value or even the absolute amount of soluble matter, which gives more or less the manure power, although indeed Dr. Maier informs me the sewage precipitate does actually contain 16 per cent. of soluble substance; we hope, however, in spite of the doubts which naturally beset a new discovery, to convince you that both members of the problem have been solved.

Description of  
Stroud and its  
sewage.

The Town of Stroud is situated in the beautiful Valley of the Froome, in Gloucestershire, and is the chief seat of the manufacture of the best West of England broad cloth. The Stroud Valley Canal places it within water communication with Bristol; and the outlet of the waters of the Valley is the river Froome. Its great command of water power placed it, before the steam engine came up, at the head of the clothing trade of England. 25, or 30, or 40 years ago however, the rivalry of Yorkshire aided by the steam giant sadly depressed its prosperity; but of late years the steam engine has come to the rescue, and the climate and the excellence of the water for dying purposes have restored somewhat of its ancient prosperity, so that clothmaking together with malting, brewing, and flour making on a large scale, have made it a busy and an active place. I give these particulars, because you will then see, how it is, that there are so many mills on the Froome river originally for the cloth works, though now in many instances applied to other purposes. In 1863, 1864, a large portion of the Town (which is built on



very irregular ground) containing about 5,000 inhabitants was sewered, and the sewage carried by a culvert to a system of open tanks three pairs in succession, and then submitted to a filtering process with lime, and the "defecated" water (for lime clears the water,) was passed by another culvert for about a quarter of a mile direct into the Froome, close to two if not three of the mills, which I have described. The tanks are themselves also situated in a place surrounded by houses on all sides at no great distance off; and now when I describe to you the state of affairs at the beginning of 1865, you will understand what difficulties Dr. Bird and the Company had to contend with, and from the evidence which will be brought before you, the satisfactoriness of the result.

This is as far as the sanitary point or first part of our problem is concerned; but there is evidence not only from Stroud, but from eye-witnesses amongst my friends and neighbours here, equally satisfactory to establish the second point, namely, that the resulting material obtained from "Dr. Bird's process" is in itself a really valuable manure; although for the time we are content to leave this assertion to be still further confirmed by repeated experiments and longer-continued application. The state of affairs at the end of 1864 and the beginning of 1865 was as follows:—The tanks, which I have described to you, were foul and offensive; the sewage waters flowed through them into the Froome in a muddy, foul, and offensively smelling state, notwithstanding the free use of lime and numerous filters. The sewage plant, a fungoid growth (the *acla protoformis* of authors)—a common plant in foul waters and sulphur springs—filled up the filter beds and rendered them useless. Numerous complaints were made by the mill-owners and mill-occupiers on the Froome, by the inhabitants in the immediate vicinity of the tanks, as to the nuisance of the stench from the tanks themselves, as well as that from the offensive exhalations arising from the mud and other matters in the stream, which accumulated till they even impeded the action of the water wheels in the mills. Legal proceedings to obtain redress were threatened by the mill-owners close by where the culvert emptied itself into the river. The water, from containing lime, killed the fish, and its action on the decaying organic matter caused the evolution of sulphuretted hydrogen gas, and other most offensive exhalations, while the ammonia was driven off in the shape of a carbonate, and the organic matter so decomposed by the lime that the resulting substance was, is, and remains useless.

Sanitary and  
agricultural re-  
sults.



About the middle of March, 1865, Dr. Bird was empowered by the Board of Health of Stroud to try his process. He immediately removed the filtering beds, cleaned out the tanks (which you remember were not of his own planning), and adapted them in a rough and cheap way to his own purpose. At first the men employed in the cleansing during the alterations were almost killed by the stench, unable to eat their meals, and often affected with nausea till they vomited. But as soon as the deodorizing precipitant was applied to the sewage stream the stench was stopped, and the men worked in comparative ease. The substance which is used is sulphurated clay, viz., clay treated with sulphuric acid, and reduced to powder. This, as you see, has the power of laying hold of and coagulating the organic and other matter in the sewage stream, and precipitating them to the bottom of the tanks like a flocculent deposit, leaving the water to a certain extent defecated and made pure.\*

Description  
of the tanks and  
the process.

At Stroud it was at first applied in the state of slush, viz., fifty pounds of the clay mixed with three hundred gallons of water twice a day, and allowed to fall in a small stream from a

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\* The hygienic effects of sulphur are well known, and the sulphurated clay has been found a very excellent disinfectant in Hospital practice. In the treatment of the Cattle Plague, Mr. Tollemache tells me that the only thing found to be an effective remedy in Cheshire is the fumigation of the cattle themselves with sulphur, and also that the men employed in the fumigation themselves improved in health. Certainly the men at the Stroud works do not seem to suffer in the least from the unpleasant work in which they are engaged, and Mr. Lawrence says, that at tin plate works with which he is connected it is the custom of the poor people in the neighbourhood to bring weakly and consumptive children into the sulphur room, that they may inhale the fumes which experience has taught them to be most beneficial in such cases of delicate and strumous constitutions. It is also not altogether beside our subject to remark, that if Dr. T. S. Cobbold's views, as to the universal adoption by Towns of sewage irrigation being favourable to the indefinite propagation of entozoic germs or embryos, be correct; as well also as that it may not be improbable, that microscopic fungoid ferments, detectable only on glycerine screens, may be largely developed from the surface of the sewage flood, and so floating through the air pass directly by inhalation into the blood, serious objections on the point of public health are reasonably urged against the irrigation practice. Now every Gardener knows practically, that nothing is in the main so useful in destroying all fungoid growths such as the *oidium*, &c., as sulphur washes or fumigations; and it is quite a work of supererogation to point out the fact, that sulphur is the great medical weapon for the destruction of that creature, whose vulgar name we decorously veil in Latin, *acari psoræ*: so that it surely is not altogether unscientific to urge, that the continuous application of sulphuric acid to the sewage stream itself, and its resulting deposit, must have a great tendency to destroy those enemies of life, and render it as hygienically harmless, as it is agriculturally valuable.



wooden vat through a man-hole into the sewage current, just before it entered tank No. 1. Then coagulation and deposition commenced, and the water passed, partially cleansed, into tank No. 2, where a like quantity of clay preparation was allowed to fall from another vat on the surface of the water; fresh defecation then took place, fresh precipitation, and the water passed, still more purified, into tank No. 3 (so that when I saw it in May, 1865, the surface was covered with the green stuff common on all our ponds, and called, I believe, *ducks' bread*), and then with the addition of 10 lbs. more of the clay at the little waterfall or tumble, just before the sewage entered the last culvert, it was rendered so approximately pure and pellucid, that I was able, by way of experiment, to take a little in the hollow of my hand and then into my mouth without the least offence. This I did again on my visit to Stroud in September, 1865, and again in March, this year, 1866. Dr. Bird reports to me that in the month of May, 1865, thousands of ephemerae were seen sporting on the surface of the two last tanks, and that he constantly sees toads, frogs, and water lizards swimming about in them as in any ordinary ponds, a good piece of evidence as regards their favourable condition with respect to animal life. In August, 1865, the tanks worked well; I, myself, will answer for them in September; in December Mr. Witchell, Clerk to the Board of Health of Stroud, stated in a letter to the Clerk of the Board of Health at Leamington, that there was no nuisance whatever arising from the sewage water, now that the tanks were worked by Dr. Bird, and that he felt sure if the Leamington tanks were in his hands the same happy result would take place there. I will myself state openly that on the three several times that I visited the tanks I never could perceive more than a sour smell, and that only at the works themselves, while standing immediately over the water as it passed from the culvert into the Froome, not two feet below the place where I was standing I could not perceive the slightest stench or even smell, and the water from the culvert flowed into the river beneath my eyes more pellucid than the Froome itself.\* Sir F. Kelly and Mr. Grimwade, who visited the works about the end of October, 1865, will both, I know, confirm my statements. The admixture of the clay is

Sanatory r  
sults in 1865.

\* I visited the works afresh on the 28th of last June, and also on the 5th of July, with the same results. Comparatively little smell in the works, though the men were dredging out and emptying the tanks of the deposit; at the outlet no perceptible smell; at the mills no offence, indeed the managers said they had nothing whatever to complain of.



now managed by a hopper similar to that of a bean crusher worked by an undershot water-wheel, which is turned by the sewage current itself, and it does its work well. Still, however, the experiment, successful as it is, is yet but in the *rough*, and, with a more artistically and engineer-like constructed apparatus, both for preparing the clay as well as for applying it to the sewage and cleansing out the deposit from the tanks and drying and fermenting it to the best advantage, there is no doubt that the system might be carried out on a larger scale to much greater perfection, and at a cost proportionably less. There is now no complaint whatever from either the houses near the works, or from the mills on the Froome. The Board of Health approve the management of the sewage tanks, the river is no longer polluted, and the authorities of Stroud, as was stated in a letter from the Town Clerk of Stroud to Mr. Notcutt, the Town Clerk of Ipswich, last October, would for sanatory reasons continue the process, even if Bird's Company were to relinquish operations. The same statement was repeated by Mr. Witchell—and most emphatically too—to a deputation from Warwick about the middle of last April. There is no complaint now of fish being killed, or any injury, or even probable danger to animals, that drink of the river. Indeed analysis shows that the water, as it now runs from the last tank, is much purer than much well water that was at one time (even if it be not now) customarily drunk in London, and than such water as in country places persons have been compelled to use in seasons of drought and defective water supply. Dr. Bird conceives that by a system of underground filtration, which he has invented, the already defecated water might be rendered absolutely pure.\* But, Gentlemen, I think I have laboured this point enough. I have shown you a process by which the sewage steam, deprived of almost all its organic matter, soluble and insoluble, is rendered so approximately pure that the first part of our problem may fairly be pronounced solved. It is rendered inoffensive to men, unhurtful to animal life, and can and does pass into the river close to the mills without nuisance, and gives rise to no complaints; while at the same time

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\* It cannot be too distinctly insisted on that the Stroud experiment is not complete, unless the tail water be thoroughly defecated, either by being used as an irrigant or filtered as proposed in the text; so that this plan, which we describe, is by no means opposed to the irrigation system, but in fact ought to be combined with it, the one being the complement of the other.



it leaves behind it in the tanks a deposit or precipitate, which is of a given manure power *per se*: and we can show, when this is done, that the defecated stream is still a fertilizer, and may therefore either be used for irrigation (if required); or (if not) allowed without mischief to flow into and mingle with the river and the brook.

We now then arrive at the second part of our proposition, namely that the material resulting from Bird's defecating process is a manure in itself, when dredged out and properly prepared; and still more, that it is an admirable basis for composts of increased energy. I think it will be the best method to give you my own experiments in the first place, and the reports received by the Company confirmatory of them in the next; for after all it is the result on the land, which is the ultimate test of a manure, as it would seem to be now understood, that no analysis is equal to that of nature; for the plant will detect the agents of fertility, where scientific analysis (valuable as it is), may fail. Not that I would wish for a moment to be understood as undervaluing scientific research, or the benefit to agriculture from the labours of Analytical Chemists in the giving to the uninitiated public a clue to the value of fertilizing substances, and their proper application as depending upon the chemically-ascertained constituents of the soil. Indeed, from the momentous discoveries in the vast field of organic chemistry made within the last few years by Mons. Berthelot in his great work on Organic Synthesis, (which has been kindly lent to me by Dr. Maier), I conceive, that it would seem we are but on the threshold, as it were, of a new exercise of human power, acting in accordance with God's cosmical laws, over organic, as has been already obtained over inorganic matter; and that yet greater results in securing from the soil food, the matter of life, may be looked for. But to proceed. It was in consequence of what I saw in May, 1865, at Stroud, that I procured from Dr. Bird one ton of the sewage manure proper, viz., without any chemical addition, except the Sulphuric Acid used in preparing it. In July I applied it after the first rain to an aftermath, before the springing of the grass, at the rate of five cwt. per acre to two acres, leaving half an acre of the field unmanured, the field being exactly  $2\frac{1}{2}$  acres in extent. The rains followed rapidly and copiously, and in a short time the action of the manure was so plain, that by the end of August, every one who looked at it, could tell the line of

Stroud agri-  
cultural results  
1865.



demarcation, where the manuring left off. I had it looked at by friends and neighbours of every rank and degree, and all were agreed on this point. It was examined at various times by Sir E. Kerrison, Sir F. Kelly, Mr. Tollemache, Mr. Colchester, Mr. Grimwade, Mr. Jennings, Mr. Clarke, C.E., and other friends, and whatever may have been their difference of opinion as to the commercial value of the product, on the point of the palpable and patent action on my grass, there was none. I may appeal on this point to Mr. Grimwade and to our Secretary Mr. William Kent. The increase of clover especially was most remarkable, and it was particularly observed by Mr. Tollemache last year, and by Dr. Maier this. I can also assure you, that the power of the manure is strongly marked now. My two cows and three heifers were fed off it from the beginning of November till nearly up to Christmas; the two cows were turned in again at the end of February, and not taken out till the first week in May. They have done well on it. I have had a good make of butter, both as to quality and quantity, allowing for the deductions of new milk constantly used; and my cook (who fortunately for me is an experienced dairy servant) tells me, she never had richer milk or finer cream. This year I have made fresh experiments with my grass, the promise of favourable results is equally good; but according to the old proverb, that a "May flood never did good," I am sorry to say, my pastures suffer like those of my neighbours from N.E. winds, blazing sun, and frosty nights. Still the action of the manure was most marked all March and April and at the beginning of May; nor has this harsh weather destroyed it, while my cows feeding off a piece of grass manured this Spring are doing excellently. I have also an experiment with wheat, which I will give in short. The plant is five acres altogether,  $2\frac{1}{2}$  acres after clover, half-an-acre after beans manured with farm-yard muck; two acres after beans grown without manure, but treated with six cwt. per acre of the sewage stuff manure ploughed in at the time of wheat sowing in November. I think on this point I may refer you to Mr. Kent who will state to you, that the wheat on the two acres is equal to that on the half-an-acre, and that allowing for the late unfavourable time for wheats generally, it looks as well for wheat after beans as can be desired. Of course the wheat on the clover land is the best. The comparison is between the half-acre of land where the beans were grown with farm-yard manure, and the two acres of unmanured

Stroud agri-  
cultural results  
1866, at home.



beans treated with the sewage stuff. I am fully aware that the bushel must decide the ultimate result, and I will see that the test is employed, as accurately as may be.\* Mr. Goodwin reports well of his barley, and the action is patent on Mr. Murrell's grass. Mr. Grimwade also can report favourably, notwithstanding the sharp winds, of his experiment on grass at Brooks Hall Farm, near Ipswich; and I have other favourable statements at hand. The same results have been repeated to me from Stroud. Dr. Bird tells me that the action of the manure on grass at Stroud is marvellous. They have also evidence in abundance as to the value of their composts. Mr. Ridler of Lydney, one of the largest farmers in Gloucestershire, was so satisfied with its effects on his root crop last year, that he intends to continue its use this coming season. He writes, "I used your manure last season for mangold  
"and swedes, and found it answer remarkably well. I had swedes  
"in September from 10 lbs. to 13 lbs. each. I shall use your  
"manure this year for roots." Mr. Lawrence, one of the Company, writing to me, says, "We have fresh evidence, in that a  
"dealer, who bought 4 tons last year 'to experiment with,' has  
"been with us lately, paying the money admitting his customers  
"were satisfied with it, and ordered 10 tons more for the same  
"customers this year." But as a still more important evidence

Stroud agri-  
cultural results  
abroad, 1865-6.

in the Company's favour, let me read a part of a letter from Messrs. Daniells and Sons, the great sugar merchants at Bristol. Speaking of the question of railway conveyance from Stroud to Bristol, they say, "We shall be glad to be informed in this matter,  
"especially, as should the manure answer, we may be receiving  
"large quantities from you. Bags containing this article, we  
"regret to learn, are quite unsuited for its conveyance to the West

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\* On the 20th of July I can state that my grass experiment (the quantity of manure per acre being precisely the same as that of 1865, viz., 5 cwt.,) has been most successful. The mowers told me they had very heavy proof indeed of the action of the manure; that they could tell to an inch when the scythe passed into the manured grass. One of them, a highly respectable man of 60, said, he had mown many an acre of grass, but never met with a thicker bottom or one harder to cut, and that he thought the crop was doubled. The wheat experiment, also, can safely be called a success—stiff in the straw and full in the ear. Potatoes grown with sewage stuff manure, 12 cwt. to the acre, will, if they escape the disease, be a good crop; and an acre of beet root, yellow globe, grown with a half coat, viz., 11 three-quarter cart loads of farm-yard muck, and 4 cwt. of compost equal parts sewage stuff and soluble green sand coprolite, can hardly be surpassed as to present plant and future promise. Mr. Grimwade authorizes me to say that the result on his grass has also been most satisfactory.



“ Indies, as they become rotten and permit the contents to escape  
 “ into the hold of the ship. This happened in the case of the  
 “ parcel supplied in November, and we fear will be so with the  
 “ subsequent shipments. Can you under these circumstances  
 “ procure casks for the purpose second hand, but sound and  
 “ strong enough to convey their contents in safety at a moderate  
 “ cost, and pack the manure accordingly previous to its depar-  
 “ ture from Cheltenham? Perhaps you will be pleased to make  
 “ enquiries at once, and let us know at what cost per ton they can  
 “ be furnished, as we have an order of ten tons shortly for ship-  
 “ ment.” And on March 26th, 1866, Mr. Lawrence writes me  
 word, “ Since my last I am glad to inform you we have received  
 “ an order for five tons of our arable manure, to be succeeded by  
 “ five tons in a fortnight for shipment to Barbadoes. This is the  
 “ fourth order, and they said, in discussing the future prospects  
 “ of our Company, that if our manure be equal to the first lot (of  
 “ which we have no doubt) their consumption would be about  
 “ 200 tons a-year. Now this coming from keen business-like  
 “ men like the Daniels looks well.\* We also are getting orders  
 “ for home use faster than we can supply.” This is, I think,  
 fair and sufficient evidence for our purpose this evening, though  
 I may state, that the Company are fully prepared to give much  
 more; and so to show, not only that they do produce a good  
 manure from matter, which has hitherto been wasted and made  
 worse than useless; but that it is done at Stroud, and can be done  
 as well elsewhere at a remunerating profit. When Sir F. Kelly  
 inspected the works at Stroud last November, he wrote to me,  
 “ Rudely as the experiment is carried out, I recognize in it a *bonâ*  
*fide* result;” and I am sure Mr. Grimwade will allow me to quote  
 the words of his letter to me after his visit to Stroud, where he  
 saw the works in their rude incipient state, chemically speaking  
 their nascent state, truth struggling into life under difficulties.  
 “ Notwithstanding every possible defect of arrangement of me-  
 “ chanical means and method in working the plan, I feel convinced,  
 “ that the sulphurated clay is a most valuable substance for treat-  
 “ ing Town Sewage; one which can convert that into gold, which  
 “ hitherto has been only a source of loss and death.” Mr. Morant,  
 who is I am sorry to say not with us here now, received the same

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\* The Messrs. Daniels have continued their orders since this was written,  
 and from other quarters also most favourable reports as to past results and  
 future demands come in.



impressions from a visit of inspection to Stroud, that underlying all the manifest rudeness of operation there was a great sanitary truth. Here surely, Gentlemen, is evidence enough to justify me in venturing to address you on a subject, which, it may fairly be said, does not properly belong to me. As a matter of commercial speculation, it is true, I ought not to interfere with it, but as a discovery of great value as regards the well being of the entire community, I am certainly within the line of my duty in striving to make it known. But before proceeding to more general reflexions let me add, that I have now evidence on my lawn of the power of the defecated water as a fertilizing irrigant. In November last, my servant made a ring with two gallons of the tail or defecated water from Stroud, on the grass. I saw nothing till about the beginning of March, when the ring of extra growth appeared and is noticeable even now although it has once been mown. In my garden also for cabbages, beans, peas, asparagus, celery, and at the rate unintentionally of  $2\frac{1}{2}$  tons per acre for currant bushes and raspberry canes it has been most effective and at the same time uninjurious. It has been used with benefit to my cucumbers. This is the evidence I bring before you now, we shall have more hereafter, but the time Dr. Bird has been at work is only since March, 1865, and as yet there has been no failure either as regards the defecation of the sewage stream or the production of manure. I shall leave the question of profit and loss to the Company, they being most anxious to give every possible information that may be required.

With regard to the more scientific part of the problem before us, I do not feel competent to deal with it as it ought to be dealt with. Yet such general conclusions as I can arrive at I will place before you, leaving the more accurate science in the hands of those friends who have made it their proper study. I may state roughly that the sulphurated clay is a sulphate of alumina combined with peroxide or sesquioxide of iron, and that it has the power of coagulating and throwing down, as well as deodorizing the organic matter in the sewage stream. As far as I can understand the analysis of the tail water made in September, 1865, it would appear that the nitrates are retained in the deposit, and Dr. Maier, of the Albert Agricultural College, Framlingham, an accomplished chemist, supports me in stating that clay being a silicate of alumina, and the sewage also containing silica, the continuous action of the sulphuric acid on the clay, in a finely divided state, as well

Stroud process—scientific view of it.



as on the sewage stuff, sets a portion of the silica free, as soluble silica or silicic acid, and therefore in an exceedingly available state for all the grasses and monocotyledonous plants, and so far accounts for the powerful action of the manure on the sugar canes, as well as on my grass. The sulphates also contained in the manure are most valuable, especially for clovers; Dr. Bird tells me the manure will cure clover-sick land. As to the per centage of ammonia, it varies from  $1\frac{1}{2}$  to 7 or 8 per cent.—this depending much on the weather; wet weather sewage not being so valuable in this respect as dry weather sewage. Also the sewage of towns, such as Birmingham, where vast quantities of mineral acids from the metal works, lime preparations, &c., from various manufactories, enter the sewers, is rendered by this chemical action comparatively valueless in an agricultural point of view. It may, however, be found of value for some scientific purposes. The amount of phosphates is relatively small, good chemical reasoning existing why it should be so. The potash in the clay and sewage matter makes it most valuable for peas, beans, cabbages, &c. There is also a prospective improvement as regards ammonia, if ever the Company should succeed in obtaining sewage stuff in quantities considerably exceeding the small quantities arising from the sewage of 5,000 people, and it is this; that if the masses of sewage stuff be protected by roof from rain, yet fully exposed to air currents at a moderate temperature and slowly fermented, then the azotized stuff would itself become a source of ammonia from the chemical combination of the hydrogen and nitrogen in the nascent state; and this being fixed, as it is evolved, by suitable and continuous doses of sulphuric acid, would sensibly increase the per centage of ammonia or ammoniacal sulphate. Now, all these matters we at the present moment waste; and, what is worse, having in bygone days poisoned God's air and God's earth with them, we now poison God's best gift in earthly things—pure water; and, indeed, if we were to listen to some schemers who propose to turn the sewage stream down deep wells into the permeable strata, Undiné would be poisoned in her innermost grotts and most recesséd caves.\*

From this alternative, Gentlemen, we offer you an escape; we offer for foul waters pure running streams; healthy river sides for the clean plunge of the swimmer in the place of the haunts of gastric fever and slow coming death; and sea bathing free from

\* *Vide* De la Motte Fouqué's most charming of tales.



the filth of the fashionable town: in short, purity and health in the stead of foulness and disease. Surely this is a noble promise! We say it can be fulfilled. Scientific evidence of its truth is not wanting, and the cost of its accomplishment is not insuperable. With your permission, Sir, I will read a letter received from Dr. Maier, Professor of Chemistry at the Albert College, Framlingham, on the first point. It gives the result of an examination of part of the water in the bottle before you.

Rev. and Dear Sir,—I am happy to say that the result of the “qualitative” analysis of the purified sewage water is a very satisfactory one, and there are no substances contained in it that could be called injurious to health. The water contains no trace of nitric acid and no organic matter. The following compounds are contained in the water:—Sulphuric acid (as sulphate of alumina, iron, magnesia, &c.); iron (as sulphate of iron, only a trace); hydrochloric acid (as chloride of sodium) “common salt”; silicic acid, a trace; alumina (as sulphate of alumina); lime (as sulphate of lime); magnesia (as sulphate of magnesia) only a trace; traces of ammonia and potash. The quantity of lime appears not to be very large, and a comparative test I made with water used for drinking, gave a much larger precipitate of oxalate of lime with the latter: it is the same case with the hydrochloric acid, Framlingham water giving a much larger precipitate of chloride of silver than the purified sewage water. The quantity of silicic acid contained in the water is very small indeed, so that I venture to say most of the silica dissolved by the sulphuric acid remained in the precipitate afforded by the sulphurated clay, viz., the manure stuff. The quantity of alumina contained in the water is pretty considerable, and so is, of course, the sulphuric acid. I only found traces of ammonia and potash, from which I draw the conclusion that these two substances are partly left in the manure. As could be expected, I found a very small quantity of iron, undoubtedly originating from the iron contained in the clay. Magnesia, the faithful companion of lime, hardly ever missing where this latter is found in nature, is contained in the water in a mere trace. As far as I can judge, the result of the analysis is favourable both for the water and for the manure, proving that the former is perfectly free from any substances injurious to health whatever, and on the other hand showing that only part of the effective substances contained in the manure is carried off by the water.

This statement, for which I beg to express my thanks to Dr. Maier, corresponds closely with a “quantitative” analysis made by Professor Völcker in September, 1865, when the water was not so well purified as it has been since. It corresponds also with two analyses just made by Mr. Horsley, of Cheltenham. As to cost in a general point of view, the supply of sulphuric acid may be increased to any extent; millions of tons, which might



be all utilized, are wasted annually at copper works and other factories. I think I am not in error when I state that, by a new process, many hundred tons weekly of sulphuric acid are precipitated from the fumes of one copper smelting work in Swansea alone, that of Mr. Vivian; besides which, demand will soon increase and keep up the supply, as the sources of sulphuric acid are unlimited. The facility and cheapness with which clay can be obtained must be self-evident to all. "Ferruginous clays, "and nearly all the pure clays, are easily acted on when "properly treated with sulphuric acid, and form good compounds for utilizing sewage matter." As regards the quantity of sulphurated clay required, he states that one ton of prepared clay a day, or 365 tons per annum, would deodorize and precipitate the sewage of Ipswich, taking the population at 40,000; and if the sewage stuff obtained at Stroud be taken as the basis of calculation, you would have 1,200 tons of fertilizing matter in the year, portable by rail or road, and enough to manure 4,800 or 5,000 acres of upland pasture. Nor will I omit here the fact, that the probability of comparative cheapness would enable the cultivator to apply it in mass, a point not to be overlooked in agriculture.

Hope for the  
future.

Thus the river would be purified and cleansed, and all complaints from Sproughton or elsewhere would cease and be heard of no more. I should also like to ask Mr. Grimwade, if he does not think it not improbable that just as imperceptible germs float zymotic disease through the air, so similar germs, fatal to fish life, may float death through polluted waters, and the delicate oyster spawn, for example, may perish in the vibrionic state? Just as the fish,

"The silver scaled fish that softly swim

"Within the sweet brook's crystal watery stream."

—*Walton's Angler.*

have, together with the pure-water-loving cray fish, passed away from the Cherwell, and left no trace behind them! So that, while the Orwell is hopeless of the oyster, even Colchester may tremble for its natives!—sad news for country cousins at Christmas time. It must be a great thing to pour such water as this into the river instead of the foul stream, of which the fat-feeding bream drinks—drinks, and despairing, dies! Well, Gentlemen, we are nearly in port now. I hope I have been plain; I



am sure I have been earnest and truthful. Surely I have brought before you a plan of sewage treatment, to which the success of one year gives a most hopeful colour.\* It is something indeed to have a prospect of keeping our streams pellucid and our rivers clear. I dream even yet of seeing once again the pleasant Wensum of my boyhood with its boating to Postwick Grove and Bramerton; when the strong swimmer shrank not from the header at the New Mills; when Thorpe water frolics were free from any smell worse than tobacco, Thompson's Nogg or Patterson's entire; and when the sweetest of all parties was the water party in the old wherry, with its champagne lunch, and the silver-toned songs of the fair ones of the old old days,

“The days when we went gipsying a long time ago.”

Why should not Father Thames flow once more unpolluted from the seven springs to the Nore? The salmon again leap over Teddington weir, sweep past Richmond Hill, through the Eton playing fields, and flash beneath the terraces and towers of Regal Windsor? Why should there not be hope for the far off Ganges, “Gunga, the mother of streams?” Why should the Hooghly still roll death past the palaces of Calcutta? It must be a great thing to send this water into the flowing current instead of the foul contents of the shores and common sewers, and so to render harbours, docks, and crowded ports more noisome than ever, terrible in our climate and beneath our gray skies; how far more terrible beneath the burning, blazing sun of India, whether the fecal matter of a great city be poured upon a lowlying delta or a brackish marsh, or be kept swinging backwards and forwards with the ebb and flood of the river, oscillating with the flux and reflux of the tidal steam.

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\* If experience should establish our position, as we firmly believe it will do, and experience alone it is to which we appeal; then great cities, instead of being centres of pestilential destruction of human life, so that they are only sustained in population by a continuous immigration of country people, would, cleansed from their own foulness, rear a firm and healthy race of town-bred workmen, and becoming themselves sources of fertilizing matter would sustain in increasing vigour that very life which their necessity demands and devours. Not altogether in a *Lucretian*, yet in a true sense could we then say of them

*Vitæ lampada tradunt.*

Lucretius de Rerum de Naturâ.



## POSTSCRIPT.

"POLLUTION OF THE THAMES.—The extent to which the water of a river so eminently fitted by nature for the supply of the wants of a great city has been polluted by the practice of making use of its channel as a common sewer may be estimated by the fact stated by Mr. Towle, an alderman of the City of Oxford, and the owner of three mills, two of which he also works, that the Weirs Mill was nearly destroyed by the sewage from the City of Oxford, and that it was no longer possible to make white paper there, in consequence of the state of the water. From seven to nine years ago the paper became so blotched that bleach was thrown away upon it, and none but brown paper is now made at this mill. The evidence of Sir Benjamin Brodie\* bears with great force on the same point. The fish of the Cherwell, which, within the memory of man, were very abundant, are now nearly extinct; and the cray fish, which will not live in impure water, were formerly numerous, and are now gone. Sir Benjamin further pointed out the important fact that no chemical analysis can prove the salubrity of water, and that it is only by the costly experiment of the effects of a supply of water on human health and life that this can be ascertained. The quantity of organic matter actually suspended may be small, and yet from the nature of its origin it may have a highly poisonous effect; so that the throwing of any sewage into a river is unjustifiable."—From *The Builder*.

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Any additional proof of the fact of the intense pollution of our rivers is almost as superfluous as to paint the violet or add perfume to the rose, but the following letter to the *Times* is too much to the point to be passed over:—

SIR,—I was yesterday alongside the River Don, between Doncaster and Goole, and saw the evil effects of town sewage being allowed to drain into our rivers. A heavy rain had for some four-and-twenty hours prevailed westward, and every conceivable filthy matter was passing down the river, and I should say the whole filth of the sewers of Sheffield, Rotherham, Barnesly, Doncaster, and numerous other towns, was being carried off. The river was as thick with black matter as the Thames off London bridge when formerly in very worst condition, and the fish (eels, pike, bream, perch, &c.) were lying sick in thousands on the bank sides, so that the inhabitants turned out in scores to take them with nets, and even hay rakes. While waiting for a train I saw hundred-weights thus taken; and if it had this effect upon the fish some 30 to 40 miles away, what would it be near the towns where the sewers discharge? What effect upon the inhabitants upon the low-lying lands along the waterside in towns thus drained?

I am, Sir, your's faithfully,

Pope's Head Alley, Cornhill, E.C., June 20.

FREDERICK KING.

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APPENDIX.

The subjoined analyses of two samples of purified water from the Stroud works by Dr. Maier shew clearly that the sulphurated clay process does effectually defecate the sewage stream, and the superiority of No. 2 over No. 1 proves also that purification depends entirely upon the accuracy with which the process is carried out.

\* Regius Professor of Chemistry, Oxford.



No. 1. Water taken from the tumble as it flows day by day into the culvert, which conveys it to the Froome.

The water was not as pure as the first sample that I analysed.

One gallon contains 2 scruples 15.14 grains of solid matter.

One gallon „ 18.36 grains of organic matter.

Per centage of solid matter ... 0.072

„ „ organic matter 0.024

The following is the composition of the solid organic matter (residue) :  
—100 parts of residue consist of

Organic matter	...	...	...	33.33
Lime	...	...	...	24.89
Sulphuric acid	...	...	...	30.44
Hydrochloric acid	...	...	...	5.56
Alumina and iron	...	...	...	2.78
Magnesia	...	...	...	1.13
Potash	...	...	...	1.07
Loss	...	...	...	0.80

100.00

The residue consists for the greater part, of organic matter, and sulphate of lime.

The percentage of solid matter and of organic substances contained in the residue, is very small, being only  $\frac{72}{1000}$  of solid and  $\frac{24}{1000}$  of organic matter.

As I stated, the water was not as pure as the first sample of which I made a qualitative analysis, and showed that already by its smell.

The water can fairly be called "approximately pure."

No. 2. Water taken from the tumble every morning, poured into a large vat, and more thoroughly purified by an additional quantity of the sulphurated clay.

One gallon contains—

Solid matter	...	...	1 dr. 0 scr.	1.25	grs.
Organic matter	...	...		6.125	grs.
Sulphuric acid, free	...	...	1 scr.	3	grs.
Per centage of solid matter	...	...		0.08	
„ organic matter	...	...		0.008	
„ free sulphuric acid	...	...		0.03	

The residue consists of—

Sulphuric acid	...	...	...	...	65.2
Organic matter	...	...	...	...	10.0
Chlorine	...	...	...	...	4.1
Alumina and iron	...	...	...	...	10.0
Lime	...	...	...	...	7.6
Magnesia	...	...	...	...	1.2
Alkali and loss	...	...	...	...	1.0

100.0

The water is much purer than the last sample I analyzed. The quantity of organic matter is very small indeed, and no offensive smell can be observed even now, after the water has been in the jar for about two weeks.

There was no free sulphuric acid in the water, No. 1, (last analysis,) this being perfectly indifferent to red and blue litmus paper. The figures of the analysis itself show that there could be no excess of sulphuric acid, and to this fact I ascribe the offensive smell of the water, after standing in the jar for a few days. The treatment was in the case of water No. 1 not complete, and most probably the quantity of sulphurated clay, and therefore the quantity of sulphuric acid too small.



Water No. 2, (present analysis,) shewed a distinct acid reaction, and according to that the figures of the analysis shew a large excess of free sulphuric acid in the residue. The amount of free acid contained in one gallon (1 scr. 3 grs.) is too small to do any harm to plants or animals.

JULIUS MAIER, PH. D.,  
University of Göttingen.

Albert College,  
Framlingham, July 18th, 1866.

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It cannot be denied, that these analyses made by Dr. Maier for my own information, shew a very remarkable defecation of the sewage stream, and one well worthy the attention even of those eminent men, who deny that water once contaminated with sewage can be purified either by filtration or any known chemical process; all that is effected being simply to clarify it, not remove the sewage. One most distinguished gentleman says, "If all the chemists in Europe told me, that after the sewage had once gone into the water, there would be no injurious effects from it, I simply would not believe it. I would not submit to any evidence on this point." Surely, as it is impossible, except in the Stone Age of the Geologist, or the Golden Age of the Poet, "When Love and all the world was young," to conceive rivers passing through populous places to have been uncontaminated with their excreta, or in other words sewage, this proves too much; and it is safer to argue, that our present evil is not sewage pollution in the abstract, but in the concrete, viz., its continuously increasing intensity, and that any absolute abatement of that intensity must *pro tanto* be a great gain; especially if the residuum obtained by the process we have described, is a fertilizer and the defecated water can be used as an effective irrigant, or be still further purified by a system of subterraneous filtration; whilst if neither one or other of these plans be acted on, it may yet pass into the river almost free from organic matter, in legal phrase the very *corpus delicti*.

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White House, Earl Soham,

July 25th, 1866.

DEAR SIR,—I have for some time, with a considerable amount of interest, watched the effects of Dr. Bird's Sewage Manure on your Wheat crop, and having this morning again inspected it, I wish to state, that I believe it to be fully equal to that part of the field which is treated with farm yard manure. I also visited your piece of Mangolds, and I consider that they are decidedly the best I have seen this year.

Believe me, dear Sir,

Your's obediently,

W. B. KENT.

Hon. Sec. Framlingham F.C.

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It will not, I fear, be possible to thrash the wheat at once from its not being in condition; but the men, who *pitched* the wheat on the sewage land said, that the sheaves were very weighty as if heavily loaden in the ears. The Potatoes turn out extremely prolific and sound, and in my garden the luxuriant growth of the Asparagus and the Raspberry Canes is most note worthy.

August 24th.

J. H. G.



It is not possible without lengthening the appendix out of all measure to do more than call the attention of the reader to the valuable report on the "Application of Sewage" in the Highland Society's Transactions, February, 1866, by James Archibald Campbell of Inverawe, Newland's Farm, Rugby, to which the premium offered by the Society of thirty sovereigns has been awarded. It is fair and able, but of course deals only with agricultural results. I will give one extract and the concluding statement, which seem to me to go a long way in support of the views maintained in the text. "The sixth point (Mr. Campbell says) is the cost to the farmer, and it is the most important of all. If the farmer is obliged to take the sewage all the year round, and every day of the year, as is so generally the case under agreement with Boards of Health and other Local Authorities, it is quite evident that a very small price can be put upon it. Under such circumstances, from *one farthing* to a *half-penny* per ton is quite sufficient, if, indeed, the latter be not too much; but if he can obtain it when he pleases, where he pleases, and in any quantity, from *two to three-pence* per ton may be given, and sometimes more." Surely here is cold comfort for Town Authorities, who have laid out their thousands of pounds in towers, pumping engines, and special culverts, &c. This sewage business is, as was once said on inspecting a tender for it, a very *tender* subject indeed. The conclusion of the paper is as follows:—"I have now given such of the the results of my experience in the application of town sewage to the farm as I think is likely to be of use. That experience has extended over eleven years, and although I fully appreciate the value of sewage for certain descriptions of crop, and under certain conditions, I do not think I should be justified in recommending it for *general* adaptation to the *usual routine* of the farm. It seems pretty evident to me, that the expense and trouble of applying it by means of pipes to arable ground would not be compensated by the *increase* of the crop. Nor could it be applied with regularity, on account of the variable nature of our climate." This is fully borne out by the details of Mr. Campbell's experiment. He then proceeds:—"To the dairy farmer for the purpose of obtaining heavy crops of green forage it will always be useful, and by its application to grass lands it may be made of essential benefit to the community. There is no reason why the sewage of all towns should not be utilized in this way, producing a larger supply of nutritious (?) milk, and protecting the water of our rivers and streams from pollution." These last three sentences are a salvo to the details in the report of experiments, which to an ordinary reader seem to be fatal to the success of the scheme except under the most favourable conditions conceivable as to position of town and nature of surrounding or attainable soil, while the plan advocated as above is limited by no such conditions, and is universally applicable. In an engineering point of view, also, it implies no serious outlay of the money of the ratepayers on towers, pumping engines, yearly coal bills, and the rest of it. Judging too from what is said in the "Report on the Agriculture of Ayrshire, by Mr. Archibald Sturrock, of Kilmarnock," one is inclined to be sceptical as to "the profitable application even of cattle urine manure to low lands, for soiling purposes; distributed as it is by gutta percha hose screwed on to stop-cocks in the iron pipes, which convey it from the steading placed at convenient distances throughout the four fields." One or two cases of success are recorded, with a distinct allusion to others of failure.



## RECAPITULATION.

Such, then, is the state of the case; enormous expense on the one side in order to carry out a system of flood-like irrigation for the purpose of cultivating an overstimulated crop of Rye Grass of questionable value and limited extent; on the other, the production, at a reasonable cost, of a precipitate of organic matter valuable as a fertilizer *per se*, and still more so as a basis for stronger compost, available by rail or road to all cultivable land and suitable to all crops, and especially producing grass of the finest quality, thus promising to the farmer an increase of the product most valuable for his live stock, and therefore enabling him to meet the ever increasing consumption of flesh meats. At the present moment the President of the Section of Economic Science and Statistics in the British Association, Mr. J. Thorold Rogers, maintains that there is "a general and considerable diminution in the amount of live stock in Great Britain for some time past," a statement which, coming from a distinguished office-bearer in so scientific a body, is of great weight. Such a supply, then, of pasture manure, at a reasonable rate, as this Stroud experiment promises, a material which at the present farmers neither can nor do obtain, ought not to be overlooked or despised. Then as to the even still more important point, that of the public health. In the first case there is high probability, indeed all but certainty, that ultimately the over-saturated soil will give out unwholesome and destructive emanations, while neither the products nor the flesh of the animals fed on the rank growths of the soil will be pure or sound. In the other case, the water deprived of almost all its organic impurities, when used as an irrigant, is in no way offensive; or it may pass into the river harmlessly; while there is also high probability that the sulphuric acid will act destructively on the entozoic embryos and microscopic blood ferments of which decaying organic matter is so fruitful.

FINIS.